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GELDARD'S HAND-BOOK ON COTTON MANUFACTURE, designed for the use of Millwrights, Managers, Overseers, Operatives, and builders of Cotton and other Machinery. Containing rules and examples for finding the speed and dimensions of all the wheels and pulleys necessary for Mill Gearing, the wheels, pulleys, rollers, etc., etc., necessary to produce any desired result at each and every operation in a cotton mill, by an original and comprehensive system of calculations, deduced from Algebra and other sources, so simplified as to come within the comprehension of all who are acquainted with the fundamental rules of common arithmetic.

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HANDBOOK

ON

COTTON MANUFACTURE;

OR,

A GUIDE TO

MACHINE-BUILDING, SPINNING AND WEAVING;

WITH PRACTICAL EXAMPLES, ALL NEEDFUL CALCULATIONS, AND MANY USEFUL AND IMPORTANT TABLES: THE WHOLE INTENDED TO BE A COM-PLETE YET COMPACT AUTHORITY FOR THE MANU-FACTURE OF COTTON.

> BY JAMES GELDARD, LONSDALE, R. I.

> > Utornry of Contines 1907 Chy of Washinston

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PREFACE.

THE utility of a suitable hand-book on Cotton Manufacture—which has become so important a branch of our national industry—can scarcely be a matter of question.

Several works have been published on the subject, both in this country and in England, each one of which has its peculiar merits: it may, perhaps, seem presumptuous in the author to add this to the number. All he asks, however, is that the judicious reader shall examine his pages, and decide for himself upon the value of their contents.

The work is designed especially for the Cotton Manufacturer, but it is hoped that it will be found useful to manufacturers of woollen and linen goods, to builders of machinery, to the general mechanic, and to the student intending to prosecute any branch of manufacture in which machinery is used.

The plan of the work is—

First. To make all necessary calculations as to the dimensions of the Mill Gearing, and the machinery to be employed.

Second. To introduce the cotton and show at a glance the draughts, and doublings, and necessary allowance for loss in working, to produce any required result. The author has had familiar acquaintance with *the best* of modern machines, American and English, and has based his calculations upon those most recently adopted in our first-class mills.

Some of the examples may seem to contain needless repetitions, but it is thought best that every feature of the statement should appear in each problem, in order that the whole may be seen and comprehended at once. The system of cancellation adopted will be found so ready an offset to these repetitions that, as will be seen, they can be easily afforded.

The work is entirely original, and although conceived amidst the noise of labor, and written in hours stolen from rest, the author has confidence in its theoretical and practical accuracy, and gladly stakes his reputation upon its success.

The author desires thus publicly to express his grateful acknowledgments for the kindness of Prof. B. F. Clark, of Brown University, who has encouraged him by pronouncing his manual mathematically correct.

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HAND-BOOK

ON

COTTON MANUFACTURE.

PART I.

MILL-GEARING.

MECHANICIANS have always disagreed as to the best mode of conveying power from the prime mover to the machinery to be impelled. Some prefer gearing, some belts and pulleys, while others prefer a mixture of both. Doubtless each system has its advantages. All agree, that, to convey the power by the shortest possible train, first to the heaviest and then the lighter machinery, is correct both in theory and practice.

Whatever system is adopted, the mode of finding the proper gears, pulleys, speed, etc., etc., is substantially the same.

Many prefer very light, well-balanced pulleys and shafting, and counter-balance the want of weight and strength by having a small driven wheel or pulley near the prime mover, and small driving pulleys near the machinery to be impelled, which gives a proportionately increased velocity to produce the same momentum. This system greatly reduces the inertia to be overcome, and tends to more uniform impulsion and utility of the power applied.

A steam-engine makes 50 double strokes per minute, and drives an upright shaft 180 revolutions per minute by a train of two pairs of wheels; the driving wheels have respectively 210 and 54 teeth.

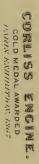
Required, the number of teeth respectively in the two driven wheels.

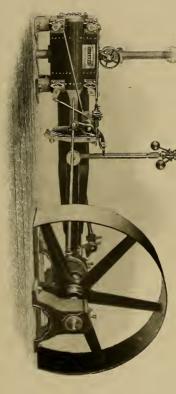
Revolutions per minute	50 Double strokes per mi-
of the upright shaft, 180	nute of the steam-
	engine.
,	210 Teeth in the first driv-
	ing wheel.
	54 Teeth in the second
	driving wheel.

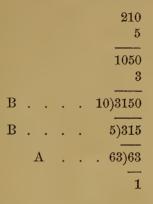
	Worked Out.
•	$1 \cdot 2 \cdot 18(0 \mid 5(0 \mid$
	210
	1·2·18(0 5(0 210 54·6·3

(Continued.)

 $\mathbf{12}$







A. 63 = 63 Teeth in the first driven wheel.

B. $10 \times 5 = 50$ Teeth in the second driven wheel.

Answer.

N.B.—It will be perceived, by a little reflection, that the driven wheels are found by first dividing the product of the double strokes per minute of the steam-engine, and the number of teeth in the driving wheels by the revolutions per minute of the upright shaft, and the quotient by as many numbers as will divide without a remainder. The last divisors are classed according to the number and size of wheels required, which is dictated by location and other circumstances. The product of the numbers in each class gives the respective wheels.

From the particulars found in the preceding example, find the revolutions per minute of the upright shaft.

	50 Double strokes per mi-
	nute of the steam-
•	engine.
Teeth in the first driven	210 Teeth in the first driv-
wheel 63	ing wheel.
Teeth in the second driv-	54 Teeth in the second
en wheel 50	driving wheel.

Worked out b	y Cancellation.
--------------	-----------------

	50·1
1.7.63	210.30
1.50	54.6

 $30 \times 6 = 180$

Answer.

	The	80	ame	e w	itl	hout	C	ance	ellation.	
Divider	nd	•		50	×	210	×	54	-180	
Divisor									- 100	

Answer.

N.B.—The product of all the terms on the left-hand side of the perpendicular line into the answer will equal the product of all the terms on the right-hand side of this line. Thus: $63 \times 50 \times 180$ —567000; $210 \times 54 \times 50$ — 567000. Hence we have the following rule to find any of the above terms: Place all the terms classed with the one sought on the left-hand side, for a divisor (less the term sought), and all the rest on the right-hand side for a dividend, and proceed by cancellation or multiplication: divide the product of the terms on the right-hand side by the product of the terms on the left-hand side, and the quotient will be the answer. This rule applies to all problems of this nature.

From the particulars found in the preceding example, find the number of teeth in the driven wheels.

 $\begin{array}{c|ccccc} Worked & out & by & Cancellation. \\ 1 \cdot 2 \cdot 18(0 & 50 \cdot 1 & \\ & & & \\ 1 \cdot 21(0 & & \\ 1 \cdot 50 & 54 \cdot 6 \cdot 3 & \\ \end{array}$

 $21 \times 3 = 63$ Teeth in the first driven wheel.

Answer.

The same without Cancellation.Dividend \cdot \cdot $\frac{50 \times 210 \times 54}{180 \times 50} = 63.$

Answer.

 $10 \times 5 = 50$ Teeth in the second driven wheel. Answer. The same without Cancellation. Dividend $\cdot \cdot \frac{50 \times 210 \times 54}{180 \times 63} = 50$ Divisor $\cdot \cdot \cdot \cdot \frac{50 \times 210 \times 54}{180 \times 63} = 50$

Answer.

From the particulars found in the preceding example, find the double strokes per minute of the steam-engine, and the number of teeth in the driving wheels.

Worked out by	y Cancellation.
	180.20.10
1.21(0	63·3·1
$1 \cdot 2 \cdot 6 \cdot 54$	180·20·10 63·3·1 5(0

 $10 \times 5 = 50$ Double strokes per minute of the steamengine.

Answer.

The same without Cancellation. Dividend . . . $\frac{180 \times 63 \times 50}{210 \times 54} = 50.$

Answer.

	/ Cancellation.
1.50	1 80·30
	180·30 63·7 50·1
1.6.54	50 ·1

 $30 \times 7 = 210$ Teeth in the first driving wheel. Answer. MILL-GEARING.

The same without Cancellation. Dividend $\cdot \cdot \cdot \frac{180 \times 63 \times 50}{54 \times 50} = 210.$

Answer.

Worked out by	/ Cancellation.
1.50	18(0
$1.50 \\ 1.21(0)$	63•3
	50.1

 $18 \times 3 = 54$ Teeth in the second driving wheel. Answer.

The same without Cancellation.
Dividend . . .
$$\frac{180 \times 63 \times 50}{210 \times 50} = 54.$$

Answer.

MIXING COTTON.

To mix together different qualities of cotton, so as to get the best possible combination for the purpose of making any given kind of yarn at the least possible expense, is an art of the very greatest importance.

The way of mixing cotton most commonly practised is to take as many bales as the mixing-room will conveniently hold, and spread them in layers on the top of each other, covering as large an area as the room will admit of. It is taken from top to bottom of the pile with a rake when wanted for use.

Some cotton-spinners obtain the best results by keeping the different qualities of cotton separate until they have passed through the cards, a system that has many arguments in its favor.

It is the most practicable way to make good, even yarn, to use one kind of cotton only, but this is not always the cheapest way; hence arises the necessity of mixing cottons.

Suppose a mill to consume 40 bales of cotton per week, each weighing 500 pounds, one half at 42 cents, and the other half at 36 cents per pound: the total cost of cotton per week would be \$7,800, while, if the whole was at 42 cents per pound, the cost per week would be \$8,400, a difference of \$600 per week, or \$100 per day, in favor of mixing.

THE WILLOW.

The Willow is the first machine to which the cotton is subjected in its process of manufacture.

The cylinder of a Bacon-Willow contains 1036 claws, and makes 500 revolutions, more or less, while the feedrollers feed one pound of cotton, displaying 1036×500 , == 518000, claws in rapid motion. These tease the

18



WHITIN'S IMPLOVED ATTEN

cotton into as many loose tufts, and, as far as is practicable, undo what has been done for convenience in transportation, free it from a superabundance of moisture and other impurities, and by the force of wind, created by the motion of the cylinder, carry it into a ventilated room convenient to the lapper.

THE LAPPER.

As will subsequently be shown, the lapper is the machine at which the cotton first receives definite form and size.

Some manufacturers contend that the size or decimal of a hank produced at a lapper cannot be depended upon as being positive; that at best it is but an approximation and guess at the quantity of cotton spread on to the lattice, substituting an "evener" for the old system of spreading a definite weight on to a definite length.

The Whiting Lapper is the one most generally appreciated in this neighborhood; being easy to manage, not liable to get out of order, and, with proper weighing, produces good and truthful results.

A lapper has three beaters. The first one makes 1800, the second 2000, and the third 2200 revolutions per minute. They are driven from an upright shaft, making 180 revolutions per minute by a train of three pairs of pulleys, and one pair of wheels. The driving wheel has 96 teeth, and the respective diameters of the driving pulleys are 40, 32, and 20 inches. How many teeth should there be in the driven wheel, and what should be the respective diameters of the driven pulleys, to drive the first beater at the speed above named?

Revolutions per minute of the first beater, 1800	180 Revolutions per minute of the upright shaft.
	96 Teeth in the driving wheel.
	40, Diameter of the first
	driving pulley in inch- es.
	32, Diameter of the second
	driving pulley in inch- es.
	20, Diameter of the third
	driving pulley in inch-
	es.

```
Worked out.

1.18(00 | 18(0.1

96

4(0

32

20

(Continued.)
```

 $\mathbf{20}$

					$96 \\ 4$
					$\frac{-}{384}$
					${768}$ 1152
					$12288\\20$
A			•		2)245760
A					2)122880
A		•			2)61440
A					2)30720
A				•	2)15360
A	•				2)7680
В		•			2)3840
В					2)1920
В					2)960
в					$2)\overline{480}$
в					2)240
	С				$2)\overline{120}$
(6	C Ion	tin	г н ес	<i>i</i> .)	2)60

D	•.	•	2)30
D	•		3)15
с.			5)5
			- 1

A. $2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 64$ Teeth in the driven wheel.

B. $2 \times 2 \times 2 \times 2 \times 2 = 32$, Diameter of the first driven pulley in inches.

C. $2 \times 2 \times 5 = 20$, Diameter of the second driven pulley in inches.

D. $2 \times 3 = 6$, Diameter of the third driven pulley in inches, which is on the same axis with the first beater. Answer.

The first beater of a lapper is driven from an upright shaft making 180 revolutions per minute by a train of three pairs of pulleys and one pair of wheels. The driving wheel has 96, and the driven wheel 64, teeth. The respective diameters of the driving pulleys are 40, 32, and 20, and of the driven pulleys, 32, 20, and 6, inches. How many revolutions per minute does the first beater make?

					180 Revolutions per minute				
					of the upright shaft.				
Teeth	\mathbf{in}	the	driven		96	Teeth	\mathbf{in}	the	driving
wheel 6		64	wheel.						

 $\underline{22}$

Diameter of the first		40, Diameter of the first
driven pulley in inch-		driving pulley in inch-
es	32	es.
Diameter of the second		32, Diameter of the second
driven pulley in inch-		driving pulley in inch-
es	20	es.
Diameter of the third		20, Diameter of the third
driven pulley in inch-		driving pulley in inch-
es	6	es.

Worked out	by	Cancellation.
------------	----	---------------

180
96 · 16 · 1
40 ·1 0
32 ·1
20.1

 $180 \times 10 = 1800$

Answer.

The same without Cancellation. Dividend $\cdot \frac{180 \times 96 \times 40 \times 32 \times 20}{64 \times 32 \times 20 \times 6} = 1800$ Answer.

The lattice-roller and lattice are, in effect, equal to a roller 4 inches in diameter. On the same axis with the

23

lattice-roller, there is a wheel that takes into a wheel with 9 teeth, on the feed-roller. On the feed-roller there is also a wheel that takes into a wheel with 42 teeth, on the under shaft. On the other end of the under shaft there is a wheel that takes into a wheel with 32 teeth, on the sideshaft. On the other end of the side-shaft there is a wheel that takes into a wheel with 32 teeth, on the clutch-shaft. On the clutch-shaft there is also a wheel that takes into a wheel with 100 teeth, on the calender-roller. On the other end of the calender-roller there is a wheel that takes into a wheel with 26 teeth, on the lap-roller. Suppose the wheels that have their dimensions given above to be driving wheels, what should be the dimensions of the driven wheels and the lap-roller to produce a draught of 3?

N.B.—The intermediate wheels are not taken into account in the above.

- 4, Diameter of the latticeroller, including lattice, in inches.
 - 9 Teeth in the wheel on the feed-roller.
- 42 Teeth in the wheel on the under shaft.
- 32 Teeth in the wheel on the side-shaft.

THE LAPPER.

32	Teeth	\mathbf{in}	the	wheel on
	the	clu	tch-s	haft.
100	Teeth	\mathbf{in}	the	wheel on r-roller.
	the e	cale	ende	r-roller.
26	Teeth	\mathbf{in}	the	wheel on
	the]	lap.	rolle	er.
3,	Draug	ght	of tl	he lapper.

Worked out.

· 26
100
$\frac{1}{2600}$
32
5200
7800
83200
32
166400
249600
$\overline{2662400}$
42
5324800
10649600
$(\overline{Continued}_2)$

25

111820800
9
$\overline{\frac{1006387200}{4}}$
$\overline{4025548800}$
C 13)12076646400
D 10)923972800
B 10)92897280
A
E 4)1327104
F 4)331776
F 4)82944
G 4)20736
G 4)5184
D 4) 1296
B
E 3)108
E 3)36
$\begin{array}{cccc} C & \ddots & \ddots & \ddots & 3 \\ & & (Continued.) & & - \end{array}$

 $\mathbf{26}$

A. 7 = 7, Diameter of the lap-roller in inches.

B. $10 \times 3 = 30$ Teeth in the wheel on the lattice-roller.

C. $13 \times 3 \times 2 = 78$ Teeth in the wheel on the feed-roller that takes into the wheel on the undershaft.

D. $10 \times 4 \times 2 = 80$ Teeth in the wheel on the undershaft that takes into the wheel on the side-shaft.

E. $4 \times 3 \times 3 = 36$ Teeth in the wheel on the sideshaft that takes into the wheel on the clutch-shaft.

F. $4 \times 4 = 16$ Teeth in the wheel on the clutchshaft that takes into the wheel on the calender-roller.

G. $4 \times 4 == 16$ Teeth in the wheel on the calenderroller that takes into the wheel on the lap-roller.

Answer.

From the particulars found in the preceding example, find the draught of the lapper.

Worked out by Cancellation. 1.4 | 7.1 1.9 | 3(0.1 1.2.6.42 | 78.3 (Continued.)

```
        1·2·32
        $(0·4·2·1)

        1·2·32
        36·4·1

        1(00
        16·1

        1·26
        16·1
```

Answer.

3

The lattice-roller and lattice of a lapper are, in effect, equal to a roller 4 inches in diameter; and the lap-roller is 6.9875 inches in diameter. Suppose the lap-roller to be the driver of the lattice by a train of six pairs of wheels; the driving wheels to have respectively 9, 45, 32, 32, 100, 26, the driven wheels 30, 100, 72, 32, 15, and 16 teeth.

What would be the draught of the lapper?

Worked out by	Cancellation.
1.4	$6.9875 \cdot 2.6875$
	30.3.1
1.15.45	100.1
$1 \cdot 2 \cdot 32$	$72 \cdot 8 \cdot 2 \cdot 1$
1.32	32.1
1.100	15.1
$1 \cdot 2.6 \cdot 26$	16.1

2.6875

Answer.

THE LAPPER.

The same without Cancellation. Dividend, $6.9875 \times 30 \times 100 \times 72 \times 32 \times 15 \times 16$ Divisor, $4 \times 9 \times 45 \times 32 \times 32 \times 100 \times 26$ Answer.

The lattice and lattice-roller are, in effect, equal to a roller 4 inches in diameter; and the feed-roller is $1\frac{1}{2}$ inches in diameter. The lattice-roller has on a wheel with 30 teeth, that, by means of an intermediate, takes into a wheel with 9 teeth on the feed-roller.

Required the draught between the lattice and the feedroller.

 $2.5 \times .5 = 1.25$

Answer.

The same without Cancellation.

The calender-roller is 4, and the lap-roller 6.9875 inches in diameter. The calender-roller has on a wheel with 16 teeth, that, by means of an intermediate, takes into a wheel with 26 teeth on the lap-roller.

Required the draught between the calender-roller and the lap-roller.

Worked out by	Cancellation.
1.4	6.9875.1.075
1.6.5.26	16.4.1

1.075

Answer.

	The	ł	same	w	ith	out	Cance	llation.	
Dividen	d		•		•		6.9875	$\times 16 = 1$	075
Divisor									
								-	Answer.

The draught between the lattice and the feed-roller is 1.25, and between the calender-roller and the lap-roller, 1.075.

Required the draught between the feed-roller and the calender-roller, the total draught being 2.6875.

Worked out by	y Cancellation.
1.125	$2.6875 \cdot 2.15 \cdot 2$
1.1.075	

 $\mathbf{2}$

Answer.

30

THE LAPPER.

The same without Cancellation.

From the particulars found in the preceding example, find the total draught of the lapper.

$$2 \times 1.25 \times 1.075 = 2.6875$$

Answer.

On the same axis with the lap-roller there is a wheel with 26 teeth, that, by means of an intermediate, takes into a wheel with 16 teeth on the calender-roller. On the calender-roller there is also a wheel with 100 teeth, that takes into a wheel with 15 teeth on the clutch-shaft. On the clutch-shaft there is a pulley 25.92 inches in diameter, driven from a pulley on the first driven shaft. On the first driven shaft there is a pulley 20 inches in diameter that drives a pulley 6 inches in diameter on the same axis with the first beater.

What should be the diameter of the pulley on the first driven shaft that drives the pulley on the clutch-shaft, to drive the lap-roller 5 revolutions per minute, the first beater making 1800 in the same time?

> 25.92, Diameter of the pulley on the clutchshaft, in inches.

COTTON MANUFACTURE.

Teeth in the wheel on	26 Teeth in the wheel on
the calender - roller	the lap-roller.
that takes into the	
wheel on the lap-	
roller 16	
Teeth in the wheel on	100 Teeth in the wheel on
the clutch-shaft \cdot . 15	the calender - roller
•	that takes into the
	wheel on the clutch-
	shaft.
Diameter of the pulley	20, Diameter of the pulley
on the same axis with	on the first driven
the beater, in inches 6	shaft that drives the
•	first beater, in inches.
Revolutions per minute	5 Revolutions per minute
of the first beater, 1800	of the lap-roller.

Worked out by Cancellation.

	25.92.1.44.24.08.02
1.4.16	26
1.3.15	1(00
1.6	20.4.1
$ \begin{array}{r} 1 \cdot 4 \cdot 16 \\ 1 \cdot 3 \cdot 15 \\ 1 \cdot 6 \\ 1 \cdot 18(00) \end{array} $	5

 $26 \times 5 \times .02 = 2.6$ inches.

Answer.

THE LAPPER.

The same without Cancellation.
Dividend,
$$\frac{25.92 \times 26 \times 100 \times 20 \times 5}{16 \times 15 \times 6 \times 1800} = 2.6$$

Answer.

From the particulars found in the preceding example, find the revolutions per minute of the first beater.

Worked out by Cancellation.

 $\begin{array}{c|c} & 5 \cdot 1 \\ 1 \cdot 4 \cdot 16 & 26 \cdot 10 \\ 1 \cdot 3 \cdot 15 & 100 \\ 1 \cdot 2 \cdot 6 & 25 \cdot 92 \cdot 8 \cdot 64 \cdot 1 \cdot 44 \cdot \cdot 36 \\ 1 \cdot 6 & 20 \cdot 5 \end{array}$

 $100 \times 10 \times 5 \times .36 = 1800$

Answer.

The same without Cancellation. Dividend . . $5 \times 26 \times 100 \times 25.92 \times 20$ Divisor . . $16 \times 15 \times 2.6 \times 6$ Answer

The fan that takes the dust from a lapper is 1 yard in diameter, driven from an upright shaft making 180 revolutions per minute by a train of three pairs of pulleys and 2^* one pair of wheels. The driving wheel has 96 teeth, and the respective diameters of the driving pulleys are 40, 30, and 20 inches. How many teeth should there be in the driven wheel, and what should be the respective diameters of the driven pulleys, to give the circumference of the fan a velocity of 1728 yards per minute ?

- 180 Revolutions per minute of the upright shaft.
 - 96 Teeth in the driving wheel.
 - 40, Diameter of the first driving pulley, in inches.
 - 30, Diameter of the second driving pulley, in inches.
 - 20, Diameter of the third driving pulley, in inches.
 - 1, Diameter of the fan, in yards.
- 3.1416, Circumference.

Velocity of the circumference of the fan per minute, in yards, 1728 THE LAPPER.

Work	ed out.		
	180.15		
	96.8		
	40 .		
	30		
	20		
	1		
$1 \cdot 12 \cdot 144 \cdot 1728$	3.1416.2618		
	15		
8			
	120		
	40		
`			
	4800		
	30		
	20		
	2880000		
	.2618		
	23040000		

(Continued.)

.

COTTON MANUFACTURE.

A	•	•	4)	753	398	34.0	000
A		•	•	•	4)	188	496
A					4)47	124
		D		•	2)11	781
В		•		•	2)	589	90.5
В		•	•	•	2)2	945	5.25
В				3)14	72.	625
В	•	•	•	•	3)4	90.	875
		D	•	• '	7)1	.63.	625
	C	•	2	3.3	75)	23.	375
							1

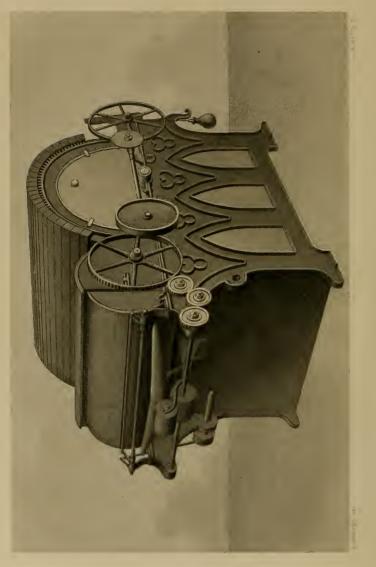
A. $4 \times 4 \times 4 = 64$ Teeth in the driven wheel.

B. $3 \times 3 \times 2 \times 2 = 36$, Diameter of the first driven pulley, in inches.

C. 23.375 === 23.375, Diameter of the second driven pulley, in inches.

D. $7 \times 2 = 14$, Diameter of the third driven pulley, in inches. Answer.

From the particulars found in the preceding example, find the velocity of the circumference of the fan per minute.



THE LAPPER.

Worked out by Cancellation.				
1·8·64 1·3·36 1·.935·4.675·23.375	180.15.3			
1.8.64	96.12			
1.3.36	40.5.1			
$1.935 \cdot 4.675 \cdot 23.375$.30.10.5			
1.2.14	20			
	1			
	3.1416.3.36.48			

 $3 \times 12 \times 5 \times 20 \times .48 = 1728$ yards.

The same without Cancellation.Dividend, $180 \times 96 \times 40 \times 30 \times 20 \times 3.1416$ 1728Divisor, $64 \times 36 \times 23.375 \times 14$ Answer.

CARDING - ENGINE.

What the Willow and Lapper perform in part, the carding-engine completes in a thorough cleansing of the cotton.

The main cylinder of a common-sized carding-engine, when carding for medium numbers, makes about 120 revolutions per minute, and contains 22 sheets of clothing, each 30×4 inches, containing 400 teeth to the square inch, and cards one pound of cotton every 20 minutes, more or less. Hence every pound of cotton is picked from the feed-rollers, fibre by fibre, by $120 \times 22 \times 30 \times 4 \times 400 \times 20 = 2534400000$ diamond-pointed teeth, which by their traction and that of the top cards, or slats, untangles the fibres, and lays them more or less parallel to each other, and by suitable apparatus, delivers them formed into a "sliver."

The main cylinder of a carding-engine is driven from an upright shaft, making 180 revolutions per minute, by a train of one pair of wheels and one pair of pulleys. The driven wheel has 96 teeth, and the driven pulley is 12 inches in diameter. How many teeth should there be in the driving wheel, and what should be the diameter of the driving pulley, to drive the main cylinder 120 revolutions per minute?

Revolutions per minute		120 Revolutions per minute		
of the upright shaft	1 80	of the main cylinder.		
		96 Teeth.in the driven		
		wheel.		
		12, Diameter of the driven		
		pulley, in inches.		

Worke	ea out.
1.3.18(0	12(0.2)
	96
	12.4

(Continued.)

96
4
384
2
B. .
$$12)\overline{768}$$

A. . . $64)\overline{64}$
1

A. 64 === 64 Teeth in the driving wheel.
B. 12 === 12, Diameter of the driving pulley, in inches.

Answer.

From the particulars found in the preceding example, find the revolutions per minute of the main cylinder.

Worked out b	y Cancellation.	
	(180.15	
1.12.96 1.12	64.8	
1.12	12.1	
15×8	==== 1 20	
		Answer.

The same without Cancellation. Dividend . . . $180 \times 64 \times 12$ Divisor . . . 96×12 = 120

Answer.

The main cylinder makes 120 revolutions per minute, and drives the doffing-cylinder by a train of two pairs of wheels. The driven wheels have each 180 teeth. How many teeth should there be in each of the driving wheels to drive the doffing-cylinder 9 revolutions per minute?

Revolutions per minute	- [9 Revolutions per minute
of the main cylinder, 19	0	of the doffing-cylin-
		der.
		180 Teeth in the first driven
		wheel.
		180 Teeth in the second
		driven wheel.

Work	ed out.
1.12(0	9
	180.15
	9 180·15 18(0
	18
	15
	90
•	18
	270
	9
(Continued.)	

CARDING-ENGINE.

Α.	•	•	•	•	1	0)2430
А.		•				3)243
В	•	•	•		•	81)81
						1

A. $10 \times 3 = 30$ Teeth in the first driving wheel. B. 81 = 81 Teeth in the second driving wheel. Answer.

From the particulars found in the preceding example, find the revolutions per minute of the doffing-cylinder.

Worked out by	y Cancellation.
	12(0.1)
1.15.180 1.9.18(0	30.2.1
1.9.18(0	81.9

9

Answer.

The	same	without	Cancellation.
Dividend			$\frac{120\times30\times81}{=9}$
			$\frac{180 \times 180}{180}$
			Answer.

The lap-roller is 41 inches in diameter, and has on a

wheel, that, by means of an intermediate, takes into a wheel with 10 teeth on the feed-roller. How many teeth should there be in the wheel on the lap-roller, and what should be the diameter of the feed-roller to produce a draught of 1.1?

4.5, Diameter of the laproller, in inches.
10 Teeth in the wheel on the feed-roller.
1.1, Draught.

Worked out.

						4.5
						10
						45.0
						1.1
						450
						450
A	•	•	•	•		3)49.50
A	•	•	•	•	•	11)16.5
	В	•		•	•	1.5)1.5
						1

A. $11 \times 3 = 33$ Teeth in the wheel on the lap-roller.

42

B. 1.5 === 1.5, Diameter of the feed-roller in inches. Answer.

From the particulars found in the preceding example, find the draught between the lap-roller and the feedroller.

> Worked out by Cancellation. 1·3·4.5 | 1.5·1

1.10 33.11.1.1

1.1

Answer.

The doffing-cylinder is 15, and the drum at the railway that drives the belt (belt included) is 10, inches in diameter. They are connected by a train of four pairs of wheels and one pair of pulleys.

Suppose the drum to be the driver, and the driving wheels to have respectively 100.70, 40, and 20 teeth, and the driving pulley to be 4 inches in diameter. How many teeth should there be in the driven wheels respectively; and what should be the diameter of the driven pulley, to produce a draught of 1.04 between the doffingcylinder and the drum at the railway?

Worke	ed out.
1(0	15
	20
	4
	40
	70
	10(0
	1.04
	1.04
	10
	10.40
	70
	728.00
	40
•	00100
	$\begin{array}{c} 29120\\ 4 \end{array}$
	110400
	116480 20
	2329600 15
-	
1	1648000 2329600
-	
Ê	34944000

CARDING-ENGINE.

			E	•	•	10)34	944000
		D			•	•	5)3	494400
A			•		•		5)	698880
A	•		•	•	•	•	2)	139776
A	•	•	•	•	•		2	2)69888
			Е	•	•	•	2	2)34944
			E	•	•	•	2	2)17472
			E	•	•	•	•	2)8736
F	3	•				•		2)4368
F	3		•	•	•			2)2184
E	3	•		•	•	•		2)1092
H	3	•		•		•		2)546
		D	• •				•	3)273
	C).						91)91
								1

A. 5 × 2 × 2 === 20 Teeth in the first driven wheel.
B. 2 × 2 × 2 × 2 === 16 Teeth in the second driven wheel.

C. 91 = 91 Teeth in the third driven wheel.

D. $5 \times 3 = 15$, Diameter of the driven pulley, in inches.

45

E. $10 \times 2 \times 2 \times 2 = 80$ Teeth in the fourth driven wheel.

From the particulars found in the preceding example, find the draught between the doffing-cylinder and the drum at the railway.

Diameter of the doffing-	
cylinder, in inches, 15	
Teeth in the fourth driv-	
ing wheel 20	
Diameter of the driving	
pulley, in inches 4	
Teeth in the third driv-	
ing wheel 40	
Teeth in the second	
driving wheel 70	
Teeth in the first driv-	
ing wheel \ldots 100	

- 10, Diameter of the drum, in inches.
- 80 Teeth in the fourth driven wheel.
- 15, Diameter of the driven pulley, in inches.
- 91 Teeth in the third driven wheel.
- 16 Teeth in the second driven wheel.
- 20 Teeth in the first driven wheel.

Worked out by Cancellation.

1.15	10.1
1.20	8(0·.2 15·1
1.4	15.1
1.40	91.13.1.3
1.7.70 1.10(0	16.4
1.10(0	20.1
	0 101

 $4 \times 1.3 \times .2 = 1.04$

Answer.

CARDING-ENGINE.

The same without Cancellation.

Dividend, $\frac{10 \times 80 \times 15 \times 91 \times 16 \times 20}{15 \times 20 \times 4 \times 40 \times 70 \times 100} = 1.04$ Answer.

The feed-roller is driven from the doffing-cylinder by a train of two pairs of wheels. The driven wheels have respectively 60 and 50 teeth. How many teeth should there be in the driving wheels to produce a draught of 80 between the lap-roller and the railway-head, allowing a draught of 1.04 at the railway, and 1.1 between the lap-roller and the feed-roller, the feed-roller being $1\frac{1}{2}$, and the doffing-cylinder 15, inches in diameter?

N.B.—In all cases where the draught of the cardingengine is mentioned in this work, the draught at the railway is included.

> Worked out. $1 \cdot 1.5 | 15 \cdot 1(0 - 60 - 50 - 1.1 - 1.1 - 1.04 \cdot .13)$

(Continued.)

60				
50				
3000				
1.1				
3000				
3000				
3300.0				
.13				
99000				
33000				
3)429.000				Ł
. 11)143			•	4
. 13)13			в	

A. $11 \times 3 = 33$ Teeth in the first driving wheel. B. 13 = 13 Teeth in the second driving wheel. Answer.

From the particulars found in the preceding example, find the draught of the card.

Diameter of the feed-		15, Diameter of the doffing
roller, in inches	1.5	• cylinder, in inches.

CARDING-ENGINE.

Teeth in the first driving wheel 13 Teeth in the second driving wheel . . . 33 60 Teeth in the first driven wheel.

- 50 Teeth in the second driven wheel.
- 1.1, Draught between the lap-roller and feedroller.
- 1.04, Draught at the railway.

Worked out by Cancellation. 1.1.5 | 15.10

	10 10
1· 13	60.2
1.30.33	50
	1.1.1
	1.04.08

 $50 \times 10 \times 2 \times .08 = 80$

Answer.

The same without Cancellation.

Dividend . . $\frac{15 \times 60 \times 50 \times 1.1 \times 1.04}{1.5 \times 13 \times 33} = 80$ Answer.

The railway-head treated on below has four pairs of 3

rollers with "Draper's Patent Evener" attached, adapted for 12 eards.

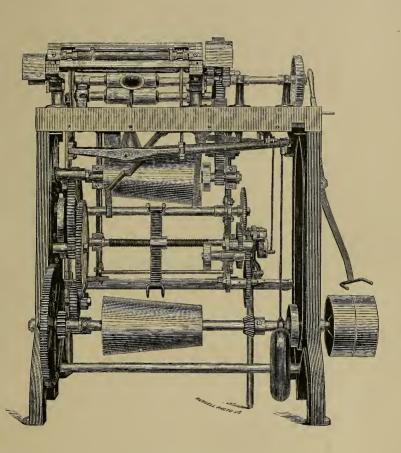
The roller next to the front-roller is called the frontmiddle-roller, and the roller next to the back-roller is called the back-middle-roller.

The front-roller is driven from the back-roller by a train of three pairs of wheels, and one pair of cones. The back-middle-roller and the front-middle-roller are each driven from the back-roller by an intermediate wheel.

The tube through which the sliver passes, and the apparatus for moving the belt on the cones, are so adjusted, that, if the fleece delivered from one of the cards should break, they will cause the belt to move from the large end of the driving cone sufficient to reduce the speed of the front-roller $\frac{1}{12}$; and, if the fleece should break from two cards, $\frac{2}{12}$, etc., etc.,—thus keeping the sliver delivered of a uniform size.

RAILWAY-HEAD.

The front-roller is $1\frac{1}{4}$ inches in diameter, and has on a wheel, that, by means of an intermediate, takes into a wheel with 80 teeth on the same axis with the delivering balls. How many teeth should there be in the wheel on the front-roller, and what should be the diameter of the delivering balls, to produce a draught of 1.02 ?



DRAPER'S RAILWAY HEAD.

Worke	ed out.	•		
	1.02			
	1.02 1.25 80			
	80			

1.25				
80				
100.00				
1.02				
20000				
100000				
3)102.0000	•	•	•	В
34)34	•			Α.

A. 34 == 34 Teeth in the wheel on the front-roller.
B. 3 == 3, Diameter of the delivering balls, in inches. Answer.

The front-roller is $1\frac{1}{4}$, and the delivering balls 3, inches in diameter. The front-roller has on a wheel with 34 teeth, that, by means of an intermediate, takes into a wheel with 80 teeth, on the same axis with the delivering balls. Required the draught.

Diameter of the front-	3, Diameter of the deliver-
roller, in inches, 1.25	ing balls, in inches.
Teeth in the wheel on	34 Teeth in the wheel on
the same axis with	the front-roller.
the delivering balls, 80	

Worked out by Cancellation. 1.1.25 | 3.2.4.03

1.23 | 3.2.4.03 | 1.80 | 34

 $34 \times .03 = 1.02$

Answer.

The same without Cancellation.

Dividend	•	•	•	•	•	$\frac{3 \times 34}{} = 1.02$
Divisor .						
						Answer.

The front-roller is driven from the back-roller by a train of 3 pairs of wheels, and one pair of cones. The driven wheels have respectively 100, 18, and 51 teeth; and the driven cone is 3 inches in diameter at the small end.

How many teeth should there be in the driving wheels respectively, and what should be the diameter of the large end of the driving cone, to produce a draught of 2 at the railway-head, allowing a draught of 1.02 between the

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front-roller and the delivering balls, the front-roller being 14, and the back-roller, 1 inch in diameter?

N.B.—The belt is always at the large end of the driving cone, and, of course, at the small end of the driven cone, when the cards are utilizing their maximum quantity.

> *Worked* out. 1.1.02 | 2

A		•	•	•	•	10)432000
	ł	3	•	•	•	•	5)43200
	F	3	•	•	•	•	5)8640
A		•	•	•	•	•	2)1728
A		•	•	•	•	•	. 2)864
A		•	•	•	•	•	. 2)432
			D				. 2)216
			D	•			. 2)108
			D				. 2)54
			D	•		•	. 2)27
	F	3		•			3)13.5
		C		•	•		4.5)4.5
							1

A. $10 \times 2 \times 2 \times 2 = 80$ Teeth in the first driving wheel.

B. $5 \times 5 \times 3 = 75$ Teeth in the second driving wheel.

C. $4.5 = 4\frac{1}{2}$, Diameter of the large end of the driving cone, in inches.

D. $2 \times 2 \times 2 \times 2 = 16$ Teeth in the third driving wheel Answer.

From the particulars found in the preceding example, find the total draught at the railway-head.

	1.02, Draught between the
	front-roller and de-
	livering balls.
Diameter of the back-	1.25, Diameter of the front-
roller, in inches 1	roller, in inches.
Teeth in the first driven	80 Teeth in the first driv-
wheel 100	ing wheel.
Teeth in the second	75 Teeth in the second
driven wheel 18	driving wheel.
Diameter of the small	4.5, Diameter of the large
end of the driven	end of the driving
cone, in inches 3	cone, in inches.
Teeth in the third driv-	16 Teeth in the third
en wheel 51	driving wheel.

Worked out by Cancellation.

	1.02.02
1	1.25
1.5.1 00	80.4.1
$1 \cdot 4 \cdot 18$	$75 \cdot 15 \cdot 5$
1.3	$4.5 \cdot 1$
1.51	16

 $16 \times 5 \times 1.25 \times .02 = 2$

Answer.

The same without Cancellation. Dividend, $\frac{1.02 \times 1.25 \times 80 \times 75 \times 4.5 \times 16}{100 \times 18 \times 3 \times 51} = 2$ Answer.

From the particulars given to find the draught between the back-roller and the front-roller, and the particulars given to find the draught between the front-roller and the delivering balls, find the total draught.

Worked out by Cancellation.

1.1.25	3.1
1 .80	34.1
1	$1.25 \cdot 1$
1.100	80.1
1.4.18	75.75.5
1.3	$4.5 \cdot 1$
1.1.5.51	16.4

 $4 \times .5 = 2$

Answer.

 $\begin{array}{c} \text{The same without Cancellation.} \\ \text{Dividend,} \quad \frac{3 \times 34 \times 1.25 \times 80 \times 75 \times 4.5 \times 16}{1.25 \times 80 \times 100 \times 18 \times 3 \times 51} = 2 \\ \text{Answer.} \end{array}$

RAILWAY-HEAD.

From the particulars found in the preceding example, find the draught between the back and the front rollers.

> Worked out by Cancellation. 1 | 1.25 1.5.100 | 80.4.1

 $1.25 \times 5 \times .3_{\frac{7}{51}} = 1.96_{\frac{4}{51}}$

Answer.

The same without Cancellation.

Dividend, $\frac{1.25 \times 80 \times 75 \times 4.5 \times 16}{100 \times 18 \times 3 \times 51} = 1.96_{\frac{4}{51}}$ Answer.

The back and the back-middle rollers are each 1 inch in diameter. The back-roller has on a wheel with 21 teeth. How many teeth should there be in the wheel on the backmiddle-roller to produce a draught of 1.05?

> Worked out by Cancellation. 1.1.05 | 21.20

> > 20

Answer.

From the particulars found in the preceding example, find the draught between the back-roller and the backmiddle-roller.

Worked	out by Cancellation.
	1.20 21.1.05
	1.05

Answer.

The back-roller and the front-middle-rollers are each 1 inch in diameter. The front-middle-roller has on a wheel with 20 teeth. How many teeth should there be in the wheel on the back-roller to produce a draught of 1.25?

 $20 \times 1.25 = 25$

Answer.

From the particulars found in the preceding example, find the draught between the back-roller and the frontmiddle-roller.

> Worked out by Cancellation. 1.20 | 25.1.25

> > 1.25

Answer.

From the wheels given to find the draught between the

58

back-roller and the back-middle-roller; and the wheels given to find the draught between the back-roller and the front-middle-roller, find the draught between the back-middle-roller and the front-middle-roller.

Worked	out b	y Cancellation.
	1·2 0	$25 \cdot 1.19 \frac{1}{21}$
	1.21	20.1

 $1.19\frac{1}{21}$

Answer.

	The	?	sam	ie	wit	thou	ut	Cancellation.
Divid	end			•	•	•		$\frac{25 \times 20}{21} = 1.19\frac{1}{21}$
Diviso	or							$\frac{1}{21 \times 20} = 1.10_{21}$
								Answer.

From the particulars given to find the total draught, and the particulars given to find the draught between the front-roller and the back-roller, find the draught between the front-roller and the delivering balls.

Worked out by Cancellation.

1:51	16.1
1.1.25	1
1.80	100.1
1.75	18.1
1.4.5	3.1
1.16	51.1

1.02

Answer.

 $\begin{array}{r} The \ same \ without \ Cancellation.\\ \underline{1.02 \times 1.25 \times 80 \times 75 \times 4.5 \times 16 \times 100 \times 18 \times 3 \times 51}_{100 \times 18 \times 3 \times 51 \times 1.25 \times 80 \times 75 \times 4.5 \times 16}\\ = 1.02 \qquad \text{Answer.} \end{array}$

N.B.—The above result will be obtained by dividing the total draught by the draught between the back-roller and the front-roller. See the following example.

The draught between the back and front rollers is $1.96\frac{4}{51}$, and the total draught is 2. Required the draught between the delivering balls and the front-roller.

Worked out by	y Cancellation.	
N.B.—1.96	$\frac{4}{51} = \frac{100}{51}$.	
	$2 51 \cdot .51$	
1.100	51.51	
$2 \times .51$:	<u> </u>	Answer.

The same without Cancellation. Dividend $\dots \dots \dots \dots \frac{51 \times 2}{100} = 1.02$ Divisor $\dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots$ Answer.

From the particulars given to find the total draught, the draught between the front-roller and the delivering balls, and the draught between the back-roller and the front-middle-roller, find the draught between the frontmiddle-roller and the front-roller.

Worked out by Cancellation.

1.1.25	3.1
1 .80	34.1
1	$1.25 \cdot 1$
1(00	80 ·1
1.4.18	$75 \cdot 3 \cdot 1$
1.3	4.5.1
1.51	16.4
1.3	1.25
1.34	$8(0 \cdot \frac{8}{51})$
1.25	2(0

 $4 \times 1.25 \times 2 \times \frac{8}{51} = 1.56\frac{44}{51}$

Answer.

The same without Cancellation.

$$3 \times 34 \times 1.25 \times 80 \times 75 \times 4.5 \times 16 \times 1.25 \times 80 \times 20$$

$$1.25 \times 80 \times 100 \times 18 \times 3 \times 51 \times 3 \times 34 \times 25$$

$$= 1.56^{44}_{51}$$
Answer.

The draught between the delivering balls and the frontroller is 1.02, and the draught between the back-roller and the front-middle-roller is 1.25. Required the draught between the front-middle-roller and the front-roller, the total draught being 2.

Worked out	by Cancellation.
	$2 \cdot 1.6 \cdot 1.56 \frac{4}{51}$
1.1.02 1.1.25	
1.1.25	

1.5655

Answer.

The same without Cancellation.Dividend
$$\cdot$$
 \cdot $\frac{2}{2}$ $=1.56_{\frac{44}{51}}$ Divisor \cdot \cdot \cdot 1.25×1.02 Answer.

The draught between the back-middle-roller and the back-roller is 1.05. The draught between the back-middle and the front-middle-roller $1.19_{2^{1}I}$. The draught

between the front-middle-roller and the front-roller is 1.56[§]⁴. The draught between the front-roller and the delivering balls is 1.02.

Required the total draught.

N.B.—1.19¹/₂₁ === ²⁵/₂₁ 1.56⁴⁴/₅₁ === ⁸⁹/₅₁ Worked out by Cancellation. | 1.05.05

1·21 25 1·51 80 1.02·.02

 $80 \times 25 \times .05 \times .02 = 2$

Answer.

The same without Cancellation. Dividend . . . $1.05 \times 25 \times 80 \times 1.02 = 2$ Divisor 51×21 Answer.

The can that receives the sliver stands upon and revolves with the disc, and, in practice, it is found that the velocity of its circumference should be to that of the delivering balls as 1 to 8.

The delivering balls are 3 inches in diameter, and drive the disc by a train of 2 pairs of wheels. The driven wheels have respectively 24 and 180 teeth. How many teeth should there be in the driving wheels respectively, and what should be the diameter of the can, to give its circumference a velocity $\frac{1}{8}$ of that of the delivering balls?

	Worked out.
	1.8 1
	3
	24.3
	180
4	180
	3
	540
	3
	B 2) 1620
	C 2)810
	$C 3)\overline{405}$
	C 3)135
	$\mathbf{B} \dots 3)45$
	A $^{3)15}$
	A
	1

64

A. $5 \times 3 = 15$ Teeth in the first driving wheel. B. $3 \times 2 = 6$ Teeth in the second driving wheel. C. $3 \times 3 \times 2 = 18$, Diameter of the can, in inches. Answer.

From the particulars found in the preceding example, find the ratio of velocity of the circumference of the delivering balls to that of the can, supposing that of the can to be 1:

L

		circumference of the
		can.
Diameter of the can, in		3, Diameter of the deliv-
inches	18	ering balls, in inches.
Teeth in the first driv-		24 Teeth in the first driv-
ing wheel	15	en wheel.
Teeth in the second		180 Teeth in the second
driving wheel	6	driven wheel or disc.

Worked out by Cancellation.

8

	1
1.18	3.1
1.3.15	24.8
$1 \cdot 2 \cdot 6$	$ 1 \\ 3.1 \\ 24.8 \\ 180.10.5.1 $

Answer.

1 Ratio of velocity of the

The same without Cancellation. Dividend $\cdot \cdot \cdot \cdot \frac{3 \times 24 \times 180}{18 \times 15 \times 6} = 8$ Answer.

DRAWING-FRAME.

As has been shown, the object attained by the previous processes in the carding department is a thorough cleansing of the cotton, untangling its fibres, laying them more or less parallel with each other, and forming them into a sliver.

The object to be attained at the drawing-frame is to repeatedly double and draw the slivers until they mutually correct any unevenness that may have occurred in their formation, and lay the fibres perfectly parallel with each other and the sliver.

The front-roller at the drawing frame is $1\frac{1}{4}$, and the delivering balls 3 inches in diameter. The front-roller has on a wheel with 27 teeth, that, by means of an intermediate, takes into the wheel on the same axis with the delivering balls. How many teeth should there be in the wheel on the same axis with the delivering balls to produce a draught of 1.08?

Diameter of the front-	3, Diameter of the deliv-
roller, in inches 1.25	ering balls, in inches.

27 Teeth in the wheel on the front-roller.

Worked out by	/ Cancellation.
1.1.25	3
	3 27·21.6·20
1.1.08	
20 × 3:	End for the second seco
The same without	ut Cancellation.
Dividend	$ 27 \times 3 - 60$
Dividend Divisor	$\frac{1.08 \times 1.25}{\text{Answer.}}$

From the particulars found in the preceding example, find the draught between the front-roller and the delivering balls.

Wa	orked out 1·1.25 1·20·60	•	ncellation. 1.6·1.08	
]	1.08		Answer.
The	same wit	hout C	ancellation.	
1 ne				
			27×3 =	1.08

The front-roller is $1\frac{1}{4}$, and the back-roller is 1 inch in diameter. The front-roller wheel has 27 and the change wheel 36 teeth. How many teeth should there be in the top-carrier and the back-roller wheel to produce a draught of 4 at the drawing head, the draught between the frontroller and the delivering balls being 1.08 ?

Diameter of the front-	1, Diameter of the back-
roller, in inches 1.25	roller, in inches.
	27 Teeth in the wheel on
	the front-roller.
	36 Teeth in the change
	wheel.
Draught between the	4, Total draught.
front-roller and the	
delivering balls 1.08	

	ed out.
1.1.25	1 27·25·20 36 4
	27.25.20
	36
1.1.08	4
	36
	20
	720 (Continued.)

				$720 \\ 4$	
В				10)2880	
В	•	•		. 4)288	
A .	•	•	•	. 72)72	
				1	

A. 72 = 72 Teeth in the top-carrier. B. $10 \times 4 = 40$ Teeth in the back-roller wheel. Answer.

From the particulars found in the preceding example, find the total draught at the drawing head.

	/ Cancellation.
1	1.25
1·3 6	40
1.27	72.2
	1.254072.21.08.04

 $40 \times 2 \times 1.25 \times .04 == 4$

Answer.

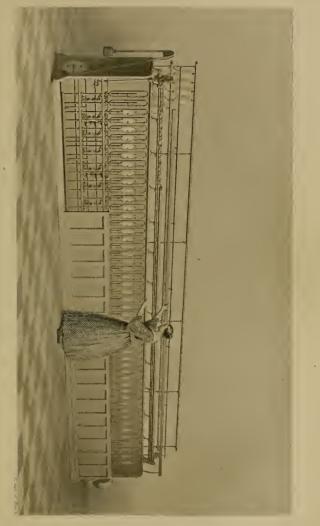
The same without Cancellation. Dividend . . $\frac{1.25 \times 40 \times 72 \times 1.08}{36 \times 27} = 4$ Answer.

COTTON MANUFACTURE.

BOBBIN AND FLY-FRAME.

An upright shaft makes 180 revolutions per minute, and has on a wheel that takes into a wheel with 96 teeth on a lying shaft. On the lying shaft there is a pulley that drives a pulley 16 inches in diameter on a countershaft. On the countershaft there is a pulley that drives a pulley 10 inches in diameter on the first driven shaft of the fly-frame. How many teeth should there be in the wheel on the upright shaft, and what should be the diameter of the driving pulleys on the lying and the countershafts to drive the first driven shaft 288 revolutions per minute?

Revolutions per minute	288 Revolutions per minute
of the upright shaft, 180	of the first driven
	shaft.
	96 Teeth in the wheel on
	the lying shaft.
	16, Diameter of the driven
	pulley on the coun-
	tershaft, in inches
	10, Diameter of the pulley
	on the first driven
	shaft of the fly-frame,
	in inches.
Constant of the second descent of the second s	



WAMES S BROWN'S PATENT SPIEDER



Worke	ed out.
1·3·1 8(0	288.96
	96.16
	16
	1(0
4	96
·	16
	a C
	576
	96
	1500
	1536
	16
	9216
	1536
Α	. 8)24576
в.,	. 6)3072
Α	8)512
в	4)64
О	16)16
0	
	1

A. $8 \times 8 = 64$ Teeth in the wheel on the upright shaft.

B. $6 \times 4 = 24$, Diameter of the driving pulley on the lying shaft, in inches.

C. 16 = 16, Diameter of the driving pulley on the countershaft, in inches.

Answer.

From the particulars found in the preceding example, find the revolutions per minute of the first driven shaft of the fly-frame.

Worked out by	
	18(0
1.8. 96	64.8
1.16	24.2
1·8·96 1·16 1(0	16.1
	····

 $18 \times 8 \times 2 = 288$

Answer.

The same without Cancellation. Dividend . . . $180 \times 64 \times 24 \times 16 = 288$ Divisor . . . $96 \times 16 \times 10$ Answer.

The first driven shaft of the fly-frame makes 288 revolutions per minute, and has on a wheel that takes into a wheel with 42 teeth on the spindle-shaft. On the spindleshaft there is a wheel that takes into a wheel with 24 teeth on the spindle. How many teeth should there be in the wheel on the first driven shaft, and the driving wheel on the spindle-shaft, to drive the spindles 720 revolutions per minute?

Revolutions per minute of the first driven shaft of the fly-frame, 288

- 720 Revolutions per minute of the spindles.
 - 42 Teeth in the driven wheel on the spindle shaft.
 - 24 Teeth in the wheel on the spindle.

Worked out.

1·24·288 | 720·60 | 42 | 24·1

					$\begin{array}{c} 42 \\ 60 \end{array}$
А.	•	•	•		10)2520
А.	•	•	•	•	. 7)252
В			•	•	. 36)36
					1

A. $10 \times 7 = 70$ Teeth in the wheel on the first driven shaft of the fly-frame.

B. 36 = 36 Teeth in the driving wheel on the spindle shaft.

Answer.

The first driven shaft makes 288 revolutions per minute, and has on a wheel with 70 teeth that takes into a wheel with 42 teeth on the spindle-shaft. On the spindle-shaft there is also a wheel with 36 teeth that takes into a wheel with 24 teeth on the spindle. How many revolutions per minute does the spindle make ?

		288 Revolutions per minute
		of the first driven
		shaft.
Teeth in the driven		70 Teeth in the wheel on
wheel on the spindle-		the first driven shaft.
shaft	42	36 Teeth in the driving
Teeth in the wheel on		wheel on the spindle-
the spindle	24	shaft.

Workea	l out	by C	lancell	lation.
--------	-------	------	---------	---------

	288·4 8
1.6.42	70.10.5 36.3
$1 \cdot 2 \cdot 24$	36•3

 $48 \times 5 \times 3 = 720$

Answer.

BOBBIN AND FLY-FRAME.

The same without Cancellation. Dividend $\cdot \cdot \cdot \frac{288 \times 70 \times 36}{42 \times 24} = 720$ Answer.

In treating on the epicyclic train of wheels, or what is technically called the differential coupling, it has been thought best to name each wheel and its use. The object to be obtained by the differential coupling is gradually to increase the speed of the bobbin at the same rate as its diameter increases, since it is essential that the bobbin and the front-roller have equal surface velocities.

The train of wheels in the differential coupling are 5 in number, 3 of which are on the same axis with the first driven shaft. The first wheel is made fast to the first driven shaft, and is called the fast internal wheel. The second or middle wheel revolves loose upon the first driven shaft, and is called the differential wheel. The third wheel is made fast to a hollow cylinder that revolves loose upon the first driven shaft, and is called the loose internal wheel. The other two (only one of which is necessary) are intermediate or carrying wheels, connecting the fast and loose internal wheels : they are fast to, and have their axis in the plane of the differential wheel. The fast and loose internal wheels are both of the same dimensions, and need not be taken into ac-

75

count; but there is a wheel outside of the differential coupling, called the external wheel, that is made fast to the same hollow cylinder as the loose internal wheel, which, with the differential wheel, will be found in the following examples, and will answer every purpose for calculating anything pertaining to the differential coupling.

It is obvious that if the differential wheel were held fast, the external wheel and the fast and loose internal wheels would all revolve at the same speed, and that, if it were made to revolve at the same speed as the fast internal wheel, the external wheel would stand still. Hence it is by having the differential wheel revolve in the same direction as the fast internal wheel, but at a slower rate, equal to the difference in speed between the flyer and the bobbin, that the surface velocity of the bobbin is made to keep pace with that of the front-roller.

N.B.—In the following example, the differential wheel is supposed to stand still.

The external wheel makes 288 revolutions per minute, and takes into a wheel with 42 teeth on the bobbin-shaft. On the bobbin-shaft there is a wheel that takes into a wheel with 40 teeth, to which the bobbin is made fast. How many teeth should there be in the external wheel, and the driving wheel on the bobbin-shaft, to drive the bobbin 720 revolutions per minute?

Revolutions per minute of the external wheel, 288

- 720 Revolutions per minute of the bobbin.
 - 42 Teeth in the driven wheel on the bobbinshaft.
 - 40 Teeth in the wheel to which the bobbin is made fast.

Worked out. 1.2.24.288 | 720.60.5 42.21 40

21					
5					
105					
40					
10)4200	•	•	•	•	А.
10)420	•	•	•	•	Α.
. 42)42	•	•	•	•	В
1					

A. $10 \times 10 = 100$ Teeth in the external wheel.

B. 42 === 42 Teeth in the driving wheel on the bobbin-shaft. Answer.

N.B.—In the following example the differential wheel is supposed to stand still.

The external wheel makes 288 revolutions per minute, has 100 teeth, and takes into a wheel with 42 teeth on the bobbin-shaft. On the bobbin-shaft there is also a wheel with 42 teeth that takes into a wheel with 40 teeth, to which the bobbin is made fast. How many revolutions per minute does the bobbin make?

1 288 Revolutions per minute

· · · · · · · · · · · · · · · · · · ·	
	of the external wheel.
Teeth in the driven	100 Teeth in the external
wheel on the bobbin-	wheel.
shaft 4	2
Teeth in the wheel to	42 Teeth in the driving
which the bobbin is	wheel on the bobbin-
made fast 4	0 shaft.

Worked out by Cancellation.

78

BOBBIN AND FLY-FRAME.

The same without Cancellation.

Dividend . . . $\frac{288 \times 100 \times 42}{42 \times 40} = 720$ Answer.

The first driven shaft makes 288 revolutions per minute, and has on a wheel with 20 teeth, that takes into a wheel on the grooved shaft. On the other end of the grooved shaft there is a wheel with 100 teeth, that takes into a wheel on the front-roller. How many teeth should there be in the wheel on the grooved shaft, that takes into the wheel on the first driven shaft, and the wheel on the front-roller, to drive the front-roller 96 revolutions per minute?

Revolutions per minute of the front-roller . 96

- 288 Revolutions per minute of the first driven shaft.
 - 20 Teeth in the wheel on the first driven shaft.
- 100 Teeth in the wheel that takes into the wheel on the frontroller.

Worked out.			
$1.8.96 \mid 288.24.3$			
20			
100			
20			
3			
$\frac{1}{60}$			
100			
A 10)6000			
A 10)600			
B 60)60			
1			

A. $10 \times 10 = 100$ Teeth in the wheel on the front-roller.

B. 60 = 60 Teeth in the driven wheel on the grooved shaft. Answer.

The first driven shaft makes 288 revolutions per minute, and has on a wheel with 20 teeth that takes into a wheel with 60 teeth on the grooved shaft. On the other end of the grooved shaft there is a wheel with 100 teeth, that takes into a wheel with 100 teeth on the front-roller. How many revolutions per minute does the front-roller make?

. 2

* **x**



BOBBIN AND FLY-FRAME.

288 Revolutions per minute of the first driven shaft.

Teeth in the driven wheel on the grooved shaft 60 Teeth in the wheel on the front-roller . . 100 20 Teeth in the wheel on the first driven shaft.100 Teeth in the driving

wheel on the grooved shaft.

Worked out by Cancellation.

 $48 \times 2 = 96$

Answer.

The same without Cancellation.Dividend \cdot \cdot $\frac{288 \times 20 \times 100}{100 \times 60} = 96$ Divisor \cdot \cdot \cdot 100×60

Answer.

The front-roller is 14 inches in diameter, and makes 96 revolutions per minute, and the spindle makes 720 revolutions per minute. How many turns of twist per inch is there in the roving?

4*

Revolutions per minute	720 Revolutions per minute
of the front-roller . 96	of the spindle.
Diameter of the front-	
roller, in inches 1.25	
Ratio of circumference	
to diameter 3.1416	

Worked out by Cancellation. 1.8.96 | 720.60.7.5.6.1.9 1.1.25 1.3.1416 |

1.9

Answer.

r.

The	same	without	Cancellation.	
Dividend			720	1 9
Divisor .		96	imes 1.25 $ imes$ 3.1416	
				Answei

The spindle makes 720 and the front-roller 96 revolutions per minute. How many revolutions does the spindle make while the front-roller makes 1?

> Worked out by Cancellation. 1.8.96 | 720.60.7.5

> > 7.5

Answer.

N.B.—If it is admitted that the diameter of the empty bobbin is equal to that of the front-roller, the spindle making $7\frac{1}{2}$, while the front-roller makes 1 revolution, it will be evident that the bobbin will have to make 1 revolution less than the spindle in the same time, in order to wind on the roving as fast as it is delivered by the frontroller (making no allowance for shrinkage in twisting), until the first layer is wound on to the bobbin; therefore the bobbin will make $6\frac{1}{2}$, while the spindle makes $7\frac{1}{2}$ revolutions.

If the bobbin makes $6\frac{1}{2}$, while the spindle makes $7\frac{1}{2}$ revolutions, how many revolutions per minute will the bobbin make, if the spindle makes 720?

Worked out by	y Cancellation.
	720.2400
1.3.1.5.7.5	$6.5 \cdot 1.3 \cdot .26$

 $2400 \times .26 = 624$

Answer.

The same without Cancellation.

The bobbin makes 624 revolutions per minute, while winding on the first layer of roving. The wheel to which the bobbin is made fast has 40 teeth, and takes into a wheel with 42 teeth on the bobbin-shaft. On the bobbinshaft there is also a wheel with 42 teeth that takes into the external wheel, which has 100 teeth. How many revolutions per minute does the external wheel make ?

- Teeth in the wheel on the bobbin-shaft that takes into the wheel to which the bobbin is made fast, 42 Teeth in the external wheel 100
- 624 Revolutions per minute of the bobbin.
 - 40 Teeth in the wheel to which the bobbin is made fast.
 - 42 Teeth in the wheel on the bobbin-shaft that takes into the external wheel.

Worked out by Cancellation.				
	624			
1.42	624 4(0·.4 42·1 ~			
1.10(0	42·1 -			
624×.4=	<u>249.6</u> Answer.			
The same witho	ut Cancellation.			
Dividend	$. \underbrace{624 \times 40 \times 42}_{= 249.6}$			
Divisor	$. 100 \times 42$			
	Answer.			

The first driven shaft makes 288, and the external wheel 249.6 revolutions per minute, while winding the first layer of roving on to the bobbin. How many revolutions per minute has the external wheel been retarded, admitting that it would have revolved at the same speed as the first driven shaft, if the differential wheel had stood still?

22

88.0	
49.6	
38.4	A

The wheel to which the bobbin is made fast has 40 teeth, and takes into a wheel with 42 teeth on the bobbinshaft. On the bobbin-shaft there is also a wheel with 42 teeth that takes into the external wheel, which has 100 teeth. The differential wheel retards the external wheel 38.4 revolutions per minute. How many revolutions per minute is the bobbin retarded?

	38.4 Revolutions per minute
	that the external
	wheel is retarded.
eeth in the wheel on	100 Teeth in the external
the bobbin-shaft that	wheel.
takes into the exter-	
nal wheel 42	
(Conti	nued.)

Te

nswer.

Teeth in the wheel to which the bobbin-shaft is made fast . . . 40 42 Teeth in the wheel on the bobbin-shaft that takes into the wheel to which the bobbin is made fast.

Worked out by Cancellation.

 $\begin{array}{c|c} & 38.4 \\ 1 \cdot 42 & 10(0 \cdot 2.5 \\ 1 \cdot 4(0 & 42 \cdot 1 \end{array}$

 $38.4 \times 2.5 = 96$

Answer.

-	The	sa	me	w	itho	out Cancellation.	
Dividen	d.		•		•	$\frac{38.4 \times 100 \times 42}{96} = 96$	
						$\frac{1}{42 \times 40}$	
						Answei	r.

N.B.—It will be observed from the above that the bobbin, while winding on the first layer of roving, is retarded exactly the same number of revolutions per minute as the front-roller makes, which is right (making no allowance for shrinkage in twisting), because the empty bobbin and the front-roller are both of the same dimensions, and the winding on is effected by the bobbin falling behind the spindle. The first driven shaft makes 288 revolutions per minute, and has on a wheel with 20 teeth that takes into a wheel with 60 teeth on the grooved shaft. On the grooved shaft there is a pulley 5 inches in diameter that drives the cone at the small end.

On the same axis with the cone there is a wheel with 54 teeth that takes into a wheel on a short shaft. On the other end of the short shaft there is a wheel with 32 teeth that takes into the differential wheel. How many teeth should there be in the driven wheel on the short shaft and the differential wheel, and what should be the diameter of the small end of the cone, to drive the differential wheel 38.4 revolutions per minute ?

N.B.—The belt is always at the small end of the cone at the commencement of the bobbin, when the winding on is effected by the bobbin falling behind the spindle; and every time the differential wheel makes one revolution, it reduces that of the external wheel the same.

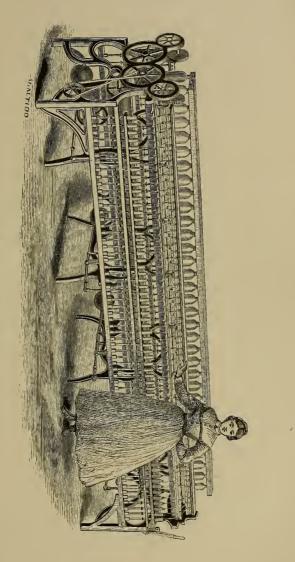
- 288 Revolutions per minute of the first driven shaft.
 - 20 Teeth in the wheel on the first driven shaft.
 - 5 Diameter of the pulley on the grooved shaft, in inches.

COTTON MANUFACTURE.

54	Teeth in the wheel
	the same axis w
	the cone.
32	Teeth in the wheel t
	takes into the dif
	ential wheel.

1.3.2.38.4	
1.3.60	20.1
	5
	54
	$32 \cdot 10$

					54
					10
					540
					5
					2700
					8
	~				
	С	•	•	•	10)21600
B	;.				10)2160
					0)010
A		•	•	•	. 2)216
	С				. 2)108
D					0)54
B_{α}		•	2)	•	. 2)54
Con	vin	ue	a.)		



FALES & JENKS' SPINNING FRAME.

BOBBIN AND FLY-FRAME.

В.	•	•	•	•		3)27
C					•	3)9
C	•				•	3)3
						1

A. 2 = 2 Diameter of the small end of the cone, in inches.

B. $10 \times 2 \times 3 = 60$ Teeth in the driven wheel on the short shaft.

C. $10 \times 2 \times 3 \times 3 = 180$ Teeth in the differential wheel.

Answer.

The first driven shaft makes 288 revolutions per minute, and has on a wheel with 20 teeth that takes into a wheel with 60 teeth, on the grooved shaft. On the grooved shaft there is a pulley 5 inches in diameter, that drives the cone at the small end, which is 2 inches in diameter. On the same axis with the cone there is a wheel with 54 teeth that takes into a wheel with 60 teeth, on a short shaft. On the other end of the short shaft there is a wheel with 32 teeth, that takes into the differential wheel, which has 180 teeth. How many revolutions per minute does the differential wheel make?

COTTON MANUFACTURE.

Teeth	\mathbf{in}	\mathbf{the}	wheel	on	
the	gro	oved	l shaft	•	60

- Diameter of the small end of the cone, in inches 2 Teeth in the driven wheel, on the short shaft 60 Teeth in the differential wheel 180
- 288 Revolutions per minute of the first driven shaft.
 - 20 Teeth in the wheel, on the first driven shaft.
 - 5 Diameter of the pulley on the grooved shaft, in inches.
 - 54 Teeth in the wheel on the same axis with the cone.
 - 32 Teeth in the wheel that takes into the differential wheel.

Worked out by Cancellation. $1.3.60$ $288.24.8.4.1$ $1.3.60$ 20.1 1.2 5.1 $1.5.60$ 54.6 $1.5.20.180$ $32.6.4$					
	$288 \cdot 24 \cdot 8 \cdot 4 \cdot 1$				
1.3.60	20.1				
1.2	5.1				
1.5.60	54.6				
1.5.20.180	32.6.4				

 $6.4 \times 6 = 38.4$ Answer.

The same without Cancellation. Dividend . . $\frac{288 \times 20 \times 5 \times 54 \times 32}{60 \times 2 \times 60 \times 180} = 38.4$

Answer.

The first driven shaft makes 288 revolutions per minute, and has on a wheel with 20 teeth that takes into a wheel with 60 teeth, on the grooved shaft. On the grooved shaft there is a pulley 5 inches in diameter that drives the cone at the small end, which is 2 inches in diameter. On the same axis with the cone there is a wheel with 54 teeth, that takes into a wheel with 60 teeth, on a short shaft. On the other end of the short shaft there is a wheel with 32 teeth, that takes into the differential wheel, which has 180 teeth. The external wheel has 100 teeth and takes into a wheel with 42 teeth, on the bobbin shaft. On the bobbin shaft there is also a wheel with 42 teeth, that takes into a wheel with 40 teeth, to which the bobbin is made fast. How many revolutions per minute is the bobbin retarded ?

N.B.—The above includes the whole train of wheels, pulley, and cone leading from the first driven shaft through the differential coupling to the bobbin.

ofTeeth in the wheel, onthe grooved shaft60Diameter of the small615000<t

- 288 Revolutions per minute of the first driven shaft.
 - 20 Teeth in the wheel, on the first driven shaft.
 - 5 Diameter of the pulley on the grooved shaft, in inches.

Teeth in the driven	54 Teeth in the wheel, on
wheel, on the short	the same axis with
shaft 60	the cone.
Teeth in the differen-	32 Teeth in the wheel that
tial wheel 180	takes into the differ-
	ential wheel.
Teeth in the driven	100 Teeth in the external
wheel, on the bobbin	wheel.
shaft 42	
Teeth in the wheel to	42 Teeth in the driving
which the bobbin is	wheel, on the bobbin
made fast 40	shaft.

Worked out by Cancellation.

	288.24.6.3
1.6(0 1.2	20.1
1.2	5.1
1.5. 60	54.9.1
1.20.180	32
1.42	1(00
1.4(0	42.1
32×3	——96 Answer.

The .	same	without	Cancellation.
-------	------	---------	---------------

Dividend	$\frac{288 \times 20 \times 5 \times 54 \times 32 \times 100 \times 42}{= 96}$
Divisor .	$60 \times 2 \times 60 \times 180 \times 42 \times 40$

Answer.

From the revolutions per minute of the front-roller, and the train of wheels, and the pulley and cone leading from the front-roller to the bobbin, find how many revolutions per minute the bobbin is retarded.

Worked out by Cancellation.

	96
1.100	100.1
$1 \cdot 2$	5.1
1.2.10.60	54.6.1
1.2.18(0	$32 \cdot 16 \cdot 4 \cdot 2 \cdot 1$
1.42	1(00
1.4(0)	42.1

96

Answer.

The same without Cancellation.

Dividend $\underbrace{96 \times 100 \times 5 \times 54 \times 32 \times 100 \times 42}_{\text{Divisor}} = 96$

Answer.

N.B.—Every time the bobbin is retarded or falls behind the spindle one revolution, it laps the roving once round the bobbin; consequently, the front-roller and empty bobbin both being of the same dimensions, the front-roller making 96 revolutions per minute, and the bobbin falling behind the spindle 96 revolutions per minute, the roving will be wound on to the bobbin as fast as it is delivered from the front-roller (making no allowance for shrinkage in twisting).

The front-roller wheel has 30 and the change-wheel 32 teeth, and the back-roller is one inch in diameter. How many teeth should there be in the top-carrier and the back-roller wheel, and what should be the diameter of the front-roller to produce a draught of 7?

W

Torke	ed out.
	30
	30 32
	$8 = \frac{8}{8}$ of an inch.
	7

	32
	30
	960
	8
	7680
	7
A	$10)\overline{53760}$
B	. 2)5376

В	•	•		2)2688
В	.•	•		2)1344
в	•		•	7)672
•	C	•		96)96
				1

A. 10 = 10 Diameter of the front-roller in eighths of an inch.

B. $7 \times 2 \times 2 \times 2 = 56$ Teeth in the back-roller wheel.

C. 96 === 96 Teeth in the top-carrier.

Answer.

The front-roller is $1\frac{1}{4}$ and the back-roller one inch in diameter. The front-roller wheel has 30, the top-carrier 96, the change-wheel 32, and the back-roller wheel 56 teeth. Required the draught.

- 10 Diameter of the front in eighths of an inch.
- 56 Teeth in the back-rollerwheel.
- 96 Teeth in the top-carrier.

COTTON MANUFACTURE.

Worked out by Cancellation. 1.8 | 1(0 1.4.32 | 56.7 1.3(0 | 96.12.3.1

 $\overline{7}$

Answer.

The same without Cancellation.

Dividend	•			$\frac{10 \times 56 \times 96}{2} = 7$
				$8 \times 32 \times 30$
				Answer.

What should be the draught between the middle and front rollers, if 19 is drawn into 20 between the back and middle rollers, the total draught being 7?

Worked out by Cancellation. 1.4.20 7 19.3.8.95 7 × .95 === 6.65

Answer.

The front-roller is $1\frac{1}{4}$ and the middle-roller one inch in diameter. The front-roller wheel has 30, and the changewheel 35 teeth. How many teeth should there be in the top-carrier and the middle-roller wheel to produce a draught of 6.65 between the middle and the front rollers?

Ţ	Vorked out.
$\frac{10}{8}$ of an inch	$1(0 \begin{vmatrix} 3(0) \\ 35 \\ 8 = \frac{8}{8} \text{ of an inch.} \\ 6.65 \end{vmatrix}$
В.	$ \begin{array}{r} 6.65 \\ 8 \\ 53.20 \\ 35 \\ 26600 \\ 15960 \\ 1862.00 \\ 3 \\ 2)5586.00 \end{array} $
Α	2)5586-00 3)2793
В.	7)931 Continued.) 5

В	• =	•	•	•	7)133
А.					19)19

A. $19 \times 3 = 57$ Teeth in the middle-roller wheel.

B. $7 \times 7 \times 2 = 98$ Teeth in the top-carrier.

Answer.

The front-r. ller is $1\frac{1}{4}$ and the middle-roller one inch in diameter. The front-roller wheel has 30, the top-carrier 98, the change-wheel 35, and the middle-roller wheel 57 teeth. Required the draught between the middle and the front-rollers.

Diameter of the middle-		10, Diameter of the front-
roller, in eighths of		roller, in eighths of
an inch	8	an inch.
Teeth in the change-		57 Teeth in the middle-rol-
wheel	35	ler wheel.
Teeth in the front-roller		98 Teeth in the top-carrier.
wheel		

Worked out by	y Cancellation.	
1.8	1(0	
1.7.35	$57 \cdot 11.4 \cdot 3.8$ 98 · 12.25 · 1.75	
1 ·3(0	98.12.25.1.75	
3.8×1.75	6.65	Answer.

BOBBIN AND FLY-FRAME.

The same without Cancellation.

Dividend $\frac{10 \times 57 \times 98}{8 \times 35 \times 30} = 6.65$ Divisor Answer.

From the particulars given, to find the draught between the back and the front, and the middle and the front rollers. Find the draught between the back and the middle rollers.

Worked out by Can	cellation.
-------------------	------------

 $\begin{array}{c|ccccc} 1(0 & 8\cdot1 \\ 1\cdot1.9\cdot5.7\cdot11.4\cdot57 & 35\cdot5\cdot1 \\ 1\cdot7\cdot49\cdot98 & 30\cdot1 \\ & 1\cdot8 & 1(0 \\ 1\cdot4\cdot32 & 56\cdot8\cdot2\cdot1 \\ & 1\cdot30 & 96\cdot12\cdot6\cdot2\cdot1.05\frac{5}{1\cdot9}\end{array}$

 $1.05\frac{5}{19}$

Answer.

The same without Cancellation.

Dividend . $\frac{8 \times 35 \times 30 \times 10 \times 56 \times 96}{10 \times 57 \times 98 \times 8 \times 32 \times 30} = 1.05\frac{5}{19}$

Answer.

The draught between the back and the front-rollers is 7, and the draught between the middle and the front-rollers is 6.65. Required the draught between the back and the middle rollers.

 $1.6.65 \mid 7.1.05\frac{5}{1.9}$

$1.05\frac{5}{19}$

Answer.

A Fly-Frame is making coarse roving with a one-inch back-roller, a $1\frac{1}{4}$ inch front-roller, a 32 front-roller wheel, a 96 top-carrier 40 change-wheel, and a 64 back-roller wheel. Required the draught.

> Worked out by Cancellation. 1.8 | 1(0 1.32 | 96.48.6 1.2.4(0 | 64.2.1

> > 6

Answer.

The same without Cancellation.

The first layer of roving on the bobbin is 6 inches long, containing 30 laps per inch; consequently, the coppingrail will have to traverse 6 inches, and the bobbin make $30 \times 6 = 180$ revolutions, while winding on the layer, and, as has been shown in preceding examples, the empty bobbin and the front-roller are both of the same dimensions, and in effect, both move at the same speed, while winding on the first layer of roving. The rack to which the copping-rail is made fast is driven from the coneshaft by 5 pairs of wheels, and the wheel that takes into The driven wheels contain respectively, 90, the rack. 100, 60, 80, and 80 teeth, and the rack 4 teeth per inch. From the above particulars and the train of wheels, and the pulley and cone leading from the front-roller to the cone, find driving wheels that will make the copping-rail traverse 6 inches, while the front-roller makes 180 revolutions.

5

in inches

- 100 Teeth in the wheel on the grooved shaft.
 - 2, Diameter of the small end of the cone, in inches.
 - 90 First driven wheel from the cone.

1	100	Second	driven	wheel
		from [·]	the cone.	
	60	Third	driven	wheel
I		from [·]	the cone.	
	80	Fourth	driven	wheel
ľ		from '	the cone.	
1	80	Fifth dri	iven whe	el from
		the co	one.	
	4	Teeth p	er inch	in the
		rack.		
	6	Length	of the fi	rst lay-
		er, in	inches.	

Worked out.

1.2.180	
1.100	100.1
1.5	$2 \cdot 1$
	90.1
	100.20
	60
	80
	80
	4
	6

6								
4								
$\overline{24}$								
80								
1920								
80								
153600								
60								
9216000								
20	_							
184320000	10)1	•		•		•	В	
)18432000	10)		•	E				
0)1843200	. 10	•	•	•		C		
10)184320	. 1		•	•	•	•	•	A
2)18432			•	E				
2)9216			•	•	D			
4)4608		•	•	•	D			
8)1152	• •	•	•	•	D			
. 3)144			•				- •	A
. 3(48			•			С		
. 16)16			•	Ţ				
1								

A. $10 \times 3 = 30$ Teeth in the wheel on the same axis with the cone or first driving wheel.

B. 10 == 10 Teeth in the second driving wheel.

C. $10 \times 3 = 30$ Teeth in the third driving wheel.

D. $8 \times 4 \times 2 = 64$ Teeth in the fourth driving wheel.

E. $10 \times 2 = 20$ Teeth in the fifth driving wheel.

F. 16 = 16 Teeth in the wheel that takes into the rack.

Answer.

From the particulars found in the preceding example, find the length of the first layer of roving on the bobbin.

Worked out by Cancellation.

	18(0.6
1.100	100.1
$1 \cdot 2$	5.1
1.3.90	30·1
1(00	1(0
$1 \cdot 4 \cdot 12 \cdot 60$	3(0 ·1
1(0.80	$64 \cdot 8 \cdot 2 \cdot 1$
1.20.80	20.1
1.4	16.4.1
~ -	

6 inches.

Answer.

BOBBIN AND FLY-FRAME.

$$\begin{array}{c} The \ same \ without \ Cancellation.\\ \mbox{Dividend,}\\ \mbox{Divisor,} & \frac{180 \times 100 \times 5 \times 30 \times 10 \times 30 \times 64 \times 20 \times 16}{100 \times 2 \times 90 \times 100 \times 60 \times 80 \times 80 \times 4} = 6\\ \mbox{Answer.} \end{array}$$

From the particulars found in the preceding example, find how many revolutions the front-roller makes while the first layer of roving is being wound on to the bobbin.

Worked out by Cancellation					
	6.2.1				
1.4.16					
1.20	80.4.1				
1.2.4.8.64	80.10.2.1				
1. 30	60.2.1				
1(0 1·3(0 1·5	1(00				
1· 3(0	90				
1.5	2				
1.100	100.1				

 $90 \times 2 = 180$

Answer.

	The same without Cancellation.
Dividend,	$\frac{6 \times 4 \times 80 \times 80 \times 60 \times 100 \times 90 \times 2 \times 100}{180} = 180$
Divisor,	$16 \times 20 \times 64 \times 30 \times 10 \times 30 \times 5 \times 100$
	٨

Answer.

5*

From the particulars found in the preceding example, find how many teeth there is in the reversing wheels.

N.B.—The reversing wheels take into the wheel with 10 teeth. They are two in number, only one of which is in operation at a time.

Worked out by Cancellation.

	180.2.1
1(00	100
$1 \cdot 2$	5.1
1.90	3(0.1
	1(0
$1 \cdot 4 \cdot 20 \cdot 60$	30.5.1
1.2.10.80	$64 \cdot 8 \cdot 2 \cdot 1$
1·4· 80	20.1
1.4	16.4.1
1.6	

100

Answer.

The same without Cancellation.

Dividend, $\frac{180 \times 100 \times 5 \times 30 \times 10 \times 30 \times 64 \times 20 \times 16}{100 \times 2 \times 90 \times 60 \times 80 \times 80 \times 4 \times 6} = 100$

Answer.

SPINNING-FRAME.

SPINNING-FRAME.

An upright shaft in a spinning-room makes 180 revolutions per minute, and has on a wheel that takes into a wheel with 64 teeth, on a lying-shaft. On the lying-shaft there is a pulley that drives a pulley 12 inches in diameter, on a counter-shaft. On the counter-shaft there is a pulley that drives a pulley 8 inches in diameter, on the same axis with the cylinder of the spinning-frame. How many teeth should there be in the wheel on the upright shaft, and what should be the diameter of the driving pulleys on the lying and counter shafts, to drive the cylinder 900 revolutions per minute ?

Revolutions per minute	900 Revolutions per minute
of the upright shaft. 180	of the cylinder.
	64 Teeth in the wheel on
	the lying shaft.
	12, Diameter of the driven
	pulley on the counter-
	shaft, in inches.
	8, Diameter of the pulley
	on the same axis with
	the cylinder, in inch-
	es.

COTTON MANUFACTURE.

Worke	ed out.
1.3.18(0)	90(0.30
	64
	12.2
	8

64						
30						
$\overline{1920}$						
2						
3840						
8						
$. 10)\overline{30720}$	- 0.			•	•	ſ
2)3072			•	•	С	
6)1536				•	B]
4)256		•	•	•	B]
8)64	•			•	•	r
8)8			•	•	С	
- 1						

A. $10 \times 8 = 80$ Teeth in the wheel, on the upright shaft.

A

B. $6 \times 4 = 24$, Diameter of the pulley on the lying shaft, in inches.

C. $8 \times 2 = 16$, Diameter of the driving pulley on the counter-shaft, in inches.

Answer.

From the particulars found in the preceding example, find the revolutions per minute of the cylinder.

Cancellation.
180.45
80.10
$24 \cdot 2 \cdot 1$
180·45 80·10 24·2·1 16·2

 $45 \times 10 \times 2 = 900$

Answer.

The same without Cancellation.

Dividend . . . $\frac{180 \times 80 \times 24 \times 16}{64 \times 12 \times 8} = 900$ Answer.

The cylinder makes 900 revolutions per minute, and the spindle-warls are one inch in diameter. What should be the diameter of the cylinder to drive the spindles 6300 revolutions per minute?

COTTON MANUFACTURE.

Worke	d out by Cancellation	ι.
	1.900 6300.7	
	7	Answer.

The cylinder makes 900 revolutions per minute, and on the same axis there is a pulley that drives a pulley 15 inches in diameter, on a stud. On the same axis with the pulley on the stud, there is a wheel that, by means of an intermediate, takes into a wheel with 70 teeth on the front-roller. What should be the diameter of the pulley on the same axis with the cylinder, and how many teeth should there be in the wheel on the same axis with the pulley on the stud, to drive the front-roller 60 revolutions per minute?

Revolutions per minute	60 Revolutions per minute
of the cylinder 900	of the front-roller.
	15, Diameter of the pulley
	on the stud, in inches.
	70 Teeth in the wheel on
· ·	the front-roller.

	ed out.
1·3·9 (00	6(0.2
	15.5
	7(0

(Continued.)

$$\begin{array}{r}
7 \\
5 \\
35 \\
2 \\
A \\
. \\
. \\
7)\overline{70} \\
A \\
. \\
. \\
2)\overline{10} \\
B \\
. \\
. \\
5)\overline{5} \\
1
\end{array}$$

A. $7 \times 2 = 14$ Teeth in the wheel on the same axis with the pulley on the stud.

B. 5 = 5, Diameter of the pulley on the same axis with the cylinder, in inches.

Answer.

From the particulars found in the preceding example, find the revolutions per minute of the front-roller.

Worked out by Cancellation. 1.15 900.60 5.1 1.14.70 14.1

60

Answer.

COTTON MANUFACTURE.

The same without Cancellation.

The front-roller is one inch in diameter, and makes 60 revolutions per minute, and the spindles make 6300 revolutions per minute. Required the number of turns of twist per inch in the yarn.

> Worked out by Cancellation. 1.6(0 | 630(0.105.8.75.33.42 1.2618.3.1416 |

> > 33.42

Answer.

The same without Cancellation.

Dividend $\cdot \cdot \cdot \cdot \cdot \frac{6300}{3.1416 \times 60} = 33.42$ Divisor $\cdot \cdot \cdot \cdot \cdot \cdot \cdot \frac{3.1416 \times 60}{3.1416 \times 60}$

The cylinder is 7 inches in diameter, and on the same axis there is a pulley 5 inches in diameter that drives a pulley 15 inches in diameter, on a stud. On the same axis with the pulley on the stud, there is a wheel with 14 teeth that, by means of an intermediate, takes into a wheel with 70 teeth, on the front-roller. Required the number of turns of twist per inch in the yarn, the front-roller being one inch in diameter.

Diameter of the frontroller, in inches . . 1 Circumference . . 3.1416 Diameter of the pulley on the same axis with the cylinder, in inches 5 Teeth in the wheel on the same axis with the pulley on the stud 14

- 7, Diameter of the cylinder, in inches.
- 15, Diameter of the pulley on the stud, in inches.
- 70 Teeth in the wheel on the front-roller.

Worked out by Cancellation. 1 7.1 1.4488.3.1416 1.5 15.33.42 1.14 70.14.1

33.42

Answer.

The same without Cancellation. Dividend $\dots \qquad \frac{7 \times 15 \times 70}{3.1416 \times 5 \times 14} = 33.42$

Answer.

The heart or traverse motion makes one revolution while two layers of yarn are being wound on the bobbin. On the same axis with the heart there is a wheel with 72 teeth driven by a worm. On the same axis with the worm there is a pulley 9 inches in diameter, driven from a pulley on a stood. On the same axis with the pulley on the stood there is a wheel with 32 teeth that takes into a wheel on the front-roller. How many teeth should there be in the wheel on the front-roller, and what should be the diameter of the pulley on the stood, to make each layer of yarn 15 yards long, the front-roller being one inch in diameter, making no allowance for shrinkage in twisting?

2

1

Layers wound on while the heart makes one revolution The worm is equal to one tooth, in effect .

- 1 Revolutions of the heart.
- 72 Teeth in the wheel on the same axis with the heart.
 - 9, Diameter of the pulley on the same axes with the worm, in inches.
- 32 Teeth in the wheel on the same axis with the pulley on the stud.

Inches in one yard	36	1, Diameter of the front-
		roller, in inches.
		3.1416 Ratio of circumfer-
		ence to diameter.
Length of one layer of		
yarn, in yards	15	

Worked out.

1.2	1
1	$72 \cdot 6 \cdot 2 \cdot 1$
	9.3
	32
1·3· 36	1
	$3.1416 \cdot .62832$
1.3.15	

			.62832
			32
			$\overline{125664}$
			188496
			20.10624
			3
A		•	$2)\overline{60.31872}$
A (Continu	· · ·	•	3)30.15936

A. $2 \times 3 \times 4 = 24$ Teeth in the wheel on the front-roller.

B. 2.51328 = 2.51328, Diameter of the pulley on the stood, in inches.

Answer.

From the particulars found in the preceding example, find the number of yards in one layer of yarn.

 $1.25 \times 4 \times 3 = 15$ Answer.

The same without Cancellation. Dividend . . . $\frac{72 \times 9 \times 32 \times 3.1416}{2 \times 2.51328 \times 24 \times 36} = 15$ Answer.

MASON'S MULE.

An upright shaft in a mule-room makes 180 revolutions per minute, and has on a wheel that takes into a wheel with 60 teeth, on a lying-shaft. On the lying-shaft there is a pulley that drives a pulley 12 inches in diameter, on the twist-shaft. How many teeth should there be in the wheel on the upright shaft, and what should be the diameter of the pulley on the lying-shaft, to drive the mule 3½ stretches per minute, the twist-shaft making 75 revolutions per stretch, and the time occupied in drawing out and twisting being three-quarters of the time necessary to perform the whole stretch?

N.B.—The twist-shaft makes from one to three revolutions, according to the size of the cop, while taking in the carriage, but there is a loss of about that amount while falling from the maximum to the minimum speed necessary for backing off.

Revolutions per minute of the upright shaft 180 Time necessary for drawing out and twisting....3

- 75 Revolutions per stretch of the twist-shaft.
 - 4 Time necessary to perform the whole stretch.
- 60 Teeth in the wheel on the lying-shaft.

12,	Diameter	of	the	pull	ley
	on the	twi	st-sl	haft,	in
	inches.				
3.5	Stretches]	per	\min	ute.	

ed out.
75.25
75•25 4
60.1
60·1 12·4
3.5

					25
					4
					100
					4
					400
					3.5
					2000
					1200
A	L 0	•	•	۰	7)1400.0
٨					10)000
A	۰ ۱	•	•	٠	. 10)200
	Β.				. 20)20
					1

A. $10 \times 7 = 70$ Teeth in the wheel on the upright shaft.

B. 20 = 20, Diameter of the pulley on the lyingshaft, in inches.

Answer.

From the particulars found in the preceding example, find how many stretches per minute the mule will make.

	y Cancellation.
1.5.15.75	180·3·1 70·17.5·3.5 20·5·1 3·1
1.60	$70 \cdot 17.5 \cdot 3.5$
1.4.12	20.5.1
1.4	3.1

3.5

Answer.

The same without Cancellation.

Dividend . . . $\frac{180 \times 70 \times 20 \times 3}{75 \times 60 \times 12 \times 4} = 3.5$ Divisor Answer.

The cam that permits the belt to pass from the fast to the loose pulley makes one revolution per stretch. On the same axis with the cam there is a wheel that takes into a wheel with 36 teeth on the worm-wheel-shaft. On the worm-wheel-shaft there is also a wheel that takes into a worm on the twist-shaft. How many teeth should there be in the wheel on the cam-shaft, and the wheel that takes into the worm, to permit the twist-shaft to make 75 revolutions per stretch?

Worked out.

75 Revolutions per stretch
of the twist-shaft.
36 Teeth in the driving
wheel on the worm-
wheel-shaft.

75						
36						
$\overline{450}$						
225						
5)2700	F.	•	•	•	•	В
5)540	•			•	•	А.
3)108			•	•	•	А.
3)36					•	А.
3)12		•	•			В
4)4		•	•			В
- 1						

A. $5 \times 3 \times 3 = 45$ Teeth in the wheel that takes into the worm.

B. $5 \times 3 \times 4 = 60$ Teeth in the wheel on the camshaft.

Answer.

From the particulars found in the preceding example, find how many revolutions the twist-shaft makes per stretch.

Worked out	by	Cancellation.
	4	45.15
1.3.3(3 6	30•5

 $15 \times 5 = 75$ Answer.

The twist-shaft has on a wheel with 21 teeth that, by means of an intermediate, takes into a wheel on the front-roller. How many teeth are there in the wheel on the front-roller, if 68 revolutions of the twist-shaft turn out 59.816064 inches, the front-roller being one inch in diameter?

	68 Revolutions of the			
	twist-shaft.			
	21 Teeth in the wheel on			
	the twist-shaft.			
Length turned out, in	1, Diameter of the front-			
inches 59.816064	roller, in inches.			
	3.1416 Circumference.			
Worked out by	y Cancellation.			
	68·34·17·1			
	21.75			
1.28.4.76.9.52.19.04.59.816064	1			
	3.1416.1			
•				

75

Answer.

The same without Cancellation.Dividend \dots $\frac{68 \times 21 \times 3.1416}{59.816064} = 75$ Divisor \dots $\frac{59.816064}{59.816064}$

The wheel that takes into the worm has 45 teeth. On the same axis with this wheel there is a wheel with 36 teeth that takes into a wheel with 60 teeth, on the camshaft. The spindle-warl is one inch, and the twist-pulley 17 inches in diameter, and the length of the stretch is 59.816064 inches. Required the twist per inch in the yarn.

45 Teeth in the wheel that
takes into the worm.
60 Teeth in the wheel on
the cam-shaft.
17, Diameter of the twist-
pulley, in inches.

Worked out by Cancellation. 1·3·36 45·15·21.31 + 1·3·36 60·5·1 1 17·1			
	$45 \cdot 15 \cdot 21.31 +$		
1.3.36	60.5.1		
1	17.1		
1.7037184·3.518592·59.816064			

21.31 +

Answer.

The same without Cancellation. Dividend . . . $\frac{45 \times 60 \times 17}{36 \times 59.816064} = 21.31 +$

Answer.

The Mason's Mule is so constructed as to take in and out the carriage by means of a spur-wheel and chain. The wheel has a certain number of spurs, and each spur takes into a link in the chain, and, taken together, they are, in effect, equal to a pulley and band 3 inches in effective diameter. On the same axis with the spur-wheel (the back shaft), there is a wheel driven from a wheel with 28 teeth, on an intermediate shaft. On the intermediate shaft there is also a wheel driven from a wheel with 30 teeth on the same axis with the front-roller. How many teeth are there in the wheel on the back shaft, and the driven wheel on the intermediate shaft, if the surface velocity of the front-roller and the traverse of the carriage are equal, the front-roller being one inch in diameter ?

Worked out.

	30 Tee
Diameter of the front-	3, Effe
roller, in inches 1	1

28	Teeth	\mathbf{in}	$^{\mathrm{th}}$	e d	riving
	wh	eel,	on	the	inter-
	me	diat	e sh	aft.	

- 30 Teeth in the wheel on the same axis with the front-roller.
 - 3, Effective diameter of the spur-wheel and chain, in inches.

					28
					30
					` <u> </u>
					840
					3
Α.	•	•	•	•	12)2520
А.	•	•		•	. 6)210
в				•	. 35)35
					1

A. $12 \times 6 = 72$ Teeth in the driven wheel, on the intermediate shaft.

B. 35 == 35 Teeth in the wheel, on the back shaft. Answer.

From the particulars found in the preceding example, find how many inches the carriage will be taken out while the rollers deliver 59.816064 inches.

Worked	out	by	Cancellation.
			59.816064
1.2	19.7	0 9	20.5.1

1·5·35 28·7·1 3·1

59.816064

The same without Cancellation. Dividend . $59.816064 \times 30 \times 28 \times 3$ Divisor . . 72×35 Answer.

The wheel on the front-roller for taking out the carriage has 30 teeth, and the rollers deliver 59.816064 inches per stretch. How many inches will the rollers deliver with a wheel with 32 teeth ?

Worked out by	/ Cancellation.
	$59.816064 \cdot 14.954016$
1.4.32	59.816064·14.954016 30·3.75

 $14.954016 \times 3.75 = 56.07756$

Answer.

The same without Cancellation.

Dividend . . . $59.816064 \times 30 = 56.07756$ Divisor 32Answer.

The front-roller delivers 56.07756, and the length of the stretch is 59.816064 inches. How many inches does the carriage gain per stretch?

MASON'S MULE.	127
59.816064	
56.077560	
3.738504	

Answer.

From the particulars found in the preceding example, find the draught at the carriage.

Worked out by Cancellation. 1.56.07756 | 59.816064.1.06

1.06

Answer.

The spur-wheel on the back shaft, and the chain by which the carriage is taken in and out are, in effect, equal to a pulley and band 3 inches in effective diameter. On the back shaft there is a wheel that takes into a wheel with 168 teeth, on an intermediate shaft. On the intermediate shaft there is a wheel that takes into the bottom sliding-rack. The relative velocity of the bottom to that of the top sliding-rack is as 5 to 4. On a second intermediate shaft there is a wheel with 21 teeth that takes into the top sliding-rack. On this shaft there is also a wheel that takes into a wheel with 24 teeth, on the same axis with the twist-pulley. How many teeth should there be in the wheel on the back shaft, the wheel that takes into the bottom sliding-rack, and the wheel on the second intermediate shaft that takes into the wheel on the same axis with the twist-pulley; and what should be the diameter of the twist-pulley and the spindle, to give the bare spindle a surface velocity equal to the velocity of the carriage while going in, the spindle-warl being one inch in diameter ?

N.B.—There is nothing between the twist-pulley and the spindle-warl that needs to be taken into consideration in solving the above problem.

	3, Effective diameter of
	the spur-wheel and
	chain, in inches.
	168 Teeth in the wheel that
	takes into the wheel,
	on the back shaft.
	21 Teeth in the wheel that
	takes into the top
	sliding-rack.
	24 Teeth in the wheel on
	the same axis with
	the twist-pulley.
	1, Diameter of the spin-
	dle-warl, in inches.
Relative velocity of the	5, Relative velocity of the
top sliding-rack 4	bottom sliding-rack.

128

Worked out. $\begin{vmatrix} 3\\ 168\\ 21\\ 24.6\\ 1\\ 1.4\\ 5 \end{vmatrix}$

	168
	3
	${504}$
	21
	$\overline{504}$
	1008
	$\overline{10584}$
	6
	63504
	5
Е.	5)317520.0
Е.	5)635040.0
D	. 7)1270080
A	7)181440
(Contraction)	6*

COTTON MANUFACTURE.

	С	•	•	•	•		12)25920
A	•	•	•	•	•	•	5)2160
		D			•	•	. 2)432
	С			•	•	•	. 8)216
В				•		•	. 27)27
							1

A. $7 \times 5 = 35$ Teeth in the wheel on the back shaft. B. 27 = 27 Teeth in the wheel that takes into the bottom sliding-rack.

C. $12 \times 8 = 96$ Teeth in the wheel on the second intermediate shaft, that takes into the wheel on the same axis with the twist-pulley.

D. $7 \times 2 = 14$, Diameter of the twist-pulley in inches.

E. $.5 \times .5 = .25$, Diameter of the spindle, in inches.

From the particulars found in the preceding example, find how much yarn will be wound on to the bare spindle while the spur-wheel takes in 59.816064 inches of chain.

> Worked out by Cancellation. 1.3.12.3 1.14.168 (Continued.)

130

	27.9.3.
1.5	4.1
1.3.21	
1.3.24	$96 \cdot 8 \cdot 1$
1	14•1

59.816064 inches.

Answer.

The same without Cancellation.

Div. $\frac{59.816064 \times .25 \times 35 \times 27 \times 4 \times 96 \times 14}{3 \times 168 \times 5 \times 21 \times 24} = 59.816064$ Answer.

From the particulars found in the preceding example, find how many inches of chain will be taken in per stretch of 59.816064 inches.

Worked out by Cancellation.

	59.816064
1.25	3.1
1.5.35	168.14.1
1.3.9.27	
1.4	5.20.5.1
	21.7.1
1.8.96	$24 \cdot 3 \cdot 1$
1.14	
K0.01	COC4

59.816064

COTTON MANUFACTURE.

The same without Cancellation.

Dividend,
$$\frac{59.816064 \times 3 \times 168 \times 5 \times 21 \times 24}{.25 \times 35 \times 27 \times 4 \times 96 \times 14} = 59.816064$$
Answer

From the particulars found in the preceding example, find the diameter of the twist-pulley.

Worked out by Cancellation.		
	1	
1.7.35	168.14	
1.25	3.1	
	21·3·1	
1.4	5.1	
1.3.9.27		
1.8.96	1 168·14 3·1 21·3·1 5·1 24·3·12·3·1	

14 inches.

Answer.

The same without Cancellation.

Dividend . . $\frac{168 \times 3 \times 21 \times 5 \times 24}{35 \times .25 \times 4 \times 27 \times 96} = 14$ inches. Answer.

From the particulars found in the preceding example, find the diameter of the spindle.

MASON'S MULE.

Worked out by Cancellation.

 $\begin{array}{c} 3 \cdot 1 \\ 21 \cdot 7 \cdot 1 \\ 1 \cdot 4 \\ 5 \cdot 1 \\ 1 \cdot 3 \cdot 9 \cdot 27 \\ 1 \cdot 8 \cdot 96 \\ 1 \cdot 5 \cdot 35 \\ 1 \cdot 5 \cdot 35 \\ 1 \cdot 68 \cdot 14 \cdot 1 \\ 1 \cdot 14 \\ 1 \cdot .25 \end{array}$

 $.25 = \frac{1}{4}$ of an inch.

Answer.

The same without Cancellation.

Dividend . . $\frac{3 \times 21 \times 5 \times 24 \times 168}{4 \times 27 \times 96 \times 35 \times 14}$ = .25 Divisor . . . Answer.

How many revolutions must the spindle make to wind the yarn on to the bare spindle while the carriage is going in, the diameter of the spindle being a quarter of an inch, and the length of the stretch 59.816064 inches?

Worked out by	y Cancellation.
1.25	59.816064·19.04·76.16
1.3.1416	

76.16

COTTON MANUFACTURE.

The same without Cancellation.Dividend \cdot \cdot \cdot 59.816064Divisor \cdot \cdot \cdot $3.1416 \times .25$ Answer.

Find how many inches of chain the spur-wheel will take in, while the spindle makes 76.16 revolutions.

y Cancellation.
$76.16 \cdot 19.04$
$24 \cdot 3 \cdot 1$ $21 \cdot 7 \cdot 1$
21.7.1
5.1
$168 \cdot 14 \cdot 1$
3.1
3.1416

 $3.1416 \times 19.04 = 59.816064$

Answer.

The same without Cancellation.

Div., $\frac{76.16 \times 24 \times 21 \times 5 \times 168 \times 3 \times 3.1416}{14 \times 96 \times 4 \times 27 \times 35} = 59.816064$

The length of the cop is regulated more or less by the copping-rail and shaper, and not wholly by the length of traverse of the nut on the screw in the recess of the builder. It is found by observation that a well proportioned and well built cop, having on 630 stretches of No. 40 filling, will measure from extreme point to extreme point, as much more than the traverse of said nut, as 19 is more than 14. On the same axis with the screw in the recess of the builder, there is a wheel that takes into a wheel with 27 teeth. On the same axis with the latter wheel there is a spur-wheel that moves one spur per stretch. How many threads per inch are there in the screw; how many teeth in the wheel on the same axis with the screw; how many spurs in the spur-wheel, and what is the length of the cop, if it contains 630 stretches, and the traverse of the nut on the screw in the recess of the builder, is to the length of the cop as 14 to 19?

630 Stretches on the cop.
27 Teeth in the wheel that takes into the wheel on the same axis with the screw.
19, Proportionate length of the cop.

Proportionate length of traverse of the nut in the recess of the builder 14

Worked out.					
	630.90.45				
	27				
1.2.14	19				
	45				
	27				
	315				
	90				
	$\overline{1215}$				
	19				
	$\frac{10935}{10935}$				
	1215				
Α	. 3)23085				
в	. 6)7695				
С	. 3)1282.5				
С	. 3)427.5				
в	. 10)142.5				
Α	. 3)14.25				
D .	. 4.75)4.75				
	1				

A. $3 \times 3 = 9$ Threads per inch in the screw.

B. $10 \times 6 = 60$ Teeth in the wheel on the same axis with the screw.

C. $3 \times 3 = 9$ Spurs in the spur-wheel.

W

D. 4.75 = 4.75, The length of the cop, in inches.

Answer.

From the particulars found in the preceding example, find the length of the cop, in inches.

orked out by	/ Cancellation.
1.9	$\begin{array}{c} 63(0\cdot9\cdot1\\ 27\cdot9\cdot4.5\cdot1\\ 19\cdot9.5\cdot4.75\end{array}$
$1 \cdot 2 \cdot 6(0$	$27 \cdot 9 \cdot 4.5 \cdot 1$
1.2.14	$19 \cdot 9.5 \cdot 4.75$
$1 \cdot 2 \cdot 9$	

4.75

Answer.

The same without Cancellation.

From the particulars found in the preceding example, find the number of stretches on a cop.

COTTON MANUFACTURE.

Worked out by	y Cancellation.
	$4.75 \cdot 1$
	9.3
1.3.27	60.15
	9.1
1.3.27 1.4.75.19	14

 $15 \times 14 \times 3 = 630$

Answer.

The same without Cancellation. Dividend . . $\frac{4.75 \times 9 \times 60 \times 9 \times 14}{27 \times 19} = 630$ Answer.

From the particulars found in the preceding example, find the number of threads per inch in the screw.

 Worked out by Cancellation.

 $1 \cdot 4.75$ $63(0 \cdot 7 \cdot 1)$
 $1 \cdot 3 \cdot 6(0)$ $27 \cdot 9$
 $1 \cdot 9$ $1 \cdot 9$
 $1 \cdot 2 \cdot 14$ $19 \cdot 4 \cdot 2 \cdot 1$

9

MASON'S MULE.

From the particulars found in the preceding example, find the number of teeth in the wheel on the same axis with the screw.

Worked out by	y Cancellation
	y Cancellation 630·70·10 27·3 19·4·2
1.9	
	27.3
1.9	
$1 \cdot 2 \cdot 14$	19.4.2
1.4.75	

 $10 \times 3 \times 2 = 60$

Answer.

	Th	e	sam	ie	wi	thout	Cancellation.
Dividen	d	•		•			$\underline{630 \times 27 \times 19} = 60$
							$9 \times 9 \times 14 \times 4.75$
							Answer.

The back-roller is seven-eighths of an inch in diameter. The front-roller wheel has 30, and the change-wheel 36 teeth. How many teeth should there be in the top-carrier and the back-roller wheel, and what should be the diameter of the front-roller to produce a draught of 9?

Worke	ed out.
	 7, Back-roller in eighths of an inch. 30 Teeth in the front-roller wheel. 36 Teeth in the change- wheel. 9, Draught.
А	$ \begin{array}{r} 36 \\ 30 \\ \overline{1080} \\ 7 \\ \overline{7560} \\ 9 \\ 4)\overline{68040} \end{array} $
Α	. 2)17010
в	5)8505
в	3)1701
(Contin	nued.)

140

7)567	•	•	•	•	В
81)81		•	•	σ.	0
1					

A. $4 \times 2 = 8$, Diameter of the front-roller, in eighths of an inch.

B. $5 \times 3 \times 7 = 105$ Teeth in the top-carrier.

C. 81 == 81 teeth in the back-roller wheel.

Answer.

From the particulars found in the preceding example, find the draught between the back and the front rollers.

> Worked out by Cancellation. 1·7 | 8·4·1 1·2·30 | 105·15·1 1·9·36 | 81·9

> > 9

Answer.

The same without Cancellation.

Dividend $\cdot \cdot \cdot \cdot \cdot \cdot \frac{8 \times 105 \times 81}{7 \times 30 \times 36} = 9$ Divisor $\cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \frac{7 \times 30 \times 36}{7 \times 30 \times 36}$

THE FRANKLIN MULE.

A mule is driven from an upright shaft making 180 revolutions per minute, by a train of three pairs of pulleys, and one pair of wheels. The driven wheel has 64 teeth, and the respective diameters of the driven pulleys are 20, 18, and 12 inches. How many teeth should there be in the driving wheel, and what should be the respective diameters of the driving pulleys, to drive the mule 34 stretches per minute, the twist-shaft making 72 revolutions per stretch, and the time occupied in drawing out and twisting being three-quarters of the time necessary to perform the whole stretch ?

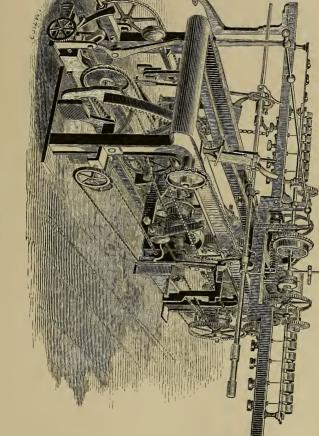
3

Revolutions of the upright shaft per minute, 180

Time occupied in drawing out and twisting, 72 Revolutions of the twistshaft per stretch.

3.25 Stretches per minute.

- 4 Time occupied in performing the whole stretch.
- 64 Teeth in the driven wheel.
- 20, Diameter of the first driven pulley, in inches.
- 18, Diameter of the second driven pulley, in inches.



FRANKLIN MULE.

•

12, Diameter of the third driven pulley (which is on the twist-shaft), in inches.

	ed out.
1.18(0	$72 \cdot 24$
	3.25
1.3	4
	64
	2(0 18·1
	18.1
	12

(Continued.)

0

3.25
24

1 300
650
78.00
4
T
312
64
1248
1872

143

19968					
2					
39936					
12					-*
79872					
39936					
)479232	12)		•	•	A
6)39936	e	•	•	•	A
8)6656			D		
2)832		•	D		
2)416		•	•	C	
. 10)208		•	•	C	
20.8)20.8				;.	I
1					

A. $12 \times 6 = 72$ Teeth in the driving wheel.

B. 20.8 === 20.8, Diameter of the first driving pulley, in inches.

C. $10 \times 2 = 20$, Diameter of the second driving pulley, in inches.

D. $8 \times 2 = 16$, Diameter of the third driving pulley, in inches.

A mule is driven from an upright shaft making 180 revolutions per minute, by a train of three pairs of pulleys and one pair of wheels; the driving wheel has 72, and the driven wheel 64 teeth. The respective diameters of the driving pulleys are 20.8, 20, and 16, and the driven pulleys 20, 18, and 12 inches. How many stretches per minute does the mule make, allowing the last driven pulley (which is on the twist-shaft), to make 72 revolutions per stretch, and the time occupied in drawing out and twisting being three-quarters of the time necessary to perform the whole stretch?

Revolutions of the twist-		180 Re
shaft per stretch	72	
Time occupied in per-		3, T
forming the whole		
stretch	4	
Teeth in the driven		72 T
wheel	64	
Diameter of the first		20.8, I
driven pulley, in inch-		
es	20	
Diameter of the second		20, D
driven pulley, in inch-		
es	1 8	
	1	7
/		

- 180 Revolutions of the upright shaft per minute.
 - 3, Time occupied in drawing out and twisting.
- 72 Teeth in the driving wheel.
- 20.8, Diameter of the first driving pulley, in inches.
 - 20, Diameter of the second driving pulley, in inches.

Diameter of the third	16, Diameter of the third
driven pulley (which	driving pulley, in
is on the twist-shaft),	inches.
in inches 12	

Worked out by Cancellation.

	1.72	18(0.1)
	1.4	3.1
1.	8.64	72.1
· 1	$\cdot 2(0$	$20.8 \cdot 2.6$
•	1.18	20.10.1.25
1.	3.12	16.4.1

 $2.6 \times 1.25 = 3.25$

Answer.

The same without Cancellation. Dividend $180 \times 3 \times 72 \times 20.8 \times 20 \times 16$ Divisor $72 \times 4 \times 64 \times 20 \times 18 \times 12$ Answer.

The twist-pulley is 17 inches in diameter, makes 72 revolutions per stretch, and drives the pulley on the drumshaft. On the drum-shaft there is a wheel with 50 teeth that takes into a wheel on the same axis with the drum; the drum is 10 inches in diameter, and drives the spindles. How many teeth should there be in the wheel on the same

146

axis with the drum; what should be the diameter of the pulley on the drum-shaft, and the spindle-warl, and what should be the length of the stretch to put 20 turns of twist per inch into the yarn?

		72 Revolutions per stretch
		of the twist-pulley.
		17, Diameter of the twist-
		pulley, in inches.
		50 Teeth in the wheel on
		the drum-shaft.
		10, Diameter of the drum
		in inches.
Turns of twist per inch		
in the yarn	20	

Work	ked out.
	72.36
	17
	50
	1(0
1.2(0	
	0.0
	36 17
	11

(Continued.)

							$252\\36\\\overline{612}\\50$
A					1	0)3()600
В						10)8	3060
В						2)306
В			•			3)153
	С					5	1)51
		D		•			1

A. 10 = 10, Diameter of the pulley on the drumshaft, in inches.

B. $10 \times 2 \times 3 = 60$, Length of the stretch, in inches.

C. 51 = 51 Teeth in the wheel on the same axis with the drum.

D. 1 = 1, Diameter of the spindle-warl, in inches.

Answer.

The twist-pulley makes 72 revolutions per stretch, is 17 inches in diameter, and drives the pulley on the drumshaft which is 10 inches in diameter. On the drum-shaft there is a wheel with 50 teeth that takes into a wheel with 51 teeth, on the same axis with the drum. The drum is 10 inches in diameter and drives the spindles, the warls of which is one inch in diameter. How many turns of twist per inch is there in the yarn, the length of the stretch being 60 inches ?

Diameter of the pulley	
on the drum-shaft, in	
inches	10
Teeth in the wheel on	
the same axis with	
the drum	51
Diameter of the spindle-	
warl, in inches	1
Length of the stretch,	
in inches	60

- 72 Revolutions per stretch of the upright shaft.
- 17, Diameter of the twistpulley, in inches.
- 50 Teeth in the wheel on the drum-shaft.
- 10, Diameter of the drum, in inches.

Worked out by Cancellation.

 $\begin{array}{c|c|c} & 72 \cdot 12 \cdot 4 \\ 1(0 & 17 \cdot 1 \\ 1 \cdot 17 \cdot 51 & 5(0 \\ 1 & 1(0 \\ 1 \cdot 6(0 & \end{array} \\ \end{array}$

 $5 \times 4 = 20$

The same without Cancellation.

Dividend $\frac{72 \times 17 \times 50 \times 10}{10 \times 51 \times 60} = 20$ Divisor Answer.

The twist-shaft makes 68 revolutions per stretch while in connection with the rollers, and has on a wheel with 18 teeth that, by means of an intermediate, takes into a wheel on the roller-shaft. On the other end of the rollershaft, there is a wheel with 40 teeth that takes into a wheel on the front-roller. How many teeth should there be in the driven wheel on the roller-shaft, and the wheel on the front-roller, to turn out 60.0831 inches per stretch, the front-roller being one inch in diameter ?

- 68 Revolutions per stretch of the twist-shaft while in connection with the rollers.
- 18 Teeth in the wheel on the twist shaft.
- 40 Teeth in the wheel on the roller-shaft that takes into the wheel on the front-roller.

	1, Diameter of the froller,
	in inches.
Length turned out per	3.1416, Circumference.
stretch, in inches, 60.0831	

Work	ced out.			
	68.32			
	18.2			
	40			
$1 \cdot 2.125 \cdot 19.125 \cdot 60.0831$	1			
	3.1416.1			
	32			
	2			
	64			
	40			
Α	4)2560			
Α	2)640			
Α	4)320			
Α	2)80			
в	$ 40)\overline{40}$			

A. $4 \times 2 \times 4 \times 2 = 64$ Teeth in the driven wheel on the roller-shaft.

B. 40 = 40 Teeth in the wheel on the front-roller.

Answer.

The twist-shaft makes 68 revolutions per stretch while in connection with the rollers, and has on a wheel with 18 teeth that takes into a wheel with 64 teeth, on the rollershaft. On the other end of the roller-shaft there is a wheel with 40 teeth, that takes into a wheel with 40 teeth, on the front-roller. How many inches will be turned out per stretch, the front-roller being one inch in diameter?

- 68 Revolutions per stretch of the twist-shaft while in connection with the rollers.
- 18 Teeth in the wheel on the twist-shaft.
- 40 Teeth in the driving wheel on the rollershaft.
 - 1, Diameter of the frontroller, in inches.
- 3.1416 Circumference.

THE FRANKLIN MULE.

Worked out by Cancellation.

 $\begin{array}{c|ccccc}
 & 68.17 \\
1.8.16.64 & 18.9 \\
1.40 & 40.1 \\
1 \\
3.1416.3927
\end{array}$

 $17 \times 9 \times .3927 = 60.0831$ Answer.

	Th	e	sa	me	without	Canc	ellation.	
Divider	nd.				$68 \times 18 >$	$< 40 \times$	3.1416_	60.0831
Divisor						4×40		000000
								Answer.

The front-roller is one inch in diameter, and has on a wheel that takes into a wheel with 40 teeth, on the rollershaft. On the other end of the roller-shaft there is a wheel that takes into a wheel with 64 teeth, on the drawing-out shaft. On the other end of the drawing-out shaft there is a wheel that takes into a wheel with 40 teeth, on the scroll-shaft. How many teeth should there be in the wheel on the front-roller, the wheel on the roller-shaft that takes into the wheel on the drawing-out shaft, and the wheel that takes into the wheel on the scroll-shaft; and what should be the diameter of the scroll to give it a surface velocity equal to that of the front-roller ?

4	
	40 Teeth in the wheel on
	the roller-shaft that
	takes into the wheel
	on the front-roller.
	64 Teeth in the wheel on
	the drawing-out shaft
	that takes into the
	wheel on the roller-
	shaft.
	40 Teeth in the wheel on
	the scroll-shaft.
	1, Diameter of the front-
	roller, in inches.

Worked out.

					64
					40
					$\overline{2560}$
					40
	C				10)102400
A	•	•	•		10)10240
A	•	•	•		. 2)1024
A	•		•		. 2)512
((Iont	in	ueà	2.)	

	С.	•	•	•	2)256
В		•	•	•	2)128
В		•	•	•		2)64
В	•	•		•		2)32
B		•	•	•		2)16
в		•				2)8
	D	•				2)4
-	D		•			2)2
						1

A. $10 \times 2 \times 2 = 40$ Teeth in the wheel on the frontroller.

B. $2 \times 2 \times 2 \times 2 \times 2 = 32$ Teeth in the wheel on the roller-shaft, that takes into the wheel on the drawing-out shaft.

C. $10 \times 2 = 20$ Teeth in the wheel that takes into the wheel on the scroll-shaft.

D. $2 \times 2 = 4$, Diameter of the scroll, in inches.

Answer.

The front-roller is one, and the scroll is 4 inches in diameter. The front-roller has on a wheel with 40 teeth that takes into a wheel with 40 teeth, on the roller-shaft. On the other end of the roller-shaft there is a wheel with 32 teeth that takes into a wheel with 64 teeth, on the drawing-out shaft. On the other end of the drawing-out shaft there is a wheel with 20 teeth that takes into a wheel with 40 teeth, on the scroll-shaft. What is the surface velocity per stretch of the scroll, if that of the front-roller is 60.0831 ?

N.B.—In practice it is necessary to add the diameter of the drawing-out band to that of the scroll.

		60.0831, Surface velocity per stretch of the front- roller.
Diameter of the front-		4, Diameter of the scroll,
roller, in inches	1	in inches.
Teeth in the wheel on		40 Teeth in the wheel on
the roller-shaft, that		the front-roller.
takes into the wheel		
on the front-roller .	40	
Teeth in the wheel on		32 Teeth in the wheel on
the drawing-out shaft		the roller-shaft, that
that takes into the		takes into the wheel
wheel on the roller-		on the drawing-out
shaft	64	shaft.
Teeth in the wheel on		20 Teeth in the wheel on
the scroll-shaft	40	the drawing-out shaft,
		that takes into the
		wheel on the scroll-
		shaft.

r

156

Worked out by Cancellation.

	60.0831
1	4.1
1.40	40.1
1.2.64	32.1
1.4(0)	2(0.1)

60.0831

Answer.

The same without Cancellation. Dividend . $60.0831 \times 4 \times 40 \times 32 \times 20$ Divisor . . $40 \times 64 \times 40$ = 60.0831

Answer.

The spindle is $\frac{6}{25}$, the spindle-warl is one, and the drum is 10 inches in diameter. On the same axis with the drum there is a wheel with 51 teeth that takes into a wheel with 50 teeth, on the drum-shaft. On the drumshaft there is also a wheel that takes into a wheel with 34 teeth, on the same axis with the winding-on drum. How many teeth should there be in the wheel on the drum-shaft that takes into the wheel on the same axis with the winding-on drum; and what should be the diameter of the winding-on drum, to give it a surface velocity equal to that of the bare spindle, when winding on the first stretch of yarn ? 1

Diameter	of	the	spindle-
----------	----	-----	----------

warl, in inches .	. I
Teeth in the wheel	on
the same axis wi	th
the drum	. 51

- .24, Diameter of the spindle, in inches.
 - 10, Diameter of the drum, in inches.
 - 50 Teeth in the wheel on the drum shaft that takes into the wheel on the same axis with the drum.
 - 34 Teeth in the wheel on the same axis with the winding-on drum.

Worked out.

	.2408
1	10
1.3.51	50
	$34 \cdot 2$

	50
	2
	100
	10
	1000
	.08
(Continued.)	

A	•	•	•	•	1	.0)8	80.00
A		•	•	•	•		2)8
	В						- 4)4
							- 1

A. $10 \times 2 = 20$ Teeth in the wheel on the drumshaft that takes into the wheel on the same axis with the winding-on drum.

B. 4 ==== 4, Diameter of the winding-on drum, in inches. Answer.

The spindle is $\frac{6}{25}$ of an inch in diameter, and has on a warl one inch in diameter, driven from a drum 10 inches in diameter. On the same axis with the drum there is a wheel with 51 teeth that takes into a wheel with 50 teeth, on the drum-shaft. On the drum-shaft there is a wheel with 20 teeth that takes into a wheel with 34 teeth, on the same axis with the winding-on drum. What is the surface velocity of the spindle when winding on the first stretch of yarn, if the winding-on drum throws off 60.0831 inches of chain, the winding-on drum being 4 inches in diameter?

60.0831 Inches of chain thrown off when winding on the first stretch of yarn.

ø

Diameter of the spindle,		4, Diameter of the wind-
in inches	.24	ing-on drum, in inches.
Teeth in the wheel on		20 Teeth in the wheel on
the same axis with		the drum-shaft that
the winding-on drum	34	takes into the wheel
		on the same axis with
		the winding-on drum.
Teeth in the wheel on		51 Teeth in the wheel on
the drum-shaft that		the same axis with the
takes into the wheel		drum.
on the same axis with		
the drum \ldots .	50	
Diameter of the drum,		1, Diameter of the spindle-
in inches	10	warl, in inches.

Worked out by Cancellation.					
	60.0831				
1.24	4.1				
$1 \cdot 2 \cdot 8.5 \cdot 34$	2(0.1				
1.50	$51 \cdot 212.5 \cdot 4.25 \cdot 1$				
1(0	60.0831 4·1 2(0·1 51·212.5·4.25·1 1				
. 60.0	Answer.				

The same without Cancellation.Dividend. $\frac{60.0831 \times 4 \times 20 \times 51}{.24 \times 34 \times 50 \times 10} = 60.0831$

Answer.

.

DRESSING-MACHINE.

A dresser is driven from an upright shaft, making 180 revolutions per minute, by a train of three pairs of pulleys and one pair of wheels; the driving wheel has 96 teeth, and the driving pulleys are 20, 18, and 10 inches in diameter, respectively. How many teeth should there be in the driven wheel; and what should be the diameter of the driven pulleys, respectively, to drive the first driven shaft of the dresser 100 revolutions per minute?

Revolutio	ons of	the	first	
driven	shaft	of	the	
dresser	per n	ainu	te .	100

- 180 Revolutions of the upright shaft per minute.
 - 96 Teeth in the driving wheel.
 - 20, Diameter of the first driving pulley, in inches.
 - 18, Diameter of the second driving pulley, in inches.
 - 10, Diameter of the third driving pulley, in inches.

Worke	ed out.
1(00	180
	96
	2(0
	18
	1(0

					180
					96
					1080
					1620
					17280
					2
					34560
					18
					276480
					34560
В	•			1(0)622080
В	•	•	•		3)62208
	(0	Con	tin	uei	<i>ī</i> .)

DRESSING-MACHINE.

	С	ļ	•	•	•	3)20736
\mathbf{A}	•	•	•	•	•	4)6912
\mathbf{A}		•				2)1728
A		•	•	•	•	. 2)864
A			•			. 4)432
	C	ļ	•	•		. 3)108
	C					. 3)36
		I).			. 12)12

A. $4 \times 2 \times 2 \times 4 = 64$ Teeth in the driven wheel.

B. $10 \times 3 = 30$, Diameter of the first driven pulley, in inches.

C. $3 \times 3 \times 3 = 27$, Diameter of the second driven pulley, in inches.

D. 12 ==== 12, Diameter of the third driven pulley, in inches.

Answer.

9

From the particulars found in the preceding example, find the revolutions per minute of the first driven shaft of the dresser.

COTTON MANUFACTURE.

Worked out by Cancellation.

	18(0.6.2)
$1 \cdot 2 \cdot 8 \cdot 64$	$\frac{18(0.6.2}{96.12.1}$
1.3(0	
1.9.27	
1.12	10

 $10 \times 5 \times 2 = 100$

Answer.

The same without Cancellation. Dividend . . . $\frac{180 \times 96 \times 20 \times 18 \times 10}{64 \times 30 \times 27 \times 12} = 100$ Answer.

The first driven shaft makes 100 revolutions per minute, and drives the centre beam by a train of 4 pairs of wheels and one pair of cones. The large end of the driving cone is 9 inches in diameter, and the driving wheels have 50, 20, 20, and 20 teeth respectively. What should be the diameter of the small end of the driven cone; and how many teeth should there be in the driven wheels, respectively, to give the empty beam a surface velocity of 4 yards per minute, the beam being 5 inches in diameter?

> 100 Revolutions per minute of the first driven shaft.

DRESSING-MACHINE.

	9, Diameter of the large
	end of the driving
	cone, in inches.
	50 Teeth in the first driv-
	ing wheel.
	20 Teeth in the second
	driving wheel.
	20 Teeth in the third driv-
	ing wheel.
	20 Teeth in the fourth
	driving wheel.
Inches in one yard 36	5, Diameter of the empty
	beam, in inches.
	3.1416, Circumference.
Surface velocity per	,
minute of the empty	
beam, in yards 4	
	d out.
11 07 112	100
	9.3
	50
	20
	20
•	20.5
1.3.36	5
2000	3.1416.2618
1.4	
L	

		.2618
		5
		1.3090
		5
		6.5450
		20
		130.9000
		20
		2618.0000
		2018.0000
		130900.0000
		130900.0000
		392700.0000
		100
Е.	10)39	9270000.0000
Е.		10)3927000
		. 5)392700
		. 5)78540
(0	mting	([au

(Continued.)

В

В

DRESSING-MACHINE.

в	•	•	•	•	•	•	2)15708
	1)			•	•	. 2)7854
(C	•	•	•	•	•	. 5)3927
(C	•	•		•	•	. 2)785.4
(C	•	•	•		•	. 5)392.7
])	•	•	•	•	. 5)78.54
])	•	•	•	•	3)15.708
А.		•	•		•	5	.236)5.236
							1

A. 5.236 = 5.236, Diameter of the small end of the driven cone, in inches.

B. $5 \times 5 \times 2 = 50$ Teeth in the first driven wheel.

C. $5 \times 2 \times 5 = 50$ Teeth in the second driven wheel.

D. $5 \times 3 \times 2 = 30$ Teeth in the third driven wheel.

E. $10 \times 10 = 100$ Teeth in the beam-flange, or fourth driven wheel.

Answer.

From the particulars found in the preceding example, find the surface velocity of the empty beam per minute.

Worked out by Cancellation.

 $\begin{array}{c|cccc} & 100 \cdot 1 \\ \hline 1 \cdot 2.618 \cdot 5.236 & 9 \cdot 1 \\ \hline 1 \cdot 50 & 50 \cdot 1 \\ \hline 1 \cdot 50 & 2(0 \cdot 1 \\ \hline 1 \cdot 3(0 & 2(0 \\ \hline 1 \cdot 100 & 20 \cdot 5 \\ \hline 1 \cdot 4 \cdot 36 & 5 \cdot 1 \\ \hline 3.1416 \cdot 1.2 \cdot 4 \end{array}$

 $5 \times 2 \times .4 = 4$ yards.

Answer.

The same without Cancellation.

Div., $\frac{100 \times 9 \times 50 \times 20 \times 20 \times 20 \times 5 \times 3.1416}{5.236 \times 50 \times 50 \times 30 \times 100 \times 36} = 4 \text{ yards.}$ Answer.

N.B.—The surface velocity of the empty beam, as shown in the preceding example, is as quick as will probably ever be required for any kind of work; in practice it is found necessary to vary the velocity according to circumstances, such as facilities for drying, fineness of yarn, and the progressively increasing size of the beam, which is done by causing the belt to traverse on the cones.

As some kinds of work requires more wind than others,

and as local circumstances has more or less to do with making it effective, it is impossible to lay down any rule that will answer in all cases with respect to quantity. It is estimated by some mechanicians that the circumference of a fan should have a velocity of 2600 yards per minute, to equal a storm of wind; the way to find which or any other velocity that may be required, will be found in the following example:

A fan, one yard in diameter, is driven from an upright shaft making 180 revolutions per minute, by a train of 3 pairs of pulleys and one pair of wheels. The driving pulleys are 42, 39, and 20 inches in diameter, respectively, and the driving wheel has 96 teeth. What should be the diameter of the driven pulleys, respectively, and how many teeth should there be in the driven wheel, to give the circumference of the fan a velocity of 2600 yards per minute?

- Velocity of the circumference of the fan per minute, in yards, 2600
- 180 Revolutions per minute of the upright shaft.
 - 96 Teeth in the driving wheel.
 - 42, Diameter of the first driving pulley, in inches.

39, Diameter of the second
driving pulley, in
inches.
20, Diameter of the third
driving pulley, in
inches.
1, Diameter of the fan, in
yards.
3.1416, Circumference.

	ed out.
1.13.26(00	18(0.9
	96
	42
	39.3
	2(0
	1
	3.1416
	0.0

96
9
864
42
1728
3456

ł

							36288
							3
							108864
							2
							217728
							3.1416
							1306368
							217728
						8	70912
						21	7728
						653	184
А.			•		-	12)684	014.2848
А.	•					7)57	001.1904
В	•	•	•	•	•	. 6)8	143.0272
В	•		•	•		. 6)1	357.1712
	С	•	•	•	•	. 8)	226.1952
	С		•	•	•	. 4)28.2744
		D	•		•	7.068	6)7.0686

A. $12 \times 7 = 84$ Teeth in the driven wheel:

B. $6 \times 6 = 36$, Diameter of the first driven pulley, in inches.

C. $8 \times 4 = 32$, Diameter of the second driven pulley, in inches.

D. 7.0686 = 7.0686, Diameter of the third driven pulley, or pulley on the same axis with the fan, in inches. Answer.

From the particulars found in the preceding example, find the velocity per minute of the circumference of the fan.

Worked out by Cancellation.

	180.80.10
1.7.84	96.8
1.6.36	$42 \cdot 6 \cdot 1$
1.4.32	39.6.5
$1 \cdot 2.25 \cdot 7.0686$	20.5
	1
	3.1416.1

 $10 \times 8 \times 5 \times 6.5 = 2600$ yards.

Answer.

The same without Cancellation. Dividend, $\frac{180 \times 96 \times 42 \times 39 \times 20 \times 3.1416}{84 \times 36 \times 32 \times 7.0686} = 2600$ yards.

Answer.

In practice it is found, that on account of shrinkage in weaving a certain kind of cloth, that it takes 1.0472 yards of warp to make one yard of cloth. The warp is measured by the neck-roller, on the end of which there is a worm that takes into a wheel with 100 teeth, and every time the wheel makes a revolution it causes a mark to be made on the warp; this mark indicates where to cut the cloth into lengths called cuts (hence the term cut-mark). What should be the diameter of the neck-roller, to mark the warp into lengths requisite for weaving cuts of cloth 42 yards long ?

	42, Length of a cut of cloth, in yards.
	36 Inches in one yard.
Teeth in the wheel that	
takes into the worm. 100	
Ratio of circumference	
to diameter 3.1416	
	1.0472, Length of warp re-
	quired for one yard of
	cloth, in yards.

Worked out by Cancellation. $\begin{vmatrix}
42 \cdot 4.2 \cdot .42 \\
36 \cdot 12 \\
1 \cdot 10 \cdot 100
\end{vmatrix}$ (Continued.)

$$12 \times .42 = 5.04$$
 inches.

Answer.

The same without Cancellation.

Dividend	•	•	•	•	•	$\frac{42 \times 36 \times 1.0472}{5.04} = 5.04$
						100×3.1416 0.01
						Answer.

From the particulars found in the preceding example, find the number of yards in a cut of cloth.

Worked out by Cancellation. 1.12.36 3.1416.3.1 100 1.1.0472

 $100 \times .42 = 42$

Answer.

The same without Cancellation.

Dividend $5.04 \times 3.1416 \times 100 = 42$ Divisor $36 \times 1.0472 = 42$

Answer.

POWER-LOOM.

A loom is driven from an upright shaft making 180 revolutions per minute, by a train of two pairs of pulleys and one pair of wheels. The driving pulleys are $17\frac{1}{2}$, and 8 inches in diameter, and the driving wheel has 96 teeth. What should be the diameter of the driven pulleys, respectively, and how many teeth should there be in the driven wheel, to drive the loom 140 picks per minute?

Picks per minute of the	180 Revolutions per minute
loom 140	of the upright shaft.
	96 Teeth in the driving
	wheel.
	17.5, Diameter of the first
	driving pulley, in
	inches.
	8, Diameter of the second
	· driving pulley, in
	inches.

Worke	ed out.
1.7.14(0	18(0.9
	96
	$17.5 \cdot 2.5$
	8

(Continued.)

									96
									9
									${864}$
									8
									$\overline{6912}$
									2.5
									13824
A		•		•				8)	17280.0
A		•				•	•		8)2160
		С	•	•	•		•		12)270
	в		•					2	2.5)22.5
•									· 1

A. $8 \times 8 = 64$ Teeth in the driven wheel.

B. 22.5 === 22.5, Diameter of the first driven pulley, in inches.

C. 12 = 12, Diameter of the second driven pulley on the crank-shaft of the loom, in inches.

Answer.

From the particulars found in the preceding example, find how many picks per minute the loom will make. Worked out by Cancellation.

 $\begin{array}{c|c} & 180 \cdot 200 \\ \hline 1 \cdot 8 \cdot 64 & 96 \cdot 12 \cdot 1 \\ 1 \cdot .9 \cdot 4 .5 \cdot 22 .5 & 17 \cdot 5 \cdot 3 \cdot 5 \cdot .7 \\ \hline 1 \cdot 12 & 8 \cdot 1 \end{array}$

 $200 \times .7 = 140$ Answer.

The same without Cancellation.

Dividend . . . $\frac{180 \times 96 \times 17.5 \times 8}{64 \times 22.5 \times 12} = 140$ Divisor Answer.

The ratchet wheel of the take-up motion has 80 teeth, and takes up one tooth every two picks, and the emeryroller wheel has 90 teeth. How many teeth should there be in the wheel that takes into the emery-roller wheel; and what should be the circumference of the emery-roller to produce cloth with 72 picks per inch?

> 80 Teeth in the ratchetwheel. 2, Takes up one tooth every two picks. 90 Teeth in the emery-roller wheel.

Picks per inch in the	
cloth 72	
Work	ed out.
	80.10
	2 90·10
	90.10
1.9.72	
	10
	10
	100
	2
Α	8)200
Α	2)25
	2)20
В	12.5)12.5

1

A. $8 \times 2 = 16$ Teeth in the wheel that takes into the emery-roller wheel.

B. 12.5 === 12.5, Circumference of the emery-roller, in inches.

Answer.

178

Pieles

" inch in the

From the particulars found in the preceding example, find the picks per inch in the cloth.

 $18 \times 4 = 72$

Answer.

The	same	without	Cancellation.
-----	------	---------	---------------

Dividend	•	•	•	•	•	•	•	$\frac{80 \times 2 \times 90}{2} = 72$
								12.5×16
								Answer.

From the particulars found in the preceding example, find the number of teeth in the ratchet wheel.

Worked out by Cancellation. 1.10.90
16
12.5.1.25
72.8.4
1.2

 $16 \times 4 \times 1.25 = 80$

Answer.

COTTON MANUFACTURE.

The same without Cancellation.

From the particulars found in the preceding example, find how many picks the loom makes while the ratchetwheel moves one tooth.

Worked out by	/ Cancellation.				
1.10.90	16.1				
	16·1 12.5·2.5 72·8·.8				
	$72 \cdot 8 \cdot .8$				
1.5.80					
$2.5 \times .8 = 2$					

Answer.

The same without Cancellation.

Dividend $\frac{16 \times 12.5 \times 72}{90 \times 80} = 2$ Divisor Answer.

From the particulars found in the preceding example, find the number of teeth in the emery-roller wheel.

POWER-LOOM.

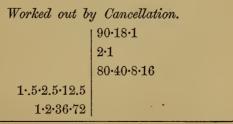
Worked out by Cancellation. . | 16.1 12.5.2.5 72.36 1.5.80 1.2 |

 $36 \times 2.5 = 90$

Answer.

From the particulars found in the preceding example, find the number of teeth in the wheel that takes into the emery-roller wheel.

16



Answer.

	The	sa	me	w	tho	nıt	Ca	ince	ellation.
Dividend	ł.								$\frac{90 \times 2 \times 80}{16} = 16$
									12.5×72
									Answer.

From the particulars found in the preceding example, find the circumference of the emery-roller.

Worked out by	/ Cancellation.
1.16	90·10 2·1 80·5·1.25
	$2 \cdot 1$
	80.5.1.25
$1 \cdot 4 \cdot 8 \cdot 72$	

 $10 \times 1.25 = 12.5$ inches.

Answer.

If the circumference of the emery-roller is $12\frac{1}{2}$ inches, what will be its diameter ?

 $12.5 \div 3.1416 = 3.9788 + \text{ inches.}$ Answer.

If a change-wheel with 16 teeth puts in 72 picks per inch, how many picks per inch will a change-wheel with 18 teeth put in ?

Worked out by	Cancellation.
1	72.4
1.18	16
$16 \times 4 -$	- 64 Answer

	T_{i}	he	sa	me	w	ithe	out	Ca	anc	ella	ution.
Divider	ıd		•		•	•	•	•			$\frac{72 \times 16}{2} = 64$
Divisor											
											Answer.

The taking-up ratchet-wheel has 96 teeth, and on the same axis there is a wheel that takes into a wheel with 90 teeth, on the same axis with the emery-roller. How many teeth are there in the wheel on the same axis with the ratchet-wheel; and what is the circumference of the emery-roller, if the loom is putting in 100 picks per inch, and taking up one tooth every 2 picks?

	96 Teeth in the ratchet-
	wheel.
	90 Teeth in the wheel on
	the same axis with the
	emery-roller.
Picks per inch in the	2 Picks put in while the
cloth 100	ratchet-wheel takes up
	one tooth.

Work	ed out.
1.10(0	96 9(0•.9 2 *

96				
.9				
86.4				
2				
5)172.8		•	•	A
3)34.56	•	•	•	A
			~	~
11.52)11.52		•	3]
1				

A. $5 \times 3 = 15$ Teeth in the wheel on the same axis with the ratchet-wheel.

B. 11.52 <u>11.52</u> Circumference of the emeryroller, in inches.

Answer.

From the particulars found in the preceding example, find the picks per inch in the cloth.

```
Worked out by Cancellation.
```

```
100 \times 2 \times .5 = 100
```

Answer.

The	same	without	Cancellation.

Dividend		•	•		•	$\frac{2 \times 96 \times 90}{100} = 100$
						15×11.52
						Answer.

The taking-up ratchet-wheel containing 96 teeth takes up one tooth every 2 picks. On the same axis with the taking-up ratchet-wheel there is a wheel with 15 teeth that takes into a wheel on the same axis with the emery-roller containing 90 teeth. The diameter of the emery-roller is to that of the full beam as one to 3. The beam-flange containing 108 teeth takes into a wheel on a horizontal shaft. On the horizontal shaft there is also a wheel with 14 teeth that takes into a worm. On the same axis with the worm there is a wheel with 28 teeth that takes into a wheel on the same axis with the let-off ratchet-wheel; the latter wheel contains 120 teeth. How many teeth should there be in the wheel that takes into the beam-flange, and the wheel on the same axis with the let-off ratchet-wheel, if the latter wheel lets off one tooth per pick while weaving the first lap of a full beam, making no allowance for shrinkage in weaving?

Teeth in the taking-up	.5, The taking-up ratchet-
ratchet-wheel 96	wheel takes up one
	tooth every 2 picks,
	which is equal to one
	half tooth per pick.
Teeth in the wheel on	15 Teeth in the wheel on
the same axis with	the same axis with
the emery-roller 90	the taking-up ratchet
	wheel.
Relative diameter of the	1, Relative diameter of
full beam 3	the emery-roller.
	108 Teeth in the beam-
	flange.
	14 Teeth in the wheel that
	takes into the worm.
	28 Teeth in the wheel that
	takes into the wheel
	on the same axis with
	the let-off ratchet-
	wheel.
	120 Teeth in the let-off
·	ratchet-wheel.

Worked out.

.8.96	.5
1. 9(0	15.5
1.3	1
	108.9.1
	14
	28
	12(0.1.5

	28
	1.5
	14 0
	28
	42.0
	14
	1680
	420
	588.0
	5
	2940.0
	.5
Continued.)	

A	• •	•	•	•	1())1	470.00
в				•		•	7)147
В		•			•	•	7)21
A	•		•	•	•		. 3)3
							- 1

A. $10 \times 3 = 30$ Teeth in the wheel that takes into the beam-flange.

B. $7 \times 7 = 49$ Teeth in the wheel on the same axis with the let-off ratchet-wheel.

Answer.

From the particulars found in the preceding example, find how many teeth the let-off ratchet-wheel will move while the loom makes one pick.

Worked out by Cancellation.					
$\begin{array}{c} 1 \cdot 2 \cdot 8 \cdot 96 \\ 1 \cdot 9 (0 \\ 1 \cdot 3 \end{array}$	12(0.4.1				
	.5				
1.9(0	15.5.1				
1.3					
1.3.15.30	108.9.1				
	14.2.1				
1·3·15·30 1·7·49	28.4.2				
$2 \times .5 =$	=1 Answer.				

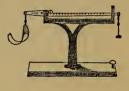
WEIGHING YARN, SLIVER, ETC.

The same without Cancellation. Dividend . $\frac{120 \times .5 \times 15 \times 108 \times 14 \times 28}{96 \times 90 \times 3 \times 30 \times 49} = 1.$

Answer.

WEIGHING YARN, SLIVER, ETC.

Correct instruments for weighing the sliver, roving, and yarn, in the various branches of carding and spinning, are of such vast importance in the manufacture of cotton



that the author has taken the liberty to mention a very excellent kind of scales, made by J. R. Brown & Sharpe, Providence, R. I. They are intended for very delicate weighing, the tenth of a grain being easily estimated by them. Their general construction is so simple that the cut will show it without a description. The length of the beam is about eight inches, and the long arm, which has a small weight sliding upon it, is divided into a hundred parts; these divisions indicate grains, and are numbered so as to be easily read. On the end of the long arm of the beam is a small pan, or hook, on which other weights are placed when more than 100 grains are required to be weighed. The extra weights are numbered 100, 200, 400, and 800, so that any number, from one to 1600 grains, can be weighed by them.

As will be seen, the following tables are all made with

a view to using some such scales as the above, but will answer equally well for any scales by which the weight in grains can be ascertained.

The following table for weighing with troy weight, and reckoning by avoirdupois weight, will be found useful to those who use ounces, pennyweights, and grains, with the "beam and pans" scales:

24 grains equal one pennyweight.

18 pennyweights $5\frac{1}{2}$ grains, troy, equal one ounce avoirdupois.

16 ounces equal one pound.

The home-made weights too commonly used, made from bits of tin, wire, lead, or other small pieces of metal, cannot, as a general thing, be depended upon as being very correct, not because they cannot be made a definite weight, but rather because few have the means of making them Suppose that for want of sufficiently delicate tools in so. adjusting a weight of 175 grains, we should happen to make it 176 grains; the difference would be but one grain, yet the consequence would be considerable. 175 grains weight of No. 40 cotton yarn, is 840 yards in length, and 176 grains weight of the same is 844.8 yards in length, a difference of 4.8 yards per hank, or 192 yards per pound. Very true, yarn can be made as regular in size by using such weights; but as to the accuracy of the size, it cannot be called better than a mere guess.



PART II.

CARDING.

YARN, ROVING, AND SLIVER TABLES.

54 inches = 1 thread. 4320 inches = 80 = 1 lea. 30240 inches 560 7 = 1 hank, or 840 yards.

Counts of yarn and hank-roving signify the number of hanks in one pound.

Whatever number of yards are weighed, multiply them by the number of grains in one pound avoirdupois, for a dividend, and their weight in grains by the number of yards in one hank for a divisor, and the quotient will be the number.

One hank contains 840 yards, and one pound avoirdupois contains 14 ozs. 11 dwts. 16 grains, troy, or 7000 grains. Hence, the yards in one hank are to the grains in one pound as 840 is to 7000, or 12 to 100.

N.B.—See tables on page 281.

Example.

If 50400 yards weigh one pound, what is the number ?

Worked out by Cancellation. 1.7(000 | 5040(0.720.60 1.12 | 1(00

60

Answer.

The same without Cancellation.

Dividend					$50400 \times 100 = 60$
					7000×12
					Answer.

How many yards are there in one pound of No. 60 yarn?

Worked out by Cancellation.

$$\begin{array}{c|c}
70(00 \\
60 \\
1(00 \\
12
\end{array}$$

 $70 \times 60 \times 12 = 50400$

Answer.

The same without Cancellation.Dividend \cdot \cdot $\frac{7000 \times 60 \times 12}{100} = 50400$ Divisor \cdot \cdot 100Answer.

N.B.—The same result will be found by multiplying the number of yards in one hank by the number.

$$Example.$$

$$840 \times 60 = 50400.$$

Answer.

What is the weight of 50400 yards of No. 60?

V

Vorked out by Cancellation.

$$1.6(0)$$
 1.12
 $10(0)$

 $700 \times 10 = 7000$ grains, or one pound avoirdupois. Answer.

N.B.—It is by the above rule that all the compendious tables are made.

Examples explanatory of the sliver, roving, and yarn tables. What is the weight of 6 yards of No. .025 sliver?

No. of the sliver	•	025	6, Length of sliver,	in
			yards.	
$\frac{1}{70}$ of 840	•	. 12	$100 \frac{1}{70}$ of 7000.	

Worked out by Cancellation. 1.025 | 6.1 1.2.12 | 100.50.2000

2000 grains.

Answer.

The same without Cancellation.

Dividend	•	•	•	•	•	$\frac{6 \times 100}{2000} = 2000$ grains.
Divisor .						$.025 \times 12$
	•					Answer.

If 6 yards of sliver weighs 2000 grains, what is the number?

Worked out by Cancellation.	
1.2000 6.1	
$\begin{array}{c c} 1 \cdot 2000 & 6 \cdot 1 \\ 1 \cdot 2 \cdot 12 & 100 \cdot 50 \cdot .025 \end{array}$	
.025	Answer.
The same without Cancellation.	
Dividend 6×100	.= .025

Divisor $\frac{1}{2000 \times 12}$ Answer.

How many yards of No. .025 sliver will it take to weigh 2000 grains ?

		Wa	ork	ed	ou	t b	y (Cancellation.
20(00 .025 1(00 12								
	.025							
	1(00 12							
	$20 \times 12 \times .025 = 6$							
								Answer.
	1	'nе	sa	me	w	itho	out	Cancellation.
Dividen	ıd							$2000 \times .025 \times 12_{-6}$
Divisor								100

Answer.

What is the weight of 12 yards of a four-hank roving ?

Worked out by Cancellation.	
$1.4 \mid 12.1$	
$ \begin{array}{c c} 1 \cdot 4 & 12 \cdot 1 \\ 1 \cdot 12 & 100 \cdot 25 \end{array} $	
25 grains.	Answer.
The same without Cancellation	•
Dividend 12×100 4×12	25 grains.
Divisor $\ldots \ldots 4 \times 12$	

Answer.

I 12 yards of roving weigh 25 grains, what is the number?

Worked out by Cancellation.	
$1.25 \mid 12.1$	
$\begin{array}{c c} 1 \cdot 25 & 12 \cdot 1 \\ 1 \cdot 12 & 100 \cdot 4 \end{array}$	
4	Answer.

The same without Cancellation.

Dividend	1	•	•	•	•	•	•		$\frac{12 \times 100}{4} = 4$
									25×12
									Answer.

How many yards of a four-hank roving will it take to weigh 25 grains ?

Worked out by Cancellation.	
$\begin{vmatrix} 25 \cdot 1 \\ 4 \cdot 1 \end{vmatrix}$	
4.1	
1.4.100 12	
12	Answer.
The same without Cancellation.	
Dividend $25 \times 4 \times 1$	2_{-12}
Divisor $\dots \dots \dots$	12
	Answer.

What is the weight of 840 yards or one hank of No. 40 yarn?

 $25 \times 7 = 175$ grains.

Answer.

The same without Cancellation. Dividend $\frac{840 \times 100}{40 \times 12} = 175$ grains.

Answer.

If 840 yards of yarn weigh 175 grains, what is the number?

Worked out by	y Cancellation.
1.7.175	840.70.10
1.12	840·70·10 100·4

 $10 \times 4 = 40$ Answer.

The same without Cancellation.	The	same	without	Cancellation.	
--------------------------------	-----	------	---------	---------------	--

How many yards of No. 40 will it take to weigh 175 grains?

Worked out by Cancellation.					
	175				
1.10(0	4(0.4				
1.10(0	12				
$175 \times 12 \times .4 = 840$ Answer.					
The same witho	ut Cancellation.				
Dividend	$.175 \times 40 \times 12_{-840}$				

Divisor \dots $\frac{175 \times 40 \times 12}{100} = 840$ Answer.

If 30 ounces of cotton is spread 48 inches in length, what proportion of a hank is it?

Weight of a spread, in	16 Ounces in one pound.
ounces 30	
Inches in one yard 36	48, Length of a spread, in
	inches.
Yards in one hank	

	y Cancellation.
30	16
9.36	48.4.1
70.840	16 48·4·1

 $16 \div 70 \times 30 \times 9 = 0.00084656_{189}^{16}$ Answer.

The same without Cancellation. Dividend . . . $\frac{16 \times 48}{30 \times 36 \times 840} = 0.00084656\frac{16}{189}$ Divisor . . . $30 \times 36 \times 840$ Answer.

If 30 ounces of cotton is spread on 48 inches of lattice, and the doublings are 3 at the finisher-lapper, 80 at the breaker-card railway, 8 at the finisher-card railway, 2 at the first head of drawing, 4 at the second head of drawing, 2 at the third head of drawing, and 2 at the fine flyframe, what should be the draught at the mule, the fine fly-frame, the coarse fly-frame, the third head of drawing, the second head of drawing, the first head of drawing, the railway head, the finisher-cards, the breaker-cards, the finisher-lapper, and the breaker-lapper, to produce No. 40, making an allowance of 14 per cent. for loss in working ?

Ounces in one pound . 16	30, Weight of a spread, in
	ounces.
Length of a spread, in	36 Inches in one yard.
inches 48	
	840 Yards in one hank.
	40 No. produced.
Cent 100	86, Cent less 14.
	3, Doubling at the finisher-
	lapper.

80, Doubling at the break-
er-card railway.
8, Doubling at the finish-
er-card railway.
2, Doubling at the first
head of drawing.
4, Doubling at the second
head of drawing.
2, Doubling at the third
head of drawing.
2, Doubling at the fine
fly-frame.

Worked out.

$1 \cdot 2 \cdot 16$	3(0
$1 \cdot 4 \cdot 48$	36
	84(0.7
	40
1(00	86
	3
	80
	8.1
	2.1
	4.1
	2
	2

(Continued.)

36	
3	
108	
7	
756	
40	
30240	
86	
181440	
241920	
2600640	
3	
7801920	
80	
624153600	
2	
1248307200	
2	
2)2496614400	G
	(Continued.) 9*

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	D	•	•	•	•	•	•	2)1248307200
	D	•	•	•	•	•	•	2)624153600
	E	•	•	•	•	•	•	2)312076800
	E	•	•	•	•	•	•	2)156038400
		F	•	•	•	•	•	. 2)78019200
		F	•	•	•	•	•	. 2)39009600
				н	•		•	. 2)19504800
		•		H	•	•		. 2)9752400
				н	•	•	•	. 2)4876200
				н	•		•	. 2)2438100
С		•	•				•	. 2)1219050
				1	•	•	•	2)609525
				I	•	•	•	. 2)304762.5
				1	•	•	•	. 2)152381.25
				1	•			. 2)76190.625
	10			I				5)38095.3125
	(U)	ont	in	ued.)			

	С	•	•	•	•	•	•	•	•	3)7619.0625
А.	•	•	•	•	•		•			3)2539.6875
А.	•	•	•	•	•		•	•	•	3)846.5625
						J		•	•	3)282.1875
					H	•	•		•	. 5)94.0625
В		•	•	•		•		•		. 7)18.8125
							K			2.6875)2.6875
										1

A. $3 \times 3 = 9$, Draught at the mule.

B. 7 = 7, Draught at the fine fly-frame.

C. $3 \times 2 = 6$, Draught at the coarse fly-frame.

D. $2 \times 2 = 4$, Draught at the third head of drawing.

E. $2 \times 2 = 4$, Draught at the second head of drawing.

F. $2 \times 2 = 4$, Draught at the first head of drawing.

G. 2 ____ 2, Draught at the railway head.

H. $5 \times 2 \times 2 \times 2 \times 2 = 80$, Draught at the finishercards.

I. $5 \times 2 \times 2 \times 2 \times 2 = 80$, Draught at the breakercards.

J. 3 == 3, Draught at the finisher-lapper.

K. 2.6875 == 2.6875, Draught at the breaker-lapper. Answer. From the particulars found in the preceding example, find the number produced.

Worked out by Cancellation.		
1.3(0)	16.2.1	
1.9.36	48·4·1	
1.7.84(0		
$1 \cdot 2.6875 \cdot 10.75 \cdot 43 \cdot 86$	1(00	
	$2.6875 \cdot 1$	
1.3	3.1	
	80.1	
1. 80	80.40	
1.8	$2 \cdot 1$	
1.2	4·1	
1.4	4.1	
1.2	4·1	
	6.2.1	
1.2	7.1	
	9.1	

40

Answer.

	The same without Cancellation.	
Dividend,	$16 \times 48 \times 100 \times 2.6875 \times 3 \times 80 \times 80 \times 2 \times$	4
	$\times 4 \times 4 \times 6 \times 7 \times 9$	-40
Divisor,	$30 \times 36 \times 840 \times 86 \times 3 \times 80 \times 8 \times 2 \times 4 \times 2$	
	$\times 2$	
	A	

From the particulars found in the preceding example, find the weight of a spread.

Worked out by Cancellation.		
	16.2.1 Ounces in one pound.	
· 1·9·36	48·4·1	
1.7.84(0		
$1 \cdot 2.6875 \cdot 10.75 \cdot 43 \cdot 86$	10(0.5	
	2.6875.1	
1.3	3.1	
	80.1	
1.80	80.2.1	
1.8	2.1	
1.2	4.1	
1.4	4.1	
1.2	4.1	
	6	
1.2	7.1	
	9.1	
1.40		
6×5 ====	30 ounces. Answer.	

	The same without Cancel	llation.
Dividend,	$16 \times 48 \times 100 \times 2.6875 \times 3$	$\times 80 \times 80 \times 2 \times 4$
	$\times 4 \times 4 \times 6 \times 7 \times 9$	=30
Divisor,	$36 \times 840 \times 86 \times 3 \times 80 \times 8$	$\times 2 \times 4 \times 2 \times 2$
	imes 40	Answer.

From the particulars found in the preceding example, find the length of a spread.

Worked out by Cancellation.		
	36.4 Inches in one yard.	
1.2.16	3(0.1	
	84(0.12	
1(00	$86 \cdot 21.5 \cdot 5.375 \cdot 2.6875 \cdot 1$	
1.2.6875		
1.3	3.1	
1.80		
1.2.80	80.1	
1.2	8.1	
1.4	$2 \cdot 1$	
1.4	4.1	
1.4	2.1	
1.3.6		
1.7	2.1	
1.9		
	40.1	

 $12 \times 4 = 48$ inches.

Answer.

	The same without Cancella	tion.
Dividend,	$36 \times 30 \times 840 \times 86 \times 3 \times 80 \times$	$8 \times 2 \times 4 \times 2$
	$\times 2 \times 40$	
Divisor,	$16 \times 100 \times 2.6875 \times 3 \times 80 \times 80 \times 2 \times 4$	
	imes 4 $ imes$ 4 $ imes$ 6 $ imes$ 7 $ imes$ 9	Answer.

From the particulars found in the preceding example, find the decimal of a hank of a spread.

Worked out by Cancellation.

4(0
$2 \cdot 1$
2.1
4·1
$2 \cdot 1$
8.1
80.1
3.1
86.21.5.5.375.2.6875.1

 $^{4 \}div 9 \times 7 \times 3 \times 5 \times 5 = 0.00084656 \frac{16}{189}$ Answer.

The same without Cancellation.

Div. $\frac{40 \times 2 \times 2 \times 4 \times 2 \times 8 \times 80 \times 3 \times 68}{9 \times 7 \times 6 \times 4 \times 4 \times 4 \times 2 \times 80 \times 80} = 0.00084656_{18.9}^{1.6}$ $\times 3 \times 2.6875 \times 100$

Answer.

From the particulars found in the preceding example, find what the number would be if there was no loss in working.

Worked out by Cancellation.		
1.5.30	$ 16 \cdot 2 \cdot 1$	
1.4.36	48·4·2	
1.7.84(0		
	$2.6875 \cdot .5375$	
1.3	3.1	
	80.1	
1. 80	8(0	
1 ·8	2.1	
1.2	4·1	
1.4	4·1	
$1\cdot 2$	4	
	6·1	
1.2	7.1	
	9.1	

 $.5375 \times 2 \times 8 \times 4 = 34.4$ Answer.

The same without Cancellation.

Div.	$16 \times 48 \times 2.6875 \times 3 \times 80 \times 80 \times 2 \times 4 \times 4 \times 4$
	$\frac{\times 6 \times 7 \times 9}{= 34.4}$
Divis.	$30 \times 36 \times 840 \times 3 \times 80 \times 8 \times 2 \times 4 \times 2 \times 2$
	Answer.

N.B.—The particulars found in the fourteen following examples, are taken from the above.

From the particulars found in the preceding example, find the decimal of a hank, produced at the breaker-lapper, commencing at the length and weight spread on the lattice, making no allowance for loss in working.

Worked out by Cancellation.

30	16
9.36	48.4.1
70.840	
	2.6875

 $2.6875 \times 16 \div 70 \times 9 \times 30 = 0.00227 \frac{97}{189}$ Answer.

The same without Cancellation.

Dividend . . . $\frac{16 \times 48 \times 2.6875}{30 \times 36 \times 840} = 0.00227 \frac{9.7}{1.8.9}$ Answer.

Find the decimal of a hank produced at the breakerlapper, commencing at the number produced, making no allowance for loss in working.

COTTON MANUFACTURE.

Worked out by Cancellation.		
	34.4.8.6.86	
9		
7	2.1	
6		
1.2.4	2.1	
1.4	4.1	
1.4	2.1	
1.2	8.1	
1.10.80	80.1	
1.80		
1.3	3.1	

 $.86 \div 9 \times 7 \times 6 = 0.00227 \frac{97}{189}$ Answer.

The same without Cancellation.

Div. $\frac{34.4 \times 2 \times 2 \times 4 \times 2 \times 8 \times 80 \times 3}{9 \times 7 \times 6 \times 4 \times 4 \times 4 \times 2 \times 80 \times 80 \times 3} = 0.00227_{\frac{97}{189}}$

Answer.

Find the decimal of a hank produced at the breakercards, commencing at the length and weight spread on the lattice, making no allowance for loss in working.

> Worked out by Cancellation. 1.5.30 | 16.4.1 9.36 | 48.8 (Continued.)

$$\begin{array}{c|c} \mathbf{21} \cdot \mathbf{84}(0 \\ \mathbf{2.6875} \cdot .5375 \\ \mathbf{1} \cdot \mathbf{3} \\ \mathbf{3} \cdot \mathbf{1} \\ \mathbf{8}(0 \end{array}$$

$$5375 \times 8 \times 8 \div 21 \times 9 = 0.182 \frac{2}{189}$$

Answer.

The same without Cancellation.
Dividend,
$$\frac{16 \times 48 \times 2.6875 \times 3 \times 80}{30 \times 36 \times 840 \times 3} = 0.182_{\frac{2}{189}}$$
Answer.

Find the decimal of a hank produced at the breakercards, commencing at the number produced, making no allowance for loss in working.

Worked out by Cancellation.	
	34.4
9	
7	2.1
3.6	
1.4	2.1
1.4	4.1
1.2.4	2.1
1.2	8.2.1
1.80	80.1

 $34.4 \div 9 \times 7 \times 3 = 0.182 \frac{2}{139}$ Answer.

COTTON MANUFACTURE.

The same without Cancellation.Dividend, . . $34.4 \times 2 \times 2 \times 4 \times 2 \times 8 \times 80$ Divisor . . . $9 \times 7 \times 6 \times 4 \times 4 \times 4 \times 2 \times 80$ Answer.

Find the decimal of a hank produced at the railwayhead, commencing at the length and weight spread on the lattice, making no allowance for loss in working.

Worked out by	y Cancellation.
3.6.30	16
3·6·30 9·36 7·84(0	48.4.1
7.84(0	
•	$2.6875 \cdot .5375$
1.3	3·1 80·1 8(0·1 2·1
	80.1
1.80	8(0.1
1.8	2.1

 $.5375 \times 16 \div 3 \times 9 \times 7 = 0.0455_{\frac{5}{189}}$

Answer.

	The same without Cancellation.
Dividend,	$\frac{16 \times 48 \times 2.6875 \times 3 \times 80 \times 80 \times 2}{16 \times 10^{-5} \times 1$
Divisor,	$30 \times 36 \times 840 \times 3 \times 80 \times 8$

Answer.

Find the decimal of a hank produced at the railwayhead, commencing at the number produced, making no allowance for loss in working.

Worked out by Cancellation.		
	$34.4 \cdot 8.6$	
9		
7	$2 \cdot 1$	
3.6		
1.2.4	$2 \cdot 1$	
1.4	4.1	
7 3·6 1·2·4 1·4 1·4	2.1	

 $8.6 \div 9 \times 7 \times 3 = 0.0455 \frac{5}{18.9}$ Answer.

The same without Cancellation.

Dividend . $\frac{34.4 \times 2 \times 2 \times 4 \times 2}{9 \times 7 \times 6 \times 4 \times 4 \times 4} = 0.0455 \frac{5}{189}$

Answer.

Find the decimal of a hank produced at the first head of drawing, commencing at the length and weight spread on the lattice, making no allowance for loss in working.

> Worked out by Cancellation. 3.6.30 | 16 9.36 | 48.4.1 7.84(0 |(Continued.)

	$2.6875 \cdot .5375$
1.3	3.1
	8(0.1
1 ·80	80.1
1.8	$2 \cdot 1$
$1 \cdot 2$	$4\cdot 2$

 $.5375 \times 16 \times 2 \div 9 \times 7 \times 3 = 0.091_{\frac{1}{189}}$

Answer.

The same without Cancellation. Div. $\frac{16 \times 48 \times 2.6875 \times 3 \times 80 \times 80 \times 2 \times 4}{30 \times 36 \times 840 \times 3 \times 80 \times 8 \times 2} = 0.091 \frac{1}{189}$ Answer.

Find the decimal of a hank produced at the first head of drawing, commencing at the number produced, making no allowance for loss in working.

Worked out by Cancellation.

	$34.4 \cdot 8.6$
9	
7	2
3.6	
7 3·6 1·4 1·4	$2 \cdot 1$
1.4	4·1

 $8.6 \times 2 \div 9 \times 7 \times 3 = 0.091_{18.9}$ Answer.

The same without Cancellation.
Dividend . . .
$$\frac{34.4 \times 2 \times 2 \times 4}{9 \times 7 \times 6 \times 4 \times 4} = 0.091_{\frac{1}{189}}$$

Divisor $9 \times 7 \times 6 \times 4 \times 4$
Answer.

Find the decimal of a hank produced at the third head of drawing, commencing at the length and weight spread on the lattice, making no allowance for loss in working.

Worked out by Cancellation.		
3.6.30	16	
9.36	48.4	
7.84(0		
	2.6875.5375	
1.3	3.1	
	8(0.1	
1.80	80.1	
1.8	2.1	
1.2	4.1	
1.4	4.1	
1.2	4.2.1	

 $.5375 \times 16 \times 4 \div 9 \times 7 \times 3 = 0.182_{\frac{2}{189}}$ Answer.

	The same without Cancellation.
Dividend,	$16 \times 48 \times 2.6875 \times 3 \times 80 \times 80 \times 2 \times 4$
	$\times 4 \times 4$ = 0.182 ² / ₁₈₉
Divisor,	$30 \times 36 \times 840 \times 3 \times 80 \times 8 \times 2 \times 4 \times 2$
	Answer.

Find the decimal of a hank produced at the third head of drawing, commencing at the number produced, making no allowance for loss in working.

Worked out by Cancellation.
9
7
2·1
$$3\cdot 6$$

 $34.4 \div 9 \times 7 \times 3 = 0.182_{189}^{2}$

Answer.

The same without Cancellation.
Dividend
$$\dots \dots \dots \dots \dots \frac{34.4 \times 2}{9 \times 7 \times 6} = 0.182_{\frac{2}{189}}$$
Answe

Find the hank-roving produced at the coarse fly-frame, commencing at the length and weight spread on the lattice, making no allowance for loss in working.

```
Worked out by Cancellation.

1.5.30 16

9.36 48.4

7.84(0 2.6875.5375

(Continued.)
```

1.3	$3 \cdot 1$
	8(0.1
1 ·80	80 ·1
1.8	2
$1\cdot 2$	4·1
1.4	4·1
$1 \cdot 2$	$4 \cdot 2 \cdot 1$
	6.1

$$5375 \times 16 \times 4 \times 2 \div 9 \times 7 = 1.092_{\frac{4}{63}}^{4}$$
 Answer.

The same without Cancellation.
Div.
$$16 \times 48 \times 2.6875 \times 3 \times 80 \times 80 \times 2 \times 4$$

 $\times 4 \times 4 \times 6$
Divisor, $30 \times 36 \times 840 \times 3 \times 80 \times 8 \times 2 \times 4 \times 2$
Answer.

Find the hank-roving produced at the coarse fly-frame, commencing at the number produced, making no allowance for loss in working.

$$\begin{array}{c|c} 34.4\\ 9\\7\\2 \end{array}$$

 $34.4 \times 2 \div 9 \times 7 = 1.092_{\frac{4}{63}}$

Answer.

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COTTON MANUFACTURE.

Find the hank-roving produced at the fine fly-frame, commencing at the length and weight spread on the lattice, making no allowance for loss in working.

Worked out by Cancellation.

1.5.30	16
9.36	48•4
1.12.84(0)	
	2.6875.5375
1.3	3.1
	8(0.1
1.80	80.1
1.8	2.1
1.2	4.1
1.4	4.1
1.2	$4 \cdot 2 \cdot 1$
	6.1
1.2	7.1

 $.5375 \times 4 \times 16 \div 9 = 3.8$

Answer.

The same without Cancellation.

Div.	$16 \times 48 \times 2.6875 \times 3 \times 80 \times 80 \times 2 \times 4 \times 4 \times 4$	
	$- \times 6 \times 7 = 3.83$	2
Divisor,	$30 \times 36 \times 840 \times 3 \times 80 \times 8 \times 2 \times 4 \times 2 \times 2$	Í
	Answer.	

 $\mathbf{218}$

Find the hank-roving produced at the fine fly-frame, commencing at the number produced, making no allowance for loss in working.

$$\begin{array}{c|c}
 & 34 \cdot 4 \\
 & 9 \\
\hline
 & 34.4 \div 9 = 3.8^{2}_{3}
\end{array}$$

Answer.

From the length and weight spread on the lattice, the doubling, and the particulars given, to find the draught at each and every machine from the lapper to the mule. Find the number produced, making an allowance of 14 per cent. for loss in working.

Worked out by Cancellation.
$$1\cdot3(0 | 16\cdot2\cdot1$$
 $1\cdot9\cdot36 | 48\cdot4\cdot1$ $1\cdot9\cdot36 | 48\cdot4\cdot1$ $1\cdot7\cdot84(0 | 1\cdot2.6875\cdot10.75\cdot43\cdot86 | 1(00)$ Single.Breaker-Lapper. $1\cdot4 | 6.9875\cdot2.6875\cdot1 | 1\cdot9 | 30\cdot3\cdot1 | 1\cdot15\cdot45 | 100\cdot1 | 1\cdot2\cdot32 | 72\cdot8\cdot2\cdot1 | 1\cdot2\cdot32 | 72\cdot8\cdot2\cdot1 | 1\cdot32 | 32\cdot1 | 1\cdot100 | 15\cdot1 | (Continued.)$

	1.2.6.26	16.1
Doublings	1.3	Finisher-Lapper.
Ŭ	1.4	
	1.9	3(0.1
	$1 \cdot 2 \cdot 6 \cdot 42$	78.3.1
	$1 \cdot 2 \cdot 32$	8(0•4•2•1
	$1 \cdot 2 \cdot 32$	36•4•1
	1(00	16.1
	1.26	16.1
	Single.	Breaker Cards.
	1.1.5.4.5	1(0
•	1(0	33.1
	1.13	6(0.3.1
	1.33	5(0.1
	1.20	80.40
	$1 \cdot 2 \cdot 4$	15.1(0
	1.8.40	91.13.1
	1.7(0	$16 \cdot 2 \cdot 1$
	1(00	20.1
Doubling	1.80	Finisher Cards.
	1.1.5.4.5	1(0
	1(0	33.1
	1.13	6(0.3.1
	1 •33	5(0.1
	1.20	80.1
	$1 \cdot 2 \cdot 4$	15.1(0
	(Cont	inued.)

	1.8.40	91.13.1
	1.7(0	$16 \cdot 2 \cdot 1$
	1(00	20.1
Doubling .	1.8	Railway Head.
	1	3.1
	1.80	34.1
	1.4.100	80.1
	1.4.18	75.3.1
		$4.5 \cdot 1$
	$1 \cdot . 5 \cdot 1 . 5 \cdot 51$	$16 \cdot 4 \cdot 8 \cdot 2 \cdot 1$
Doubling .	$\ldots 1.2$	0
		3.1
	1.6(0)	
	1.3.36	
		$72 \cdot 6 \cdot 2 \cdot 1$
Doubling .		Second head of drawing.
	1	3.1
	1.6(0	
	1.3.36	
		$72 \cdot 6 \cdot 1$
Doubling .		Third head of drawing.
	1	3.1
	1.6(0	
	1.3.36	
		72.6.1
	Single.	Coarse Fly-Frame.
(Continued.)		

	1.8	1(0
	1.32	96.48.6.1
	1·2·4 (0	$64 \cdot 2 \cdot 1$
Doubling	1.2	Fine Fly-Frame.
•	1.8	1(0
	1.4.32	56.7.1
	1 •3(0	$96 \cdot 24 \cdot 8 \cdot 1$
	Single.	Mule.
	1.7	8.4.1
	1·2·3 0	$105 \cdot 15 \cdot 1$
	1.9.36	81.9.1

40

Answer.

LOSS IN WORKING.

The number shown by the draughts and doublings, and the number produced, are proportional to the weight of spread in an inverse ratio.

Example.

The number shown by the draughts and doublings is 34.4, but the number actually produced is 40. Required the loss in working, the weight of a spread being 30 ounces.

$$1.4(0 \begin{vmatrix} 3(0) \\ 34.4.8.6 \end{vmatrix}$$

$$8.6 \times 3 = 25.8$$
 ounces utilized.

30 ounces weight of a spread.

25.8 weight utilized.

4.2 = 4 ounces and $87\frac{1}{2}$ grains loss in working from 30 ounces.

Answer.

The number shown by the draughts and doublings is 34.4, but the number actually produced is 40. Required the percentage utilized.

Worked out by Cancellation. 1.4(0 | 34.4.8.6

8.6×10 === 86

Answer.

The hank-roving shown by the draughts and doublings

is $3\frac{1}{2}$, but the hank-roving actually produced is 4. Required the loss in working, the weight of a spread being 30 ounces.

$$4 \begin{vmatrix} 30.7.5 \\ 3.5 \end{vmatrix}$$

 $7.5 \times 3.5 = 26.25$ ounces utilized. 30.00 ounces weight of a spread. 26.25 ounces utilized.

1

3.75 ounces loss in working 30 ounces.

Answer.

The hank-roving shown by the draughts and doublings is $3\frac{1}{2}$, but the hank-roving actually produced is 4. Required the percentage utilized.

Worked out b	y Cancellation.	
	100·25 3.5	
1.4	3.5	
25×3.5	$= 87\frac{1}{2}$	Answer.

The same without Cancellate	ion.
-----------------------------	------

Answer.

N.B.—By the above rule the loss in working can be found at each and every operation, from the lapper to the mule.

A railway head works successively 10 hours per day, and produces a No. $.0455_{180}^{5}$ sliver. The front-roller being 14 inches in diameter, how many revolutions per minute should it make to supply a certain number of mule-spindles that produce 312 pounds of yarn per day, allowing 4 per cent. for loss in working ?

189	8.6, No. of sliver in 189ths.
	7000 Grains in one pound.
	312 Pounds of yarn pro-
	· duced.
$\frac{1}{70}$ of 7000 100	12, $\frac{1}{70}$ of 840.
Diameter of front-roller,	36 inches in one yard.
in inches 1.25	
Ratio of circumference	
to diameter \cdot . 3.1416	
Hours per day 10	
Minutes in one hour . 60	
Cent less 4 96	100 Cent.

Worked out by Cancellation. 3.21.63.189 | 8.6 | 70(00.10.1 (Continued.)

$312 \cdot 39 \cdot 13$
12.1
36.6.2.1.6
100.1

 $13 \times 8.6 \times 1.6 \div .31416 \times 3 = 189 \frac{9391}{11781}$ Answer.

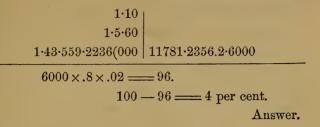
 $\begin{array}{rl} The \ same \ without \ Cancellation.\\ \hline {\rm Div.} & \frac{8.6 \times 7000 \times 312. \times 12 \times 36 \times 100}{189 \times 100 \times 1.25 \times 3.1416 \times 10 \times 60 \times 96} {=} 189_{\substack{93.91\\11781}}\\ \hline {\rm Answer.} \end{array}$

From the particulars found in the preceding example, find the percentage of loss in working.

Worked out by Cancellation.

 $\begin{array}{c|c} 100 \cdot 1 \\ \hline 1 \cdot 3 \cdot 27 \cdot 189 \\ \hline 8.6 \cdot .86 \cdot .02 \\ 7(000 \cdot 1 \\ 312 \cdot 104 \cdot 13 \cdot 1 \\ \hline 1 \cdot 100 \\ 12 \cdot 1 \\ \hline 1 \cdot 1.25 \\ \hline 36 \cdot 4 \cdot 3.2 \cdot .8 \\ \hline 1 \cdot .3927 \cdot 3.1416 \\ \hline (Continued.) \end{array}$

LOSS IN WORKING.



The same without Cancellation.

A drawing-frame works successively 10 hours per day, and produces a No. $182\frac{2}{188}$ roving. The front-roller being $1\frac{1}{4}$ inches in diameter, how many revolutions per minute should it make for 4 deliveries to supply a certain number of mule spindles that produce 312 pounds of yarn per day, allowing 3 per cent. for loss in working ?

189	34.4, No. of sliver in 189ths.
	34.4, No. of sliver in 189ths. 7000 Grains in one pound.
	312 Pounds of yarn pro-
	duced.
$\frac{1}{70}$ of 7000 100	$12, \frac{1}{70}$ of 840.
Diameter of front-roll-	36 Inches in one yard.
er, in inches 1.25	

Ratio of circumference	
to diameter 3.141	6
Hours per day 1	0
Minutes per hour 6	0
Number of deliveries .	4
Cent less 3 9	7 100 Cent.

Worked out by Cancellation.

$1 \cdot 3 \cdot 27 \cdot 189$	34.4
	70(00.10.8
	312.104
1.100	12.2
1.1.25	$36 \cdot 4 \cdot 1$
3.1416	
1(0	
1.6(0	
1.4	
97	100.1

 $104 \times 34.4 \times 8 \times 2 \div 3.1416 \times 97 = 187_{\frac{320147}{380919}}$

Answer.

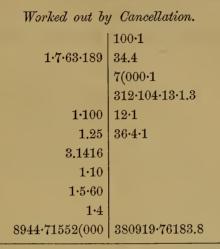
The same without Cancellation.

Dividend,	$\frac{34.4 \times 7000 \times 312 \times 12 \times 36 \times 100}{187320147} = 1873201477}{320147}$
Divisor,	$189 \times 100 \times 1.25 \times 3.1416 \times 10$
	$\times 60 \times 4 \times 97$

Answer.

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From the particulars found in the preceding example, find the percentage of loss in working.



$$76183.8 \times 1.3 \times 34.4 \div 8944 \times 1.25 \times 3.1416 = 97$$

 $100 - 97 = 3$ per cent.

Answer.

$$\begin{array}{c} The \ same \ without \ Cancellation.\\ \text{Div.}\\ \text{Divisor,} \ \begin{array}{c} 100 \times 34.4 \times 7000 \times 312 \times 12 \times 36 \times 380919 \\ \hline 189 \times 100 \times 1.25 \times 3.1416 \times 10 \times 60 \times 4 \\ \times 71552000 \\ \hline 100 - 97 = 3 \end{array} = 97.$$

A coarse fly-frame works successively 10 hours per day,

and produces a No. 1.092_{63}^{4} roving. The front-roller being $1\frac{1}{4}$ inches in diameter, how many revolutions per minute should it make for 40 spindles to supply a certain number of mule-spindles that produce 312 pounds of yarn per day, allowing 2 per cent. for loss in working ?

63	68.8, Hank-roving in 63ds.
	7000 Grains in one pound.
	312 Pounds of yarn pro-
	duced.
$\frac{1}{70}$ of 7000 100	$12, \frac{1}{70}$ of 840.
Diameter of the front-	36 Inches in one yard.
roller, in inches 1.25	
Ratio of circumference	
to diameter 3.1416	
Hours per day 10	
Minutes in one hour . 60	
Cent less 2 98	100 Cent.
Number of spindles . 40	

Worked out by Cancellation.

 $\begin{array}{c|c} 1 \cdot 9 \cdot 63 & 68.8 \\ & 7(000 \cdot 1 \\ & 312 \\ 1 \cdot 100 & 12 \cdot 2 \cdot 1.6 \\ 1 \cdot 1.25 & 36 \cdot 4 \cdot 1 \\ (Continued.) \end{array}$

$$\begin{array}{c|c}
3.1416 \\
1(0 \\
1.6(0 \\
98 \\
1.4(0 \\
\end{array}$$

 $312 \times 68.8 \times 1.6 \div 3.1416 \times 98 = 111_{\frac{2}{3}\frac{3}{8}\frac{2}{4}\frac{9}{8}\frac{4}{6}}$ Answer.

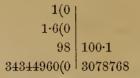
	The same without Cancellation.
Dividend,	$\frac{68.8 \times 7000 \times 312 \times 12 \times 36 \times 100}{3848446} = 111 \frac{313994}{3848446}$
Divisor,	$63 \times 100 \times 1.25 \times 3.1416 \times 10 \times 60$
	$\times 98 \times 40$

Answer.

From the particulars found in the preceding example, find the number of coarse fly-frame spindles necessary to supply the mule-spindles.

Worked out by Cancellation.

$$\begin{array}{c|c} 312\cdot104\\ 1\cdot3\cdot21\cdot63 & 68.8\\ 7(000\cdot1\\ 1\cdot100 & 12\cdot2\cdot1.6\\ 1\cdot1.25 & 36\cdot12\cdot1\\ .2618\cdot3.1416 & \\ & (Continued.) \end{array}$$



 $3078768 \times 1.6 \times 68.8 \times 104 \div 34344960 \times 98 \times .2618 = 40$ Answer.

 $\begin{array}{c} \text{Dividend,} & \underline{312 \times 68.8 \times 7000 \times 12 \times 36 \times 100 \times 3078768}_{63 \times 100 \times 1.25 \times 3.1416 \times 10 \times 60 \times 98 \times 343449600} {=} 40 \end{array}$

Answer.

How many pounds of cotton per day should be weighed on to the lapper to supply a certain number of mule-spindles that produce 312 pounds of yarn in the same time; allowing 14 per cent. for loss in working ?

Answer.

How many weighings of cotton per day will it require to supply a certain number of mule-spindles producing 312 pounds of yarn in the same time; allowing 30 ounces to a weighing, and 14 per cent. for loss in working?

.

.

•



SPINNING.

Worked out by Cancellation. 1.3(0 | 16 86 | 10(0

 $104 \times 16 \times 10 \div 86 = 193_{43}^{21}$

Answer.

	The	sa	me	w	itho	ut	Cancellatio	m.	
Dividen	d.					31	$2 \times 16 \times 10$	0_	19321
Divisor		•	•				30×86		10043
									Answer

SPINNING.

The back-roller of a mule is seven-eighths of an inch in diameter. The change-wheel has 40, and the front-roller wheel 24 teeth. How many teeth should there be in the back-roller wheel and the top-carrier, and what should be the diameter of the front-roller to produce No. 40 from an 8 hank-roving, run in double; the length of the stretch being 60, and the rollers deliver 58 inches?

> 7, Diameter of the backroller, in eighths of an inch.

Hank-roving 8 Length of stretch, in inches 60	 40 Teeth in the change-wheel. 24 Teeth in the front-roller wheel. 40, Number produced. 2, Double-roving. 58, Length delivered by the rollers, in inches.
Worke	ed out.
	7 4(0 24·4 40·5
1·8 1·6(0	2
	58 2
	$\frac{116}{5}$
	580 4
	2320 4
(Continued.)	9280 7

	В	•	•	•	•	10)64960
A		•		•	•	. 8)6496
	B		•	•	•	. 7)812
		C	•	•	•	116)116
						1

A. 8 = 8, Diameter of the front-roller in eighths of an inch.

B. $10 \times 7 = 70$ Teeth in the back roller wheel.

C. 116 === 166 Teeth in the top-carrier.

Answer.

From the particulars found in the preceding example, find the number produced.

Worked out by	y Cancellation.	
1.2	8.2.1	
1.7	8.1	
$1 \cdot 2$ $1 \cdot 7$ $1 \cdot 4(0$	7(0.1	
1.3.24	116.58.2	
1.2 9.58	60 · 20 [·]	
$20 \times 2 = 40$ Answ		

The same without Cancellation. Dividend, \dots $\frac{8 \times 8 \times 70 \times 116 \times 60}{2 \times 7 \times 40 \times 24 \times 58} = 40$

From the particulars found in the preceding example, find the hank-roving.

Worked out by Cancellation.

 $\begin{array}{c|c} & 4(0\cdot 1) \\ 1\cdot 2\cdot 8 & 7\cdot 1 \\ 1\cdot 7(0) & 4(0\cdot 1) \\ 1\cdot 29\cdot 116 & 24\cdot 4 \\ 1\cdot 6(0) & 58\cdot 2 \\ 2\cdot 1 \end{array}$

 $4 \times 2 = 8$ hank-roving.

Answer.

The same without Cancellation.

From the particulars found in the preceding example, find the diameter of the back-roller.

Worked out by Cancellation.

$$\begin{array}{c|c}
1\cdot2 \\
1\cdot4(0 \\
8\cdot2\cdot1 \\
(Continued.)
\end{array}$$

 $7 = \frac{7}{8}$ of an inch. Answer.

	The	same without Cancellation.
Dividend		$8 \times 8 \times 70 \times 116 \times 60 - 7 - 7$ of an inch
Divisor .		$\frac{8 \times 8 \times 70 \times 116 \times 60}{2 \times 40 \times 40 \times 24 \times 58} = 7 = \frac{7}{8}$ of an inch.
		Answer.

From the particulars found in the preceding example, find the diameter of the front-roller.

Worked out by Cancellation			
1.2.8	2.1		
•	4(0.1		
	7.1		
1.7(0	4(0.2.1		
1.58.116	24.8		
$1 \cdot 2 \cdot 8$ $1 \cdot 7(0)$ $1 \cdot 58 \cdot 116$ $1 \cdot 3 \cdot 6(0)$	58.1		
0 0	a • 1 •		

 $8 = \frac{8}{8}$ of an inch. Answer.

The same without Cancellation. Dividend . $\frac{2 \times 40 \times 7 \times 40 \times 24 \times 58}{8 \times 70 \times 116 \times 60} = 8 = \frac{8}{8}$ of an inch. From the particulars found in the preceding example, find the number of teeth in the back-roller wheel.

	y Cancellation.
	4(0.2)
1.8	2.1
	40.5
1.8	7
1.58.116	$24 \cdot 3 \cdot 1$
$1.8 \\ 1.8 \\ 1.58.116 \\ 1.2.6(0)$	58.1

 $7 \times 5 \times 2 = 70$

Answer.

The same without Cancellation.

Dividend $\dots \qquad \frac{40 \times 2 \times 40 \times 7 \times 24 \times 58}{8 \times 8 \times 116 \times 60} = 70$ Divisor $\dots \qquad \dots \qquad Answer.$

From the particulars found in the preceding example, find the number of teeth in the change-wheel.

Worked out by Cancellation. $1\cdot 2 \begin{vmatrix} 70\cdot 10 \\ 8\cdot 2 \\ 1\cdot 4(0 \end{vmatrix}$ (Continued.)

 $10 \times 2 \times 2 = 40$ Answer.

The same without Cancellation.
Dividend
$$\dots \dots \frac{70 \times 8 \times 8 \times 116 \times 60}{2 \times 40 \times 7 \times 24 \times 58} = 40$$

Answer.

From the particulars found in the preceding example, find the number of teeth in the top-carrier.

Worked out by Cancellation.

	24.3.1
1.8	2.1
	4(0.1
1.2.8	7.1
1.7(0	4(0.2
1.3.6(0	24·3·1 2·1 4(0·1 7·1 4(0·2 58
$58 \times 2 =$	

The same without Cancellation. $24 \times 2 \times 40 \times 7 \times 40 \times 58$

Dividend . $24 \times 2 \times 40 \times 7 \times 40 \times 58 = 116$ Divisor . . $8 \times 8 \times 70 \times 60$

From the particulars found in the preceding example, find the number of teeth in the front-roller wheel.

Worked out by	y Cancellation.
	116.2
1.2	8.2
1.4(0	
1.7	8.2.1
1.4(0	7(0.1
$ \begin{array}{r} 1 \cdot 2 \\ 1 \cdot 4(0 \\ 1 \cdot 7 \\ 1 \cdot 4(0 \\ 1 \cdot 58 \\ \end{array} $	6(0
and the second	

 $6 \times 2 \times 2 = 24$

Answer.

The same without Cancellation. Dividend . . . $\frac{116 \times 8 \times 8 \times 70 \times 60}{2 \times 40 \times 7 \times 40 \times 58} = 24$ Answer.

From the particulars found in the preceding example, find how many inches the rollers deliver per stretch.

Worked out by Cancellation.

$$\begin{array}{c|c}
 & 1 \cdot 2 \\
 & 1 \cdot 2 \\
 & 1 \cdot 4(0 \\
 & (Continued.)
\end{array}$$

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1.7	$8\cdot 2$
1.4(0	7(0.1)
1.4.24	116.29

 $29 \times 2 = 58$ inches. Answer.

The	sa	me	without	Cancellatio	n.	
Dividend .		6	$0 \times 8 \times 8$	×70×116_	- 58	inches
Divisor .					- 00	1101105.
						Answer.

From the particulars found in the preceding example, find the length of the stretch.

Worked out by	
1.8 1.8 1.7(0 1.2.116	58.1
1.8	2.1
	40.5
1.8	7.1
1.7(0)	4(0
$1 \cdot 2 \cdot 116$	24.3

The same without Cancellation. Dividend . $\frac{58 \times 2 \times 40 \times 7 \times 40 \times 24}{8 \times 8 \times 70 \times 116} = 60$ inches.

The back-roller is seven-eighths, and the front-roller eight-eighths of an inch in diameter. The front-roller wheel has 24, the top-carrier 116, the change-wheel 40, and the back-roller wheel 70 teeth. The rollers deliver 58, and the length of the stretch is 60 inches. Required the total draught at the nulle.

Worked out by	y Cancellation.
$ \begin{array}{r} 1.7 \\ 1.4(0) \\ 1.6.12.24 \\ 1.58 \end{array} $	8.4.1
1.4(0	7(0.1
$1 \cdot 6 \cdot 12 \cdot 24$	$116 \cdot 2 \cdot 1$
1.58	60.10

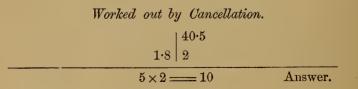
10

Answer.

The same without Cancellation.

Dividend $\frac{8 \times 70 \times 116 \times 60}{7 \times 40 \times 24 \times 58} = 10$ Divisor Answer.

The number spun is 40 from an 8 hank-roving, run in double. Required the draught.



SPINNING.

The same without Cancellation.

The back-roller is seven-eighths, and the front-roller eight-eighths of an inch in diameter. The front-roller wheel has 24, the top-carrier 116, the change-wheel 40, and the back-roller wheel 70 teeth. Required the draught at the rollers.

> Worked out by Cancellation. $\begin{array}{c|c}
> 1.7 \\
> 1.4(0 \\
> 1.3.24
> \end{array} \begin{vmatrix} 8.1 \\
> 7(0.1 \\
> 116.29.93 \\
> \end{array}$

> > $9\frac{2}{3}$

Answer.

The same without Cancellation.

The length of the stretch is 60 and the rollers deliver 58 inches. Required the draught at the carriage.

Worked	out by Cancellation.	
	$1.58 \mid 60.1\frac{1}{2.9}$	
	$1_{\frac{1}{29}}$	Answer.

The draught at the rollers is $9\frac{2}{3}$, and the draught at the carriage is $1\frac{1}{29}$. Required the total draught at the mule.

Worked out by Cancellation. 1·3 | 29·1 1·29 | 30·10

10

Answer.

The same without Cancellation.

Dividend	•				$\frac{29 \times 30}{10} = 10$
Divisor .					
					Answer.

The length of the stretch is 60, and the rollers deliver 58 inches. Required the gain of the carriage per stretch.

 $\begin{array}{c}
60 \\
58 \\
\hline
2 \text{ inches.}
\end{array}$

The draught at the rollers is $9\frac{2}{3}$. The length of the stretch is 60, and the rollers deliver 58 inches. Required the number spun from an 8 hank-roving, run in double.

Worked out by	y Cancellation.
1.2	8.4.2
1.2 1.3 1.2.58	29.1
$1 \cdot 2 \cdot 58$	60.20
20×2	40

Answer.

The same without Cancellation.

Dividend	•	•		• -	•	•	$\frac{8 \times 29 \times 60}{40} = 40$
							$2 \times 3 \times 58$
							Answer

If No. 40 is spun from a 4 hank-roving, with a changewheel containing 40 teeth, how many teeth should there be in the change-wheel to spin No. 60 from a $7\frac{1}{2}$ hankroving?

Worked out by Cancellation.

$$1 \cdot 4$$
 40
 $1 \cdot 4$
 $7.5 \cdot 1.25$
 $1 \cdot 6(0)$
 $4(0 \cdot 1)$
 $40 \times 1.25 = 50$
 Answer.

COTTON MANUFACTURE.

A set of cops weighs 11 lbs., and has on 630 stretches. Length of stretch, 60 inches; number of cops in the set, 352. Required the average number.

	y Cancellation.
	352·32·8 60·5
1·3· 36	60.5
1.21.84(0	
1.11	
	63(0.21.1
8 × 5 =	<u> </u>
The same witho	ut Cancellation.
Dividend	$352 \times 60 \times 630 - 40$

Divisor $\frac{362\times00\times000}{36\times840\times11} = 40$ Answer.

From the particulars found in the preceding example, find the number of stretches in the set.

Worked out by Cancellation. | 11.1 | 40.5 (Continued.)

	1	he	80	me	U	vith	out	Cancellation.	
Divider	ıd						11	$\times 40 \times 840 \times 36$	- 630
								352×60	_ 000
									Answer.

From the particulars found in the preceding example, find the length of the stretch.

Worked out by	y Cancellation.	
	11.1	
	40.5	
1.4.32.352		
	84(0·21·1 36·12	
	36.12	
1.21.63(0		
$12 \times 5 ==$	= 60 inches.	Answer.
The same witho	ut Cancellation.	

Dividend	•	•	•	$\frac{11 \times 40 \times 840 \times 36}{1000} = 60$ inches.
				352×630
				Answer.

From the particulars found in the preceding example, find the number of cops in the set.

 Worked out by Cancellation.

 11

 4(0

 1.7.21.63(0

 84(0.28.4)

 1.6(0

 $11 \times 4 \times 4 \times 2 = 352$

Answer.

The same without Cancellation. Dividend $\dots \dots \underbrace{11 \times 40 \times 840 \times 36}_{630 \times 60} = 352$ Answer.

From the particulars found in the preceding example, find the weight of the set.

Worked out by Cancellation. 1.21.84(0 1.4(0 1.2.6.36 60(0.1



SPINNING.

The power furnished for driving mules is sufficient to drive them 3 stretches per minute, and they utilize $\frac{14}{15}$ of the same. Required the product per spindle per day of 12 hours, the length of the stretch being 60 inches.

Inches in one yard 30	60, Length of stretch, in
	inches.
	3 Stretches per minute.
	60 Minutes in one hour.
	12 Hours per day.
Power furnished 18	5 14, Power utilized.
Yards in one hank 840	

Worked	out	by	Can	cellation.
--------	-----	----	-----	------------

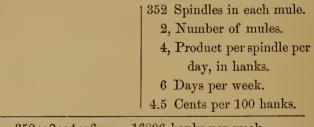
60.5.1
3.1
6(0.2
12.1
14.2

 $2 \times 2 = 4$ hanks.

1

The same without Cancellation. Dividend . $\frac{60 \times 3 \times 60 \times 12 \times 14}{36 \times 15 \times 840} = 4$ hanks. Answer.

A pair of mules, each containing 352 spindles, produce 4 hanks per spindle per day. How many hanks will that be per week, and what will the spinners' wages amount to, at $4\frac{1}{2}$ cents per 100 hanks?



 $352 \times 2 \times 4 \times 6 = 16896$ hanks per week. $16896 \times 4.5 \div 100 = \$7.60\frac{8}{25}$

Answer.

To find the requisite number of turns of twist per inch for warp and filling.

Rule.

For warp, multiply the square root of the number by $3\frac{3}{4}$, and for filling, by $3\frac{1}{4}$, and the product will be the number of turns of twist per inch required.

Examples.

How many turns of twist per inch will be required for No. 40 warp?

6)40(6.324 +
36
108)400
123) 400
369
1262) 3100
2524
12644)57600
50576
7024
(02 1
6.324
6.324
6.324
6.324 3.75
$ \begin{array}{r} 6.324 \\ 3.75 \\ \\ 31620 \\ \end{array} $
$6.324 \\ 3.75 \\ \\ 31620 \\ 44268$
$6.324 \\ 3.75 \\ \\ 31620 \\ 44268$

How many turns of twist per inch will be required for No. 40 filling ?

6)40(6.324 +	
36	
 123)400 369	
1262)3100 2524	
12644)57600	
50576	
7024	
$6.324 \times 3.25 = 20.553$	Answer.

Another way to find the requisite turns of twist per inch of yarn :—Admitting that 25 turns of twist per inch of yarn is sufficient for No. 50 warp, and the same for No. 60 filling, and that the twist in different numbers of yarn is as the square of the twist to the number of the yarn, we get the following

Rule.

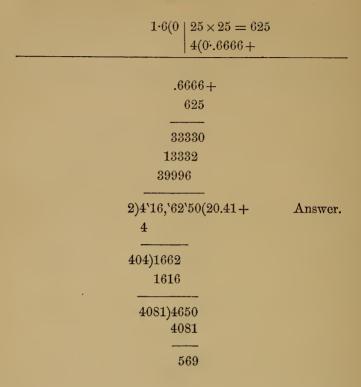
As No. 50 is to the square of 25, so is the given No. to the square of the twist per inch required.

 $\mathbf{252}$

How many turns of twist per inch is required for No. 40 warp?

$\begin{array}{c c c c c c c c c c c c c c c c c c c $	5.125
125	
4	
2)5'00(22.36+	Answer.
4	
42)100	
84	
 443)1600	
1329	
4466)27100	
26796	
304	

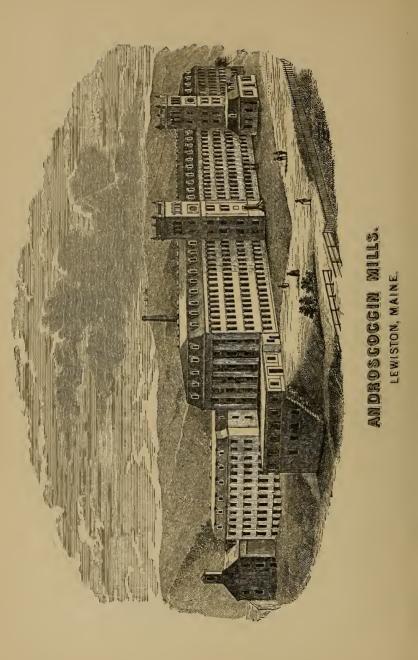
How many turns of twist per inch is required for No. 40 filling?



N.B.—There are many other rules in use for finding the requisite twist per inch of yarn, each of which has its advantages, but the above are generally considered the simplest and best.

The *practical* rule is, to try the yarn by breaking it. If the fibres draw out of warp instead of breaking off short, it has not twist enough; for filling, that need not be minded, if it works well in the mule and the loom.

ð



MANUFACTURING.

How many hanks of yarn will be required to make a warp of 14 cuts, each 42 yards long, 30 inches wide at the reed, and 64 threads to the inch, allowing $\frac{1}{18}$ for shrinkage in weaving?

	by Cancellation.
. 1.2.84(0	42.1
	3(0
	64
. 1•2•84(0	14.7

 $64 \times 7 \times 3 + \frac{1}{18} = 1418.66 +$ Answer.

	The	sa	me	w	ith	out	\mathcal{C}	anc	ellation.
Dividend		42	×	30	\times	64	×	14	$+\frac{1}{18} = 1418.66 +$
Divisor .					84	0			1 18 - 1110.00 -
									Answer.

How many hanks of filling will be required to fill a warp of 14 cuts, each 42 yards long, 30 inches wide at the reed, and 64 picks to the inch, allowing $\frac{1}{60}$ for waste?

	y Cancellation.
1.2.84(0)	42.1
	3(0
	64
1.2.84(0	14.7

 $64 \times 7 \times 3 + \frac{1}{60} = 1366.4$ Answer.

COTTON MANUFACTURE.

The same without Cancellation.

In 1418.666 hanks of No. 36, how many pounds?

Worked out by Cancellation. 1.4.32 | 1418.666.177.333.44.333 44.333

Answer.

In 1366.4 hanks of No. 30, how many pounds?

Worked out by Cancellation. 1·3·36 | 1366.4·113.866·37.955

37.955

Answer.

If 44.33+ pounds of yarn be sufficient for a warp of 14 cuts, each 42 yards long, including shrinkage in weaving, and 37.955 pounds of filling be sufficient to fill the same including waste, what will be the total weight of warp and filling necessary to make the 14 cuts ? 44.33337.955 82.288 pounds.

Answer.

If 82.288 pounds of warp and filling have been used in making 14 cuts of cloth, each 42 yards long, how many yards per pound is utilized ?

> Worked out by Cancellation. 42.510414 1.82 288

 $14 \times .5104 = 7.1456$

Answer.

The same without Cancellation.

 Dividend
 \cdot \cdot \cdot $\frac{42 \times 14}{82.288} = 7.1456$

 Divisor
 \cdot \cdot \cdot \cdot \cdot

Another way to find the number of yards per pound utilized from the same particulars :---

 $64 + \frac{1}{60}$ Picks == 65.66636 No. of filling. $64 + \frac{1}{18}$ Reed == 67.55532 No. of warp.133.22168Width of the reed, in
inches 3068Warp and filling in-
cluded 2840 Yards in one hank.

Worked out by Cancellation.

 $14 \times .51 + = 7.14 +$ Answer.

Find the number of yards of cloth per pound from the following particulars :---

Picks per inch	•	•	•	•	•	100
Counts of filling				•		40
Counts of warp						32
Shrinkage of war	р	in v	wea	vii	ıg	$\frac{1}{10}$

Worked out by Cancellation. Worked out by Cancellation. $42\cdot3.5$, Width of reed. $100\cdot25$ Picks per inch. No. of filling . . . $1\cdot4(0)$ $1\cdot12$ 10(0

 $25 \times 10 \times 3.5 = 875$ grains weight of filling in one yard of cloth.

No. of warp . . . 1.4.32 1.12 100.25

 $25 \times 6 \times 5.25 + \frac{1}{10} = 866.25$ grains weight of warp in one yard of cloth.

866.25 875.00 174.25)7000.00(4+ yards. 6965.00

35.00

Another way to find the number of yards of cloth per pound from the same particulars :

Worked out by	/ Cancellation.
100 .	40
$100 \cdot 72 + \frac{1}{10} = 79.2$	32
1.179.2	72.4+
1.42	
1.2	
	840-20-10
$10 \times .4 +$	= 4+ Answer.

If it requires 866.25 grains of warp to make one yard of cloth, as seen in a preceding example, how many pounds will be required to make a warp of 10 cuts, each 40 yards long ?

 Worked out by Cancellation.

 10

 4(0.4

 1.7.70(00

 866.25.123.75

 123.75 × .4 == 49.5

 Answer.

 The same without Cancellation.

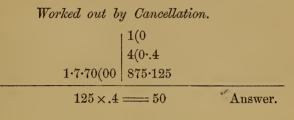
 Dividend
 ...

 10 × 40 × 866.25

 49.5

Answer.

If it requires 875 grains of filling to make one yard of cloth, how many pounds will it require to make 10 cuts, each 40 yards long?



	The	sa	me	wi	the	nıt	Ca	incellation.	
Dividen	d.		•	•	•			$\frac{10 \times 40 \times 875}{50} = 50$	
								7000	
								Answer	•

If it requires $49\frac{1}{2}$ pounds of warp, and 50 pounds of filling, to make 10 cuts of cloth, each 40 yards long, what is the total weight of warp and filling required?

49.5 50.0 99.5 pounds.

Answer.

How many hanks of yarn will be required to make a warp of 10 cuts, each 40 yards long, to be woven in a 72 reed, 42 inches wide, making an allowance of $\frac{1}{10}$ for shrinkage in weaving.

ן	Vorked out b	y Cancell	lation.	
		1(0		
		40		
		42.6		
		$\begin{array}{c} 42 \cdot 6 \\ 72 \cdot 6 \end{array}$		
	1.7.84(0			
	40 0 0 1			4

 $40 \times 6 \times 6 + \frac{1}{10} = 1584$ Answer.

The same without Cancellation.

Dividend . . . $\frac{10 \times 40 \times 42 \times 72}{840} + \frac{1}{10} = 1584$ Answer.

If 1584 hanks of yarn weigh $49\frac{1}{2}$ pounds, what is the number?

Worked out by Cancellation.

 $\begin{array}{c|c} & 1584 \cdot 32 \\ 84(0 \cdot 12 \cdot 1 \\ 1 \cdot 49.5 \\ 1 \cdot 7(000 \\ 1 \cdot 12 \end{array} \\ 1(00 \end{array}$

32

Answer.

262

The same without Cancellation.

In 10 cuts of cloth, each 40 yards long, woven in a reed 42 inches wide, 100 picks to the inch, how many hanks of filling?

Worked out by Cancellation.

 1(0

 40·10

 42·2

 100

 $100 \times 10 \times 2 = 2000$

Answer.

The same without Cancellation.

If 2000 hanks of filling weigh 50 pounds, what is the number?

```
Worked out by Cancellation.
```

	2(000)
	840.120.10
1.50	
1.7(000	
1.12	100.2

 $10 \times 2 \times 2 = 40$

Answer.

The same without Cancellation.

Dividend	•	•	•	•	$\frac{2000 \times 840 \times 100}{40} = 40$
					$50 \times 7000 \times 12$
					Answer.

Find the number of yards per pound of cloth from the following particulars:

Counts under the glass, 66 threads of warp and 89 of filling per inch.

Width of reed	33 inches.
Counts of warp	33
Counts of filling	40
Shrinkage in weaving of warp and	filling, 16.

Worked out by Cancellation.

Counts of warp . . 1.33

1.12 100

 $100 \times 5.5 + \frac{1}{16} = 584.375$ grains weight of warp in one yard of cloth.

		33.11, Width of reed.
		80.2 Picks per inch.
Counts of filling	1.40	
1	·4·12	100.25

 $25 \times 11 \times 2 + \frac{1}{16} = 584.375$ grains weight of filling in one yard of cloth.

584.375 584.375

 $\frac{1168.75(0)7000.00(0(5.9+\\5843.75$

1156.2501051.875

104.375

Answer.

Another way to find the number of yards of cloth per pound from the same particulars :

Worked out by Cancellation.									
Reed	•			•			66	33	Warp.
Picks	•	•	•	•	•	•	80	40	Warp. Filling.
						1.2	2.146	73.	1
							1.33		
							$1 \cdot 2$		
_								840	0.420.210.6.36
$6.36 \text{ less } {}_{16}^{1} = 5.9 +$									

Answer.

How many pounds of No. 50 yarn will it take to make a beam of 10 cuts, according to the following particulars:

Length of cuts			•	•	60 yards.
Count of reed		•	•	•	92
Width of reed		•	•		42 inches.
Shrinkage in we	eav	ing	•		$\frac{1}{10}$

Worked out by Cancellation. | 1(0 6(0.1.2 42.3.5.5 (Continued.)



$$92 \times 1.2 \times .5 + \frac{1}{10} = 60.72$$

Answer.

The same without Cancellation.
Dividend . . .
$$\frac{10 \times 60 \times 42 \times 92}{50 \times 840} + \frac{1}{10} = 60.72$$

Answer.

How many pounds of No. 60 filling will it take to fill 10 cuts, according to the following particulars?

Length of cuts	•	•	•	•	60 yards.
Width of reed					42 inches.
Picks per inch		•			108

Worked out by Cancellation.

$$1(0 \\ 60 \cdot 1 \\ 42 \cdot 6 \\ 108 \cdot 9 \\ 1 \cdot 60 \\ 1 \cdot 60 \\ 1 \cdot 60 \\ 1 \cdot 60 \\ 1 \cdot 6 \\ 1 \cdot 6$$

Answer.

The same without Cancellation. Dividend $\frac{10 \times 60 \times 42 \times 108}{840 \times 60} = 54$ Answer.

If there are 60.72 pounds of warp and 54 pounds of filling in 10 cuts of cloth, each 60 yards long, how many yards of cloth are there to the pound?

Worked out by	y Cancellation.
60.72	
54	
$1 \cdot 11.472 \cdot 114.72$	
	10.1 60.5.2+
	60.5.2+
5.2	+ Answer.

Find the number of yards per pound of cloth from the following particulars:

Count of reed .	•			92			
Width of reed .				42 inches.			
Picks per inch .				108			
Counts of warp.				50			
Counts of filling				60			
Shrinkage of warp in weaving, $\frac{1}{10}$.							

 $92 \times 3.5 \times 2 + \frac{1}{10} = 708.4$ grains weight of warp in one yard of cloth.

 $10 \times 9 \times 7 = 630$ grains weight of filling in one yard of cloth.

Another way to find the number of yards of cloth per pound from the same particulars:

Worke	ed out by	y Cancellation.	
Reed $92 + \frac{1}{10} = $	101.2	50 Warp.	
Picks	108	60 Filling.	
	1.209.2	110.52 +	
Width of reed	. 1.42		
Warp and filling .	. 1.2		
		840-20-10	
1($) \times 52 +$		Answer

Another way to find the number of yards of cloth per pound :

Rule.

Cut from the cloth a piece two inches square. The weight of this multiplied by half the width of the cloth, gives a product which, divided into 389, equals the number of yards per pound.

Example.

In the above example the cloth is 42 inches wide, consequently, one yard contains $42 \times 36.=1512$ square inches, and weighs 708.4+630.=1338.4 grains. A piece of cloth 2 inches square contains $2 \times 2=4$ square inches. Hence, $1338.4 \times 4 \div 1512 = 3\frac{102.2}{189}$ grains weight of the 4 square inches. If 4 square inches of cloth weigh $3\frac{102.2}{189}$ grains, how many yards are there to the pound?

N.B. $-3\frac{102.2}{189} = \frac{669.2}{189}$.

Worked out by Cancellation. 669.2 | 189.63.9 1.7.21 | 389

 $389 \times 9 \div 669.2 = 5.2$ yards. Answer.

	T.he	sα	me	w	ithe	put	Cancellation.
Dividen	d.		•		•	18	$\frac{9 \times 389}{9.2 \times 21} = 5.2$ yards.
Divisor	•	•	•	•	•	66	9.2×21

Answer.

A piece of lawn is 36 inches wide, and counts, under the glass, 80×80 . The filling is No. 80, and the warp No. 75; how many yards are there to the pound, admitting the warp and filling to shrink $\frac{1}{20}$ in weaving?

Worked out by	y Cancellation.
1.3.75 1.12	36-3-1
	80
1.3.75	
1.12	100.4

 $80 \times 4 + \frac{1}{20} = 336$ grains weight of warp in one yard of eloth.

$$\begin{array}{c|c}
36.3 \\
80.1 \\
1.80 \\
1.12 \\
100
\end{array}$$

 $100 \times 3 + \frac{1}{20} = 315$ grains weight of filling in one yard of cloth.

336		
315		
651))7000(10.7+	Answer.
	651	
	4900	
	4557	
. 0	343	

Another way to find the number of yards of cloth per pound from the same particulars:

Worked out by	y Cancellation.
Reed $80 + \frac{1}{20} = 84$	80 Warp.
Reed $80 + \frac{1}{20} = 84$ Picks $80 + \frac{1}{20} = 84$	75 Filling.
1.2.4.168	155.77.5.32.2.10.7+
Width of cloth 1.3.36	
Warp and filling 1.2	
	840.70.1
1(Answer.

Suppose a loom to work successively at the rate of 140 picks per minute, how long would it be weaving a cut of 42 yards with 100 picks per inch?

Worked out by	y Cancellation.
	42.3.1
	36.18
1·1 4(0	1(00
1 •14(0 1 •2•6(0	
18 h	
Dividend	the two set of the two set of the two sets $\frac{42 \times 36 \times 100}{100} = 18$ hours.
Divisor	· · · · · · · · · · · · · · · · · · ·
	Answer.

If the power furnished for driving a loom be sufficient to drive it 140 picks per minute, and the actual product is 34.125 yards, containing 100 picks per inch, in 18 hours, how much per cent. of the power does it utilize ?

Worked out by Cancellation.						
	100.50					
	100·50 34.125·4.875·1.625					
	36.2.1					
1.7.14(0 1.18	1(00					
1.18						
1.3.6(0						

 $50 \times 1.625 = 81.25$ per cent. Answer.

273

The same without Cancellation.
Dividend . . .
$$\frac{100 \times 34.125 \times 36 \times 100}{140 \times 18 \times 60} = 81.25$$

Answer.

Suppose a loom to work successively at the rate of 128 picks per minute, how long will it be weaving a cut 46 yards long, containing 80 picks per inch?

Worked out by	y Cancellation.
$1 \cdot 8 \cdot 16 \cdot 128$	46.5.75
	36•3
$1 \cdot 8 \cdot 16 \cdot 128$	80 ·10·2·1
1.5.60	

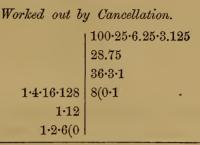
 $5.75 \times 3 = 17.25 = 17$ hours 15 minutes.

Answer.

The same without Cancellation.

Dividend $\frac{46 \times 36 \times 80}{128 \times 60} = 17.25$ Divisor Answer.

If the power furnished for driving a loom is sufficient to drive it 128 picks per minute, and the actual product is $28\frac{3}{4}$ yards, containing 80 picks per inch, in 12 hours, how much per cent. of said power does it utilize?



$$28.75 \times 3.125 = 89.84375$$
 per cent.

Answer.

The same without Cancellation. Dividend . $\frac{100 \times 28.75 \times 36 \times 80}{128 \times 12 \times 60} = 89.84375$

Answer.

Admitting the power furnished for driving looms to be sufficient to drive them 120 picks per minute, and that they utilize 90 per cent. of the same, the cloth to be made into cuts each 45 yards long, containing 80 picks per inch, what will be the monthly wages of a five loom weaver at 36 cents per cut, allowing 12 hours to the day, and 24 working days to the month?

> Worked out by Cancellation. $\begin{vmatrix} 36\cdot 1\\ 1\cdot 8(0 & 12(0\\ (Continued.) \end{vmatrix}$

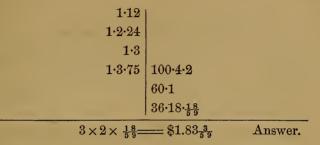
	6(0
	12
	24.3
	5.1
1(00	9(0.1
1.5.45	
1· 36	

 $12 \times 12 \times 6 \times 3 \implies$ \$25.92 Answer.

	T	he	same without Cancellation.	
Dividend		•	$\underline{36 \times 120 \times 60 \times 12 \times 24 \times 5 \times 90}$	× \$25.92
Divisor .				× @10.01
			Δ	newor

Admitting the power furnished for driving looms to be sufficient to drive them 118 picks per minute, and that they utilize 75 per cent. of the same, the cloth to be made into cuts, each 60 yards long, containing 108 picks per inch, how much per cut should be paid to a three-loom weaver to make \$36 per month, allowing 12 hours to the day, and 24 working days to the month?

> Worked out by Cancellation. 1.59.118 1.60 (Continued.)



		Th	e se	ame without Cancellation.	
Dividend				$36 \times 108 \times 100 \times 60 \times 36$	- \$1 83 3
Divisor .	•			$\frac{36\times108\times100\times60\times36}{118\times60\times12\times24\times3\times75}$	- \$1.00 39
					Answer.

From the particulars found in the preceding example, find the weaver's monthly wages.

Worked out by	y Canc	ellai	tior	ı.	
1.59	108.1				$(\frac{108}{59} \text{ of } \$1.)$
1.108	118.2				
	60.1				
	12.1				
	24.6				
	3.1				
1.4.1 00	75.3				
1.60					
1.3.36					
$6 \times 2 \times 3$	\$3	6.			Answer.

COTTON MANUFACTURE.

The same without Cancellation.

Dividend . . . $\frac{108 \times 118 \times 60 \times 12 \times 24 \times 3 \times 75}{59 \times 108 \times 100 \times 60 \times 36} = \$36.$ Answer.

Admitting the labor and skill required to weave 14 twill cuts per loom, on five looms per month, to be equal to that required to weave 16 cambric cuts per loom on 4 looms in the same time, and the price paid for the cambric 39 cents, and the twill 28 cents per cut, how much per cut should be advanced on the twills to make the monthly wages of the weavers equal, if the cambric is advanced to 42 cents per cut?

Worked out by Cancellation.	
42.6	
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	
1.7.14 16.8	
$8 \times 6 \times .8 - 28 = 10.4$ cents.	
	Answer.

Dividend	•	•	•	$42 \times 4 \times 16$ 28 = 10.4 cents.
Divisor.				

The same without Cancellation.

Answer.

From the particulars found in the preceding example, find the monthly wages of the twill and cambric weavers at the advanced price.

 Twill
 .
 .
 $38.4 \times 14 \times 5 \implies 26.88

 Cambric
 .
 .
 $42 \times 16 \times 4 \implies 26.88

 Answer.
 .
 .

Admitting the labor and skill required to weave 16 cambric cuts per loom on 4 looms per month, to be equal to that required to weave 14 twill cuts per loom on 5 looms in the same time, and the price paid for the twill is 38.4 cents per cut, how much per cut should be paid for the cambric to make the monthly wages of the weavers equal ?

 $7 \times 5 \times 1.2 = 42$ cents.

Answer.

The same without Cancellation. Dividend $\frac{38.4 \times 5 \times 14}{4 \times 16} = 42$ cents.

Answer.

If one weaver weaves 16 cambric cuts per loom per month on 4 looms, and another weaves 14 twill cuts per loom on 5 looms in the same time, and an advance of 6 cents per cut is made on the twill, how many cents per cut should the cambric be advanced to make the monthly advance of the weavers' wages equal ?

> Worked out by Cancellation. 1.16 6.3 1.4.7.4375 1.2.4 5

 $5 \times 3 \times .4375 = 6_{\frac{9}{16}}$ cents.

Answer.

The same without Cancellation.

From the particulars found in the preceding example, find the monthly advance in the weavers' wages.

 Cambric
 .
 .
 $6\frac{9}{16} \times 16 \times 4 = 4.20

 Twill
 .
 .
 .
 $6 \times 14 \times 5 = 4.20

 Answer.

280

SLIVER TABLE,

Showing the size of sliver from No. .01 to .09, by the weight of 6 yards, in grains.

Number.	Grains.	Number.	Grains.	Number.	Grains.
.01	5000	.037	1351	.064	781
.011	4545	.038	1316	.065	769
.012	4167	.039	1282	.066	758
.013	3846	.04	1250	.067	746
.014	3571	.041	1220	.068	735
.015	3333	.042	1191	.069	725
.016	3125	.043	1163	.07	714
.017	2941	.044	1136	.071	704
.018	2778	.045	1111	.072	694
.019	2632	.046	1087	.073	685
.02	2500	.047	1064	.074	676
.021	2381	.048	1042	.075	667
.022	2273	.049	1020	.076	658
.023	2174	.05	1000	.077	649
.024	2083	051	980	.078	641
.025	2000	.052	962	.079	633
.026	1923	.053	943	.08	625
.027	1852	.054	926	.081	617
.028	1786	.055	909	.082	610
.029	1724	.056	893	.083	602
.03	1667	.057	877	.084	595
.031	1613	.058	862	.085	588
.032	1563	.059	847	.086	581
.033	1515	.06	833	.087	575
.034	1471	.061	820	.088	568
.035	1429	.062	806	.089	562
.036	1389	.063	794	.09	55 6

COTTON MANUFACTURE.

SLIVER TABLE,

Showing the size of sliver from No. .091 to No. .236, by the weight of 6 yards, in grains.

Number.	Grains.	Number.	Grains.	Number.	Grains.
Number. .091 .092 .093 .094 .095 .096 .097 .098 .099 .1 .102 .104 .106	Grains. 549 543 538 532 526 521 515 510 505 500 490 481 472	Number. .134 .136 .138 .14 .142 .144 .146 .148 .15 .152 .154 .156 .158	Grains. 373 368 362 357 352 347 342 338 333 329 325 321 316	Number. .186 .188 .19 .192 .194 .196 .198 .2 .202 .204 .206 .208 .21	Grains. 269 266 263 260 258 255 253 250 248 245 243 240 238
$\begin{array}{c} .108\\ .11\\ .112\\ .114\\ .116\\ .118\\ .12\\ .122\\ .124\\ .126\\ .128\\ .13\\ .132\end{array}$	$\begin{array}{r} 463\\ 455\\ 446\\ 439\\ 431\\ 424\\ 417\\ 410\\ 403\\ 397\\ 391\\ 385\\ 379\\ \end{array}$	$\begin{array}{c} .16\\ .162\\ .164\\ .166\\ .168\\ .17\\ .172\\ .174\\ .176\\ .178\\ .18\\ .182\\ .182\\ .184\\ \end{array}$	$\begin{array}{c} 313\\ 309\\ 305\\ 301\\ 298\\ 294\\ 291\\ 287\\ 284\\ 281\\ 278\\ 275\\ 275\\ 272\\ \end{array}$	$\begin{array}{c} .212\\ .214\\ .216\\ .218\\ .22\\ .222\\ .224\\ .226\\ .228\\ .23\\ .232\\ .234\\ .236\\ .232\\ .234\\ .236\\ \end{array}$	$\begin{array}{c} 236 \\ 234 \\ 231 \\ 229 \\ 227 \\ 225 \\ 223 \\ 221 \\ 219 \\ 217 \\ 216 \\ 214 \\ 212 \end{array}$

CARDING.

SLIVER TABLE,

Showing the size of sliver from No. .238 to No. 1, by the weight of 6 yards, in grains.

$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Number.	Grains.	Number.	Grains.	Number.	Grains.
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{c} .238\\ .24\\ .242\\ .242\\ .244\\ .246\\ .248\\ .25\\ .252\\ .252\\ .254\\ .256\\ .258\\ .26\\ .262\\ .264\\ .266\\ .268\\ .27\\ .272\\ .274\\ .276\end{array}$	$\begin{array}{c} 210\\ 208\\ 207\\ 205\\ 203\\ 202\\ 200\\ 198\\ 197\\ 195\\ 194\\ 192\\ 191\\ 189\\ 188\\ 187\\ 185\\ 185\\ 184\\ 182\\ 181\\ \end{array}$	$\begin{array}{c} .292\\ .294\\ .296\\ .298\\ .3\\ .31\\ .32\\ .33\\ .34\\ .35\\ .36\\ .37\\ .38\\ .39\\ .4\\ .41\\ .42\\ .43\\ .44\\ .45\\ \end{array}$	$\begin{array}{c} 171\\ 170\\ 169\\ 168\\ 167\\ 161\\ 156\\ 152\\ 147\\ 143\\ 139\\ 135\\ 132\\ 128\\ 128\\ 125\\ 122\\ 119\\ 116\\ 114\\ 111\\ \end{array}$	$\begin{array}{c} .53\\ .54\\ .55\\ .56\\ .57\\ .58\\ .59\\ .6\\ .62\\ .64\\ .66\\ .68\\ .7\\ .72\\ .74\\ .76\\ .78\\ .8\\ .82\\ .84 \end{array}$	$\begin{array}{c} 94\\ 93\\ 91\\ 89\\ 88\\ 86\\ 85\\ 83\\ 81\\ 78\\ 76\\ 74\\ 71\\ 69\\ 68\\ 66\\ 64\\ 63\\ 61\\ 60\\ \end{array}$
$\begin{array}{c c c c c c c c c c c c c c c c c c c $.28 .282 .284 .286	$179 \\ 177 \\ 176 \\ 175$	$.47 \\ .48 \\ .49 \\ .5$	$106 \\ 104 \\ 102 \\ 100$.88 .9 .92 .94	$57 \\ 56 \\ 54 \\ 53$
.282 177 .48 104 .9 56	.274 .276 .278	$182 \\ 181 \\ 180$	$.44 \\ .45 \\ .46$	$114 \\ 111 \\ 109$.82 .84 .86	$ \begin{array}{r} 61 \\ 60 \\ 58 \end{array} $

ROVING TABLE,

Showing the size of roving from No. .05 to No. 8, by the weight of 12 yards, in grains.

.05 .052	2000						
	2000						
.052		.108	926	.185	541	.8	125
I	1923	.11	909	.19	526	.85	118
.054	1852	.112	893	.195	513	.9	111
.056	1786	.114	877	.2	500	.95	105
.058	1724	.116	862	.205	488	1.	100
.06	1667	.118	847	.21	476	1.05	95
.062	1613	.12	833	.215	465	1.2	83
.064	1563	.122	820	.22	455	1.25	80
.066	1515	.124	806	.225	444	1.3	77
.068	1471	.126	794	.23	435	1.35	74
.07	1429	.128	781	.235	426	1.4	71
.072	1389	.13	769	.24	417	1.5	-67
.074	1350	.132	758	.245	408	1.65	61
.076	1316	.134	746	.25	400	1.8	55
.078	1282	.136	735	.275	364	2.	50
.08	1250	.138	725	.3	333	2.25	44
.082	1220	.14	714	.325	308	2.75	36
.084	1190	.143	699	.35	286	3.	- 33
.086	1163	.146	685	.375	267	3.5	29
.088	1136	.149	671	.4	250	4.	25
.09	1111	.152	658	.425	235	4.5	22
.092	1087	.155	645	.45	222	5.	20
.094	1064	.158	633	.475	211	5.5	18
.096	1042	.161	621	.5	200	6.	17
.098	1020	.165	606	.55	182	6.5	15
1	1000	.169	592	.6	167	7.	14
.102	980	.173	578	.65	154	7.5	13
.104	962	.177	565	.7	143	8.	13
.106	943	.181	552	.75	133		

SPINNING.

YARN TABLE,

Showing the size of yarn from No. 1 to No. 120, by the weight of one hank in grains.

No.	Grains.	No.	Grains.	No.	Grains.	No.	Grains.	No.	Grains.
									-
1	7000	25	280	49	143	73	96	97	72
2	3500	26	269	50	140	74	95	98	71
3	2333	27	259	51	137	75	93	99	71
4	1750	28	250	52	135	76	92	100	70
5	1400	29	241	53	132	77	91	101	69
6	1167	30	233	54	130	78	90	102	69
7	1000	31	226	55	127	79	89	103	68
8	875	32	219	56	125	80	88	104	67
9	778	33	212	57	123	81	86	105	67
10	700	34	206	58	121	82	85	106	66
11	636	35	200	59	119	83	84	107	65
12	583	36	194	60	117	84	83	108	65
13	538	37	189	61	115	85	82	109	64
14	500	38	184	62	113	86	81	110	64
15	467	39	179	63	111	87	80	111	63
16	438	40	175	64	109	88	80	112	63
17	412	41	171	65	108	89	79	113	62
18	389	42	167	66	106	90	78	114	61
19	368	43	163	67	104	91	77	115	61
20	350	44	159	68	103	92	76	116	60
21	333	45	156	69	101	93	75	117	60
22	318	46	152	70	100	94	74	118	59
23	304	47	149	71	99	95	74	119	59
24	292	48	146	72	97	96	73	120	58

COTTON MANUFACTURE.

EXPLANATION OF THE REED TABLE.

1. Manchester, Stockport, and the United States count by the number of ends in one inch.

2. Bolton counts by the number of beers on $24\frac{1}{2}$ inches, 20 dents to a beer.

3. Blackburn counts by the number of beers on 45 inches, 20 dents to a beer.

4. 6-4ths, Preston, counts by the number of beers on 58 inches, 20 dents to a beer.

5. 9-8ths, Preston, counts by the number of beers on 44 inches, 20 dents to a beer.

6. 4-4ths, Preston, counts by the number of beers on 39 inches, 20 dents to a beer.

7. 7-8ths, Preston, counts by the number of beers on 34 inches, 20 dents to a beer.

8. Nankeen counts by the number of beers on 20 inches, 19 dents to a beer.

9. Scotch and Carlisle count by the number of dents on 37 inches.

Goods shrink about $\frac{1}{10}$ in bleaching or finishing.

The following table shows at a glance the number of dents in an inch, and the corresponding count of reed. The first column contains the number of dents in one inch, opposite to which are the counts of the reeds according to the system of counting.

Scotch and Carlisle.	$\begin{array}{c} 740\\777\\851\\851\\851\\855\\999\\9999\\11036\\1110\\1113\\1125\\11258\\11258\\11258\\11258\\11258\\11258\\11258\\1228\\122$
Nankeen.	$\begin{array}{c} 21.05\\ 22.1\\ 222.1\\ 222.1\\ 225.26\\ 225.$
Blackburn.	$\begin{array}{c} 45\\ 45\\ 47.25\\ 51.75\\ 54\\ 54.25\\ 56.25\\ 56.25\\ 60.75\\ 63.25\\ 63.25\\ 63.25\\ 63.25\\ 63.25\\ 63.25\\ 74.25\\ 74.25\\ 77.5\\ 78.75$
Preston, 7-8ths.	$\begin{array}{c} 325.7\\ 345.9\\ 51.2\\ 51.$
Preston, 4-4ths.	$\begin{array}{c} 39\\ 242.9\\ 442.8\\ 442.8\\ 444.85\\ 544.7\\ 552.65\\ 54.7\\ 56.55\\ 56.55\\ 56.55\\ 56.55\\ 56.35\\ 66.3\\ 66.3\\ 66.3\\ 66.3\\ 66.3\\ 68.25\\ 68$
Preston, 9-8ths.	$\begin{array}{c} 44\\ 46.2\\ 48.4\\ 55.6\\ 57.2\\ 57.2\\ 63.8\\ 63.8\\ 63.8\\ 63.8\\ 77.2\\ 77.2\\ 77.2\\ 77.2\\ 77.2\\ 77.2\\ 79.2\\ 77.2\\ 7$
Preston, 6-4ths.	$\begin{array}{c} 58\\ 58\\ 66.7\\ 66.7\\ 66.7\\ 66.7\\ 66.7\\ 75.4\\ 72.5\\ 81.2\\ 84.1\\ 84.1\\ 87\\ 82.3\\$
Bolton.	$\begin{array}{c} 24.25\\ 25.46\\ 25.46\\ 26.67\\ 27.88\\ 29.1\\ 30.31\\ 31.52\\ 32.73\\ 32.73\\ 32.73\\ 32.73\\ 32.73\\ 32.73\\ 32.73\\ 32.73\\ 32.73\\ 32.73\\ 32.73\\ 32.73\\ 32.75\\ 32.73\\ 32.73\\ 32.73\\ 32.73\\ 32.75\\ 32.73\\ 32.75\\ 32.73\\ 32.75\\ 32.75\\ 32.73\\ 32.75\\ 32.73\\ 32.75\\ 32.$
Manchester, Stockport, and United States.	$\begin{array}{c} & & & \\ & & & & \\ & & & \\ & & & \\ & & & \\ & & & & \\ & & & \\ & & & & & \\ & & & & \\ & & & & \\ & & & & & \\ & & & & & \\ & & & & & \\ & & & & & \\ & & & & & \\ & & & & & \\ & & & & & \\ & & & & & \\ & & & & & \\ & & & & & \\ &$
No. of Dents in • one inch.	86 22 10 0 28 27 6 5 4 23 29 10 3 3 5 4 3 3 29 10 0 28 29 28 29 20 3 5 4 5 5 5 7 5 7 5 7 5 7 5 7 5 7 5 7 5 7

REED TABLE.

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COTTON MANUFACTURE.

1369	1406	1443	1480	1517	1554	1591	1628	1665	1702	1739	1776	1813	1850	1887	1924	1961	1998	2035	2072	2109	2146	2183	2220
38.94	4()	41.05	42.1	43.15	44.21	45.26	46.31	47.36	48.42	49.47	50.52	51.57	52.63	53.67	54.72	55.78	56.84	57.9	58.9	60	61.05	62.1	63.15
83.25	85.5	87.75	00	92.25	94.5	96.75	66	101.2	103.5	105.75	108	110.25	112.5	114.75	117	119.25	121.5	123.75	126	128.25	130.5	132.75	135
62.9	64.6	66.3	68	69.7	71.4	73.1	74.8	76.5	78.2	79.9	81.6	83.3	85	86.7	88.4	90.1	91.8	93.5	95.2	96.9	98.6	100.3	102
72.15	74.1	76.05	78	79.95	81.9	83.85	85.8	87.75	89.7	91.65	93.6	95.55	97.5	99.45	101.4	103.35	105.3	107.25	109.2	111.15	113.1	115.05	117
81.4	83.6	85.8	88	90.2	92.4	. 94.6	96.8	66	101.2	103.4	105.6	107.8	110	112.2	114.4	116.6	118.8	121	123.2	125.4	127.6	129.8	132
107.3	110.2	113.1	116	118.9	121.8	124.7	127.6	130.5	133.4	136.3	139.2	142.1	145	148.9	151.8	154.7	157.6	159.5	162.4	165.3	168.2	171.1	174
44.86	46.07	47.28	48.5	49.71	50.9	52.13	53.35	54.56	55.71	56.98	58.3	59.41	66.62	61.83	63.04	64.25	65.46	66.69	6.7.9	69.11	70.33	71.56	72.75
74	76	78	80	82	84	86	88	90	93	94	96	98	100	102	104	106	108	110	112	114	116	118	120
37	38	39	0 1	41	42	43	44	45	46	47	1 8	49	50	51	52	53	54	55	56	57	58	59	60

REED TABLE.

LINEN YARN TABLE,

Showing the weight of one lea, or cut, in grains, from No. 1 to No. 200.

The first column is the number of the yarn, opposite to which is the weight, in grains, according to the length weighed, which, in the table, is one cut, or 300 yards.

One lea, or cut, of linen yarn contains 300 yards, and one pound avoirdupois contains 7000 grains troy; hence, the yards in one cut are to the grains in one pound, as 300 is to 7000, or 3 to 70.

To find the number.

Multiply the length in yards by 70, and divide their product by the weight, in grains, multiplied by 3.

Example.

If 2400 yards weigh 7000 grains, what is the number?

Worked out by Cancellation. 1.7(000 24(00.8 1.3 7(0.1	
8	Answer.
The same without Cancellation	
Dividend	×70_8
Divisor $\ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \overline{7000}$	$\times 3$

Answer.

290

How many yards are there in one pound of No. 8?

Worked out l	by Cancellation.
	7000·100 8 3
	8
1.70	3

 $100 \times 8 \times 3 = 2400$

Answer.

The same without Cancellation.

What is the weight of 2400 yards of No. 8?

Worked	out	by	Cancellation.
			2400.800.100
	1	3	70

 $100 \times 70 = 7000$ grains, or one pound.

Answer.

The same without Cancellation. Dividend $\frac{2400 \times 70}{8 \times 3} = 7000$ grains. Answer.

LINEN Y.	ARN	TA	\mathbf{BL}	Е.
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Number.	Grains.	Number.	Grains.	Number.	Grains.			
Number. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	$\begin{array}{c} \text{Grains.} \\ \hline \\ 7000 \\ 3500 \\ 2333 \\ 1750 \\ 1400 \\ 1167 \\ 1000 \\ 875 \\ 778 \\ 700 \\ 636 \\ 583 \\ 538 \\ 500 \\ 467 \end{array}$	Number. 20 25 30 35 40 45 55 60 65 70 75 80 85 90	Grains. 350 280 233 200 175 156 140 127 117 108 100 93 88 82 78	Number. 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185	$\begin{array}{c} \text{Grains.}\\ \hline \\ 61\\ 58\\ 56\\ 54\\ 52\\ 50\\ 48\\ 47\\ 45\\ 44\\ 42\\ 41\\ 40\\ 39\\ 38\\ \end{array}$			
$ \begin{array}{c} 19 \\ 16 \\ 17 \\ 18 \\ 19 \end{array} $	$ \begin{array}{r} 438 \\ 412 \\ 389 \\ 368 \end{array} $	$ \begin{array}{r} 95 \\ 100 \\ 105 \\ 110 \end{array} $	$74 \\ 70 \\ 67 \\ 64$	190 190 195 200	37 36 35			

WORSTED AND WOOLLEN YARN TABLE,

Showing the weight of one hank, in grains, from No. 1 to No. 200.

The first column is the number of the yarn, opposite to which is the weight in grains, according to the length weighed, which, in the table, is one hank, or 560 yards.

One pound avoirdupois contains 7000 grains troy, and one hank of woollen yarn contains 560 yards; hence, the yards in one hank are to the grains in one pound, as 560 is to 7000, or 14 to 175.

To find the number.

Multiply the length in yards by 175, and divide their product by the weight in grains multiplied by 14.

Example.

If 5600 yards weigh one pound, what is the number?

1.17.5.70(00	by Cancellation. 0 56(00·4·1 4 175·10
	10 Answer.
The same with	hout Cancellation.
Dividend	$ \frac{5600 \times 175}{.} = 10$
Divisor	
· ·	Answer.

What is the weight of 5600 yards of No. 10?

Worked out by Cancellation.

$$1(0 \mid 560(0.40)$$

 $1.14 \mid 175$

 $175 \times 40 = 7000$ grains, or one pound.

Answer.

The same without Cancellation. Dividend $\cdot \cdot \cdot \frac{5600 \times 175}{10 \times 14} = 7000$ grains. Answer.

How many yards are there in one pound of No. 10?

Worked out by	y Cancellation.
	7000-200
	10.2
1.35.175	7000·200 10·2 14

 $200 \times 14 \times 2 = 5600$

Answer.

The same without Cancellation. Dividend $\dots \dots \frac{7000 \times 10 \times 14}{175} = 5600$

Answer.

WORSTED AND WOOLLEN YARN TABLE,

Showing the weight of one hank, in grains, from No. 1 . to No. 200.

Number. Grains.		Number.	Grains.	Number.	Grains.			
1	7000	20	350	115	61			
2	3500	25	280	120	58			
3	2333	30	233	125	56			
4	1750	35	200	130	54			
$\frac{4}{5}$	1400	40	175	135	52			
	1167	45	156	140	50			
$\begin{array}{c} 6 \\ 7 \end{array}$	1000	50	140	145	48			
8 9	875	55	127	150	47			
9	778	60	117	155	45			
10	700	65	108	160	44			
11	636	. 70	100	165	42			
12	583	75	93	170	41			
13	538	80	88	175	40			
14	500	85	82	180	39			
15	467	90	78	185	38			
16	438	95	74	190	37			
17	412	100	70	195	36			
18	389	105	67	200	35			
19	368	110	64					

RAILWAY-HEAD.

WITH DRAPER'S PATENT EVENER ATTACHED.

The following tables and remarks were furnished by Mr. George Draper, Hopedale, Mass:

Below I give a table showing the actual result of the use of the Eveners in the Boott Cotton Mills at Lowell, from July 19 to August 4, 1866. The drawing from each of the heads was weighed carefully over 150 times. The

TABLE OF WEIGHTS WHERE THE EVENER WAS USED.

		73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88		
-	_						_	3					<u> </u>						
				_	—		_	1	1		1		<u> </u>						
						—	2	_	1		<u> </u>			-					
	_					<u> </u>	-	1	$\frac{1}{1}$	1	-	<u> </u>	-			_			
					 	1	2	3	3	$\frac{1}{1}$	2		<u> </u>	-		_			
		<u> </u>				$\frac{1}{1}$	4	2	5	-	<u> </u>		<u> </u>		—		—		
		1		4	1	2	<u>+</u> 3	2	1	-								_	
		1	1	4		3	1	1	 _				<u> </u>			·			
		-	<u> </u>	1	3					<u> </u>		-	<u> </u>	<u> </u>					
			1	$\frac{2}{1}$	2		1	2	1						—	_			
		<u> </u>	- <u>-</u> -		6			_		-					<u> </u>				
					2		4	1	$\frac{2}{2}$	1									
il —					2	1	1	2	3	-1					-				
				1	1	1	<u> </u>	2	3	1	<u>+</u>	1							
						2	4	1	2		1								
				3	1	3			<u> </u>	3				_					
				1	2	1	1	3	2										
						1	4		3										
						1	3	1	3										
		2	2	16	20	17	31	25	30	9	3	1							

RAILWAY-HEAD.

Standard aimed at was 79 grains (between the black lines) for a given length. The drawing was straightened out, a strip of board laid on, and the drawing cut off at each end with a sharp knife, and then carefully weighed. Mark the result—any weighing not varying more than 4 or 5 grains from the standard, either way, would make comparatively little difference. That weighing 72 in number 20 yarn, would vary one number one way, and 83 one number the other way. That with the Evener in weigh-

TABLE OF WEIGHTS WHERE THE EVENER WAS NOT USED.

		73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	
	_				1		2	_	_									
					1	1				1	_							
									1		1			1				
				1	1									1				
				2	1	1	2	1	2	2	1							
			1		1	3	1	1	4				1					
		1		1	1	1	1	2		2	1	1	2		1			
				1	2		1			3		3	3		1	·		
		_			1	1		1	1	1		1	2					
							1		1		1		3	1			1	
				2	2		1	3		1		1						
					1		1	3		1	3				1			
		1	2			3		2	2									
	<u> </u>		1		1		1	2		2		1			1	1		
			1		2	2	1	2	1				1					
				1	2		1	1	1		1			1		1		
				1	2		1	1			1	1						
				2	1		2	1	1									
		2	5	11	20	12	16	20	14	13	9	8	12	4	4	2	1	

ing 156 times in three weeks, varied more than that only 4 times, 2 times 73 and 2 times 74. Now look at the other weight at the same time, and under the same circumstances, *except* the Evener. Out of 153 weighings, that weighed 75—7 times and more than 83—23 times. The one with the Evener weighed right, or within one grain of right, 86 times, while the one without the Evener did but 50 times. In one the weighings are between 73 and 83—in the other scattered from 73 to 88.

N. B.—The above is by some called Hayden & Wyllys' Patent Evener.

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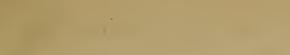
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