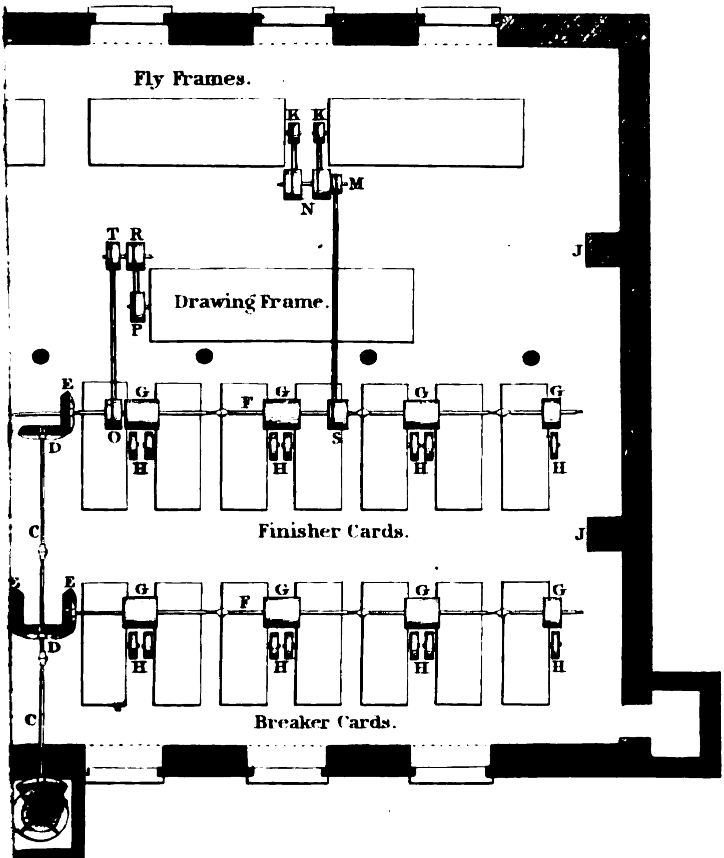
THE

THEORY AND PRACTICE

OF

COTTON SPINNING.

PLATE II.



D. Allen Sc.

THE

THEORY AND PRACTICE

OF

COTTON SPINNING;

OR

THE CARDING AND SPINNING MASTER'S

ASSISTANT:

SHOWING

The use of each Machine employed in the whole process—how to adjust and adapt them to suit the various kinds of Cotton, and the different qualities of Yarn.

AND

How to perform the various Calculations connected with the different departments of COTTON SPINNING.

ILLUSTRATED BY

APPROPRIATE ENGRAVINGS.

ALSO,

An Historical Sketch of the Rise and Progress of COTTON SPINNING, and a short Account of the cultivation of Cotton, quantities imported and consumed, different growths, &c.

SECOND EDITION.

GLASGOW:

JOHN NIVEN, JUN., 158, TRONGATE;

WHITTAKER, TREACHER, & ARNOT, AND G. HEBERT, LONDON;

J. & J. THOMSON, MANCHESTER;

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MDCCCXXXIII.

John Harvey Treat.

PREFACE.

When so many publications on almost every subject are daily issuing from the press, it is much to be regretted, that nothing has ever appeared on the art of cotton spinning, fitted to assist the master, manager, or artisan, in acquiring a correct and systematical knowledge of the *real* principles of the business. Almost every other important art or manufacture has its periodical, or other publication, wherein its principles are elucidated, its improvements recorded, and its difficulties explained, and to which the artisan can apply in cases of difficulty; but the manager of a Cotton Spinning Factory can only acquire a proper knowledge of his business, by long experience and application in the practical department of the manufacture, and it will depend upon the situation in which he is placed, and the advantages he enjoys, if he ever obtain that correct knowledge of all its details, which is essentially necessary to render him fully qualified for managing a large establishment with satisfaction or profit to the proprietors. Hence a treatise on this subject, in which the principles of the art may be *unfolded*, and its details *explained* and *exemplified*, has long been felt and acknowledged as a desideratum by the trade; to supply which the following treatise is respectfully presented to their notice.

It might be supposed that a complete knowledge of the business may easily be obtained by *verbal* communications; but experience has too frequently shown, that those who have attained the most correct knowledge of the art, in all its details, are more disposed to monopolize, for their own benefit, the advantage arising from their more enlarged experience, than communicate it to others who may not have had the same opportunities; consequently, while the principles of the art are left to *verbal* communications, many of our best establishments will continue to be conducted by those, who, though they may have had long experience in the practical department, will frequently be found deficient in *theory:* and it is only when *theory* and *practice* are combined, that efficiency can be attained in effecting improvements.

The following treatise was originally designed for the author's personal use, and had his own feelings only been consulted, it never would have met the public eye. But being accustomed to take notes of particular occurrences, and make remarks on the various processes in the manufacture, and the different machines employed—and having had the pleasure of intimacy and correspondence with managers and mechanics whose knowledge and experience he highly values; whatever knowledge or information could be acquired by practice and observation—by conversation and correspondence with friends and others, was committed to writing. These notes and observations after being arranged, were seen by some particular friends, who, having examined them, strongly urged their publication; giving as their reasons most of those already stated. He would therefore beg leave to remind any who may feel disposed to criticise, that although the design and plan of the work is original, yet from the diversity of opinion that exists among managers regarding many things connected with the business, it cannot be expected that a first treatise upon the subject will be entirely free from imperfections. In preparing it for the press, however, every care has been taken to collect the best and most *useful* information on the various articles, and to insert only what was found consistent with the practice and experience of others. Also the opinions and suggestions of some experienced mechanics have been adopted, which give to a great part of the work more the character of a compilation than an original treatise; and it is presumed this *concentration* of talent and experience, will give it a degree of importance that it would not otherwise possess. For if it contain little original matter, yet what was known partly to one and partly to another, is here collected and arranged in systematical order, and brought within the reach of *all* who choose to avail themselves of it; so that the whole theory of the business may be studied as a system, independent of the practical part. The articles were mostly written at different periods, and in the midst of other avocations, which will account for various apparent repetitions, and other little discrepancies. There is no pretension to literary merits—the chief embellishments that have been studied throughout are *perspicuity* and *simplicity*.

As much depends on the plan of a Mill, and the arrangement of its different departments, for promoting the progress of the various operations, it was deemed proper, in the first place, to lay down a plan, and point out the manner in which the apartments might be advantageously arranged. And with a view to have the large gearing represented in the most approved form, several respectable mechanics were consulted; and it is believed that it is represented on the plan that is now generally adopted by mill-wrights and engineers in this country.

In the detail of the process, the raw material is traced from the cotton bag, throughout the various stages of its progress, till it becomes finished yarn. Every machine employed in the process is introduced in its order, their use and operations described, and how to adjust and adapt them to suit the various kinds of cotton, and the different sizes of yarn pointed out. Rules for performing all calculations connected with the business, are distinctly laid down and exemplified: but in order to illustrate the descriptions and calculations, it was necessary to have drawings of the different machines, for the purpose of reference; the *newest* and *best* machines were therefore selected, and the most *exact* measurement of their various proportions taken; so that each of the engravings may be relied on for accuracy of representation, according to the different scales to which they are drawn. And with a view to the utmost simplicity, the calculations are generally wrought out at full length; so that any operative acquainted with the common rules of arithmetic, may easily comprehend, and be able to apply them to practice.

To the manager, carding or spinning master, who may be young in business, and desirous of information, the following treatise, it is hoped, may prove acceptable. And even to those who may have been long in business, it, perhaps, may be found to contain something not unworthy of their favourable regard; as there is much of it, though not entirely, new, yet not generally known. Many of the calculations are original, and it is hoped all of them will be found useful. The historical sketch of the rise and progress of cotton spinning, and the article on cotton, if not useful, may, at least, be found interesting.

Proprietors and others having neither time nor desire to attain a knowledge of the business by *laborious* practice, may find this work an important auxiliary in acquiring it. It may also be interesting to mechanics employed in making and fitting up machinery, as each machine employed in the process forms the subject of a separate article. Late improvements are described, and the best machines pointed out—their operations explained, and rules for calculating their various movements exemplified.

Should this work prove useful to those for whom it is designed—should it be the means of enabling them to acquire a more correct and systematic knowledge of the real principles of their art—should it in any degree prove worthy of their favourable regard, let the desire to be useful be accepted as an apology for its imperfections.

JAMES MONTGOMERY.

July, 1832.

PREFACE

TO THE

SECOND EDITION.

The very favourable manner in which this work has been received, and the flattering assurances of its utility which the author has obtained from those who are every way competent to judge, sufficiently testify the approbation with which it has been regarded: and in preparing a second edition for the press, the utmost attention has been bestowed on it, in order to render it still more useful to those engaged in the practical department of cotton spinning, as well as more interesting to the public in general.

The whole has been carefully and thoroughly revised. Considerable additions have been made to various articles. An additional Plate is given, being considered necessary to illustrate an important principle in the construction of the Fly Frame. Several improvements are described in this edition, which the former did not embrace, particularly an account of Roberts' Self-acting Mule, at present attracting considerable attention. The historical sketch of the rise and progress of cotton spinning, and the present state of the cotton manufacture of Great Britain, are rendered much more full and explicit. A statement of the cotton manufacture of America, selected from the most authentic sources, is also given, from which the progress of our enterprising rivals may be contrasted with our own.

After the careful revisal this treatise has undergone, it is hoped that it will be found to merit an additional share of that approbation which it has already received.

J. M.

November, 1833.

CONTENTS.

EXPLANATION OF SEVERAL TERMS

USED IN THE FOLLOWING WORK.

Fly of a Mule,—(see Plate III. Fig. 2d.) is, in England, generally denominated the *Rim*; but, in Scotland, is always called the *Fly*. It is that part of the Mule, by which the operative regulates the rotary motion of the spindles, in winding the yarn on to the cope. A number of the English Mules are wrought with a handle or winch.

Bevel Shaft,—sometimes called the *Diagonal Shaft*, or the *Long Driver*, is a small shaft that connects the rim shaft with the front rollers.

Wharve, Warf, or Warve,—a small pulley fixed on a spindle in the Stretching Frame or Mule.

Grist Pinion,—sometimes called the *altering* or *changing Pinion*, is the pinion that regulates the draught or draft, *(see B, Fig. 4th Plate III.)*

Crown Wheel,—sometimes denominated *Stud Wheel* or *Top Carrier*, *(see C, Fig. 4th Plate III.)*

Delivering Ball,—or Delivering Rollers, are the rollers that deliver the cotton from any machine. In Carding Engines and Drawing Frames, that part of the roller over which the cotton passes being larger in diameter, is called the Ball of the Roller, hence the *Delivering Ball.*

Calender Rollers,—the Delivering Rollers of a Spreading Machine, so called from the great pressure which they exert upon the cotton whilst passing through between them.

Radial Arm,—from Radius.—The Arm of a Quadrant, the length of which is equal to one-half the diameter of a circle.

Cam,—a part of a Machine which partakes of the form of a Cylinder, a Cone, and a Spiral.

Size of Yarn,—in England called the *Counts of Yarn;* signifies the number of hanks in one pound.

Lea, Slip, or Cut,—the seventh part of a hank.

Warp and Weft.—Warp is frequently called *Twist.*—It is the yarn prepared for the longitudinal part of the web of cloth.—Weft is that which is used for the transverse threads.

ARITHMETICAL SIGNS

USED IN THE FOLLOWING WORK.

$+$ *Plus*, the sign of Addition,—used to denote that the numbers between which it stands are to be added together.

$=$ The sign of Equality,—used to denote that the quantities between which it stands are equal to one another; thus the expression $4 + 5 = 9$, means that 4 and 5 added together are equal to 9.

$-$ *Minus*, the sign of Subtraction,—when placed between two numbers, denotes that the lesser is to be taken from the greater.

$\times$ The sign of Multiplication,—when placed between two numbers, denotes that they are to be multiplied together.

$\div$ The sign of Division,—when placed between two numbers, denotes that the former is divided by the latter. The division of one number by another is also denoted by writing the dividend above the divisor, with a line drawn between them, thus, $\frac{144}{6} = 24$, denotes that 144 is divided by 6, and the quotient is 24.

: :: : The sign of Proportion, or equality of ratios.

THE

THEORY AND PRACTICE

OF

COTTON SPINNING.

PLAN OR FORM OF A COTTON SPINNING FACTORY.

Before proceeding to detail the process of cotton spinning, it has been deemed proper, in the first place, to lay down the plan of a Cotton Mill, and point out the manner in which all the different departments should be arranged. And in the second place, to show the method of tracing out the speed of all the different shafts and machines, from the power which gives the first motion, to the remotest movement in the whole establishment.

First, with respect to the plan of a Mill, or the form in which it ought to be built.

In all Factories where there is a variety of machinery employed in the manufacturing of any particular kind of goods, it has always been found that the manner in which the machinery is placed, together with the arrangement of the different departments, has a very prominent influence in either retarding or accelerating the progress of the work. And in no place is this influence more sensibly observed than in a Cotton Spinning Factory. These arrangements, however, will entirely depend upon the form in which the house itself is built; for unless it is built on the most approved plan, the various departments cannot be arranged in the most advantageous manner. Yet the plan of many Spinning Factories, is often the result of particular circumstances rather than choice or design on the part of the proprietors. The situation of the ground or space upon which the Mill is to be erected, must always be taken into consideration in laying down the plan, or fixing upon the particular form of the buildings; and in many cases, these must just be made to suit the space of ground on which they must stand. But when the situation and extent of the premises are such as to afford ample scope for the proprietors to build their Mill upon any plan or form they may think proper, it would add much to their profit, and be advantageous to the workers generally, to have it erected upon that plan which experience might point out as best adapted for having the machinery, and all the various departments and offices, arranged in such a way as to afford the greatest facility for accelerating the progress of the work in all its different stages.

In order to accomplish this, it will be necessary that the various departments be so situated, as to prevent all unnecessary going to and from any apartments of the work by the workers employed about the establishment; therefore it is considered advantageous that the different offices, such as ware-room, picking-room, mechanic's shop, &c. should, if possible, be contained within the walls of the Mill, and not in any separate or detached buildings, there being a continued communication with these and the other departments of the work; and when situated at a distance from each other, a great deal of time will be consumed in going to and from the one to the other.

The following plan of a Cotton Mill is considered particularly adapted for having all the different departments arranged in the manner recommended above.

Plate I. contains the ground plan of a Cotton Mill, 145 feet long, and 37 feet wide within the walls. There is also a wing attached to one end, the length of which is 64 feet by 20. Suppose that the walls are built of brick, 1½ feet thick will be sufficient. A house of these dimensions would cover a space of 7461 square feet, besides the staircase and water closets.

The same Plate contains the plan of a spinning-room, wherein is represented the seats and outlines of the jennies, together with all the top gearing and carrying belts. As many prefer having the fly in the middle, and as a house 37 feet wide affords ample space for jennies of 300 spindles each, their head stocks and all the top gearing are represented in the centre of the house.

The situation of the engine and boiler-houses are also laid down in Plate I. The whole extent of ground required for all these would be 24,765 square feet, including sufficient space for an outer court and a wall to surround the whole premises, if deemed necessary. Regarding the most proper situation for the engine, there is much diversity of opinion amongst mechanics and spinners. Some contend that it should be placed at one end of the Mill; as when the engine and boiler-houses are ranged in a line with the other buildings, it gives the whole a more neat and uniform appearance: others consider the situation represented in the Plate the fittest place for it. But without expressing any opinion of my own, as either of these situations for the engine is, perhaps, more frequently adopted as a matter of convenience rather than utility, the site of the engine and boiler-houses are laid down in Plate I. in the situation best suited for giving a full and accurate representation of the whole.

In Plates I. and II. there is represented a wing attached to the body of the Mill, the different departments of which should be occupied for the various offices, or separate apartments, necessarily required in Cotton Spinning Factories—as it must be very disadvantageous to have any of these into separate or detached buildings.

The body of the Mill being 145 feet by 37 within the walls; and supposing it to be 6 stories high, a house of these dimensions would be capable of containing 23,000 spindles, with all the necessary preparation for average numbers. It would require an engine of between 40 and 50 horses' power to drive a Mill of this extent. And here it may be remarked, that every Spinning Factory ought to have a little more power than is merely necessary to drive it; because it is well known to those employed about Cotton Mills, that the weight of the machinery will often vary with the weather, the quality of the oil used, &c.; consequently, when there is barely a sufficiency of power, the engine will frequently be so overburdened, as to render it incapable of driving the machinery at a regular speed, thus requiring more trouble and expense for fuel, &c. It is, therefore, strongly recommended that this point be particularly attended to.

The breadth of the Mill laid down in Plates I. and II. being 37 feet, affords ample room for arranging all the different machines in the carding department in the best order, both for promoting the progress of the work, and allowing the different workers employed in this department, to attend to their employments, without being in the least incommoded for want of sufficient room. 145 feet in length would afford ample space for 8 pairs of mule jennies in one flat; and the whole machinery contained in this space, might, with perfect safety, be driven by two upright shafts. But for a Mill much longer, two upright shafts would scarcely be sufficient.

There is no particular reason for laying down the plan of a Mill of the dimensions specified above, only that in drawing out a plan, it was necessary to fix upon a given length and breadth, and that which is contained in the Plates has been adopted, merely as being supposed to represent in extent (of length and breadth,) the average of the Spinning Mills in this country. New Mills are in general much wider than 37 feet, particularly in England, where many of those lately erected extend to upwards of 50 feet, and, indeed, from 40 to 50 feet in breadth, within the walls, seem now to be most generally approved of. But the object at present is, not so much to show what ought to be the dimensions of a Cotton Spinning Factory, as to point out the particular form or plan upon which the house would require to be built, so as to admit of having all the departments arranged in the best order.

It has been stated that the wing should be appropriated for the different offices, or separate apartments, required about such an establishment; it is therefore suggested, that the ground flat should be used for the yarn room, (or ware-room,) because it is the most fit and suitable place for that purpose.

The second flat of the wing, should be appropriated for a mechanic's shop, at one end of which there might be a small private room for the manager.

Mechanics who are employed about Cotton Mills are generally paid by stated wages; therefore, when their work-shop is situated at a distance from the body of the work, a great part of their time will be consumed in going to and from the different departments of the Mill where they may have occasion to be employed; and will prevent them from accomplishing their work so cleverly as they might do if more commodiously situated; consequently, whatever enables them to perform their work in the shortest time, will, of course, cause less expense to the establishment.

The 3d and 4th flats of the wing should be appropriated for picking-rooms, and the cotton bags could be brought up and taken in by the door M (Plate II.) by means of power from the engine.

The other flats of the wing may be occupied for reeling-rooms, holding furnishings, &c. The want of some places for such purposes have often been the cause of much trouble and expense. The cotton and waste cellars should be a detached building to lessen the risk and save insurance.

The other departments of the work might be arranged as follows: As the raw material is prepared in the carding-room for all the spinning departments, the cards ought to be placed as near the centre of the Mill as possible. A Factory of the dimensions recommended, viz. six stories, would require two preparation rooms; these might be placed in the 3d and 4th flats, on the same floor with the picking-rooms. And as there is always a constant communication between these two departments; if they are placed at a distance from each other, a great deal of time will, unavoidably, be lost in passing to and from the one to the other; but by the arrangement here recommended, very little time will be lost; for the laps can be carried direct from the spreading machines to the back of the breaker cards by the door L (Plate II.) and the tops, strips, or other waste, returned in the same way, without trouble or hinderance.

If the cards be placed in the 3d and 4th flats, then the 1st, 2d, 5th, and 6th, together with the garret flat, must all be filled with spinning.

The length of the Mill within the walls being 145 feet; allowing 8 feet 10 inches for the breadth of each jenny, would give sufficient room for containing 8 pairs of jennies in each flat, besides leaving a vacant space of about 4 feet at one end, which might be appropriated for containing rove boxes, and likewise for allowing room for two hatchways J J, Plate I. for the purpose of conveying the rovings from the carding to the spinning-rooms, by the power.

In the plan of a carding-room in Plate II. there is represented a vacant space at one end, which might also be appropriated to the same purposes as that in the spinning flats, that is, for holding rove boxes, and for the two hatchways J J. And with a view to have the rovings always conveyed from the carding to the spinning-rooms when wanted, in a regular and orderly manner, the following arrangement is recommended:—Let three boxes be prepared for each spinner, and numbered according to the number of the jennies to which they belong; two of these boxes to be always in the spinning flat, and the other in the carding-room; when any spinner wanted rovings, he could send one of his boxes to the carding-room, and have the other box returned full of rovings: and that no time may be lost in receiving the empty one into the carding-room, and returning the full one back to the spinning flat, small bells might be fixed in the carding-room close to the hatchways, each bell numbered according to the number of the spinning flat, with a wire fixed, one end to the bell, and the other in the spinning flat to which the bell belongs. When rovings were wanted in any of the spinning flats, the person wanting them would only have to pull the wire to ring the bell in the carding-room, and thus give notice to the boy appointed to wait upon the hatchway, when he, by looking at the number of the bell, would know in which flat the rovings were wanted, and, by sending the rove-conductor to that flat, would have the empty box returned, when he could immediately send back a full box of rovings of the same number as the empty box received. All this could be done with very little trouble, or loss of time, and without the rovings sustaining the smallest injury; whereas, when they have to be carried from the carding to the spinning-rooms, by piecers or others, besides the time lost, they are liable to be injured, and not unfrequently destroyed. No method, therefore, of conveying the rovings from the carding to the spinning-room, can be so safe or expeditious, as the one recommended.

In the plan of a Mill represented in Plate I., the staircase is placed on the outside of the Mill, where it always ought to be; and by the plan here laid down, it will at once be perceived that the outer door may be kept shut during working hours, when all communication out and in to the Mill would then be by the front door M, and through the ware-room.

Such then is the plan of a Cotton Mill, which is supposed to be particularly adapted for having all the different departments properly arranged, and which presents the greatest facilities for enabling each class to pursue their various employments. Hence it is best adapted for accelerating the progress of the work as a whole; because, whatever gives freedom to a workman in the performance of any piece of labour, or removes incumbrance out of his way, will enable him to perform a greater quantity of labour in the same time.

As it is obvious that the particular arrangement of the different departments, and the order in which the machinery is placed, will always have a prominent influence upon the productive capabilities of large establishments; the advantage of having them arranged in the best manner which practical wisdom and experience can suggest, is so apparent, as to require no force of language to prove. And if such arrangements depend upon the particular form or plan upon which the Factory is built, then the importance or advantage arising from the adoption of the most approved plan, is so obvious, as to admit of no further comment.

THE METHOD OF CALCULATING THE SPEED OF ALL THE DIFFERENT SHAFTS AND MACHINES THROUGHOUT THE ESTABLISHMENT.

In the second place, it was proposed to show the method of tracing out the speed of the different shafts and machines, from the power which gives the first motion to the remotest movement in the whole establishment.

In calculating the speed of the various shafts, the first thing to be done is to find the revolutions per minute of the first or main shaft; and when this is known, the principle upon which to proceed in tracing out the speed per minute of all the other shafts throughout the establishment, is both simple and easy to be understood, and will be illustrated in the following pages: meantime, I proceed to show the method of finding the speed of the main shaft. Suppose the first moving power to be a water wheel: Find how many revolutions it makes per minute, then, how many teeth are in the spur or bevel wheel. Multiply this number by the revolutions of the wheel per minute, and divide the last product by the number of teeth in the pinion acting in the same, and the result will be the revolutions of the first shaft per minute.

But if the first moving power should be an engine, the first thing to be done is to find the number of strokes the engine makes per minute; and if the engine crank be attached to a wheel, then every double stroke of the engine will make one revolution of this wheel, and it will be the first driving wheel. Multiply the number of teeth which it contains by its revolutions per minute, and divide the product by the number of teeth in the pinion which is fixed on the end of the first shaft, and the result thus obtained will be the revolutions per minute of the shaft. And when the speed of the first shaft is thus found, the process of tracing out the speed of all the others, will be comparatively easy.

In the plan of the large gearing, represented in Plate I., the crank of the engine is supposed to be attached to the end of the first shaft A; therefore, every double stroke of the engine will make one revolution of this shaft.

Now suppose an engine of 50 horses' power, and making 40 single strokes per minute equal to 20 revolutions of the first shaft A; therefore this shaft revolves 20 times per minute. Upon the end of the first shaft there is a large driving wheel B, containing 96 teeth, driving the second shafts D D. Upon one end of the second shafts are two pinions C C, containing 48 teeth each, driven by the large wheel B. Upon the other end are two wheels E E, containing 56 teeth each, driving the upright shafts; upon the foot of which are the pinions F F, containing 32 teeth: upon the top of the upright shafts are the wheels A A, (Plate II.) containing 54 teeth each; these wheels drive the cross shafts G, (Plate I.) and C, (Plate II.) The pinions upon the ends of the cross shafts (which receive the motion from the upright shafts) contain 42 teeth each.

Required the revolutions per minute of each shaft?

Rule. Multiply the speed per minute of the first shaft A, by the number of teeth in the first driving wheel B, and divide the product by the number of teeth in the pinion C, which is fixed upon one end of the second shaft D, and the result will be the speed per minute of the second shaft D. In like manner, the speed of the upright shaft may be obtained by multiplying the speed per minute of the second shaft D, by the teeth in the driving wheel E, which is fixed upon the other end of the second shaft D, and dividing the product by the number of teeth in the pinion F which is on the foot of the upright shaft. And to find the speed of the cross shafts G and C (Plates I. and II.) multiply the speed per minute of the upright shaft by the teeth in the wheel A, (Plate II.) on the top of the upright shaft, and divide the product by the teeth in the pinion B on the cross shaft: and so by the same process, the speed of any shaft may be traced out, however remote, or at whatever distance it may be situated from the first moving power.

EXAMPLES.

Speed per minute of the first shaft A, 20 revolutions.
Number of teeth on the first driving wheel B, 96
Number of teeth in the pinion C, 48)1920(40 speed per minute of 2d shaft D.
192

Speed of 2d shaft D per minute, . . . 40 revolutions.
Number of teeth in the wheel E, . . 56
Number of teeth on the pinion F, . 32)2240(70 speed of upright shaft.
224

Speed of upright shafts per minute, ... 70
Teeth in the wheel A on the top of upright shaft, 54 Plate II.
Teeth on the pinion B on the cross shaft, 42)3780(90 speed of cross shafts.
378

To find the speed per minute of any given shaft.

RULE. Begin at the first moving power, and trace out all the driving and all the driven wheels separately. Multiply all the driving wheels together, and their product by the speed per minute of the first shaft; then multiply all the driven wheels together, including the first driven wheel on the given shaft; (the speed of which we wish to ascertain;) divide the product of the drivers by the product of the driven, and the result thus obtained will be the speed of the given shaft.

Required the speed of cross shafts G and C, Plates I. and II?

EXAMPLE.

Driving Wheels.		*Driven Wheels or Pinions.*	
First Wheel B Plate I. .	96	Second Pinion C Plate I. .	48
Third Wheel E do. . .	56	Fourth Pinion F do. . .	32
Fifth Wheel A Plate II. .	54	Sixth Pinion B Plate II. .	42

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                 96                    48
                 56                    32
                ---                   ---
                576                    96
               480                    144
               ----                  ----
               5376                  1536
                 54                    42
              -----                 -----
              21504                  3072
             26880                  6144
             ------                 -----
             290304                 64512
Speed of shaft A, 20
             -------
      64512)5806080(90 speed of the cross shafts G and C.
            580608
```

The preceding examples sufficiently illustrate the process of tracing out the speed of all the different shafts; for by the same process the speed of any number of shafts throughout all their windings, may be traced even to the remotest department of the Factory.

The speed per minute of the cross shafts, which give motion to all the machinery in both the carding and spinning-rooms, should always range from 88 to 90 revolutions. By the preceding examples the speed of the cross shafts will be found to be 90 revolutions per minute (according to the plan of the large gearing represented in Plates I. and II.) When the speed of the cross shafts is known, the speed of all the different machines in either the carding or spinning departments, may be easily ascertained.

To commence with the spinning department.

To find the speed per minute of the Fly on the Jenny.

RULE. Begin first at the cross shaft G, (Plate I.) and trace out all the driving and driven pullies and drums separately, from the large driving pullies H, on the cross shaft, to the fast and loose belt pullies on the axle of the fly on the jenny. Multiply the diameters of all the driving pullies and drums together, and their product by the speed of the cross shaft G.*—Then multiply the diameters of all driven

* In all calculations of this kind where the drivers and driven are separated and multiplied together, with a view to ascertain their

pullies and drums together, and with their product divide the product of the drivers as found above; the result will be the revolutions of the fly per minute.

The large driving pullies H, upon the cross shaft G, are 20 inches in diameter; and the top speed pullies O, are 18 inches in diameter; likewise, all the belt drums *a a a*, Plate I. and belt pullies A, (Plate III.) are the same in diameter, viz. 18 inches.

Required the revolutions of the fly or rim per minute?

EXAMPLE.—*See Plates I. and III.*

Driving Drums and Pullies.	*Driven Drums and Pullies.*
Pullies H on cross shaft G, 30 inch.	Top speed pullies O O O, 18 in.
Belt drums, *a a a*, . 18* do.	Belt pullies A, Plate III. 18* in.

Speed of cross shaft G per minute, . 90
Diameter of pullies H, ... 20
Diameter of top speed pullies O, 18)1800(100 revolutions per
18 minute of the belt
pullies A A A, Plate III. Fig. 1st. 2d. 3d.

The wheel B, on the same shaft with the pullies A, contains 74 teeth, and working into the wheel C, of 84 teeth, on the axle of the fly.

---

relative speed, should wheels, containing the same number of teeth or drums, or pullies of the same diameter, occur on both sides; these may be omitted in the operation.

* The drums *a a a*, Plate I. and the belt pullies A, Plate III. being of the same diameter, are therefore omitted in the operation.

```
Speed per minute of belt pullies A,  100
Teeth in the wheel B, . . . .         74
Teeth in the wheel C,   . .  84)7400(88.09 revolutions of the
                                672        fly per minute on the
                                 680       1st. speed.
                                 672
                                  800
                                  756
                                   44
```

The wheel D, on the same shaft with the pullies A, contains 84 teeth, and working into the wheel F, of 74 teeth, on the axle of the fly.

```
Speed per minute of belt pullies A,  100
Teeth in the wheel D, . . . .         84
Teeth in the wheel F,   . .  74)8400(113.5 revolutions of the
                                74         fly per minute on the
                                100        2d. speed.
                                 74
                                 260
                                 222
                                  380
                                  370
                                   10
```

The revolutions of the Fly being known—To find the revolutions of the Front Roller of the Jenny per minute.

RULE. Begin at the bevel wheel *a*, (Plate III.) on the axle of the fly, and trace out the driving and driven wheels from it to the wheel on the front roller.—Multiply the number of teeth in the drivers together, and their product by the revolutions of the fly, and multiply the number of teeth in the driven together.—Divide the product of the former by the product of the latter, and the result will be the revolutions of the front roller per minute.

EXAMPLE.—*See Plate III. Fig. 2d.*

Drivers.	*Driven.*
Wheel *a* on axle of fly, . 50*	Wheel *b* on top of bevel shaft, ... 50
Wheel *c* on under end of bevel shaft, ... 34	Wheel on front roller, . 50*

```
Revolutions of the fly per minute, . . . 88.09 on first speed.
Teeth in the wheel c on under end of bevel shaft, 34
                                            35236
                                           26427
Wheel b on top of bevel shaft, . .     50)2995.06(59.90 revolu-
                                           250      tions of the front
                                            495     roller per min.
                                            450
                                             450
                                             450
                                               6
```

To find the revolutions of the Spindle for one of the Fly and of the Spindle per minute.

RULE. When the wharves are one inch diameter, multiply the diameter of the fly by the diameter of the drum-band groove in the twist pulley, and divide by the diameter of the fly-band groove.

Suppose the diameter of the fly to be 40 inches, fly-band groove in twist pulley 14½, and drum-band groove 16 inches.

Required the revolutions of the spindle for one of the fly?

---

* The wheel *a* on axle of fly, and the wheel on the front roller containing the same number of teeth, are therefore omitted. *See Note, page* 28.

EXAMPLE.

Diameter of fly, ... 40 inches.
  Do. of drum-band groove, . 16
  Do. of fly-band groove, 14.5)640.0(44 revolutions of the spindle
                                        580   for one of the fly.
                                        600
                                        580
                                         20

The revolutions of the spindle for one of the fly being 44, this multiplied by the revolutions of fly per minute, gives the revolutions of the spindle per minute.

Revolutions of fly on the first speed, $88.09 \times 44 = 3875.96$ revolutions of spindle per minute on first speed.

Revolutions of fly on the second speed, $113.5 \times 44 = 4994.0$ revolutions of spindle per minute on second speed.

Note. It is difficult to find any general rule by which the revolutions of the spindle for one of the fly or rim can be exactly ascertained by calculation, because these are often found to vary according to the thickness of the drum and fly-bands, the diameters of the wharves, &c. The older these bands are, they become smaller and sink deeper into the grooves; hence the variations of the spindle in proportion to the fly. The above rule, however, will be found to come as near the truth as any which has hitherto been suggested.

The cross shafts C C, (Plate II.) which give motion to the various machines in the carding and picking-rooms, revolve 90 times per minute.

Required the speed of the different machines in these departments?

To find the speed of the Cards per minute.

RULE. Begin at the cross shaft C, and multiply its revolutions per minute by the number of teeth in the wheel D, and divide the product by the teeth in the pinion E, on the card drum shaft F; this will give the revolutions of the shaft F per minute.—Multiply this by the diameter of the card drums G G, and divide the product by the diameter of the belt pullies H H, on the axle of the card cylinder; the result thus obtained, will be the revolutions of the card cylinder per minute.

EXAMPLE.—*See Plate II.*

Teeth in the wheel D, . .	40	Teeth in the pinion E, . .	36
Diameter of card drums G,	18 in.	Diameter of belt pullies H,	16

Speed of cross shaft C, . . 90
Teeth in driving wheel D on do. 40
Teeth in driven pinion E, 36)3600(100* revolutions per minute of
36 the card drum shaft F.

Revolutions of shaft F per minute, . . . 100
Diameter of card drums G, ... 18 inches.
Diameter of belt pullies H on axle of card, 16)1800(112.5 revolutions
16 of card cylinder
20 per minute.
16
40
32
80
80

* The shafts F F, in carding and picking-rooms, revolving at the rate of 100 times per minute, the speed of all the different machines in these departments are calculated from this.

To find the revolutions per minute of the Delivering Shaft in the Card.

RULE. Begin at the pinion on the main axle of the card cylinder, and trace out the driving and driven wheels, or pinions, separately, from it to the pinion on the end of the delivering shaft. Multiply all the drivers together, and their product by the revolutions of the cylinder per minute; then multiply all the driven together, and with their product divide the product of the former.

EXAMPLE.—*See Plate IV. Fig. 2d.*

Drivers.		*Driven.*	
Teeth in pinion E on main axle,	20	Teeth in wheel F, . .	144
Teeth in pinion G, . . .	48	Teeth in pinion J, . . .	22

```
Revolutions of cylinder per minute, 112.5 | Teeth on wheel F, 144
Teeth in pinion E on main axle,   .   20  | Teeth on pinion J,  22
                                  ------- |                    ---
                                  2250.0  |                    288
Teeth in pinion G,  . . . . .  .      48  |                   288
                                  ------- |                   ----
                                  180000  |                   3168
                                  90000   |
                            -----------
                        3168)108000.0(34.09* revolutions of de-
                             9504         livering shaft per minute.
                             -----
                             12960
                             12672
                             ------
                              28800
                              28512
                              -----
                                288
```

The revolutions of the delivering shaft per minute being 34.09, by multiplying it by the circumference

---

* The revolutions of the feeding roller is found by the same method as the delivering shaft.

of the delivering ball, gives the length produced per minute.

To find the speed per minute of the Cylinder Shaft in the Drawing Frame.

RULE. Multiply the diameters of the drums O and R together, and their product by the speed per minute of the shaft F, and multiply the diameters of the driven pullies T and P together. Divide the product of the former by the product of the latter; the result is the speed per minute of the cylinder shaft.

EXAMPLE.—*See Plate II.*

Driving Drums.		*Driven Pullies.*	
Speed of shaft F, . . .	100	Diameter of pulley T, .	16.75
Diameter of drum O, . .	18	Diameter of pulley P, .	. 16
	1800		10050
Diameter of drum R,	. 18		1675
	14400		268.00
	1800		

268.00)32400.00(120.89 revolutions of cylinder shaft per minute.
268
560
536
2400
2144
2560
2412
148

To find the speed of the Fly or Tube Frames per minute.

RULE. Multiply the diameters of the driving drums S and N together, and their product by the speed of shaft F; and multiply the diameters of the speed-pulley M, and the belt-pulley K, on the end of the frame shaft together. Divide the product of the former by the product of the latter, and the result is the speed per minute of the frame shaft.

EXAMPLE.—*See Plate II.*

Speed per minute of shaft F,	100	Diameter of speed-pulley M,	13¾
Diameter of drum S, .	18 in.	Diameter of belt-pulley K,	11½
Diameter of drum N, .	18 in.		

Speed of shaft F,	100	Diameter of pulley M,	13.75
Diameter of drum S,	18	Diameter of pulley K,	11.5
	1800		6875
Diameter of drum N,	18		1375
	14400		1375
	1800		158.125

158.125)32400.000(204.90 speed of fly or tube frame shaft per minute.
316250
775000
632500
1425000
1423125
18750

To find the speed per minute of the Scutching Machine.

Rule. Multiply the speed per minute of the shaft F in the picking-room, by the diameter of the main drum A, and the product by the diameter of the drum C; then multiply the diameter of the drum B by the diameter of the belt-pullies E, on the shaft O on the machine. Divide the product of the former by the product of the latter; the result wilt be the speed per minute of the shaft O.

EXAMPLE.—*See Plate II.*

Speed of shaft F per minute,	100	Diameter of drum B, . .	18
Diameter of drum A, . .	24	Diameter of belt pullies E,	$10\frac{1}{2}$
Diameter of drum C, . .	22		180
			9
			189

```
Speed of shaft F,   .  100
Diameter of drum A,     24
                      2400
Diameter of drum C,     22
                      4800
                     4800
             189)52800(279.36 revolutions per minute of shaft
                 378                  O in scutching machine.
                 1500
                 1323
                  1770
                  1701
                    690
                    567
                    1230
                    1134
                      96
```

To find the speed of the Willow per minute.

RULE. Multiply the speed of the shaft F and the diameter of the drum A together, and divide the product by the diameter of the belt pullies H on the axle of the willow; the result is its revolutions per minute.*

---

* The drums B B being merely intermediates, are, therefore, not taken into the calculation.

EXAMPLE.—*See Plate II.*

Speed of shaft F, ... 100
Diameter of drum A, . . . 24
Diameter of belt pullies H, 7.5)2400.0(320 revolutions of willow per minute.
225
150
150

To find the speed of the Spreading Machine per minute.

RULE. Multiply the diameter of the drums A and X together, and their product by the speed per minute of the main shaft F; then multiply the diameter of the speed pullies Y and the belt pullies J together. Divide the product of the former by the product of the latter; and the result is the speed of the machine per minute.

EXAMPLE.—*See Plate II.*

Speed of shaft F per minute,	100	Diameter of pulley Y, .	18 in.
Diameter of drum A, .	24	Diameter of belt pullies J,	17
Diameter of drum X, .	22		126
			18
			306

Speed of shaft F, . . 100
Diameter of drum A, . . 24
2400
Diameter of drum X, . 22
4800
4800
306)52800(172.54 speed of spreading machine per minute.
306
2220
2142
780
612
1680
1530
1500
1224
276

The speed of shaft F multiplied by the diameter of drum A, and divided by the diameter of pulley Y, gives the speed of drum X.

$\frac{100 \times 24}{18} = 133.33$ revolutions per minute of drum X.—*See Plate II.*

The preceding calculations are merely intended to exemplify the method of tracing out the motions of the various shafts and machines, from the power which gives the *first* motion, to the remotest movement in the whole establishment.

Here it may be remarked, however, that the plan of the shafts and other gearing, in some of the old establishments especially, will be found much more complicated than that which is represented in the plans contained in Plates I. and II.; yet still the principles upon which their various speeds are calculated are always the same, and have been exemplified in the preceding pages; and if once these are properly understood, the method of tracing out the speed of every shaft throughout all the ramifications, of even the most complicated establishment, will be comparatively easy.

Millwrights have attained great perfection in the plan and form of the large gearing in Cotton Factories. The make and plan of the shafts and other gearing fitted up in mills that have been lately built, forms a most striking contrast for neatness and simplicity to that which is to be seen in old establishments erected about thirty or forty years ago. Not only does the former excel the latter for neatness and simplicity, but it is also more safe and durable—not so liable to accident, and exhausts less of the moving power. Brass, from the peculiar fineness of its particles, has long been esteemed by mechanics for bushes for the journals of shafts to run upon, yet, contrary to all expectation, cast iron bushes have been found even superior to them for durability; in proof of which it may be mentioned, that there are, perhaps, no machine that cuts up the bushes faster than the scutcher, owing to the rapidity of its motion, which is from 1400 to 1600 revolutions per minute; yet scutchers are to be found in this neighbourhood, that have run on cast iron bushes for about fourteen years, and at this day seem to be as close and tight as when first fitted up; and from their present appearance, may yet be expected to run double that time before they require to be replaced. It is proper to state, however, that thin plates of steel had been welded on the journals of the scutchers, which, after being turned and adjusted, perhaps the thickness of the steel did not exceed $\frac{1}{16}$ of an inch: the cast iron bushes were also case-hardened; and wherever cast iron bushes are used, both the journals and bushes should be prepared in the same manner; which, if properly done, will be found to suit the intended purposes far beyond expectation.

The mode of coupling shafts together is likewise greatly improved; instead of the clumsy square coupling-box that was formerly used, various methods have been adopted for coupling shafts together, all attended with more or less success: but the neatest and simplest of any that I have yet seen, (especially for light gearing, that is shafts of three inches diameter and under) is the common male and female screw; and when there is a flanche on the male screw, just at the termination of the thread, this, when screwed up close to the female, turned and polished on the outside, looks extremely neat, and runs perfectly smooth and free, without the least shake or vibration, to which square couplings are always liable.

Amongst the many improvements that have been made in Cotton Factories, that of heating them with steam is none of the least important. The merits of this invention is ascribed to Mr. Neil Snodgrass, an ingenious mechanic in Glasgow. By steam being conveyed through pipes into the different flats, an agreeable, safe, and wholesome heat, can be equally diffused throughout the whole Factory, even to its remotest apartment, by which means all kind of humidity is completely absorbed, which, next to the comfort of the workers, is the only use for which heat is required in Cotton Factories at all. But steam pipes require to be very accurately fitted up and adjusted, and particularly so as to allow the cold air and waste water to escape freely at their extremities upon the introduction of the steam. To accomplish this, many different plans have been tried; but, perhaps, the expansion valve is the most approved: these again are made in various forms; and the one, of which a sketch is given in Plate L Fig. 2d, is not excelled for neatness and efficiency by any that I have yet seen: for a description of which see the Plate. A is the steam pipe; C is a small cylinder fixed on the extreme end of it: when the pipe expands with the heat, the rod D is pressed forward at the bottom; but being connected with the wire E at the top, which is supposed to be a fixture, it only turns on the stud J, by which means the cross arm R is brought downward at the point F, and thereby depresses the piston G, which shuts the valve H on the mouth of the waste water pipe B. Again, when the pipe A contracts, the valve H is opened by the same means; and by lengthening or shortening the wire E, the valve can be opened to any degree that is required.

In the subsequent detail of the process of cotton spinning, each machine will be introduced in the order in which it is employed, the latest improvements will be pointed out, and the method of calculating the draughts, together with all other calculations connected with cotton spinning, shall be accurately described and exemplified.

DETAIL

OF THE

PROCESS OF COTTON SPINNING.

In detailing the process of cotton spinning, it is not the design of the writer to advert to all the little casualties, or point out the many difficulties that frequently occur in practice; his object is merely to give a general outline of the whole process, by tracing it step by step, from its commencement with the raw material, through the various stages of its progress, from the cotton bag until it is finished into yarn. Each machine employed in the process, will be introduced in its order, and form the subject of a separate article. The manner in which they should be adjusted, and how to adapt them to suit the various kinds of cotton and qualities of yarn, will be pointed out. His object is to lay down a complete theory of the business, without entering into all the minutiæ of the practical department of it. And in prosecuting this design, he will not scruple to avail himself of the best information he can obtain.

ON MIXING COTTONS.

The first thing to be done with the cotton previous to its being put into any machine whatever, is to mix together a number of bags all into one heap, commonly called a bing or bunker of cotton, the necessity of which arises from the great variety in the qualities of the different bags, which renders it impossible to produce a yarn of uniform quality, unless a number of these are incorporated together.

To make up a bing of cotton properly, is a matter of great importance, and should never be left to the charge of those who are ignorant of the evil that may arise from careless or unequal mixing of the cotton. When making up the bing, every bag or bale that is to be mixed, should be brought forward one by one, opened and spread out equally over the whole surface of the bing, beginning first at the bottom, and so on alternately, layer above layer, or bag above bag, and pressed down, or trampled, exactly in the same manner as building a hay stack. And when the cotton is taken out, it should be pulled from the one side in a regular cut, as it were, from top to bottom. In some Factories, an instrument, made in the form of a gardener's rake, is employed for tearing down the cotton from the sides of the bing, which tearing down is considered to be nearly of as much benefit to the cotton as putting it through the willow.

No general rule can be laid down for the particular kinds of cotton that should be used for making any given quality of yarn. Every manager must make up the mixture according to the quality of the yarn required, the machinery he has to make it, and the price at which it is to be sold. Cotton that is soft and short in the staple or fibre, is best adapted for wefts; that which is long and strong, is better suited for warps. But when short and long cottons are mixed together, the long staple being a heavier body, tends to throw out the short, and render the yarn unequal and unevenly. Therefore whatever cottons are to be mixed, it will be of great benefit to the yarn that they be nearly equal in the length of the staple. The cottons generally used for coarse weft, are Bengal, Surat, the common and middling qualities of Upland and Orleans, and the better kinds of waste, such as tops and flyings. For fine weft, Upland, Orleans, Bahia, Demerara, Egyptian, Sea-Island. For coarse warp, Upland, Orleans, Maranham, Egyptian. For fine warp, Orleans, Pernambuco, Egyptian, Sea-Island.

Some experienced managers disapprove of mixing more than two or three different kinds of cotton together, because they frequently find that when too many sorts are combined together, they do not incorporate so equally as might be required for making a uniform quality of yarn; but when only two kinds of cotton are to be combined together, the best place for doing it equally is at the doubler attached to the lapping machine, which will be afterwards described. Before leaving this article, it may again be remarked, that the greatest care and attention is particularly requisite at making up the bing, so as to have it equally and uniformly mixed: and the same attention is equally required, when taking the cotton out of the bing, so as to have it done by a regular cut, as it were, from top to bottom: and unless this be particularly attended to, a regular and uniform quality of yarn cannot be produced.

THE WILLOW.

THE first machine the cotton is made to pass through is the Willow.

All the cotton that comes to this country has to be brought from a great distance, hence it is requisite to have it put up into as little bulk as possible; for this purpose it is put into a press of great mechanical power, where it is compressed as hard as a piece of wood, then sewed up into bags, and bound round with hoops or cords; so when these bags are opened, the cotton is found all gathered up into hard clotted lumps. Now the use of the willow is to tear these asunder, and open up the cotton, so as to make it spread equally at the scutching machine.

The willow is considered to be very destructive to the cotton, as having a great tendency to break the staple or fibres, and thereby weaken the strength of the yarn; hence it is not very popular amongst a number of managers, who think that its use might be superseded by hand teazing, or by a regular and systematic pulling down at the bing, either by the hand or with a cotton rake.

The willow also cleans the sand and seeds out of the cotton, and prevents them from injuring any other machine which they might pass through. Tops, strips, or any other very soft cottons, should never be put through the willow; and even good cotton, should never be allowed to remain long in operation; for it has often been observed, that the cotton sustains less injury by being put twice hurriedly through, than by keeping it long in, at only one operation.

THE SCUTCHING MACHINE

From the Willow the cotton is carried direct to the Scutching Machine, the use of which is to open up the cotton, so as to make it spread equally into a given length and breadth at the spreading machine, and that it may be taken into the feeding-rollers of the same, in a uniform body of equal thickness. This machine also beats out the sand, seeds, and dead cotton, and makes the fibres open and spread out; so that when the cotton enters the cards, the fibres are separated in such a manner, that the card teeth may take hold of each one by itself.

In former times, all this was accomplished in a very simple but effectual manner, by having a frame made exactly like the frame of a common table, and covered with small cords, fixed at both ends, and parallel with the two sides; upon these cords the cotton was laid, and beaten with switches that were smoothed and kept for the purpose. By beating the cotton in this manner, the fibres were opened so as to separate easily, the sand and seeds fell down between the cords, the gins and dead cotton that did not fall down in this way, were picked out with the hand. By undergoing this operation, the cotton was perfectly cleaned and prepared for being spread and put into the cards.

This practice of beating the cotton is still continued in some Factories that spin very fine numbers, because the best cottons are sometimes very full of gins or seeds; if these are broken into the cotton, it is impossible to make a clear and level thread of yarn; and fine yarn requires to have the cotton perfectly cleaned and purified from all these substances, which cannot be accomplished so effectually with machinery as by beating and picking it with the hand.

Yet simple and effectual though this method may have been, still it was attended with a good deal of labour, besides a considerable expense; to obviate both of which, various machines have been invented, but none of these seems to have given satisfaction for any length of time, except the common scutching machine, which has now become so popular as to be generally used in most of the spinning factories in this country.

Scutching machines are now made in various forms, according to the taste of the managers of factories; but whatever be the form in which they are constructed, the principles upon which they operate are always the same. Plate IV. Fig. 1st, contains a ground view of a section of one of these machines, which has been found to answer the purpose remarkably well. In front of the machine, two wooden rollers are fitted up at proper distances from each other, one of them G, close in front of the feeding-rollers E, by which it is driven; round these, there is a cloth joined at each end and made to revolve; on the upper side of which the cotton is spread, and by it carried up to the feeding-rollers, through which it passes by a slow motion, when the scutcher, revolving at the rate of about 1600 times per minute, the beaters *a a*, strike the cotton so rapidly, that the fibres are forced to open and spread out, while the sand, seeds, &c. falling upon wires, called the harp,*

---

* Harps are sometimes made of iron rods $1\frac{1}{4}$ inch broad, and $\frac{1}{4}$ thick, and placed with their edge uppermost, only a little beveled,

drop down beneath the machine altogether; but the cotton being carried round by the velocity of the beaters, is met again by another revolving cloth, moving in the same manner as the former, by which it is again carried up to the second feeding-rollers H, where it passes through the same operation, only a little quicker. Instead of a cloth in front of the second feeding-rollers, and at the back of the second scutcher for delivering the cotton, straps are sometimes used with small slips of wood fixed upon them, the length of which is nearly the breadth of the machine, and about $\frac{1}{2}$ inch broad, and $\frac{5}{16}$ thick; these set a little separate, allow sand or seeds to drop down between them, while the cotton is carried forward.

The above description shows that the scutching machine may be regarded as an excellent substitute for the old method of beating the cotton with switches; at the same time, it must be obvious, that all kinds of cotton will not require to undergo the same scutching. If, for example, Surats, Boweds, &c. be made to pass through the same operation as Egyptian and Sea-Island cotton, the one will either be destroyed, or the other will not be sufficiently done; therefore, the speed of the scutcher, or beaters, should always be adapted to the nature of the cotton. Short and soft cottons require much less scutching than long; and when tops, strips, or flow-

so as to allow the cotton to pass freely over them, while the sand, seeds, &c. drop down between them.

ings, are to be put through, they ought to get as little as possible, just as much as beat out the seeds or gins: and for long cottons, the beaters should be set at a proper distance from the rollers, lest they break the fibres, and thereby weaken the strength of the yarn.

How to calculate the speed of the various movements in the Scutching Machine.

Begin at the shaft O, on which are the fast and loose belt pullies A, Plate IV. Fig. 1st, the speed of which was found to be 279.36 revolutions per minute; *(See page 37;)* on the one end of this shaft there is a large pulley B, 42 inches diameter, driving the first scutcher by a belt passing round the pulley C 7¼ inches. The pulley D is 8½ inches, and drives the second scutcher by a belt passing round F 7¼ inches diameter.

Required the revolutions per minute of the first and second scutchers?

RULE. Multiply the speed per minute of the shaft O, by the diameter of the pulley B, and divide the product by the diameter of the pulley C, on the end of the first scutcher shaft; the result is the revolutions of the first scutcher per minute.—Multiply it by the diameter of the pulley D, and divide by the diameter of the pulley F, on the end of the second scutcher shaft; the result is its revolutions per minute.

EXAMPLE.—*See Plate IV. Fig. 1st.*

```
Speed per minute of pulley B, 279.36
Diameter of           do.        42
                              ------
                              55872
                             111744
                            --------
Diameter of pulley C, 7.25)11733.12(1618.36 revolutions of first
                             725              scutcher per minute.
                             ----
                             4483
                             4350
                             -----
                              1331
                               725
                              -----
                               6062
                               5800
                               -----
                                2620
                                2175
                                -----
                                 4450
                                 4350
                                 ----
                                  100
```

$$\frac{1618.36 \times 8\frac{1}{2}}{7\frac{1}{4}} = 1897.37 \text{ revolutions of second scutcher per minute.}$$

To find the revolutions of the Feeding-Rollers per minute.

Upon the end of the shaft O there is a pinion *r*, containing 19 teeth, working into the wheel *z* of 140 teeth, to which is attached the pulley *y*, of 7 inches diameter, and driving the second feeding-rollers H by means of a belt passing round the pulley *x*, the diameter of which is 13 inches. The pulley *u* is 7 inches diameter, and drives the first feeding-rollers E by a belt passing round the pulley *n*, 13 inches in diameter.

Required the revolutions of the first and second feeding-rollers per minute?

RULE. Multiply the number of teeth in the pinion *r* and the diameter of the pulley *y* together, and their product by the revolutions per minute of the shaft O: multiply the number of teeth in the wheel *z* by the diameter of the pulley *x*; divide the product of the former by the product of the latter, and the result is the revolutions of the second feeding-rollers per minute. Multiply it by the diameter of the pulley *u*, and divide by the pulley *n*, which gives the revolutions of the first feeding-rollers per minute.

EXAMPLE.—*See Plate IV. Fig. 1st.*

Revolutions per minute of shaft O, 279.36
Teeth in pinion *r*, ... 19 Teeth in wheel *z*, 140
251424 Diameter of pulley *x*, 13
27936 420
5307.84 140
Diameter of the pulley *y*, ... 7 1820
1820)37154.88(20.41 revolutions of 2d
3640 feeding-rollers H per min.
7548
7280
2688
1820
868

Revolutions of second feeding-rollers, 20.41
Diameter of pulley *u*, ... 7
Diameter of pulley *n*, . . . 13)142.87(10.99 revolutions of
13 first feeding-rollers
128 E per minute.
117
117
117

By the above examples the speed of the different parts of this machine is as follows.

Revolutions of first feeding-rollers per minute,	......	10.99
Do. of first scutcher	do.	1618.36
Do. of scutcher for one of feeding-rollers,		147.26
Revolutions of second feeding-rollers per minute,	...	20.41
Do. of second scutcher	do.	1897.37
Do. of scutcher for one of feeding-rollers,	...	92.96

Single scutching machines are those with only one scutcher; double machines have two scutchers: *see Plate IV. Fig. 1st.* Some prefer the single machine with three blades in the scutcher: they suppose that the cotton is both cleaner and better opened when put twice through this machine, than when put only once through one having two scutchers. To have the cotton well opened and cleaned at the scutching, is doubtless an object of essential importance; whatever therefore can accomplish this object in the shortest time, and with the least injury to the cotton, ought certainly to be adopted; and a machine, having two or three scutchers into it, is undoubtedly the most preferable: it is not uncommon, indeed, to find these machines with even *four* scutchers, instead of only one or two. Managers are now generally disposed to give the cotton a considerable degree of more scutching than was the practice a few years ago; hence double machines are now *most* approved of.

An improvement is just now in course of trial upon the scutching machine, of the ultimate success of which no doubt is entertained. It consists of having the machine furnished with a pair of calender-rollers for delivering the cotton on to a lap-drum, round which it is made to roll, until it acquires a given thickness, when it is taken off and carried to a spreading machine, made in the form of a common spreading table, with 4 pairs of fluted rollers at the one end, through which it passes and undergoes a draught of 2, or 3 to 1,* and from which it is delivered into a box, and carried from thence direct to the back of the cards. But previous to its being put into the scutching machine, the cotton is weighed, and spread into a given length and breadth, the same as at a spreading machine; so the thickness of the cotton on the lap-drum can be regulated by the quantity put through.

The benefit expected from this improvement is a better intermixture of the cottons. For spinning coarse wefts; tops, strips, and flowings, are frequently mixed with the cotton previous to its being put through the scutching machine. Now when these do not incorporate equally, they tend to deteriorate the quality of the yarn, and render it unequal in its grist. The same effect may also arise from unequal mixing at the bing; but the lap-drum is intended to obviate the evil arising from either of these; for by the cotton rolling round the drum, the different qualities are so perfectly intermixed, that a more uniform quality of yarn may reasonably be expected.

* Although a drawing-head is introduced into this new machine, I do not approve of it as stated in page 57.

THE SPREADING MACHINE.

The Spreading Machine, although but a recent invention, has now become so popular, that there are few Spinning Factories in this country where it has not been adopted. The use of this machine is to spread a given weight of cotton into a given length and breadth, so that it may be led into the cards in in a uniform body of equal thickness.

There are still a number of managers somewhat prejudiced against these machines, particularly in those Factories that spin fine numbers, where the feed or lap requires to be very light and thin spread, which cannot be done so perfectly with the machine as by hand-spreading; but, perhaps, the evil here complained of might be obviated, by spreading heavy, and leading the cotton proportionably slower into the cards. Other managers object to these machines, because of the inequality of their spreading: upon one lap there may be about 6 or 7 different weighings, each from 8 to 10 oz.; it is frequently found that these will vary one, two, and sometimes three oz., which renders it impossible to produce a regular and uniform size of yarn: this, no doubt, arises, in a great measure, from carelessness on the part of those who attend the machine.

The weight of cotton for each spreading ought to be weighed with the most scrupulous exactness. And unless this be particularly attended to at all times, it is impossible to produce a regular and uniform quality of yarn. But sometimes the cause of this inequality in the spreading arises from the particular make of the machine, or the principle upon which it operates. There are a number of spreading machines fitted up with a drawing-head in front of the scutcher, as at the feeding-rollers; others with a drawing-head between the scutcher and calender-rollers. I approve of neither of these; and it surely requires no great discernment to perceive the impropriety of making cotton pass through a drawing-head before the fibres are first straighted and made to lie all one way; now this is not done until it passes through the carding engines. In all that part of the process through which the cotton has to pass previous to its being put through the cards, the fibres will be lying in every direction in which they may accidentally be thrown; and while in this state, it is impossible to spread the feeding perfectly equal; some parts will be found a little thicker, and some thinner than others; but passing it through a drawing-head, would tend rather to enlarge than remove these inequalities; besides, a drawing-head at the back of the scutcher especially, will have a great tendency to what is called "stringing the cotton;" the effects of which are considered to be very injurious to the yarn. That there ought to be a draught in the spreading machine is admitted; but this ought to be through the body of the machine, and not at a drawing-head, that is to say, the calender-rollers should be made to deliver more than the feeding-rollers receive.

The chief advantages of the spreading machines are supposed to lie in their economy; they save a considerable expense by requiring fewer hands than would be necessary for hand-spreading: yet when constructed upon proper principles, and made sufficiently strong for the work they have to perform, when attended to with proper care and attention, they are, in *many* cases, found to suit their purpose equally, and sometimes better, than hand-spreading, as well with respect to the quality of the work they produce, as their economy.

Plate V. contains a representation of a spreading machine, constructed on the principle recommended above, which, for simplicity of form, strength of all its parts, and the excellent work which it produces, is decidedly the best I have yet seen.

The operations of the spreading and scutching machines are so exactly alike, that it is unnecessary, after having described the one, to take up time explaining the other.

In tracing out the first motions of the various machines, the speed per minute of the belt-pullies J J, (Plate II.) of the spreading machines, was found to be 172.54, and that of the drums X X 133.33 per minute, *(See page 39.)* The same drum X and the belt-pullies J, are represented in Plate V. Fig. 1st.

To find the revolutions per minute of the Scutcher in the Spreading Machine.

RULE. Multiply the speed per minute of the drum X by its diameter, and the diameter of the drum C; then multiply the diameters of the pullies B and D together, and divide the product of the former by the product of the latter; the result is the speed per minute of the scutcher.

EXAMPLE.—*See Plate V. Fig. 1st.*

```
Revolutions of drum X per minute, 133.33
Diameter of do. . . . . . . .     22
                                 -----
                                 26666
                                26666    Diameter of pulley B, 9
                                -------
                                2933.26  Diameter of pulley D, 6
Diameter of drum C, . . . . .     17.5                        --
                                -------                       54
                               1466630
                              2053282
                              293326
                           ------------
                         54)51332.050(950.593 revolutions per
                            486           minute of the scutcher.
                            ---
                             273
                             270
                             ---
                               320
                               270
                               ---
                                505
                                486
                                ---
                                 190
                                 162
                                 ---
                                  28
```

The shaft E revolves 172.54 times per minute, on the one end of which are the belt pullies J; and passing under the machine, it also gives motion to the wheels and pinions on the opposite side. *See Plate V. Fig. 1st. and 2d.* On the end of this same shaft are the two pinions F, driving the feeding and calender rollers by a range of wheels.—*See Fig. 2d.*

To find the revolutions per minute of the Feeding-Rollers.

Rule. Multiply the number of teeth in the pinion F, by the revolutions per minute of the shaft E, on which it is fixed, and divide the product by the number of teeth in the wheel A, on the end of the feeding-roller; the result is the revolutions of the feeding-rollers per minute.

EXAMPLE.—*See Plate V. Fig. 1st. and 2d.*

```
Revolutions per minute of shaft E, Fig. 1st. 172.54
Teeth in pinion F, Fig. 2d. . . . . .            18
                                           138032
                                           17254
Teeth in wheel A, Fig. 2d.  . .     144)3105.72(21.56 revolutions
                                           288          per minute of
                                            225         feeding rollers.
                                            144
                                             817
                                             720
                                              972
                                              864
                                              106
```

Note. The wheels G G G being merely intermediate, are, therefore, not taken into the above calculation. And here it may be remarked once for all, that intermediate wheels or drums are never taken into the operation of calculating the speed or draught of any kind of machinery: and likewise, when wheels of the same number of teeth, or drums of the same diameter, occur on both sides, (that is both as drivers and driven, or leaders and followers,) they are also omitted with a view to abridge the process.

To find the revolutions per minute of the Calender Rollers.

RULE. Multiply the number of teeth in the pinion F, Fig. 2d. by the revolutions of the shaft E, Fig. 1st. per minute, and the product by the teeth in the pinion N; and multiply the number of teeth in wheels M and P. Divide the product of the former by the product of the latter; the result is the revolutions of the calender-rollers per minute.

EXAMPLE.—*See Plate V. Fig. 1st and 2d.*

Revolutions per minute of shaft
E, Fig. 1st. 172.54
Teeth in pinion F, Fig. 1st & 2d. 18

138032
17254

3105.72 Teeth in wheel M, 48
Teeth in pinion N, ... 22 Teeth in wheel P, 96

621144 288
621144 432

4608)68325.84(14.82 revolutions ℔ minute of calender rollers. 4608
4608
22245
18432
38138
36864
12744
9216
3528

To find the draught of the Spreading Machine.

RULE. Begin at the wheel A on the end of the feeding-roller, call it the first leader, and the next wheel or pinion, call it the first follower;* and so trace out all the leading and following wheels from the wheel A to the wheel P on the end of the calender-roller, which will be the last follower. Multiply all the leaders together, and their product

* The distinction of leader and follower is chosen in this place, rather than driver and driven, because the two wheels A and P, at both extremes of the machine, are driven wheels, and to call either of them drivers, might, perhaps, be misunderstood.

by the diameter of the calender-roller; then multiply all the followers together, and their product by the diameter of the feeding-roller. Divide the product of the leaders by the product of the followers, and the result is the draught of the spreading machine. All intermediate wheels are omitted.

EXAMPLE.—*See Plate V. Fig. 1st and 2d.*

Leaders.	*Followers.*
Wheel A on feeding roller, 144 teeth	Wheel P on calender rollers, 96 teeth
Pinion F on driving shaft, 18* do.	Wheel F on driving shaft, 18* do.
Pinion N, ... 22 do.	Wheel M, ... 48 do.
Diameter of calender rollers, 4½ inch	Diameter of feeding rollers, 1½ in.

Teeth in wheel A, . .	144	Teeth in wheel P, . .	96
Teeth in pinion N, . .	22	Teeth in wheel M, . .	48
	288		768
	288		384
	3168		4608
Diameter of calender roller,	4.5	Diameter of feeding rollers,	1.5
	15840		23040
	12672		4608
6912.0)14256.0(2.06 draught of spreading machine.			6912.0
	138240		
	432000		
	414720		
	17280		

The cotton is weighed previous to being put into the spreading machine, and when spread into a given length, breadth, and thickness, is called a feed; a number of these follow each other, so that a continuous web of cotton passes through the machine,

* Omitted as occurring on both sides.

and is rolled on a wooden roller, until it be of sufficient size, when it is carried to the carding engine, in which state it is called a breaker lap.

CARDING ENGINE.

THE Card is a kind of brush, made of wires stuck through a sheet of leather, and made to point all one way at a certain angle; two of these nailed on separate boards, to which handles were attached, formed the rude instruments by which the process of carding was performed in the early period of cotton spinning in this country. Previous to the year 1760, various improvements had been attempted in the process of carding. James Hargreaves, a weaver at Stanhill, near Church, in Lancashire, an illiterate man, is said to be the inventor, or at least to have improved the stock cards which succeeded the hand card. By their means one person was enabled to perform double the work, and with more ease, than by the former method. This improved mode of carding consisted in having one of the cards fixed, while the other being suspended by a cord over a pulley fixed to the roof, was worked by the carder; and in this way, two or three cards might be applied to the same stock. But this contrivance, however ingenious, was still a slow and laborious process, and was soon superseded by the cylinder cards, or the carding engine, the inventor of which has not been recorded. But it is known that the father of the late, or grandfather of the present Sir Robert Peel, was the first who used it: and that as early as the year 1762, he, with the assistance of Hargreaves, erected a carding engine with cylinders, at Blackburn, which differed very little from those now in use, except that it had no mechanism for detaching the cotton from the cards, an operation which was performed by women with hand cards. Afterwards, this was done by the application of a roller with tin plates, like the floats of a water-wheel, which, revolving with a quick motion, scraped the cotton off the cards. This was a rude contrivance, and in its operation injured both the cotton and the cards. Mr. Arkwright, afterwards Sir Richard Arkwright, about this period, had made some most valuable and ingenious improvements in the process of spinning cotton, for which he obtained several patents. By him, also, the carding engine was greatly improved: in place of the roller with tin plates, he substituted a metal plate, toothed at the edge like a comb, which, instead of being made to revolve like the other, was moved rapidly, in a perpendicular direction, by a crank, and with slight, but reiterated strokes, detached the cotton from the cards in a uniform fleece. In place of sheet cards, with which the doffing cylinder had hitherto been covered, he employed narrow fillet cards, wound round it in a spiral form; by this contrivance a continuity of the fleece was produced, which, as it left the card, was gradually contracted by the conductor, and delivered by rollers into the can, in the form of a continued carding, or rowan, which is now called a card end.

The taking off the cotton from the cards in this manner, is one of the most beautiful and curious operations in the whole process of cotton spinning, and renders the carding engine one of the most important machines employed in the process.

Carding engines have sometimes been made to consist of one large cylinder, and a number of smaller ones, called urchins, disposed at proper distances over above the main cylinder, and revolving in opposite directions to it, but nearly in contact; by which means the cotton was delivered from cylinder to cylinder, until it came to the finishing cylinder called the doffer, from which it was taken off by the comb. At present, carding engines are generally made to consist of only two cylinders, sometimes three; one at the feeding-rollers, called the lickerin. But the main cylinder is covered with a kind of arch, composed of several pieces of wood called tops, which have no motion, having sheet cards fixed on them, and nearly in contact with the main cylinder.

If any machine in the whole process of cotton spinning be of more use and importance than another, it is the carding engine; nor do I see how its use can at all be dispensed with; and in fact it may be said, that the process of cotton spinning (properly speaking) begins only at the carding; for all the previous departments of the process are merely preparatory to this, and consist chiefly, in mixing, cleaning, and opening the cotton, so as that the cards may take the best effect upon it.

Previous to the cotton being put through the carding engine, the fibres may be lying in every direction into which they may be accidentally thrown; but the use of the carding is to draw out the fibres of the cotton, to straight, and lay them side by side, and form them into a thread commonly called an end; this is the first formation of the thread of yarn. It is first begun in the carding engine, and advanced onward, step by step, through each successive machine in its order, until it is completed at the spinning machine.

When the fibres are properly straighted, and the end equally formed at the carding, there is good reason to expect a superior quality of yarn, but failing this, an inferior quality is unavoidable; for no skill or attention applied to any subsequent department of the process, can altogether remedy the injuries the cotton may have sustained in this; hence, it is an object of the highest importance in cotton spinning, to have the carding engines always properly set and adjusted to suit the particular kind of cotton used, and the quality of the yarn required.

If the carding engine could straight the fibres perfectly, and reduce the grist of the thread or end to its requisite degree of fineness, then nothing more would be wanting to complete the whole process, than merely to twist this thread which the cards had formed; but though such perfection is not yet attained at the carding, still their use is the same, viz. to straight, or in some degree divide, the fibres of the cotton wool, and form a uniform, even, and level thread or end, and the better they can be made to accomplish this, the nearer are they brought to perfection.

In adjusting and fitting up carding engines, great care should be taken to have all their parts properly levelled; the bite of the feeding-rollers should especially be on a perfect level with the centre of the main cylinder, both cylinders should be turned until perfectly exact, and always kept so if possible; but through the influence of the variations of the temperature, &c. the cylinders are frequently found to swell or shrink, and thereby become unjust, notwithstanding all the care that may be taken to prevent it: when this takes place, the only remedy is to strip them of their sheets, and turn them anew, until they are perfectly just; for to work with card cylinders not exactly circular, is attended with the most injurious effects upon the cotton.

To obviate this tendency of card cylinders becoming unjust, cast iron ones have lately been invented, but do not seem to have given general satisfaction. The difficulty of fixing the sheets upon them, together with their great weight, seem to be much against their being generally approved of: it is known that one carding engine with cast iron cylinders will weigh 9 cwt.; now two flats of a mill filled each with upwards of 70 of these, together with other frames of great weight, might, perhaps, be attended with some danger. But leaving this altogether out of view, I would suppose it an excellent improvement to have the doffing cylinders made of cast iron, as they are much more exposed to the variations of the temperature; and, besides, there is no difficulty whatever in fixing the filleting on a cast iron doffing cylinder.

Seeing it is an object of some importance to keep card cylinders from going off the truth, to which they have a great tendency, particular care should be taken to have the wood well seasoned before it is made into cylinders. New carding engines should be allowed to stand at least two months in their place, exposed to the heat of the mill, before they commence operations; during which they should be turned and adjusted several times. When the wood appears to be sufficiently seasoned, and to have shrunk as much as may be expected, let any of the seams which may have opened, be then ploughed out, and pieces of well dried mahogany soaked in glue, hammered into the place as hard as possible; after which they may be turned, adjusted, and rubbed with lint-seed oil, and immediately sheeted and covered in on all sides; and the filleting being put on the doffing cylinder, the fast grinders are then to be applied to both, until the teeth are brought to the requisite exactness. If the tops be also sheeted and ground, the carding engine is then prepared to be set and adjusted in all its parts, in order to commence operations.

The setting of all the different parts of a carding engine requires particular attention, that it may be done in the manner most adapted for making them perform their office to the best purpose. The following method of adjusting them is recommended.

The feeding-rollers, and both cylinders, as already mentioned, should be fitted up to a perfect level, and the bite of the rollers directly opposite the centre of the main cylinder. The doffing cylinder and feeding-rollers, are also to be set as close to the main cylinder, as will just allow them to revolve without touching, and no more. Some carding-masters use a piece of tin for a gauge, which they place upon the main cylinder, and press up the rollers and the doffer as close as the tin will allow, and there fix them; others employ no other gauge but the eye and the ear, and certainly when these are good, they are preferable. In setting the tops, the fore-side, or the side next to the feeding-rollers, should be raised up about $\frac{3}{16}$ths of an inch off the cylinder sheets; but the side next the doffing cylinder should be set as close as just to allow the one to pass the other without touching. At first thought, one would naturally suppose, that the most proper method of setting the tops, would be to have them equally flat at both sides; but a very little reflection will convince any, that the former is the most approved. The main cylinders are generally about three feet in diameter, and when revolving at the rate of about 112 revolutions per minute, they must exert a considerable centrifugal force, which will make the cotton that adheres to the cylinder sheets have a great tendency to fly off; consequently, when the tops are set perfectly flat, it will strike, as it were, against the fore-side of the top sheet, without taking proper effect; but if the tops be set in the manner recommended, the cotton, by the centrifugal force of the cylinder, will be forced right into the teeth of the top sheets, when they and the cylinder sheets, both taking hold at the same time, will have the best effect in straighting the fibres, while the seeds, gins, &c. being driven into the top sheets, will remain fast, until they are taken out by the person appointed to clean them. If the carding engines be set in this manner, close, sharp, and well cleaned at the bottom, there is nothing to fear, with proper care and attention, as to the working of them. And as a proper manner of working and keeping the carding engines in good trim, is deemed of equal importance to that of fitting up and setting them in the most approved manner, a few remarks upon that subject may not be out of place here.

To keep or manage carding engines properly, they require at all times to be kept particularly clean and well oiled, especially the axles of the cylinders; for if these be allowed to cut and wear down, the cylinders will be thrown off the level, and when in that state, it will be impossible to make them produce superior work. A regular and uniform system of topping and stripping should at all times be punctually kept up; the cylinders should be brushed out at least once a-day, and at the same time sharped with a hand grinder; the fast grinder should be applied, at least, once every eight or nine months, or oftener, if required. The tops might be brushed out and sharped once a-week. The laps should be neatly joined to one another; one should never be allowed to overlap the other, nor should the one be consumed before the other be joined to it; either of these might cause an inequality in the grist of the end which the carding engines produce, and of course, a cloud in the yarn. The cans should never be too hard pressed, nor allowed to choke up and run over; for here the end is so soft and tender, that it cannot endure much handling without being strained.

And however prevalent the practice of making two or more carding engines deliver into one can, I still think it is attended with injurious effects, because the end which comes from the far card, when suspended, is found incapable of bearing itself without stretching; and to prevent it from sinking on the floor, the can card requires to be driven a little quicker, in order to keep it up: now if the end was to stretch equally at all parts, no evil whatever would result therefrom; but this is not to be supposed, owing to the very unequal produce of the carding engines: and if their motions be attentively observed, it will frequently be found that this end hangs down near to the floor, at other times that it is drawn up close and tight; which proves both the unequal produce of the carding engines, and the unequal stretching of the ends which come from the far cards to the cans; and hence the impropriety of making more than one carding engine deliver into one can is quite apparent.

But the fact of two or three feet long of the end which the carding engines produce, being unable to sustain its own weight, proves its weakness and its unfitness for enduring much handling without being injured; and therefore it should not be too hard pressed into the cans, because it is apt, in consequence of its weakness, to be strained or stretched when pulled out of the cans again, and thereby rendered uneven and unequal in its grist.

It is not uncommon in many respectable Factories, to find the manager much puzzled to prevent the finisher laps from hanging down, or what is called "bagging," in the middle, or at either of the sides; their only remedy for which is to have the under feeding-roller fluted, and the upper one perfectly smooth. Other managers again have never found the above as a matter of difficulty; and, perhaps, it might be useful to inquire into the cause, why the finisher cards in some Factories feed-in the lap equally and uniformly, whilst in others, they take up quite irregularly and unevenly. Now it is believed, that the chief causes of it arise from the manner in which the lap itself is formed, the way in which the feeding-rollers are set, and the state of repair in which the carding engines are generally kept. If the lap be not built equally, firm, and compact upon the wooden roller, it cannot be expected that the roller will empty uniformly and evenly. If the stand upon which the feeding-rollers bear, be cut or worn by the friction of the rollers, then they cannot be made to work so steady as might be required; it will likewise be impossible to set them sufficiently exact; but when the stand has a broad bearing for the feeding-rollers, and not cut or worn, so as to give the rollers as little play as possible; when they are set equally close at both ends, and not acted upon by a greater quantity of friction at the one end than the other; and when the cards are kept sharp and well cleaned, there is nothing to prevent the finisher laps from taking up equally at all parts. But to remove the evil here complained of, by having the upper feeding-roller made perfectly smooth, is only to introduce another much worse in its effects, it being generally admitted, that the cause of the lap bagging, arises from the bend of the incumbent roller. When there is a great weight suspended from each end, the roller springs up in the centre, and hence the lap does not take up evenly, but hangs down in the middle; but the same spring, or bend, will take place with a smooth roller as with a fluted one; and if the lap does not slack or bag with a smooth roller, it is because it does not hold so fast, but allows the cards to pull in the lap faster at times than the rollers deliver it; and if the lap be not led into the cards equally at all times, neither will the end which they produce be equal in its grist at all parts.

It is often recommended that all breaker-cards should be fitted up with a lickerin *a*, *(See Plate IV. Fig. 2d.)* because it saves the sheets from being injured by any hard substance which might chance to pass in with the cotton; it also cleans the cotton, and makes it card considerably better. Now where there are only single carding, a lickerin is altogether indispensable, and, perhaps, it might be of some benefit to have it on those carding engines that are to prepare the cotton for power-loom warps; but in all other circumstances it is not supposed to be indispensably necessary.

And with respect to single and double carding, it is believed that single carding may do well enough for all weft numbers under No. 36, but not for warps, except for very coarse numbers. Double carding has the advantage of the lapping machine, which single carding cannot have. Now, the lapping machine is considered to be an improvement of great utility in the preparatory department of cotton spinning; because, however equally the cotton may have been mixed together at the bing, or however carefully it may have been taken out, still there will be found a great irregularity in the produce of the carding engines, especially the breakers; but when these ends which are produced from the breaker-cards are all intermixed, and blended together at the lapping machine for the purpose of forming a lap for the finisher-cards, a much more equal and uniform produce from the finishing-cards is thereby obtained, than could be from the breakers.

When speaking of the method of mixing cottons, it was mentioned, that when only two kinds of cotton were to be combined together, the best method of doing this, so as to have them equally incorporated, was to have it done at the doubler attached to the lapping machine. This may be done in the following manner: Put as many breaker-cards upon each kind of cotton as will correspond with the proportions of the cottons that are to be combined, and by taking the cans from the breakers to the doubler in the same proportion, and running their ends together, these united ends being taken to form a lap, this lap will contain as many plies of each kind as will correspond with the proportions which may have been put into the breaker-cards. No method of combining different kinds of cotton together can be equal to this for having them equally and uniformly intermixed in all parts of the lap. But this can only be conveniently accomplished, when there are no more than two kinds of cotton to be combined together.

The doubler attached to the lapping machine is frequently made with a drawing head upon it, the utility of which is very apparent; because if there be a drawing head upon the doubler, with a draught of 2 to 1, then double the number of ends will be required to form a lap than would be necessary with a doubler having no draught at all. For example; suppose that there are 6 ends united together at the doubler, 5 of these united ends would be sufficient to form a lap, which would be 30 in all; but with a draught of 2 to 1 upon the doubler, instead of only 5, double that number of ends would be required to form a lap of the same body or weight of cotton as the former, by which means a much better mixture of the produce of the breaker-cards would be obtained, and consequently a more equal and regular quality of yarn produced. But a drawing head upon the doubler attached to the lapping machine is only adapted for fine light work; for coarse work there will necessarily be a heavy body of cotton passing through the rollers, when it will be impossible to make it draw equal or evenly.

An improved method of forming the finisher lap has been adopted in some places, and very much approved of. It is done as follows: The doubler is entirely laid aside, and two laps are made in the common way, but containing only one half the number of ends; these are afterwards run together, so as to form one lap; that is, suppose the lap to contain 60 ends in all; two are first made containing only 30 ends each; these are placed the one a little above the other, and passed through between the rollers of the machine, where their fleeces are united together, and rolled on a wooden roller, so as to form only one lap for the finisher carding engines, containing the same number of card ends as the former, viz. 60. Laps made in this way are found to take up much more uniformly at the back of the finishers, than those made in the common way, that is, with a doubler attached to the lapping machine.

The speed per minute of the lapping machine may be regulated to 30 revolutions, and the speed per minute of the front roller of the doubler may be regulated to 110 revolutions.

To adapt or adjust the carding engines to suit the different kinds of cotton used, and the qualities of the yarn required, managers generally prefer a particular quality of sheets to suit a certain range of numbers; for low numbers, a coarse quality of sheets, and a finer quality, for fine numbers, &c. The tops next to the feeding-rollers are always coarser than those next to the doffing cylinder.

A table or scale for sheeting carding engines, is given next page, adapted to suit any number from No. 10 to No. 200. It may be proper to mention in this place, that the quality of card sheets are always distinguished in this country by the number of wires in the breadth of the sheet, which is always understood to be 3½ inches for the cylinder, and 2 inches for the tops; but the most proper way to distinguish the quality of the card sheets, is by the number of wires in one inch: by this way, what is now called No. 70, would then be called 20 inch wire, &c. The crowns of card sheets are the number of wires in one inch counted lengthwise.

Scale of Sheets and Filletings for Carding Engines.

To Card for all sizes of Yarn	Cylinder Sheets.	Crowns.	Tops 1st, 2d, and 3d.	Crowns.	Tops 4th, 5th, 6th, 7th, & 8th.	Crowns.	Tops 9th, 10th, and 11th.	Crowns.	Breadth of Top Sheets.	Filletings.	
between No. 10 and No. 36.	80	8	20	7	26	7	28	8	$1\frac{1}{2}$	90	Breakers.
	80	9	24	8	28	8	30	8	$1\frac{1}{2}$	90	Finishers.
Between No. 36 & No. 100.	80	9	26	7	30	8	35	9	$1\frac{1}{2}$	90	Breakers.
	90	10	30	8	35	9	40	10	$1\frac{1}{4}$	100	Finishers.
Between No. 100 & No. 200.	90	10	30	8	38	9	40	10	$1\frac{1}{2}$	100	Breakers.
	100	12	35	9	40	10	45	12	$1\frac{1}{2}$	110	Finishers.

When carding engines are fitted up and adjusted in the manner which has been recommended, and kept or attended to with care and attention, they may be fairly expected to give satisfaction.

The following is a short description of the way in which they operate. The cotton is led into the cards by a very slow motion, the feeding-rollers being only one inch in diameter, and revolving at the rate of about 2 times per minute, and the main cylinder at the rate of 112, by which the teeth in the sheets take hold of the fibres just as they come through the rollers, straighting and carrying them up to the tops, which acting against the cylinder sheets force the fibres to stretch out and lie all one way; the teeth in the filleting on the doffing cylinder being also pointed right against the teeth in the cylinder sheets, and set as close to the main cylinder as just to allow the one to pass the other without touching, by which the cotton is thrown off the main cylinder on to the doffer, from which it is taken off by the comb in the form of a thin web or fleece: this is again compressed by the conductor that leads it into the delivering ball, from which it is delivered into the cans in the form of a thick soft thread called an end. To take the cotton better off the main cylinder and make it deliver freely from the doffer by the operation of the comb, some prefer having the teeth of the filleting on the doffing cylinder set with a considerable angle, others disapprove of this; as should the teeth of the filleting meet with any accident by which they might be flattened, those that are set at the greatest angle will be most difficult to set up and adjust, and hence more likely to injure the cotton by unequal carding.

From the above description, it may easily be perceived that the carding engines will have a great tendency to break the staples of the cotton; hence experienced managers disapprove of allowing it to remain long in operation at the carding: but particularly, cotton that is coarse and short in the fibres, ought to be put quickly through the carding engine, as otherwise it is very likely to be turned into naps and flowings, and cannot produce yarn so smooth and evenly as might be desired. In recommending to pass the cotton quickly through the carding process, it is not intended to approve of feeding it in by a quick motion, but rather the opposite; it should be spread thick, and led into the card by a *very slow* motion, by which means it is more likely to be better straighted, and produce smoother yarn. But again, the doffing cylinder should be driven at a quick speed, so as to take the cotton faster off the main cylinder, and thereby prevent it from being injured by too much operation between the main cylinder and the tops.

After what has been said respecting the method of fitting up, adjusting, and working the carding engines, it now only remains, that the method of performing the various calculations required about them be exemplified.

At page 33, the revolutions of the main cylinder per minute was found to be 112½, which is considered to be a very good medium speed for average numbers. The revolutions of the main cylinder per minute may range from 90 to 130, according to the quality of the yarn for which it is to prepare cotton, that is, supposing it to be three feet in diameter.

The revolutions per minute of the delivering shaft was also found to be 34.09.

Required the length produced per minute by the carding engine?

RULE. Multiply the revolutions per minute of the delivering shaft by the circumference of the delivering ball.

EXAMPLE.

```
Revolutions per minute of delivering shaft, 34.09
Circumference of delivering ball,  .  .  .  7.5 inch.
                                          -------
                                          17045
                                         23863
                                         -------
                                         255.675 length in inches pro-
                                                       duced per minute.
```

To find the revolutions of the Doffing Cylinder per minute.

Rule. Multiply the number of teeth in the pinions E and G together, and the product by the revolutions of the main cylinder per minute; and multiply the number of teeth in wheels F and H together. Divide the product of the former by the product of the latter; the result is the revolutions of the doffing cylinder per minute.

EXAMPLE.—*See Plate IV. Fig. 2d.*

```
Teeth in pinion E,  .  .  .   20 | Teeth in wheel F,  .  .  144
Teeth in pinion G,  .  .  .   48 | Teeth in wheel H,   .    144
                             ----                           ----
                             960                            576
Revolutions of main cylinder, 112.5 per minute.            576
                             ----                          144
                             4800                         -----
                            1920                          20736
                           960
                          960
                       ---------
                  20736)108000.0(5.20 revolutions of the doffing
                        103680           cylinder per minute.
                        ---------
                          43200
                          41472
                         -------
                          17280
```

To find the revolutions of the Main Cylinder for one of the Doffing Cylinder.

RULE. Multiply the number of teeth in the wheels F and H together, and the number of teeth in the pinions E and G together. Divide the product of the former by the product of the latter; the result is the revolutions of the main cylinder for one of the doffer.

EXAMPLE.—*See Plate IV. Fig. 2d.*

Teeth in wheel F,	. .	144	Teeth in pinion E,	. .	20
Teeth in wheel H,	. .	144	Teeth in pinion G,	. .	48
		576			960

```
 576
 576
144
960)20736(21.6 revolutions of the main cylin-
    1920           der for one of the doffer.
     1536
      960
      5760
      5760
```

The revolutions of the main cylinder for one of the doffer, ranges from 16 to 30, according to the kind of cotton used, and the quality of the yarn required.

To find the revolutions per minute of the Feeding-Rollers.

RULE. Trace out the driving and driven wheels, or pinions, from the pinion E on the axle of main cylinder, to the wheel R on the end of the feeding-rollers. Multiply the number of teeth in the driving pinions together, and the product by the revolutions of the main cylinder per minute; and multiply the number of teeth in the driven wheels together, then divide the product of the former by the product of the latter; the result is the revolutions per minute of the feeding-rollers.

EXAMPLE.—*See Plate IV. Fig. 2d.*

Drivers.		*Driven.*	
Pinion E on main axle,	20 teeth.	Wheel C, ...	36
Pinion D, ...	18 do.	Wheel B, ...	144
Pinion A, ...	18 do.	Wheel R, ...	144

Revolutions ⅌ min. of main cylinder, 112.5
Teeth in pinion E, on do. . . . 20
2250.0
Teeth in pinion D, ... 18
180000
22500
40500.0
Teeth in pinion A, ... 18
3240000
405000

Teeth in wheel C, 36
Teeth in wheel B, 144
144
144
36
5184
Teeth in wheel R, 144
20736
20736
5184
746496

746496)729000.0(0.97 revolutions ⅌ minute of the feeding rollers.
6718464
5715360
5225472
489888

To find the revolutions of the Main Cylinder for one of the Feeding-Rollers.

RULE. Multiply the number of teeth in the wheels C B and R together, and the teeth in the pinions E D and A together. Divide the product of the former by the product of the latter; the result is the revolutions of the main cylinder for one of the feeding-rollers.

EXAMPLE.—*See Plate IV. Fig. 2d.*

Teeth in wheel C, . .	36	Teeth in pinion E, . . .	20
Teeth in wheel B, . .	144	Teeth in pinion D, . . .	18
	144		360
	144	Teeth in pinion A,	18
	36		2880
	5184		360
Teeth in wheel R, . .	144		6480
	20736		
	20736		
	5184		

6480)746496(115 revolutions of the main cylinder for one of the feeding-rollers.
6480
9849
6480
33696
32400
1296

According to the form in which carding engines are generally made, the wheel R (Plate IV. Fig. 2d.) is driven by the pinion A, on the pap of the stud wheel B; and when it is necessary, to feed the cotton very slowly into the card, the feeding pinion requires to be so small that the pap of the stud wheel cannot receive it: to obviate this difficulty and give a full command of the speed of the feeding-rollers, an improvement has lately been made upon the side gearing of the carding engine, which, though simple and obvious, yet is found so perfectly adapted to the intended purpose, that it gives general satisfaction. It consists of an additional stud wheel and pinion C D, (Plate IV. Fig. 2d.) by means of which, the proportion between the speed of the main cylinder and feeding-rollers may be varied to any degree that can necessarily be required. By the last example, it was shown that the revolutions of the main cylinder is 115 for one of the feeding-rollers, and by smaller pinions it might be varied still farther, but even this, it is presumed, will be found too much for general purposes. The revolutions of the main cylinder for one of the feeding-rollers, should generally range from 70 to 100, according to the quality of the cotton; that is, supposing the main cylinder to be three feet in diameter, the feeding-rollers one inch, and the doffing cylinder fourteen inches. But the wheels and pinions on the carding engine, represented in Plate IV. Fig. 2d. are supposed to be adapted for single carding, and are calculated to show how much the speed of the main cylinder and the feeding-rollers might be varied. A lick-erin *(a)* is also represented on the carding engine, in Plate IV. Fig. 2d. as being much recommended by a number of managers, and particularly indispensable where there is only single carding. Single carding is when the cotton passes through only one set of cards. Double carding is when two sets of cards are employed called breakers and finishers.

To find the draught of the Carding Engine.

Rule. Begin at the wheel R on the end of the feeding-rollers, and call it the first leader, and the small pinion A the first follower, and so trace out all the leaders and followers separately from the wheel R to the pinion J on the end of the delivering shaft, which is the last follower. Multiply the number of teeth in all the leaders together, and their product by the diameter of the delivering ball. In like manner, multiply all the followers together, and their product by the diameter of the feeding-rollers. Divide the product of the former by the product of the latter; the result is the draught of the carding engine.

EXAMPLE.—*See Plate IV. Fig. 2d.*

Leaders.		*Followers.*	
Wheel R on feeding-rol.	144 teeth.	Pinion A, ...	18 teeth.
Wheel B, ...	144 * do.	Pinion D, ...	18 do.
Wheel C, ...	36 do.	Pinion E on main axle,	20 * do.
Pinion E on main axle,	20 * do.	Wheel F, ...	144 * do.
Pinion G, ...	48 do.	Wheel H on doffer,	144 * do.
Wheel H on doffer, . .	144 * do.	Pin. J. on delivering shaft,	22 do.
Diameter of delivering ball,	$2\frac{1}{4}$ in.	Diameter of feeding-rollers,	1 in.

---

* The wheel H on the axle of the doffing cylinder, and the pinion E on the axle of the main cylinder, are both leaders and followers, and therefore omitted in the operation; also the wheels B and F, because containing each the same number of teeth. The wheels K K K, are intermediate wheels.

Teeth in wheel R, .	144	Teeth in pinion A, .	18
Teeth in wheel C, .	36	Teeth in pinion D, .	18
	864		144
	432		18
	5184		324
Teeth in pinion G, .	48	Teeth in pinion J, .	22
	41472		648
	20736		648
	248832		7128
Dia. of delivering ball,	$2\frac{1}{4}$ inch.		
	497664		
	62208		

7128)559872(78.54 draught of carding engine.
49896
60912
57024
38880
35640
32400
28512
3888

Carding engines that are made with the greatest number of working tops, possess an advantage over those having fewer, just in proportion to their number of tops respectively. I have seen some very excellent carding engines, having fourteen working tops, which give them a decided advantage over those that have only eleven, because the cotton may be passed quicker through them in proportion to their additional number, and at the same time have the same effect produced upon it. The tops, indeed, are so narrow as to admit of a sheet only $1\frac{1}{2}$ inch broad, but even this is supposed to be an improvement, as being much easier set to advantage;

besides, when cleaning the tops, two are generally taken off at a time: now those with a broad sheet are more likely to make a weak part on the end which the cards produce, than those with a narrow sheet.

After passing the carding engine, the cotton having been formed into a thick soft ribbon called an end, is received into cans, and carried from thence to the drawing frame, which is the next machine in the process.

A patent has lately been taken out by Mr. Hugh Bolton of Sharples, in the parish of Bolton Le Moor, county of Lancaster, for an improvement on the carding engine, which consists of a plate of iron or steel, the length of which is equal to the breadth of the main cylinder, and four or five inches broad; the one edge of the plate is kept as sharp as possible, and the other is turned up about one inch; this is placed right under the blank top next to the doffing cylinder, with the sharp edge close upon the teeth of the sheets on the main cylinder, so as merely to allow the one to pass the other without touching. By this means, whatever motes, gins, or other substances, adhere to the surface of the main cylinder, are cut by the sharp edge of the patent blade, and received on above, whilst the opposite edge of the blade, being turned up, prevents them from being carried over upon the doffing cylinder. There is also a small waste roller moving with a slow motion above the plate, or blade, which takes up any flowings, or particles of cotton that may be thrown up by the centrifugal force of the cylinder. The object of this improvement, is to smooth the surface of the main cylinder, and clean the cotton; and seems particularly adapted for the purpose for which it is intended. It has been tried in Johnstone, and gives great satisfaction. The sand, seeds, &c. collected in one day upon eight carding engines, were weighed, and found to weigh eleven ounces. It is particularly adapted for coarse numbers.

THE DRAWING FRAME.

Previous to the days of Richard Arkwright, all cotton yarn made in this country, was drawn by the spinner between the finger and the thumb. But we are indebted to him for those valuable inventions, by means of which that slow and laborious process is entirely superseded, and the operation performed by machinery in a more perfect and expeditious manner, than ever could have been accomplished by the former method.

Arkwright, upon seeing a bar of red hot iron elongated by passing it through between a pair of rollers, immediately conceived the idea of drawing cotton by a similar process, and upon this first idea all his subsequent inventions and improvements are founded. It is obvious, that to pass cotton through between a pair of rollers, may compress, but cannot stretch it; and the analogy between the elongation of a bar of iron, and the drawing of cotton by passing them through between rollers, must indeed be very remote. But the hint once given to an ingenious and inventive mind, seeming impossibilities are soon overcome; and though one pair of rollers cannot draw the cotton, yet, by passing it through between two pairs, and making the front rollers revolve faster than the back ones, it may be drawn to any extent required. The invention and application of this simple process to the art of cotton spinning, laid the foundation of those various improvements which followed each other in rapid succession, and introduced a new era in the history of our country.

The effect produced by the relative motion of the rollers, is called the draught; and the Drawing Frame is the first machine where this principle is applied, from which it derives its name. Attempts have lately been made to introduce this principle into the spreading machine, but these have not been approved of for reasons already stated.

The use of the drawing frame is to straight the fibres of the cotton, and lay them longitudinally in a parallel direction, so as to form a more smooth and level thread than could be produced otherwise. To take a given weight of cotton, and straight out the fibres; to lay them side by side, and twist them together, may be said to comprehend the whole art and process of cotton spinning. The elementary operations through which it passes, in being brought into a state of yarn, are comprehended under the general terms of drawing, doubling, and twisting. Upon a proper arrangement and adjustment of these the particular quality of the yarn, in a great measure, depends. In the spreading machine a given weight of cotton is spread into a given length, breadth, and thickness. The carding engine straights out the fibres, although very imperfectly, and forms the thread, which, by doubling, drawing, and twisting, is advanced onward step by step, through each successive machine, in their order. As it proceeds through the various machines, the end which has been formed at the carding engine is reduced in its grist, and the fibres are laid in a more uniform and parallel direction, until it is finished into a thread of yarn at the jenny. But after passing the carding engine, perhaps there is no machine in the whole process so well adapted for straighting the fibres as the drawing frame; and the means here employed for that purpose, is the doubling of two or more ends together, and drawing them out again to their former grist. When the whole doubling and drawing throughout the process are judiciously arranged to suit the particular kind of cotton that may be used, a superior quality of yarn may be reasonably expected; but if these are not arranged with proper judgment and experience, nor adapted to suit the nature of the cotton, the yarn, however good the raw material, cannot fail to be inferior in its quality; therefore, as a proper system of doubling and drawing is a most essential part of cotton spinning, the following re-remarks are suggested from experience.

Too many doublings may be as injurious to the yarn as too few, because it is not so much from the mere multiplicity of doublings that it is to be improved, as from a suitable arrangement of them in the proper places, and their adaptation to the quality of the cotton and the yarn required. Cotton that is long and strong in the staple or fibre, requires to be oftener doubled than that which is short and weak; and for spinning very low numbers from Waste, Surat, or Madras cottons, the fewer doublings the better. I have seen some excellent No. 36 wefts made from Waste and Boweds, with no more than 64 doublings throughout the process. Where-ever there is an unnecessary doubling, there will be an additional drawing required: now much draught upon short cotton always tends to injure and weaken the thread. Long cotton, again, requires to be frequently doubled and drawn, in order to have the fibres properly straighted and laid in a parallel direction. When there is a sufficiency of doubling at the most suitable departments of the process, when the fibres are well straighted and twisted together, the yarn will be more level and evenly, as well as stronger and smoother, and hence better adapted for warps than wefts; for while warp yarn requires to be strong and smooth, weft requires to be soft and woolly, that it may throw a kind of wool upon the cloth into which it is woven, and give it a more full and rich appearance; therefore the cotton should be much oftener doubled to prepare it for warps, than is necessary for wefts.

The drawing frame appears to be the most suitable place in the whole process for doubling; and if at this department the cotton receive its full quantum of doubling, there is less need for it being farther continued. It is not asserted that a doubling at either the slabbing or stretching frame, will have no good effect upon the yarn; but, on the contrary, a doubling at either or both of these frames may greatly improve it, when it can be done with safety; this, however, cannot always be obtained without being attended with injurious effects. For to admit of being doubled at the slabbing frame, the end will require to be reduced very fine at the last heads of the drawing frame; and for being doubled at the stretching frame, the rovings must be reduced at the slabbing frame. Now the ends as they leave the drawing frame are so soft and tender, that it seems impossible to make them pass through the operation of pressing into, and pulling out of the cans again, without stretching or overstraining them; and more especially, if they have been reduced very fine, with a view to be doubled. Again, if the slab or coarse rovings be winded on bobbins at the winding machine, they are there more liable to injury than at any other stage of the process; for owing to the tugging and pulling they must endure while winding, they cannot escape being damaged by overstraining, and every little stretch makes a weak part, or a cloud, in the yarn. And if thus liable to injury, it certainly would be much safer to have no doubling at all at the stretching frame, when the rovings being single would have double the strength, and be better fitted to undergo their necessary operations without injury. But when the rovings are prepared in a fly or tube frame, the winding process is entirely superseded, and, consequently, the risk of stretching them avoided, and therefore a doubling at the stretching frame might, in these circumstances, be obtained with greater safety.

To have a doubling at the slabbing frame, and, at the same time, give sufficient strength to the ends, so as to prevent them from stretching when pulled out of the cans, sometimes the two last heads of the drawing frame are made to deliver into one can; thus, by uniting the two ends together, they are made stronger, and not so likely to yield to the strain of pulling them out again. This, however, is much objected to for making too much waste.

As the principal use of the drawing frame is to straight the fibres, and lay them side by side; so the design of any doubling after the drawing frame, is not so much the better straighting the fibres, as to equalise the grist of the end or thread; for however carefully the cotton may have been managed throughout the different departments of the process, or however perfectly the various machines may be adjusted, it will still be found, after it is made into yarn, that the thread is more or less unequal in its grist; some parts will be smaller, and some thicker than others; now frequent doubling tends greatly to remove these inequalities; but, perhaps, there is no stage of the process where the benefit of a doubling is so perceptible as at the jenny. A doubling at the slabbing frame, as already remarked, is often attended with injurious effects, owing to the extreme weakness of the ends, which cannot bear the slight pull that is necessary to draw them out of the cans, without stretching them a little. The tender rovings are equally liable to injury from the same cause, viz. weakness. But at the jenny, the thread is reduced to its proper grist, and receives its full quantum of twist, therefore it is liable to no further damage by stretching; consequently a doubling here, may be regarded as the grand specific for all the little injuries the end may have sustained in any department of the previous process. And if the cotton has been sufficiently doubled and drawn at the drawing frame, with a doubling at the jenny, one at any of the intermediate machines, may safely be dispensed with. No mule yarn can equal that which is made from double rove; for in doubling here, it seldom happens that two weak parts come exactly together, and hence the thread is more level and uniformly equal in its grist, than can otherwise be produced from the mule, and therefore a doubling at the jenny cannot be too strongly recommended.

Plate VI. Fig. 3d. represents a ground view of one head of the drawing frame. Suppose a frame having six of these heads with the two that are placed in the centre reversed, or delivering the contrary way from the two first and the two finishing heads. Four cans are placed at the back of each of the two first heads, containing two ends each, which may be supposed to have been united at the carding engine, or at a doubler fitted up at one end of the drawing frame for that purpose. These four double ends, making eight in all, are combined together whilst passing through the head; and by the relative motion of the rollers, are drawn out generally about eight or nine inches; so that the single end, which is delivered into the can in front, may be supposed to be somewhat finer than one of those that were taken up at the back of the head. And if eight of these are again united at each of the centre heads, this will make 64 doublings; eight ends again united at each of the two finishing heads, would make the number of doublings 512, which, with a doubling at the slabbing frame and jenny, would raise the amount of doublings throughout the process to 2048. This I would consider to be quite sufficient for any numbers of common yarns below 100°. But for very fine numbers, or for a superior quality of warp yarn, such as is required for power-looms, a drawing frame with eight, instead of six heads, is certainly preferable, by which the cotton could be put four times through the frame; whereas, by the other, three times drawn is the utmost that can be obtained; and in place of doubling the card ends together, by making two carding engines deliver into one can, a small doubler might be fitted up at one end of the drawing frame, with a drawing head upon it, and calculated to give a draught of two or three to one, when the cans could be brought direct from the carding engine to this doubler, where three single ends might be united into one, and afterwards passed through the drawing frame, in the regular order of eight ends to the head; by this means the number of doublings throughout the process would be increased to a considerable amount, as may be seen by the following:

Number of ends united at the doubler,	....	3
Do.	at the first heads of drawing, ...	8
		24
Do.	at second heads, ...	8
		192
Do.	at third heads, ...	8
		1536
Do.	at fourth heads, ...	8
Total doublings in the drawing frame,	....	12288

And suppose a doubling at the slabbing frame and jenny, the whole amount of doublings throughout the process would then be 49152, which I would consider the utmost that could necessarily be required for any quality of yarn whatever.

That much depends upon a proper system of doubling and drawing for making a superior quality of yarn, is generally admitted. And as I believe that it is owing to the particular management of this essential part of the process that enables one spinner to excel another in the quality of the yarns they produce, too much importance cannot be attached to this subject. For whatever be the quality of the cotton that is used, or the yarn required, the whole doubling and drawing must be regulated accordingly. And unless the one be adjusted to suit the other, it is vain to expect a superior quality of yarn.

Drawing frames are generally made with two beams, and a space of about six or seven inches between them. *(See Plate VI. Fig. 3d.)* Now, in adjusting the draughts, care should be taken to have rather more on the front than on the back beam, and especially, there should be no draught whatever between the beams; because all cotton being of a short nature, and inclined to shrink together when at liberty; if it be drawn while passing through the back beam, it will be apt to shrink together when passing through the space between them, and thereby make the end produced by the drawing frame rather clouded and uneven; therefore, the draught should be so adjusted, as merely to prevent the cotton from falling down between the beams, and no more. This remark also applies to all machines that have two beams, or two tiers of rollers, and a wide space between them.

The space between the rollers of each beam, where the cotton is drawn by their relative motions, should likewise be adjusted to suit the length of the staple or fibres of the wool. It is difficult to point out the precise distance at which the rollers should be set from each other, because the exact length of the fibres cannot be easily ascertained. But if the length of the fibres could be accurately pointed out, I would recommend the following scale of distances at which the rollers should be set.

If the length of the fibres be $\frac{7}{8}$ of an inch, for a draught from $1\frac{1}{2}$ to 7 inches, the space between the rollers may be from $\frac{7}{8}$ to $1\frac{1}{8}$ inches from centre to centre. If the fibres be 1 inch, and the draught from $1\frac{1}{2}$ to 7 inches, the space from centre to centre may be from 1 to $1\frac{3}{16}$ inches. If the fibres be $1\frac{1}{8}$, draught as above, space from $1\frac{1}{8}$ to $1\frac{3}{8}$. If the fibres be $1\frac{5}{16}$ to $1\frac{1}{2}$, with a draught as formerly, the space between the rollers, from centre to centre, may be from $1\frac{5}{16}$ to $1\frac{5}{8}$ inches, &c. these various distances are easily regulated by shifting stands.

It has often been disputed whether the drawing frame should be fitted up with dead or lever weights: upon this subject a considerable diversity of opinion exists among managers. The dead weight is, doubtless, the most solid and uniform, as it acts always the same; whereas the lever acts with a kind of vibratory motion, caused by the shaking and agitation of the machinery, together with the inequalities in the body of the cotton that passes through between the rollers. Dead weight is only adapted for fine light cotton; for when there is a heavy body of cotton, that is long and strong in the fibre, passing through the frame, it requires a very great load of dead weight suspended from the rollers, to make it draw equally; whereas the other, by shifting the weight upon the lever, can be adjusted to suit either heavy or light cotton, and, therefore, is preferable to the dead weight. But, perhaps, it might be an improvement to have drawing frames adapted for both, that they might be changed when found necessary.

The drawing head represented in Plate VI., is much approved of for its neat and handsome appearance; the fluted part of the rollers, as may be seen by examining the Plate, (Fig. 3d.) extends to between six and seven inches, which allows the cotton to spread over a broad surface, by which it draws more freely, than when, by the old plan, the fluted part of the rollers was made into four divisions, by which the cotton was collected into a small space, and, consequently, the upper rollers were frequently raised off the under ones, which prevented the cotton from drawing so equally as might be desired.

The belt pullies P are placed before the front beam, so that motion is conveyed from them backwards to the back beam: in consequence of which the whole weight of driving the back beam, and back rollers of the front beam, is thrown upon the small pinion E, and therefore this pinion lasts but a short time: to obviate which, an improvement has lately been attempted, which consists of having the belt pullies placed between the front and back beams, and attached to a small shaft that extends to the opposite side of the head, and upon which two wheels are fixed, one drives the front and the other the back beam; by this means the whole weight of driving the head is so equally balanced upon this shaft, that it moves perfectly smooth and uniform without any vibratory motion to which old frames are sometimes subject.

But this, though good in principle, has, notwithstanding, been disapproved of, as rendering the machine rather too complex, and requiring too many wheels, simplicity being the great aim of all machine makers, either in improving the old, or constructing new machines.

A new form of the drawing frame, or rather an old one greatly improved, has also been introduced of late, and seems to be giving general satisfaction. It consists of only one beam, with four tiers of rollers set close together, by means of which the draughts can be divided into three separate spaces instead of two, as in frames made in the common form. The only objection to this new form of the drawing frame is, that in consequence of the pinions being set so close together, and little or no space left for changing or shifting them, the draught of the frame cannot be altered more than about two or three teeth of a pinion.

To find the revolutions per minute of the Front Rollers in the Drawing Frame.

RULE. Multiply the revolutions per minute of the cylinder shaft by the diameter of the cylinder, and the product by the number of teeth in the wheel H, to which the belt pullies P are attached; and multiply the diameter of the belt pullies P, by the number of teeth in the wheel F, which is fixed on the end of the front roller. Divide the product of the former by the product of the latter, and the result is the revolutions of the front rollers per minute.

EXAMPLE.—*See Plate VI. Fig. 1st, 2d, and 3d.*

Suppose the revolutions of the cylinder shaft to be 120 per minute.—*See page* 35.

Diameter of cylinder, ... 5½ in.

600
60
660

Teeth in the wheel H attached to the belt pullies P, 76

3960
4620

228)50160(220 revolutions of the front rollers per minute.
456
456
456

Diam. of pullies P, 6 in.
Teeth in wheel F, 38
228

To find the Draught of the Drawing Frame.

Rule. Begin at the wheel A on the back roller of the back beam, call it the first leader; and the pinion B on the front roller, the first follower; so trace out all the leaders and followers separately from the wheel A to the wheel G on the end of the delivering shaft, which is the last follower; multiply the number of teeth in all the leaders together, and the product by the diameter of the delivering ball; then multiply the number of teeth in all the followers together, and the product by the diameter of the back roller. Divide the product of the former by the product of the latter; and the result is the draught of the drawing frame.

EXAMPLE.—*See Plate VI. Fig. 1st, 2d, and 3d.*

Leaders.	*Followers.*
Back rol. A, back beam, 44 teeth.	Front rol. B, back beam, 16 teeth.
Front do. C, do. 44 do.	Back do. D, front beam, 42* do.
Back rol. D, front beam, 42* do.	Front do. E, do. 16 do.
Front do. F, do. 38 do.	Wheel G on delivering shaft, 76 do.
Diameter of delivering ball, 2¼ in.	Diameter of back roller, 1 inch.

* The wheel D on the back roller of the front beam, is both a leader and follower; and the wheels H H, &c. are intermediate wheels, therefore they are all omitted in the calculation.

Wheel A, ...	44	Pinion B, .	16
Wheel C, ...	44	Pinion E, .	16
	176		96
	176		16
	1936		256
Wheel F, ...	38	Wheel G, .	76
	15488		1536
	5808		1792
	73568		19456
Diameter of delivering ball,	2¼		
	147136		
	18392		

19456)165528(8.50 draught of the drawing frame.
155648
98800
97280
15200

To find the revolutions of the Back Roller per min.

RULE. Begin at the pinion E on the front roller of the front beam, call it the first leader, and the wheel D the first follower; trace out the leaders and followers from the pinion E, to the wheel A on the back roller of the back beam, which will be the last follower. Multiply the number of teeth in all the leaders together, and the product by the revolutions of the front rollers per minute, and the number of teeth in all the followers together. Divide the product of the former by the product of the latter; and the result is the revolutions of the back roller per minute.

EXAMPLE.—*See Plate VI. Fig. 1st, 2d, and 3d.*

Leaders.	*Followers.*
Pinion E on the front roller of front beam, . . 16 teeth.	Wheel D on back roller of front beam, ... 42 teeth.*
Wheel D on back rol. of do. 42 do.*	Wheel C on front roller of back beam, ... 44 teeth.
Pinion B on front roller of back beam, ... 16 teeth.	Wheel A on back roll. of do. 44 do.

Revolutions of front rollers per minute, ... 220
Pinion E on front roller of front beam, ... 16

1320
220
3520

Pinion A on front roller of back beam, ... 16

21120
3520

Wheel C on front roller of back beam, ... 44
Wheel A on back roller of do. 44

176
176
1936

1936)56320(28.57 revolutions of back rollers per minute.
3972
16600
15488
11120
9680
14400
13552
848

The revolutions of the back rollers per minute multiplied by the circumference, gives the length taken in by the back rollers per minute.

* These occur as both driver and driven, and are therefore omitted in the operation.

Revolutions of back rollers per minute, . .	28.57
Circumference of do.	3.14
	11428
	2857
	8571
Length taken in by the back roller per minute,	89.7098 inches.

If the back rollers of the two first heads of a drawing frame revolve at the rate of 28.57 times per minute, and take up 89.70 inches of a card end in the same time, how many carding engines will be required to supply these two first heads, supposing eight ends going up at each head, and that each carding engine delivers 256 inches per minute, (*see page* 83.) no allowance to be made for stoppages?

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

EXAMPLE.

Length taken in by the back rollers per minute,	89.70 inches.
Number of ends put up at the two heads, . . .	16
	53820
	8970
Inches delivered by each carding engine,	256)1435.20(5.60
	1280
	1552
	1536
	160

By these calculations, each drawing frame is supposed to require about 5½ carding engines to furnish it with a regular supply of cotton. In practice, however, $5\frac{1}{2}$ would scarcely be sufficient for each drawing, even though the carding engines are not subject to so many stoppages as the other. The above is merely intended to exemplify the method of performing these calculations, as the number of carding engines required for each drawing frame depends entirely upon the qualities of the yarn for which they are preparing the cotton, and the speeds at which they are driven. Every manager arranges these to suit himself, therefore no general rule can be laid down. It is not uncommon in practice, to find one drawing frame quite competent to take away the whole of what is delivered from eight or ten carding engines of 24 inches in breadth of cylinder.

In the plan of a carding room in Plate II., the carding engines are supposed to be divided into four systems. The first contains eleven, the second ten, the third eight, and the fourth seven. To each of the first and second are represented two drawing frames, and one to each of the third and fourth. The length which each drawing frame is represented, is supposed to suit six heads, but there is sufficient space allowed for any number of heads that may be thought proper. The vacant space beneath the cross shafts C C is supposed to contain the lapping machines and racks for holding the lap rollers.

Before leaving this subject, it may be proper to take notice of an improved method of filling the cans, both at the drawing frame and carding engines, which is giving great satisfaction. Any one who has been in a carding room, must have observed the constant attention required to the filling of the cans, to change them when full, and press them gently when filling; and the injury to which the ends are always liable at this stage of the process, either by being too hard pressed into the cans, or allowed to choke up and run over. Now the object of the improvement here referred to, is to make the cans fill themselves, without the aid of attendants. It consists of having a pair of rollers placed right under the delivering rollers of the carding engine or drawing head, and fixed about two or three inches from the floor; a round plate of iron is placed above these rollers, with a small hole in the centre; the mouth of the can is placed upon this plate with the bottom upwards, and as the end descends from the delivering rollers, it is brought up between the under rollers, which are pressed together with a spring; and passing through the hole in the iron plate, it is then, by the constant operation of the rollers, forced up into the can, until it is full: when this takes place, a small counter, driven by the machine, gives warning to the attendant, who immediately removes the full can and replaces an empty one, which is made fast to the iron plate with a set screw. Motion is communicated to the under rollers, by a small upright shaft, driven by a bevel pinion on the delivering shaft, and moves the under rollers by bevel pinions at the same speed as the delivering rollers above. Sometimes the cans are filled from above; which is accomplished by having the delivering rollers laid parallel with each other, and pressed together by a lever and weight; a circular plate of iron with a small hole in the centre, is fixed close under the rollers; when an empty can is placed right below this plate, the motion of the delivering rollers presses the end down into the can, until it is full, of which the attendant is apprised by a warning bell or check, as in the former. By these simple contrivances, the cans are filled equally and gradually, without being too hard pressed: they also empty perfectly free, without sustaining the smallest injury; and by which there is a great saving of both labour and waste. Cans will take two hours to fill by this process at the carding engine, and twenty minutes at the front of the drawing frame; and when filled, they will take from eight to ten hours to empty, either at the back of the drawing frame or tube frame: so that in consequence of the cans requiring so little trouble, and so seldom changed, the attendants, having more time, can thereby apply themselves with greater diligence to those parts of the operations that require most attention.

THE SLABBING FRAME.

THE principal use of those machines that intervene between the drawing frame and the jenny, is to reduce the grist of the end preparatory to its being spun into a small thread of the required fineness. The fibres of the cotton being straighted in the drawing frame, and laid side by side, parallel with each other, but not having as yet been twisted, it is therefore improper to reduce it too fine at this department of the process, because it is so weak and tender, and unfit even to sustain its own weight, without being greatly injured; hence it is requisite, when reducing the grist of the end, to give it a degree of twist, so that it may have adhesion sufficient to make it undergo the necessary operations.

The first machine which the cotton has to pass through, after the drawing frame, is called the Slabbing Frame; and when the cotton is delivered from the slabbing frame, it is then called slab, slub, or coarse rovings; this is also the first machine that communicates twist to the cotton. And here it may be remarked, that, to make good rovings, is a most important object in cotton spinning; they ought to be uniformly level and evenly in their grist, having an equal degree of twist in all their parts, and no more than is necessary to give the requisite strength.

Various kinds of slabbing frames have been invented, and brought into use at different periods, all of which seem to be making way for the fly and tube frames: these appear now to be the most popular, and therefore a short description of some of the others is all that shall be attempted in this place.

THE CAN FRAME.

The first of which we have any information, is the Can Frame that was used by Arkwright, and which, like the drawing frame, consists of rollers fitted up in a similar manner; those with which I am acquainted, have generally four pairs, with the two back pairs a little separated from the front ones, and distinguished by the names of the front and back beams. The cotton, when passing through the rollers, undergoes a draught which is regulated by circumstances, or by the opinion of the manager; in general it may run from 10 to 14 inches: from the rollers it is delivered into a revolving can, made in the form of a truncated cone: on the top of the can there is a small funnel, through which the roving passes; while the revolving of the can gives it a degree of twist, which can also be regulated by the speed at which the can revolves; and by its centrifugal motion, the roving is coiled round within until the can is full, when it is taken out, and wound on bobbins at a winding block or machine, driven either by the hand or by the power.

The cans are supported at the bottom on pivots; and to keep them steady when revolving, the funnel at the top is guided by a collar attached to the framing. There is also a pulley fixed to the bottom of the can, by which it is driven with a band from a cylinder shaft that extends the whole length of the frame. The cans have each a door upon one side for taking out the rovings. This door is secured by a sliding ring which fits the outside of the can, and when pushed down, keeps the door shut; but when drawn up to the top, the door may be opened, and the roving taken out.

The can frame has for many years been the most popular machine that has been employed as a slabbing frame, although it has been found defective in several respects; as the twist which it communicates is not equally and uniformly diffused over all parts of the rovings: to obviate this defect, Arkwright tried rollers at the top of the revolving can, moving at the same rate as the front rollers of the beam which delivered the rovings. This, however, was afterwards abandoned, as being attended with considerable objections in practice. Rovings that are prepared in can frames require to be winded on bobbins by a separate process, by which they are frequently injured, besides being attended with additional expense. Various inventions have been attempted to obviate this last objection, to which the can frame has all along been liable. The first that shall be noticed is the skeleton frame.

THE SKELETON FRAME.

To save the tender rovings from the injury to which they are liable while winding on bobbins at the winding block, or winding machine, a frame, known by the name of the Skeleton Frame, but which is properly only an improvement upon the can frame, was for some time much used in several Factories. It consisted of a revolving frame (called the skeleton) with a top and bottom similar to the revolving can: a can was placed within this frame; and when full of rovings, it was taken out and carried direct to the back of a stretching frame, where the rovings were further reduced and prepared for the jenny, by which the operation of winding was entirely superseded; and, perhaps, no method has yet been tried that made better rove than the skeleton and stretching frames together. It may easily be perceived, however, that the process of the skeleton frame must have been very slow, and of course expensive; and therefore has never been brought very generally into use.

THE JACK FRAME.

Another machine called the Jack Frame, (sometimes jack in the box) was long used in several places, which both prepared the rovings and wound them on bobbins at the same time. It was a very ingenious but extremely complicated machine. It had also a revolving frame, within which a small cylinder moved vertically, the surface motion of which was exactly the same as the front rollers of the beam; the bobbin resting upon this cylinder was moved by friction, by this means it took up the roving at the same rate as was delivered by the rollers, and at the same time twist was communicated to the roving by the horizontal rotatory motion of the jack, and was also built uniformly on the bobbin by means of a directing-wire.

All these machines, however ingeniously contrived, or well adapted to the purposes for which they were invented, must still be admitted to have been slow in their operations, and expensive for tear and wear; and although they were at one period greatly approved of, yet they are now become old and obsolete, and are generally laid aside to make way for the fly and tube frames, which, from the great satisfaction they have hitherto given, seem likely to be the only machines that will be generally employed as slabbing frames throughout the trade, and therefore the remarks upon each of these will be a little more detailed.

THE FLY FRAME.

THIS important machine having undergone considerable improvements a few years ago, has now become one of the most popular machines employed in the whole process of cotton spinning, whether it be used merely as a slabbing frame, or, both for slabbing and finishing. When used for the latter, it prepares a superior quality of rove* for the jennies, abridges the process, and saves a considerable expense. It is, perhaps, one of the most ingenious machines employed in the preparatory department of the process, though somewhat complex in its construction; and can be adapted for making rovings of any grist, from a ¼ hank to 30 hanks. This frame has become so popular, and attracted so much notice, that the other frames already mentioned have now become nearly obsolete, and are generally thrown aside; so that, in the course of a few years, they will

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* The produce of the fly frame, or any other machine when employed merely as a slabbing frame, is generally called slab or slub; but when this is reduced into a fine state for the jenny, it is then denominated rove or roving.

be known only by name to many of those employed in the operative department of the business.

The fly frame, instead of revolving cans, has a certain number of spindles placed at equal distances from each other; a forked piece of iron is adjusted on the top of each spindle, called a flyer, both the legs of which are now made in the form of a tube, for the purpose of receiving the roving, and conveying it to the bobbin. The rollers deliver the roving to the top of the flyer, where it passes through a small hole right above the centre of the spindle, called the eye of the flyer, and from which it descends through the tube to the bobbin, which is fitted loosely on the spindle. The flyer revolves rapidly round the bobbin, and winds the roving on it as fast as it is delivered by the rollers. The motion of the rollers and spindles are equal and uniform at all times; hence the twist is equally diffused over all parts of the roving. But to adapt the taking up of the roving to the uniform delivery of the rollers, the speed of the bobbin must be variable and unequal; for while it increases in diameter, the velocity of its acting circumference must always remain the same; therefore the ratio of its accelerating motion must be equal to the ratio of its increasing diameter, that is supposing the bobbin to follow the flyer; sometimes, however, the flyer follows the bobbin, in which case the speed of the bobbin must decrease in the same ratio as above.

Various contrivances have been attempted for accomplishing this change on the velocity of the bobbins; a short description of a few of them will be quite sufficient for our present purpose.

In some machines this variable motion of the bobbins is produced, by means of two cones placed with the thick end of the one directly opposite the small end of the other; the one of these cones, revolving uniformly, communicates motion to the other, by means of a revolving belt passing round both; and by being shifted to either extremity, varies the speed of the other. From the second cone, the bobbins receive their motion by bands from a pulley connected with it; which pass round pullies resting on an iron rail, called the bobbin rail; the bobbins resting on these pullies, are carried round along with them: both bobbins and pullies are loosely fitted on the spindles, that they may the more freely rise and fall by the ascending and descending motions of the bobbin rail. The diameter of the one cone increases in the same proportion as the other decreases; so the velocity of the bobbins are accelerated, or retarded according to the shift of the belt: this is also adjusted to suit the grist of the rovings.

The fly frames now generally in use are greatly improved, and the mechanism, by means of which the variable motion of the bobbins is accomplished, is various, according to the make of the different machines. In the one, generally denominated the patent fly frame, the variable motion of the bobbin is accomplished, by means of a most ingenious and curious invention. It has only one cone, and upon the shaft which passes through the centre of the frame, called the frame shaft, *(see patent motion for fly frame, Plate VII. Fig. 4th.)* there are two pullies, about 10 inches in diameter; one of which drives the spindles by a band, and is called the twist pulley; the other conveys motion to the bobbins, and is called the bobbin pulley. Both pullies are hollowed out on one side, and about 2¾ inches broad on the rim, and when placed close together with their hollow sides towards each other, they resemble a solid box. The twist pulley being made fast to the shaft, communicates a regular and uniform motion to the spindles; but the bobbin pulley, as it requires to give a variable motion to the bobbins, is fitted loosely on the shaft, and kept from receding from the twist pulley, by means of a small ring S fastened to the shaft with a set screw. The most ingenious part of the invention lies in the means by which motion is communicated to the bobbin pulley: but to give a full and minute description of all its parts, would require a variety of drawings to illustrate it by references to them; this, however, is not considered necessary, as a general description may suffice for the present.

The two pullies F P, are both fitted on the frame shaft G G; the one, viz. the twist pulley F, is made fast, while the bobbin pulley P, is loose; and instead of coming in contact with each other, there is a spur wheel A, of the same diameter as the pullies fitted loosely on the shaft, right between them; the pullies are set close to the wheel on each side, with their hollow sides inward: there is also a small bevel pinion B B, fitted within each of the pullies, and facing the sides of the spur wheel A; between two of the spokes of which is another bevel pinion C, containing the same number of teeth as the other two; and when the two pullies are set close to the wheel on each side, the pinions B B, inside the pullies, are brought into contact with the pinion C, betwixt the spokes of the spur wheel; and, therefore, as the twist pulley is made fast to, and revolves with the shaft, it communicates motion to the bobbin pulley, by means of the bevel pinions inside, which are wholly concealed from view. It is therefore obvious, that when the pullies are properly set with the inside pinions in pitch, the twist pulley, revolving at the same rate as the frame shaft, will communicate an equal motion to the bobbin pulley, provided the spur wheel in the centre either stands still, or moves round along with the twist pulley, when the pinions inside being all in contact, will carry round the bobbin pulley at the same speed. When the twist pulley stands still, and the spur wheel revolves, the pinion between the spokes of the wheel runs round on the other pinion fixed inside the twist pulley;

while, at the same time, it moves the bobbin pulley in the same direction with the wheel, at the rate of two revolutions of the pulley for one of the wheel; hence the variable motion of the bobbin pulley is entirely effected by the motion of the centre wheel; for unless the centre wheel either stand still, or revolve at the same speed as the twist pulley, the motion of the two pullies cannot be equal.

If the spur wheel revolves in the same direction with the twist pulley, the bobbin pulley will lose two revolutions on the twist pulley for every revolution of the wheel; but if the wheel revolve in an opposite direction, it will gain in the same proportion; therefore, the taking up of the bobbin is adjusted by the motion of the spur wheel: this motion again is regulated by means of the cone E. Now from the end of the frame shaft G G—on which the pullies are adjusted—motion is conveyed by a range of wheels to the beam rollers, and to a small shaft between the beams: there is a sliding pulley fitted on this shaft, which shifts one tooth of the rack at every ascent and descent of the bobbin rail; and as this sliding pulley drives the cone by means of a belt passing round both, and every shift of the pulley shifts the belt farther on to the thick part of the cone, consequently the motion of the cone is retarded more and more at every shift of the belt, and being connected with the centre spur wheel by wheel work, it produces the retardation or acceleration of the centre wheel, and with it the bobbin pulley, which adapts the surface motion of the bobbins to the uniform delivery of the rollers. The ascending and descending motion of the bobbin rail is also effected by the same range of wheels and pinions that connects the cone with the centre spur wheel, and therefore its motions are regulated by the same means as the speed of the bobbins.

The wheel on the end of the frame shaft that communicates motion to the beam rollers, likewise drives the small shaft between the beams, and therefore when the speed of the rollers is increased or decreased, with a view to give more or less twist to the roving, this shaft is effected in the same manner, and with it the cone, and also all the other parts of the machine, except the spindles, the motion of which is always equal and uniform.

The above machine is much admired for its ingenuity, and has lately been much improved, on the principle of substituting wheels and pinions, in place of bands, for driving the spindles and bobbins: and when made upon this plan, it is decidedly the best, and, perhaps, the least complicated of any that are now used.

Another fly frame, rather different from the one described above, is greatly approved of by a number of managers, both for a slabbing and finishing frame. Like the above, it consists of only one cone, *(see Plate VII. Fig. 2d.)* which conveys motion to the bobbins by means of the belt *b b* passing round the pulley S, on the same shaft with the bobbin pulley T. The band that drives the pullies, on which the bobbins rest, passes round the pulley T, and is driven by it. The cone is connected with the traverse lever D D, by the connecting wire W. The traverse lever is also fixed to the rack N, which shifts one tooth in the direction of the cone at every ascent or descent of the bobbin rail. The cone is also shifted by the connecting wire, and as it revolves with a uniform motion, the belt *b b*, by advancing farther on to the thick part of the cone, increases the speed of the bobbins, in proportion to the increased circumference of that part of the cone to which it has shifted. If all the teeth in the rack were equally distant from each other, the length of every shift of the cone would likewise be the same, and, consequently, the velocity of the bobbin accelerated in an equal proportion at every shift.

But, as already remarked, the ratio of the increasing speed of the bobbins, must be equal to its increasing diameter: suppose the diameter of one ply of roving to be $\frac{1}{32}$* of an inch, then every shift

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* For each tooth in the rack there will be one layer of roving laid on the bobbin; now a rack containing 28 teeth, will lay on 28 layers equal to 56 ply of roving in the diameter of the full bobbin. If the diameter of the bobbin when empty be one inch, and $2\frac{3}{4}$ when full, this will be 56 ply of roving in the space of $1\frac{3}{4}$ inch; equal to 32 ply in one inch, therefore each ply will be $\frac{1}{32}$ of an inch in thickness.

of the cone must increase the speed of the bobbin in the proportion of $\frac{1}{32}$ to its diameter, at whatever stage it may have arrived in its progress of filling. If the barrel of the bobbin when empty be one inch, every layer of roving that is laid on, will increase its diameter accordingly; when its diameter has increased to $1\frac{1}{2}$ inch, the next layer of roving will make it $\frac{1}{32}$ more, and therefore the shift of the cone at this stage must increase its speed in the proportion of $\frac{1}{32}$ to $1\frac{1}{2}$; when the bobbin is two inches, the shift of the cone must increase its speed in the proportion of $\frac{1}{32}$ to 2, &c.; and so must its velocity increase in the same ratio with its increasing diameter, until it is full.

The cone is shifted by means of the rack, the number of teeth in which is in proportion to the grist of the roving, and, consequently, the ratio of the increasing velocity of the bobbin depends upon the manner in which the teeth of the rack are divided, and the graduated form of the cone; therefore, as it may be interesting to those employed in making or superintending these machines, to understand the rules by which the cone and the racks are made, the following examples are here inserted, as tending to illustrate and exemplify the principles upon which these rules are founded.

Rules for forming the Cone and dividing the teeth of Racks for Fly Frames.

Find, in the first place, the diameter of one ply of roving; and, second, the diameter and circumference of the empty bobbin: likewise of every different layer of roving laid on from the beginning until it is full.

To find the diameter of one ply of roving.

Divide the difference between the empty and full bobbin by the number of layers, the quotient will be the diameter of one layer, one half of which will be the diameter of one ply, there being two plies into each layer.

If the diameter of the empty bobbin be one inch and $2\frac{3}{4}$ inches when full, their difference will be $1\frac{3}{4}$; and suppose there are 20 layers, then $1.75 \div 20 =$ .0875, diameter of one layer, one half of which is .04375, equal to the diameter of one ply of roving: therefore as each layer will increase the preceding diameter by .0875, the different diameters may be regarded as an increasing equidifferent series, the number of layers being the number of terms, and the diameter of one layer the common difference. And suppose the circumference of one inch to be 3.1415, then the diameter of bobbin at each layer, multiplied by the circumference of one inch, gives the circumference of each layer respectively; the diameters and circumferences will therefore stand as under.

	Diameter.				Circumference.
Empty bobbin,	1 inch		3.1415	=	3.1415
1st layer, ——	1.0875	×	3.1415	=	3.4163
2d do. ——	1.1750	×	3.1415	=	3.6912
3d do. ——	1.2625	×	3.1415	=	3.9661
4th do. ——	1.3500	×	3.1415	=	4.2410
5th do. ——	1.4375	×	3.1415	=	4.5159
6th do. ——	1.5250	×	3.1415	=	4.7907
7th do. ——	1.6125	×	3.1415	=	5.0656
8th do. ——	1.7000	×	3.1415	=	5.3405
9th do. ——	1.7875	×	3.1415	=	5.6154
10th do. ——	1.8950	×	3.1415	=	5.8903
11th do. ——	1.9625	×	3.1415	=	6.1651
12th do. ——	2.0500	×	3.1415	=	6.4407
13th do. ——	2.1375	×	3.1415	=	6.6207
14th do. ——	2.2250	×	3.1415	=	6.9898
15th do. ——	2.3125	×	3.1415	=	7.2647
16th do. ——	2.4000	×	3.1415	=	7.5396
17th do. ——	2.4875	×	3.1415	=	7.8144
18th do. ——	2.5750	×	3.1415	=	8.0893
19th do. ——	2.6625	×	3.1415	=	8.3642
20th do. ——	2.7500	×	3.1415	=	8.6391

Having found the diameter and circumference of the bobbin at the different layers as above, proceed next to find how many revolutions of an empty bobbin will be required to take up a given length of roving, suppose 99 inches; and likewise the revolutions of the spindle, and cone shaft for the same. Then subtract the revolutions of the bobbin required, from the revolutions of the spindle: multiply the remainder by the diameter of the bobbin pulley, and divide by the revolutions of the cone shaft; the result will be the diameter of the cone required.

To find the revolutions of an empty bobbin required to take up 99 inches of roving.

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

```
Circumference of empty bobbin 3.1415)99.0000(31.51 revolutions of
                                     94245         empty bobbin
                                     -----         required.
                                      47550
                                      31414
                                     ------
                                     161360
                                     157075
                                     ------
                                       42860
                                       31415
                                       -----
                                       11445
```

To find the revolutions of the Spindle for 99 inches of roving.

Suppose $1\frac{1}{2}$ twists on each inch of roving; then multiply the given length by the twists per inch; the result is the revolutions of the spindle.

$99 \times 1\frac{1}{2} = 148$ revolutions of the spindle.

To find the revolutions of the Cone Shaft for 99 inches of roving.

Multiply the revolutions of the cone shaft per minute, (*see page* 36.) by 148, and divide by the revolutions of the spindle per minute, (*see page* 138.)

204 × 148 ÷ 585.42 = 51.8 revolutions of cone shaft for 99 inches of roving.

Revolutions of spindle, . . 148
Revolutions of empty bobbin, 31.51

116.49
Diameter of bobbin pulley, . 3.5

58245
34947

Rev. of cone shaft, 51.8)407.715(7.87 diameter of cone required to begin an empty bobbin.
3626

4511
4144

3675
3626

49

The following calculations give the diameters of the cone at the different layers.

For empty bobbin	99÷3.1415=31.51—148×3.5÷51.8=7.87	dia. of cone	for empty bobbin.
1st layer	99÷3.4163=28.97—148×3.5÷51.8=8.04	do.	for 1st layer.
2d do.	99÷3.6912=26.82—148×3.5÷51.8=8.18	do.	for 2d do.
3d do.	99÷3.9661=24.96—148×3.5÷51.8=8.31	do.	for 3d do.
4th do.	99÷4.2410=23.34—148×3.5÷51.8=8.42	do.	for 4th do.
5th do.	99÷4.5159=21.92—148×3.5÷51.8=8.51	do.	for 5th do.
6th do.	99÷4.7907=20.66—148×3.5÷51.8=8.60	do.	for 6th do.
7th do.	99÷5.0656=19.54—148×3.5÷51.8=8.67	do.	for 7th do.
8th do.	99÷5.3405=18.53—148×3.5÷51.8=8.74	do.	for 8th do.
9th do.	99÷5.6154=17.63—148×3.5÷51.8=8.80	do.	for 9th do.
10th do.	99÷5.8903=16.80—148×3.5÷51.8=8.86	do.	for 10th do.
11th do.	99÷6.1651=16.05—148×3.5÷51.8=8.92	do.	for 11th do.
12th do.	90÷6.4407=15.37—148×3.5÷51.8=8.96	do.	for 12th do.
13th do.	99÷6.7149=14.74—148×3.5÷51.8=9	do.	for 13th do.
14th do.	99÷6.9898=14.16—148×3.5÷51.8=9.04	do.	for 14th do.
15th do.	99÷7.2647=13.62—148×3.5÷51.8=9.07	do.	for 15th do.
16th do.	99÷7.5396=13.13—148×3.5÷51.8=9.11	do.	for 16th do.
17th do.	99÷7.8144=12.66—148×3.5÷51.8=9.14	do.	for 17th do.
18th do.	99÷8.0893=12.23—148×3.5÷51.8=9.17	do.	for 18th do.
19th do.	99÷8.3642=11.83—148×3.5÷51.8=9.20	do.	for 19th do.
20th do.	99÷8.6391=11.45—148×3.5÷51.8=9.22	do.	for 20th do.

The above calculations give the correct diameters of the cone for the different layers; that is supposing the pullies S and T *(see back view of Fig. 2d. Plate VII.)* to be exactly the same in diameter; but, the pulley S—as represented in the Plate—is six, and the pulley T eight inches in diameter; therefore, to adapt the cone to suit them, it would require to be less in the proportion of 4 to 3 than that which is given above; its graduating form, however, must still be the same; and as it is obvious that the difference between the diameters of the cone for the different layers, become gradually less as the bobbin fills; so must the length, which the cone shifts for the different layers, gradually decrease in the same proportion; but the cone is shifted by means of the rack, consequently the rule by which the teeth of the rack are divided, must be founded on the principles laid down above.

Plate VIII. Fig. 1st, represents a cone, with the different shifts drawn according to the preceding rules; the distance between each shift, as represented on the cone, is exactly proportioned to the difference between the diameters for the different layers, as found by the above calculations.

If parallel lines, corresponding with the number of layers that are laid on the bobbin, be set at equal distances from each other, and divided into various lengths, according to the divisions of the cone for the different layers, it will be found that the difference of their lengths will form a perfect parabolic curve; *(see Fig. 2d. Plate VIII.)* hence the reason why this has been adopted, as the most proper figure by which to divide the teeth of the rack, *(see Plate IX. Fig. 1st.)* A A is a segment of a parabola. The two sides, A B and B A, are a right angle, forming two sides of a square, the length of each is equal to the length of the rack to be divided. Having a piece of hard wood, formed exactly the same as the figure A E B F A, the rack is placed right under the side E, and the side F being divided into equal divisions, the number of which are the same as the number of teeth intended to be cut in the rack. From each of these divisions on the side F, lines parallel with the side E are drawn across the segment of the parabolic curve. From the points where these lines intersect the curve, perpendicular lines parallel with the side F are drawn down to the rack; and the teeth are marked, one on each side alternately, at the points on which the perpendicular lines fall, *(see Plate IX. Fig. 1st.)* If the rack be divided in this manner, and the cone formed according to the rule mentioned above, every shift of the cone can be adjusted so perfectly, as to adapt the ratio of the increasing speed of the bobbin to its increasing diameter with the greatest exactness, and thereby regulate the velocity of its acting circumference, to the equal and uniform delivery of the rollers.

Fig. 3d. Plate VIII. exemplifies the method of forming a parabola. A circle is divided into 32 equal parts; the distance from the centre to the point B, is one-eighth of its diameter: the arc A B has the same radius as the circle; and within the arc A B, each division of the circle is subdivided into four equal parts. Now the parabola A A A is formed, by taking the distance from the centre of the circle, to the points where the subdivisions intersect the arc A B, and transferring them to the respective divisions of the circle; as 1 to 1, 2 to 2, 3 to 3, &c. A much more simple and easy method of forming a parabola is given in *Simpson's Geometry*. The above, however, is, perhaps, more generally practised, and has been found particularly adapted to the intended purpose. A machine has likewise been constructed on the same principle, and can be used for dividing a rack into any number of teeth that can possibly be required, by means of a scroll or snail wheel; *(see Plate IX. Fig. 2d.)* A A is a dividing plate similar to those used for cutting the teeth of pinions; B B, a snail wheel fixed on the axle of the dividing plate; E E, a sliding square. The range of the snail wheel is exactly equal to the length of the rack to be divided, and is connected with the sliding square, moving in the direction of its centre. The rack is placed within the range of the square (as represented in the Plate) which is in its proper position for marking the first tooth. The dividing plate is to be divided into circles, each of which is again divided into as many parts as may be required. The catch H is set upon the outer circle, which is represented as containing 20 parts or divisions, by moving the dividing plate, and, of course, the snail wheel in the direction of the figures 2, 3, 4, &c. to 20, moving the square, and marking a tooth at every division of the circle: a rack containing 20 teeth may be formed every way adapted to the fly frames. And in the same manner, it is obvious, that to form a rack, containing any number of teeth, it is only necessary to move the catch H to the circle containing the number of divisions required, and proceed as above. The catch is supposed to hold the plate at every division, when the sliding square moves downward in the direction of the centre of the snail wheel, until the point *a* rests upon the side of the snail; (the rack being always fixed) the square is then brought into a proper position for marking another tooth. F F F, is the framing upon which the whole is fitted.

Arkwright, upon finding the defects of his can frame, attempted a fly frame for preparing his rovings, which he constructed upon the same principle as his water frame. But as the bobbin filled with roving, it became heavier, and, consequently, required more force to drag it round; it rested on a wooden rail, and was retarded by friction from moving as fast as the spindle and flyer. Now it is obvious, that if the bobbin remains stationary, while the flyer revolves swiftly round it, the roving, instead of winding on the bobbin, would instantly be broken; and again, if the bobbin revolved as fast as the flyer, it could not take up the roving; therefore the bobbin requires a slow motion, and that motion to increase gradually as it fills; for the length of roving taken up by the bobbin depends upon the difference of the speed of the bobbin and flyer. Arkwright, however, with all his ingenuity, could not invent the mechanism required to produce this varying motion of the bobbin; and hence his fly frame was abandoned as inadequate to the purpose for which it was intended. But in the fly frames described above, this motion of the bobbin can be adjusted to the greatest precision.

In the common flax wheel, the flyer has a number of teeth, for the purpose of guiding the thread on to the bobbin, and when the thread is shifted from tooth to tooth, the bobbin is filled equally from end to end. In the fly frame, however, this is accomplished by a piece of very ingenious mechanism, by means of which the bobbin rail is made to rise and fall by a regular motion, which, like the speed of the bobbin, varies in proportion to its circumference. For if the delivery of the rollers be uniform, it is obvious that the circumference of the bobbins will increase as they fill; and, consequently, more length of roving will be required for each revolution of the bobbin; therefore the alternate ascending and descending motion of the bobbins must be retarded in the ratio of their increasing circumference. In the common fly frame this varying motion is produced by the friction pulley E, *(see Plate VII. Fig. 2d.)* the traverse lever D D, as already mentioned, is fixed to the rack at the top, while at the point C it supports the shaft G, on the top of which is the friction pulley E, which has no teeth, but is covered with leather or cording, and bearing against the face of the friction plate J, is moved by contact, and at the same time is connected with the shaft F by wheel-work. On the end of this shaft there is a small pinion driving the mangle wheel K, the teeth of which are so contrived that the pinion works on both sides; so when the mangle wheel moves round a certain length, the pinion, by shifting to the opposite side, drives it as much in the contrary direction; therefore, the wheel being fixed on the end of the shaft P P, which raises or depresses the bobbin rail by means of the pinion N acting into the rack O, the alternate movement of the mangle wheel causes a constant alternate ascending and descending motion in the bobbin rail: and as the rack shifts one tooth every time the bobbin rail ascends, and another when it descends; so the traverse lever being fixed to the rack, shifts along with it, always in the direction of the cone, while at the point C, it raises the shaft G; and as the friction pulley approaches the centre of the plate J, its motion decreases in the proportion of the increasing circumference of the bobbin.

An improvement has lately been made upon the fly frame, which was partially noticed when describing the patent fly frame, and seems to give the greatest satisfaction wherever it has been tried. It consists of two shafts with teethed wheels for driving the spindles and bobbins, instead of bands; by which the motion of the spindles is more regular and uniform, and, consequently, the twist more equally diffused over all parts of the roving: bands when they get old, have a great tendency to slip, and therefore their motion is not so sure as wheel and pinion. Sometimes the bands are still retained for driving the bobbins, while the wheels are employed for driving the spindles only; as by the latter the frame is much less complex, particularly the common fly frame, than by driving both spindles and bobbins by wheels.

At page 36, the speed of the fly frame shaft, A A, (Plate VII. Fig. 2d.) was found to be 204.90 revolutions per minute. The pinion R upon this shaft, that gives motion to the front rollers, contains 28 teeth, driving the front rollers by intermediate wheels. The wheel M on the front roller is supposed to contain 56 teeth: required the revolutions of the front rollers per minute?

RULE. Multiply the number of teeth in the pinion R on the frame shaft by the revolutions of the shaft per minute, and divide the product by the number of teeth in the twist wheel M, which is fixed on the end of the front roller; the result is the revolutions of the front rollers per minute.

EXAMPLE.

```
Revolutions of frame shaft A ⅌ minute, 204.90
Teeth in the pinion R on do.    .  .  .     28
                                        ------
                                        163920
                                        40980
                                       -------
Teeth in twist wheel M,    .  .  56)5737.20(102.45 revolutions of
                                     56             the front rollers
                                     ---            per minute.
                                      137
                                      112
                                      ---
                                       252
                                       224
                                       ---
                                        280
                                        280
```

To find the revolutions of the Spindles per minute.

RULE. Multiply the revolutions of the shaft A (Plate VII. Fig. 2d.) per minute, by the diameter of the twist pulley B, and divide the product by the diameter of the small pulley on the spindle, which is driven by the band.

EXAMPLE.

```
Revolutions of frame shaft A per minute, 204.90
Diameter of the twist pulley B,   .   .     10
Diameter of pulley on the spindle, 3.5)2049.00(585.42 revolutions
                                       175         of spindles per
                                       ---
                                       299         minute.
                                       280
                                       ---
                                        190
                                        175
                                        ---
                                         150
                                         140
                                         ---
                                          100
                                           70
                                          ---
                                           30
```

To find the twists per inch on the roving in the Fly Frame.

RULE. Multiply the circumference of the front roller by its revolutions per minute, this will give the length produced per minute. Divide the revolutions of the spindle per minute by it; the result will be twists per inch on the roving.

EXAMPLE.

```
Revolutions of the front roller per minute, 102.45
Circumference of       do.       suppose,     3.93
                                             -------
                                             30735
                                            92205
                                           30735
                                           --------
                                           402.6285

          Rev. of spindle.
 402.62)585.42(1.45 twists per inch on the roving.
        40262
        ------
        182800
        161048
        ------
         217520
         201310
         ------
          16210
```

The method of calculating the draughts of the drawing frame, fly frame, tube frame, &c. being exactly the same, and having exemplified one, viz. the method of calculating the draught of the drawing frame, it is unnecessary to exemplify the method of calculating the draught of the others.

The fly frame has of late acquired a considerable degree of importance; and from the improvements now in progress, it is supposed that it will still become more popular. It is somewhat complex, and requires very accurate adjustment; but by subsequent improvements, may yet be much simplified and more easily managed. It would be of great advantage to those who may have the charge of managing and adjusting this machine, that they understood correctly the principles upon which it is constructed, and how its various parts are adapted to each other; for it is not to be supposed, that one whose knowledge is derived merely from having witnessed its operations, can be so well qualified for managing or adjusting it, as those who are thoroughly acquainted with the principles of the machine, the methods by which its component parts are calculated to suit each other, and the purposes for which they are intended. These considerations will therefore justify the space allotted to it in this treatise.

THE TUBE FRAME.

The Tube Frame is but of recent date, has already given great satisfaction, and is considered a very important machine, especially for spinning coarse numbers, as it is generally used for a finishing frame: but when employed as a slabbing frame, and where the roving is afterwards to be reduced at a stretching or fly frame preparatory to its being spun into a fine thread at the jenny, it may be used in the preparation department for any numbers of yarn whatever.

Tube frames seldom prepare rovings finer than $4\frac{1}{2}$ hanks, as owing to their peculiar construction they communicate no twist; consequently the rovings require to have some body or thickness to give them strength sufficient to pull round the bobbins without being overstrained. Although some excellent yarn, as high as Nos. 60 and 70, have been spun from rovings prepared in these frames, yet, in general, they are not used for any numbers above 50.

The chief merit of the tube frame lies in the quantity of roving it produces in a given time. For in respect to quantity, it seems to possess capabilities which belongs to no other machine employed in the whole process of cotton spinning.

The tube frames, instead of revolving cans, have revolving horizontal cylinders parallel with the beam rollers, and placed about 12 inches in front of the beam for single frames; but double tube frames have one cylinder about 10 inches from the beam, and the other about 19 or 20: the velocity of the acting circumference of the cylinders is generally the same as the front rollers. Sometimes it has been tried, with good effect, to drive the cylinder rather faster than the rollers, by which the thread of roving is kept firm and tight, and, consequently, the tubes take better hold of it, and build it harder on the bobbins; the bobbins rest upon the cylinder, and are moved by contact: a small hollow cast iron tube, about $4\frac{3}{8}$ inches in length, is fitted up in front of the bobbin, through which the roving passes, until about $\frac{7}{8}$ of an inch from the point, where it is brought out by a small opening, and carried over what is called the bridge of the tube, when it again enters, and is brought out by a hole at the point, called the eye, while the roving is passing through: the tube is made to revolve about eight or nine thousand times per minute; and by being brought over the bridge, it is taken hold of by the tube, and twisted as hard as a piece of cord between the tube and the rollers; but all of which is entirely thrown out again between the bridge of the tube and the bobbin; so that when the roving is laid upon the bobbin, it has no twist whatever; the bobbins merely revolve in the same manner as the front rollers, so as to take up the roving exactly as it is delivered; but they have no rotatory motion, and, therefore, it is impossible to give the roving any degree of twist while it is winding on the bobbin. In the making and fitting up of the tube frame, the great object to be attended to, is the proper form and adjustment of the tube; it must stand at a right angle to the bobbin, and pointing rather below the centre; the width of the eye must be proportioned to the grist of the roving. The angle formed by the roving while passing over the bridge, must be sufficiently acute, to make the tube take hold of it, and at the same time allow it to pass freely through. To have the fibres of the roving well laid and smoothed down, and bound hard and close on the bobbin, is a most essential object in the adjustment and management of this frame.

The front rollers of the tube frame can be driven at the rate of 400 revolutions per minute with perfect safety; while the utmost speed of the fly frame rollers, seldom exceeds 120, and even that is above their average. But even with the front rollers revolving 390 times per minute, the tube frame is capable of supplying rovings for the jennies in the proportion of 80 spindles to each tube, the roving 3¼ hanks, and each spindle producing about 19 hanks of No. 36 wefts per week. There are tube frames that supply rovings for a greater number of jenny spindles to each tube, but the above, it is presumed, will be found nearly their average. If one tube supply roving for 80 jenny spindles, producing 19 hanks of No. 36° per week, then the weekly produce of each tube will stand as follows.

Spindles, Hks.
$$80 \times 19 = 1520 \text{ hanks, or } \frac{1520}{36} = 42 \text{ lbs. } 3 \text{ oz. of yarn,}$$
No. 36° per week from each tube.

The history of cotton spinning, does not furnish an example of any machine, the capabilities of which can bear a comparison with this. If 42 lbs. 3 oz. of yarn be spun from the produce of one tube, 1181 lbs. 1 oz. may then be obtained from the produce of a frame containing 28 tubes. But its capabilities will appear more prominently, if contrasted with other frames employed for similar purposes. The following results have, therefore, been taken in several respectable Spinning Factories, as the average produce of the stretching frame, fly frame, and can frame.

With a 3¼ hank roving, and each mule spindle producing 19 hanks per week of No. 36 wefts.

Each stretching frame spindle prepares roving for			13	jenny spindles.
Each fly frame	do.	do.	17	do.
Each tube of the tube frame		do.	80	do.

And suppose the slab or coarse rovings, to be ½ hank, and prepared for the same numbers, viz. 36° each jenny spindle producing as above.

Each can of the can frame prepares rovings for		70	jenny spindles.
Each spindle of the fly frame	do.	100	do.
Each tube of the tube frame	do.	nearly 480	do.

The above comparison of the produce of these frames, is intended to show that the productive capabilities of the tube frame exceed that of the fly frame, in the proportion of 80 to 17, and the stretching frame, in the proportion of 80 to 13. And when employed as a slabbing frame, it exceeds the fly frame, in the proportion of 480 to 100, and the can frame, in the proportion of 480 to 70. If to all this is added, the expense incurred for winding the rovings by a separate process, where the can and stretching frames are still employed; besides the quantity of waste that is made at the winding process, together with the injury to which the rovings are liable when passing through that operation, it will be admitted that the can frame is the least productive, the most expensive, and injurious to the cotton. The tube frame far exceeds any of the others for quantity; but in point of quality, the roving produced by it, is inferior to that produced by either the stretching or fly frame. In consequence of the tube frame rovings having no twist, they are so extremely soft and tender, that they are frequently breaking, and thereby cause a greater quantity of waste than any of the other frames, which will ever be regarded as an insuperable objection to this machine, notwithstanding its great produce; and should the improvements now in progress upon the fly frame succeed, it is confidently expected that it will yet supersede the tube frame altogether: as the fly frame, when properly adjusted, always makes a superior quality of roving; and could it only be driven with safety at a quicker speed than has hitherto been practicable, it would certainly become the most popular of any.

The method of calculating the revolutions of the front rollers, is exactly the same as for the fly frame, and the draught is calculated by the same method as the drawing frame; it is, therefore, unnecessary to exemplify them in this place.

The method of dividing the teeth of the racks for tube frames, is exactly the same as for that of fly frames; only the proper figure (instead of a segment of a parabolic curve) is a segment of a circle, the radius of which is equal to the length of the radius bar of the frame. If the radius bar be six feet, then a segment of a six feet circle is the proper figure.

THE STRETCHING FRAME.

Stretching Frames appear to be going out of use altogether, as almost every manager seems to prefer the finishing fly or tube frame in their stead; and therefore it will be unnecessary to occupy much time in describing them, especially as they bear so close a resemblance in all respects to the mule jenny, which is afterwards to be noticed.

The use of the stretching frame is to reduce the grist of the roving, and prepare it for being spun into a fine thread at the jenny. A doubling at the stretching frame, when it can be conveniently obtained, tends to equalise the grist of the roving, and consequently, improve the quality of the yarn. The name of this machine would seem to import that it reduces the roving by stretching it, but this, however, is not the case; the roving is reduced here by drawing it between the rollers, which is a distinct process from that of stretching. In the adjustment of the stretching frame, an important object to be attended to, is to make it so as to give the roving no stretch whatever. The carriage should recede from the beam exactly as the rollers give out the reduced roving; and instead of stretching, it should rather, if any thing, lose a very little; and while the spindles are receding from the rollers, they should communicate the full portion of twist that is necessary; so that when the carriage comes to the head, the twisting should immediately stop.

The method of calculating the draught of the stretching frame, is exactly the same as the jenny, which shall afterwards be exemplified.

To find the diameter of a Mendoza Pulley, that will make the carriage and spindles recede from the rollers exactly as the roving is delivered, without either gaining or losing.*

Rule. Multiply the number of teeth in the mendoza wheel by the diameter of the front roller; and divide the product by the number of teeth in the pinion on the front roller that drives the mendoza wheel; and from the result thus obtained, subtract the diameter of the mendoza band; the remainder will be the diameter of the mendoza pulley required.

EXAMPLE.

Teeth in mendoza wheel, 112	Teeth in pinion on front roller, 19
Diameter of front roller, 1⅛ inch.	Diameter of mendoza band, ½ in.

```
    112
     1⅛
    ———
    112
     14
   ————
19)126( 6.63
   114   .5   diameter of mendoza band.
   ———
    120 6.13 = 6⅛ inches, diameter of pulley required.
    114
    ———
     60
     57
     ——
      3
```

* The proper name of this pulley is the taking-out pulley; but the name mendoza being commonly used amongst operatives and mechanics, it is therefore retained, as best understood.

The rovings produced by the stretching frame being very soft and tender, require to be carefully handled, as the least injury sustained by them will also injure the yarn; therefore the stretching frame requires to be adjusted with the greatest exactness, and the rollers especially, should be kept particularly clean and well oiled.

Stretching frames are preferred by some managers for the purpose of obtaining a uniform size of yarn at the jenny. For by weighing the sets of roving thrown off by the stretching frame at regular intervals, the variation of the cotton is more easily discovered and checked by changing the pinions, and hence a more regular and uniform size of yarn will be produced. They are also preferred by some for obtaining a doubling at the jenny, as the rovings produced by the stretching frame being built on the spindles in the form of a cone, occupy less space than bobbins, and hence are better suited for being set close together, so as to have two plies for one thread of yarn. But it is obvious that a doubling might be conveniently enough obtained with bobbins, by adapting their dimensions to the space they are to occupy.

SPINNING MACHINES.

THE COMMON JENNY.

THE spindle and distaff seem to have been the only implements used for spinning yarn, by the most ancient nations, of whose early history we have any authentic record. And even to this day, in India, and many other of the less civilized parts of the world, the same rude instruments are used for similar purposes, and appear to have been introduced into Britain only in the reign of Henry VIII. These simple implements of domestic industry, have long been superseded in the more enlightened nations of Europe, by the invention of the well known machine called the spinning wheel; the name of the inventor has not been handed down to us; but for many years it continued to be the only machine used for the spinning of cotton yarn in this country, until about the middle of the last century, when the extending commerce of Great Britain increased the demand for cotton yarn, and various contrivances were attempted to expedite the process of spinning by the application of machinery, none of which seem to have succeeded until the invention of the spinning jenny in 1767, by James Hargreaves, who has already been mentioned as the inventor of the stock card. As some of the most important discoveries in the arts and sciences have been suggested from the most trivial occurrences, so it was with the spinning jenny. Hargreaves upon seeing a common spinning wheel accidentally overturned, continue its motion for some time whilst lying on its side, immediately conceived the design of attempting to form a spinning machine, which he afterwards constructed in a very rude manner, containing only eight spindles, driven by bands from a horizontal wheel; but which, by subsequent improvements, was greatly enlarged, till at length it contained upwards of 80 spindles. The spinning machine, thus invented, was denominated the common jenny, which is carefully to be distinguished from the mule jenny,* the one now generally used. The cylinder cards were in use several years before the invention of the common jenny, and prepared the rovings for it; which were passed through between two pieces of

* As the common jenny is now almost entirely out of use and unknown to the greater part of those employed in the operative department of the business; the single term jenny is generally employed throughout the whole of this Treatise, when the mule jenny is spoken of, but it is easy to determine from the sense of the passage that it is the mule that is referred to.

wood called the clasp, lying in a horizontal direction the whole length of the machine: the rovings were put through a certain length, when the clasp, by closing together, held them fast, while the spinner, seizing them with the hand, stretched them out a proper length, and formed them into threads of yarn, which were twisted by the spindle, and wound on the same, in the form of a cone. These jennies continued long in use for making weft yarn, even after Arkwright's mode of spinning had been introduced. The cotton was prepared for being spun with the common jenny, by immersing it in soap and water, and afterwards pressing out the water in a screw-press, and drying the cotton in a stove.

The common jenny underwent many alterations and improvements; the vertical was substituted for the horizontal wheel, which rendered it a more neat and commodious machine. It entirely superseded the one thread wheel, and, for a considerable time the whole wefts, used in the manufacture of cotton goods, continued to be spun by this machine, until, by the invention of the mule jenny, the other, in its turn, was also superseded. In the common jenny, the cotton was stretched, but not drawn; as the mode of drawing cotton between rollers, was a later invention, and belongs wholly to Arkwright.

WATER SPINNING FRAME AND THROSTLE.

WHILE Hargreaves was suffering persecution and encountering poverty, Arkwright was busily employed in endeavouring to construct a machine which was destined to change the mode of spinning altogether; but, from his want of mechanical knowledge, it was long after the invention of the common jenny before he could bring to perfection the idea he had formed in his own mind. Arkwright's invention consisted in a peculiar application of rollers, to perform precisely the same operation as was performed by the spinner with the finger and thumb, in drawing out and disengaging the fibres of the wool, so as to bring the thread to its proper grist. The combination of this original and ingenious invention, with the spindle and flyer of the common domestic spinning wheel, formed the spinning machine for which Arkwright obtained his first patent in 1769, and on which all his subsequent improvements were founded. The first mill he erected for his spinning frames, was at Nottingham, and was driven by horses. In 1771, he erected another at Cromford, in Derbyshire, which was moved by water. And as these were the first spinning machines that were moved by water, they have, in consequence, been generally denominated Water Spinning Frames. The yarn produced by this machine, from its strength and smoothness, was found to be peculiarly adapted for warps; hence it derived the name Water Twist, from the name of the machine in which it was spun; and the throstle being merely an improvement on the water frame, the yarn produced from either, still retains the name Water Twist. For many years after the invention of the water spinning frame, the yarn spun from it was used by most manufacturers for warps, while that spun by the common jenny, from its woolly softness, was made choice of for wefts. But previous to the invention of Arkwright's spinning frame, linen yarn was generally used for warps. Arkwright is said to have obtained his first idea of substituting rollers, in place of the finger and thumb for drawing out the fibres of the wool in the process of spinning cotton, from seeing the action of the common rolling mill in iron works, used for the purpose of elongating red hot bars of iron, as formerly mentioned. By others, it is said, that he got the first idea of his invention from one Kay, a watchmaker in Warrington. But be that as it may, the merit of bringing the first idea into practice belongs to Arkwright alone.

The spinning frame is universally admitted to be a most wonderful and ingenious invention; and, in its consequences, as a source of national or individual wealth, has not a parallel in the history of our country.* This admirable machine underwent various important improvements after it was first set to work, and was brought to its highest state of improvement, by Arkwright, in the year 1775.

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* Some estimate may be formed of the importance of Arkwright's invention of the spinning machine, by comparing the present state of our cotton manufacture with what it was fifty years ago. "It has been said that the yarn produced at that time in England by the one thread wheel, the only spinning machine then known, did not exceed in quantity what 50,000 spindles of our present machinery can yield." But at the present time, the cotton manufacture of this country (next to agriculture) is the most extensive occupation in which our diversified population are engaged. "Mr. Owen calculates that two hundred arms with machines, now manufacture as much cotton as *twenty millions* of arms were able to manufacture without machines forty years ago; and that the cotton now manufactured, in the course of one year in Great Britain, would require, without machines, *sixteen millions* of workmen with simple wheels."

"The value of the cotton goods now manufactured in Great Britain amounts to the enormous sum of *forty millions a year, twenty millions* of which are exported. The amount of capital invested in the whole manufacture is estimated at upwards of £56,000,000, and the number of persons employed is rated at *a million and a half.* Every country in Europe has participated in the benefit of the spinning frame. America manufactures cotton yarn to a great extent by means of machinery. Egypt and India have likewise employed the spinning machines in manufacturing their cottons. In fact, the extension of the cotton manufacture through the different parts of the world that has been accomplished by the inventions of Arkwright and his successors; the influence it has had upon the manners and customs of mankind, by the vast source of commercial intercourse it has opened amongst nations; and the happiness and comforts it has introduced amongst the lower classes of society, by providing employment, and furnishing them with cheap and healthful clothing, are incidents altogether unprecedented in the history of commerce."

Another machine, known by the name of the throstle frame, but which is only an improvement on the former, was brought into use some time after the introduction of the water frame; both machines are the same in principle. The throstle is only a little more simplified, and requires less power to drive it. Each head in the water frame, has a distinct set of gearing, and is driven by a separate motion; and, consequently, each head can be stopped, or set a going at pleasure, independently of the others. In the throstle frame, all the rollers on either side are connected together, and the spindles on both sides are driven by bands from a cylinder B, *(see Plate X. Fig. 1st.)* extending the whole length of the machine; on the one end of the cylinder are the fast and loose belt pullies, and from its axle, motion is conveyed to the rollers by a range of wheels and pinions to each side; and therefore, by stopping the cylinder, the whole machine is immediately stopped. Both the water frame and throstle have three sets of rollers A *(see Plate X. Fig. 1st.)* through which the rove is made to pass, and undergoes a draught of from 5 to 8 inches; and instead of being twisted and wound on the spindle, as in the jenny, it is twisted by a flyer, and wound on a bobbin similar to the spindle and fly frames, which have already been described. In the fly frame, the bobbins require to be driven by a separate motion from that of the spindle, which must also vary in proportion to the increasing diameter of the bobbins, so as to regulate the velocity of its acting circumference to the uniform delivery of the rollers. But the thread spun by either the water frame or throstle, has sufficient strength of itself to bear the drag of the bobbin, and therefore no mechanism is necessary for regulating its motion: in both of these frames the velocity of the bobbin is retarded by friction, which can be increased, to any degree that may be required, by means of washers of cloth or leather; and being thus retarded, the thread, by the motion of the flyer, drags round the bobbin after it, with a velocity equal to the difference between the motion of the flyer and the surface motion of the front roller, or the length of thread delivered out by the roller.

The flyer, fixed on the spindles of both water frame and throstle, resembles that which is employed in the fly frames, and consists of a forked piece of iron, both legs of which are solid, not tubular, but twisted somewhat like a cork-screw at the lower extremities, *a a; (see Plate X. Fig. 1st.)* a piece of iron is also fixed on the top, the point *e* of which is twisted in the same manner, and serves for the eye of the flyer. Sometimes the eye is made of a hooked piece of wire attached to the framing. The thread is put through this eye, which keeps it steady, as, otherwise, it might be thrown out by the centrifugal force of the flyer, and form a considerable arch between the rollers and the eye *a* at the lower extremity that conducts the yarn on to the bobbin. The flyer, revolving rapidly, communicates twist to the yarn, which is kept from vibrating by the eye *e* at the top, from which it descends to the eye *a*; but the bobbin resting on the traverse rail, and retarded by washers from revolving with the same velocity as the flyer, the thread is thereby wound on as fast as given out by the rollers; whilst the traverse rail, ascending and descending by a regular alternate motion, fills the bobbins equally from end to end. This alternate motion of the traverse rail, is accomplished by means of a heart, with cranks and levers, and is called the heart motion. As the yarn is only wound on the bobbin with a velocity equal to the difference between the velocity of the flyer and the acting circumference of the front roller, it, therefore, requires to have sufficient strength, to drag round the bobbin after the flyer without breaking the thread; consequently these machines are only adapted for spinning low numbers, from No. 50 and downwards; they likewise require a rather better quality of cotton than might be necessary for mule yarn of the same numbers.

The spinning frames that were constructed under the auspices of Arkwright himself, were brought to a very high state of improvement; and those that have been generally used since his time, are constructed upon the same principle; any alterations that have been made, are chiefly upon the form or framing of the machine; as that which was formerly made of wood, is now made of cast iron, which gives it a more neat and handsome appearance, and renders it more durable.

Plate X. Fig. 1st, represents an end view of a throstle frame, that is greatly admired both for strength and neatness, as well as for simplicity; and seeing the water frames are generally superseded by the throstles, which have now become so important, as to cause a considerable excitement throughout the trade, the following part of this article will be chiefly confined to the latter.

Between twenty and thirty years ago, or particularly during the late French war, when the commerce of Great Britain had increased to an unprecedented extent, in so much that the whole supply of manufactured goods were, on several occasions, inadequate to the demand, especially those of the finer qualities; the throstle frames not being adapted for spinning fine yarn, were, in a great measure, superseded by the mule jenny: and a number of proprietors of Spinning Factories, who had both water frames and throstles in active operation, threw them aside entirely, for the purpose of introducing mules. The consequence was, that very few water frames or throstles were left in the country. Those few manufacturers who still retained them, frequently enjoyed a brisk demand for their Water Twist, even when mule yarn (in consequence of the general stagnation of trade which followed) was scarcely asked after; and since so many Power Loom Factories have been established, by which the coarser fabrics of cotton cloth are manufactured from 70 to 80 per cent. cheaper than formerly, the demand for yarns of the lower description has completely preponderated; and Water Twist, from its strength and wiry smoothness, being peculiarly adapted for warps to the power looms, it is therefore much in demand by manufacturers; hence a most evident reaction has taken place amongst the proprietors of Spinning Factories regarding the supposed merits of the throstle frame and the mule. The attention of the trade seems now wholly engrossed with the throstles; the quality and quantity of the yarn they produce; its cheapness; and the improvements now in course of trial, the issue of which is exciting the most intense interest: such, indeed, is the importance now attached to these machines, that it is supposed they will, in a short time, entirely supersede the use of mules for spinning all numbers of yarn below No. 50; and, indeed, several proprietors are contemplating the probable advantages that might result from throwing out their mules, and supplying their place with throstles.

Although the throstle frames generally in use are the same in principle with those invented by Arkwright; yet by the various improvements that have been made on their form, or general construction, they are now capable of producing a superior quality, as well as a greater quantity of yarn, in a given time, than could formerly have been supposed. The yarn produced from these machines, as already remarked, is principally used for warps; but in some places, owing to late improvements, they are employed for spinning a superior quality of wefts, which, instead of being lapped on bobbins, is built on the spindle, the same as in the mule, in the form of a neat compact pirn cope, every way prepared for putting into the shuttle. Other improvements upon the throstle, or rather new inventions of equal, or, perhaps, higher importance, are just now attracting considerable notice, both in Scotland and England; as it is confidently asserted, that by means of these improvements, the throstles will be rendered capable of producing a greater quantity, in a given time, than any other spinning machine that has ever yet been tried. But without taking further notice of these inventions in this place, as they will afterwards be described at the end of the article on the mule jenny, where the productive capabilities of the different spinning machines will be more conveniently contrasted, and a comparison of their relative merits more distinctly pointed out; the method of performing some calculations connected with the throstle frame, will here be exemplified.

To find the revolutions of the Front Rollers in the Throstle Frame.

RULE. Begin at the pinion C, on the axle of the cylinder; call it the first driver, and trace out the driving and driven wheels and pinions from it to the wheel G on the end of the front roller. Multiply the number of teeth in the driving wheels together, and the product by the revolutions of the cylinder per minute; and multiply the number of teeth in the driven wheels together.* Divide the product of the former by the product of the latter, and the result is the revolutions of the front rollers per minute.

EXAMPLE.—*See Plate X. Fig. 1st.*

Drivers.		*Driven.*	
Pinion C on cylinder, . . .	38 teeth.	Wheel D,	110 teeth.
Pinion E, ...	34 do.	Wheel G,	100 do.
	152		11000
	114		
	1292		
Revolutions of the cylinder ℔ min.	500		

11000)646000(58.72 revolutions of the front roller per minute.
55
96
88
80
77
30
22
8

* The wheels F F are intermediate wheels, and therefore omitted.

To find the revolutions of the Spindle per minute.

RULE. Multiply the revolutions of the cylinder per minute, by its diameter; and divide the product by the diameter of the wharve.

The cylinder revolves 500 times per minute, the diameter of which is eight inches; and the diameter of the wharve one inch.

EXAMPLE.

Revolutions of cylinder, Diameter of wharve, $\frac{500 \times 8}{1} = 4000$ revolutions of spindle ⅌ min.

To find the Twists per inch on the Yarn, suppose No. 36.

RULE. Multiply the revolutions of the front roller by its circumference, and divide the revolutions of the spindle per minute by the product.

EXAMPLE.

```
Revolutions ⅌ minute of the front roller, 58.72
        Circumference of     do.   .   3⅛ inches.
                                   ------
                                   17616
                                     734
                                   ------
                                  183.50)4000.00(21.70 twists
                                          3670      ⅌ inch on
                                          ----
                                          3300      the yarn.
                                          1835
                                          -----
                                          14650
                                          12845
                                          -----
                                           18050
```

The spindles of the throstle frame are supported at the foot by a brass step; and the collar *b*, a little above the middle, guides it in its place, and keeps it steady; but the flyer being fixed on the top, the weight of which causes the spindle, when revolving with too great rapidity, to vibrate to such a degree, as will either throw off the flyer, or destroy the spindle; hence they cannot with safety be driven much above 4000 revolutions per minute. This vibratory tendency of the spindle retards the speed of the machine, and prevents it from producing that quantity of which it is otherwise capable. Its produce per spindle seldom exceeds 4½ hanks per day of 12 hours, and even this is above the average.

Mr. Henry Gore, machine maker in Manchester, has lately taken out a patent for an improvement upon the Throstle Frame, of which the following description is taken from the *Repertory of Arts*.

" The machine, called a " Throstle Machine" by the spinners, which works with spindles, bobbins, and flyers, is the subject of this improvement. Mr. Gore has observed, that the common spindles are heavier, longer, and thicker than needful; that they vibrate, and have less than the necessary resistance when they are made smaller and lighter than usual. These defects, he thinks, arise from the spindles being inserted into their bearings immediately above the bobbins: and he proposes to improve the machine to promote friction and consequent resistance, to allow of lighter and shorter spindles, and to cure other defects, by casing part of the spindles in a hollow tube. This tube, of much larger caliber than the spindle requires to move freely in, is attached by a nut and screw on to the spindle, about one-third of its length above the bobbins, or that part that works in the bush. The tube is fitted at its top and bottom, with softer matter, to the size of the spindle. The tube receives the bobbins, and continues some height up the spindle above the top of the bobbin, and just beneath the lower part of the horns of the flyer.

This is the whole improvement. The spindle may be made as usual, and worked as usual. The bobbins must be made with a larger bore than if they fitted on the spindle, and the friction will be greater of course. In the twisting or spinning of yarn or thread, this will be found a considerable advantage, by the increased resistance to the motion of the spindle. The throstle jennies may be all fitted with spindles, bushed with these tubes. There is nothing else altered, but the spindle is supported, and may be made lighter with safety, and the bearing is used immediately above the bobbin as now. The beam in which the spindles work, and that in which they are secured at top, is not altered, there is the usual contrivance for turning the spindle; and, indeed, nothing need be changed but the bobbins, and nothing added but the tubes. The improvement seems well calculated to promote the intended effect."

Mr. William Shanks, Jun., of the Bridge-of-Weir, near Johnstone, has likewise made an improvement on the throstle frame, which, from the originality of the contrivance, is worthy of being recorded.

It has already been observed, that the yarn spun upon the throstle frames, from its strength and smoothness, is particularly adapted for warps, and that it requires a better quality of cotton to produce the same Nos. of yarn on the throstle frame, than is required for the mules; hence to make weft yarn on the throstle, from an inferior quality of cotton or waste, has always been a desideratum; to supply which is the object of this improvement. In the common throstle, the flyer is fixed right on the top of the spindle, and placed at a short distance from the rollers. Now Mr. Shanks conceived, that if the spindles were placed at a greater distance from the rollers, and a slight vibration communicated to the threads as they descended to the flyers, it would have a tendency to start the fibres of the cotton, and make the yarn more full and woolly, so as to adapt it for wefts. Hence this improvement consists in having the spindles placed at the distance of about eighteen inches from the rollers, and the flyer, instead of being fixed on the top of the spindle, is fixed about three inches from the top, that is, the spindle ascends three inches above the flyer, and the yarn as it descends from the rollers, twists two or three times round the point of the spindle the same as in the mule, and is conveyed from that to the lower extremities of the flyer, by which it is wound on the bobbin. There is a circular piece of tin about 1¼ inches in diameter, fixed on the top of the flyer, with a concave side uppermost; this keeps the yarn out from the spindle, only allowing it to twist two or three times round the point; so that it descends freely down to the bobbin without much strain, and thereby admits of being soft twisted. This is the whole improvement. The twisting of the yarn on the top of the spindles and their distance from the rollers, gives a slight vibration to the yarn, which raises the fibres of the cotton, and makes the threads more rough and woolly than can be produced on yarn spun upon the common throstle.

Throstles made upon the above principle, have been working for some time in Mr. Shanks' new mill, at Bridge-of-Weir, and are found completely suited to their intended purpose, viz. to make coarse weft yarn from an inferior quality of cotton or waste, and at a cheaper rate than can be accomplished by the common mule.

The improvement is not secured by patents. Mr. Shanks, in the most generous manner, freely admits any person to witness their operations, or appropriate all its advantages to themselves, if they choose.

There are various other important improvements in course of trial upon the throstle frame both in England and Scotland, which might have been noticed had it been considered necessary; the above, however, is sufficient for our present purpose.

THE MULE JENNY.

After Arkwright's spinning frames had been about ten years in operation, another spinning machine was announced to the public, the invention of Mr. Samuel Crompton. This was properly not a new machine, but a compound of the two already in use, hence it derived the name of the mule jenny. The essential part of Arkwright's mode of spinning lay in the drawing of the cotton by rollers, instead of the finger and thumb. In Hargreaves' jenny the cotton underwent the operation of stretching, not drawing. The combination of both these elementary operations by means of one machine constitutes the mule. Here the roving is both drawn and stretched. The stretching takes place after it has been drawn by the rollers, the effect of which is twofold. It makes the yarn finer, and likewise more level and uniform in its grist; for those parts of the thread that are thickest when delivered by the rollers, do not take on the twist so freely as the smaller parts; hence being softer, they yield more easily in stretching, meanwhile the twist becomes more equally diffused over the whole thread.

The yarn produced by either the water frame or throstle, must have sufficient strength to bear the drag of the bobbin; for this reason, these machines are seldom employed to spin any yarns above No. 40, and perhaps No. 50 is the highest. But in the mule no bobbins are used; and the yarn is built on the spindles in such a manner as to throw little or no stress upon it. In this respect, therefore, the mule possesses a most decided advantage over the others, both in the varieties of quality and fineness of grist; for it can be adapted for spinning any quality or size from No. 1 to 350.

The mule being a compound of the water frame and common jenny, the roving is prepared for it in the same manner as for the water frame, and reduced to its proper grist by the elementary operations of both. In the rollers it is drawn, and by the spindles receding from the roller, it is stretched. The amount of draught in the rollers is regulated by circumstances, and the length stretched is regulated by the grist of the yarn. The spindles are disposed on a carriage at equal distances from each other. The machine being put in motion, the carriage recedes from the rollers as fast as the reduced rovings are delivered; the spindles, at the same time, revolving rapidly, giving twist to the yarn sufficient to make it bear stretching. The distance which the spindles recede from the rollers is called the stretch, which is generally about 54 or 56 inches; and when the spindles recede faster from the rollers than the yarn is given out, this is called the gaining of the carriage, or the inches gained; sometimes it is called the mendoza stretch, as being accomplished by means of the mendoza pulley.

After delivering a certain length of yarn, the rollers stop; but when spinning fine numbers, the carriage continues to recede, and the spindles to revolve; this is denominated the second stretch; and even when the stretching is completed, the spindles continue still to revolve, until the full quantum of twist has been communicated. But in order to save time, they revolve more rapidly after the rollers stop, and while the yarn is twisting; the mechanism by means of which this increased rapidity is accomplished, is generally denominated the double-speed; but the slow speed, while the carriage is receding, is called the first speed; and the quicker motion of the spindles, when the carriage arrives at the head, is called the second speed; when the full portion of twist has been given to the thread, the mule disengages itself from the other moving parts by which it is driven. The operative then returns the carriage home to the rollers; while, with the one hand, he manages the fly or rim, and by it the spindles; with the other, he guides the wire of the faller, so as to build the thread on the spindle in a conical form, called a cope: he also knows from habit, or practice, the necessary force, or motion, he should communicate to the fly, so as to keep the yarn always at that degree of tension which, without injuring it, will make the cope firm and compact.

The mule was originally wrought by the operative's hand, but in the year 1792, Mr. William Kelly, at that time manager of Lanark Mills, obtained a patent for a mode of working this machine by power: yet it was not till a considerable time afterwards that it was generally adopted. Mr. Kelly, although the undisputed inventor of the process, and in possession of a patent right to it, freely allowed all who chose to avail themselves of its advantages.

The spinning machines, whether water frame, throstle, or jenny, being the last employed in the process, they, for that reason, require particular attention. If the cotton sustain injury by any machine in the previous departments, it may sometimes be remedied a little in the after process; but the yarn, being completed at the spinning, if it be damaged there, it is then past all remedy; hence these machines require to be adjusted with the greatest exactness; and, indeed, every machine in the whole process requires to be adjusted in this manner, in order to produce a superior quality of work.

The mule is rather a complex machine, and therefore all its parts should be fitted and adjusted with great precision. The beam and rollers should be perfectly level and straight; the top rollers, being driven by friction, should be kept clean and well oiled about the friction points. The space between the rollers must be suited to the length of the staple of cotton. The following scale of distances between the rollers from centre to centre is recommended.*

	Draught from	Distance from
For cotton $\frac{7}{8}$ inch in length of staple,	6 to 12	$\frac{7}{8}$ to $1\frac{1}{16}$
Do. 1 do. do. do.	– –	1 – $1\frac{3}{16}$
Do. $1\frac{1}{8}$ do. do. do.	– –	1 – $1\frac{3}{8}$
Do. $1\frac{3}{16}$ do. do. do.	– –	1 – $1\frac{1}{2}$
Do. $1\frac{1}{4}$ do. do. do.	– –	1 – $1\frac{1}{2}$

The carriage should be equally balanced, and all the gearing so adjusted, as to work with freedom, or without the least interruption whatever. And to have the faller and spindle frame set with the

* One of the best or most important improvements that has ever been made on the mule, is the invention of shifting stands and saddle bars, by which the distance between the rollers can be adjusted to suit any kind of cotton. And, certainly, if proprietors were aware of their advantages, they would be more generally adopted.

greatest exactness, is an object of the utmost importance, in order to make a neat and compact cope. The spindles also should be all precisely the same length and thickness. The inches gained on the length of the stretch should vary according to the size of the yarn. The following scale has been adopted with good effect:

For spinning from No. 25 to No. 32, the gaining of the carriage may range from 1 to 2½ inches. Between No. 32 and No. 46, gaining from 2½ to 4 inches; between No. 46 and No. 54, from 4 to 5 inches; between No. 54 and No. 64, from 5 to 6 inches; between No. 64 and No. 70, from 6 to 6½ inches, &c. The second stretch might commence at No. 70, and from that to No. 84, it may range from 1 to 1½ inches. Above these numbers it will increase according to the size of the yarn. From No. 120 to 200 the second stretch will range from 4½ to 7 inches.

To regulate the twisting of the yarn, and the gaining of the carriage, so as to suit the quality of the cotton and the particular size of the yarn, is an object of essential importance in the adjusting of the mule. The amount of twist should always be sufficient to make the yarn sustain its own weight perfectly, or to keep it at that degree of tension that will prevent it from hanging down, and at the same time allow it to stretch freely withont breaking.

For spinning warp yarns, the carriage sometimes is fitted up with an ingenious piece of mechanism, by which it is made to run in a little after the yarn has been fully stretched, and during the time it is receiving its full portion of twist; and by allowing it thus to twist in, gives the thread a kind of elastic quality that is of great benefit to it, especially when intended for power-loom warps, which have to undergo a considerable number of operations, as winding, warping, dressing, &c.

The method of calculating the speed of the fly, the front roller, and spindle per minute, was exemplified at pages 30, 31, 32. And here it may be remarked, that the revolutions of the fly, with the single speed, may range from 108 to 116 revolutions per minute, for numbers between No. 20 and No. 80. It is not necessary to use the double-speed for any numbers below 80, unless the yarn be very weak, or for a particular quality of warps. But whatever be the speed of the fly, the revolutions per minute of the spindles should never exceed 4600: for to raise them above that, might cause them to vibrate so as either to destroy the spindle or injure the yarn.

Plate III. Fig. 4th, represents an end stand of a jenny, with the pinions, &c. The number of teeth in the wheels and pinions are as follows: The pinion A on the front roller, 18 teeth; grist pinion B, 24 teeth; crown wheel C, 72 teeth; back roller wheel D, 56 teeth. Diameter of front roller one inch, and back roller $\frac{7}{8}$ inch.

To find the draught in the Rollers of the Jenny, with the above Wheels and Pinions.

Rule. Multiply the number of teeth in the driving pinions A and B together, and the product by the diameter of the back roller; and multiply the number of teeth in the wheels C and D together, and the product by the diameter of the front roller. Divide the product of the latter by the product of the former, and the result is the draught in the rollers of the jenny.

EXAMPLE.—*See Plate III. Fig. 4th.*

Driven.		*Drivers.*	
Crown wheel C, .	72 teeth.	Front roller pinion A,	18 teeth.
Back roller wheel D,	56 do.	Grist pinion B, . .	24 do.
	432		72
	360		36
	4032		432
Dia. of front roller, $\frac{8}{8}$ =	8	Diameter of back roller, $\frac{7}{8}$ =	7
	3024)32256(10.66 draught on jenny.		3024

3024
20160
18144
20160
18144
2016

If the roller draught of the jenny be 10.66, and length of the stretch 56 inches, gaining of the carriage 5 inches: what size of yarn will be produced from a 5 hank roving?

RULE. Multiply the hank roving by the roller draught, and the product by the length of the stretch. Divide the last product by the inches of yarn given out by the roller, that is, the length of the stretch wanting the inches gained.

EXAMPLE.

```
Roller draught on jenny, . . . . . . .                10.66
Hank roving, . . . . . . . . . . . .                      5
                                                       ----
                                                       5330
Full length of stretch, . . . . . . . .                  56 inches.
                                                      -----
                                                      31980
                                                     26650
                                                    -------
Length of stretch wanting the inches gained, 51)2984.80(58.52 size of
                                                255      yarn required.
                                                ---
                                                 434
                                                 408
                                                 ---
                                                  268
                                                  255
                                                  ---
                                                   130
                                                   102
                                                   ---
                                                    28
```

The following Table of draughts is calculated for the wheels and pinions mentioned above. And it would be advantageous for every spinning master to have tables of this sort adapted for every kind of jennies under his charge, as it would often save much trouble and uncertainty, especially when making changes in the numbers of the yarn, or shifting roving from one kind of jennies to another.

TABLE OF DRAUGHTS,

Calculated for a crown wheel of 72 teeth, back roller wheel 56, and front roller pinion 18 teeth. Diameter of front roller 1 inch, back roller $\frac{7}{8}$, showing the draughts produced by any grist pinion from a 20 to 35 teeth.

Grist Pinions.	Draughts.	Grist Pinions.	Draughts.	Grist Pinions.	Draughts.	Grist Pinions.	Draughts.
20	12.8	24	10.66	28	9.14	32	8.00
21	12.18	25	10.24	29	8.82	33	7.75
22	11.63	26	9.84	30	8.53	34	7.52
23	11.12	27	9.48	31	8.25	35	7.31

The hank roving being given—Find the grist pinion required to produce any given size of yarn.

RULE. Divide the size of the yarn required, by the hank roving given, and the quotient will be the extension or draught which the roving must undergo in order to reduce it to the grist of yarn required; and having ascertained this, find by the above Table what grist pinion will produce that draught nearly, as there must be some allowance for the gaining of the carriage.

EXAMPLE.

What grist pinion will produce No. 60 from a $5\frac{1}{2}$ hank roving?

```
5.5)60(10.90 draught required to reduce a 5½ hank roving to
    55           No. 60 yarn.
    ---
     500
     495
     ---
      50
```

By referring to the foregoing Table, it will be found that a grist pinion of 26 teeth gives a draught of 9.84; now No. 60 will require 5 inches of mendoza stretch, therefore proceed, as in the last example, to find the size of yarn produced from a $5\frac{1}{2}$ hank roving, with a draught of 9.84 in the roller, and 5 inches of gaining in the carriage.

```
Roller draught, . . . . . . . . . . .  9.84
Hank roving,  . . . . . . . . . . . .   5.5
                                      -----
                                       4920
                                      4920
                                     ------
                                     54.120
Full length of stretch, . . . . . . .    56
                                     ------
                                     324720
                                    270600
                                   --------
Length of stretch wanting the inches gained, 51)3030.720(59.42 size
                                      255     of yarn pro-
                                      ---
                                       480    duced, which
                                       459    is about equal
                                       ---
                                        217   59½.
                                        204
                                        ---
                                         132
                                         102
                                         ---
                                          30
```

From the preceding example, it will appear, that to produce No. 60 from a 5½ hank roving, will require a grist pinion with 26 teeth, allowing 5 inches of gaining or mendoza stretch, although the result is only 59½, yet this is as near 60 as can be produced.

To find what Grist Pinion to put on the Jennies, so as to change the size of Yarn, they are presently spinning, to any other given size required.

RULE. Multiply the number of teeth in the present grist pinion by the present size of yarn, and divide the product by the size of yarn required.

EXAMPLE.

If at present spinning No. 60 with a grist pinion containing 28 teeth, what pinion must be put on to produce No. 70?

Present size, . . . No. 60
Present grist pinion, . . 28 teeth.
Size of yarn required, 70)1680(24 pin. required to produce No. 70.
140
280
280

Spinning masters who have occasion to be frequently changing the sizes of yarn, may sometimes be at a loss to know the precise quantity of twist that particular numbers will require, unless they have some rule to direct them how to find what twist will suit any given numbers of either weft or warps. There are several rules for finding this, but only two shall be mentioned in this place, which are considered to be the most correct.

RULE 1st. If for warp yarn, allow 25 twists to the inch, or 25 revolutions of the spindle for the inch of yarn of No. 50, and the same for No. 60 wefts.

Taking the above for the data upon which to proceed. To find the twists per inch that any given size of yarn will require.

RULE 2d. If for warp yarn; as No. 50 : is to the square of 25 : : so is the given size : to the square of the twists per inch which the given size requires.

EXAMPLE.

How many twists per inch will No. 64 warp yarn require?

As No. 50 : 25 × 25 = 625 : : 64
64
2500
3750
50)40000
Find the square root of . 800(28$\frac{1}{3}$ twist per inch required for No. 64 warps.
4
48)400
384
16)$\frac{16}{48}$ = $\frac{1}{3}$

RULE 3d. If for weft yarn, as No. 60 : is to the square of 25 : : so is the given size : to the square of the twists per inch, which the given size of yarn requires.

EXAMPLE.

How many twists per inch will No. 80 wefts require?

```
As No. 60 : 25 × 25 = 625 : : 80
                           80
                    60)50000
Find the square root of  823.33(28.69  twists per inch required
                         4              for No. 80 wefts.
                    48)423
                    8 384
                   566)3933
                     6 3396
                  5729)53700
                        51561
                         2139
```

There is another short and simple rule approved of by some managers for finding the twists per inch, which any given size will require; which may be shortly stated without exemplifying it.

RULE. Multiply the square root of the given size by $3\frac{3}{4}$ if for warp yarn, and by $3\frac{1}{4}$ if for wefts; the result of either will be the twists per inch which the given size of yarn requires.

To find the proper diameter of a Mendoza Pulley that will produce any given mendoza stretch.

Rule. Multiply the number of teeth in the mendoza wheel M, *(see Plate III. Fig. 1st and 3d)* by the diameter of the front roller, and divide the product by the number of teeth in the pinion H on the front roller that drives the mendoza wheel; from the result thus obtained, subtract the diameter of the mendoza band, and the remainder will be the diameter of a pulley that would make the carriage recede from the rollers at the same rate as the yarn is given out.

Suppose mendoza wheel M contains 112, and the pinion on the front roller that drives it 18 teeth; diameter of the front roller 1 inch, and mendoza band $\frac{5}{8}$: required the diameter of a pulley that would give no mendoza stretch.

$\frac{112 \times 1}{18} = 6\frac{1}{4}$ from which subtract the diameter of the mendoza band $\frac{5}{8}$—$6\frac{1}{4} = 5\frac{5}{8}$ diameter of pulley required.

Required the diameter of a mendoza pulley P, *(see Plate III. Fig. 1st and 2d)* that would give 5 inches of gaining on a stretch of 56 inches.

Rule. Subtract the gaining required from the whole length of the stretch, then, as the remainder : is to the full length of the stretch : : so is the diameter of the pulley found above : to the diameter of a pulley that would give 5 inches of gaining.

EXAMPLE.

```
Length of stretch, 56
Gaining required,   5
                   --
                   51 : 56 : : 5 5/8
                            5 5/8
                          -------
                            280
                             35
                          -------
                 51)315(6.17 diameter of pulley (P) required to give
                    306          5 inches of gaining on a stretch of 56
                    ---          inches.
                     90
                     51
                    ---
                    390
                    357
                    ---
                     33
```

A very ingenious mendoza pulley has lately been invented, which deserves particular notice. It is made of cast iron, and consists of two parts, each part forms one side; and when placed together, they appear as one solid pulley, with a very deep groove. One side is fixed on the mendoza shaft, the other is moveable, and may be taken off at pleasure. The two parts are kept together by a screw and nut, and by merely unscrewing the nut, they are opened and the groove widened, so that the band sinks deeper into the groove; but by screwing the nut, the sides are placed closer together, and the band pressed out towards the circumference; that is, the circumference of the pulley, as it were, admits of variation, and serves all the purposes of a variety of pullies with different diameters for increasing or decreasing the gaining of the carriage. By this pulley the gaining can be adjusted with the greatest precision to suit any grist of yarn; and having experienced its peculiar advantages for spinning different numbers, it is recommended, with the greatest confidence, to the notice of the trade; and certainly if its merits were properly known, it would be more generally adopted.

Managers of Spinning Factories do not seem yet to be agreed upon what is the most proper dimensions of a mule jenny. Some contend that mules containing from 264 to 288 spindles are the most profitable, because they generally turn off a much greater quantity of yarn, in proportion to their spindles, than those of a larger size; and besides, they are easier to work or manage, and not so destructive to the drum and fly bands, having less weight to drive. Others again suppose, that as all mules, of whatever size, require the same gearing, as well as drums and belts, to move them, the larger the better; as a Factory filled with mules of a large size will require less power to drive it; having less gearing, it will require fewer belts, &c. &c. It is proper to remark, however, that large mules are become much more popular than they were some years ago. Several respectable spinners in England, who have mules containing 300 spindles each and upwards, are said to be coupling two of these together with the fly in the middle, and thus forming one large mule of 600 spindles out of two; that is, making two pairs into one; and instead of being placed cross the house, they are set lengthwise; no house being sufficiently wide to contain mules of such dimensions.

Various ingenious contrivances have been attempted, with a view to enlarge the dimensions of the mule, without enlarging in the same proportion the space which they occupy; as, for example, it has been tried to have one mule placed right above the other, and adjusted in such a manner, that it required only one operative to attend and manage these double tiered mules; but however ingenious this contrivance, it was subject to many objections in practice, and therefore was abandoned. Another attempt to connect two pairs of mules together, was found much more practicable than the former. This consisted in placing one right in front of the other, and coupling them together in such a manner, that one set of gearing served both; these are generally denominated "daggers," and are still used in several Factories, but have never become very popular. And, indeed, neither these, nor several other contrivances which might have been mentioned, seem to have been possessed of sufficient merit, to attract much notice; they showed the ingenuity of the inventors, but were found inadequate to their proposed end, viz. to abridge the expense of workmanship, by enabling the operatives to produce a greater quantity of work at a cheaper rate.

The common mule, with the fly at the one end, seems to be the most popular of any that has yet been tried; although the greater part of the managers in this country seem to prefer having the fly in the middle for all mule jennies containing 300 spindles and upwards; this, however, is matter of taste; as there are numbers of mule jennies in England, containing a much greater number of spindles than these, and having the fly at one end. The benefit supposed to be derived from placing the fly in the middle is, that it saves the rollers and pinions from the great strain to which they are liable when they are all driven from one end, as the first rollers having to move all the others, there is a great weight thrown upon them, and the pinions that drive them; consequently, when the beam is very long, and containing, perhaps, thirty fifteen-inch rollers, the strain upon the pinions and first rollers is so great, that they soon cut and give way; but when the motion comes from the centre, the strain on the pinions is equal only to one half the weight of the beam, and therefore the pinions and rollers last much longer, and run smoother. But even mules having the fly in the middle, are also subject to several objections which the others are not, as the fallers being connected together in the centre by coupling wires and cranks, they are seldom found so steady and firm as when all in one piece; this, together with several other little disadvantages that might be mentioned, do not belong to those having the fly at one end.

There is a species of mule, called box organs, frequently used for spinning very fine numbers. They look extremely neat, as the gearing is mostly all concealed, and can be made to occupy rather less space than the common mule; as that space which, in the common mule, is occupied with the gearing, may, in the organs, be in part occupied with spindles. They also possess all the advantages of mules having the fly in the middle, without being liable to their disadvantages; for the faller, as well as the carriage, may be all in one piece, without requiring to be coupled together with bolts, coupling wires, &c. These mules, however, are only adapted for very fine numbers, and possess no advantages over the common mule, so far as I am acquainted, except those already mentioned.

IMPROVEMENTS

ON

VARIOUS SPINNING MACHINES.

SELF-ACTING MULE.

It is not designed to enumerate all the improvements and new inventions upon Spinning Machines, that have been brought into operation at different periods: only a few of the most important, which are attracting particular attention at the present time shall be noticed, and of these, a general description is all that is intended.

Important improvements and ingenious inventions are, at present, in course of trial upon the throstle frame: the mule has also underwent various alterations, and attained to great perfection; but still the grand disideratum was yet unsupplied, viz. a mule to act itself, without the aid of attendants, further than merely to piece broken threads of yarn, and to clean, oil, and keep the machinery in order. At length, however, this has also been accomplished by Mr. Richard Roberts, civil engineer and machine-maker, Manchester. This gentleman has invented that which has puzzled the most intelligent mechanics for these thirty years past. For it is known, that for upwards of twenty-five years, the attention of various spinners and mechanics in England, Scotland, France, and America, have been occupied with the invention of what is termed self-acting mules. Many have been invented and secured by patents, but few have been found practically efficient. And it is believed that the inventions of the following parties only have been put into operation beyond the purposes of mere experiment, viz. the Messrs. Eatons of Wiln, in Derbyshire; and of France, Mr. De Jongh of Warrington; Mr. Roberts and Mr. Knowles of Manchester; Mr. Buchanan of the Catrine Mills, Scotland; and Dr. Brewster of America.

Regarding the self-acting mules invented by the Messrs. Eatons, it is supposed that not more than twelve of these have been put in operation at Manchester and at Wiln, besides a few in France. Those at the former place did not give satisfaction, and, consequently, were dismantled. A few are said to be partially kept in operation at Wiln, whilst those in France proved a total failure.

Mr. De Jongh put about twelve in operation in a mill at Warrington. He also obtained two patents for his self-acting mule, but, in practice, they were found defective, and were, therefore, abandoned.

Mr. Buchanan of the Catrine Mills, has still a few in operation, but their principle has never been disclosed to the public.

The self-acting mules invented by Dr. Brewster, are said to be adapted for spinning woollen only, and employed for that purpose on a very limited scale in America, but have not yet been introduced into this country.

The first approximation to an entirely successful effort to render mules self-acting, was an invention of Mr. Roberts of Manchester, for which he obtained a patent in 1825. One of the principal objects of which, was the mode of governing the faller, in winding the yarn on the spindles in the form of a cope, during the running in of the carriage, by means of an under or counter faller. The great novelty and ingenuity of which was universally admitted, and proved the main step to the accomplishment of that object which had so long been a desideratum. Upon the above principle several mules were put in operation, but from various causes were not extensively adopted.

Mr. De Jongh took out a third patent in 1827, for improvements on his self-acting mule, and having made arrangements with Mr. Roberts for the purpose of combining their inventions, about thirty mules were made under this patent for spinning woollen and cotton, which were fitted up with Mr. Roberts' counter faller, an accompaniment necessarily required to render Mr. De Jongh's mule in reality self-acting. But these mules, although reported to be still in operation, are said not to be giving satisfaction.

Mr. Roberts obtained a second patent in 1830, for improvements on his former invention, and by a combination of these under his two patents, has constructed a self-acting mule, which is admitted by all who have had fair opportunities of witnessing its merits, to exceed their most sanguine expectations.

Mr. Knowles of Manchester, obtained a patent for a self-acting mule in 1831, but upon the enrolment of his specification, it was found he had infringed on both of Mr. Roberts' patents, which led to a suit in the Court of Chancery, that terminated in favour of the latter, consequently, the self-acting mule, which is at present attracting so much notice in the trade, and coming into general use, is exclusively the invention of Mr. Roberts.

To attempt any thing like a minute description of this machine, would be a too difficult and laborious task, owing to its complexity and multiplicity of moving parts, and, perhaps, no description could be sufficiently plain to be generally understood, unless accompanied with drawings for the purpose of reference, therefore, a short descriptive notice of it is all that is intended.

The two great and most formidable difficulties in the way of obtaining a perfect self-acting mule are, first, the invention of a proper combination of mechanism by which to govern the faller, so as to build the yarn on the spindles in a conical form, and make a neat, firm, and compact cope: and second, to regulate the rotary motion of the spindles, so as to keep the yarn always at a proper degree of tension, according to the gradually varying form and increasing diameter of the cope. Both of these great difficulties have been overcome by the ingenious contrivances of Mr. Roberts, and forms the subject of inventions for which he has obtained two patents.

The first thing that attracts attention upon seeing Roberts' self-acting mule, is the two fallers; one of which is denominated the under or counter faller, having the horizontal wire placed beneath the yarn, and about two or three inches from the spindle points. The other faller is in all respects the same as that in the common hand mule. The invention of the counter faller, as already stated, was the first successful effort to the completion of an entirely self-acting mule. The whole machine is driven by means of a belt passing round fast and loose pullies, the same as the common mule; from these, motion is conveyed to the different parts of the mule by shafts, wheels and pinions, pullies with endless bands, &c. One of these bands, by passing round a pulley fixed on a rotary shaft connected with the front rollers, causes the carriage to recede from the rollers; and when the receding carriage has reached its destination, and the full portion of twist has been communicated to the yarn, a cam upon a lateral shaft, is brought to act against a lever, so as to move sideways, and shift the driving belt from the fast, on to the loose pullies, upon which the spindles stand still, until another movement immediately brings a clutch-box to act upon a part of the machinery, which turns them the reverse way, in order to uncoil the yarn from the top of the spindles; and while the yarn is being backed off the spindles, the counter faller rises; at the same time, the other faller that builds the yarn on the copes is depressed; and the wires of the two acting upon the *yarn* in opposite directions, effectually regulates its tension so as to prevent it from slacking or collecting into snarls: and during the running in of the carriage, while the yarn is winding on the copes, the wires of the fallers gradually approximate to the same level, until the counter faller is depressed down to its proper position, where it rests until another stretch has been completed.

The faller that builds the yarn on the cope, is brought down at the time the backing off takes place, by means of compound levers acted upon by rotary cams; and as the horizontal wire of the faller directs the laying on of the yarn, its movements are determined, by a *lever* and *friction roller* running along a kind of inclined plane, called the shaper; which acts differently upon the lever, and by means of it, upon the *faller*, at every successive stretch, and causes it to regulate the laying of the yarn upon the copes, in that particular form which the shaper directs.

These contrivances govern the faller when building the yarn on the spindles, so perfectly, as to form a cope uniformly neat, firm, and compact, and which cannot be excelled by the hand of the most skilful and attentive workman.

The mechanism by means of which the rotary motion of the spindles is regulated during the running in of the carriage, so as to suit the gradually varying form, and increasing diameter of the cope, is equally as ingenious as the above. It is accomplished by a small drum or barrel, placed at the end of the carriage next to the head-stock: two cords are fixed with their one end to this drum, and coiled round it in opposite directions, so that when one is coiling on, the other is winding off. The one cord passes over a carrier pulley at the back part of the machine, and has a weight suspended from its extremity, which acts as a counterbalance to the opposite cord: the weight causes the cord to which it is attached, to uncoil off the drum as the carriage recedes from the rollers, while at the same time the other cord is coiling on. The drum is also connected with teethed wheels, which come into gear with that part of the machinery that moves the spindles, exactly while the yarn is being backed off, after having received its full portion of twist. The cord which causes the winding-on drum to revolve during the running in of the carriage, has its one extremity attached to a radial arm of a quadrant, which describes an arc, whilst the winding-on drum is receding from the point of attachment in a straight line; and as the carriage recedes, the cord is uncoiled, by which the drum revolves, and with it the spindles; the amount of rotation communicated to the spindles, is regulated by the length of cord to be uncoiled: and suppose the rotation of the spindles to be adjusted, so as just to wind on the first stretch of yarn on the bare spindles; as the diameter of the cope increases by each succeeding layer, fewer revolutions will be requisite to effect the winding-on of the constant length; therefore the whole quantity of motion imparted to the spindles during a run in, must undergo progressive diminution so long as the cope is increasing, which goes on until the bottom is formed: this decrease of motion in the spindles is obtained by lessening the quantity of cord to be uncoiled from the winding-on drum. To effect which, the *point* of the radial arm to which the uncoiled cord is attached, progressively changes as the increasing bulk of the cope requires fewer revolutions of the spindles, to take up the length of yarn produced at each successive stretch.

Such, then, is a brief description of this important machine, which, perhaps, is not sufficiently clear to be generally understood, as its vast multiplicity of different movements renders it extremely complex and difficult to give any thing like an intelligible description of it. But its leading features are, 1st, The levers and their appendages, which depress the faller that guides the yarn on to the copes, and raises the counter-faller in backing off: 2d, A method of regulating the movements of the faller, and forming the cope to its required shape, by the assistance of friction rollers and an inclined plane: 3d, Changing or reversing the motions of twisting and backing off, as the different parts of the operation are required to be brought into action: 4th, Regulating the coiling or winding of the yarn upon the copes, according to their gradually increasing diameter, by uncoiling a cord from a drum or barrel, which turns the spindles. The amount of rotation imparted to the spindles, is adjusted by the length of cord to be uncoiled from the winding-on drum.

The self-acting mule described above, is necessarily complex; but, perhaps, it is one of the most beautiful specimens of mechanical combination that is to be found; exhibiting a rare degree of original invention, highly creditable to the ingenuity and perseverance of the inventor; whilst, at the same time, it furnishes an illustrious example of the wonderful perfection to which machinery has attained in our manufacturing processes. But whether, after a few years trial, it will be found practically efficient, remains to be proven: meantime, however, it seems to be coming into very general use, both in England and Scotland. For although but a short time since its completion, there are now self-acting mules in which describes an arc, whilst the winding-on drum is receding from the point of attachment in a straight line; and as the carriage recedes, the cord is uncoiled, by which the drum revolves, and with it the spindles; the amount of rotation communicated to the spindles, is regulated by the length of cord to be uncoiled: and suppose the rotation of the spindles to be adjusted, so as just to wind on the first stretch of yarn on the bare spindles; as the diameter of the cope increases by each succeeding layer, fewer revolutions will be requisite to effect the winding-on of the constant length; therefore the whole quantity of motion imparted to the spindles during a run in, must undergo progressive diminution so long as the cope is in working hours, including casual stoppages for doffing, &c. &c.

Nos. of Yarn.	Twist.	Weft.
16	4½ hanks.	4⅞ hanks.
24	4¼	4⅝
32	4	4⅜
40	3¾	4⅛

The produce of the intermediate numbers are proportionate to the above. None of the self-acting mules that have been tried in Scotland have, as yet, been able to produce the quantities given in the above statement; neither is the quality of their produce equal to specimens that have been sent from different parts in England, where they are in full operation; but this is to be expected; for when

The levers and their appendages, which depress the faller that guides the yarn on to the copes, and raises the counter-faller in backing off: 2d, A method of regulating the movements of the faller, and forming the cope to its required shape, by the assistance of friction rollers and an inclined plane: 3d, Changing or reversing the motions of twisting and backing off, as the different parts of the operation are required to be brought into action: 4th, Regulating the coiling or winding of the yarn upon the copes, according to their gradually increasing diameter, by uncoiling a cord from a drum or barrel, which turns the spindles. The amount of rotation imparted to the spindles. is adjusted by the length of cord to be tear and wear, as compared with the ha... But from the experience of some eminent spinners, and others who have made experiments on the same, it appears that the extra power required, in cases of an *equal* number of spindles and *speed*, does not exceed five per cent. And with respect to the additional tear and wear, it is the confident opinion of those who have had the best opportunities of ascertaining the fact, that an extra mechanic, together with an overlooker to every twenty or thirty pairs of mules, will be an ample allowance for repairing and keeping them in working order, whilst the expense of material will be but trivial.

It is unnecessary here to specify the advantages and disadvantages that may be expected to arise from the introduction of self-acting mules, in place of those now generally used; these, upon reflection, may be very obvious to every person. Meantime, however, the long acknowledged desideratum has at length been supplied by the ingenious inventions referred to in the preceding pages, and its results will very soon be ascertained.

DANFORTH THROSTLE.

At page 163 it was observed, that the flyer being fixed on the top of the spindle, and having nothing to keep it steady, its weight caused the spindle to vibrate, (when revolving with too great rapidity) to such a degree, as would either throw off the flyer, or destroy the spindle; and therefore the frame could not with safety be driven above a certain speed, which prevented it from producing that quantity of yarn in a given time, of which it is otherwise capable. This circumstance having attracted the attention of some mechanics in America, led them to the trial of various experiments, with a view to obviate this vibratory tendency of the spindle, and allow it to be driven at a higher speed than had formerly been practicable, which have issued in certain inventions of a most important nature, and are at present attracting particular notice amongst the proprietors of Spinning Factories in this country.

The first of these inventions that claims our notice, is the one generally denominated the Danforth Throstle, being the invention of an ingenious mechanic in America, of the name of Danforth. It consists of a *stationary* spindle, A A, *(see Plate X. Fig. 3d)* which, instead of a flyer, has a circular polished cone, or cape, B, suspended from the top. The wharve *a* is fitted loosely on the spindle, and resting on the traverse rail C C, similar to the roving fly frame. The bobbin also rests upon the wharve, and is carried rapidly round with it, and thereby twists the yarn as it descends from the rollers. A tin case, called the guard, is fixed behind the cones, and constructed so as to form a kind of recess for each, with a vacant space of about one-half inch between them; and the thread, while twisting, is thrown out by the centrifugal force of the bobbin, and passing through this space between the cone and the guard, is retarded by atmospheric resistance, aided by the slight friction against the guard and the bottom of the cone, which (retardation) causes it to lap up or wind on the bobbin, whilst both wharve and bobbin, by means of the traverse rail, ascends and descends by a uniform alternate motion; meanwhile the rim or edge of the cone directs the yarn on to the bobbin, and causes it to fill equally from end to end.

The yarn is brought through an eye the same as

SPINNING, No. 20.

One spindle of the common mule produces 22 hanks per week of 69 working hours, or nearly 4 hanks per day, and costs one penny per pound for spinning.

500 spindles require one horse power.

One spindle of Roberts' self-acting mule produces 24 hanks per week of 69 working hours, or 4 hanks per day, and supposed to cost ¾d. per pound for spinning.

475 spindles require one horse power.

One spindle of the common throstle produces 26½ hanks per week of 69 working hours, or nearly 4½ hanks per day, and costs ⅝d. per pound for spinning.

300 spindles require one horse power.
200 do. one piecer.

One spindle of the Danforth throstle produces 41 hanks per week of 69 working hours, or about 7 hanks per day, and costs about ⅜d. per pound for spinning.

290 spindles supposed to require one horse power.
200 do. do. one piecer.

One spindle of the Glasgow patent throstle produces 41 hanks per week of 69 working hours, or about 7 hanks per day, and costs ⅜d. per pound for spinning.

285 spindles supposed to require one horse power.
200 do. do. one piecer.

Mr. Gore's improved throstle is said to produce 6 hanks per spindle per day, or 36 hanks per week, and requires the same power and piecing as the common throstle.

The Glasgow Patent Throstle is certainly a very important machine, and has produced results unknown before in the art of cotton spinning; yet it has not been so extensively adopted as might have been expected. But the success of every new machine is considered doubtful until it has been fairly proven, therefore, proprietors having their establishments already filled with spinning machines that have been in general use, are not likely to throw them aside to make room for new ones, without being fully convinced of the advantages to be derived from the change; and this, perhaps, may be the reason why these, and other machines of a similar character, are so long in being generally adopted. But it is unnecessary to say more at present regarding the merits of the above-named throstle, as it is soon to be tried, on an extensive scale, in a mill now erecting at Greenhead in Glasgow, expressly calculated for throstles of this description, where its powers will be more fully developed, and its advantages or disadvantages, as compared with other spinning machines, more easily ascertained.

The Danforth Throstle has undergone some improvements, and is now more extensively adopted than was at first anticipated. It is seldom used for any numbers above 30, as its advantages decrease when used for higher numbers.

Mr. Gore's improvement on the throstle frame, is reported to be very popular about Manchester, and found to be particularly adapted to the purpose for which it is designed, viz. to steady the spindle and prevent vibration, to which it has a great tendency when driven at a high speed. This, Mr. Gore has accomplished by a very simple contrivance, and I have no doubt but his improved throstle spindle will be very generally adopted.

Mr. Shanks' throstle, though a very ingenious contrivance, has not yet been adopted by any other spinner, so far as I have heard.

There are various other improvements on the throstle just now in course of trial, to which it is unnecessary here to advert. It is believed that those mentioned above are the most important that have yet been made known to the public.

The important improvements and new inventions described in the preceding pages, will, doubtless, be attended with the most important results to the cotton manufacture. It will introduce facilities into the process of spinning that will enable our manufacturers to bring a cheaper article to the market, and compete more successfully with foreign spinners. The ultimate effects of which will be to promote the general good, by extending our trade, and furnishing a greater demand for labour and capital. Hence these improvements ought to be regarded with feelings of satisfaction by all, but especially by the working classes, as they tend to benefit them more than any other class of the community, both by providing employment, and cheap, healthful, and comfortable clothing, &c.

MISCELLANEOUS PROBLEMS.

THE following calculations have been reserved for a separate article, being chiefly of a general nature. They are wholly taken from practice, and are useful in as far as they exemplify the principles upon which to proceed in similar cases: it is obvious, however, that many things will occur in practice requiring calculation which cannot be embraced in this treatise, therefore, the following are only a few examples out of many that might have been given.

With respect to the first, viz. the method of calculating the prices of yarn; the utility, nay, the necessity for every manager of a Cotton Spinning Factory having a correct method of ascertaining the cost of every pound of yarn made under his charge, both the price of the mixture, and the expense of workmanship, is surely so apparent, as to require no further demonstration. The difference between the cost price (viz. the price of material and expense of workmanship) and the selling price, is the nett profit gained upon the pound, and therefore the manager should know this in order to ascertain whether the proprietors are gaining or losing by their establishment. The other calculations contained in this article, are sometimes useful in practice, especially when making changes in the qualities of the yarn; in which cases it will often save much time and trouble, to be expert in performing any calculations that may be required.

PROBLEM I.

CALCULATIONS OF THE PRICES OF YARN.

To find the cost of one pound of Yarn from the whole produce in any given time, suppose 12 *days.*

RULE. Add together the whole expense of workmanship, and the amount of all the incidental charges, such as interest, insurance, feu duties, coals, oil, banding, leather, paper, &c. &c. Reduce the whole sum to pence, and divide by the lbs. produced. Reduce the remainder, if any, to 16ths, and divide again by the lbs. produced; the result thus obtained, will be the cost of one lb. in pence and 16ths of a penny.

EXAMPLE I.

Suppose the quantity produced in 12 days to be 13,736 lbs. equal to 45,440 spyndles, and the expense of workmanship as follows:

	£	s.	d.
In picking room department,	£5	10	6
Carding do.	41	14	8
Spinning and stretching,	177	10	4
Ware-room and reeling department,	37	6	3
Mechanics,	8	17	0
Sweeper, Porter, and others,	1	14	0
Overseers, &c.	2	18	0
Expense of workmanship,	£275	10	9
Incidental charges for 12 days, suppose,	140	0	0
	£415	10	9

```
                      £415 10  9
                        20
                      ----
                      8310
                        12
                      ----
Produced in 12 days, 13736 lb.)99729(7 4/16 d. cost of one lb. of yarn.
                      96152
                      -----
                       3577
                         16
                      -----
                      21462
                       3577
                      -----
                13736)57232(4/16
                      54944
                      -----
                       2288
```

The above operation shows the nett cost of one lb. of such yarn to be $7\frac{4}{16}$d. nearly.

To find the cost of one pound of Yarn, including the price of the raw material.

Rule. Find how many ounces of cotton are required to make one pound of yarn. And if two or more kinds of cotton are to be mixed together, find the proportion of each, its price, and likewise the price of the compound, add it to the former result, and this will give the full cost of one lb. of yarn including the raw material.

To find the price of any compound mixture.

RULE. Find the proportion of ounces of each kind of cotton in the mixture, and their price per lb. which reduce to 16ths. Then, as one lb. : is to the price of one lb. : : so is the proportion of ounces of each kind of cotton in the compound (separately) to its price: and having found the price of each kind of cotton according to its proportion in the mixture, then add these together, and their sum to the expense of workmanship; the result will be the cost of one pound of yarn, including material.

EXAMPLE II.

Suppose it takes 19 oz. of cotton to make one pound of yarn, the yarn No. 60, and the mixture 17 oz. of Orleans, at $6\frac{5}{8}$d., and two oz. of Pernambuco, at $8\frac{3}{4}$d.

Reduce $6\frac{5}{8}$d. to 16ths thus, $6\frac{5}{8}$d.

```
                       oz.   16     oz.
                            ----
Then,  .  .  .      as 16 :  106 : : 17
                              17
                            ----
                             742
                            106       16ths.
                           -----
                       16)1802(112.62 price of 17 oz. of Orleans.
                          16
                          --
                           20
                           16
                           --
                            42
                            32
                            --
                            100
                             96
                            ---
                              40
                              32
                              --
                               8
```

Reduce $8\frac{3}{4}$d. to 16ths thus $8\frac{3}{4}$

```
                         oz.  16       oz.
Then, . . . as 16 : 140 : : 2
                          2  16ths.
                    16)280(17.5 price of 2 oz. of Pernambuco.
                       16
                       120
                       112
                        80
                        80
```

Add these together, viz.

		16ths.
17 oz. of Orleans, @ $6\frac{5}{8}$d. ℔ lb. =		112.62
2 oz. Pernambuco, @ $8\frac{3}{4}$d. ℔ lb. =		17.50
Price of the mixture, ...		130.12 16ths.

Which is equal to $8\frac{2}{16}$d. And added to the expense of workmanship, viz. $7\frac{4}{16}$d. + $8\frac{2}{16}$d. lb. = $15\frac{6}{16}$d. ℔ lb.

To find the average number or size of the yarn, having the quantity given and the number of spyndles produced therefrom.

RULE. Reduce the spyndles to hanks, and divide by the number of pounds.

EXAMPLE III.

Suppose the lbs. produced to be 13736, equal to 45440 spyndles.

```
Spyndles produced,  45440
Hanks in a Spyndle,    18
                   363520
                   45440
Lbs. produced, 13736)817920(59½ average number or size.
                     68680
                     131120
                     123624
                       7496
```

To find the cost of each number or size in the whole range of Spinning, say from 50 *to* 80.

Rule. Divide the number of hanks produced in all by each number separately, and take the quotients for the lbs. produced, and divide the expense of workmanship by it, and the quotient arising from this operation will be the cost of each number respectively.

Or by another and better method: Find first the number of hanks produced in all, and divide it by the two extremes, or by the highest and lowest numbers separately, and divide the whole expense of workmanship by each of the quotients; the results arising from this operation, will be the cost of each of these numbers, that is, the highest and lowest in the whole range of spinning, which was supposed to be 50 and 80. Having found the cost of the two extremes, subtract the lowest from the highest, and let their difference be equally divided amongst all the intermediate numbers.

EXAMPLE IV.

The hanks produced are 817920, (see Example III.) divide these by 50 and by 80, which was supposed to be the two extremes, and each of the quotients will be the lbs. produced, supposing the whole spinning to have been either of these numbers:—Divide the expense of workmanship by the number of lbs.

Size. Hanks.
50)817920(16358 lbs. produced, supposing the whole spinning to have been No. 50.
50
317
300
179
150
292
250
420
400
20

Size. Hanks.
80)817920(10224 lbs. produced, supposing the whole spinning to have been No. 80.
80
179
160
192
160
320
320

Expense of workmanship in pence, 99729d. (see Example I.)
Lbs. produced of No. 50, 16358)99729($6\frac{1}{16}$ cost of one lb. of No. 50.
98148
1581
16
9486
1581
16358)25296($\frac{1}{16}$
16358
8938

Lbs. produced of No. 80, 10224)99729($9\frac{12}{16}$ cost of one lb. of No. 80.
92016
7713
16
46278
7713
10224)123408($\frac{12}{16}$
122688
720

From cost of 80 $= 9\frac{13}{16}$d.
Take cost of 50 $= 6\frac{1}{16}$d.
The difference is $3\frac{12}{16}$d. which being divided by 14, the number of intermediate Nos. gives $\frac{4}{16}$. Therefore let the cost of each intermediate No. or size advance by $\frac{4}{16}$d. thus:

No. 50	52	54	56	58	60	62	64
cost $6\frac{1}{16}$d.	$6\frac{5}{16}$d.	$6\frac{9}{16}$d.	$6\frac{13}{16}$d.	$7\frac{1}{16}$d.	$7\frac{5}{16}$d.	$7\frac{9}{16}$d.	$7\frac{13}{16}$d.

No. 66	68	70	72	74	76	78	80
cost $8\frac{1}{16}$d.	$8\frac{5}{16}$d.	$8\frac{9}{16}$d.	$8\frac{13}{16}$d.	$9\frac{1}{16}$d.	$9\frac{5}{16}$d.	$9\frac{9}{16}$d.	$9\frac{13}{16}$d.

The cost of the material added to each will show the nett cost of yarn.

To find the cost of Yarn produced from a single system in any given time.

RULE. Find how many feet of carding are in the whole mill by measuring the length of all the finisher doffing cylinders; and again, how many feet of carding are in each system; then find the expense of those departments which are common to all the systems, and take the proportion of that expense according to the proportion which the number of feet in the system bears to the number of feet of carding in the whole mill, and likewise the same proportion of the incidental charges, add them together with the wages paid to the hands employed in the system, and proceed as formerly.

EXAMPLE V.

Suppose 120 feet of carding in the whole mill, 30 feet in each system, and 12 pairs of jennies spinning 3168 lbs. of No. 64 warp yarn in 12 days.

Picking-room,	3 hands	@ 14/ ⅌ 12 days,	- - -	£2	2	0
Do.	1	@ 9/ do.	- - - -	0	9	0
Do.	1	@ 18/ do.	- - - -	0	18	0
				£3	9	0

Then, as 120 feet of carding : £3.9 : : 30 (Feet.) : 17/3

```
        20
        --
        69
        30
      ----
120)2070(17/3
     120
     ---
      870
      840
      ---
       30
       12
      ---
120)360(3                         £0 17 3
```

One spreader who spreads for feet 50 @ 14/ ⅌ 12 days.

As 50 feet is to : 14/ : : so is 30 feet to : 8/5 -	0	8	5
1 hand @ 4/, and card feeder-breakers 6/ = - -	0	10	0
1 do. do. finisher - - - -	0	7	0
2 do. first drawer @ 8/6 - - - - - - - -	0	17	0
2 do. second do. @ 10/ - - - - - - - - -	1	0	0
1 hand, slabbing frame, - - - - - - - - -	0	9	0
2 toppers @ 14/ = - - - - - - - - - - -	1	8	0
1 hand, lapping machine, - - - - - - - - -	0	12	0
2 sharpers, one @ 8/ and one @ 14/ = - - - -	1	2	0
Carding master - - - - - - - - - - - - -	2	0	0
3 stretchers @ 21/ = - - - - - - - - - - -	3	3	0
Spinning 3168 lbs. @ 3¼d. - - - - - - - -	42	18	0
Reeling @ 1/ for 50 spindles - - - - - - - -	11	5	3

Mechanics @ £12 ⅌ 12 days.

As 120 feet of carding : £12 : : 30 feet of carding : £3. 3 0 0

```
        30
        --
120)360(3
     360
```

Carried forward, - - - - £69 16 11

Brought forward, - - - -	£69	16	11
Overseer @ £4 ₩ 12 days.			
As 120 feet of carding : £4 : : 30 feet of carding £1.	1	0	0
Wareroom hands, 3 @ 14/ = £2 2			
Do. 1 @ 12/ = 0 12			
Do. 2 @ 7/ = 0 14			
£3 8			
As 120 feet of carding : £3 . 8/ : : 30 ft. of carding : 17/	0	17	0

```
  20
  68
   30
120)2040(17/
    120
     840
     840
```

Porter, sweeper, or others, 18/ ₩ 12 days.			
As 120 feet of carding : 18/ : : 30 feet of carding : 4/6	0	4	6
Incidental charges, £160 ₩ 12 days.			
As 120 feet : £160 : : 30 feet : £40 - - - -	40	0	0
	£111	18	5

The whole proportion of the expense of workmanship belonging to one system is £111 . 18 . 5. Divide this by the pounds produced, and the quotient will be the cost of one pound, to which add the price of the material, and the result will be the nett cost of one lb. of yarn.

```
                   £111 . 18 . 5
                          20
                        2238
                          12
Lbs. produced, 3168)26861(8 7/16d. expense of workmanship for
                    25344            one lb. of yarn.
                     1517
                       16
                     9102
                     1517
               3168)24272(7
                    22176
                     2096
```

Cost of material, 9½ oz. of Egyptians, @ 8½d. ⅌ lb. =	$5\frac{1}{16}$d.
9¼ oz. Demerara, @ 7½d. ⅌ lb. =	$4\frac{7}{16}$d.
	$9\frac{8}{16}$d.
Expense of workmanship, ⅌ lb.	$8\frac{7}{16}$d.
Nett cost of one lb. of yarn, ...	1/$5\frac{15}{16}$d.

The following Statement exemplifies a very simple and correct method of calculating the balance of Profit or Loss from the whole establishment per fortnight, (each pay day) of any Spinning Factory, and which may be done as speedily as the minuter calculations, when the annual cost is ascertained.

Supposed Annual Expense in A. B. & Co.'s Factory, and not entered in Wages Book, January 1832.

Stock in Trade, £5000, at 5 ⅌ cent.	£250
Machinery, £10000, at 7½ do. for tear and wear,	750
Coals and Grease for Engine, &c.	250
Paper, Twine, Banding, &c.	80
Oil,	70
Materials for Tradesmen to keep Machinery in repair,	70
Carriage of Cotton and Yarn,	50
Skins and Cloth for covering Rollers,	50
Manager's Wages,	150
	£1720

Divide by 26, being the number of fortnights in the year, and each, the period when the workers are paid, ...£66 3 1

Statement of the Profit or Loss, per Fortnight, in A. B. & Company's Factory.

DATE. 1832.			Yarn spun ℔ fortnight.	Cotton consumed.	Price of Cotton.	Average Size of Yarn.	Price of Yarn.	Amount of Charges.			Value of Yarn.			Loss ℔ Fortnight.			Profit ℔ Fortnight.		
Jan.	14	* Yarn spun last fortnight, ℔ Wages Book,	*Lbs.* 8000	*Lbs.* 10000	*d.* 5½	50	*s. d.* 1 3	£ 229	*s.* 3	*d.* 4	£ 500	*s.* 0	*d.* 0						
		Wages paid ℔ Wages Book, ...	....	....	......	......	......	133	6	8									
		Guarantee and commission, @ 8¼ ℔ cent. on Yarn, ...	....	....	......	......	......	41	5	0									
		On cost ℔ fortnight, ℔ Statement,	....	....	......	......	......	66	3	1									
											469	18	1						
																	£30	1	11

* This supposes the factory spinning only one system of yarn, but if more is going on, it is equally easy to state each from the wages book, as also prices of cottons, as they may be superior, or inferior from invoices.

PROBLEM II.

The length and weight of the lap being given— How to find the size of the yarn. The lap to be taken at the finishing carding engines.

RULE. Multiply the length of the given lap by the whole amount of the draughts through the process, beginning at the finishing carding engines: and divide the product by the number of doublings, the result will be the number of inches produced from the given length of the lap. Divide these by the product of the circumference of the reel, multiplied by the threads in a lea, and the leas in a hank of yarn; the last result will be the hanks produced from the given weight of the lap; then, as the given weight of the lap (deducting so much for flowings) : is to the drachms in one lb. : : so is the hanks produced from the given lap : to the hanks in one lb.

Suppose the weight of the lap (taken at the finishing carding engines) to be 122 drachms, length of ditto 70 inches, and the draughts as follows. Draught of carding engine 60. Draught of drawing frame, 1st. heads 8.5 × 2d. heads 8.5 × 3d. heads 8.5 = 614.125. Draught of fly frame $11\frac{1}{2}$. Draught of jenny 8. The number of doublings in all 512. Allowing 10 drachms for tops, strips, flowings, &c. Required the size of the yarn.

EXAMPLE I.

Draught of drawing frame, 614.125
Draught of carding engines, . 60
36847.500
Draught of fly frame, . . $11\frac{1}{2}$
405322500
18423750
423746.250
Draught of jenny, . . . 8
3389970.000
Length of lap, ... 70 inches.
Number of doublings, 512)237297900.0(463472.46 inches produced from the given lap.
2048
3249
3072
1777
1536
2419
2048
3710
3584
1260
1024
2360
2048
3120
3072
48

The given lap multiplied by the whole draught, and divided by the number of doublings, gives as the result 463472.46 inches. These reduced to hanks, gives the number of hanks produced from 122 drachms, the weight of the given lap.

EXAMPLE II.

```
Circumference of the reel, 54 inches.
Threads in a lea, . . .  80
                        ----
                        4320
Leas in a hank, . . .      7
                        -----
                        30240)463472.46(15.32 hanks produced
                              30240           from the given lap,
                              ------          viz. 122 drachms.
                              161072
                              151200
                              ------
                               98724
                               90720
                               -----
                                80046
                                60480
                                -----
                                19566
```

The hanks produced from 122 drs. being 15.32. Then to find the hanks produced from one lb. Deduct 10 drs. for flowings, &c. and as the remainder : is to the drs. in one lb. : : so is the hanks produced from 122 drs. : to the hanks in one lb.

EXAMPLE III.

```
Weight of the given lap, . . 122 drs.
Deduct for tops, strips, flowings, &c. 10
                             --- Drs. in a lb.  Hks.
                             112 : 256 : : 15.32
                                             256
                                            ----
                                            9192
                                           7660
                                          3064
                                      -----------
                                  112)3921.92(35.01 5/7 size
                                      336             of yarn
                                      ---             required.
                                       561
                                       560
                                       ---
                                         192
                                         112
                                         ---
                                          80
                                      16)---=5/7
                                         112
```

Multiply the result thus obtained by the full length of the stretch, and divide the product by the length of the stretch, wanting the inches gained, the quotient will be the nett size of the yarn obtained by practice.

EXAMPLE IV.

Size of yarn produced as above, ... $35.01\frac{5}{7}$
Full length of the stretch, ... 56

21006
17505
40

Length of stretch wanting inches gained, 54)1960.96(36.31 nett size produced by practice.

162
340
324
169
162
76
54
22

PROBLEM III.

The length and weight of the lap being given, together with the size of the yarn obtained by practice; how to find the quantity of cotton lost in the process by tops, strips, flowings, &c.

RULE. Proceed as in last problem to find the size of the yarn without making an allowance for flowings, &c. and subtract the result from the real or true size obtained by practice; then as the real or true size : is to their difference : : so is the weight of the given lap : to the quantity lost in the process.

Proceeding as in last problem to find the size of the yarn, making no allowance for flowings, &c. the result obtained is 33.33; subtracting this from the size obtained by practice, the result is as follows.

EXAMPLE.

```
Size obtained by practice, 36.31
Size obtained as above,    33.33
                           -----       Drs.
                36.31  :  2.98  : :  122
                           122
                          ----
                           596
                          596
                         298
                        ------
                36.31)363.56(10 drs. lost in the process by tops,
                      3631          strips, flowings, &c.
                      ----
                         46
```

Though the last problem does not give the quantity lost in the spreading machine and breaker carding engines, this does not detract from its utility; it is useful for showing the loss or gain on the different qualities of cotton that may occasionally be used.

PROBLEM IV.

It frequently occurs in practice, that it is found necessary to make some additional doublings in certain departments of the process; and when the doublings are increased, the grist of the yarn will also be increased in the same proportion, unless there be a proportionate increase of draught. But if the whole of the additional draught required be put upon one machine, it is likely to injure the yarn, hence it is always considered most beneficial to divide any extra draught that may be required amongst the different machines, so that there may not be an excess in any one place; therefore when making any alterations of this kind, it is necessary to have some correct rule, by which to ascertain at once the precise quantity of draught required for each particular place, so as to produce the same size as formerly. The following rules are therefore suggested as having been found peculiarly suited for that purpose.

RULE. Find, in the first place, the size of yarn that results from an increase of doublings, without a proportionate increase of draught; and, in the second place, find the present draught, on the different places intended to be altered; let all be multiplied together to ascertain the amount. Then as the size of yarn resulting from the additional doublings : is to the present size : : so is the present amount of draught : to the amount of draught required to produce the same size of yarn as formerly.

Suppose the present size of yarn to be No. 40, and prepared in a drawing frame, having three pairs of drawing heads with a draught of 8½ on each, and in the fly frame a draught of 11½; the whole doubling throughout the process being only 512. But with a view to improve the quality of the yarn, it is intended to give another full doubling at the fly frame, which will raise the amount of doublings, in all, to 1024. Required the necessary draught for the fly frame and drawing heads, to produce the same size of yarn as formerly, notwithstanding this additional doubling.

EXAMPLE I.

Present size of yarn, No. 40. Size resulting from a full doubling at the fly frame, No. 20.

Present draught in the drawing frame,	614.125	(see Problem II.)
Draught in the fly frame, ...	11.5	
	3070625	
	614125	
	614125	
	7062.4375	
Present size, ...	40	
	20)282497.5000	
Amount of draught required, .	14124.8750	

Having found the amount of draught required to raise No. 20 to 40: Then suppose any given draught for the fly frame, and divide the amount by it; and the cube root of the quotient will be the draught required for each head of the drawing frame.

EXAMPLE II.

Suppose the draught of the fly frame now to be 14.5, then divide the amount of draught required by it.

```
14.5)14124.8750(974.129
     1305
     ----
      1074
      1015
      ----
        598
        580
        ---
         187
         145
         ---
          425
          290
          ---
          1350
          1305
          ----
            45
```

The amount of draught required to produce No. 40, being divided by the draught now supposed to be put on the fly frame, viz. 14.5, the result obtained is 974.129, the cube root of which is the draught required for each head of the drawing frame.

EXAMPLE III.

```
9 × 9 × 300 = 24300
9 × 9 × 30  =  2430  974.129(9.91 cube root, or draught
    9 × 9   =    81  729               required for each head
              -----  -------           of the drawing frame.
              26811 )245.129
                     241299
                     --------
9.9 × 9.9 × 300 = 29403.00 )3830000
  1 × 30 × 9.9  =   297.0   2970100
                            -------
        1 × 1   =     1      859900
                  --------
                  29701.00
```

One example is considered quite sufficient to exemplify the principle laid down in the above calculations, for, it is obvious, that whatever be the addition that is made to the number of doublings in any department of the process, the draught required, to produce the same size of yarn as formerly, may be ascertained by the same rule as here laid down and illustrated. But for a drawing frame, where the cotton is only twice drawn; after having found the amount of draught required for the whole frame, the square root of that number will be the draught required for each head. In the preceding example, the cotton is supposed to be three times drawn, and therefore the cube root of the amount of draught required for the whole frame is the draught required for each head; and when the cotton is four times drawn, then extract the fourth or biquadrate root, &c.

PROBLEM V.

Suppose an establishment where the can and stretching frames have long been used, but which are now to be laid aside for the purpose of introducing tube frames in their place, and the draught which formerly was divided between the can frame, stretching frame, and jenny, is now to be divided between the tube frame and jenny, in the proportion of $2\frac{3}{4}$ in the former, to one in the latter.

Required the nett draught in each (according to the above proportion) that will produce No. 36, with a doubling at the tube frame.

RULE 1st. Find the size of the end delivered at the last heads of the drawing frame, by measuring off a certain length, suppose $17\frac{1}{2}$ yards, and weighing it; then its size will be as its weight (suppose two ounces) multiplied by the number of yards in one hank : is to one hank : : so is the length of the given end multiplied by the ounces in one lb. to its size.

EXAMPLE I.

Wt. of given end.		Yds. in one hk.		Hk.		Length of given end.		Oz. in a lb.
As 2 oz.	×	840	:	1	: :	$17\frac{1}{2}$	×	16
		2						$17\frac{1}{2}$
		1680						112
								16
								8

$$1680)280 \quad \frac{280}{1680} = \frac{1}{6} \text{ hank, size of the given end.}$$

The end delivered at the last heads of the drawing frame being $\frac{1}{6}$ hank, this when doubled at the tube frame is equal to $\frac{1}{12}$ hank.

To find the whole amount of draught required to reduce this end to No. 36.

RULE 2d. Multiply the size of the end by the size of the yarn required, and the product is the amount of draught required to produce that size of yarn; having ascertained the amount of draught, then find by the rule of double position the nett draught for the tube frame and jenny, according to the proportions required.

Size of the end after being doubled $\frac{1}{12}$ × No. 36 = 432, amount of draught required to produce No. 36. If the draught required for the jenny be once known, by multiplying it by $2\frac{3}{4}$, the draught required for the tube frame is also found, To find the former the question now resolves itself into a simple problem in double position, and may shortly be stated thus. What figure is that which being multiplied by $2\frac{3}{4}$, and again by itself, the result will be 432?

EXAMPLE II.

Suppose for the first position $10 \times 2\frac{3}{4} = 27\frac{1}{2} \times 10 = 275$ first result. Suppose for the second position $12 \times 2\frac{3}{4} = 33 \times 12 = 396$ second result.

Result of first position subtracted from 432—275 = 157 error.
Result of second position subtracted from 432—396 = 36 error.
Difference of the errors, ... 121

```
Difference of errors.  Difference of position.  Error of second position.
   As 121      :     2    :    :     36
                                      2
                                   ----
                              121)720(0.59 correction to be applied
                                  605          to second position.
                                  ----
                                  1150
                                  1089
                                  ----
                                    61
```

The result obtained as above is 0.59, which is rather more than ½ that is to be added to 12 the second position. Then supposing the draught for the jenny to be 12½, required the draught for the tube frame.

$$12.5 \times 2.75 = 34.375 \text{ draught of the tube frame.}$$

Multiply the draught of the tube frame and jenny together to find the amount, thus $12.5 \times 34.375 = 429.6875$. The amount of draught being 429.6875, this divided by the size of the end gives the size of the yarn.

EXAMPLE III.

```
Size of the end, 1/12)429.68(35.80 size of yarn wanting the gaining
                      36              of the carriage.
                      --
                       69
                       60
                       --
                        96
                        96
                        --
                         8
```

Suppose the full length of the stretch to be 56 inches, and the gaining in the carriage two inches;

then multiply the above result by 56, and divide the product by 54, the result thus obtained will be the nett size of the yarn.

EXAMPLE IV.

```
                                              35.80
Full length of stretch, . . . . . . . .         56
                                             ------
                                             21480
                                            17900
                                            -------
Length of stretch wanting inches gained, 54)2004.80(37.12 size of
                                            162          yarn required.
                                            ---
                                             384
                                             378
                                             ---
                                               68
                                               54
                                              ---
                                              140
                                              108
                                              ---
                                               32
```

The above calculations are intended to exemplify the method of producing any given size of yarn from the end delivered, by the last heads of the drawing frame; and it is obvious that whatever may be the alterations that are made, whether the carding engines be made to feed quicker or slower, the spreading made heavier or lighter; or should the draught upon the drawing frame be increased or diminished; by ascertaining the size of the end delivered at the finishing heads of the drawing frame, it is easy to find what draughts are required to produce any given size of yarn; and therefore it is of great utility in practice, both for saving time and preventing a waste of cotton, especially when making such alterations or changes as those referred to.

PROBLEM VI.

To find the size of roving in Stretching Frames.

Rule. Multiply the number of teeth in the counter pinion by the teeth in the bell wheel,* and the product by the circumference of the front roller, and multiply the last product by the number of spindles in the frame.

Then multiply the circumference of the reel by the threads in a lea, and the product by the leas in a hank of yarn. Divide the former result by the last product.

EXAMPLE.

Counter pinion, ... 21	
Bell wheel, ... 120	Circumference of the reel, 54 inch.
2520	Threads in a lea, . . 80
Circumference of roller, 3.14	4320
10080	Leas in a hank, . . . 7
2520	30240
7560	
7912.80	
Spindles in the frame, 120	

30240)949536.00(31.40
90720
42336
30240
120960
120960

* The counter pinion is moved by an endless screw or worm, attached to the front roller; and the bell wheel, by one connected with the pinion; so that the pinion moves one tooth, for every revolution of the roller; and the bell wheel one tooth, for every revolution of the counter pinion.

Multiply the above result by the ounces in a lb. and divide the product by the weight of a set of roving.

```
                                 31.40
                                    16 ounces in a lb.
                                 -----
                                 18840
                                 3140
                             Oz. ------
Suppose a set of roving,    116)502.40(4.33 size of roving required.
                                 464
                                 ----
                                  384
                                  348
                                  ---
                                   360
                                   348
                                   ---
                                    12
```

The preceding calculations may, perhaps, be considered too diffuse to be of much practical utility; but it was necessary to extend them out at full length, in order to render them sufficiently simple to be generally understood. And when the principle of any calculation is distinctly understood, the operations can easily be curtailed. The object in view throughout the whole work, has been to render all the calculations as simple as possible, so that any operative acquainted with the common rules of arithmetic might easily comprehend them, and be able to apply them to practice. Those occupying a charge in Spinning Factories, and who may occasionally require to make calculations, such as have here been exemplified, soon acquire as much expertness as to be able to perform any of them, even in less time than is necessary to read some of those contained in the preceding pages.

One example only of each kind is given as being quite sufficient to exemplify the principle laid down; more might have been added, had it appeared necessary; but any ingenious carding or spinning master, can easily diversify these, or suggest others. And for young carding and spinning masters, who may have newly entered into a charge in any of the departments, or for operatives and mechanics, who may be looking forward to such a situation, it is of the utmost importance that they exercise themselves in performing all kinds of calculations connected with the business, and thereby acquire expertness in performing them when necessary, as it will be the means of saving much trouble and uncertainty afterwards.

REMARKS

ON THE

MANAGEMENT AND GOVERNMENT

OF

SPINNING FACTORIES.

Cotton Spinning Factories, like all other establishments where a large capital is invested for the purpose of manufacturing any particular kind of goods upon an extensive scale, require to be very skilfully managed in order to make them profitable, either for producing a superior quality of yarn, or turning off a large quantity in proportion to the extent of the machinery. All the different departments may be arranged in the most judicious manner, and every machine made and adjusted on the most approved principles, and yet the establishment, from the way it is managed and the mode of government which generally prevails, may be greatly deficient in respect both to the quantity and quality of its produce. And considering the amount of capital invested in these establishments, it might be expected that proprietors would be much more scrupulous in the choice of those to whom they confided the charge of them, than they frequently are: for it is now become proverbial, that interest and influence, not merit, are the only means by which these situations are obtained; hence the reason why certain proprietors realise a high profit from their establishment, whilst others can scarcely secure the interest of the sunk capital. It is an erroneous opinion, which too much prevails, to suppose that any person, who may not have been early and long practised in the business, can, notwithstanding, acquire as much knowledge by their own experience, in the course of a few months, as will qualify them for taking the full charge of a Spinning Factory. At all events, it will be admitted, that those who have been brought up to the business, and had long experience in the different departments, where they had many opportunities of seeing the methods of adapting the different machines to suit the various qualities of cotton, and sizes of yarn, and who know how to adjust machinery in the event of any little accidents or casualties that frequently occur in practice, must possess a decided advantage over those who have not enjoyed so favourable opportunities. But it is not intended here to enter into a minute disquisition on the management of Cotton Factories, but only to give a few hints, and mention some of the qualifications, which may be useful for those to cultivate who may be looking forward to the situation of manager.

It would be advantageous for the manager of a Cotton Mill to have a thorough knowledge of the business *in all* its details, as without this he must sometimes leave much of the management of certain departments to others, and they, occupying only a subordinate situation, are likely to feel a subordinate responsibility, and hence may arise much mismanagement, attended with loss to the proprietors, and followed with reflections on the manager; and if he is not himself thoroughly acquainted with the business, he will not be so able to detect the deficiencies of others, and therefore be more liable to be taken advantage of. But the manager who knows his business, can both give directions to those that are under him, as well as discern whether they are qualified for the situations they occupy, and when they fail in their duty.

It is a most essential qualification on the part of the manager, that he be expert in performing *all kinds* of calculations connected with the business; the advantages of which will be apparent in various respects. First, in regulating the *speed* of the different machines; second, in adjusting the *draughts* of the various machines; and third, in making *changes* in the qualities of the cotton and sizes of the yarn.

In regulating the *speed* of the various machines, particularly in the preparation department, it is important to have them so that the one shall not be overdriven, nor the other working at an under speed. Let the carding engines be adjusted to such a speed as will suit the nature of the cotton and the quality of the yarn for which they are preparing it; the speed of the drawing frame should also be regulated to take up exactly what the carding engines bring forward, without any unnecessary loss of time on the part of either, and all the other machines should be regulated in the same manner. But it might be desirable to ascertain the most advantageous speed, at which the different machines should be driven for the various qualities of yarn. The number of carding engines that should be allowed to the drawing frame, supposing the carding engines to be two feet broad, and the heads of the drawing frame paired two by two. It might, likewise, be proper to know the number of fly frame and jenny spindles that should be allowed to the foot of finishing carding, that is to every foot in the breadth of doffing cylinders. But, perhaps, there is nothing in the whole process, regarding which there exists a greater diversity of opinion amongst managers than these particulars; in fact, it is almost impossible to find two Mills exactly alike in this respect; some managers drive their machinery at a greater speed than others; some spread the cotton heavier; others pass it quicker through the carding: there are also some carding engines with more working tops than others, which admit of the cotton being put quicker through, whilst the same effect is produced upon it, &c. &c. It is, therefore, impossible to lay down any rule that might be taken as a standard for every Factory; because what would suit one could not be adopted in another, as their system of working might be very different in various respects. After a good deal of inquiry at a number of different Mills, and after having obtained the opinions of various managers, carding and spinning masters, the following Table has been drawn up,—examined by several managers, and considered as good an average as could be selected.

To prepare for all numbers from No. 200 and upwards, allow five or six carding engines to one drawing frame, supposing the heads to be paired two and two, and the carding engines eighteen inches broad:—and from No. 200 down to No. 150, allow six or seven carding engines to the drawing frame:—and eight or nine from No. 150 down to No. 100. From No. 100 down to No. 80, allow seven or eight carding engines, two feet broad, to each drawing frame, heads paired as above:—and from No. 80 downwards, the carding engines may range from eight to ten.

Every foot in the breadth of finisher carding engines prepares for jenny and fly frame spindles according to the following Table.

Jenny Spindles.		Sizes of Yarn.		Hanks ℔ week.		Fly Frame Spindles.
130	Spinning these	20	And producing	21	} ...	16
138	—	30	—	20		
148	—	40	—	19	} ...	17
162	—	50	—	18		
186	—	60	—	17	} ...	18
213	—	70	—	16		
242	—	80	—	15	} ...	20
278	—	90	—	14		
315	—	100	—	12	} ...	22
350	—	110	—	11		
390	—	120	—	10	} ...	25
430	—	130	—	9		

This Table has been drawn up, after the minutest inquiry, and it is presumed will be found a pretty fair average, although the weekly produce may perhaps be rated rather too high, especially for warp yarn, but not so for wefts. It might also be useful when commencing a new Factory. For if the range of numbers designed to be spun is once known, it is not difficult to ascertain from the above Table the proportions of the different machines required. And though throstle frame spindles are not included, yet it is easy to calculate the number that should be allowed for each foot of carding by comparing the hanks they are capable of producing in a given time with the produce of the mules.

The proper adjustment of the draughts on the different machines is also of equal importance to a proper arrangement of the speed. Excess of draught on any one machine, while there is less than necessary on another, should be uniformly avoided; indeed, the draughts should be as nearly equalized as is consistent with a profitable and approved mode of either preparing or spinning the different qualities of cotton, as that which is long and strong in the fibre, requires both more doubling and drawing than that which is short and weak, especially in the preparation department.

To change the sizes of the yarn and qualities of the cotton are things of frequent occurrence, and therefore to be expert and correct at these is a matter of the most essential importance; but this can only be properly acquired by practice and experience. Yet 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 rule is given at page 229, by which to ascertain the quantity of cotton lost in the process by tops, strips, flowings, &c. and it is absolutely necessary that the manager should always keep a correct account of this loss, that he may know what cotton, or which mode of working is the most profitable; as it is possible enough that he may sometimes make changes, with a view to economy, but which, at the same time, may be attended with a loss of which he is not sensible. But to render this a little more apparent; suppose one system in a Mill spinning No. 36, from a mixture of cotton that costs 6d. per lb., each pair of jennies at these numbers may be supposed to throw off 55 lbs. of yarn per day; and after deducting all expenses the nett profit gained is 2d. per lb. But with a view to realise a still higher profit, the quality of the cotton is reduced ½d. per lb.; this inferior cotton is not so productive as the former, for instead of 55 lbs., as formerly, each pair of jennies now produce only 50 lbs. of yarn per day, from the same weight of cotton as that from which 55 lbs. had been obtained when using the better quality of cotton: now here is a deficiency of 5 lbs. per day at 2d. per lb., amounting to 10d. of loss on the profits of 55 lbs. besides having 5 lbs. of cotton at 5½d. per lb. converted into waste, supposed to be worth only 3½d. per lb.; this is another loss of 2d. per lb. on the quality of the cotton, amounting to 10d. on the 5 lbs., which, being added to the former, makes 1s. 8d. And taking an estimate of all the permanent expenses incurred in one day* (taking one day with

* In this estimate is included the wages paid to all classes of workers about the establishment, who are paid by the day, together with all other incidental expenses, for furnishings, tear and wear of machinery, insurance, interest, &c. &c.

another throughout the year) it is found that each of the 55 lbs. of yarn costs 3d. per lb. to prepare it into roving for the spinning. Now 55 lbs. at 3d. per lb. = 13s. 9d., consequently, if it costs 13s. 9d. to prepare roving for 55 lbs. of yarn, when using the first quality of cotton, it will also cost 13s. 9d. to prepare roving for 50 lbs. when using the second quality—the weight of cotton required for each quantity of yarn supposed to be equal; here then is 3d. per lb. paid for the 5 lbs. of deficient yarn = 1s. 3d., and adding it to the former loss makes 2s. 11d. But by reducing the quality of the cotton ½d. per lb. there was gained upon the 55 lbs. 2s. 3½d. Therefore the loss upon the whole will stand thus:

Loss, ...	£0	2	11
Gain, ...	0	2	3½
which leaves a nett loss of, ...	£0	0	7½

on 55 lbs. of yarn.

That these statements are not exaggerated will, it is presumed, be generally admitted by practical men, who have had fair opportunities of witnessing the effects arising from different qualities of cotton. They are also intended to show that the profit supposed to be derived from using a cheaper quality of cotton is often much more imaginery than real: for when an inferior cotton is used, there is a loss sustained upon it throughout every department of the process, which can only be known by tracing it through the various stages of its progress. Likewise, in working an inferior quality of cotton, there is always a less quantity of yarn produced in a given time, but a much greater quantity of waste; besides, the yarn being of an inferior quality, is likely to hurt the credit of the manufacturer; whereas a superior quality will always support his credit, command a fair price, and secure a sale; so that he will often have his money when others have their stock.

Another primary object in the management of a Spinning Factory, that ought to be studied by the manager, is the avoiding all *unnecessary* expenses by alterations on the plan of the gearing, or arrangement of the machinery, especially such as might only be adapted to please the eye rather than improve the productive capabilities of the establishment. To have the large gearing all fitted up on the most approved plan, and the machinery arranged in the manner best calculated to facilitate the progress of the work, are, doubtless, objects of the greatest importance; but when once the establishment has been filled with machinery, and all its arrangements completed, it is better to let it remain as it is, than try to improve it; and, indeed, to begin then to make alterations, would be highly objectionable, because the money expended on these alterations might far exceed all the advantages arising from the supposed improvements. To keep all the machinery in good repair, and in the best working order, cannot be too highly recommended; as without doing so, it is impossible to produce a regular and uniform good quality of yarn; and to keep machinery in good order, by regular care and attention, is much easier than to repair it after it has been allowed to go out of repair from negligence and want of care.

But if it be necessary in order to render the business a source of profit to the proprietors that the manager know how to adjust the various machines, and adapt them to suit the different kinds of cotton and qualities of yarn, and that he be properly qualified to superintend and direct the various operations through which the cotton must pass, in being manufactured into yarn; it is no less necessary that a proper mode of government should generally prevail throughout the whole establishment, and, doubtless, it requires much wisdom and consideration, to know how to act on all occasions in the government of a large establishment, where there are a number of different classes of workers employed, so as to avoid all *unnecessary* severity, and, at the same time, maintain proper authority. I do not hesitate to assert, that a Spinning Factory can never be managed more profitably, and more to the satisfaction of the proprietors, than when there exists a good feeling and a good understanding between the manager and workers. But to the manager who has an extensive charge, the duties of which he is anxious to discharge faithfully, circumstances will frequently occur, tending to agitate the mind and ruffle the temper, on which occasions it is difficult for him to act with that consideration and prudence which he himself would approve of; and it is, perhaps, much easier for one person to lay down rules for another to walk by, than to act up to them himself. But this is a very tender point to touch upon, and shall, therefore, be treated very briefly. It may, therefore, be stated, in a general way, that in governing a Spinning Factory with propriety, it would be prudent for the manager, while guarding against too much *lenity* on the one hand, to be careful to avoid too much *severity* on the other; let him be firm and decisive in all his measures, but not overbearing and tyrannical;—not too distant and haughty, but affable and easy of access, yet not too familiar. In the giving of orders or directions, it is much better to give them in a pleasant manner, but with few words; they are then likely to be received with a good grace, and promptly obeyed. But to be frequently giving orders and laying down rules, which are never followed up, tends only to harass the mind without any good effect. If the manager be strictly just and impartial, showing no desire to favour one more than another, but always treating every person according to their merits, it generally has a good effect on the minds of those that are under him, by impressing them with the assurance that it is only by uniform attention to their business that they can secure his approbation: in a word, let the manager, at all times, maintain that dignified deportment which good sense would dictate—let him conduct himself so as to make this impression on the minds of all that are under him, viz. that while they continue to attend their work quietly and diligently, they will not be causelessly interfered with, but allowed to attend their employment in peace. In the above remarks there is no reference to any particular manager, or individual Mill, they are merely suggested from the complaints and observations that are constantly to be heard amongst the various classes of workers employed in Cotton Factories. And whilst it is absolutely necessary to maintain a proper authority, and keep uniform good order, as the end of all government is order; yet it must be pleasant for the manager to have no jarring contentions with the workers; and unless he know what are subjects of general complaint, he cannot be supposed to know how to frame his conduct so as to support his authority, and, at the same time, avoid some of those unpleasant disputes between managers and workers which have frequently occurred.

There are a few things that may next be mentioned, which have often been subjects of complaint amongst operative spinners, and if they could be avoided, might be the means of preventing some of those unhappy disputes which bring the parties before the public. First, operatives are generally unwilling to submit to *fines* either for bad work or improper conduct: it seems to be a general feeling amongst them, that they would much rather have the master to turn them away than fine them. It is vain to tell them, that it is for their own benefit, that a fine of one or two shillings is exacted rather than throw them out of employment. If the fines were given to some benevolent or charitable institution, it would not be so objectionable, but when they are retained by the proprietor, the operatives generally ascribe it to a certain *propensity*. Operatives frequently complain of the sizes of their yarn, and are sometimes doubtful that they do not get strict justice: and perhaps there are few things about Spinning Factories that have caused more disputes between the masters and operatives. But were it known to the operatives that it is the particular *wish* and *order* of the proprietors, to give the fair and exact size of the yarn, so as to render *equal* justice to both parties, it might be the means of preventing much private murmuring and dissatisfaction amongst them. When a master has occasion to expostulate with the operatives about any particular faults,—if he apply any opprobrious or degrading epithets,—swear over them,—and use such language as is calculated to hurt their feelings, it is likely to be attended with unpleasant effects, as it is not soon forgotten, and is apt to make the workers forget their own faults, and think only upon the overbearing conduct of their masters, and thereby prevent the exercise of that affection between master and servant that is necessary for the comfort of both.

Such, then, are a few of those things which cause frequent disputes between the masters and operatives; they are merely stated here without saying whether they are right or wrong, or whether it is the duty of the masters to attend to them or not. But to proceed with this delicate subject. In regard to the carding and spinning master's situation, these being rather different, require somewhat different modes of government. In the spinning department there are men who have the charge of their own work, and are paid only for what they do, and responsible both for the quantity and quality of their work; they can also be made sensible of the consequences that would result from any degree of carelessness or negligence on their part; and hence it is not necessary that the spinning master should be always present. But this is not the case in the carding department, for there they are mostly women on set wages, whom it is difficult to make sensible of their responsibility, and the evils resulting from carelessness on their part; and, therefore, they require to be constantly looked over: hence, the carding master should never be out of their view, as much depends upon the proper management of the carding department for making good yarn; so, of course, the carding master should seldom, if ever, be absent, as his very presence might prevent many faults that would otherwise take place. It is the duty of both carding and spinning masters to superintend all the machinery under their charge; to see that it is kept in good order; to trim and adjust it; to suit the various qualities of cotton and sizes of yarn. But whilst the spinning master requires to act with prudence and caution—to be just and impartial—firm and decisive—always on the alert to prevent rather than check faults, after they have taken place; yet good discipline is of the very first importance in the carding room. The carding master must act with the utmost vigilance and promptitude, and sometimes with a degree of seeming severity, that is not so necessary in the other.

AN

HISTORICAL SKETCH

OF THE

RISE AND PROGRESS

OF

COTTON SPINNING.

The surprising perfection to which the art of Cotton Spinning has attained—the vast amount of capital invested in the business—the important place it now occupies amongst the staple manufactures of our country—and the number of our industrious population, to whom it furnishes employment, unite to render a short historical sketch of its rise and progress a subject of interesting inquiry: and although such knowledge is not considered necessary in order to qualify any one for taking a charge in a Spinning Factory; yet it is presumed that an outline of the history of cotton spinning will not be thought superfluous in a work professing to be a treatise on the art.

The manufacturing of cloth was introduced into Great Britain by the Romans. "Our ancestors, previous to their arrival, being partially covered with the skins of animals, and the parts exposed were painted red of various figures. The Romans soon after established a woollen manufactory at Winchester, for clothing their army, and instructed the natives in the culture of flax and in weaving. Little farther is known of the art till the reign of Edward III. who is distinguished as the first monarch in this island who directed his attention to the promotion of the arts and manufactures. The particular branch that he encouraged was the woollen manufacture; introducing, for this purpose, in the year 1331, a number of weavers and cloth workers from the continent of Europe. They were followed by two Brabant linen weavers, who also received the patronage of the king, and settled at York. They were again followed by numbers of their countrymen; so that in 1351 foreign weavers are described as being numerous in London."

But respecting the cotton manufacture, it is well known to have had its origin in the East, the country where the cotton plant is indigenous; and from the earliest ages India has been celebrated for the manufacture of cotton cloth, large quantities of it being annually imported into Europe. Notwithstanding this, however, and although the Indian stands unrivalled even by the British manufactures, their implements are rude and simple, evidently the invention of an early period. The fitting out of an

Indian weaver, with all his necessary machinery for cleaning, preparing, and spinning the wool, to the converting it into the finest muslin, does not exceed, in value, a few shillings. Yet though the manufacturing of cotton cloth has long been practised in the Eastern world, no progress has ever been made by them in improving the machinery, by which the spinning of yarn is accomplished. The distaff and spindle are the only implements used for that purpose; the same that appears to have been used for the spinning of yarn by nations of the remotest antiquity. "And it is worthy of observation, that in all the countries which have been discovered by navigators for the last three centuries, these simple machines have been employed for the above purposes. Hence it has been inferred that the same wants lead to the same means of relief. The use of the needle, too, has been cited as a farther proof of that opinion, and Pagan nations, unable to trace such useful contrivances to their true origin, attribute their invention to some one of their false deities."

It is supposed that in Europe cotton cloth was first manufactured in the commercial states of Italy: by others, it is said that the first attempts to manufacture cotton goods were made by the people of the Low Countries. But the latter is doubted by several writers, who suppose that from Italy it made its way into the Netherlands, and that it was brought from thence to this country* by Protestant refugees, about the end of the sixteenth, or beginning of the seventeenth century.

The spindle and distaff are said to have been introduced into this country, only in the reign of Henry VIII., but were soon laid aside upon the invention of the well known machine called the spinning wheel, which, in a commercial point of view, was no great improvement; but for many years it continued the only machine used for the spinning of cotton yarn, "until about the middle of the last century, when the increase of the manufacture of cotton goods increased the demand for yarn; in so much, that a pause would naturally have ensued, and beyond which there could have been no advance, but with the slow and gradual increase of population; but as the demand for goods increased, various contrivances were attempted for expediting the process of spinning; and several men of genius directed their attention to it, but all with equal

* The earliest records of the cotton manufacture of Britain that are extant, are from Lewis Roberts' Treasure of Traffic, published in 1641, in which he says, "The town of Manchester buys cotton wool from London that comes from Cyprus and Smyrna, and works the same into Fustians, Vermillions, and Dimities." Fustians were also manufactured at Bolton about the same period, and in 1756, cotton velvets were made by Jeremiah Clarke, and cotton quiltings, by Joseph Shaw, at Bolton.

want of success, until the invention of the spinning jenny, in 1767, by James Hargreaves." The form of this machine, and the incident that suggested the first idea of it to his mind, have already been mentioned. Its invention gave a new impulse to the cotton manufacture, by increasing the produce of yarn, and with it the demand for cotton goods. Cylinder cards were invented some time previous to the invention of the jenny, and prepared the cotton for it, by which the progress of the manufacture was greatly facilitated. It seems uncertain who was the inventor of the cylinder cards: but it is known that the father of the late Sir Robert Peel erected one at Blackburn, with the assistance of Hargreaves, as early as the year 1762. Hargreaves is also said to have been the first who employed the stock card, used in the woollen trade, in the carding of cotton. But this ingenious man was not allowed to reap the fruits of his own inventions in peace. For the popular prejudice being raised against him—as the people who had hitherto earned their subsistence by hand spinning conceived that the spinning machine invented by him would cause their ruin, they, therefore, mobbed Hargreaves' house, broke into it, and destroyed his machine; and when experience had shown to others the value and importance of his new mode of spinning, the people again rose, scoured the country, and destroyed every spinning machine they could find.

But by this time he had found it prudent to remove to Nottingham, where he assisted various persons in the construction of machinery, and where a serious affray took place, in opposition to the new machines, in which he and others are said to have been severely wounded. Some time after this he died in poverty, neglected and little known to the country that has since reaped the fruits of his important inventions. Hargreaves' spinning jenny was at first but rudely constructed, but in a short time was greatly improved, and notwithstanding the determined opposition it met with at first, it soon spread rapidly over the country, and may be considered as a first step in that series of inventions which has made so great an alteration in the state of manufactures in this country, substituting the power of machinery for the labour of man, and tending so much to increase the production of capital; and it is worthy of observation, that those who were most strenuous in opposing these inventions, were the first to avail themselves of their advantages.

Shortly after the invention of the spinning jenny, Mr. Arkwright, afterwards Sir Richard Arkwright, brought forward that wonderful piece of mechanism, the spinning frame, in the construction of which he had long been laboriously engaged; but from his want of mechanical knowledge, he had great difficulty in getting any combination of machinery to answer the idea he had formed in his mind; and, indeed, after his plans had been sufficiently matured, and the construction of his machine so far advanced, as to demonstrate its value, other difficulties of a still more formidable nature presented themselves, and would have disheartened any but the most ardent genius. His finances not being sufficient to enable him to commence business on his own account, few seemed willing to hazard capital sufficient to enable him to secure his invention by patents, and commence operations with them in the spinning of cotton yarn. At length, however, he was so fortunate as to secure the co-operation of some persons who had sufficient discernment to see the merit of the invention, and he, consequently, obtained his first patent for spinning with rollers in 1769. The first Mill he erected was at Nottingham, which was worked with horses; but this mode of working being found expensive, another larger Mill was erected in 1771, at Cromford, in Derbyshire, which was moved by water: at this place he generally resided during the remainder of his life.

The spinning machine invented by Arkwright is called the water spinning frame, a description of which is given in a former part of this treatise, and therefore need not be repeated; but as the name of Arkwright is so identified with the history of cotton spinning, perhaps a sketch of his life may not be uninteresting.

"Richard Arkwright was born at Preston, in Lancashire, in the year 1732. He was the youngest of *thirteen* children. He was brought up to the occupation of a barber, and supported himself by this employment till he was more than thirty years of age. We are not informed of the peculiar circumstances that first directed his attention to the cotton manufacture, but it seems probable that his residence in a manufacturing district gave him some knowledge of the common mechanical processes, and that he took an interest in the complaints made by his neighbours of the deficient supply of *cotton yarn*. Almost the only part of England where the cotton manufacture was introduced was Lancashire, and there all the processes of art were extremely defective. Down to the year 1765, *calicoes*, then, and now one of the staple fabrics of that wealthy district, were obliged to be made of *linen warp*, as cotton could not be spun *strong enough* for the purpose. But the ingenuity of the people was now at work, changes were daily introduced, and in this, as well as other manufactures, England began that prodigious career of improvement by which she has ever since *distanced* the other nations of Europe."

Great improvements had been made in the carding process, and about this time Hargreaves' jenny was invented, which caused considerable excitement in the country. But Arkwright's machine, with which he was busily occupied for some years, was the most important improvement that had ever yet been introduced into the process of cotton spinning; "and, indeed, if the steam engine be excepted, we do not know any mechanical invention that has made such an amazing addition to the activity, industry, and opulence of this country, as the invention of Arkwright's spinning frame," which he brought forward some years after the invention of Hargreaves' jenny. "Some doubts have been entertained of the justice of his claims to the first idea of his invention; but it is beyond all doubt that he was the first person who rendered it of practical utility, and by that means he was raised from one of the most humble occupations in society, to one of affluence and fame." The allegations brought against the originality of his inventions are in substance as follows:

"In the year 1767, Arkwright had given up his business as a barber, and was travelling through the country for the purpose of buying hair. He came to Warrington, formed an intimacy with a watchmaker, named John Kay, and showed him some plan of his for obtaining *perpetual motion*. Kay ridiculed his idea, and told him that his ingenuity might be better employed in finding out some method of spinning to supersede the common one thread wheel. Kay had formerly been employed to make a spinning engine for a Mr. Hayes, and the knowledge he had by that means acquired, he communicated to Arkwright. The mechanical knowledge of the latter was but slender, while Kay, as might be presumed from his business as a watchmaker, was well acquainted with machinery and mechanical combinations. Kay and Arkwright made a machine in conjunction, but the merit of the first suggestion of the principle, it is said, is attributable to Kay."

"Such is the account that ascribes the invention to Kay, and merely the improvement of the machinery to Arkwright. But it must be observed, in the first place, that the machine which Kay constructed for Mr. Hayes did not succeed, and it is well known that many others besides Hayes was at that time engaged in making experiments to change the mode of spinning,—but all these were uniformly *unsuccessful.* Had Kay's *communication* been at all important, it is very unlikely that Arkwright would have had so many difficulties to encounter in bringing his machine into practical operation, nor would he have required so much pecuniary aid, nor so much important information from skilful mechanics, as we know he received. From the time that Mr. Arkwright began his experiments on spinning, till he brought his machinery to perfection, five years elapsed, and he expended more than *twenty thousand pounds* without receiving any return. This money was of course advanced by persons who had confidence in his integrity, as well as his talents; his rivals (as usual) reproached him in after life with having made his fortune by means of *borrowed capital*, and employed against him all those invidious reflections that are aimed at those whose success raises them above the dead level of mediocrity."

"Mr. Arkwright entered into partnership with Mr. Smally of Preston, (his native place,) but as occurred to the unfortunate Hargreaves, the spinners rose to put down their machinery—their establishment was ruined, and they were both forced to remove to Nottingham. At this place he persuaded two bankers, of the name of Wright, to advance him considerable sums for the purpose of bringing his machinery to perfection; but when they found the advances becoming heavier than they anticipated, and the success doubtful, they advised him to get Mr. Need, an eminent stocking manufacturer, to take *their interest* in the establishment off their hands. When Mr. Need was applied to, he referred to his partner, Mr. Shute, and said, he would be guided by his opinion of the utility of the improvement. Shute was a man of great mechanical skill; he saw at a glance the advantages of the proposed plan, and the facility with which any of its remaining defects might be obviated. The advances of the Messrs. Wright were repaid to them; and Messrs. Shute and Need entered into partnership with Mr. Arkwright for the purpose of *spinning cotton with* *rollers.* He took out his first patent for his spinning frame in 1769, as already mentioned, and erected his first Mill at Nottingham; and after a short time, he erected a larger one at Cromford, in Derbyshire."

"The spinning frame has justly been held to be a wonderful invention; it has nothing in common with the spinning jenny of Hargreaves, except that it performs the same process. The machinery for drawing and spinning the cotton was his grandest conception—all his subsequent inventions, though of great importance, did not require the same originality of mind, as they were rather improvements and combinations of his former inventions than new ideas. His patent was contested in the year 1772, on the ground that his improvements were not original, but he obtained a verdict in his favour, and enjoyed the patent to the end of its term. His inventions being entirely new, he applied them, with the happiest success, in various forms, in the preparation of the raw material, for all of which he obtained a patent in 1775. But after reiterated contests with rival manufacturers, this patent was cancelled in the year 1785 by the Court of King's Bench, under the pretext that all the mechanical applications combined with it were not original."

The contests alluded to above, related chiefly to the operation of carding, which was now brought to a state of great perfection. Mr. Arkwright's right to the invention of the crank and comb, for taking off the cotton from the doffing cylinder in a continued fleece, was disputed in the last hearing of his cause. His claims, however, to the spiral cards, which produce the continued carding, has never been disputed. "That all these inventions and improvements, which are ascribed to Arkwright, should have been the production of an individual without education, or any previous mechanical knowledge or experience, is most extraordinary. Yet he was engaged at the same time in many other concerns arising from the peculiarity of his circumstances. While he was extending the business on a large scale, he was introducing into every department of it a system of order and cleanliness till then unknown in any manufacture; and all these exertions, too, were made when he was suffering under an oppressive disorder, which at last terminated his life."

"Though his second patent was cancelled, Mr. Arkwright now enjoyed the full tide of prosperity; wealth flowed profusely into his lap; and if his first difficulties were many, his final success was cheering. He was for a short time in partnership with David Dale, Esq. of the Lanark Cotton Mills. His spinning machines were spreading over the kingdom, and he received an annual sum—the tribute of invention, it might be called, for each spindle employed. His success raised him enemies, whom his irritability of temper did not tend to conciliate; while his competitors, in the struggle for wealth, meanly taunted him with the lowness of his original station, and thereby showed that *they* would never have emerged from obscurity, had such been their lot. It was in allusion to his original occupation, and to his connection with Mr. Dale, that he is reported to have said of his enemies—that he would put his razor into the hands of a Scotchman who would *shave* them all. He was particularly friendly to Scotchmen, and gave them free access to his establishments."

The improvements introduced by Watt into the steam engine, rendered it of primary importance in giving motion to machinery; and the benefit of Arkwright's inventions were soon rapidly extended by its application to cotton spinning. The first steam engine erected by Boulton and Watt, for Arkwright, was in the year 1790, at Cromford, in Derbyshire.

"We have little more to relate concerning the remaining incidents of the life of Arkwright. On the 22d December 1786, he received the honour of *Knighthood*, on presenting an address to his Majesty, from the Sheriff and Hundred of Wicksworth. He died at his seat at Cromford, in Derbyshire, 3d August, 1792."

"Sir Richard Arkwright was of a hasty and capricious temper, and though a man of great powers of mind, he could never entirely shake off the rude habits of early life, nor adopt the sentiments which befitted the rank to which his talents had raised him." Yet in his case we find a rare specimen of profound genius and invincible perseverance, struggling against their most formidable enemies, *poverty* and *prejudice*. Whether all the inventions ascribed to him were originally his own or not, is of no consequence to us, it is, at least, more than probable, that, but for him, they would have perished with their authors, none of whom, except himself, had the determination and courage, to face the multiplied difficulties that lay in the way of achieving a practical exemplification of what they had conceived in their own minds, and thereby demonstrating their power and value. When Arkwright first commenced to give a practical demonstration of the usefulness of his invention, he was poor, friendless, and unknown. It is said of him, that, about this time, an election contest having taken place in the town of Preston, of which he was a burgess; before he could be brought into the poll room, his friends had to subscribe as much as furnish him with a decent suit of clothes. It may also be added, that, upon one occasion, he and Kay together made application to a Mr. Atherton for some pecuniary assistance, to enable them to prosecute their plans; but the poor appearance of Arkwright, alone determined that gentleman to have nothing to do with the adventure. Can we have a more exciting example, then, of what a resolute mind may do in apparently the most hopeless circumstances?—of what ingenuity and perseverance together may overcome, in the pursuit of what they are determined to accomplish? And this is the grand lesson which the history of Arkwright is fitted to teach—to give ourselves wholly to one object, and never despair of attaining it (if an honourable one,) even though opposed by the most untoward circumstances.

Previous to the inventions of the jenny and spinning frame, it was customary for the manufacturers, when employing their weavers, to give them a stated quantity of linen warp, and a proportional quantity of cotton wool, which the weaver had to get spun into weft, and for weaving which he received a fixed price when he returned the web. So fast, however, was the weaving outstripping the spinning at this time, that the weaver often found himself obliged to pay more than he had been allowed by his employers for this part of the process. Yet he durst not complain, lest his looms should be left unemployed by the refusal of the spinner to spin his yarn. Had this state of things continued, the further progress of the art must have been stopped. But the inventions of Hargreaves and Arkwright together supplied a desideratum then extensively felt and acknowledged, and gave a spur to the cotton manufacture of this country, which has been gradually improving from that time till the present. Bnt we must not omit to mention another spinning machine, viz. the mule jenny that was invented during the term of Arkwright's first patent, and which aided, in conjunction with the others, to extend the manufacture, and advance our country to that state of commercial greatness which it has now attained. The mule jenny is a compound of the two former; it partakes of the essential properties of Arkwright's invention, viz. the rollers producing the effect of the finger and thumb; and on the application of this part of the system to the jenny of Hargreaves, the merits of the mule, in a great measure, consist. Its utility, however, is very great, and, in fact, with its invention commenced an entirely new era in our cotton manufacture: all the finer descriptions of cotton goods may date their origin from the introduction of this machine, and much greater variety in the qualities of yarn has been spun by it, than ever before had been attainable. As an example of the extreme divisibility of matter, and degree of tenuity or fineness of which it is found practicable to spin cotton yarn with the mule, it may be mentioned, that one pound of cotton wool has been spun by it into 350 hanks, each hank measuring 840 yards, and forming together a thread 167 miles long. The price usually paid by the Glasgow manufacturers for the finer descriptions of yarn, at first spun by the mule jenny, was *twenty guineas per pound*.

"The mule was invented by Mr. Samuel Crompton, formerly of Hall in the wood near Bolton, in Lancashire, a person of very great ingenuity, and to whom the public is indebted for many other valuable improvements in the cotton manufacture." He also laboured under many difficulties in bringing his machine to perfection, as may be gathered from the following extract of a letter he sent to a friend: "In regard to the mule, the date of its being first completed, was in the year 1779: at the end of the following year I was under the necessity of making it public, or destroying it, as it was not in my power to keep it and work it, and to destroy it was too painful a task, having been four and a half years, at least, wherein every moment of time and power of mind, as well as expense, which my other employment would permit, were devoted to this one end, the having good yarn to weave; so that destroy it I could not." The mule did not come into very general use, until after the dissolution of Arkwright's second patent in 1785, ten years after its discovery. Yet so rapid was the progress it made, that, in 1787, only two years after its introduction, no less than 500,000 pieces of cotton muslin—a species of fabric never before attempted—were made in Great Britain, the manufacture of it having been begun simultaneously in Bolton, Glasgow, and Paisley.

Mr. Crompton never took out a patent for his invention, yet it is satisfactory to know, that Parliament, in 1812, voted him £5000 as a reward for his discovery; and during the investigation that took place at the time, before a Committee of the House of Commons, it was proved that there were then *four millions* of spindles employed on Mr. Crompton's principle; that two-thirds of the steam engines for spinning cotton turned mules, and that the value of the buildings, machinery, &c. employed on the same principle, amounted to about *four millions* sterling. Mr. Kennedy, in his memoirs of Mr. Crompton, has stated, that the number of mule spindles employed had, in 1829, been raised to 7,000,000; they were, in 1832, rated at 8,000,000.

The mule was at first wrought by the spinner's hand, but Mr. William Kelly, of the Lanark Cotton Mills, early obtained a patent for moving them by power; but in a short time he generously gave up his right, and allowed all who chose to partake of the benefit of it. Many different plans were tried with the mule, and its improvements were progressive: it has now, however, attained to a state of great perfection.

" The spinning machines of Arkwright and others had not been long in operation in England, until they attracted the notice of traders in Scotland, who soon attempted what was then to many a most lucrative branch of manufacture. But it is difficult to plant a manufacture in a new country, even where there is no secret in the process; and the difficulty was still greater in this instance, where pains were taken to keep the business involved in mystery. Many who had been employed in the works of Arkwright, left his service, pretending to a knowledge of the business which they did not possess; and those men were eagerly sought after by new adventurers in the manufacture in both kingdoms. But in most cases those adventurers were no gainers by the acquisition. This may easily be conceived, when we consider how very little a great proportion of the people now employed in our Cotton Mills know, and how much less they can communicate of the construction of the machinery, or the general system of the business; and if such be the case at present, what must it have been at the period of which we are speaking, and among men very deficient in the simplest branches of education. Notwithstanding these obstructions, however, several establishments were soon formed in Scotland."

It is supposed that the first cotton spun by water in Scotland was in the island of Bute, in what had been a lint mill, and was afterwards for some time the corn mill of Rothsay. But this was only by way of trial, and before the completion of the larger cotton mill. Nearly about the same period cotton was spun at Pennycuick mills, near Edinburgh. About the year 1780, the mill of Barrhead, in the parish of Neilston, was completed; soon afterwards that of Busby, in the parish of Mearns. And in the year 1782, a large mill of six stories was erected at Johnstone,—a place still celebrated for the *enterprising* spirit of its inhabitants. This was the first extensive establishment in Renfrewshire; and there is reason to suppose it was the first in Scotland that was productive of much profit to the proprietors. It now belongs to the respectable firm of Browns, Malloch & Co. Originally it was managed by people from England, but they proved of the description alluded to above, and the proprietors were, in all probability, indebted to the discernment, perseverance, and mechanical genius of Mr. Robert Burns, a native of Paisley, for rescuing the concern from ruin, and rendering the business a source of affluence. Shortly after the completion of this mill at Johnstone, another extensive establishment was erected at Blantyre, the property of James Monteith, Esq. and continues to this day in the same family, having hitherto been conducted and managed in a manner worthy of the honourable and enterprising spirit of its present proprietor, Henry Monteith, Esq. of Carstairs. Having already mentioned the establishment of Mr. Dale's works at Lanark, in which Mr. Arkwright himself was for sometime a partner, it is unnecessary to enter further into detail. Suffice it to say, that the number of cotton spinning mills in Scotland is now considerably above one hundred, and the number of persons employed, directly or indirectly, in the spinning of cotton yarn in

Great Britain, are estimated at about a *million and a half*. Since the invention of the spinning machines mentioned above, the commerce of Great Britain has been advancing with gigantic strides, until she has attained an elevated rank among the nations, unparalleled in the history of the world. But how has she acquired all this greatness?—Not from her numerical strength, for, in this respect, she cannot compare with many of the other nations of Europe—not from her geographical extent of territory or situation, for she occupies but a small speck in the German Ocean—but from her manufactures and her commerce: and what would either of these have attained to without her cotton manufacture? But this must ever have remained an insignificant branch of traffic, except for those invaluable machines, by which the spinning of yarn is accomplished; their invention, therefore, forms an epoch in her history. "Watt," said a celebrated French civil engineer, "improves the steam engine, and this single improvement causes the industry of England to make an immense stride. This machine represents, at the present time, the power of *three hundred thousand* horses, or of *two millions* of men, strong and well fitted for labour, who should work day and night without interruption and without repose, to augment the riches of a country, not more than two-thirds the extent of France. A hairdresser invents, or at least brings into action, a machine for spinning cotton; this alone gives to British industry an immense superiority. Fifty years only after this great discovery, more than *one million* of the inhabitants of England are employed in those operations which depend, directly or indirectly, on the action of this machine. Lastly, England exports cotton spun and woven by an admirable system of machinery, to the value of *four hundred millions* of francs yearly. The Indies, so long superior to Europe—the Indies inundated the West with her products, and exhausted the treasures of Europe—the Indies are conquered in their turn. The British navigator travels in quest of the cotton of India,—brings it from a distance of four thousand leagues,—commits it to an operation of the machine of Arkwright and of those that are attached to it,—carries back their products to the East,—making them again to travel four thousand leagues, and in spite of the loss of time—in spite of the enormous expense incurred by this voyage of eight thousand leagues, the cotton manufactured by the machinery of England becomes less costly than the cotton of India spun and woven by the hand near the field that produced it, and sold at the nearest market. So great is the power of the progress of machinery." *(See M. Dupin's Address to the Mechanics of Paris in the Mechanics' Magazine.)*

In estimating the progress of the manufacture of cotton yarn, it is necessary to take into the account the small quantity produced formerly with what is produced now. The quantity produced previous to the invention of the spinning machines, must have been very small; for to go no farther back than 1781, fourteen years after the invention of Hargreaves' jenny, we find that in that year there were imported of cotton wool 5,198,788 lbs. In 1832, the imports were about 277,200,000 lbs.!! In the former year the exports of cotton yarn were 96,788 lbs.; in 1832, they exceeded 74,500,000 lbs.!! On an average of three years, ending with 1814, the total imports of cotton wool were 58,100,000 lbs. Last year, the exports of cotton yarn alone, exceeded by more than a fourth the total imports of cotton for 1814! If the export of cotton yarn be a traffic not so desirable as that in manufactured goods, still it is of great importance to the country, since the value added to the raw material by spinning, is fully as much as is added to flax, silk, or wool, by the complete manufacture of the goods. This circumstance, therefore, renders the spinning of cotton of vast moment to this country, in providing employment for our industrious population.

The number of yards of cotton cloth exported in 1829, was 402,517,196, valued at nearly *thirteen millions* of pounds sterling! Since that time, however, a great increase has taken place. The number of yards annually consumed at home, is now upwards of 400,000,000!! In 1760, the value of the whole cotton goods then manufactured, was estimated at two hundred thousand pounds; at present, they are rated at *forty millions!! twenty millions* of which are exported!! The total value of cotton goods annually manufactured in Scotland, was estimated by Sir John Sinclair, some years ago, at nearly seven millions; at present, however, the value of cotton goods manufactured in and around Glasgow, is ascertained to be upwards of *six millions* yearly!!

Mr. M'Culloch estimates the amount of capital employed in the whole manufacture as follows:

Capital employed in purchasing the raw material, .	£6,000,000
Capital employed in the payment of wages, . . .	15,000,000
Capital invested in spinning mills, power and hand looms, workshops, warehouses, &c.	35,000,000
Total, ...	£56,000,000

Eight per cent. of the above sum, is allowed for interest on capital invested in the manufacture, wages for superintendence, &c., which gives a sum of £4,480,000, two millions of which are allowed for the purchase of materials to repair the waste of buildings, tear and wear of machinery, and effect insurances;—purchase coals for engine, oil, tallow, banding, and meet all other outgoings necessary to keep the works in operation, which leaves the sum of £2,480,000, as profits for the proprietors' wages for superintendence, &c.

" If we are nearly right in these estimates, it will follow—allowance being made for old and infirm persons, children, &c. dependent upon those who are actually employed in the various departments of the cotton manufacture, and in the construction, repair, &c. of the machinery and buildings required to carry it on—that it must furnish, on the most moderate computation, subsistence for from 1,200,000 to 1,500,000 persons. And for this new and most prolific source of wealth, we are indebted, partly and principally, to the extraordinary genius and talents of a few individuals, but, in a great degree, also, to that security of property and freedom of industry, which give confidence and energy to all who embark in industrious undertakings, and to that universal diffusion of intelligence, which enables those who carry on any work, to press every power of nature into their service, and avail themselves of productive capacities, of which a less instructed people would be wholly ignorant."

The great and wonderful extent to which the cotton manufacture has arisen would almost exceed our belief, were we not certain that the above statements are all collected from the most authentic sources, and can be relied upon for their accuracy; nor could the most enthusiastic admirer of Arkwright's inventions, ever have anticipated the high state of perfection to which our machinery has attained, and the quantities it is now capable of bringing forward, as compared with its original produce. The great increase in the quantity of yarn now produced, does not arise so much from a greater number of hands being employed, or more mills in operation, as from the improvements on the machinery, and the superior skill and dexterity acquired by our artisans, in managing it in the different processes of the manufacture.

Not only does the improved state of our machinery enable us to produce a much greater quantity of cotton goods than formerly, but even that which we do produce, can be brought to the market seventy and eighty per cent. cheaper. And it is from these two taken together, that we estimate the advantages resulting to society from the inventions of Arkwright and others, which the following extract from the "Working Man's Companion" will tend more forcibly to illustrate.

"Nearly twenty years after Arkwright had begun to spin by machinery, the price of a particular sort of cotton yarn, much used in the manufacture of calico, was thirty-eight shillings a pound. That same yarn is now sold for between three and four shillings, or one-twelfth of its price forty years ago. If cotton goods were worn only by the few rich, as they were worn in ancient times, and even in the latter half of the last century, that difference of price would not be a great object; but the price is a very important object, when every man, woman, and child in the united kingdom, has to pay it. About four hundred millions yards of cotton cloth, are annually consumed by the inhabitants of Great Britain; this distributed amongst a population of twenty-five millions, gives sixteen yards to each individual yearly. We will suppose that no individual would buy these sixteen yards of cloth, unless he or she wanted them; that this plenty of cloth is a desirable thing; that it is conducive to warmth and cleanliness, and therefore to health; that it would be a great privation to go without the cloth. At sixpence a yard the four hundred millions yards amount to ten millions pounds sterling. At half-a-crown per yard, which we will take as the average price about five and twenty years ago, they would amount to fifty millions of pounds sterling—an amount equal to all the taxes annually paid in Great Britain and Ireland. At twelve times the present price, or six shillings per yard, (which proportion we get by knowing the price of yarn forty years ago, and comparing it with the current price of yarn at the present day,) the cost of four hundred millions yards of cotton cloth would be one hundred and twenty millions of pounds sterling. It is perfectly clear that no such sum of money could be paid for cotton goods, and that, in fact, instead of ten millions being spent in this article of clothing by persons of all classes, in consequence of the cheapness of the commodity, we should go back to very nearly the same consumption that existed before Arkwright's invention, that is, to the consumption of the year 1750, when the whole amount of the cotton manufacture of the kingdom, did not exceed the annual value of two hundred thousand pounds. At that rate of value, the quantity of cloth manufactured could not have been equal to one-five-hundredth part of that which is now manufactured for home consumption: so that thirty-one individuals now consume sixteen yards of cloth each, where one person, eighty years ago, consumed only one yard."

No improvement or inventions in any other branch of our national manufactures, it is presumed, has ever been the means of producing such a vast amount of good to society generally, as the improvements that have been made in the cotton manufacture, and the facility with which each family or individual can now procure warm and healthful clothing. It is surely matter of gratulation to perceive, that the trade is still improving, as may be seen from the increasing consumpt of cotton wool. The consumpt of the year 1832 having exceeded all that have preceded it; and the extent to which it may yet be brought, cannot possibly be determined, although there must be a *limit*, beyond which it is *impossible* it can extend: but whether it has already reached that limit, or, having reached it, whether it shall remain stationary, and maintain that high pre-eminence to which it has already attained, or, begin to decline, are, doubtless, questions which it would be extremely interesting to be able to answer. One thing, however, is certain, that profits are now so low, that, in many cases, proprietors do not realise above five per cent. of interest on the capital invested in the business; therefore, our only hope of making farther progress, now lies in the improvements that may be made on the machinery, and the facilities that may be thereby introduced into any department, by which the processes may be expedited, and the goods produced at less expense. But so long as any of those impolitic regulations are avoided, by which the energies of our manufacturers might be cramped, and advantages given to foreigners which we do not ourselves possess, it is confidently believed that we have nothing to dread from foreign competition. Upon this subject, however, the following very judicious remarks of Mr. M'Culloch, are highly deserving of notice.

" Such being the vast extent and importance of the cotton manufacture, the probability of our preserving our ascendency in it, becomes a very interesting topic of inquiry. But it is obvious, that a great deal of conjecture must always insinuate itself into our reasonings, with respect to the future state of any branch of manufacturing industry. They are all liable to be affected by so many contingent and unforeseen circumstances, that it is impossible to predicate with any thing like certainty, what may be their condition a few years hence. But abstracting from the effect of national struggles and commotions, which can neither be foreseen nor calculated, we do not think that there is any thing in our state, or in that of the different commercial and manufacturing countries of the world, that would lead us to anticipate that the gloomy forebodings of those who contend that the cotton manufacture of England has reached its zenith, and that it must now begin to decline, will be realised. The natural capabilities we possess for carrying on the business of manufacturing, are, all things considered, decidedly superior to those of any other people. But the superiority to which we have already arrived, is, perhaps, the greatest advantage in our favour. Our master manufacturers, engineers, and artisans, are more intelligent, skilful, and enterprising, than those of any other country, and the extraordinary inventions they have already made, and their familiarity with all the principles and details of the business, will not only enable them to perfect the processes already in use, but can hardly fail to lead to the discovery of others. Our establishments for spinning, weaving, printing, bleaching, &c. are infinitely more complete and perfect, than any that exist elsewhere: the division of labour in them is carried to an incomparably greater extent, the workmen are trained from infancy to industrious habits, and have attained their peculiar dexterity and sleight of hand in the performance of their separate tasks, that can only be acquired by long and unremitting application to the same employment; why then, having all these advantages on our side, should we not keep the start we have already gained? Every other people that attempt to set up manufactures, must obviously labour under the greatest difficulties, as compared with us. Their establishments cannot at first be sufficiently large to enable the division of employments to be carried to any considerable extent; at the same time that expertness in manipulation and in the details of the various processes, can only be attained by slow degrees. It appears, therefore, reasonable to conclude, that such new beginners having to withstand the competition of those who have already arrived at a very high degree of perfection in the art, must be immediately driven out of every market equally accessible to both parties, and that nothing but the aid derived from restrictive regulations and prohibitions, will be effectual to prevent the total destruction of their establishments in the countries where they are set up." *See Commercial Dictionary, article, Cotton Manufacture.*

The following STATEMENTS *show the present state of the cotton yarn manufacture of Great Britain,—the quantity of cotton consumed or converted into yarn,—the weight of yarn produced, and the number of spindles and hands required to produce the same,—the estimated amount of capital invested in buildings, machinery, &c. &c.*

Cotton consumed in England in 1832, ...	802,200 bags.
Do. do. in Scotland, ...	89,100
Total in England and Scotland, ...	891,300 bags.
Suppose the average weight of each bag, ...	311 lbs.
	9,804,300
	26,739
Number of lbs. consumed, ...	277,194,300 lbs.

Suppose the quantity of cotton converted into yarn in 1832 to have been . . . . 277,200,000 lbs.
Allowing 1⅝ oz. per lb. lost in spinning, ... 28,153,125

Quantity of yarn produced, ... 249,046,875 lbs.

Suppose the above yarn to average No. 50, the number of hanks produced will be 12,452,343,750

Each spindle produces 2½ hanks per day, 300 working days in a year.—Number of spindles employed, ... 16,603,125

The estimated valuation of buildings, machinery, &c. is 17/6 per spindle, which shows the amount of capital invested in cotton spinning in Great Britain to be . . £14,527,734 . 7 . 6

Suppose each person employed within the Factories to produce 120 hanks per day, 300 working days in a year, the number of hands employed will be 345,898

The above merely takes in those employed within the Factories. Machine-makers, engineers, masons, wrights, card-makers, warehousemen, carriers, shippers, &c. &c. are not included.

If the above yarn be No. 50, and the quantity produced in 1832 woven into a 10.00° jaconet, warp and weft the same quality, the quantity of cloth produced in one year will be 2,390,850,000 square yards, 2½ lbs. of yarn being sufficient to make 24 square yards of cloth—the cloth produced last year would cover a surface of 771 square miles.

Total quantity of yarn spun in Scotland in 1832, 24,896,361 lbs.

Total quantity of yarn spun in England in 1832, and disposed of as under:	224,150,514 lbs.
Exported in yarn from England last year, . .	71,662,850 lbs.
Do. in thread, ...	1,041,273 do.
Do. in manufactured goods, ...	61,251,380 do.
Estimated quantity of yarn sent to Scotland & Ireland,	5,700,000 do.
Exports of mixed manufactures, such as cotton banding, candle and lamp wick, wadding, &c.	12,000,000 do.
Total exports from England, ...	151,655,503 do.
Consumed at home, ...	72,495,011 do.
Total manufactured and exported, ...	224,150,514 lbs.

Weight of yarn exported from England in manufactured goods in 1832—61,251,380 lbs. @ 2/2 per lb. = £6,635,566 . 3 . 4.

Manufactured goods exported from England (1832)	61,251,380 lbs.
Yarn consumed at home, ...	72,495,011
Total, ...	133,746,391 lbs.
Divided by 52, shows the weekly consumption =	2,572,046 lbs.

Suppose each loom to use 12½ lbs. weekly the number employed in England will be . . . . 205,764 looms.

Allowing each loom to consume 4 lbs. of flour weekly, the consumpt of flour per week will be . . . . 823,056 lbs.
Making the annual consumpt, 42,798,912 lbs. or 218,362 barrels (of 196 lbs.) or 178,329 loads (of 240 lbs.) each.

If the number of spindles employed in England and Scotland be 16,603,125
Allowing 500 to each horse power, then to move the above spindles will require 33,206 horses' power, allowing 340 lbs. of coals to each horse power per day, the consumpt for the above will be 5,040 tons, 3 cwt. 3 qrs. 20 lbs. of coals, or 1,512,059 tons yearly, of 300 working days.

Dr. Cleland, in his historical account of the steam engine, says, that an engine of 30 horse power, working 10 hours per day in a mill, will consume, on an average of summer and winter, about 4 tons of coal dross.

Coals 4 Tons. × 20 Cwt. × 4 Qrs. × 28 Lbs. × 16 Oz. = 143360 oz. consumed in 10 hours,

or $\frac{143360 \times 11\frac{1}{2}}{10} = 164864$ oz. consumed in $11\frac{1}{2}$ hours.

One horse power moves 500 spindles spinning No. 50, with the necessary preparation each spindle produces $2\frac{1}{2}$ hanks in $11\frac{1}{2}$ hours = 1250 hanks from 500 spindles per $11\frac{1}{2}$ hours, therefore a 30 horse power engine will produce 37,500 hanks in the same time.

Coals consumed in $11\frac{1}{2}$ hours, 164,864 Oz.
Hanks produced in do. 37,500

$\frac{164,864}{37,500} = 4.39$ oz. of coals estimated to produce one hank.

	Cwt.	Qr.	Lb.	Oz.	
Each horse power requires	3	0	7	7	of coals ℔ day of $11\frac{1}{2}$ hours.
And produces 1250 hanks = 25 lbs. of yarn in					do.

According to Dr. Cleland's account of the number and power of steam engines employed in and around Glasgow, the horses' power employed in spinning cotton in a space extending not more than two miles from the cross, was, in 1825, equal to 893, since that period there have been several additions to that number. At the present time, it is estimated that the power employed for spinning cotton, in the same space, is equal to upwards of a thousand horses, which may be supposed to consume 153 tons of coals per day, or 45,900 per year of 300 working days.

The following Table was furnished by Mr. Kennedy of Manchester, to a Committee of the House of Commons on the East India Company's affairs, and shows the prices of Cotton Yarn—the average produce per spindle per day—the expense of workmanship—and the cost of the raw material in England in the years 1812 *and* 1830.

Hanks ℔ day ℔ Spindle.			Prices of Cotton & Waste ℔ lb.		Labour ℔ lb.		Cost ℔ lb.	
Nos. of Yarn	1812*	1830	1812	1830	1812	1830	1812	1830
	Hks.	Hks.	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
40	2.	2.75	1—6	0—7	1—0	0—7½	2—6	1— 2½
60	1.5	2.5	2—0	0—10	1—6	1—0½	3—6	1—10½
80	1.5	2.	2—2	0—11¼	2—2	1—7½	4—4	2— 6¾
100	1.4	1.8	2—4	1— 1¾	2—10	2—2½	5—2	3— 4¼
120	1.25	1.65	2—6	1—4	3—6	2—8	6—0	4— 0
150	1.	1.33	2—10	1—8	6—6	4—11	9—4	6— 7
200	.75	.90	3—4	3—0	16—8	11—6	20—0	14— 6
250	.05	.06	4—0	3—8	31—0	24—6	35—0	28— 2

* Since 1812, there have been great improvements made on the spinning machinery, which accounts for the greater produce per

Present State of the Cotton Manufacture in the United States of America, according to the report of a committee appointed by Congress in the beginning of the year 1832, *to enquire into the progress of their spinning and manufacture of cotton goods.*

Number of Mills in 12 States, ...	795
Spindles in do.	1,246,503
Looms, ...	33,506

Weight of cotton consumed in 1831, . . .	77,557,316 lbs.
Allowing 2 oz. per lb. lost in spinning, . . .	9,694,664
Total weight of yarn produced, ...	67,862,652 lbs.
Do. do. do. weekly, . . .	1,305,051

Averaging 16⅝ oz. per spindle weekly.

If the whole 1,305,051 lbs. were manufactured by the 33,506 looms, each loom, on an average, must have consumed 39 lbs. of yarn weekly, a proof that the goods manufactured were of a very heavy description.

According to the same report, the number of males employed in the cotton manufacture were	18,539
Females do. do.	38,927
Total employed in the whole manufacture, ...	57,466

The weight of flour consumed in their cotton manufacture in 1831, was 1,641,253 lbs. or 8,374 barrels, 196 lbs. each, the weekly average of which is 31,562 lbs. nearly one lb. to each loom.

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spindle in 1830, as compared with the former year. The above estimates of the produce, however, are considered too low, at least as far as regards Spinning Factories in Scotland.

The amount paid for wages in 1831, was 10,294,444 dollars, or £2,144,780, being £42,895 per week, averaging 14/11 *to each person employed as above.*

The American Tariff has been greatly modified of late; as it now stands, the duties levied on cotton goods imported from foreign countries are as follows:

Plain calicoes, &c. not exceeding in value 1/4½ ⅌ square yard, to pay 4⅛d. ⅌ yard duty.

Printed or coloured calicoes, &c. not exceeding 1/7 ⅌ square yard, to pay 4¾d. ⅌ yard duty.

Cotton yarn unbleached or uncoloured, and not exceeding in value 2/8¾ ⅌ lb. to pay 8$\frac{3}{16}$d. ⅌ lb. duty.

Bleached or coloured yarn, not exceeding 3/4½ ⅌ lb. to pay 10⅛d. ⅌ lb. duty.

By an Act passed 2d March, 1833, *the present Duties are to be reduced from and after* 31*st December, current; and a farther progressive reduction is to take place, as follows:*

"That, from and after the 31st day of December, 1833, in all cases where duties are imposed on foreign imports by the Act of July 14, 1832, entitled "An Act to alter and amend the several Acts imposing duties on imports," or by any other Act, shall exceed twenty per centum on the value thereof, one-tenth part of such excess shall be deducted; from and after the 31st day of December 1835, another tenth part thereof shall be deducted; from and after the 31st day of December 1837, another tenth part shall be deducted; from and after the 31st day of December 1839, another tenth part thereof shall be deducted; and from and after the 31st day of December 1841, one half of the residue of such excess shall be deducted: and from and after the 30th day of June 1842, the other half thereof shall be deducted."

ON COTTON;

ITS MODE OF CULTIVATION, IMPORT AND CONSUMPT, PRICES, DIFFERENT QUALITIES, &c.

THE word cotton is derived from an Arabic word "Cootn." In our language it is a name which is very loosely given to any vegetable filamentous substance, but is correctly appropriated to that peculiar vegetable matter, consisting of innumerable fine filaments, arranged together within an external coat, and enveloping the seed of the genus Gossypium; this genus belongs to the class Monodelphia, order Polyandria. Botanists enumerate ten species of Gossypium, which are distinguished by the form of the leaf and the size of the tree.

Only a few of the species are cultivated by Europeans. The mode of cultivation differs only in the general detail; some species are *annual*, others *perennial:* some are indigenous to the Eastern, and others to the Western world. The cotton plant is extensively cultivated in different parts of the East Indies, in which countries it requires three seasons to bring the seed to maturity. It is also cultivated to a considerable extent in the Mogul Empire, in the kingdoms of Siam and Pegu, in Sumatra, Persia, Arabia, Asia Minor, Natolia, Smyrna, and Aleppo: also, in Sierra Leone and other parts of Africa; particularly in Egypt, where, within these few years past, a very superior quality of cotton has been raised, and seems to be cultivated to a great extent. The first imported into this country, was in the year 1823, where it now ranks in price and quality next to Sea-Island cotton.

The cotton plant is also cultivated in Candia, Cyprus, Malta; and attempts have recently been made to cultivate it in Spain and the South of France. It is grown in some parts of the Russian Empire; in Astracan, Orenburg, Levant, &c. But the chief supply of the British market is from South America, the East and West Indies, and the Southern States of the American Union; in all of which countries it is cultivated to a great extent.

The cotton plant has been known to ripen its pods or bulbs in sheltered situations in England. J. Blackburn, Esq., M. P. had a gown made from cotton grown in his own garden, for a dress for his lady to appear at conrt. Four ounces of the raw material made 7½ yards muslin 1½ yard broad.

" The mode of cultivating the cotton plant depends upon its being *annual* or *perennial*. In general the *annual* cotton tree thrives best in a dry gravelly soil; it is also said to answer better in old than in newly cultivated lands. An exposure to the East, where the country is hilly, is considered by some to be of importance. The planters generally commence preparing their lands in February, and put in the seed during March and April. Holes are made in rows, at the distance of from seven to eight feet; into each of these an indefinite quantity of seed is laid, which, in a short time, begins to germinate; and as soon as the young plants rise to the height of six or seven inches, they are all, except two or three of the most vigorous, pulled up by the roots. The surviving plants are pruned twice before the month of August, so as to keep them down to the height of about four feet. This is absolutely necessary, as when there is great abundance, the difficulty of gathering the cotton is increased, without any addition to the quantity." At first, great attention is requisite to keep down the weeds and grass, which, if not eradicated, would soon destroy the young plants. The plant on its first appearance, and for a few weeks, is extremely tender; the slightest frost hurts or kills it. When this happens, a new crop is usually sown, though with dubious success. Light showery weather is said to be most favourable to the plentifulness of the crop. The gathering season commences partially in August, but is general in September and October, and continues, when the weather is fine and dry, till Christmas, as the pods ripen and open gradually.

"On the coast of Guiana and the Brazils the *perennial* cotton tree is almost exclusively cultivated.

On the coast of Guiana, the land is all alluvial mud, thrown out of the great rivers that empty themselves into the ocean in its immediate neighbourhood. Land is daily formed by the same causes. The elevation above the level of the sea is so inconsiderable, as to render inundations not uncommon; and the whole country is intersected by ditches, without which no cultivation could be carried on. This peculiarity of the country is to be considered, whatever be the object of cultivation; but there are some particulars that are to be exclusively attended to by the cotton planter. The land in which the cotton is to be planted, must be formed into beds of about 36 feet wide, which are to be surrounded by drains that run across the estate. These beds are also to be raised a little in the middle, to allow the superabundant water to run off. When the land is properly prepared, it is divided into squares of from three to six feet, according to its nature; but the average is about five feet. The squares are marked out by a line prepared for that purpose; or by pickets stuck into the ground, in which small holes, four or five inches deep, and six or eight wide, are dug with a hoe; a little light earth is then scraped into the hole, and a small handful of seed laid upon it; the whole is then lightly covered with earth. If the weather be showery, (which it ought to be when cotton is planted,) the seed will spring up in the course of three or four days. When the plants are about three inches high, they are then thinned, leaving only three or four in each hole; this is generally done within a month after being planted. About the same time the ground generally requires a first weeding, which is also repeated every month, until the trees are fully grown. At the second or third weeding, one tree only is left in each hole; and then if it be eighteen inches, or two feet high, the tops are nipped off, to make it throw out a sufficient number of lateral shoots. The usual period of planting cotton in Dutch Guiana, is during the months of December, January, April, and May. If in the two first months, which are the most preferable, the tree will require to be pruned in June, to prevent its becoming too high. This is done about three feet above ground: at the same time, all the shoots from the stem above one foot from the ground are pulled off; but if the cotton be planted in April and May, the branches will only require to be nipped about twice with the finger, and the plant will generally yield some cotton before Christmas; indeed, from the month of October, if the weather be dry. In general, however, the cotton tree rarely produces a full crop before it has attained its second year, and its duration is generally estimated at four or five years; but in some places, it is said, that they are seldom cultivated more than two or three years in succession, as after that they cease to bear with the same abundance. The replanting is not done in any regular way; but whenever a tree fails, another is planted in its place, which is called supplying a field of cotton. This is particularly attended to at the period of weeding. The cotton trees that are a year old are regularly pruned once a year, between the months of April and July. The time of beginning depends, in a great measure, on the state of the weather, and the prospects of the tree yielding any more."

"In regular seasons the crop in Guiana is generally finished in April; and if the season be mild, May is the fittest month for pruning, but the fields must be previously weeded; and after the pruning, the utmost attention should be paid to keeping the ground free from grass and weeds, which grow very rapidly at this season. The cotton, if the weather be favourable, begins to throw out abundance of blossoms by the end of July, or the beginning of August; the pods form in succession, and generally begin to open in about six weeks: it rarely happens that there is any general picking before the end of October, and it continues till about the end of December, making what is called the first crop. After the gathering of the first crop, the ground should be well weeded, the rainy season then commences, the trees grow rapidly, and blossom so, that the second crop should begin in February, and last to the middle of April. In Guiana, however, the second crop is frequently injured, if not destroyed, by the prevalence of cold winds and rains from December to April."

"The blue clay is considered in Guiana to be the soil best suited to the growth of this plant, but in other countries, dry or gravelly soil is equally productive, if situated near the sea, a circumstance which has given rise to the opinion, that salt contributes to the growth of the cotton tree."

Throughout the United States the cotton tree is an annual plant, and is not cultivated north of latitude 35°; but some successful experiments as to the possibility of raising it, have been made in the neighbourhood of New York, or latitude 40°. Cotton was first shipped as an article of commerce about the year 1793, from the United States; it had previously been cultivated for domestic purposes only.

All cotton, except Upland and New Orleans, yield black seed; but these two give green seed. In Charleston, and other parts of America, Sea Island cotton is often distinguished by the name black seed. And Uplands, by the designation, green seed cottons. That which is grown in Paraguay, called the Mandigu, is produced by shrubs scarcely bigger than a hazel, with wood and bark like the elder, and clothed with plenty of soft woolly leaves. Between three and four leaves, with which the unripe nuts are surrounded, grow flowers larger than roses, composed of three broad yellow petals streaked with red, and white stamins grow in the bottom of the flowers. The blossoms at length become fruit of a green colour, oval, or rather conical, and, when full grown, larger than a plum. When ripe, it turns black, separates into three parts, thrusting out white cotton full of black seeds, resembling pistachoe nuts in size and shape.

The cotton plant is top-rooted, and, consequently, it requires sufficient depth of rich light soil. Being of a succulent nature, it is very liable to be injured by spring frosts, or very wet seasons, but more particularly, by a most destructive insect called chenille, a caterpillar, which has been known to destroy whole fields of the most promising crops in a single night. Several travellers have given various accounts of this insect. Dr. Chisholm describes it as being very beautiful, and about an inch in length, with stripes of white down the back, and one on each side, the intermediate spaces being a fine glossy black. The head is round and corneous, armed with two lateral corneous jaws, forming a powerful instrument of destruction. "The most singular circumstances respecting this insect, are the fragrant scent that is emitted from the plant on which it feeds, though neither the plant nor the insect possess any scent whatever when separate: also the manner in which the ova are sometimes preserved for a whole year, without any appearance of the chenille, and resisting the efforts of the planters to destroy them, by the use of fire and other methods; and the surprising speed with which its ravages are carried to the most distant parts of the plantation. Sulphureous vapours, &c. have been applied to the infected plants, and found effectual, but attended with considerable expense to purchase apparatus, and apply it separately to each plant."

"The cotton tree is also subject to a disease called the blast or blight, which seems to be occasioned by two opposite causes; an excess of vegetation, resembling the plethora of animals, which destroys the fruit only; and an exhaustion of vegetation, producing a state similar to gangrene, which nearly, if not entirely, destroys the whole plant. This disease is also sometimes brought on by the root being for any considerable time immersed in water. Little progress has yet been made in the curious and useful study of tracing the resemblance between the diseases of plants and animals; of this resemblance, however, the cotton tree is a striking example, and the treatment adopted should be of a similar kind. In cases where the disease is occasioned by the excessive vegetation of the plants, produced by a redundancy of moisture, every means should be used for draining the fields, besides the common method of deepening the channels into the sea, and putting on larger flood-gates. The placing a steam-engine, so as to throw the water over the dam into the sea, has been tried, and with good success. The want of sufficient moisture, which occasions a still more destructive disorder, is not so easily remedied; the only thing to be done in this case, is to carry a canal into the interior of the country, so as to obtain a supply of fresh water from the springs. When the gangrene, (which is properly speaking the blast) appears, a cure is impossible; all that can be done must be by prevention, or curing the first state of the disease. Insects, called by the planters cotton bugs, are found by thousands in the pods of the diseased plants, and seem to hasten their destruction."

"After the cotton is gathered, it is exposed to the rays of the sun, on a tile or wooden platform, for two or three days, till it is perfectly dry and hard. The seeds are then separated by passing it through between two wooden rollers, which are slightly grooved, and about $\frac{5}{8}$ of an inch in diameter; this is called ginning the cotton; and when ginned, it is carefully picked, to free it from broken seeds, dried leaves, or yellow locks of cotton, &c. Twenty lbs. of cotton from the plant usually produce five of clean cotton, and between three and four hundred lbs. of the latter, is considered a good crop off one acre. The practice of switching the cotton was introduced, but not generally adopted, because not approved of by manufacturers. The cotton is afterwards compressed into bales, which is done by means of a screw-press:* in this state it is sent to Europe, and employed for making those various beautiful fabrics that do infinite credit to British ingenuity and industry."

"Cotton was known to the ancients, and is particularly described by Pliny: we have not, however, been able to discover the mode of its manufacture

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* When cotton is packed up in square bales, it is done in a press. In the round bags, it is packed in the following manner: A negro going within the bag, (which is suspended from the ground) is supplied with cotton, which he puts in layers beneath his feet, and this being occasionally slightly wetted, acquires the requisite firmness. There are many instances of deceit practised in the packing of cotton; this is well known to the cotton spinners in Britain, large stones, pieces of metal, sand, or cotton seeds, being found upon opening the bags. I once saw upon the wharf at Charleston, a waggon load of cotton, which, from the uncommon weight of each bale, excited the suspicion of the weigher, who caused them to be cut across, when the contents, excepting about two inches next the outside, were found to be completely soaked with water. This was a very barefaced attempt at imposition; but the owner of the cotton reaped the fruit of his ingenuity, by losing the whole; as the moment that the operation of cutting the bags commenced, did he make his retreat with his waggon as quickly as possible, for fear of worse consequences. At this time, cotton was worth a hundred dollars per bale, without any damping. It is very seldom that a merchant who has shipped cotton, can recover any thing here in case of false packing being discovered in Britain. When accused of such base practices, the people say, that they are merely retaliating upon the British for their gross fraud in their manner of putting up goods, especially those that come from Manchester. It would be well for both parties to conduct their commerce upon honourable principles. Much bad blood is engendered on account of these tricks, and many unworthy surmises cast upon merchants of integrity and honour.—(*Six years residence in America by Peter Neilson.*)

in those early periods. The beauty of the substance, and its obvious applicability to many purposes, would, no doubt, excite a very early attention; but it was not until the wonderful facilities which were introduced into the spinning of the raw material, that it became an object of extensive cultivation. In India, indeed, where manual labour is cheap, it has long been cultivated, and manufactured into muslins and calicoes by the simple apparatus of the inhabitants. England boasts of having introduced those improvements in machinery which have rendered cotton an object of immense attention to Europeans." But previous to the year 1793, the cotton used in Britain for the manufacture of the coarser articles was (with the exception of a small quantity imported from India) wholly grown in our own and the French West India Islands; that for the better kind of these goods, was raised in Surinam, or Demerara and Berbice; the wool for the fine goods was grown in Brazils, and that for the very few fine muslins, then manufactured, in the Isle of Bourbon. Had we continued to be confined to these countries for our supply of cotton, the progress of the manufacture would have been greatly retarded, from the difficulty that would have been experienced in making the production of the raw material keep pace with the increasing consumption; and added to this, we might not have been able to obtain the qualities of wool suited to the finer descriptions of goods, which the improved state of the machinery now enables us to undertake. But fortunately, about the year 1790, the planters, in the Southern States of the American Union, began to turn their attention to the raising of cotton wool, and besides carrying the cultivation to a great extent, they have produced qualities of cotton before unknown; so that the quantity of cotton now produced in the western hemisphere, in Asia, Africa, and the South of Europe, is incredibly great, and might be increased in an indefinite proportion, provided that there was a market for it; but, like every thing else for which there has been an unexampled demand, too much is produced, and its value has decreased in a corresponding ratio. In consequence of which, the inferior descriptions of cotton are now sold at prices scarcely sufficient to cover the expense of growing it. Hence planters are forced to employ every means likely to improve the quality of the wool, either by adopting the most approved methods of cultivation, or chiefly, by a proper selection of seed. Of late years, the latter has been much more successfully attended to by cotton growers than in former periods, when cotton wool sold at a much higher price. The black seed (Sea Island) cotton of America, is now cultivated to some extent in the East Indies, Egypt, and other parts, from which much superior wools have been produced than was formerly grown in these countries. And even in America, superior qualities have been obtained by a careful selection of the best seeds of that commonly known by the name of Upland cottons; in proof of which the following account of a new species of cotton has been received from a gentleman residing in South Carolina.

" A Mr. Burrell Lyles brought to this market, (Charleston) a few days since, three bales of cotton, in store at Messrs. Woods & Subers, the staple of which is said, by good judges, to be superior to any that has been seen here. Eleven cents. per lb. has been offered for it, and refused. I am told by Mr. Lyles, that, about four years ago, he discovered in his crop, a single stalk remarkable for its height and the number of pods that came to maturity, and opened earlier than the rest. He saved and planted the seed from this stalk separately, from year to year, and this year, (1832) he was enabled to plant about fourteen acres. The soil is of medium quality of Upland, and the average height of the stalk about eight feet, occasionally they shoot up the height of 12 or 13 feet. Mr. Lyles calculates the product at an average of a bale of 325 lbs. in the acre. The writer has seen the crop, and knows the description is not exaggerated; and having some knowledge of cotton planting, confidently thinks the product per acre is not overrated. The contrast between that and the adjoining crop of the common stock upon lands of the same quality is so great, as to force it upon the attention of the mere passenger.

Mr. Lyles has thus given a practical illustration of the advantages that may be expected to result from a proper attention to the selection of seed for planting in all the departments of agriculture, and it is to be hoped that, in the sale of his seed, he will reap the reward due to his care. For the present he has contracted to dispose of all, or most of his stock, at a moderate price, in such quantities, as to disseminate it pretty generally through that part of the country in which he lives. And if the anticipations of it are realised in a few years, it will be worth more to South Carolina than the combined products of all the gold mines of North and South Carolina and Georgia together." That success may attend every attempt to improve the quality of the cotton grown in the Carolinas and Georgia, is devoutly to be wished by every British spinner. Much inferior cotton comes from that quarter, which is of little profit to proprietors, whilst it harasses the minds of those who have to work it.

While the price of cotton wool has been declining for a number of years back, the quantity consumed by British manufacturers has been gradually increasing in the same proportion. Some estimate may be formed of the increasing consumpt of cotton wool in Great Britain, by taking into account the quantities consumed at different periods, as for example:

The quantity consumed in the year		1775	was,	137,160 lbs.
Do.	do.	1790	-	1,757,504 do.
Do.	do.	1805	-	59,700,000 do.
Do.	do.	1820	-	120,265,000 do.
Do.	do.	1831	-	262,700,000 do.
Do.	do.	1832*	-	277,190,000 do.

From the above statement, it will be seen that the consumpt of cotton wool has been rapidly increasing these fifty years back, and it is impossible to form any idea of the extent to which the manufacturing of cotton goods may yet be carried in this country.

The following Tables show, more distinctly, the import, export, and consumpt of cotton wool in Great Britain, for a period of fourteen years, ending 1832; also, the extreme prices current, at Liverpool, at the close of each year. Together with the produce, export, and home consumpt of cotton yarn, during the same period, by which the gradually improving state of the cotton manufacture may easily be ascertained.

* The average weekly consumption of cotton wool in Great Britain in 1832, has been estimated at 17,140 bags, (of the average weight of 311 lbs) consisting of 6,219 Upland—5,321 Orleans and Albama—519 Sea Island, total 12,059 American—2,843 Brazil—881 Egyptian—1,161 East India and 196 West India, &c. Being an increase on the consumption of 1831 of 910 bags per week.

STATEMENT *of the Import, Export, and Consumption of Cotton Wool, in Great Britain, for* 1832.—*In Packages, at the Average Weight of* 311 *lbs.*

	BAGS.			BAGS.
Stock in the Ports, 1st January, 1832, .	276,300	Export to the Continent and Ireland.—23,800 American—5,100 Brazil and West India—36,400 East India—1,800 Egyptian, . .		67,100
Stock in Dealers and Spinners' hands. England, . . . 102,000 Scotland, . . . 8,000	110,000	Taken for consumption of England and Scotland from the Ports, . .	866,300	
Import in 1832, ...	902,300	Decrease of Stocks in hands of Dealers and Spinners, ...	25,000	
		Consumed in England 802,200, or 15,427 bags per week, . . . Consumed in Scotland 89,100, or 1,713 bags per week;		891,300
		Remaining on hand in the Ports, 1st Jan. 1833,		245,200
		In Dealers & Spinners' hands, England, 77,000 Do. do. do. Scotland, 8,000		85,000
	1,288,600			1,288,600

Statement of the Import of Cotton Wool into Great Britain, from 1819 till 1832 inclusive; and of the Quantity taken for Export and for Home Consumption.

Import.	1819	1820	1821	1822	1823	1824	1825	1826	1827	1828	1829	1830	1831	1832
American, ...	205161	302395	300070	329906	452538	282371	423446	395852	646776	444390	463076	618527	608887	628766
Brazil, ...	125415	180086	121085	143505	144611	143310	193942	55590	120111	167362	159536	191468	168288	114585
East India, ...	184259	57923	30095	19263	38393	50852	60484	64699	73738	84855	80489	35019	76764	109298
Egyptian, &c....	....	....	....	....	5623	38022	11023	47621	22450	32889	24739	14752	38124	41183
West India, ...	31300	31247	40428	40770	27632	25537	31988	18188	30988	20056	18867	11721	11304	8490
Total, ...	546135	571651	491678	533444	668797	540092	820883	581950	894063	749552	746707	871487	903367	902322
Export, ...	66800	28400	52600	59300	35400	53600	72800	95000	69100	63700	118100	33400	74600	67100
Consumpt, ...	434300	466900	499100	544800	560100	604900	599600	510900	674800	732200	745200	832100	857800	891300
Or per week in packages, averaging 311 lbs.	8352	8979	9598	10477	10771	11633	11531	9825	12977	14080	14331	16002	16496	17140

Extreme Prices of Cotton Wool in Liverpool, on 31st December of each year, from 1819 till 1832 inclusive.

	1819	1820	1821	1822	1823	1824	1825	1826	1827	1828	1829	1830	1831	1832
	d. *d.*	*d.* *d.*	*d.* *d.*	*d.* *d.*	*d.* *d.*	*d.* *d.*	*d.* *d.*	*d.* *d.*	*d.* *d.*	*d.* *d.*	*d.* *d.*	*d.* *d.*	*d.* *d.*	*d.* *d.*
Sea Island, ...	26 *a* 36	17½ *a* 28	14½ *a* 28	14½ *a* 24	13 *a* 22	17 *a* 27	20 *a* 27	10 *a* 20	11¼ *a* 18	12 *a* 20	11½ *a* 21	11½ *a* 20	9½ *a* 18	10¾ *a* 18
Orleans, ...	12¼ - 17	8¼ - 14	8½ - 12½	7 - 11	8 - 11½	9 - 12	8 - 12	7 - 9	5½ - 8¾	6 - 9	5⅞ - 8	6¼ - 8	5 - 8	6½ - 9
Upland, ...	12¼ - 13¾	8 - 10½	7¾ - 11	6¼ - 8½	7¼ - 9¾	9 - 10½	6½ - 9½	6⅜ - 7½	4⅞ - 7	5¾ - 7	5⅝ - 7	5⅞ - 7⅜	4⅞ - 7	6⅜ - 7⅞
Egyptian, ...	....	....	....	....	10 - 11	10¾ - 11½	9½ - 11	7¼ - 8½	7 - 8½	7 - 8½	6½ - 8¼	8 - 9½	7⅜ - 8¾	8¼ - 9¼
Pernambucco,	16¾ - 17¾	11½ - 13	11½ - 12½	10¼ - 11½	11 - 12	11¾ - 13	11¼ - 12¼	10 - 11	8¼ - 9¼	7½ - 8½	7¼ - 8	7½ - 8⅜	7 - 9	8¾ - 9¾
Maranham, ...	15¾ - 16	11¼ - 12	11 - 11½	9¼ - 10¼	10½ - 11	10½ - 11⅜	10⅝ - 11¼	8¾ - 9¾	7½ - 8¼	7¼ - 7¾	6⅜ - 7	7 - 7⅝	6 - 7⅞	7⅝ - 9¼
Demerara, ...	14 - 18	11 - 14	9½ - 13	8½ - 11½	10 - 12	10 - 13	10 - 12½	8 - 11	6¾ - 9½	6¾ - 9	5½ - 8	6½ - 9	6 - 9½	7½ - 10½
West India, ..	12 - 13½	10 - 11½	8 - 9½	7½ - 8¼	8 - 9	8 - 9	8 - 9½	6½ - 7½	6 - 7	6 - 7	5¼ - 6¼	6 - 7	5½ - 6½	6½ - 8½
Surat, ...	7½ - 12	6¾ - 9½	6½ - 8½	5¼ - 7¼	6 - 7½	5¾ - 8	5½ - 7	5 - 6½	3⅞ - 5½	3½ - 5	3 - 5½	4½ - 5¾	3¼ - 4¾	4¼ - 6

Exports of Cotton Yarn from Great Britain, from 1818 till 1832 inclusive.

Years.	Russia and Ports in the Baltic.	Germany, Belgium & Holland.	France, and Ports in the Mediterranean.	Africa and N. and S. America.	India and China.	Totals.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
1818	5.913.691	7.937.234	876.957	13.932	1.861	14.743.675
1819	3.779.544	13.124.637	1.157.593	22.665	971	18.085.410
1820	9.060.052	11.859.802	2.089.451	22.009	1.011	23.032.325
1821	4.815.114	14.819.820	1.863.340	21.674	6.421	21.526.369
1822	4.948.619	18.764.070	2.838.828	20.673	23.278	26.595.468
1823	7.148.497	16.694.715	3.383.204	29.035	123.535	27.378.986
1824	12.304.373	16.497.594	4.652.063	45.616	105 864	33.605.510
1825	9.369.333	19.721.419	3.264.078	51.408	235.366	32.641.604
1826	12.380.188	22.160.331	6.671.463	47.732	919.807	42.179.521
1827	11.481.650	23.225.400	5.675.140	170.797	2.793.645	43.346.632
1828	14.838.515	18.169.935	5.826.280	222.872	4.185.280	43.242.882
1829	17.564.062	31.262.142	8.203.386	636.274	2.896.325	60.562.189
1830	17.855.541	29.718.184	11.485.195	327.483	4.291.713	63.678.116
1831	14.352.638	28.023.322	10.792.384	1.689.155	6.703.655	61.561.154
1832	20.516.822	39.479.666	7.805.977	1.443.534	5.317.193	74.563.192

Total Quantities of Cotton Yarn Produced, Exported, and Consumed in Great Britain, from 1818 till 1832 inclusive.

Years.	Cotton Consumed.	Yarn Produced.	EXPORTED.		CONSUMED AT HOME.	
			Annually.	Average of three years.	Annually.	Average of three years.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
1818	109.902.000	98.911.800	14.743.675		84 168.125	
1819	109.518.000	98.566.200	18.085.410	18.620.470	80.480.790	83.285.030
1820	120.265.000	108.238.500	23.032.325		85.206.175	
1821	129.029.000	116.126.100	21.526.369		95.599.731	
1822	145.493.000	130.943.700	26.595.468	25.166.941	104.348.232	103.766.799
1823	154.146.000	138.731.400	27.378.986		111.352.414	
1824	165.174.000	148.656.600	33.605.510		115.051.090	
1825	166.831.000	150.147.900	32.641.604	36.142.212	117.506.296	108.523.190
1826	150.213.000	135.191.700	42.179.521		93.012.179	
1827	197.200.000	177.480.000	43.346.632		134.133 368	
1828	217.860.000	196.074.000	43.242.882	49.050.568	152.831.118	141.227.432
1829	219.200.000	197.280.000	60.562.189		136.717.811	
1830	247.600 000	222.840,000	63.678.116		159.161.884	
1831	262.700.000	236.430.000	61.561.154	66.600.821	174.868.846	169.559.179
1832	276.900.000	249.210 000	74.563.193		174.646 808	

During the current year prices of cotton have fluctuated considerably. At the beginning of the year, it was ascertained that the stock of cotton in the country was much less than at the corresponding period of the preceding year, whilst the consumpt was considerably greater. And about the end of May, it became the prevailing opinion, that the supply for Europe would not be sufficient to prevent a great diminution of stock before the end of the year. Prices, consequently, advanced with a rapidity that astonished even the speculators themselves, and by the 23d August, at which date they had attained their maximum, the following were the current prices in Liverpool, and about 50 per cent. higher than at the beginning of the year:

Sea-Island,	14½d.	@	30d.
Uplands,	10d.	@	12½d.
Orleans,	10d.	@	13d.
Egyptians,	13d.	@	15d.
Demerara and Berbice,	11d.	@	13d.
Surat,	7d.	@	8¾d.

From these high rates, the decline has been rapid in the extreme, (now, 26th Oct., about 2d. from the highest point) and, apparently, with less reason than there was for the advance; as, notwithstanding some late decrease of consumpt, the stock at Christmas is expected to be less than at the same period of 1832. The imports up to this date (26th Oct.) are as follow:

Imports from 1st January to this period,	801,790 bags.
Imports in the same period of last year,	797,591
Increase,	4,199 bags.

DIFFERENT GROWTHS OF COTTON.

Cotton is now so extensively manufactured into a great variety of different qualities of cloth, that a short account of the various descriptions imported into the British market, with a few remarks upon their qualities—the estimation in which they are generally held by manufacturers—the countries where they are cultivated, &c. may, perhaps, not be uninteresting to managers, carding and spinning masters, and to those interested in its manufacture.

Cotton is generally distinguished by its colour, and the length, strength, and fineness of its fibres. There are many varieties of cotton, their names being principally derived from the countries where they are cultivated. Also, under each general name, there are various denominations, distinguished by the particular province or district of the country where they are grown. In the following short account of the different descriptions, each kind is classed under the name of the country in which it is cultivated.

SMYRNA WOOL.

THE cotton wool known by the above name was formerly imported from the Levant, in quantities proportioned to the then trifling demand. At one time it was the only cotton wool to be met with, excepting a few bags occasionally imported from the West Indies. Although it has a soft silky appearance, yet it is neither well fitted to endure the necessary operations in being manufactured into yarn, nor does it, when finished, make an article either of strength, beauty, or durability. Only a small quantity is now imported, and is used chiefly for making candle wick, being inflammable in a higher degree than any other kind of cotton.

EAST INDIA COTTON.

EAST India cotton includes Surat, Bengal, Madras, Bourbon, &c. The latter takes its name from the Isle of Bourbon in the Indian Ocean, where it is cultivated. It is generally a very superior cotton both for strength and fineness, although short in the staple. For a number of years it was the only cotton used for spinning yarns of the finest quality, until superseded by Sea-Island cotton, which is now found even superior to it. The quantity now imported is very small. The other kinds of East India cotton are of very low quality. They have a fine glossy and silky appearance, but are extremely short in the staple, and used only for spinning the lowest numbers of yarn. The imports have been on the increase for a number of years back, but especially since the partial opening of the trade to India in 1813; and it is supposed that the quantity cultivated might be greatly increased, and the quality improved, were it not for those impolitic regulations established under the East India monopoly for securing the revenue, &c. Hitherto East India cottons have generally been bought at the lowest prices in the British market, a proof of the low estimation in which they are held by manufacturers. But a new kind of cotton has lately been imported from Madras, said to have been raised from the same seed as the Sea-Island. It is a fine white soft wool, having a silky or glossy appearance, very clean, and equal, if not superior in quality, to the Pernambuco, but rather short in the staple. It is much inferior to the Sea-Island, but brings a much higher price than the common Madras cotton.

WEST INDIA COTTON.

THIS cotton takes its name from those numerous islands lying in the Gulph of Mexico, denominated West India Islands, where it is still cultivated to a considerable extent, although the quantity imported into Great Britain is not now one-fourth of what it was about fifteen or twenty years ago. In 1813 and 1814, the imports amounted to 73,219 and 74,800 packages; but since that period, they have been gradually decreasing. In 1830 and 1831, the imports amounted only to 11,721 and 11,304; yet, notwithstanding the great falling off in the quantity imported,—in price, it ranks with Upland and the common and middling qualities of Orleans. This wool is various in its qualities, but, in general, it is a strong coarse article, irregular in the staple, and well adapted for the manufacture of the stouter fabrics of cloth to which it is mostly applied, but is totally unfit for finer goods.

It is said that the finest quality of cotton ever brought to the English market, or probably ever grown, was raised in one of the West India Islands, viz. Tobago, upon the estate of Mr. Robley, between the years 1789 and 1792. That gentleman carried the cultivation of this article to some extent; but the price of cotton falling very low, and the growing of sugar becoming more profitable, in consequence of the destruction of the sugar plantations in the French Islands, he was induced to convert his cotton plantation into a sugar one; and the production of cotton of this description was never attempted by any other person, though, it is believed, that the price it would command would amply repay the expense of growing it.

SOUTH AMERICAN COTTON.

South American cotton includes that imported from Brazils and Guiana.

Brazil cottons are distinguished by the names of Pernambuco, Maranham, Bahia, Para, &c. according to the districts where they are grown. That which is known by the name of Pernambuco is of a fine rich cream colour, and of superior quality. It long had the reputation of being superior to any imported, the Bourbon and Sea-Island excepted. In quality, Pernambuco ranks with Egyptian; the latter is finer, but very irregular. Maranham, Bahia, and Para wools, partake much of the same general description, but are inferior both in strength and cleanness to the Pernambuco.

The imports of cotton wool from the Brazils have been remarkably steady for a long period. They seem, indeed, to have undergone little or no variation these twenty years past. In 1830 and 1831, the imports amounted to 191,468 and 168,288 packages, or 33,889,836 and 29,786,976 lbs.

The cotton imported from the coast of Guiana is distinguished by the names of Demerara and Berbice, Surinam, Cayenne, Essequibo, &c. Demerara cotton is a strong glossy wool, pretty long though unequal in the fibre, and generally well cleaned and picked before it is packed. It makes a clean stout thread, and is frequently used for fine wefts, or warps of a moderate fineness; it is rather coarse, however, for the finest qualities of either. It is usually classed with the Berbice, but the latter is considered rather inferior. In price and quality they rank with Egyptian and Pernambuco wools. Essequibo is something similar to those mentioned, but inferior. Cayenne cotton is not much imported; it is like the Demerara, a clean wool, but very long and hard in the staple, which makes it difficult to card and spin.

Surinam resembles the Demerara and Berbice in appearance, but is inferior both in strength and fineness, and similar to the Essequibo; both of them are considered to be pretty much on a level in quality with the West Indian wools. The imports, consumpt, &c. of Demerara and Berbice, Surinam, and other cottons from Guiana, have been on the decrease for some years back. The imports in 1830 and 1831 amounted to 1263 and 811 packages, or 395,319 and 253,843 lbs.

EGYPTIAN COTTON.

The first cotton imported into the English market from Egypt was in the year 1823. Since that period it has been annually imported in considerable quantities, amounting, on an average, to about 6,593,073 lbs. It is a very superior wool, of a yellowish colour, not nearly so fine and silky as American Sea-Island, but generally long and strong in the staple, though somewhat irregular and very slovenly got up; and, perhaps, no description of cotton loses less after passing through the operation of carding.

There are two sorts of Egyptian cotton imported into the British market, one is in Egypt, called Makko, and in England, common Egyptian; the other is produced from Sea-Island seed, and in Egypt is called Sennaar, in England it is denominated Sea-Island Egyptian. Besides these two, there are raised in Egypt from 15 to 20,000 bales annually, of a short staple cotton, similar in quality to that of Smyrna wool, and chiefly consumed in the country itself.

The cotton received from Egypt is found to be among the most useful that is grown, and that raised from Sea-Island seed ranks in quality next to American Sea-Island. The best qualities of this wool are generally used by manufacturers for yarn of superior quality.

COTTON FROM THE UNITED STATES.

Previous to the year 1790, North America did not supply this country with a single pound weight of cotton; it was only after the termination of the American war that cotton began to be cultivated in Carolina and Georgia, and it has succeeded so well, that it now forms one of the staple productions of the United States. But that which was first imported into the English market, was very imperfectly cleaned, and, in consequence, was for some time used only for spinning low numbers. It was soon perceived, however, that the cotton grown upon the coast, termed Sea-Island cotton, had a finer and longer staple than that which was produced farther up the country, and known by the name of Upland cotton. But some years elapsed before it was ascertained to be of a quality in every respect superior to that which was brought from the Isle of Bourbon, the only cotton then used for the finest qualities of yarn, but which is now almost entirely superseded by the former.

American cotton is generally distinguished by the names of Sea-Island, Upland, New Orleans, Alabama, Tennessee, &c.

Sea-Island cotton is the finest that is imported into this country, or, indeed, that is known, and takes its name from being grown upon small sandy islands contiguous to the shores of Georgia and Carolina, and on the Low Grounds bordering on the sea. The principal of these islands are situated between Charleston and Savannah. It is a fine silky cotton, having a yellowish tinge, both long and strong in the staple, and used only for spinning the finest qualities of yarn, or for a superior quality of power loom warps. But its qualities differ so much, that the finest specimens are often more than double the price of the inferior sorts. Its close vicinity to the sea exposes it to the inclemencies of the weather, by which it is often injured, consequently that which is thus damaged, sells at a much lower price than the better kinds of it.

Upland cotton is a different species from Sea-Island, and is grown in Virginia, North and South Carolina, and Georgia; and for a considerable time the cultivation was confined to these States. As the planting extended to the south, the quality varied in some respects, and the cotton received the name of its place of growth; hence, New Orleans cotton, Alabama, Mobile, &c. &c.

That which is known in the market by the name of New Orleans, is a very superior cotton, clean, soft, and of a glossy and silky appearance, rather short in the staple, and incorporates freely with other cottons of a longer staple. It is grown upon the banks of the Mississippi, and imported, in great quantities, into the English market, where it ranks in price and quality about equal to the common qualities of Brazil cottons. Alabama, Upland, &c. rank next to New Orleans, and are soft, short, and weak in staple.

The cultivation of cotton wool is carried to a very great extent in the United States at present. The quantity imported into this country is estimated at upwards of 230,000,000 lbs. yearly, and apparently still increasing.

METHOD OF CLEANING COTTON ABROAD.

Various methods of cleaning cotton have been adopted at different periods. In the West Indies, and on the continent of America, what is called the roller-gin has been long used. It consists of a pair of fluted rollers about $\frac{5}{8}$ of an inch in diameter, and nine or ten inches long; these are fitted up in a frame, and motion being communicated to them, the cotton is passed through between them, by which means it is separated from the seed, the diameter of the rollers being so small, that the gins, when whole, cannot be drawn in between them. In this way the staple is not at all cut, particularly Sea Island, which adheres only very slightly to the seed, but which is not the case with Upland, for it adheres so firmly to the seed, that it requires the saw-gin to clean it, as described in next page. The roller-gin is but a slow process, and therefore expensive, consequently used only for the best qualities. Switching the cotton was tried, but disapproved of by manufacturers, as tending greatly to injure it.

The cotton called Bowed Georgia, takes its name from a mode of cleaning cotton long in use. This was performed by means of the bow-string, which being raised by the hand, and suddenly let go, struck upon the cotton with great force, and thereby served both to separate the gins and open the cotton, so as to render it more fit for the processes that follow. But this mode, whatever advantages it might possess in point of quality, has been abandoned for others better adapted for quantity; and what is called Bowed Georgia, has, for a long time, in reality, been cleaned by a machine denominated a saw-gin. This machine consists of a cylinder about the size of a weaver's beam, and teeth cut out like a saw, at equal distances from each other, from which it derives its name. Instead of these saws, the machine originally had wires like card teeth, but these having been found to make what is called white naps upon the cotton, the former was substituted in their place. The saws pull the cotton through a grating, which has its openings so narrow, that the seeds cannot get through. The grating being a little inclined to the horizon, cotton is thrown upon it by the negro attending the machine, when the teeth of the saws take hold of it, and pull it through the openings, whilst the gins being pressed out, roll down the surface of the grating, and escape by an opening in the side of the machine. By the centrifugal force of the cylinder the cotton is thrown backwards, aided by another cylinder, covered with brushes, for cleaning the teeth. This machine, though not very injurious to the cotton of a short staple, yet is seldom used for the finest Sea-Island, or any other that is very long in the fibres.

It is worthy of remark, that when the Upland Georgia cotton was first brought to the English market, it yielded a higher price by about 2d. per lb. when it was cleaned by the roller-gin; but, contrary to all expectation, the saw-gin is found much better adapted for cleaning this species of cotton than the other. And what is done by it, is preferred by those who understand spinning. The saws separate the gins more effectually than the rollers, and at the same time give it a kind of teazing, which is found highly beneficial to it.

CIRCUMSTANCES CONNECTED WITH THE COTTON TRADE, CRONOLOGICALLY ARRANGED.

B.C.

340. THE cotton manufactures of India were taken notice of by the Greeks when Alexander overran Greece.

A.D.

1101. The measure of the Ell fixed by Henry I.

1280. The manufacture of cotton introduced into China from India.

1500. The first attempt made to introduce cotton goods into England.

1560. Guiccardine records the Low Countries to be the depot of India goods and of cotton from the Levant.

1565. The first Act of Parliament relating to cotton goods.

1600. The first charter granted to the English East India Company.

1631. Printed calicoes imported into England.

1640. Fustians made at Bolton.

1670. The Dutch loom first used in England.

1673. Blone, in his history of Liverpool, speaks of great cotton manufactories in the adjacent parts.

1676. Calico printing first introduced into London.

1700. The manufacturing of muslins first attempted in Paisley.

1721. The weaving of India calicoes prohibited.

1725. Linens, lawns, and cambrics, first manufactured at Glasgow. Mr. James Monteith was the first manufacturer who warped a muslin web in Scotland.

1730. Cotton spinning attempted unsuccessfully by Mr. Wyat, at Litchfield, who spun the first thread of cotton yarn ever produced without the intervention of the fingers.

1735. The cotton plant first cultivated in Surinam.

1738. Mr. Lewis Paul took out a patent for an improved mode of carding.

—— The fly shuttle invented by Mr. John Kay of Bury.

1742. The first mill for spinning cotton erected at Birmingham. It was moved by asses; but the machinery was sold in 1743.

1750. The fly shuttle in general use.

1756. Cotton velvets and quiltings first made.

1760. Mr. James Hargreaves applies the stock card to the carding of cotton with some improvements.

1762. Cylinder cards invented. First used by the father of the late Sir Robert Peel.

1763. Rouen was the principal market for the sale of cotton wool.

1767. The spinning jenny invented by Mr. James Hargreaves.

1769. Mr. Arkwright, afterwards Sir Richard Arkwright, obtained his first patent for spinning with rollers, and built his first mill at Nottingham.

1770. 5521 bags of cotton imported into Liverpool from the West Indies, 3 from New York, 4 from Virginia and Maryland, and 3 *barrels* from North Carolina.

1774. Power Looms invented by the Rev. Dr. Cartwright.

1779. Cayenne, Surinam, Essequibo, Demerara, and St. Domingo cotton most in esteem.

—— Mule jenny invented by Mr. Samuel Crompton.

1781. Brazil cotton first imported from Maranham, but very dirty.

1782. Mr. James Watt obtains his patent for the steam engine.

1783. Surat, and also Bourbon cotton, first imported, or known, about this time.

1784. Mr. Arkwright's first patent expired.

—— Cotton manufactured in Great Britain this year was 11,280,238 lbs., and valued at £3,950,000.

—— Cotton imported in small quantities from the United States.

1785. Mr. M'Intosh and Mr. Dale commenced dying Turkey red in Glasgow.

1786. Bourbon cotton sold from 7/6 to 10/ ℔ lb.

1793. Cotton, the growth of the United States, first imported in large quantities, by way of the West Indies.

1797. Scutching machine, said to be invented by Mr. Snodgrass and Mr. Cooper, first used at Johnstone.

—— About this time the saw-gin was invented.

1798. The Fame arrived with the first cargo of cotton from the East Indies.

1800 or 1801. The entire stock of American cotton in Liverpool *one* bag.

1803. Radcliff's dressing and warping machine invented.

1813. Trade to British India thrown open under certain restrictions.

1818. 105 millions of yards of cotton cloth manufactured in Glasgow, value £5,000,000.

1823. Cotton first imported from Egypt direct to Liverpool.

1825. Steam engines estimated at 893 horses' power, spinning cotton in and around Glasgow, in a space not more than two miles from the cross.

—— Mr. Roberts of Manchester, obtained a patent for an improved self-acting mule.

1830. The Danforth throstle frame introduced into England.

—— Mr. Roberts obtained a second patent for improvements on his self-acting mule.

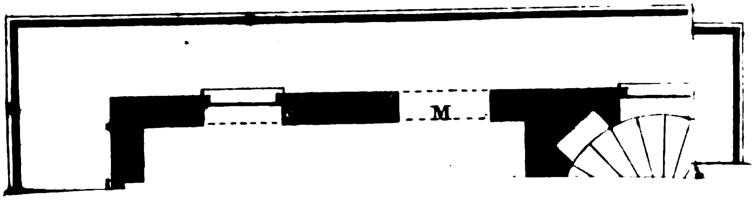
1832. Mr. Robert Montgomery of Johnstone (Scotland) obtained a patent for the three kingdoms for an improvement of the throstle frame. The first entire machine was accidentally destroyed. The second is now in full operation in the Mill of Mr. John Miller, and giving entire satisfaction.

—— The value of cotton goods now manufactured in Great Britain estimated at £40,000,000 yearly, £20,000,000 of which are exported.

The quantity of cotton cloth annually manufactured in England was, upon an average of four years, from 1824 to 1828, 759,000,000 yards, 360,000,000 of which are exported, and 399,000,000 retained for home consumption.

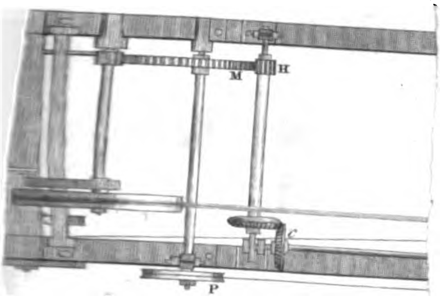
Number of power looms employed in Great Britain estimated at 203,373. The number of hands employed in all the different branches of the cotton manufacture, are supposed to amount to *a million and a half.*

J. NIVEN AND SON, PRINTERS,
55, *Glassford Street.*



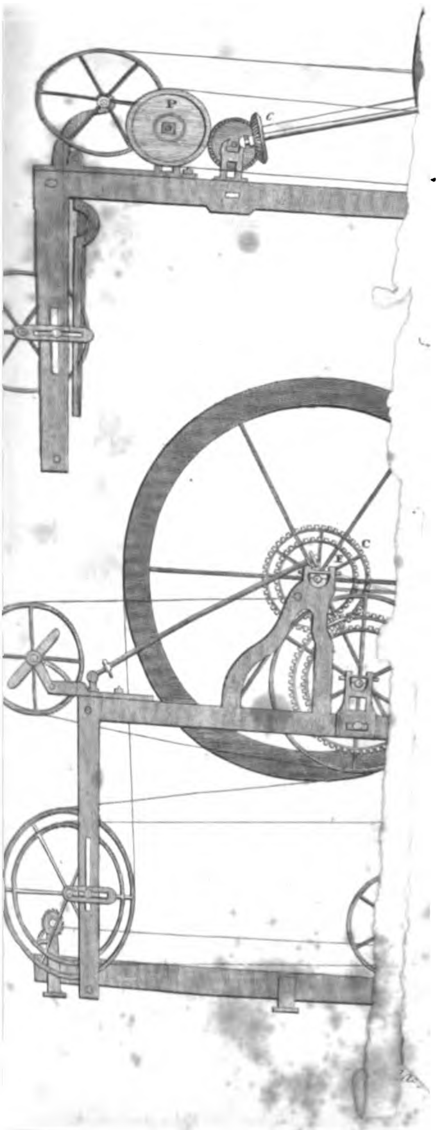
Published by John Steven

MULE



ch to a Foot

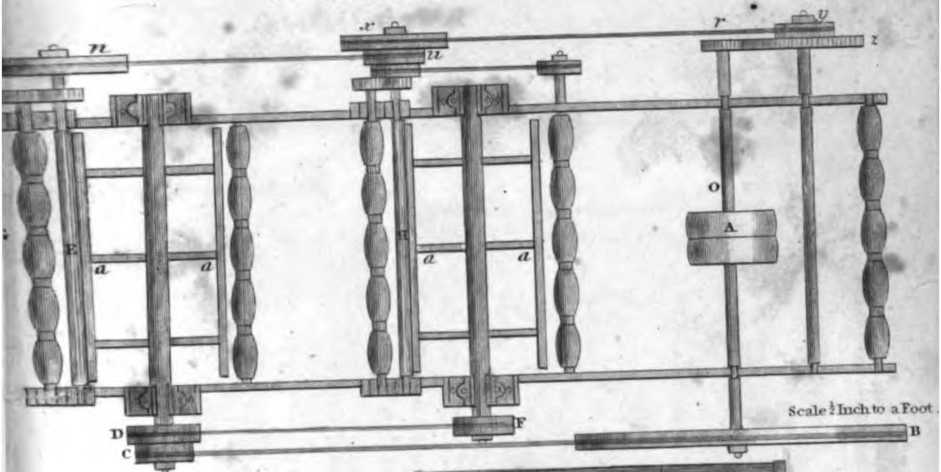
B



Glasgow Published by John Niven Jun 1833

SCUTCHING MACHINE.

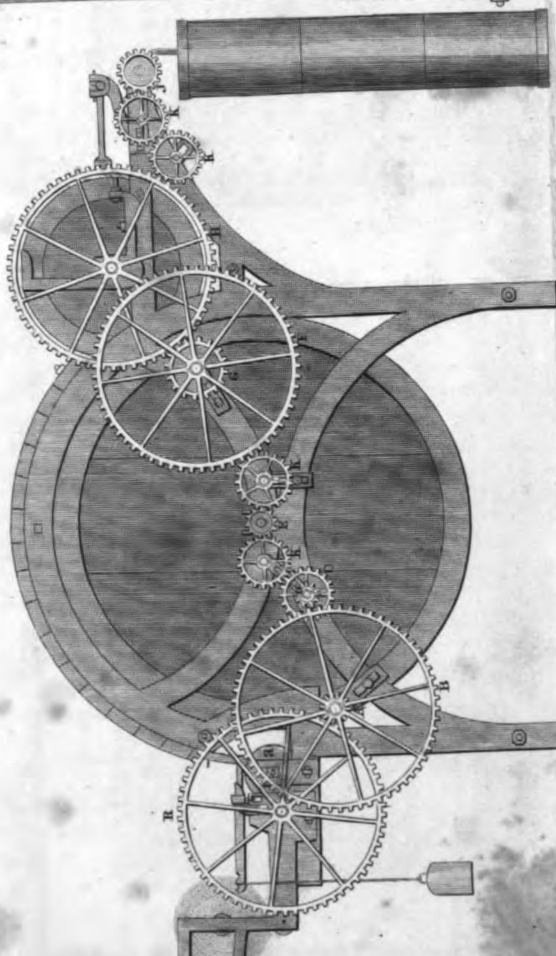
Fig 1st



Scale ½ Inch to a Foot.

CARDING ENGINE.

Fig 2nd



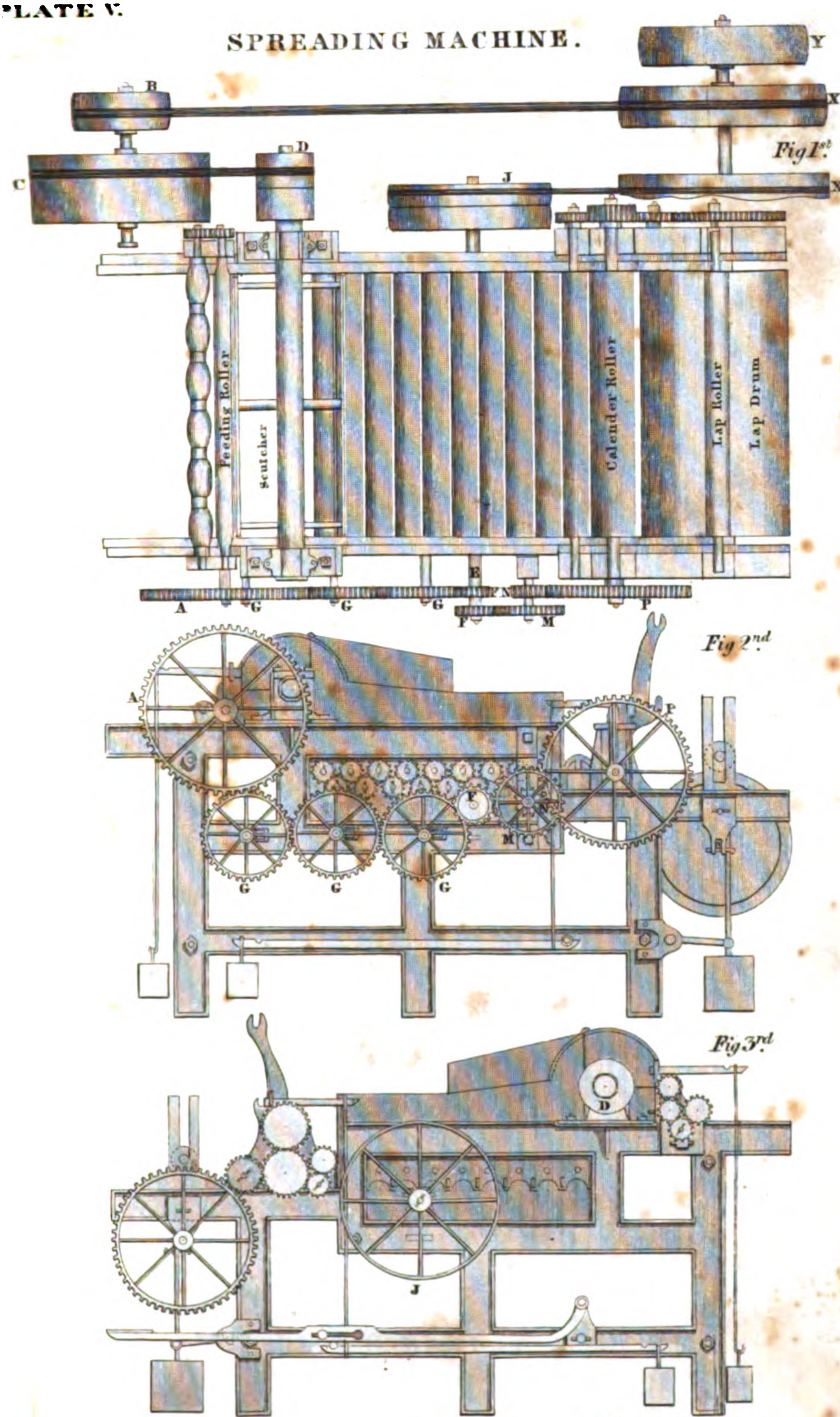
Scale ¼ of an Inch to a Foot

Glasgow Published by John Niven Jun.r 1833.

B. Allan Sc.

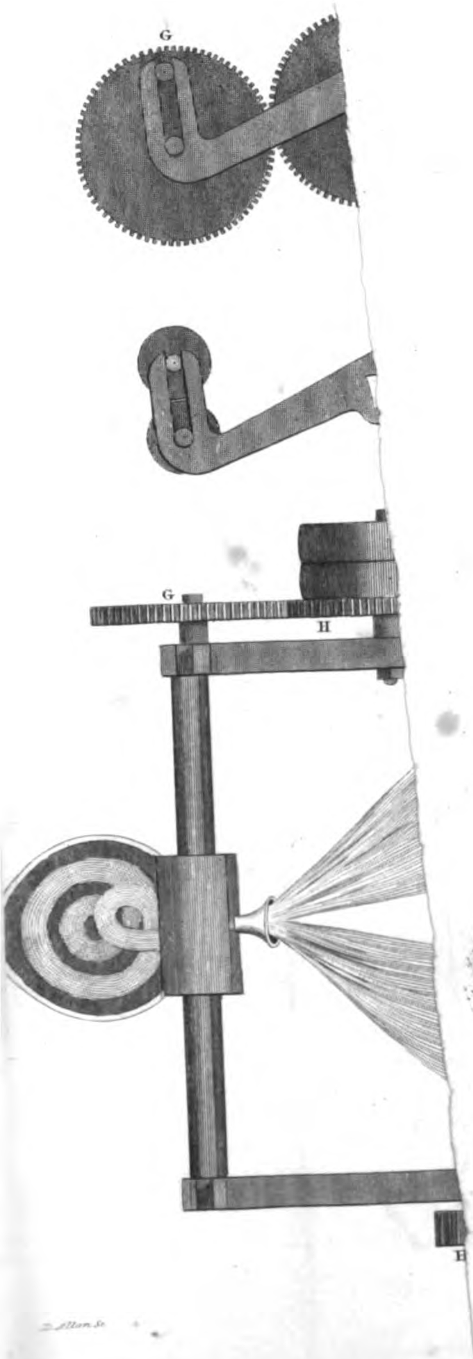
PLATE V.

SPREADING MACHINE.



Scale ⅛ of an Inch to a Foot.

Glasgow Published by John Niven Jan! 1833.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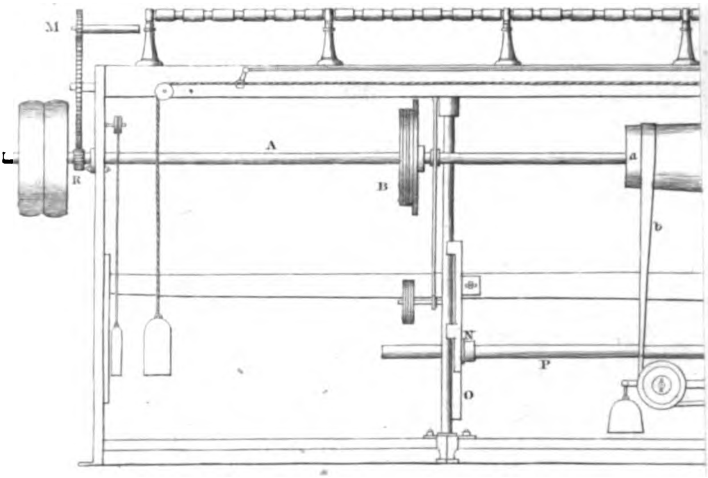
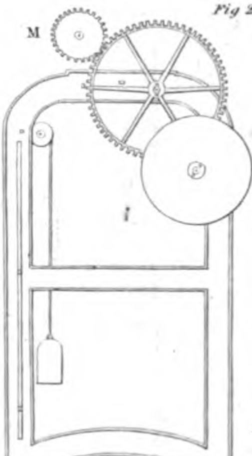
G
H
H



END VIEW

Fig 2nd

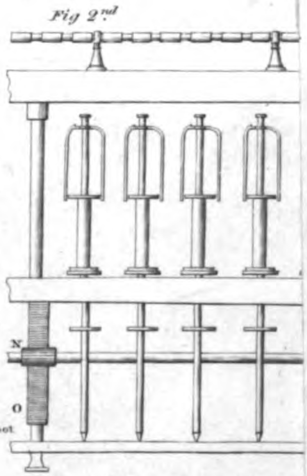


Scale $\frac{4}{8}$ of an inch to a Foot

Fig 1st

Scale 2 inches to the Foot

Fig 2nd



Glasg.

CONE & PARABOLA.

Fig 1st

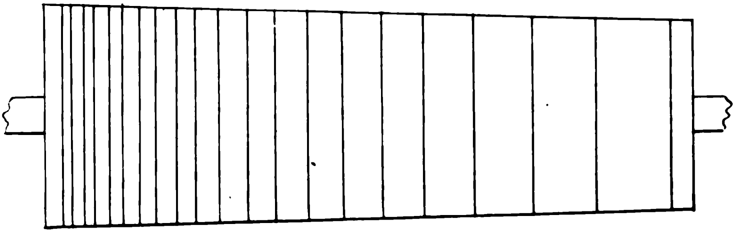
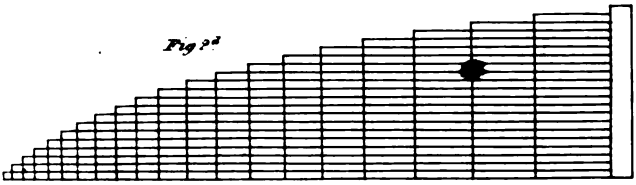


Fig 2d



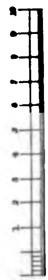
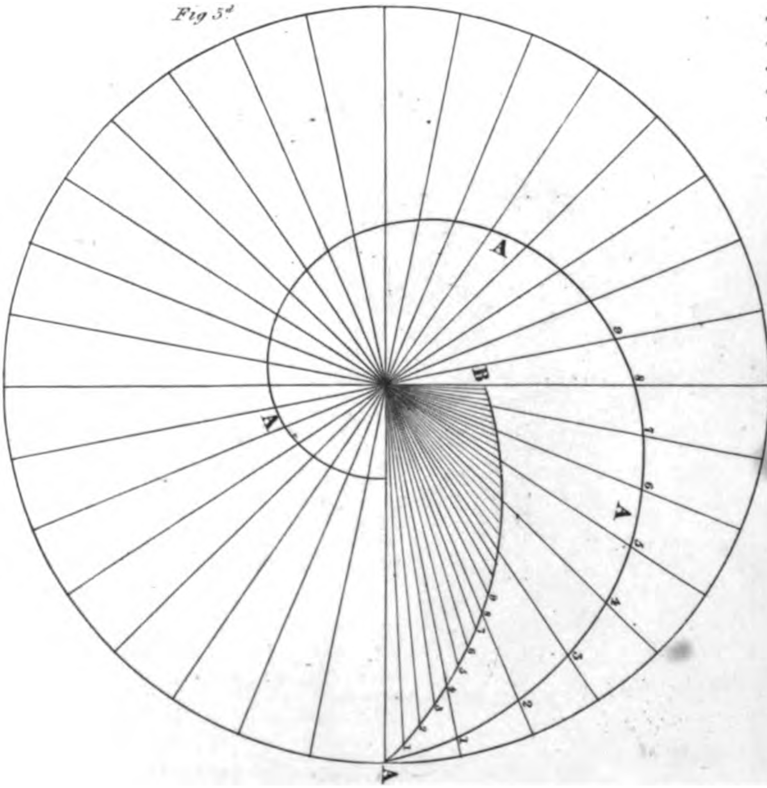


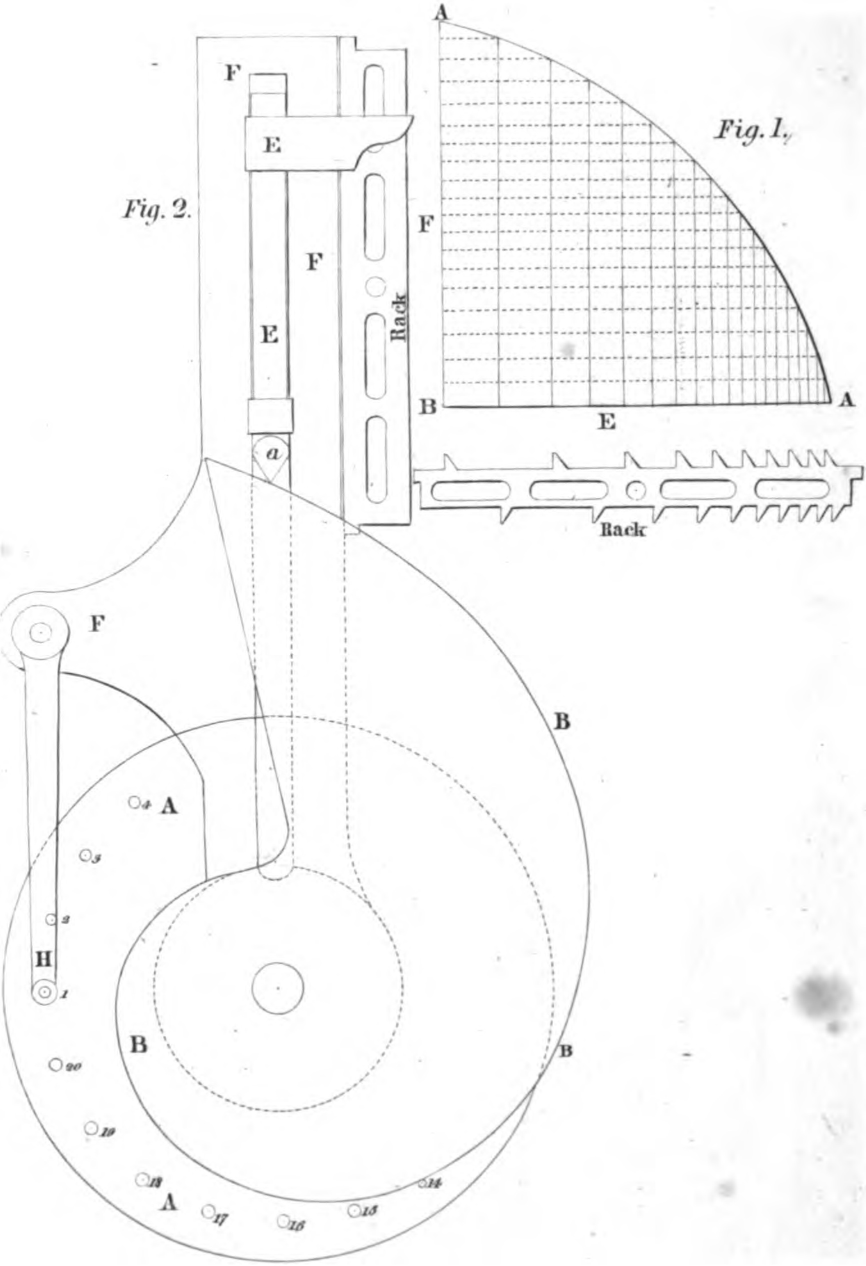
Fig 3d



Glasgow Published by John Niven Jan. 1833.

W. Ferguson Sc.

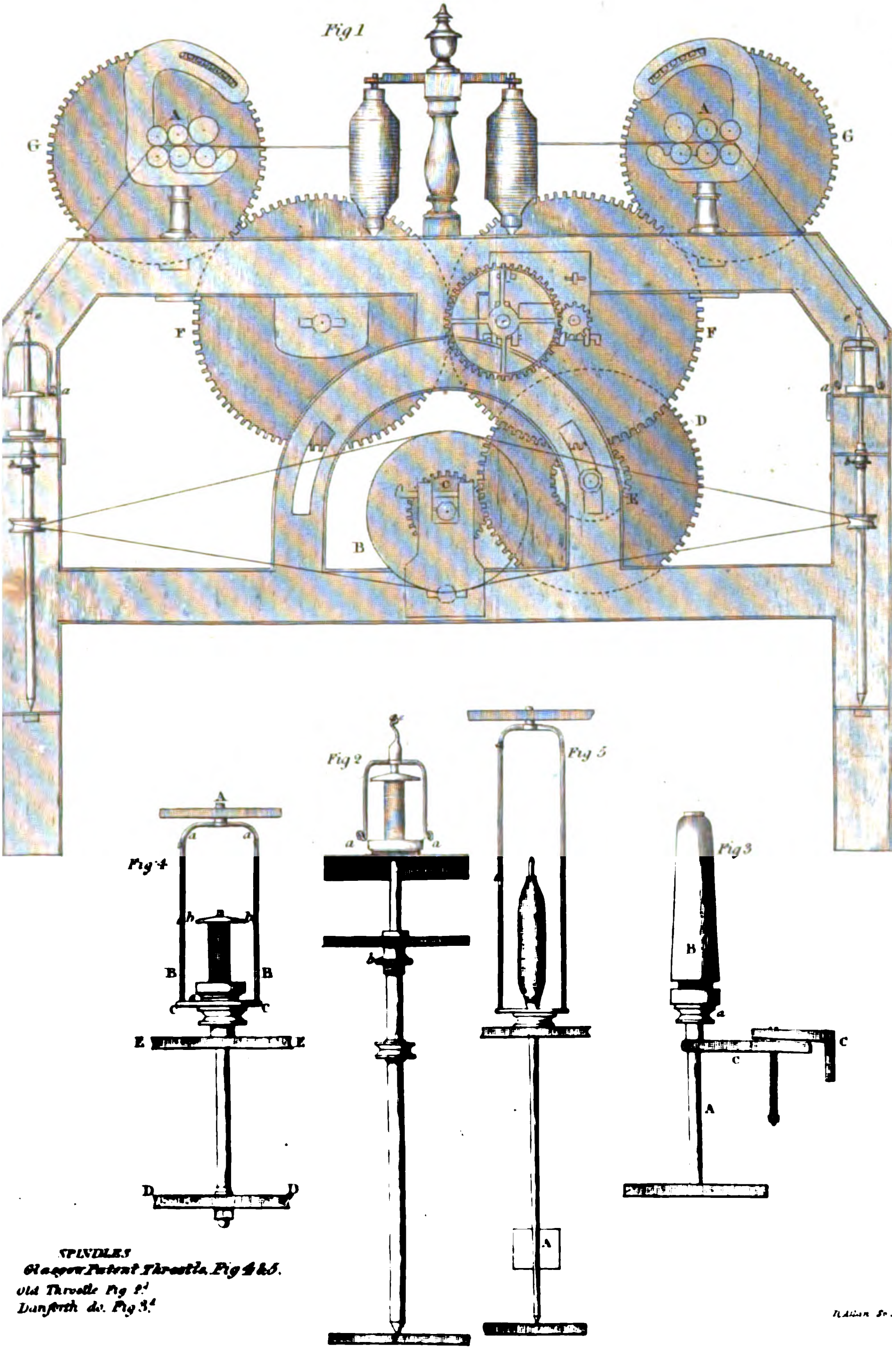
MACHINE FOR DIVIDING THE TEETH OF FLY FRAME RACKS.



Glasgow Published by John Niven Jan.^y 1833.

D. Allan Sc

END VIEW OF THROSTLE FRAME



SPINDLES
Glasgow Patent Throstle Fig 4 & 5.
Old Throstle Fig 2.d
Danforth do. Fig 3.d

R. Allan Sc.

Glasgow Published by John Niven Jun.r 1833.

CONE & PARABOLA.

PLATE VIII

Fig 1st

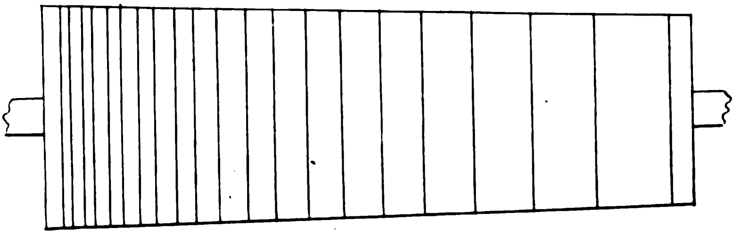


Fig 2d

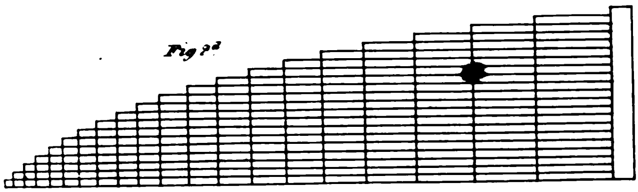
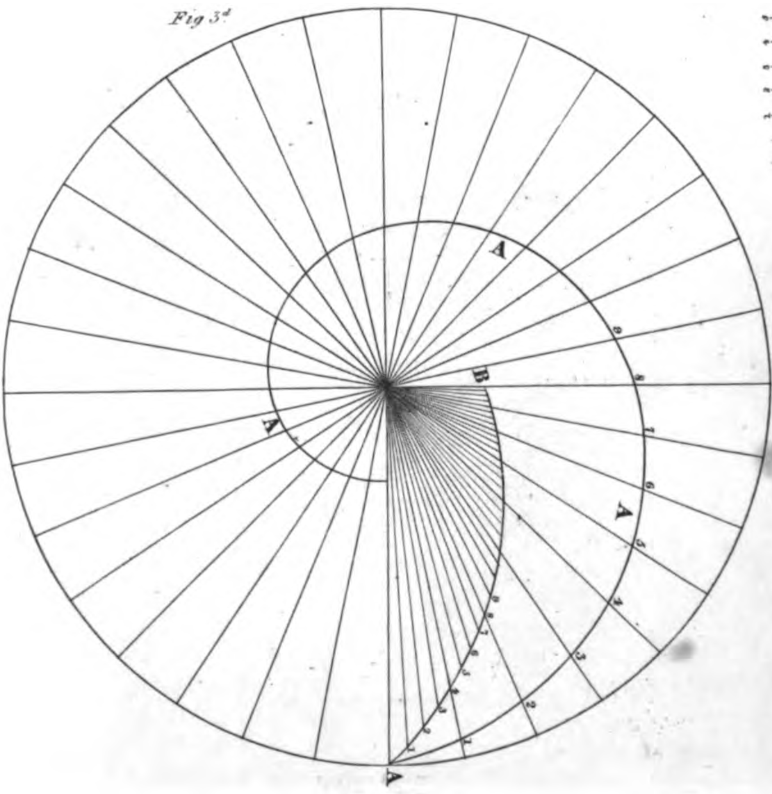


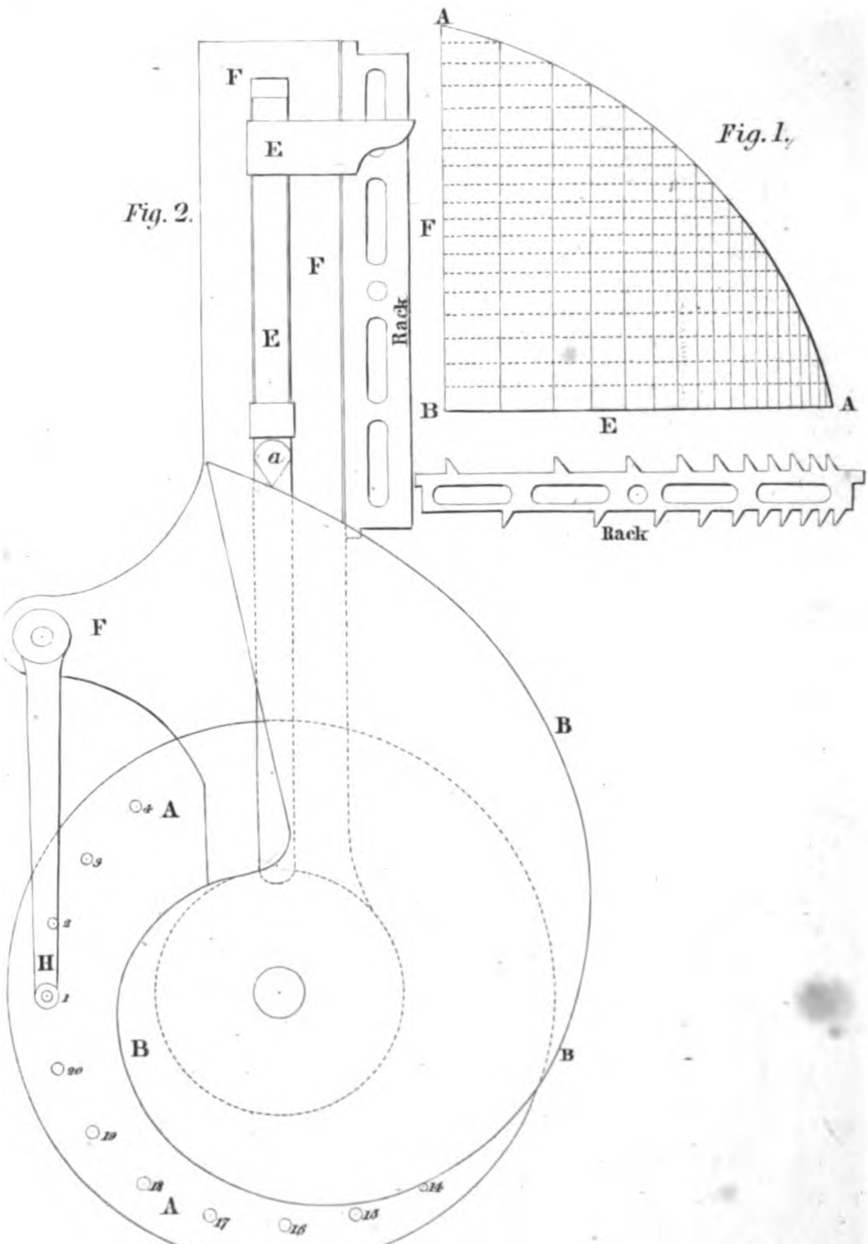
Fig 3d



Glasgow Published by John Niven Jan. 1833.

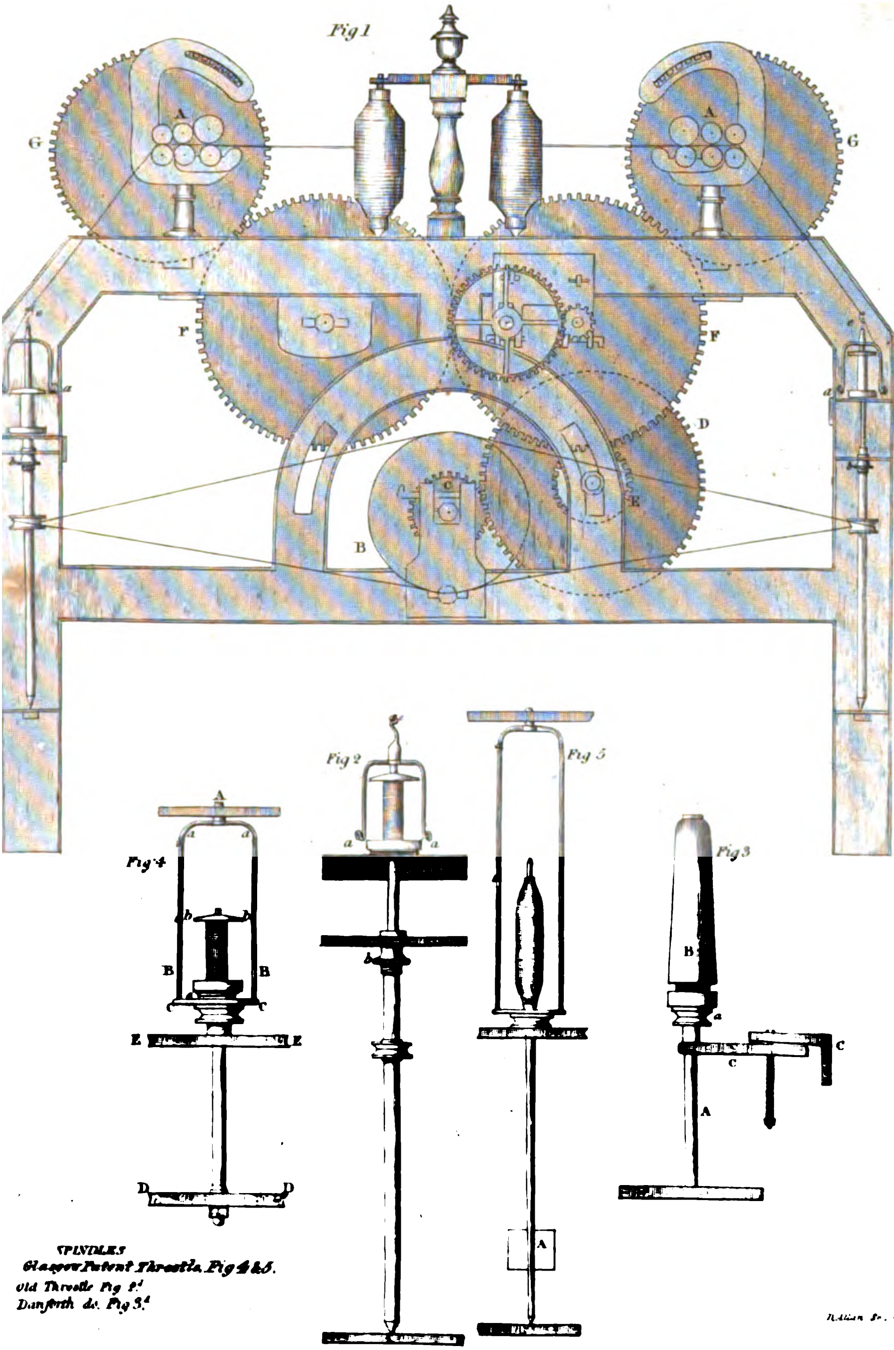
W. Fergusson Sc

MACHINE FOR DIVIDING THE TEETH OF FLY FRAME RACKS.



Glasgow Published by John Niven Jun.r 1853.
D. Allan Sc.

END VIEW OF THROSTLE FRAME



SPINDLES
Glasgow Patent Throstle, Fig 4 & 5.
Old Throstle Fig 2.d
Danforth do. Fig 3.d

Glasgow Published by John Niven Junr. 1833.