THE THEORY AND PRACTICE

OF

JUTE SPINNING:

BEING A COMPLETE DESCRIPTION
OF THE MACHINES USED IN THE PREPARATION
AND SPINNING OF JUTE YARNS

WITH ILLUSTRATIONS OF THE VARIOUS MACHINES,

SHOWING THE CALCULATIONS, TABLES OF SPEEDS, DRAFTS,
PRODUCTION, WASTE, ETC.

Including over 140 Diagrams to Scale.

BY

WILLIAM LEGGATT

MANAGER, MANHATTAN WORKS,
DUNDEE,
Author of the Second Edition of Art of Weaving.

DUNDEE: WILLIAM KIDD, WHITEHALL STREET.
EDINBURGH & GLASGOW: JOHN MENZIES & CO.
LONDON: SIMPKIN, MARSHALL, & CO., LTD.
1893.

William Kidd, Printer, Whitehall Street,
Dundee.

TO

Colonel Frank Stewart Sandeman, J.P.,

OF STANLEY. PERTHSHIRE,

THE FOLLOWING PAGES ARE RESPECTFULLY

INSCRIBED IN RECOGNITION OF MUCH KINDNESS

AND CONSIDERATION RECEIVED

DURING THE PAST TWENTY YEARS.

PREFACE.

The author has never forgotten the difficulties he had to contend with in regard to information when learning his business. It is a true saying that too much help is a bad thing, but it is quite as true that a little, just a little at the right time, is a good thing. This is the spirit in which these pages have been written. They contain information which will be found invaluable to those who are seeking with earnestness of purpose to learn their business, but they were not intended to, and will not help those who are not also willing and anxious to help themselves. Any one anxious to do this will, we feel confident, receive from a careful study of these pages a better start than ever the author received.

Nothing has been written in the book with reference to the Jute Fibre or the growth of the plant; that part of the subject the student will find in books already to hand. My endeavour has been to confine myself strictly to the practical manipulation of the fibre and the method of working the machines, explaining as briefly as possible the calculations of speeds, etc.

The man of practical experience will perhaps not find much that is new, but the book may be of service even to him as a reference for figures which are not usually at hand.

Writing a mere description of Jute Machinery will not be of much assistance to the student since there is so much detail, and that detail it is of importance to know well before you can expect to get the many wheels and pinions, &c., in your "mind's eye," hence the reason that considerable attention has been bestowed on the illustration of all the parts of the machines. These illustrations being all made to scale, very readily bring before the reader the different proportions and relations of one wheel or roller to another.

Every effort has been made to avoid errors in the calculations. There may be some, however, in the book, but, generally speaking, the figures can be relied upon.

My sincere thanks are due to A. S. Macpherson, Esq., of Messrs Fairbairn, Naylor, Macpherson, & Co., Limited, Leeds; and also to A. Gordon Thomson, Esq, of Messrs Thomson, Son, & Co., Dundee for valuable assistance rendered.

WILLIAM LEGGATT.

DUNDEE, May, 1893.

CONTENTS.

APPENDIX.

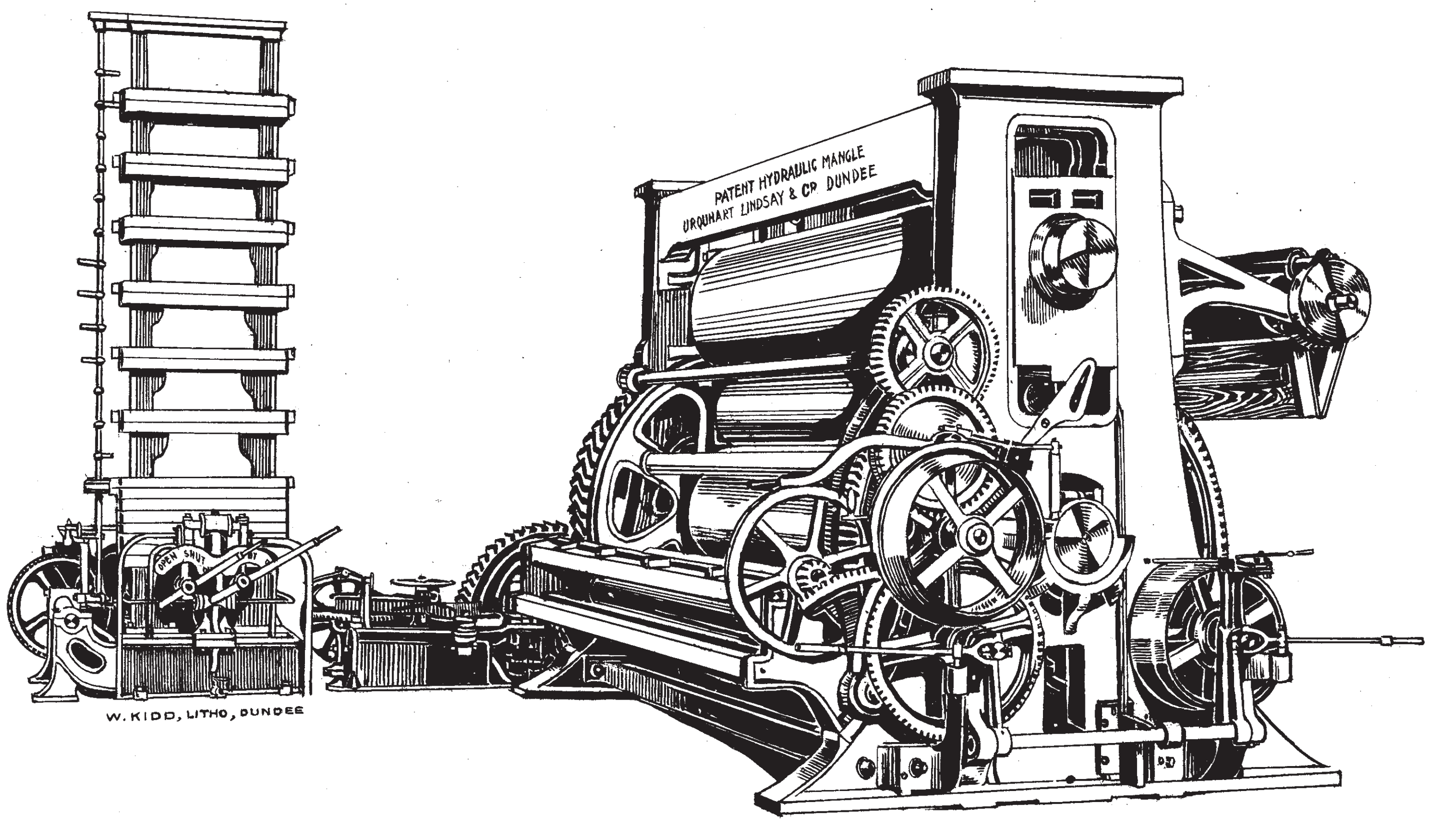
INDEX TO ILLUSTRATIONS.

PAGE.

JUTE PREPARING.

JUTE SPINNING.

COP MACHINES.



PATENT HYDRAULIC MANGLE.

FOR JUTE & LINEN FABRICS,

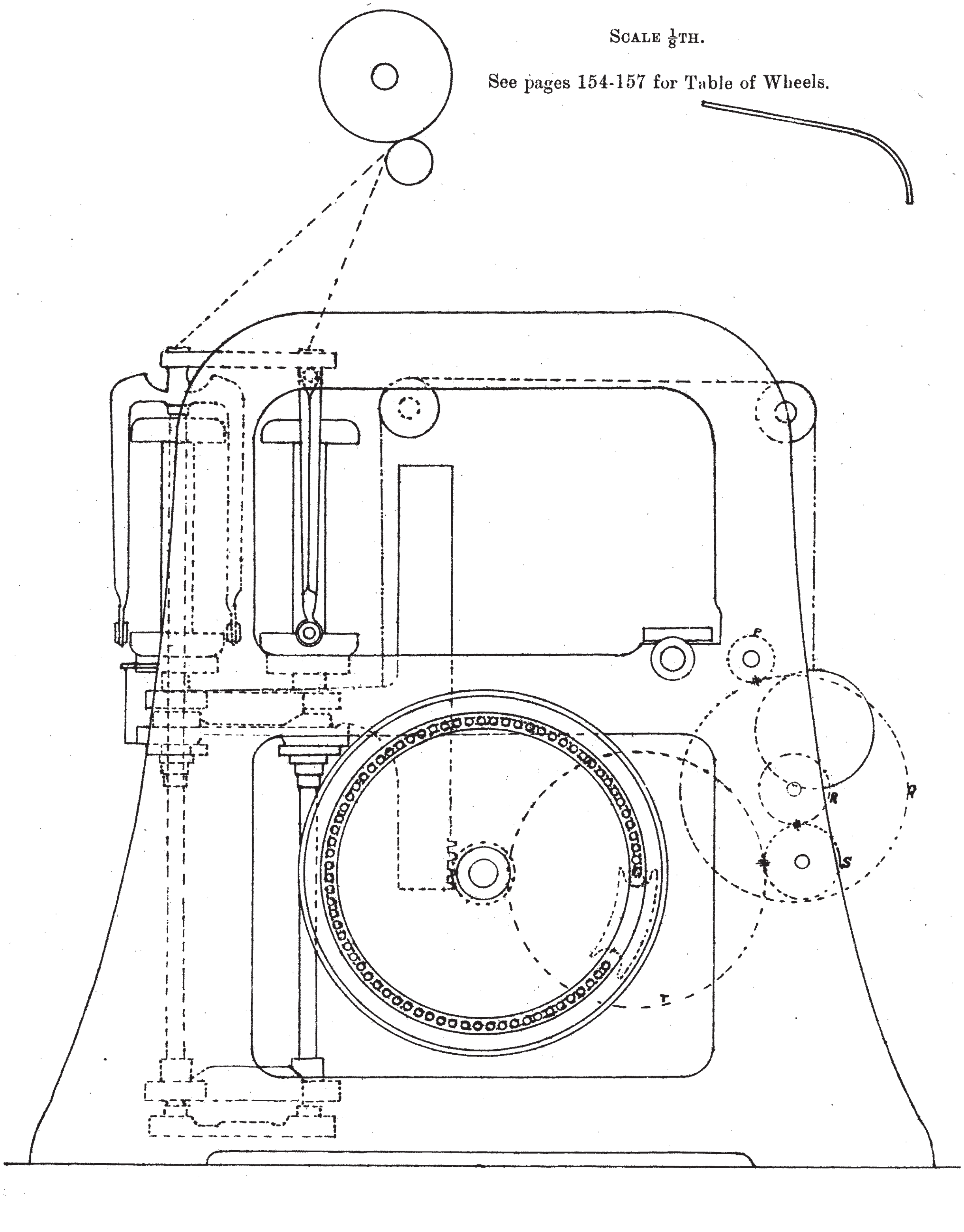
MAKERS

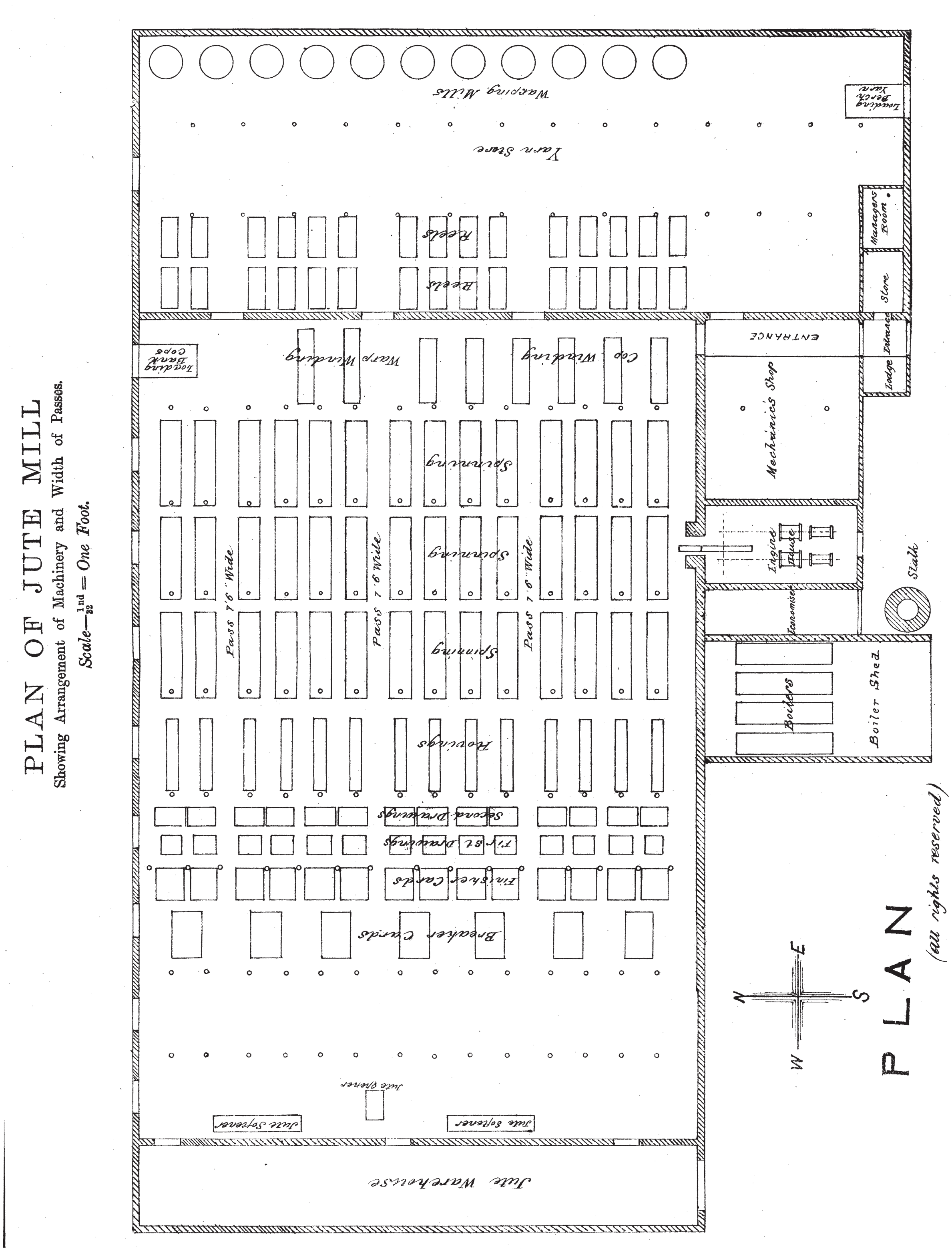
URQUHART LINDSAY & Co. Ltd. DUNDEE.

ARRANGEMENT OF GEAR FOR ROVING FRAME TRAVERSE.

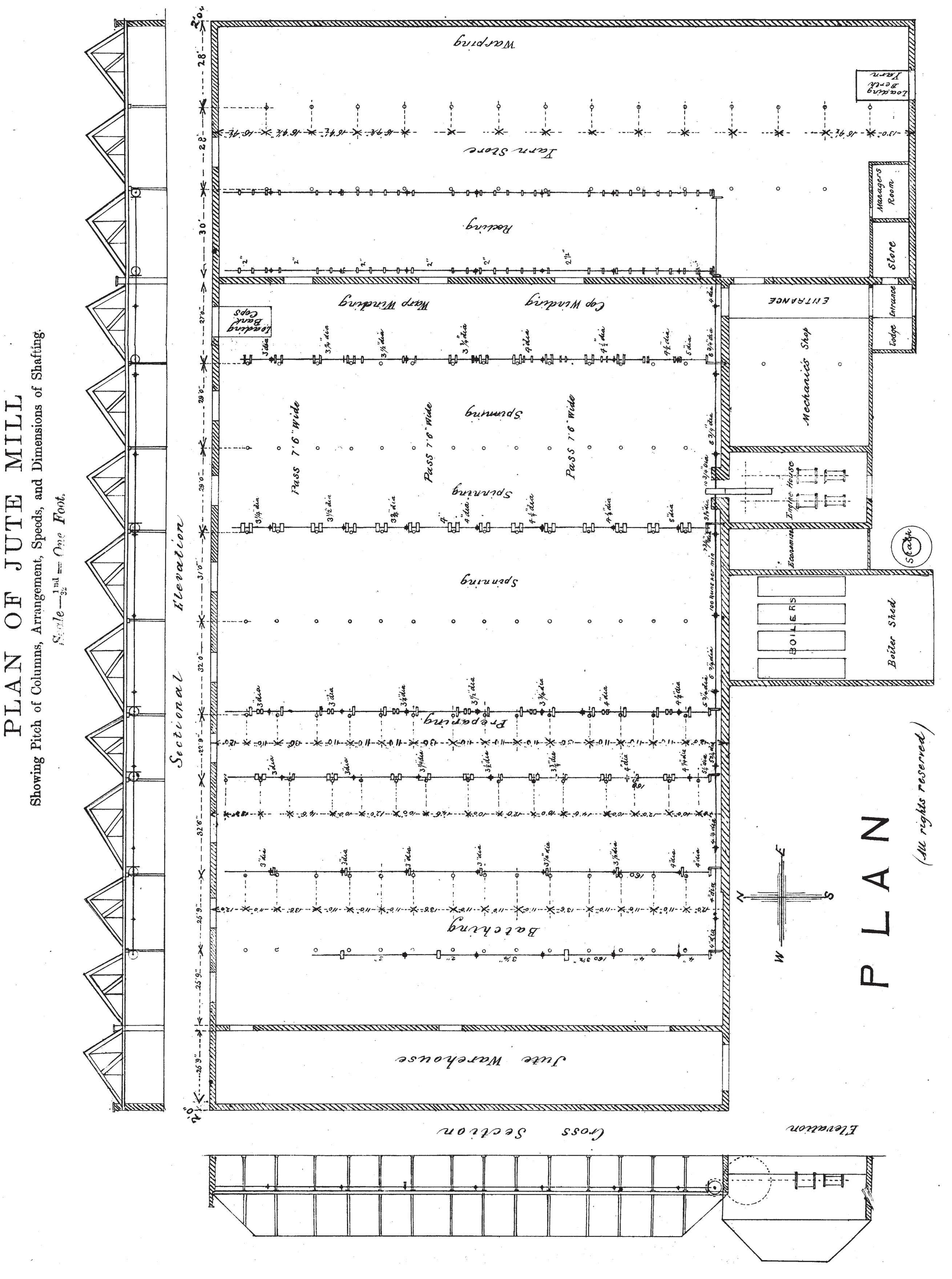
SCALE $\frac{1}{8}$TH.

See pages 154-157 for Table of Wheels.





Foldout reduced to 67% and rotated 90° to fit on page.



Foldout reduced to 67% and rotated 90° to fit on page.

It will also be observed from the plan of shafting that wheel-gearing is the method adopted throughout for driving the mill.

In the ground plan all the frames are shown the same size—72 spindles a side, 4″ pitch. I will refer to this in the chapter upon spinning and spinning machinery.

The mill as shown by the plan is laid out for the following machinery :—

1	Jute	Opener.	
2	,,	Softeners of from 47 pairs of rollers each.	
7	,,	Breakers—Cylinder 6′ × 4′.	
14	,,	Finishers—Cylinder 6′ × 4′.	
14	,,	1st Drawings—2 heads each—Push Bar.	
14	,,	2nd ,, 2 ,,	Spiral Bar.
14	,,	Rovings 10″ × 5″, 56 spindles each.	

84 Spinning Frames, 4″ pitch, 4″ traverse, 72 spindles a side = 6048 spls.

12 Cop Machines, 54 spindles a side, 4½″ Pitch.

Warping Mills and Reels.

Yarn Warehouse Accommodation.

The chapter upon Boilers and Engines gives the information as to coals, water for steam, and horse power required to drive the above; and also shows what part of that H.P. is required to drive each department, and the loss of horse power absorbed by engines, shafting, and pulleys by friction.

Before commencing the description of the several departments and the machinery, the following remarks may not be out of place at the beginning as descriptive of the general arrangements in connection with a Jute Mill.

Punctuality, cleanliness, and organization are the leading points to be kept in mind in the daily routine of a Jute Mill, and the more experience one has of jute spinning the more evident will these points become, as without them, there will not be quantity, quality, or steadiness in the daily output; and these three points are necessary in every department. It is from the study and application of these three points that good results will be obtained, rather than from an undue speed put upon the machinery.

As all the modern mills are built on the shed principle, and with no partition between the departments, every precaution should

INTRODUCTORY REMARKS.

To give in a general way some information that will be of some service to the young mechanics and mill-men anxious to learn their trade, is the object of the following pages, not going too much into detail, but stating in a plain and simple way as much as will help the student to make a start and to persevere in his efforts to learn the theoretical part of his trade, and consequently making the machinery amongst which his daily work is of more interest and attraction to him. No theories or crotchets are discussed, but an attempt has been made to explain the working of the machines, and the calculations pertaining to them, along with their arrangement in the different departments to which they belong.

Two plans of a Jute Mill are given in this book. One of these is a ground plan, and is intended to show the arrangement of machinery, the floor space taken up by each machine, the pitch of columns and roofs, and the width of passes in each direction; the other plan shows the elevation of roof, the lines of shafting, and the diameters of shafting necessary to transmit the horse power required to drive the machinery marked upon the ground plan—the speeds of the different shafts are marked upon this plan for reference. These plans are in no way exhaustive, and are not intended to be so—that is to say, they do not go into details, but they show in a broad and general manner the outstanding arrangement of a Jute Mill built upon the shed principle, and will be found useful as a reference for the information referred to in this paragraph. The reader will note that all the speeds of shafts are given in whole numbers. This has been done merely to avoid fractions, and it will be observed that in the calculations of card cylinder speeds, &c., I have also taken whole numbers for the same reason; but this in no way affects the results which are near enough for showing the method of working, and also, I may add, for all practical purposes.

be taken against fire—fires occurring on many occasions, the cause of which cannot be very easily explained. Much may be done to localize these small fires by having the departments connected to the mechanics' shop by electric wires, the alarm being sent to the mechanics when a fire occurs, and assistance is then immediately at hand. In most modern mills this plan is now generally adopted, small hose pipes being kept hanging up at various parts of the mill ready for instant action, and these small pipes with spray nozzles will be generally found, if well and properly handled, quite enough for the usual small fires which often occur, particularly in the preparing, spinning, and cop winding departments. A well organized fire brigade, with the necessary equipment, should always form part of the working arrangements of a Jute Mill, and the equipment should be periodically tried and thoroughly examined to see that all the tools are in good order and in their proper place, so that they can be got at once into action in the event of any emergency.

The sanitary arrangements should also have very special attention, and a plan of all the drains should be kept, so that in the event of anything going wrong the lines of drains can at once be traced and repairs made without loss of time and inconvenience to the working arrangements.

Jute spinning, like many other things, cannot be learned from a book, but the book may be helpful in a way. Spinning can only be learned by steady and persevering hard work and experience.

In every mill many arrangements and adaptations of the machinery have to be made to suit the requirements of the particular branch of the trade in which the mill may happen to be engaged. These arrangements I do not endeavour to describe, as they form no part of the purpose of this book. To describe in a general way the working of the machines, and the method followed in producing yarns suitable for hessian and sacking cloths, is the purpose of this book—with what success I have accomplished my task must be left for the reader to judge. With the above general explanation, I will now describe the various steps in the different departments, commencing with a chapter on boilers and engines.

THE BOILERS AND ENGINES.

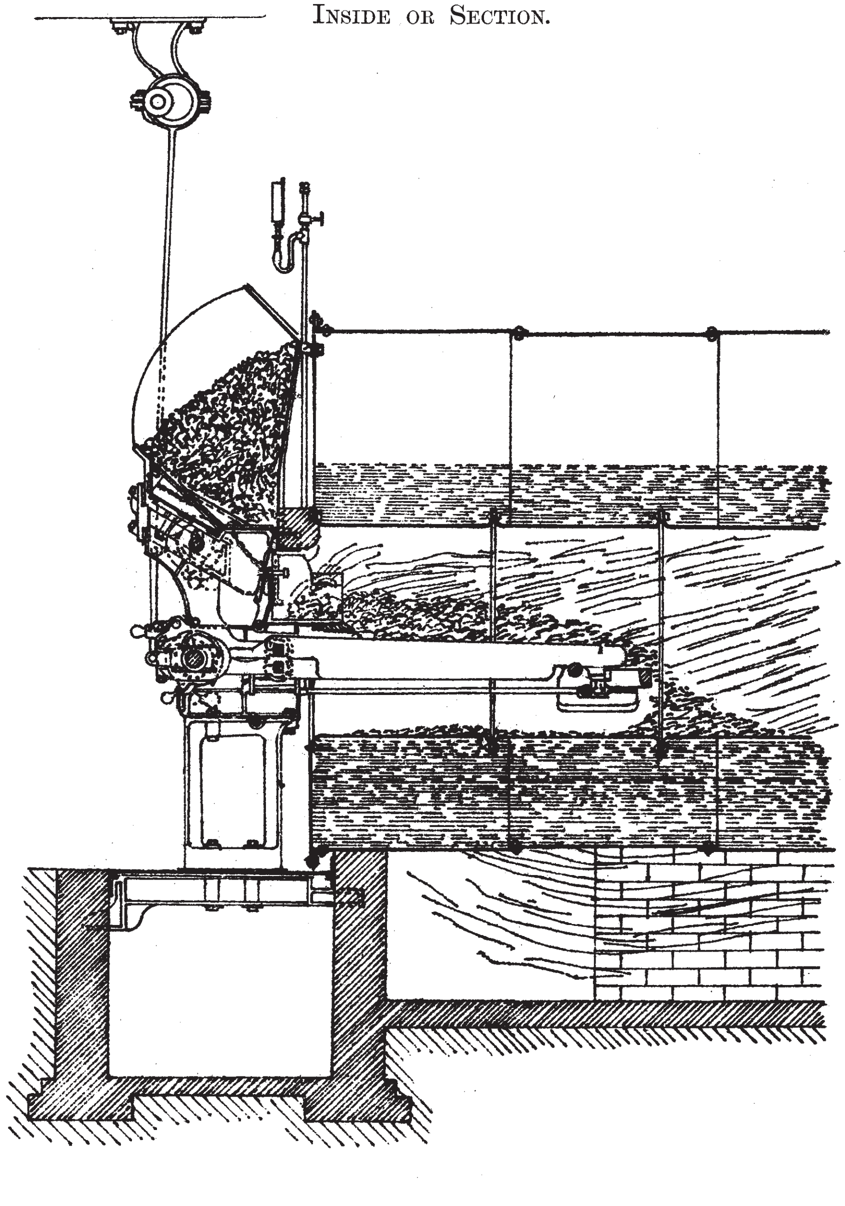
THE BOILERS.—The Boilers most commonly in use in Jute Mills are what are usually called Lancashire Boilers, and the ordinary size in use are 30′ × 7′, with two flues running right through. Sometimes the flues are what are termed duplex—that is, two flues which run into one at the back end of the firebox. Four boilers are necessary to produce steam for the machinery shown in the plan. The amount of coals and steam required for the work to be done are given in this chapter. The boilers may either be fired by hand or by a furnace-stoking apparatus. Machine firing is, although slowly being adopted, likely to become in a spinning mill the recognised method of firing boilers, as there is more regularity in the pressure of steam and the absence of smoke or dirt. Between the boilers and the chimney is usually placed a serious of pipes termed an economiser; through these pipes is passed the feed water on its way to the boilers, and the waste gases are thereby utilised to increase the temperature of the feed water. Eighty pipes per boiler will increase the temperature of the feed water from 120° to 220/230°, if there is a fair draught, say $\frac{8}{10}$ths of a column of water in a guage placed in the flue at back of boilers and in front of the economiser. If machine firing is the plan adopted, the coals are thrown into a large box or hopper, in front of the boilers, and the coals fall through an aperture in the apparatus, and are pushed into the furnace by rams worked by eccentrics or cams. The furnace bars moving at the same time, the coals are carried at the speed required into the furnace. A great many stokers of different construction are now at work, each having their own so-called special advantages. An illustration of a stoker by T. & T. Vicars is given. When working with furnace stoking apparatus it does not tend to economy to force the consumption of coal, as it leads to unnecessary waste of fuel, but you can consume from 21/22 tons of coal in a working week of 56 hours without over-driving the apparatus, and if a fair quality of Scotch coal is used the waste will not be more than 4/5°/₀. This stoker has been a long time before the public. The illustration is given here to show the principle upon which the machine works. It is not necessary to comment here upon its comparative merits with other furnace apparatus at present in use.

VICARS' NEW & IMPROVED PATENT MECHANICAL STOKER

AND

SELF-CLINKERING SMOKELESS FURNACE.

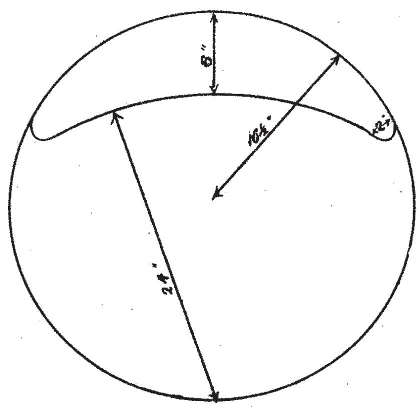
INSIDE OR SECTION.



The boilers should be cleaned internally, if the water is of a fair quality, three times a year, and the flues once a year, and the brick-work examined carefully after the annual cleaning is done. The economiser should be "blown through" once a day, and the "soot chamber" and side flues cleaned out three times a year. If the water is of a fair quality, the pipes will not require to be cleaned internally more than once in ten years.

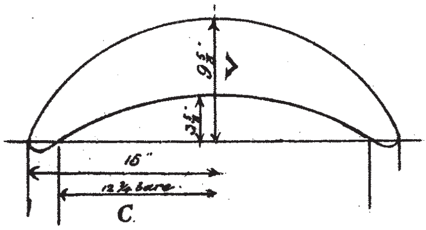
To get the full benefit of the advantages of the economiser, the boilers should be continually taking water. If the feed valves are not kept open continuously, many of the advantages of the economiser are lost. Care should also be taken to notice that the pressure upon feed water should not be more than 10 lbs. per square inch above the pressure to be carried into the boilers. If more pressure is used, it causes quite an unnecessary strain upon the feed pipes.

SECTION OF FIRE BOX OF BOILERS



TO FIND THE AREA OF OPENING WANTED ABOVE FIRE BRIDGE IN SQ INCHES

TO FIND THE AREA.



RULE IN MOLESWORTH

$$= \frac{4V}{3} \sqrt{(0.626V)^2 + C^2} = \text{Area}$$

1st

$$\frac{4V}{3} \cdot \sqrt{(0.626)^2 + C^2}$$

$$= \frac{38.5}{3} \times \sqrt{6.02525^2 + 15^2}$$

$$= 12.833 \times \sqrt{36.28 + 225}$$

$$= 12.833 \times 16.164 = 207.43$$

2nd

$$\frac{14.5}{3} \times \sqrt{2.25^2 + 12.7^2}$$

$$= 4.833 \times \sqrt{5.06 + 161.3}$$

$$= 4.833 \times 12.9 = 62.34$$

207 · 43
62 · 34

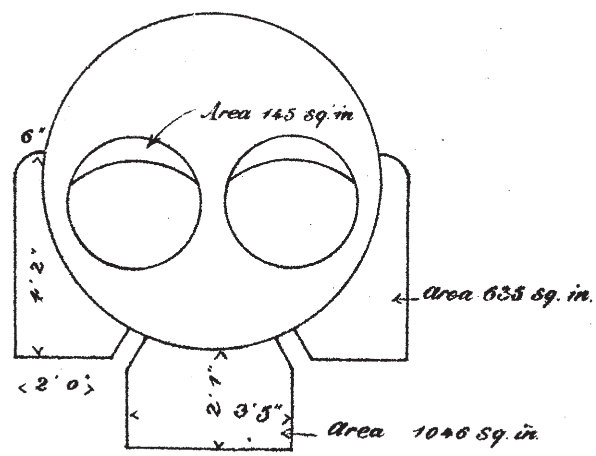
Area 145 · 09 Sq in

The following is a sectional elevation to show the form of the boiler flues, and the other diagram is a plan showing position of boilers and economisers, with arrangement of flues and dampers between boiler and chimney.

A boiler 30′ × 7′ contains 3500 galls. of water at a temperature of 60°

Economiser 320 pipes contain 2000 gallons of water at 60°

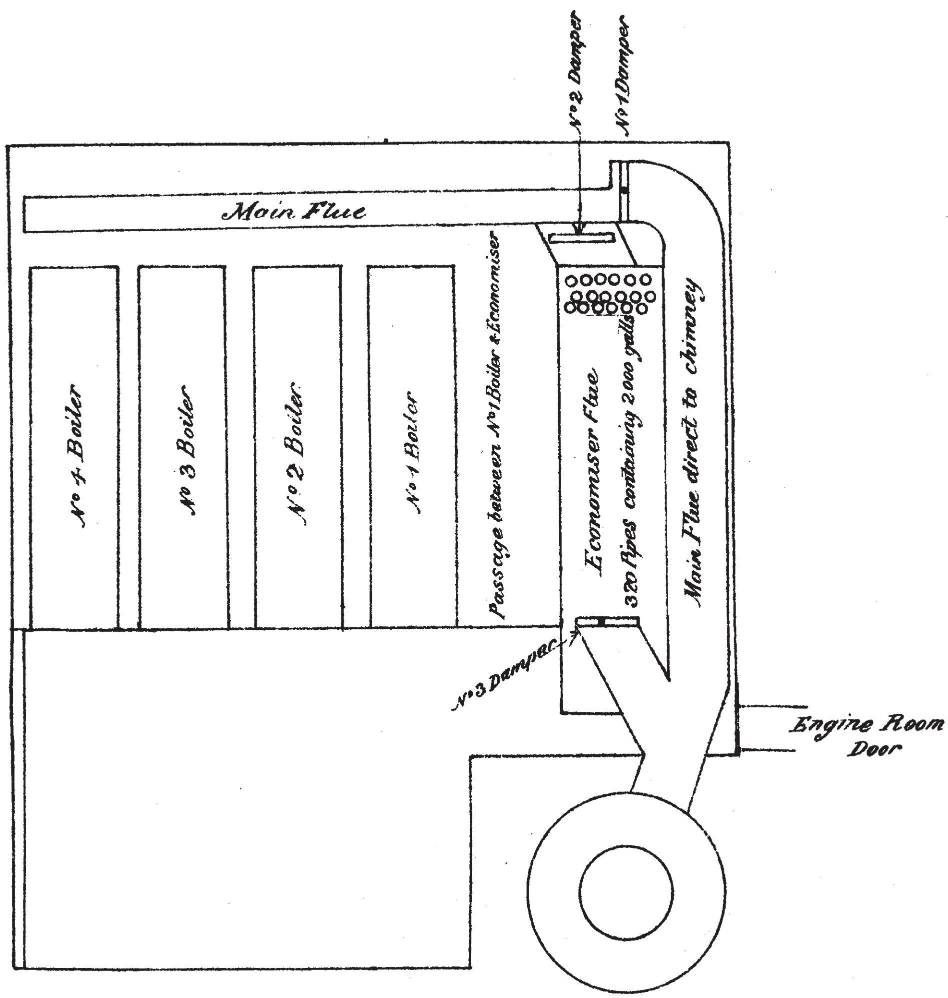
OUTLINE SHEWING AREA OF FLUES.



The centre flue is about three feet wide and two feet deep, and the side flues about two feet wide at the bottom, and at the closing-in (which is about three-fourths of a circle) about nine inches wide.

Each boiler has two dampers, which are hung and can be worked independently of each other. When the fires are at rest during the meal hours or at night, these dampers are always shut as close as possible consistent with not sending the smoke out at the furnace doors. When the furnaces are in full operation these dampers are *always full open*; if less draught is required, it is not to be got by closing these dampers, but by closing the damper in the main flue as shown further on. There are two main flues—one goes *direct to the chimney*, the other is the economiser flue through which the smoke passes to the chimney if the economiser is in operation, which it always is, unless on very rare occasions and for special purposes.

This outline will show the position of the dampers in the main flues.



Scale 7/16" = One Foot

The economiser has 320 pipes 4 inches bore, made up in 40 headers of 8 tubes each. The height of chimney is 160 feet.

No. 1 damper is on a pivot, and allows the smoke to go direct to the chimney, but is always kept shut when the economiser is working. No. 2 damper is hung on a chain from a pulley, and is opened by pulling it up; it allows the smoke to pass into the economiser and is always full up from 4 a.m. to 5.50 p.m. No 3 damper is on a pivot, and is always called the round damper; when the economiser is working the draught is regulated by the opening or closing of this damper. Always use No. 3 damper to lessen or increase the draught never use No. 2.

No. 1	Damper is	8′ × 4′ with circular top.
No. 2	„	8′ × 4′ with square top.
No. 3	„	8′ × 4′ with circular top.

THE ENGINES.—Much of the success in a spinning mill depends upon the steadiness of the drive, and this can only be attained by having a sufficient margin of power to drive the machinery. Without this margin of power there will be endless trouble and annoyance, and continual risk of engine break-down, with all the usual attendant loss of time and money.

Until very lately the form of engines most commonly made for driving Jute Mills was of the type known as compound horizontal, sometimes two cylinders placed tandem, and sometimes two cylinders placed side by side. If the engines were in pairs then the tandem engine would have two pistons on each rod, the low pressure being usually next the connecting rod; if the engine had two cylinders placed side by side, the high pressure would be connected to the one crank, and the low pressure to the other crank. In both types of engines the cranks are usually set at right angles. Corliss type of valves on both cylinders will give the best working results.

The diagrams given here to illustrate the power required to drive the machinery upon the plan are of the compound tandem type, and the data given will be found useful for reference in regard to the horse power required to drive jute machinery.

Triple expansion engines of the marine type are now being introduced, but they have not been long enough in use to be able to compare them with the former types of engines. There is much difference of opinion as to the advantages of triple expansion engines, with high speed and high boiler pressure (say) of 140/150 lbs., over compound engines of moderate speed and boiler pressure of 75/80 lbs. per square inch for driving jute mill machinery. The point will be settled by-and-by, as most other things are, by the result of experience, and the comparison of their performance from a commercial point of view.

It will greatly add to the smooth working of the engines and avoid risk of break-down if the "heating up" arrangements are as complete as possible. If the engines cannot drive the full working load at once on Monday morning at six o'clock, the "heating-up" has not been sufficiently attended to. If the heating has been properly done there should be not more than an increase of 7°/ₒ on the usual total load, and that increase should have disappeared during the first 30 minutes after the engines have been working. Engines driving the load shown on the diagrams will require the heating steam on them not less than five hours before six o'clock on Monday morning in the winter time, and the half of that in the summer time, and the expense of the steam used for this purpose will be repaid by the work done in the mill, owing to the engine going the usual speed, without risk of break-down.

ABSTRACT OF POWER.

Engine Friction, - -	70 H.P.	165·5 Friction.
Mill „ - -	95·5 H.P.	
Batching and Preparing, -	150 H.P.	674·5 Effective.
Spinning, - - -	474·5 H.P.	
Cop Winding, - - - -	50 H.P.	
Reeling, - - -		
		840·0

Total Load, - - .	840 H.P.
Friction Load, - - -	165·5 H.P.

Percentage of Power absorbed by Friction $= \frac{100 \times 165.5}{840} = 19.7\%$

Coal consumed and water evaporated at 75 lb. pressure in two weeks.

Working hours 56 per week = 112 hours.

Total Revolutions of Engine Index = 307,222.

Working hours Engine Time $\frac{307222}{45 \times 60} = 113.8$ hours.

Total Coals in two weeks = 102·9 tons = 230,496 lbs.

Total Water through Meter in two weeks = 172,043 gallons = 1,720,430 lbs.

Water evaporated per lb. of Coal at 75 lbs. pressure $= \frac{1,720,430}{230,496} = 7.46$ lbs.

Coal per H.P. per hour $= \frac{230,496}{113.8 \times 840} = 2.41$ lbs.

Water per H.P. per hour $= 24.1 \times 7.46 = 17.97$ lbs.

The pond capacity for the horse power required for the machinery shown in plan will be—

No. 1 pond from which the water is taken to the engines will require 500,000 gallons.

No. 2 pond into which the water is discharged from the engines is called the cooling pond, and should have a capacity of about 250,000 gallons, and is fitted with troughs about $3\frac{1}{2}$ feet broad and 4″/5″ deep, along which the water is allowed to run about 250 yards before falling into the pond. No special cooler will be necessary.

Engine Diagrams.—The method adopted for their calculation is as follows:—The high pressure cylinder diagrams in this case have been taken with a $\frac{1}{30}$th spring, and the low pressure cylinder with a $\frac{1}{10}$th, therefore the scale of diagrams are termed $\frac{1}{30}$th and $\frac{1}{10}$th.

1.—*The High Pressure Diagram.*

Divide it into ten parts as shown on the illustration, and measure at the centre of these spaces with the scale of the diagram—that is a $\frac{1}{30}$th in this case; add together these ten measurements and divide by ten for the average pressure in cylinder, first at the one end, and repeat the working for the other end; then with the average pressure work out the formula for the horse power in each cylinder.

Formula.

$$\frac{\text{Area of cylinder} \times \text{piston speed per minute} \times \text{average pressure.}}{33{,}000}$$

$$\frac{572{\cdot}5 \times 450 \times 32{\cdot}7}{33{,}000} = 255{\cdot}4 \text{ I.H.P.}$$

$$\frac{572{\cdot}5 \times 450 \times}{33{,}000} = 7{\cdot}8 \text{ Constant Number.}$$

$$\frac{1385{\cdot}4 \times 450 \times}{33{,}000} = 156{\cdot}2 \text{ I.H.P.}$$

$$\frac{1385{\cdot}4 \times 450 \times}{33{,}000} = 18{\cdot}89 \text{ Constant Number.}$$

For calculating the diagrams of the engines it is usual to work out the constant number for each cylinder; this constant number multiplied by the average pressure as measured from the diagram equals the indicated horse power, thus:—

Average pressure × constant = I.H.P.

In all the calculations required in the machinery throughout the mill, work with the constant number as much as possible and save time.

The friction diagrams are calculated from a piston speed of 395 feet per minute.

Particulars of engines from which diagrams were taken to illustrate the horse power required to drive the machinery upon the plan:—

Pair of Compound Horizontal Engines, cylinders placed tandem, high pressure cylinders 27″ diameter = area 572·5 sq. in.; low pressure cylinders 42″ diameter = area 1385·4 sq. in.; crank shaft 45 revolutions per minute = 450 feet—speed of piston per minute. High and low pressure cylinders both fitted with Corliss valves.

TOTAL LOAD DIAGRAMS.

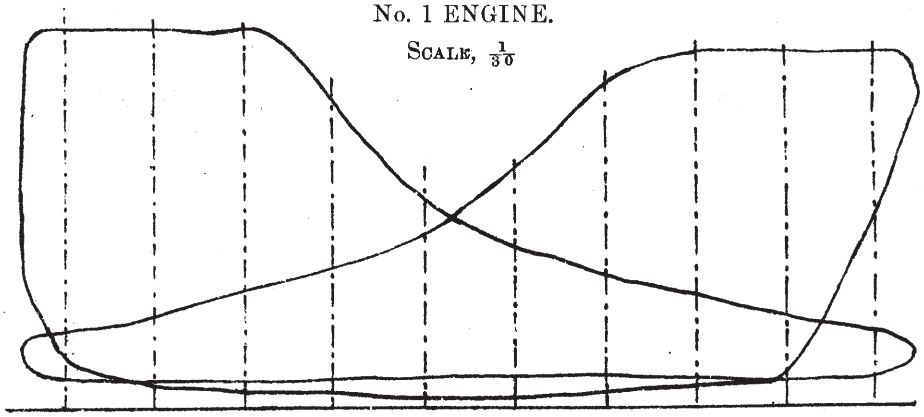
Indication of Compound Tandem Engines.

Cyls. 27″ and 42″×5′ 0″ Stroke. Boiler Pressure 62 lbs. 45 revs. per min

Temperature of Injection . . . 82°.

Temperature of Hot Well . . 121°.

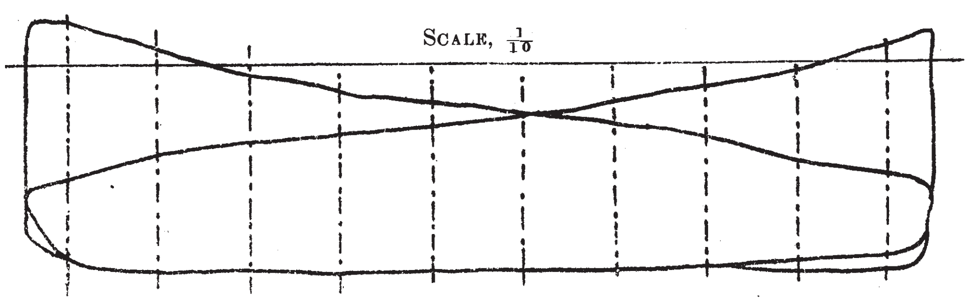
No. 1 ENGINE.



Mean Pressure—Front, 33·7 lbs. Mean Pressure—Back, 31·7 lbs.

Average Mean Pressure—32·7 lbs. per sq. inch.

I.H.P.—255·4.



Mean Pressure—Front, 8·4 lbs. Mean Pressure—Back. 8·15 lbs.

Average Mean Pressure—8·27 lbs. per sq. inch.

I.H.P.—156·2.

Total I.H.P. No. 1 Engine—411·6

TOTAL LOAD DIAGRAMS.

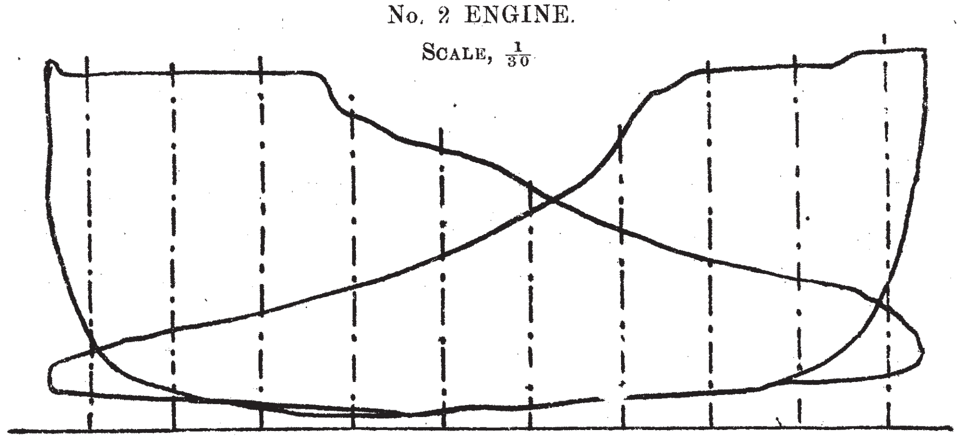
INDICATION OF COMPOUND TANDEM ENGINES.

Cyls. 27″ and 42″ × 5′ 0″ Stroke. Boiler Pressure 62 lbs. 45 revs. per min.

Temperature of Injection - - 82°.
Temperature of Hot Well - - 121°.

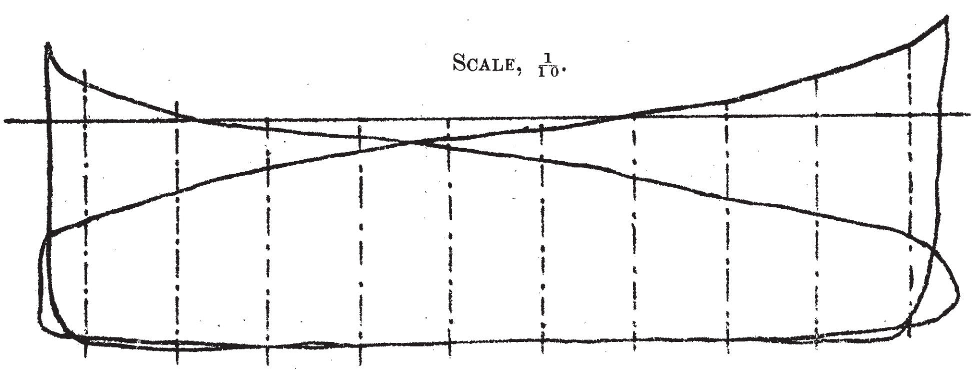
No. 2 ENGINE.

SCALE, $\frac{1}{30}$



Mean Pressure—Front, 33·6 lbs. Mean Pressure—Back, 28·35 lbs.
Average Mean Pressure—31·07 lbs. per sq. inch.
I.H.P.—242·4.

SCALE, $\frac{1}{10}$.



Mean Pressure—Front, 9·2 lbs. Mean Pressure—Back, 10·5 lbs.
Average Mean Pressure—9·85 lbs. per sq. inch.
I.H.P.—186·0.
Total I.H.P.—No. 2 Engine—428·4. Total Indicated Horse Power—840.

FRICTION DIAGRAMS.

INDICATION OF COMPOUND TANDEM ENGINES.

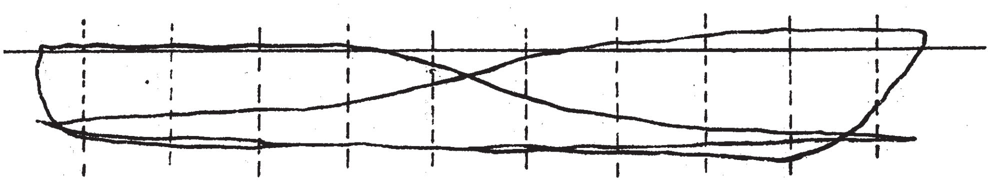
Cyls. 27″ and 42″ × 5′ 0″ Stroke. Boiler Pressure 62 lbs. 39½ revs. per min.

Temperature of Injection - - 82°.

Temperature of Hot Well - - 121°.

No. 1 ENGINE.

SCALE, $\frac{1}{20}$.

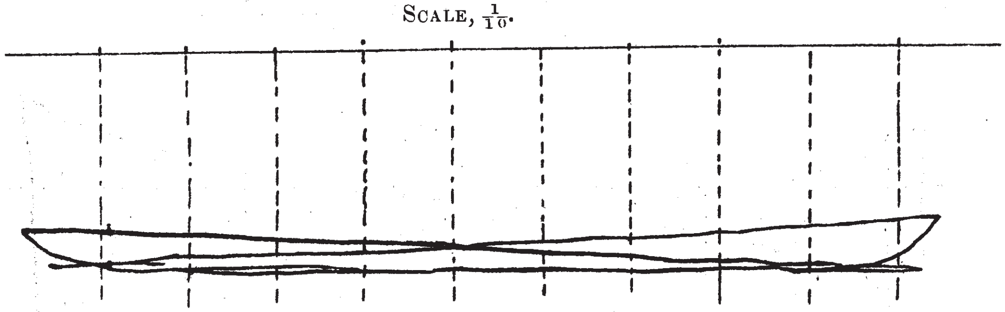


Mean Pressure—Front, 5·8 lbs. Mean Pressure—Back, 7·374 lbs

Average Mean Pressure—6·58 lbs. per sq. in.

I.H.P.—45·7.

SCALE, $\frac{1}{10}$.



Mean Pressure—Front, 1·0 lbs. Mean Pressure—Back, 1·37 lbs.

Average Mean Pressure—1·135 lbs. per sq. in.

I.H.P.—19·8.

Total I.H.P. No 1 Engine—65·5. Total Indicated Horse Power—165·5.

Total Load Indication—840 I.H.P.

Percentage of Power Absorbed by Friction—$\frac{100 \times 165 \cdot 5}{840} = 19 \cdot 7\%$

FRICTION DIAGRAMS.

INDICATION OF COMPOUND TANDEM ENGINES.

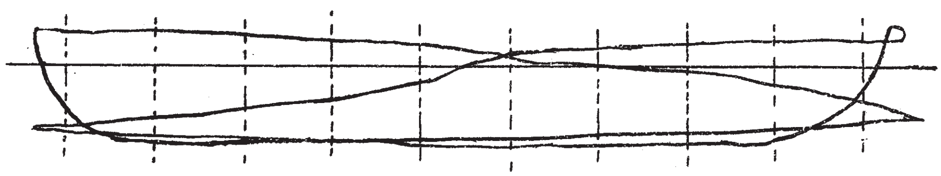
Cyls. 27″ and 42″ × 5′ 0″ Stroke. Boiler Pressure 62 lb. 39½ revs. per min.

Temperature of Injection, . . 82°.

Temperature of Hot Well, . . 121°.

No. 2 ENGINE.

SCALE $\frac{1}{20}$

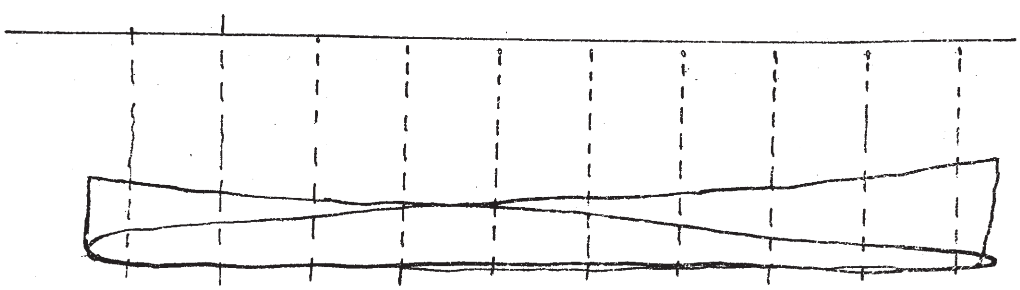


Mean Pressure—Front, 8·0 Lbs. Mean Pressure—Back, 6·4 Lbs.

Average Mean Pressure—7·2 Lbs. per Sq. In.

I.H.P.—50·1

SCALE $\frac{1}{10}$



Mean Pressure—Front, 2·5 Lbs. Mean Pressure—Back, 3·5 Lbs.

Average Mean Pressure—3·0 Lbs. per Sq. In.

I.H.P.—49·9

Total I.H.P. No. 2 Engine—100·0. Total Indicated Horse Power—165·5.

Total Load Indication—840 I.H.P.

Percentage of Power Absorbed by Friction—$\frac{100 \times 165 \cdot 5}{840} = 19 \cdot 7$ °/o

SPEEDS OF SHAFTING.

To find the speeds of the shafting :—

Crank shaft 45 revolutions per minute.

Wheel on crank shaft 130 cogs, 24½″ broad.

Pinion ,, main ,, 57 teeth, 24½″ broad.

$\frac{45 \times 130}{57} = 102 \cdot 6$ speed of main shaft.

On the plan it will be observed, for reasons given in the introduction, I have marked the speeds.

Crank shaft	45	revolutions per	minute.
Main shaft	100	,,	,,
Batching shaft	160	,,	,,
Preparing ,,	160	,,	,,
Spinning ,,	220	,,	,,

Example.—If the main shaft is 100 revolutions per minute, what will be speed of the spinning driving shaft ?

Bevel cog wheel on main shaft 66 cogs.

,, teeth pinion on spinning shaft 30 teeth.

$100 \times \frac{66}{30} = 220$ revolutions per minute.

The above is given by way of example to calculate the speed of the shafting.

Softener Drums, ...	30″dia.	× 14″	broad
Breaker and Finisher Drums, ...	28″ ,,	× 14″	,,
1st Drawing Circular ,, ...	21″ ,,	× 8″	,
1st Drawing Drums—Push Bar,	16″ ,,	× 8″	,,
2nd ,, Spiral, ...	16″ ,,	× 8″	,,
Roving Drums, ...	24″ ,,	× 6″	,,
Spinning Drums—Weft Frames,	32″ ,,	× 14″	,,
,, ,, Warp ,,	36″ ,,	× 14″	,,

JUTE BATCHING.

This is the department in which we commence to handle the material for the first time. The bales of jute are wheeled in from the jute warehouse, which will be seen from a reference to the ground plan to adjoin the batching house, and communicates with it by double iron doors. We will suppose there are six bales in the batch. These bales are set up on their ends three on either sida of the feeding end of the jute opener, the ropes by which the bale has been bound together are cut from top to bottom by an axe, the layers of jute are then laid upon the feeding table of the opener, and passed through between the rollers—this softens to a certain extent the layers of jute, and the streaks of jute of which the bale has been made up fall readily apart. These streaks or heads are laid on a low stool or platform about 8 feet long and 1½ feet broad; the batchers, who are standing in front of this platform, break up tbe large streaks or heads into streaks of about two pounds each, and lay them upon another platform of the same description, from which they are lifted by the workers who are employed feeding the softener. While the batchers are employed streaking up the jute they may also throw to one side any streak that looks too dark or rooty for the quality wanted from the batch laid down, according to the instructions given them by the overseer in charge of the department, the jute which has been rejected being used in another batch of a lower quality as the case may be. The jute passes through a series of fluted rollers pressed together by springs of either spiral or volute form, and while passing through these rollers a stream of oil and water is runuing down from pipes upon the fibres. The jute being softened and damped during this operation, is delivered at the other end of the machine, and is taken hold of by the workers, generally termed "twisters," whose work it is to twist the streak and lay it upon a waggon. They build it upon one side of this waggon or jute barrow, as it is usually termed, to the height of 18 inches. The barrow is then turned round, and they build another 18 inches, and so on alternately until the barrow is filled. While it is in process of filling, it should be tramped 3 to 4 times; this presses the jute together, and the barrow is then put aside, and should stand from 18 to 24 hours before being taken to the next process. While it is standing, the oil and water that has been put upon it is percolating through the fibre and slackening the root and dirt, and making it fit for the carding process which follows. This is what is termed machine batching, and is the form of batching that is most followed in Dundee mills, and it is claimed for this system that it has all the advantages of hand batching, and is accomplished with less trouble and expense. If hand batching is adopted, the jute is put through the softener without oil or water being put upon it; the jute is then put down in a stall in layers, and the oil and water poured upon it from a pitcher, and is allowed to lie as before, and it then has to be carried or lifted into a barrow, and taken to the next process.

Very much of the success of the working of the material in the other departments will depend upon the care and attention given to the material when it is being batched. In the preparing department, if the oil and water has not been evenly put on, and the jute has not been well spread in the softening process, lapping of the jute round the pressing rollers of the different machines will occur, causing needless waste and loss of time, and consequently loss of production. This can always be avoided if sufficient care and attention is given to the material when being batched. The batching house should be kept thoroughly clean, no oil except what is in the tanks above the softener should be kept in the mill, the bulk of the oil should be kept outside and run down through pipes to the softeners as required, and there should be no drain in this department leading from the softeners to the common sewer; a drain here often leads to much loss and carelessness. The softeners should be fitted with trays about 4″ deep laid in below the rollers, so that any oil passing through the rollers towards the floor may be caught in them and utilized. There is no valid reason why the batching house should not be as clean as any other department in the mill. Apparatus of different kinds have been fitted to softeners to regulate the fall of the oil upon the jute according to the thickness of the streaks, but I doubt if they are of much practical utility. Adjust the oil and water pipes to deliver at the rate required, and if the softener is fed with fair regularity the end will be attained suitable for all practical purposes without a lot of mechanical nick-nacks, for which there is no time in any department of an ordinary jute mill.

NOTE.—The water pipe is next the feeding end of softener, and the oil pipe from 18″ to 20″ forward from the water pipe.

Mineral oil of various qualities is now mostly used in batching, whale oil being very little used. The mineral, however, should be of *good* quality. As to the quantity required per bale, the quality of the jute and oil being used must be taken into account, and this to a great extent must be determined by one's experience of the yarn wanted. Stated in a general way, a gallon to a gallon and a quarter will be used to a bale of 400 lbs., but this is very often determined by a knowledge on the spot of what is wanted, and this quantity may often be much less and often sometimes more.

As to the quantity of jute put through a softener, this will to a certain extent be determined by the speed of the machine. The speed of the softener given will, with regular feeding, deliver 350 bales per week of 56 hours, and this will allow the streaks to be made about two pounds each, and they should never exceed this if the breaker feeder is to have a chance of making good work when spreading the jute upon the feeding table. One jute opener will pass the quantity (700 bales) in 56 hours at the speed given for this machine.

The batch put down for ordinary hessian warps should be composed of six bales—it is better not to have too many bales in the batch, as the jute will have a better chance to be well mixed, and the different characteristics of the jute in each bale will be better spread through the yarn.

4 bales or	$\frac{2}{3}$	of the batch,	second numbers	of first marks.	
2 ,,	$\frac{1}{3}$	,,	third	,,	,,

The jute for warps should be selected as free from dirt and root as possible, and uniformity of colour is desirable to avoid the chance of striping the yarn. If third numbers are being used, they will require to be of early shipment to insure the necessary colour and quality; but this batch will require care and attention, and sometmes a little judicious picking to get rid of any little root will be necessary. The weft for a good standard hessian should be made out of the same batch. My remarks as to the batch given above refer to 11 por. 13 shots $10\frac{1}{2}$ oz. and heavier. The lighter weights of hessians may be made of a lower quality of weft, the batch for which would be composed entirely of good third numbers.

In the selection of these six bales, it will be found advisable to have, at least as far as possible, a combination of strength, colour, and cleanliness; and to be able to do this, can only be learned from daily study and careful attention to the different parcels of jute as they come before you, and even with all this, and a long experience in addition, I am afraid more mistakes are often made in this department—unwittingly, of course,—than in any other department in the mill.

In reference to the amount of damp to be put on, from 15 per cent. to 20 per cent. may be given as sufficient, stated in a general way, but this also has, in a great measure, to be determined by the quality of the jute and the state of the atmosphere. The temperature of a mill on the shed principle varies very much with the temperature of the atmosphere, and this reacts upon the material in process; and although 15 per cent. to 20 per cent. may seem to be a large quantity to put in at the first process, if the jute is allowed to lie and become properly moistened, this moisture or damp will pass away in the course of being made into yarn. To put an undue amount of water into the first process is of no practical benefit in the working of the material. The loss of time and waste made if the material is too damp is out of all proportion to any advantage that can otherwise be gained. If proper attention is given to the batching and damping process, the breakers, finishers, drawings, and rovings will work from morning to night without lapping; if they do not, the damping is in all probability being overdone.

The jute opener of which we give an illustration is Messrs Butchart & Skinner's patent, and does its work better than any other machine I have seen, and is now very generally adopted by the trade. As the jute passes through, the knobs on the rollers are pressed into the 'heads' of the jute, making them soft, pliable, and easily handled.

Speed of Jute Opener as follows:—

Driving Shaft 160 revolutions per minute.

Drum on Shaft 16″ diameter.

Pulley on Opener 20″

$160 \times \frac{16}{20} = 128$ revolutions of jute opener pulleys per minute.

$128 \times \frac{30}{62} \times \frac{13}{68} = 7{\cdot}8$ revolutions of rollers per minute.

The jute softener of which we give an illustration is made by Messrs Urquhart, Lindsay, & Co., Ltd., and also by Messrs Thomson, Son, & Co. They are for all practical purposes the same machines.

Speed and Gearing of Messrs Urquhart, Lindsay, & Co., Ltd.'s, Machine is as follows :—

Driving Shaft 160 revolutions per minute.

Drum on Shaft 30″ diameter.

Pulleys on Softener 36″ diameter.

$\frac{160 \times 30}{36} = 133{\cdot}3$ revolutions per minute—Speed of Pulley Shaft.

Cross Shaft Driving Pinion 18 teeth.

Side ,, Wheel 40 teeth.

Shaft Bevel Pinion 16 teeth.

Roller ,, Wheel 25 teeth.

$\frac{133\ 3 \times 18 \times 16}{40 \times 25} = 38{\cdot}4$ revolutions of rollers per minute.

Messrs Thomson, Son, & Co.'s Machine.

Driving Shaft 160 revolutions per minute.

Drum on Shaft 30″ diameter.

Pulleys on Softener 36″ diameter.

$\frac{160 \times 30}{36} = 133{\cdot}3$ revolutions per minute—Speed of Pulley Shaft.

Cross Shaft Driving Pinion 19 teeth.

Side ,, Wheel 39 teeth.

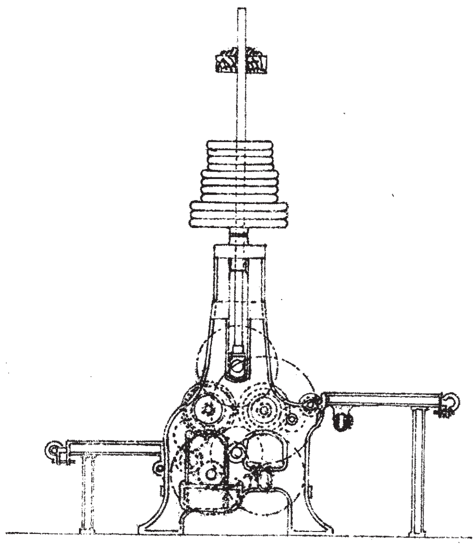
Shaft Bevel Pinion 16 teeth.

Roller ,, Wheel 25 teeth.

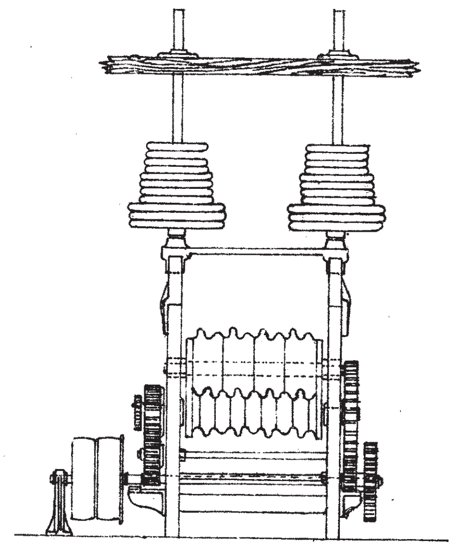
$\frac{133{\cdot}3 \times 19 \times 16}{39 \times 25} = 41{\cdot}6$ revolutions of rollers per minute.

BUTCHART'S PATENT JUTE CRUSHER.

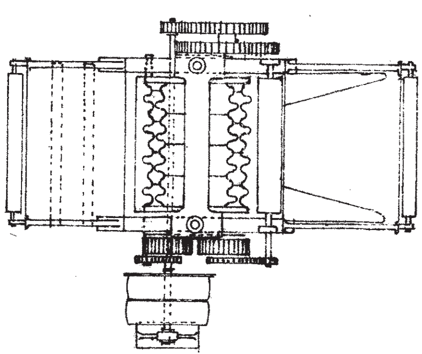
Scale—$\frac{1}{4}''$ = One Foot.



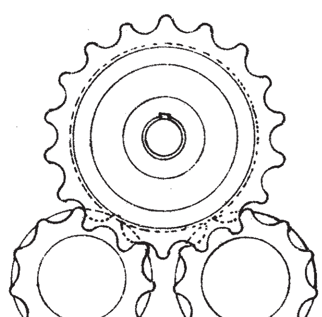
END ELEVATION



FRONT ELEVATION



PLAN



SECTION OF ROLLERS
SCALE $\frac{3}{4}''$ = ONE FOOT

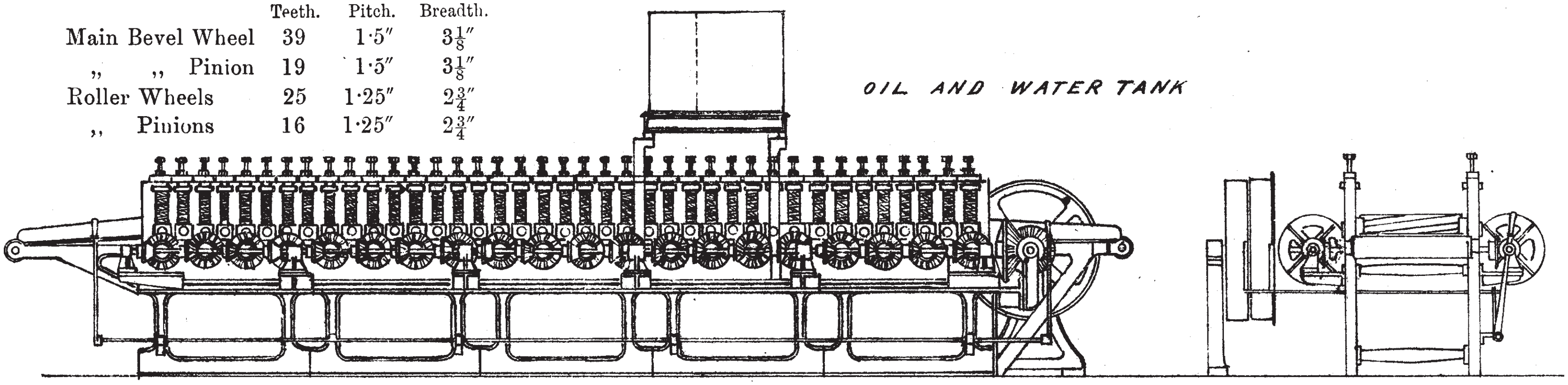
JUTE SOFTENER

39 Pair of Rollers.

Scale—$\frac{1}{4}''$ One Foot.

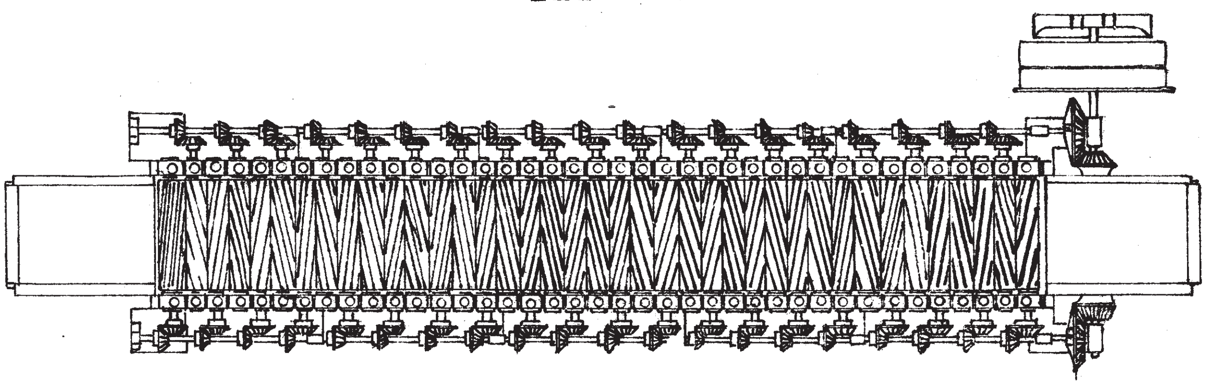
Belt Pulleys 36″ × 6″.

	No. of Teeth.	Pitch.	Breadth.
Main Bevel Wheel	39	1·5″	$3\frac{1}{8}''$
,, ,, Pinion	19	1·5″	$3\frac{1}{8}''$
Roller Wheels	25	1·25″	$2\frac{3}{4}''$
,, Pinions	16	1·25″	$2\frac{3}{4}''$



ELEVATION

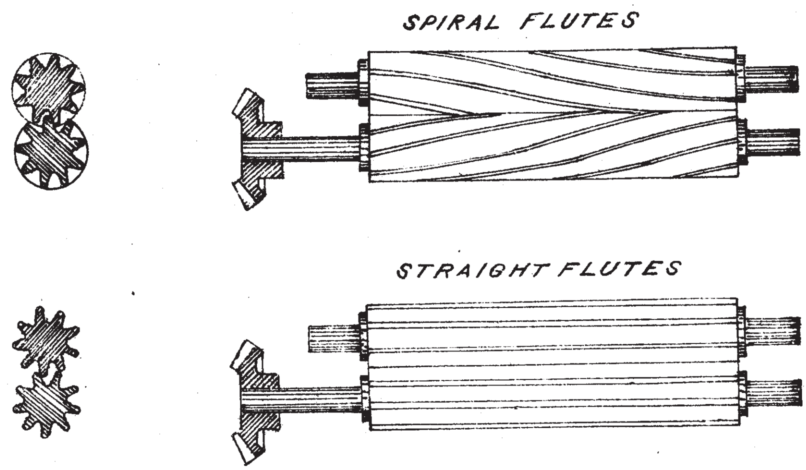
END ELEVATION



PLAN.

JUTE SOFTENER ROLLERS

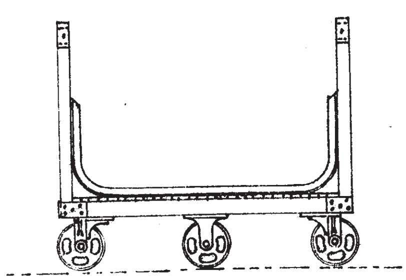
Scale—$\frac{1}{4}''$ = One Foot



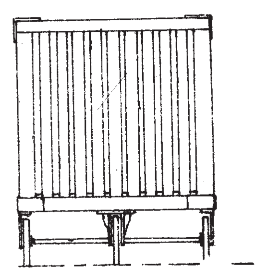
JUTE BARROW

USED IN BATCHING.

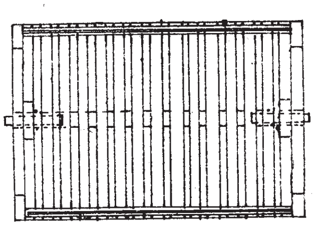
Scale—$\frac{1}{4}''$ = One Foot.



Elevation



End Elevation



PLAN

This barrow will contain Ȼ.12

JUTE PREPARING.

The process after the jute has been batched and been lying for the necessary time in the jute barrow is termed the preparing. In the preparing department, stated very briefly, the jute is converted from the "streak" into rove yarn in preparation for the spinning process. This conversion is effected by the use of five different machines, sometimes six are used, but not often, at least for ordinary hessian yarns. These machines are named—

1st.	The Jute	Breaker.
2nd.	"	Finisher.
3rd.	"	1st Drawing Frame.
4th.	"	2nd "
5th.	"	Roving Frame.

During its passage through the breaker and finisher the jute is going through what is termed the carding process—that is, it is being cut up into a sort of tow, and during the process it is being drawn to a certain extent at the same time. In the drawings a number of ends or slivers, as they are usually called, are put together and run through the drawing into one at the front, and it is being drawn out still smaller and finer during the process. In the roving frame each end is put through the roving by itself, and when passing through the roving is drawn finer still, and delivered at the front to the weight required for the yarn into which it is to be spun. While it is being delivered at the front of the roving, as it runs on to the bobbin, a certain amount of twist is put on to keep it together while it is being unwound during the spinning process. To give in detail to a certain extent a description of the work done by each of these machines, and also at the same time to show the methods of their arrangement and the calculations of the different speeds involved in each of them, along with one or two arrangements to show the weight of rove produced, will be my object in this chapter.

With reference to the quantity of jute laid on the breaker feed table, two methods are adopted. The first, and I believe the most common method, is to weigh so many pounds of jute and lay it on the feeding table of breaker during one round of a clock which is attached to the feed roller for the purpose of measurement of the jute as it is passed into the breaker; the other system is to put the jute over the breaker without weighing it, and take the cans to a machine called a balling machine. So many slivers from the breaker are made into a ball or lap, and these laps are made a certain weight for a certain length, and this determines the weight of the slivers delivered from the finisher in a certain number of yards. I give an illustration of a balling machine, and particulars of arrangements, but all the calculations in this chapter are based upon the weight of the "dollop"—that is the weight laid upon the feeding table of breaker for one round of the clock provided for that purpose. It will now be understood that all the measurement of the jute in course of being made into rove is done at the commencement, and in practice there is not found any necessity for more weighing of the material in the process of making rove.

Jute breaker cards and finishing cards are very much of the same construction; they both consist of a cylinder, usually 6 ft. long and 4 ft. diam., round which are placed rollers, called, first, feeding roller, then stripper roller, worker roller, doffer roller, drawing roller and delivering roller. All these rollers revolve in the same direction as* the cylinder; the feed roller takes the jute into the cylinder; the jute passing between the feed roller and shell as it is fed in, is retarded by the pins of feed rollers, and as it passes through the shell, it is carded, or combed, by the cylinder. The workers, although revolving in the same direction as the cylinder, from the angle at which the worker pins are set, cards, or combs, the fibre still more. The strippers, running in the same direction as the cylinder, and from the angle at which their pins are set, do not card the fibre, but clean the fibre which is on the worker, and pass it on to the cylinder again. After it passes the worker and stripper, it is taken off the cylinder by the doffer, and from the doffer is carried through between the drawing and pressing roller, which are in front of doffer, and passing down a conductor, is passed again through a delivering roller into the can.

In the case of a down-striker breaker, the fibre passes over the top of doffer on to the drawing roller; and in a full circular finisher, the fibre is passed to the drawing roller from the under side of the doffer. A reference to the "set" of the pins in each case will enable the reader to follow this explanation. Much diver-

*Note.—That is, the periphery of rollers and cylinder travel in the same direction at points of contact.

sity of opinion exists as to the best speeds for the cylinders and the different rollers to be driven. It is well known that breaker and finisher cylinders are being run at a speed which varies from 160 to 200 revolutions per minute. This diversity of opinion as to speed proves, I think, very conclusively that there must be a very wide margin, within which it is possible to work; and probably the best speed for breaker and finisher cylinders, working jute for hessian warps and wefts, will be found somewhere between these extremes; and, I believe, these speeds will be found by taking the breaker cylinder at 190 revolutions per minute, and the finisher cylinder at 180 revolutions per minute; and although, as will be seen, I take these speeds for some of the following calculations, I also give some other calculations with other speeds, which have also been found to work on the whole equally as well. The quality of the jute in process must always be taken into consideration in determining the proper speed, and in practice it is not found always convenient to be altering the speed of the breaker or finisher cylinders. It is not a difficult matter to alter the position of the shell to the cylinder, and I am convinced from experience that it is often found to be advantageous to shift the position of the shell to the cylinder, either by putting it closer or by taking it away from the cylinder when necessary, owing to the hardness or softness of the jute that is being used.

With reference to the quantity that may be put over breaker and finisher in 10 hours there is also some diversity of opinion. This, however, in practice, will, to a considerable extent, be found to be regulated by the sizes that are being spun; and if these sizes are taken—say, from 7 to 12 lbs.—in a general average way over a mill, as shown in the plan, the finisher will do about 30/35 cwt. per day of 10 hours. I am, however, well aware that there are many finishers doing less, but I also know that many finishers are doing a great deal more. In passing, I may say that the quantity named—30/35 cwt.—can easily be got over a finisher, with a dollop of moderate weight at the breakers—say 30/33 lbs.—in a single round of the clock—on a single doffer breaker—and for a double doffer breaker, with two deliveries, with rollers 16″ diameter, of 40/44 lbs., in one round of clock. And here let me remark, the single delivery breaker and finisher should not be driven faster than what is actually necessary to provide sliver to keep the system fully in motion. This is one of the great points in regard to the speed of the cards and drawings. Their speed should be so adjusted that there will be no long stoppages, which only lead to general interruption of the organization of the department. The cards and breakers should also be closed in with sheet iron, doors being made to allow of the dust being swept out as required. If they are closed in thoroughly, it will in a great measure prevent accident; and if a card takes fire, prevent it spreading to the next machine.

As shown in the plan one breaker supplies sliver for two finishers, but if a large production is wanted there is room for 9 breakers to 14 finishers.

As to the position of the breakers and finishers, in the plan given it is intended that the breaker feeding table is next the batching house, and the breaker delivering towards the back of finisher. The cans from the front of breaker will then be taken to the front of finisher by boys usually called "can trailers." These cans—say, 8 or 10 at a time—being fed into the finisher over the feeding cloth, as in the breaker, and delivered at the one side of finisher in front, it will be delivered at the right or left side, according as the finisher is right or left hand, as it is usually termed.

The cylinder lagging, or staves as they are more generally called in this quarter, require periodically to be refilled with new pins. In the case of the breaker this will have to be done twice a year.

The general method is to remove the one half of cylinder cover once every three months, and refill them. Although sometimes the fourth part of the cover is taken off every six weeks and refilled, this method, if adopted, will, of course, ensure a more general average sharpness in the pins of the cylinder cover.

The finisher staves will require to be renewed once in a year, and this is done by removing the half each six months and refilling them. The workers and strippers, &c., will run on an average, say, the workers 7 years, and the strippers 5 years.

One other point may be mentioned, and that is all the rollers except drawing roller, pressing roller, and delivering roller are covered with wood, and in course of wear they are inclined to go off the 'truth'—this causes trouble when setting the card, as it prevents the rollers from being equally set all the breadth of the card, When they are discovered to be off the truth, the staves should be taken off and the roller put into a turning lathe and made true right across the roller. All the rollers are set to a certain gauge from the cylinder, and also to a certain gauge from one another. Farther on in this chapter a table to which they should be set is given, but in practice it may be sometimes necessary to vary the setting a little in either direction.

With reference to the question as to whether double doffer breakers and finishers are better than single doffer breakers and finishers there is some difference of opinion. Certainly there are not nearly so many double doffer cards working as single doffers, and I don't think they are necessary for producing hessian warps and wefts if you have plenty of single doffer cards; but I believe from my experience that you get more off a double doffer breaker than a single doffer, particularly if you have to work a certain quality of jute, and find it necessary to do this with a fairly heavy dollop. Into the merits of this question it is not necessary to enter here. The student will not find this point trouble him for a considerable time, and by which time he will, both from theory and practice, doubtless be in a position to think it out for himself.

For the changing of the speeds in connection with the working of the breakers and finishers there are four pinions usually called change pinions. These are—first—the pinion on the end of the cylinder arbor, usually called the cylinder pinion: this pinion increases or diminishes the speed of every roller on the breaker or finisher except the stripping rollers, which are driven by a belt passing over a pulley on the opposite end of cylinder arbor, and on the inside of the driving pulleys; the second change pinion is the pinion which lengthens or shortens the draft between the feeding roller and the drawing roller, by the term draft is meant the difference between the surface velocity of the feed roller and drawing roller, the third change pinion is the pinion which increases or diminishes the speed of the workers in their relation to the surface speed of the cylinder; the fourth changes the relative speed between the drawing roller and the doffer, which lengthens or shortens the draft between doffer and drawing roller, as it is usually termed. The position of all these change pinions are marked on the illustrations of breaker and finisher, and also on all the calculations pertaining to these four points

When you increase the speed of the workers you reduce the amount of carding being done to the fibre, as there is being less resistance given to the action of the cylinder upon the fibre between the cylinder and worker pins; and when you decrease the speed of the worker the reverse action takes place, and of course more carding is done.* A reference to the manner in which the pins are set round the cylinder and round the worker will explain this to the reader. The student should also study very carefully how the pins are set in all the different rollers, so that he can take them out and put them in, understanding very thoroughly the reason in his own mind how the "sets" upon the pins are placed in the different rollers, and the cause for them being so set.

A table of all the diameters of cylinders and the other rollers over the wood over the staves and over the pins is given, and will be found

*NOTE.—The reader will observe that if the surface velocity of cylinder and worker were equal there would be no carding action.

of considerable use as a reference. All the surface speeds referred to in the calculations are taken from the circumference at the *centres of pins.*

Sufficient explanation of the machines has now been given, and we may proceed to show the calculations for surface speed and drafts.

SINGLE DOFFER BREAKER.

First, let us try and explain the way to take the draft of a breaker card, and we will try and make it as simple as possible, and we will illustrate this by putting down the letters in their order for a formula, as follows:—

$$\frac{A}{B} \times \frac{C}{D} \times \frac{E}{F} \times \frac{G}{H}$$

In the above—

A = Diameter of Drawing roller.

B = Drawing roller wheel teeth.

C = Wheel of double intermediate in gear with cylinder pinion.

D = Change or draft pinion on nave of above.

E = Wheel of double intermediate in gear with draft pinion.

F = Pinion on nave of double intermediate in gear with wheel on end of feed roller.

G = Wheel on end of feed roller

H = Diameter of feed roller.

Thus—

$$\frac{4 \times 80 \times 110 \times 110}{52 \times 26 \times 20 \times 10\frac{3}{4}} = 13{\cdot}32 \text{ draft between feed and drawing rollers.}$$

$$\frac{4 \times 80 \times 110 \times 110}{52 \times \text{Change pinion} \times 20 \times 10\frac{3}{4}} = 346{\cdot}332 = \text{Constant Number for draft.}$$

It will be observed from above, that commencing with diameter of drawing roller, omitting the single intermediate wheels, you take all the pinions and wheels as they come, one after the other, until you arrive at the feed roller, and you finish the statement of the calculation with the diameter of feed roller. If the student proceeds on these lines, he cannot go wrong if he gives the matter a little consideration and perseverance.

Note the draft of any machine, whether breaker, finisher, drawing, or roving, is the difference between the surface speed of the first and last rollers of the machine.

Next the draft, between the doffer and drawing roller—

$$\frac{A}{B} \times \frac{C}{D} \times \frac{E}{F}$$

Then, in this case—

A = Diameter of drawing roller.

B = Pinion on end of drawing roller.

C = Wheel of double intermediate in gear with pinion on end of drawing roller.

D = Pinion on nave of intermediate in gear with doffer wheel.

E = Doffer wheel.

F = Diameter of Doffer.

Thus—

$$\frac{4}{23} \times \frac{54}{26} \times \frac{88}{15\frac{1}{2}} = 2{\cdot}05 \text{ draft between doffer and drawing roller.}$$

$$\frac{4}{23} \times \frac{54}{\text{Change Pinion.}} \times \frac{88}{15\frac{1}{2}} = \text{Constant Number.}$$

Note here that, in reference to draft between doffer and drawing roller, taking the diameter of doffer at points of pins against the diameter of drawing roller at 4″ diameter, the relative speeds that have been found to work well are :—Drawing roller to revolve at a surface speed of 100 inches for 54 to 57 inches of doffer. Of course, though the diameter of doffer at points of pins is taken, it must be borne in mind that the beard projects, perhaps, 3″ to 4″ from the points of doffer pins, making a diameter of perhaps 23″ to 24″ instead of 16″ as at pin points. Even then there is a draft between the doffer and the drawing roller, but experience has shown that this difference of speed is best for the effectual clearing of the doffers, and for keeping the fibres straight. The effect I should look for with too slow a speed for the drawing roller would be that the fibre would not be as straight as is desirable, and a more or less lumpy or cloudy appearance would be given to the fleece. On the other hand, if the roller went too fast, I should expect thin parts, or breaks, in the continuity of the fleece.

For the calculations and arrangements of worker wheels, see the specifications of breaker speeds, &c.

SINGLE DOFFER FINISHER.

Finishers, drafts, &c., are done in the same manner—thus :—

$$\frac{A}{B} \times \frac{C}{D} \times \frac{E}{F} \times \frac{G}{H}$$

Then in this case—

A = Diameter of Drawing roller.

B = Wheel on end of drawing roller.

$\left.\begin{matrix} C \\ D \end{matrix}\right\} =$ Double Intermediate.

$\left.\begin{matrix} E \\ F \end{matrix}\right\} =$ Double Intermediate.

G = Wheel on end of feed roller.

H = Diameter of

Thus—

$$\frac{4}{75} \times \frac{104}{32} \times \frac{96}{28} \times \frac{96}{4} = 14{\cdot}26 = \text{draft between feed and drawing rollers}$$

$$\frac{4}{75} \times \frac{104}{32} \times \frac{96}{\text{Change Pinion.}} \times \frac{96}{4} = 399{\cdot}3593 = \text{Constant Number for draft.}$$

Again, the draft between the doffer and drawing roller—

$$\frac{A}{B} \times \frac{C}{D} \times \frac{E}{F}$$

In this case—

A = Diameter of Drawing roller.

B = Pinion on end of drawing roller.

$\left.\begin{matrix} C \\ D \end{matrix}\right\} =$ Double Intermediate.

E = Wheel on doffer.

F = Diameter of doffer.

Thus—

$$\frac{4}{23} \times \frac{60}{26} \times \frac{84}{15\frac{3}{16}} = 2{\cdot}21 = \text{draft between doffer and drawing roller.}$$

$$\frac{4}{23} \times \frac{60}{C.} \times \frac{84}{15\frac{5}{16}} = \text{Constant Number for draft.}$$

Observe that the note given in reference to draft between doffer and drawing roller applies also to the finisher card.

For the calculation and arrangement of worker wheels and speeds, see the specifications of finisher speeds, etc.

Referring to the delivery of the sliver from the drawing roller into the conductor of finisher, sometimes it is delivered in two distinct slivers, and run into one as it runs into delivering roller, and sometimes it is delivered in one sliver from the drawing roller. This is the better way, as the sliver works much better on the gills of first drawing, and there is less chance of a slack side on the sliver as it passes through the drawing, and it is delivered at the front with much more levelness and regularity than it is when made in two at the finisher.

DOUBLE DOFFER BREAKER.

$$\frac{A}{B} \times \frac{C}{D} \times \frac{E}{F} \times \frac{G}{H} = \text{Draft.}$$

Thus in this case—

A = Diameter of drawing roller.
B = Wheel on end of drawing roller.
C = } Double intermediate.
D = }
E = } Double intermediate.
F = }
G = Wheel on end of feed roller.
H = Diameter.

Thus—

$$\frac{4}{70} \times \frac{150}{34} \times \frac{150}{30} \times \frac{156}{20\frac{1}{4}} \doteq 9{\cdot}7 \text{ draft between feed and drawing rollers.}$$

$$\frac{4}{70} \times \frac{150}{\text{change pinion.}} \times \frac{150}{30} \times \frac{156}{20\frac{1}{4}} = 330{\cdot}158 \text{ constant number of draft.}$$

NOTE.—That it is the wheel on end of lower drawing roller that is taken when calculating the draft of Double Doffer Breaker.

In double doffer cards, the wheel on *bottom drawing roller* is 70, and on top roller 74 teeth. This gives a draw to the bottom so as to ensure the sliver from top rollers being taken up properly by the bottom ones.

Again the draft between the doffer and drawing roller—

$$\frac{A}{B} \times \frac{C}{D} \times \frac{E}{F}$$

In this case—

A = Diameter of drawing roller.
B = Pinion on end of ,,
C = } Double intermediate.
D = }
E = Wheel on doffer.
F = Diameter of doffer.

$$\frac{4}{24} \times \frac{57}{28} \times \frac{88}{15\frac{1}{2}} = 1{\cdot}92 \text{ draft between doffer and drawing roller.}$$

$$\frac{4}{24} \times \frac{57}{\text{change pinion.}} \times \frac{88}{15\frac{1}{2}} = 53{\cdot}935, \text{ constant number for draft.}$$

DOUBLE DOFFER FINISHER.

$$\frac{A}{B} \times \frac{C}{D} \times \frac{E}{F} = \text{Draft.}$$

Then in this case—

A = Diameter of Drawing Roller.

B = Wheel in end of „

$\frac{C}{D}$ = Double Intermediate.

E = Wheel in end of feed roller.

F = Diameter „ „

$$\frac{4}{76} \times \frac{138}{20} \times \frac{144}{4\frac{1}{4}} = 12{\cdot}03 \text{ draft between feed and drawing rollers.}$$

$$\frac{4}{76} \times \frac{138}{\text{change pinion}} \times \frac{144}{4\frac{1}{4}} = 246{\cdot}092 \text{ constant number for draft.}$$

Again the Draft between Doffer and Drawing Roller—

$$\frac{A}{B} \times \frac{C}{D} \times \frac{E}{F} =$$

Then in this case—

A = Diameter of drawing roller.

B = Pinion on end of „

$\left.\begin{matrix}C\\D\end{matrix}\right\}$ = Double Intermediate.

E = Wheel on doffer.

F = Diam. of „

$$\frac{4}{24} \times \frac{54}{25} \times \frac{88}{15\frac{1}{2}} = 2{\cdot}04 \text{ draft between doffer and feed roller.}$$

$$\frac{4}{24} \times \frac{54}{\text{change pinion}} \times \frac{88}{15\frac{1}{2}} = 51{\cdot}096 \text{ constant number for draft.}$$

NOTE.—Top Drawing Roller Wheel 80 Teeth.
Lower „ „ 76 „

ARRANGEMENT OF SINGLE DOFFER BREAKER CLOCK.

We will now describe the method followed to produce a certain weight of rove from a certain "dollop." The word dollop is the name applied to the bundles of jute laid on in one round of the clock attached to the feed roller.

Two methods for doing so are adopted—

1st. The weight laid on in one round of clock, calculated from the circumference of feed roller at centre of pins.

2nd. The weight laid on in one round of clock, calculated from the circumference of the plaiding roller. This roller is 4″ in diameter, but the thickness of the feeding cloth must be taken into account, and this makes the diameter $4\frac{1}{8}$″, or 11·95 inches in circumference.

Although the first method is preferable, the calculations of both are explained.

Taking the first method—thus :—

$$\frac{A}{B} \times \frac{C}{D}$$

In this case—

A = 3	Threaded worm on end of Feed roller, and a 3 threaded worm is equal to a pinion of 3 teeth.	
B = 42	Teeth pinion in gear with worm.	
C = 36	,,	on nave of 42 teeth pinion.
D = 36	,,	on arbor of clock.

Thus—

$\frac{3}{42} \times \frac{36}{36} = \frac{1}{14}$ And a $\frac{1}{14}$ revolution of the clock is equal to one round of feed roller, and, therefore, there are 14 revolutions of feed roller in one round of clock.

Feed roller, $10\frac{1}{2}$″ diam., according to Messrs Fairbairn, = 32·98 inches circumference.

$$\frac{32{\cdot}98 \times 14}{36''} = 12{\cdot}82 \text{ yds. in one round of the clock.}$$

In my own experience I have always found the diameter of feed roller to be $10\frac{3}{4}''$, and worked out the length of clock from that diameter—thus :—

$\frac{3}{42} \times \frac{36}{36} = \frac{1}{14}$ And, as above, 14 revolutions of feed roller for one round of clock.

$10\frac{3}{4}''$ diam. = 33·77 circumference.

$\frac{33·77 \times 14}{36''} = 13·13$ yds. in one round of clock.

Then the second method—

$$\frac{A}{B} \times \frac{C}{D} \times \frac{E}{F}$$

Then in this case—

A = Pinion on end of plaiding roller.

B = Wheel in gear with it.

C = Worm on other end of feed roller.

D = 42 teeth pinion in gear with worm.

E = 36 ,, on nave of 42 teeth pinion.

F = 36 ,, on arbor of clock.

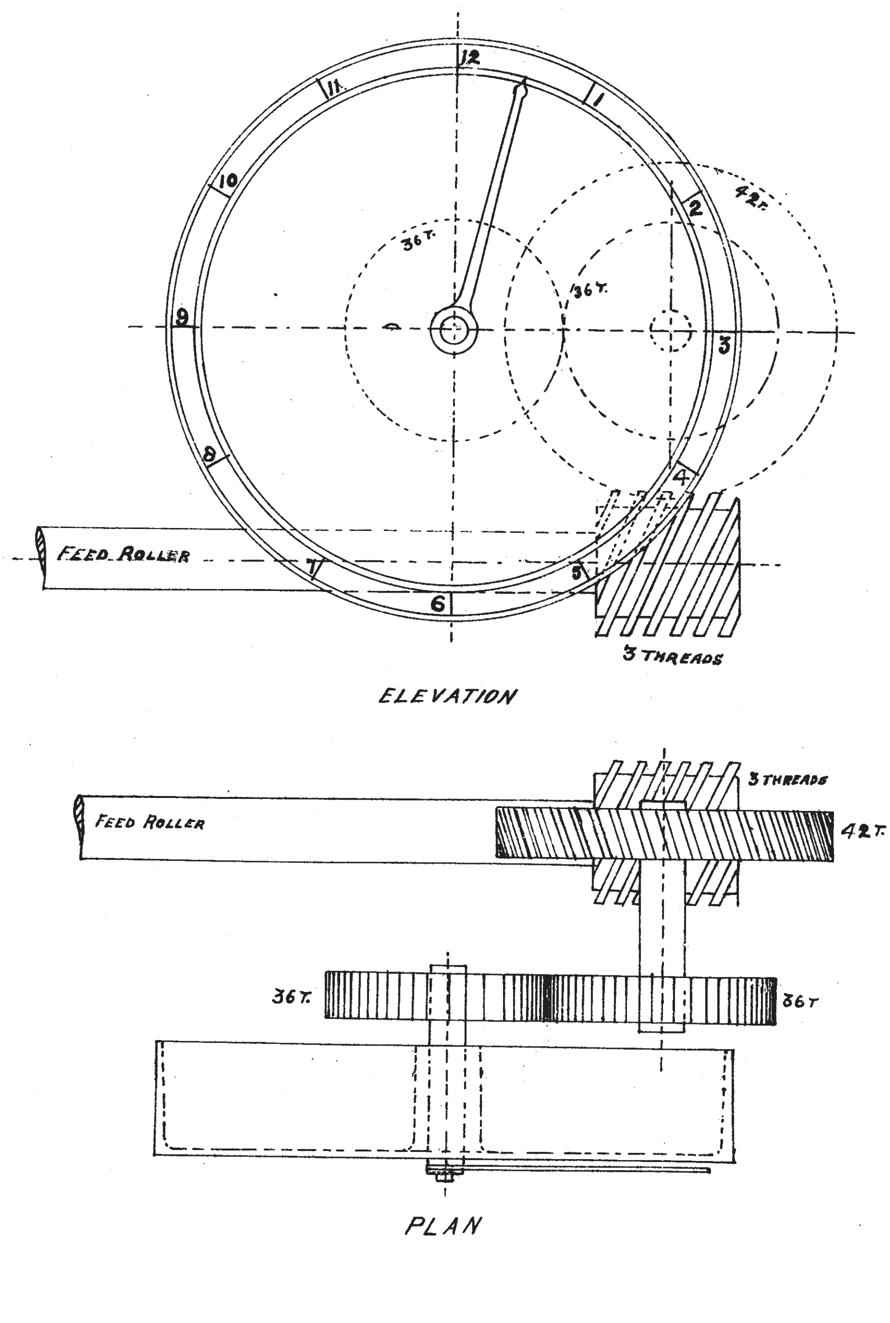
Thus—

$\frac{46}{114} \times \frac{3}{42} \times \frac{36}{36} = \frac{23}{798} = \frac{1}{35}$ Almost, therefore, $\frac{1}{35}$ of a revolution of the clock equals one round of the plaiding roller.

Plaiding roller, $4\frac{1}{8}$ diam. = 12·95 circumference.

$\frac{12·95 \times 35}{36''} = 12·6$ yards in one round of the clock.

SINGLE DOFFER BREAKER CLOCK.



SPECIFICATION AND SPEEDS OF JUTE BREAKER (Single Doffer).

Cylinder 6′ × 4′—2 Workers, 2 Strippers, 1 Doffer, Doffs with iron rollers.

Speed of Cylinder 190 revolutions per minute.

Cylinder Pulleys 24″ diameter, 6″ broad, $2\frac{1}{2}$″ bore.

Pulleys driving Strippers 14″ diameter, $3\frac{1}{2}$″ broad, $2\frac{1}{4}$″ bore.

Pulley Seats on Strippers $1\frac{3}{8}$″

Wheel	,,	workers	$1\frac{1}{4}$″
,,	,,	doffer	$1\frac{1}{4}$″
,,	,,	feeder	$1\frac{1}{4}$″
,,	,,	drawing roller	$1\frac{1}{4}$″
,,	,,	delivering ,,	$1\frac{1}{4}$″
,,	,,	tin rollers	$1\frac{1}{4}$″

	Under wood.	Over wood.	Over staves.	Centre to Centre of pins.	Over staves.	Centre to Centre of pins
Cylinder Ring, ...	$43\frac{1}{2}$″ dia.	48″ dia.	$49\frac{3}{8}$″ dia.	$49\frac{11}{16}$″ dia.	155·11″ cir.	156·09″ cir.
Nos. 1 and 2 Stripper Rings,...	$8\frac{1}{2}$,,	11 ,,	$12\frac{1}{8}$,,	$12\frac{3}{8}$,,	38·09 ,,	38·87 ,,
Nos. 1 and 2 Worker, ...	$4\frac{1}{2}$,,	7 ,,	$8\frac{1}{8}$,,	$8\frac{1}{2}$,,	25·52 ,,	26·70 ,,
Doffer Rings, ...	11 ,,	14 ,,	15 ,,	$15\frac{5}{16}$,,	47·12 ,,	48·10 ,,
Feeder ,, ...	$6\frac{1}{2}$,,	9 ,,	$10\frac{1}{8}$,,	$10\frac{1}{2}$,,	31·80 ,,	32 98 ,,

Tin Rollers 10″ diameter and 31·41″ circumference.

Drawing Rollers 4″ dia.	12·56	,,
Delivering Rollers 4″ dia.	12·56	,,
*Plaiding Roller 4″ dia	12·56	,,

*NOTE.—When this roller is used to calculate the length of breaker clock, the diameter is taken at $4\frac{1}{8}''$: this allows for thickness of feed cloth.

*Cylinder $49\frac{11}{16}''$ diameter at centre of pins = 156·09″ circumference—

$190 \times 156{\cdot}09 = 29657{\cdot}10$ ins. $= 2471{\cdot}42$ ft.—the surface speed of cylinder per minute.

Feed roller $10\frac{1}{2}''$ diameter at centre of pins = 32·98″ circumference.

Cylinder Pinion 44 teeth.

$$\frac{190 \times \overset{\text{Cyl. pin.}}{44} \times 26 \times 20}{80 \times 110 \times 110} = 4{\cdot}49 \text{ revolutions of feed roller per minute.}$$

$4{\cdot}49 \times 32{\cdot}98 = 148{\cdot}08$ ins. or 12·34 feet—surface speed of feed roller per minute.

Nos. 1 and 2 Workers $8\frac{1}{2}''$ diameter at centre of pins = 26·70″ circumference.

$$\frac{190 \times \overset{\text{Cyl. pin.}}{44} \times 48}{136 \times 138} = 21{\cdot}38 \text{ revolutions of workers per minute.}$$

$21{\cdot}38 \times 26{\cdot}70 = 570{\cdot}84$ ins. or 47·57 ft.—surface speed of workers per minute.

*NOTE.—These diameters are taken from a Fairbairn Specification.

Nos 1 and 2 Strippers $12\frac{3}{8}''$ diameter at centre of pins = 38·87″ circumference.

Pulley driving strippers 14″ diameter. Pulley on end of strippers $20\frac{1}{2}''$ diameter.

$$\frac{190 \times 14}{20\frac{1}{2}} = 129{\cdot}75 \text{ revolutions of strippers per minute.}$$

$129{\cdot}75 \times 38{\cdot}87 = 5043{\cdot}38$ ins. or 420·28 feet—surface speed of strippers per minute.

Doffer $15\frac{5}{16}''$ diameter at centre of pins = 48·10″ circumference.

$$\frac{190 \times \overset{\text{Cyl. pin.}}{44} \times 24 \times 26}{52 \times 54 \times 88} = 21{\cdot}11 \text{ revolutions of doffer per minute.}$$

21·11 × 48·10 = 1015·39 ins. or 84·61 feet—surface speed of doffer per minute.

Drawing Roller 4″ diameter = 12·56 circumference.

$$\frac{190 \times \overset{\text{Cyl. pin.}}{44}}{52} = 160{\cdot}76 \text{ revolutions of drawing roller per minute.}$$

160·76 × 12·56 = 2019·14 ins. or 168·26 feet—surface speed of drawing roller per minute.

Delivering Roller 4″ diameter = 12·56 circumference.

$$\frac{90 \times \overset{\text{Cyl. pin.}}{44} \times 23}{52 \times 24} = 154\ 07 \text{ revolutions of delivering roller per minute.}$$

154·07 × 12·56 = 1935·11 ins. or 161·25 feet—surface speed of delivering roller per minute.

Nos. 1 and 2 Tin Cylinders 10″ diameter = 31·41 circumference.

$$\frac{190 \times \overset{\text{Cyl. pin.}}{44} \times 45 \times 75}{136 \times 138 \times 84} = 17{\cdot}89 \text{ revolutions of tin cylinders per minute.}$$

17·89 × 31·41 = 561·92 ins. or 46·82 feet—surface speed of tin cylinders per minute.

Plaiding Roller 4″ diameter = 12·56 circumference.

$$\frac{190 \times \overset{\text{Cyl. pin.}}{44} \times 26 \times 20 \times 114}{80 \times 110 \times 110 \times 46} = 11{\cdot}12 \text{ revolutions of plaiding roller per minute.}$$

11·12 × 12·56 = 139·66 ins. or 11·63 feet—surface speed of plaiding roller per minute.

	Cylinder Pinion 38 T.		Cylinder Pinion 40 T.		Cylinder Pinion 42 T.		Cylinder Pinion 44 T.		Cylinder Pinion 46 T.		Cylinder Pinion 48 T.		Cylinder Pinion 50 T.	
	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs.
Speed of Cylinder per min.	Feet. 2471·42	190	Feet. 2471·42	190	Feet. 2471·42	190	Feet. 2471·52	190	Feet. 2471·42	190	Feet. 2471·42	190	Feet. 2471·42	190
,, Feed Roller ,,	10·63	3·87	11·21	4·08	11·76	4·28	12·34	4·49	12·88	4·69	13·43	4·89	14·01	5·10
,, Workers ,,	41·07	18·46	42·23	19·43	45·39	20·40	47·57	21·38	49·72	22·35	51·88	23.32	54·04	24·29
,, Strippers ,,	420·28	129·75	420·28	129·75	420·28	129·75	420·28	129·75	420·28	129·75	420·28	129·75	420·28	129·75
,, Doffer ,,	73·07	18·23	76·91	19·19	80·76	20·15	84·61	21·11	88·46	22·07	92·31	23·03	96·11	23·98
,, Drawing Roller ,,	145·31	138·84	152·97	146·15	160·62	153·46	168·26	160·76	175·91	168·07	183·56	175·38	191·21	182·69
,, Delivering ,, ,,	139·26	133·06	146·59	140·06	153·92	147·06	161·25	154·07	168·58	161·07	175·91	168·07	183·25	175·08
,, Tin Cylinders ,,	40·44	15·45	42 58	16·27	44·70	17·08	46·82	17·89	48·97	18·71	51·09	19·52	53·21	20·33
,, Plaiding Roller ,,	10·05	9·61	10·58	10·11	11·11	10·62	11·63	11·12	12·17	11·63	12·70	12·14	13·22	12·64

Cylinder Pinion 44 teeth

The Speed of the Feed Roller to the Cylinder is as 1 to 200·27.

,, ,, Workers ,, ,, 1 51·95.

,, ,, Strippers ,, ,, 1 5·88.

,, ,, Doffers ,, ,, 1 29·20.

,, ,, Drawing Roller ,, ,, 1 14·68.

,, ,, Delivering Roller ,, 1 15·32.

,, ,, Plaiding Roller ,, ,, 1 212·50.

,, ,, Workers to the Strippers is 1 8·83.

Delivering Rollers	$\frac{190 \times \text{Cyl. pin.} \times 23}{52 \times 24}$ ...	= 3·501,602	Constant No. for revs. per minute.	
Feed Roller ...	$\frac{190 \times \text{Cyl. pin.} \times 26 \times 20}{80 \times 110 \times 110}$	= ·102,066	,,	,,
Nos. 1 and 2 Workers	$\frac{190 \times \text{Cyl. pin.} \times 48}{136 \times 138}$ ...	= ·485,933	,,	,,
Doffer	$\frac{190 \times \text{Cyl. pin.} \times 24 \times 26}{52 \times 54 \times 88}$	= ·479,797	,,	,,
Drawing Roller ...	$\frac{190 \times \text{Cyl. pin.}}{52}$ ...	= 3·653,846	,,	,,
Tin Cylinders ...	$\frac{190 \times \text{Cyl. pin.} \times 45 \times 75}{136 \times 138 \times 84}$	= ·406,752	,,	,,
Plaiding Roller ...	$\frac{190 \times \text{Cyl. pin.} \times 26 \times 20 \times 114}{80 \times 110 \times 110 \times 46}$	= ·252,946	,,	,,

Setting of Breaker		
	Shell to Cylinder, ...	$\frac{7}{16}''$
	Feed Roller to Shell, ...	No. 9.
	,, Cylinder, ...	,, 16.
	No. 1 Worker to ,, ...	,, 12.
	No. 2 ,, ,, ...	,, 14.
	Nos. 1 and 2 Strippers, ...	,, 14.
	Between Strippers and Workers, ...	,, 16.
	Doffer to Cylinder, ...	,, 16.
	Drawing Roller to Doffer, ...	$\frac{3}{16}''$

The Speed of the Workers can be changed without affecting the other roller speeds as under :—

Speed of Cyl. × Cyl. Pin. × Worker.				
$\frac{190 \times 38 \times \text{Change Pinion}}{136 \times 138}$	– ·38,469	Constant No. with a	38	T. Cylinder Pinion.
$\frac{190 \times 40 \times \text{C.P.}}{136 \times 138}$	= ·40,494	,,	40	,,
$\frac{190 \times 42 \times \text{C.P.}}{136 \times 138}$	= ·42,519	,,	42	,,
$\frac{190 \times 44 \times \text{C.P.}}{136 \times 138}$	= ·44,543	,,	44	,,
$\frac{190 \times 46 \times \text{C.P.}}{136 \times 138}$	= ·46,568	,,	46	,,
$\frac{190 \times 48 \times \text{C.P.}}{136 \times 138}$	= ·48,593	,,	48	,,
$\frac{190 \times 50 \times \text{C.P.}}{136 \times 138}$	= ·50,618	,,	50	,,

REVOLUTIONS AND SURFACE SPEEDS UNDER DIFFERENT WORKER AND CYLINDER CHANGE PINIONS.

Cylinder Pinion.	WORKER, CHANGE PINIONS.											
	40	42	44	46	48	50	52	54	56	58	60 T.	
38 T	15·3876	16·1569	16·9263	17·6957	18·4651	19·2345	20·0038	20·7732	21·5426	22·3120	23·0814	Revolutions.
	34·23	35·94	37·66	39·37	41 08	42·79	44·50	46·21	47·93	49·64	51·35	Surface Speed in feet.
40	16·1976	17·0074	17·8173	18·6272	19·4371	20·2470	21·0568	21·8667	22·6766	23·4865	24·2964	Revolutions.
	36·03	37·84	39·64	41·44	43·24	45·04	46·85	48·65	50·45	52·25	54·05	Surface Speed in feet.
42	17·0076	17·8579	18·7083	19·5587	20·4091	21·2595	22·1098	22·9602	23·8106	24·6610	25·5114	Revolutions.
	37·84	39·73	41·62	43·51	45·40	47·30	49·19	51·08	52·97	54·86	56·76	Surface Speed in feet.
44	17·8172	18·7080	19 5989	20·4897	21·3806	22·2715	23·1623	24·0532	24·9440	25·8349	26·7258	Revolutions.
	39·64	41·62	43·60	45 58	47 57	49·55	51·53	53·51	55·49	57·48	59·46	Surface Speed in feet.
46	18·6272	19·5585	20·4899	21 4212	22·3526	23·2840	24·2153	25·1467	26·0780	27·0094	27·9408	Revolutions.
	41·44	43·51	45·58	47·66	49·73	51·30	53·87	55·95	58·02	60 09	62·16	Surface Speed in feet.
48	19·4372	20·4090	21·3809	22·3527	23·3246	24·2965	25·2683	26·2402	27·2120	28·1839	29·1558	Revolutions.
	43·24	45·41	47·57	49·73	51·89	54.05	56·22	58·38	60·54	62·70	64·87	Surface Speed in feet.
50	20·2472	21·2595	22·2719	23·2842	24·2966	25·3090	26·3213	27·3337	28·3460	29·3584	30·3708	Revolutions.
	45 05	47·30	49·55	51·80	54·05	56 31	58·56	60·81	63·06	65·32	67·57	Surface Speed in feet.

Dollop 32 lbs. Cylinder Pinion 44 teeth. Pulleys 24″.

Worm Working Clock, 3 threads, No. 6 pitch, $1\frac{1}{4}''$ bore.

$\frac{1}{3} \times \frac{42}{36} \times \frac{36}{1} = 14$ revolutions of feed roller for one round of clock.

Circumference of Feed Roller at centre of pins 32·98.″ Diameter $10\frac{1}{2}''$.

$32{\cdot}98 \times 14 = 461{\cdot}72$ inches or 12·82 yards for one round of clock.

$\frac{4 \times 80 \times 110 \times 110}{52 \times 26 \times 20 \times 10\frac{1}{2}} = 13{\cdot}63$ draft between feed and drawing roller.

$\frac{4 \times 80 \times 110 \times 110}{52 \times \text{C.P.} \times 20 \times 10\frac{1}{2}} = 354{\cdot}57\dot{8}$ Constant Number for draft.

$\frac{4 \times 54 \times 88}{23 \times 26 \times 15\frac{5}{16}} = 2{\cdot}07$ draft between doffer and drawing roller.

NOTE.—This draft is only necessary for the delivery of material between the doffer and the drawing roller but is not required in working out the draft between the feed and drawing roller.

$13{\cdot}63 \times 12{\cdot}82 = 174{\cdot}736$ yards delivered at the front of the breaker for one round of the clock.

Change Pinions	20	21	22	23	24	25	26	27	28	29	30 T.
Drafts -	17·72	16·88	16·11	15·41	14·77	14·18	13·63	13·13	12·66	12·22	11·81

SPECIFICATION OF PINS.

		Pitch.	Staves.	Rows.	Pins.	Size of Pins.	Length of Pi out.
Cylinder - -	71″ × 48″	$\frac{5}{8} \times \frac{5}{8}$	120	7	38	No. 12-1″	$\frac{5}{16}''$
Feed Boller - -	71 × 9	$\frac{7}{16} \times \frac{7}{16}$	24	6	81	,, $12\text{-}1\frac{1}{4}$	$\frac{3}{8}$
No. 1 Stripper -	71 × 12	$\frac{1}{2} \times \frac{1}{2}$	30	5	71	,, $13\text{-}1\frac{1}{4}$	$\frac{1}{4}$
No. 2 ,, -	71 × 12	$\frac{1}{2} \times \frac{1}{2}$	30	5	71	,, $13\text{-}1\frac{1}{4}$	$\frac{1}{4}$
No. 1 Worker -	71 × 7	$\frac{7}{16} \times \frac{7}{16}$	30	7	55	,, $13\text{-}1\frac{1}{2}$	$\frac{3}{8}$
No. 2 ,, -	71 × 7	$\frac{7}{16} \times \frac{7}{16}$	30	7	55	,, $13\text{-}1\frac{1}{2}$	$\frac{3}{8}$
Doffer - -	71 × 14	$\frac{3}{8} \times \frac{3}{8}$	34	8	81	,, $14\text{-}1\frac{1}{8}$	$\frac{5}{16}$

SINGLE DOFFER BREAKER CARD.

Sectional elevation shewing gearing at end opposite to driving pulleys.

SCALE $\frac{1}{16}$th

A	Drawing roller wheel, ...	52 teeth.
B	Intermediate, ...	108 teeth.
C	Intermediate, ...	106 teeth.
D	Changes on cylinder end, ...	20 to 60 teeth.
E	Stud wheel carrying changes, ...	90 teeth.
F	Changes, ...	20 to 60 teeth.
G	Stud wheel carrying changes, ...	80 teeth.
H	Changes, ...	20 to 60 teeth.
I	Stud wheel, ...	110 teeth.
J	Stud pinion, ...	20 teeth.
K	Feeder wheel, ...	110 teeth.
L	Feeder wheel for driving sheet rollers, ...	114 teeth.
M	Sheet roller wheel, ...	46 teeth.
N	Intermediate for driving workers, ...	108 teeth.
OO	Worker wheels, ...	138 teeth.
P	Intermediate between workers, ...	84 teeth.
QQ	Worker wheels for driving tin roller, ...	75 teeth.
RR	Tin roller wheels, ...	84 teeth.

DRAFT ARRANGEMENT—

$$\frac{4'' \times 80 \times 110 \times 110}{52 \times 26 \times 20 \times 10\frac{1}{2}''} = 13{\cdot}63 \text{ draft between feed and drawing rollers.}$$

$$\frac{4'' \times 80 \times 110 \times 110}{52 \times \text{C.P.} \times 20 \times 10\frac{1}{2}''} = 354{\cdot}578 \text{ Constant No. for draft.}$$

NOTE.—This is with feed roller taken $10\frac{1}{2}''$ diameter (Fairbairn).

Feed roller $10\frac{3}{4}''$ diameter at centre of pins.

$$\frac{4'' \times 80 \times 110 \times 110}{52 \times 26 \times 20 \times 10\frac{3}{4}''} = 13{\cdot}32 \text{ draft.}$$

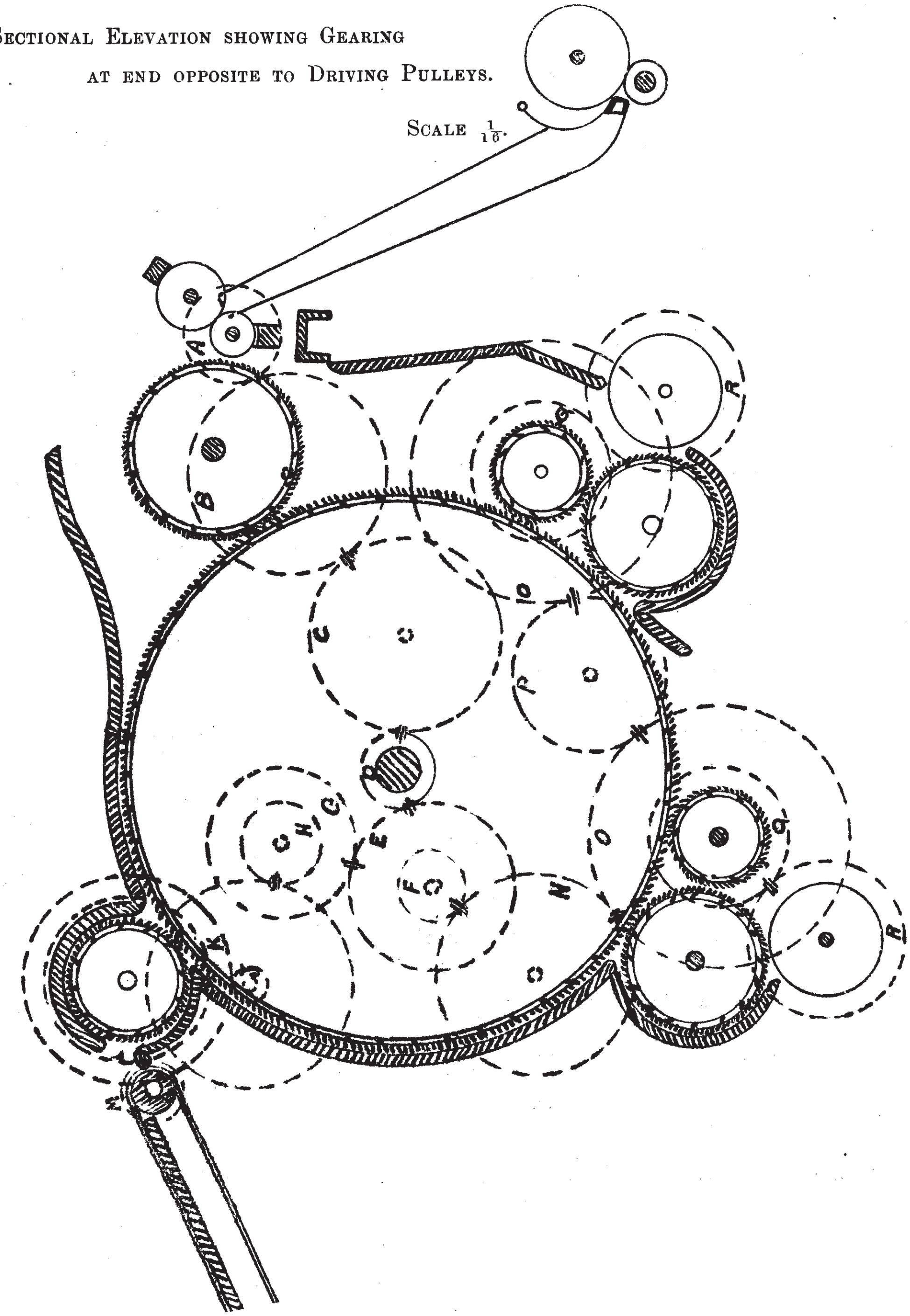
$$\frac{4'' \times 80 \times 110 \times 110}{52 \times \text{C.P.} \times 20 \times 10\frac{3}{4}''} = 346{\cdot}332 \text{ Constant No. for draft.}$$

NOTE.—C.P.—Change draft pinion.

SINGLE DOFFER BREAKER CARD.

Sectional Elevation showing Gearing
at end opposite to Driving Pulleys.

Scale 1/16.



SINGLE DOFFER BREAKER CARD.

Sectional elevation showing gearing at driving end.

SCALE $\frac{1}{16}$th.

A	Swift pulley, ...	...	...	...	14″ dia.
B B	Stripper pulleys,	...	...	...	20″ dia.
C	Stretching Pulley,	...	...	...	14″ dia.
D	Drawing roller pinion, ...	...	...	...	24 teeth.
E	Stud wheel, ...	...	...	...	54 teeth.
F	Stud pinion, ...	...	...	...	28 teeth.
G	Doffer wheel,	...	...	...	88 teeth.
H	Intermediate,	...	...	...	110 teeth.
I	Intermediate,	...	...	...	108 teeth.
J	Delivery roller pinion, ...	...	...	...	22 teeth.

Speed of Cylinder, 190 revolutions per minute.

$190 \times \frac{14}{20} = 133$ revolutions of strippers per minute.

Length of Feed Cloth, 13 feet.

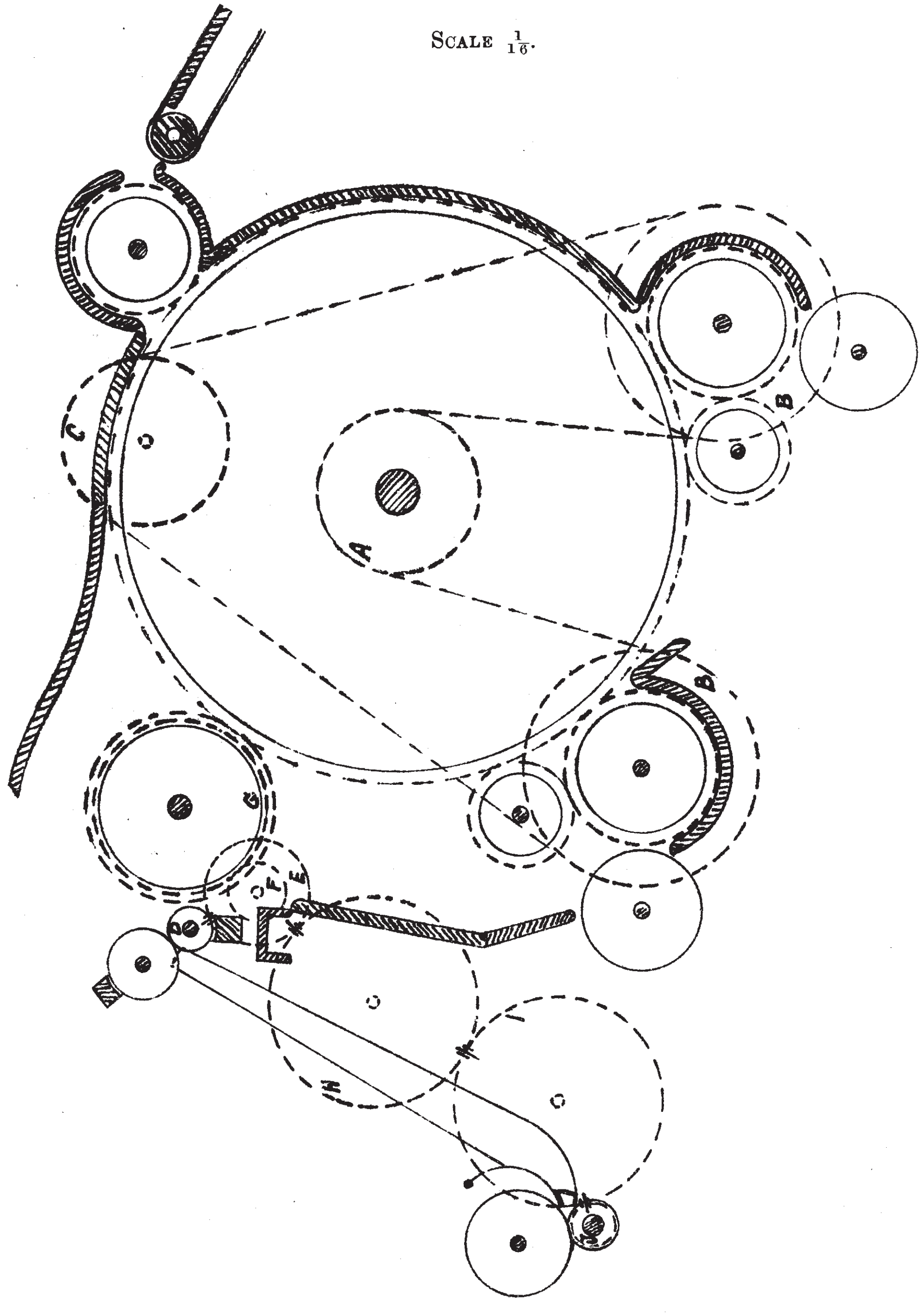
Breadth ,, ,, 5 ,, 6 inches.

One Feed Cloth is used for breaker, and it should be made of plaiding, $\frac{3}{16}$″ thick.

SINGLE DOFFER BREAKER CARD.

SECTIONAL ELEVATION SHOWING GEARING AT DRIVING END.

SCALE $\frac{1}{16}$.



SPECIFICATION AND SPEEDS OF JUTE BREAKERS (DOUBLE DOFFER).

Cylinder Pinion 44 teeth. Cylinder 184·84 revolutions per minute.

Cylinder 6′ × 4′, 2 Workers, 2 Strippers, 2 Doffers.

Fast Pulley 30″ diameter, 6″ broad, 2½″ bore.

Loose ,, 30 ,, 6 ,, 3¼ ,, (this pulley works in a bush).

Pulleys driving Strippers 12″ diameters, 3½″ broad, 3¼″ bore.

Pulley Seats	on	Strippers	-	1½″
Wheel	,,	Workers	-	1½
,,	,,	Doffers	-	1¾
,,	,,	Feeder	-	1¾
,,	,,	Drawing Roller		1¼
,,	,,	Delivering Roller		1¼
,,	,,	Tin Rollers	-	1¼

	Under Wood.	Over Wood.	Over Staves.	Centre to Centre of pins.	Over Staves.	Over Centre of pin
Cylinder ring ...	43½″ dia.	48″ dia.	49¼″ dia.	49½″ dia.	154·7 cir.	155·5 cir.
Nos. 1 and 2 Stripper rings	11½ ,,	14 ,,	15⅛ ,,	15½ ,,	47·516 ,,	48·694 ,,
Nos. 1 and 2 Worker ,,	11½ ,,	14 ,,	15⅛ ,,	15½ ,,	47·516 ,,	48·694 ,,
Doffers	11½ ,,	14 ,,	15⅛ ,,	15½ ,,	47·516 ,,	48·694 ,,
Feeder	16 ,,	18½ ,,	19¾ ,,	20¼ ,,	62·046 ,,	63·617 ,,

Tin Rollers - - -	16″ dia. and	50·265 cir.	
Upper and Lower Drawing Rollers	4 ,,	12·56	,,
Delivering Roller - -	4 ,,	12·56	,,

184·84 revolutions of cylinder per minute.

Cylinder 49½″ diameter at centre of pins = 155·5″ circumference.

184·84 × 155·5 = 28,742·62 ins. or 2395·21 feet—the surface speed of cylinder per minute.

Cylinder Pinion 44 T. Cylinder, 184·84 revolutions per minute.

Feed Roller $20\frac{1}{4}''$ diameter at centre of pins = 63·617″ circumference.

$$\overset{\text{Cyl. Pin.}}{\frac{184{\cdot}84 \times 44 \times 34 \times 30}{150 \quad 150 \quad 156}} = 2{\cdot}36 \text{ revolutions of feed roller per minute.}$$

2·36 × 63·617 = 150·13 ins. or 12·51 feet the surface speed of feed roller per minute.

Nos. 1 and 2 Workers $15\frac{1}{2}''$ diameter at centre of pins = 49·694″ circumference.

$$\overset{\text{Cyl. Pin.}}{\frac{184{\cdot}84 \times 44 \times 25}{155 \quad 144}} = 9{\cdot}10 \text{ revolutions of workers per minute.}$$

9·10 × 48·694 = 443·11 ins. or 36·92 feet the surface speed of workers per minute.

Nos. 1 and 2 Strippers $15\frac{1}{2}''$ diameter at centre of pins = 48·694″ circumference.

Pulleys driving strippers 12 ins. diameter.

,, on end of ,, 22 ,,

$$\frac{184{\cdot}84 \times 12}{22} = 100{\cdot}82 \text{ revolutions of strippers per minute.}$$

100·82 × 48·694 = 4909·32 ins. or 409·11 feet the surface speed of strippers per minute.

Doffers $15\frac{1}{2}''$ diameter at centre of pins = 48·694″ circumference.

$$\overset{\text{Cyl. Pin.}}{\frac{184{\cdot}84 \times 44 \times 24 \times 28}{74 \quad 57 \quad 88}} = 14{\cdot}72 \text{ revolutions of doffers per minute.}$$

14·72 × 48·694 = 716·77 ins. or 59·73 feet the surface speed of doffers per minute.

Lower Drawing Roller 4″ diameter = 12·56″ circumference.

$$\overset{\text{Cyl. Pin.}}{\frac{184{\cdot}84 \times 44}{70}} = 116{\cdot}18 \text{ revolutions of lower drawing roller per minute.}$$

116·18 × 12·56 = 1459·22 ins. or 121·60 ft. the surface speed of lower drawing roller per minute.

Upper Drawing Roller 4″ diameter = 12·56″ circumference.

$$\frac{\overset{\text{Cyl. Pin.}}{104{\cdot}84 \times 44}}{74} = 109{\cdot}90 \text{ revolutions of upper drawing roller per minute.}$$

109·90 × 12·56 = 1380·34 ins. or 115·02 ft. the surface speed of upper drawing roller per minute.

Delivering Roller 4″ diameter = 12·56″ circumference.

$$\frac{\overset{\text{Cyl. Pin.}}{184{\cdot}84 \times 44} \times 23}{70 \quad 22} = 121{\cdot}46 \text{ revolutions of delivering roller per minute.}$$

121·46 × 12·56 = 1525·53 ins. or 127·12 feet the surface speed of delivering roller per minute.

Tin Cylinder 16″ diameter = 50·265″ circumference.

$$\frac{\overset{\text{Cyl. Pin.}}{184{\cdot}84 \times 44} \times 25}{155 \quad 72} = 18{\cdot}21 \text{ revolutions of tin cylinders per minute.}$$

18·21 × 50·265 = 915·32 ins. or 76·27 feet the surface speed of tin cylinders per minute.

Plaiding Roller 4″ diameter = 12·56 circumference.

$$\frac{\overset{\text{Cyl. Pin.}}{184{\cdot}84 \times 44} \times 34 \times 30 \times 130}{150 \quad 150 \quad 156 \quad 31} = 9{\cdot}91 \text{ revolutions of plaiding roller per minute.}$$

9·91 × 12·56 = 124·46 ins. or 10·37 feet the surface speed of plaiding roller per minute.

	Cylinder Pinion 38 T.		Cylinder Pinion 40 T.		Cylinder Pinion 42 T.		Cylinder Pinion 44 T.		Cylinder Pinion 46 T.		Cylinder Pinion 48 T.		Cylinder Pinion 50 T.	
	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs.
Speed of Cylinder per min.	2395·21	184·84	2395·21	184·84	2395 21	184·84	Feet. 2395·21	184·84	Feet. 2395·21	184·84	Feet. 2395·21	184·84	Feet. 2395·21	184 84
,, Feed Roller ,,	10·81	2·04	11·34	2·14	11·92	2·25	12·51	2·36	13·09	2·47	13·62	2·57	14·20	2·68
,, Workers ,,	31·89	7·86	33·59	8·28	35·26	8·69	36·92	9·10	38·63	9·52	40·29	9.93	41·99	10 35
,, Strippers ,,	409·11	100·82	409·11	100·82	409·11	100·82	409·11	100·82	409·11	100·82	409·11	100·82	409·11	100·82
,, Doffers ,,	51·57	12·71	54·29	13·38	57·01	14·05	59·73	14·72	62·45	15·39	65·16	16·06	67·88	16·73
,, Lower Drawing Roller	105·02	100·34	110·54	105·62	116·67	110·90	121·60	116·18	127·12	121·46	132·65	126·74	138·18	132·02
,, Upper ,,	99·33	94·91	104·57	99·91	109·79	104·90	115·02	109·90	120·26	114·90	125·48	119·89	130·71	124·89
,, Delivering Roller	109·79	104·90	115 57	110·42	121·35	115·94	127·12	121·46	132·90	126·98	138·68	132·50	144·46	138·02
,, Tin Cylinders p. min.	65·88	15·73	69·36	16·56	72·84	17·39	76·27	18·21	79·75	19·04	83·23	19·87	86·70	20·70
,, Plaiding Roller ,,	8·94	8·55	9 43	9 01	9·90	9·46	10·37	9·91	10·84	10·36	11·31	10.81	11·78	11 26

Cylinder Pinion 44 teeth

The Speed of the Feed Roller to the Cylinder is as 1 to 191·46.

,,	Workers	,,	,,	1	64·87.
,,	Strippers	,,	,,	1	5·85.
,,	Doffers	,,	,,	1	40·10.
,,	Lower Drawing Roller		,,	1	19·69.
,,	Upper ,,		,,	1	20·82.
,,	Delivering Roller		,,	1	18·84.
,,	Workers to the Strippers			1	11·08.

Feed Roller ...	$\frac{184{\cdot}84 \times C.P. \times 34 \times 30}{150 \quad 150 \quad 156}$	= ·053,714	Constant No. for revs. per minute.	
Nos. 1 and 2 Workers	$\frac{184{\cdot}84 \times C.P. \times 25}{155 \quad 144}$ ...	= ·207,034	„	„
Doffer	$\frac{184{\cdot}84 \times C.P. \times 24 \times 28}{74 \quad 57 \quad 88}$	= ·334,641	„	„
Lower Drawing Roller	$\frac{184{\cdot}84 \times C.P.}{70}$ ...	= 2·64,057	„	„
Upper Drawing Roller	$\frac{184{\cdot}84 \times C.P.}{74}$ ...	= 2·49,783	„	„
Delivering Roller	$\frac{184{\cdot}84 \times C.P. \times 23}{70 \quad 22}$ ...	= 2·76,058	„	„
Tin Cylinders ...	$\frac{184{\cdot}84 \times C.P. \times 25}{155 \quad 72}$ ...	= ·414,068	„	„
Plaiding Rollers ...	$\frac{184{\cdot}84 \times C.P. \times 34 \times 30 \times 130}{150 \quad 150 \quad 156 \quad 31}$	= ·225,253	„	„

Setting of Double Doffer Breaker

Feed Roller to Cylinder, ...	No. 16.
„ Shell, ...	„ 9.
Shell to Cylinder, ...	$1\frac{7}{8}''$.
No. 1 Worker to Cylinder, ...	No. 14.
No. 2 „ „	„ 14.
Nos. 1 and 2 Strippers to Cylinder, ...	„ 16.
Between Workers and Strippers, ...	„ 16.
Upper Doffer to Cylinder, ...	„ 16.
Lower „ „	„ 14.
Upper Drawing Roller to Doffer, ...	„ 9.
Lower „ „	„ 9.

The speed of the workers can be changed without affecting other parts of the breaker as under :—

Speed of Cylinder. × Cyl. Pin. × Worker. Change Pinion.				
$\frac{184{\cdot}84 \times 38 \times}{155 \quad 144}$	= ·314691	Constant N. with	38	teeth cylinder pinion.
$\frac{184{\cdot}84 \times 40 \times}{155 \quad 144}$	= ·331254	„	40	„
$\frac{184{\cdot}84 \times 42 \times}{155 \quad 144}$	= ·347817	„	42	„
$\frac{184{\cdot}84 \times 44 \times}{155 \quad 144}$	= ·364379	„	44	„
$\frac{184{\cdot}84 \times 46 \times}{155 \quad 144}$	= ·380942	„	46	„
$\frac{184{\cdot}84 \times 48 \times}{165 \quad 144}$	= ·397505	„	48	„
$\frac{184{\cdot}84 \times 50 \times}{155 \quad 144}$	= ·414068	„	50	„

Cylinder Pinion.		WORKER, CHANGE PINIONS.								
		20	22	24	26	28	30	32	34	36 T.
38 T	Revolutions.	6·2938	6·9232	7·5525	8·1819	8·8113	9·4407	10·0701	10·6994	11·3288
	Surface Speed in feet.	25·5391	28·0931	30·6467	33·2007	35·7547	38·3087	40·8627	43·4163	45·9703
40	Revolutions.	6·6250	7·2875	7·9500	8·6126	9·2751	9·9376	10·6001	11·2626	11·9251
	Surface Speed in feet.	26·9664	29·5714	32·2597	34·9484	37·6368	40·5288	43·0134	45·7017	48·3900
42	Revolutions.	6·9563	7·6519	8·3476	9·0432	9·7388	10·4345	11·1301	11·8257	12·5214
	Surface Speed in feet.	28·2275	31·0501	33·8731	36·6957	39·5184	42·3414	45·1640	47·9867	50·8097
44	Revolutions.	7·2875	8·0163	8·7450	9·4738	10·2026	10·9313	11·6601	12·3888	13·1176
	Surface Speed in feet.	29·5714	32·5288	35·4857	38·4431	41·4004	44·3573	47·3147	50·2716	53·2290
46	Revolutions.	7·6188	8·3807	9·1426	9·9044	10·6663	11·4282	12·1901	12·9520	13·7139
	Surface Speed in feet.	30·9158	34·0074	37·0991	40·1904	43·2820	46·3737	49·4653	52·5570	55·6487
48	Revolutions.	7·9501	8·7451	9·5401	10·3351	11·1301	11·9251	12·7201	13·5151	14·3101
	Surface Speed in feet.	32·2601	35·4861	38·7121	41·9381	45·1640	48·3900	51·6160	54·8420	58·0680
50	Revolutions.	8·2813	9·1094	9·9376	10·7657	11·5939	12·4220	13·2501	14·0783	14·9064
	Surface Speed in feet.	33·6041	36·9644	40·3251	43·6854	47·0461	50·4064	53·7666	57·1273	60·4876

This Breaker has two deliveries, and each delivery keeps a finisher going. The dolop given here refers to each delivery separately. From the construction of this machine two qualities of material can be wrought at the same time.

Dolop 22 lbs.; Cylinder Pinion 44 teeth; Pulley 30″.

Worm working Clock 3 threads, No. 6 pitch, $1\frac{1}{4}$″ bore.

$\frac{1 \times 22}{3 \times 1} = 7\frac{1}{3}$ revolutions of feed roller for one round of clock.

Circumference of Feed Roller at centre of pins 63·61″. Diameter $20\frac{1}{4}$″.

$7\frac{1}{3} \times 63{\cdot}61 = 466{\cdot}26$ inches or 12·95 yards for one round of clock.

$\frac{4 \times 150 \times 150 \times 156}{70 \times 34\text{c.p.} \times 30 \times 20\frac{1}{4}} = 9{\cdot}71$ draft between feed and upper drawing roller.

$\frac{4 \times 57 \times 88}{24 \times 28\text{c p.} 15\frac{1}{2}} = 1{\cdot}92$,, doffer and upper drawing roller.

Draft.		Yds. per round of clock.	
9·71	×	12·95	= 125·7 yards delivered at front of breaker for one round of clock.

$\frac{4 \times 150 \times 150 \times 156}{70 \times \text{C.P.} \times 30 \times 20\frac{1}{4}} = 330{\cdot}1587$ Constant Number for draft.

$\frac{4 \times 57 \times 88}{24 \times \text{C.P.} \times 15\frac{1}{2}} = 53{\cdot}9354$,, ,, between doffer and upper drawing roller

DRAFTS.

Change Pinions	30	31	32	33	34	35	36	37	38	39	40 T.
Drafts, -	11·00	10·65	10·31	10·09	9·71	9·43	9·17	8·92	8·68	8·46	8·25

Drafts between Doffer and Upper Drawing Roller—

Change Pinions	24	25	26	27	28	29	30
Drafts, -	2·24	2·15	2·07	1·99	1·92	1·86	1·79

$\frac{4 \times 74 \times 74 \times 57 \times 88}{70 \times 74 \times 24 \times 28 \times 15\frac{1}{2}} = 2{\cdot}036$ draft between doffer and lower drawing roller.

It will be observed that there are 4 teeth more draft between the doffer and the lower drawing roller than between the doffer and the upper drawing roller—this is to keep the sliver tight between the top and bottom drawing roller.

The lower doffer is driven direct from the upper doffer, and the lower drawing roller direct from the upper drawing roller.

SPECIFICATION OF PINS.

Cylinder	71″ × 48″	$\frac{3}{4} \times \frac{3}{4}$	82	5	47	No. 12 $1\frac{1}{16}$
Feeder	× 18½	$\frac{7}{16} \times \frac{3}{8}$	63	8	54	12 $1\frac{1}{4}$
1st Stripper	× 14	$\frac{1}{2} \times \frac{1}{2}$	54	5	47	13 $1\frac{1}{4}$
2nd "	× 14	$\frac{1}{2} \times \frac{1}{2}$	54	5	47	13 $1\frac{1}{4}$
1st Worker	× 14	$\frac{7}{16} \times \frac{3}{8}$	54	7	54	13 $1\frac{3}{4}$
2nd "	× 14	$\frac{7}{16} \times \frac{3}{8}$	54	7	54	13 $1\frac{3}{4}$
1st Doffer	× 14	$\frac{3}{8} \times \frac{3}{8}$	54	7	63	14 $1\frac{1}{4}$
2nd "	× 14	$\frac{3}{8} \times \frac{3}{8}$	54	7	63	14 $1\frac{1}{4}$

ARRANGEMENT OF DOUBLE DOFFER BREAKER CLOCK.

Length of clock, calculated from diameter of feed roller, $20\frac{1}{4}$ inches = 63·61 inches circumference.

$$\frac{A}{B}$$

In this case—

A = 3 Threaded Worm on end of feed roller.

B = 22 Teeth Pinion on arbor of Clock in gear with worm.

$\frac{3}{22}$—therefore $\frac{3}{22}$ of a revolution of clock is equal to one round of a feed roller, and there are therefore $7\frac{1}{3}$ revolutions of feed roller for one round of clock.

$63{\cdot}61 \times 7\frac{1}{3} = 466{\cdot}47$ inches or 12·95 yards in one round of clock.

Length of clock calculated from plaiding roller $4\frac{1}{4}''$ diameter = 13·35 cir., two thicknesses of feed cloth included in dia. of plaiding roller.

$$\frac{A}{B} \times \frac{C}{D} =$$

In this case—

A = Pinion on end of plaiding roller.

B = Wheel in gear with it.

C = Worm on end of feed roller.

D = 22 teeth pinion on arbor of clock in gear with worm.

$\frac{31}{130} \times \frac{3}{22} = \frac{93}{2860}$ of a revolution of clock equals one round of the plaiding roller.

$\frac{2860}{93} = 30\frac{3}{4}$ revolutions of plaiding roller in one round of clock.

$\frac{13{\cdot}35 \times 30{\cdot}75}{36''} = 11{\cdot}4$ yards in one round of clock.

NOTE.—*As to the clock arrangements.*—There is a difference between the length of clock when calculated from feed and plaiding rollers. The method followed is to make the calculation at something between the speed of the feeding cloth and that of the feed roller. We estimate feeding cloth at $\frac{1}{8}''$ thick; this makes the diameter of plaiding roller equivalent to $4\frac{1}{4}''$ diameter. Then the feed roller must have a draw on the feeding cloth, so as to ensure that the latter does not tend to choke the shell feeder. Thus, the feeding cloth goes at 11·4, the feeder goes at 12·95; and we estimate that the draw of the feeder in one direction and the resistance of the sheet roller will make the real speed about 12 yards—hence the reason that Messrs Fairnbairn, Naylor, Macpherson, & Co., Ltd., speak of a 12 yards clock.

DOUBLE DOFFER BREAKER CARD.

Sectional elevation showing gearing at end opposite to driving pulleys.

SCALE $\frac{1}{16}$TH.

(*For Diagram see page 62*).

A	Feeder wheel, ...	156 teeth.
B	Changes, ...	36 to 64 teeth.
C	Stud wheel carrying do., ...	150 teeth.
D	Stud pinion, ...	20 teeth.
E	Stud wheel, ...	150 teeth.
F	Intermediate, ...	96 teeth.
G	Changes on cylinder end, ...	36 to 64 teeth.
H	Intermediate, ...	102 teeth.
I	Stud wheel, ...	155 teeth.
J	Stud pinion, ...	25 teeth.
K	Bottom drawing roller wheel, ...	70 teeth.
L	Intermediate, ...	102 teeth.
M	Top drawing roller wheel, ...	74 teeth.
N N	Worker wheels, ...	144 teeth.
O O	Tin roller wheels, ...	72 teeth.
P	Intermediate between workers, ...	90 teeth.

DRAFT ARRANGEMENT—

Feed Roller, 20″ diameter—diameter taken from Fairbairn.

$$\frac{4'' \times 150 \times 150 \times 156}{70 \times 34 \times 30 \times 20''} = 9{\cdot}83 \text{ draft.}$$

$$\frac{4'' \times 150 \times 150 \times 156}{70 \times \text{C.P} \times 30 \times 20''} = 334{\cdot}285 \text{ constant N. for draft.}$$

Feed Roller, $20\frac{1}{4}''$ diameter (see Specification of Breaker).

$$\frac{4'' \times 150 \times 150 \times 156}{70 \times 34 \times 30 \times 20\frac{1}{4}''} = 9 \, 7 \text{ draft.}$$

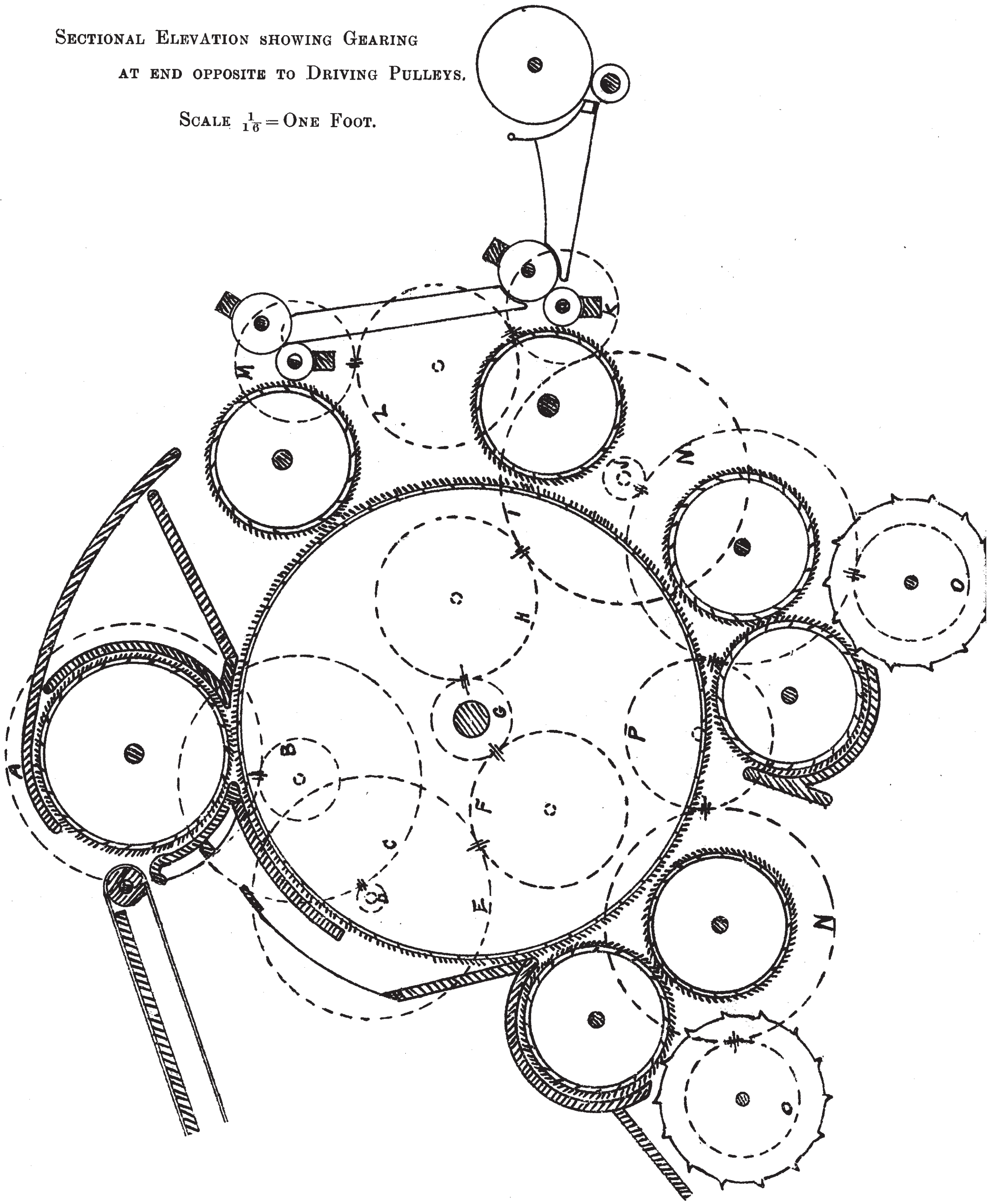
$$\frac{4'' \times 150 \times 150 \times 156}{70 \times \text{C.P.} \times 30 \times 20\frac{1}{4}''} = 330{\cdot}158 \text{ constant N. for draft.}$$

NOTE.—C.P. = Change on draft pinion.

DOUBLE DOFFER BREAKER CARD.

Sectional Elevation showing Gearing at end opposite to Driving Pulleys.

Scale $\frac{1}{16}$ = One Foot.



DOUBLE DOFFER BREAKER CARD.

Sectional elevation showing gearing at driving end.

SCALE $\frac{1}{16}$TH.

(*For Diagram see page 64*).

A	Swift Pulley, ...	12″ dia.
BB	Stripper pulleys, ...	22″ dia.
C	Stretching pulley, ...	12″ dia.
D	Feeder wheel for driving sheet roller, ...	130 teeth.
E	Sheet roller wheel, ...	31 teeth
F	Top drawing roller pinion, ...	24 teeth.
G	Stud wheel, ...	57 teeth.
H	Stud pinion, ...	28 teeth.
I I	Doffer wheels, ...	88 teeth.
J	Intermediate between doffers, ...	96 teeth.
K	Bottom drawing roller pinions, ...	24 and 25 teeth.
L	Intermediate, ...	124 teeth.
M	Delivery roller pinion, ...	23 teeth.

Speed Cylinder 184·84 revs. per minute.

$$184{\cdot}84 \times \tfrac{12}{22} = 100{\cdot}82$$ revs. of Strippers per minute.

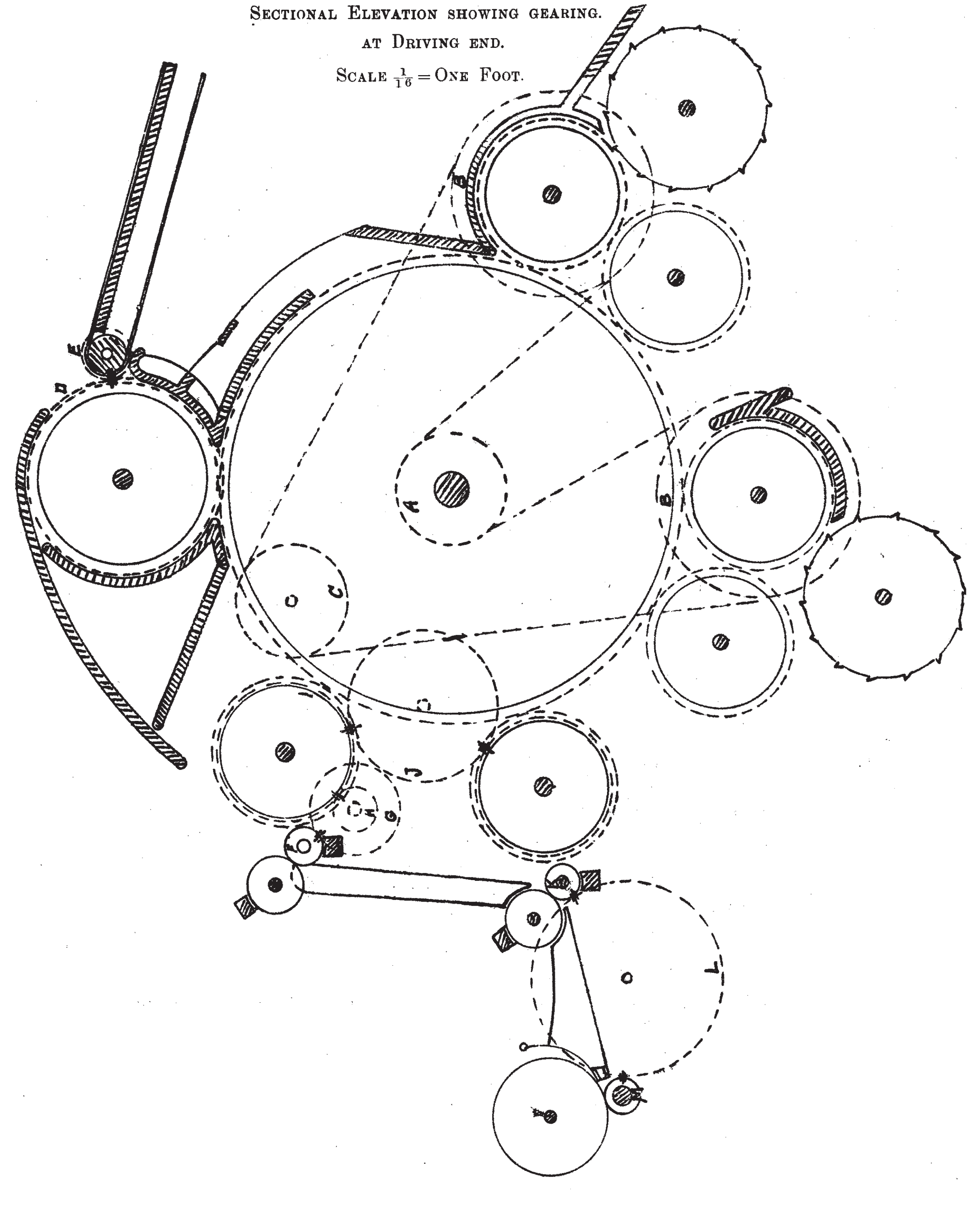
Length of Feed Cloth 14 feet.

Breadth ,, 2 feet 9 inches.

Two feed cloths are necessary for this breaker as it delivers two separate slivers.

DOUBLE DOFFER BREAKER CARD.

SECTIONAL ELEVATION SHOWING GEARING.
AT DRIVING END.
SCALE $\frac{1}{16}$ = ONE FOOT.



UP STRIKER BREAKER CARD.

Sectional elevation showing gearing at driving end.

SCALE $\frac{1}{16}$th.

(For Diagram see page 66).

A	Swift pulley, ...	14″ dia.
BB	Stripper pulleys, ...	18″ dia.
C	Stretching pulley, ...	14″ dia.
D	Drawing roller pinion, ...	24 teeth.
E	Stud Wheel, ...	54 teeth.
F	Stud pinion, ...	28 teeth.
G	Intermediate, ...	42 teeth.
H	Doffer wheel, ...	88 teeth.
I	Stud wheel, ...	24 teeth.
J	Stud pinion, ...	12 teeth.
K	Brush wheel, ...	24 teeth.
LL	Intermediate, ...	90 teeth.
M	Delivery roller pinion, ...	22 teeth.
N	Doffer wheel for driving tin roller, ...	104 teeth.
O	Tin roller wheel, ...	52 teeth.
P	Feeder wheel for driving sheet roller, ...	78 teeth.
Q	Intermediate, ...	40 teeth.
R	Sheet roller wheel, ...	32 teeth.

Cylinder 190 revolutions per minute.

$190 \times \frac{14}{18} = 147 \cdot 7$ revolutions of Strippers per minute.

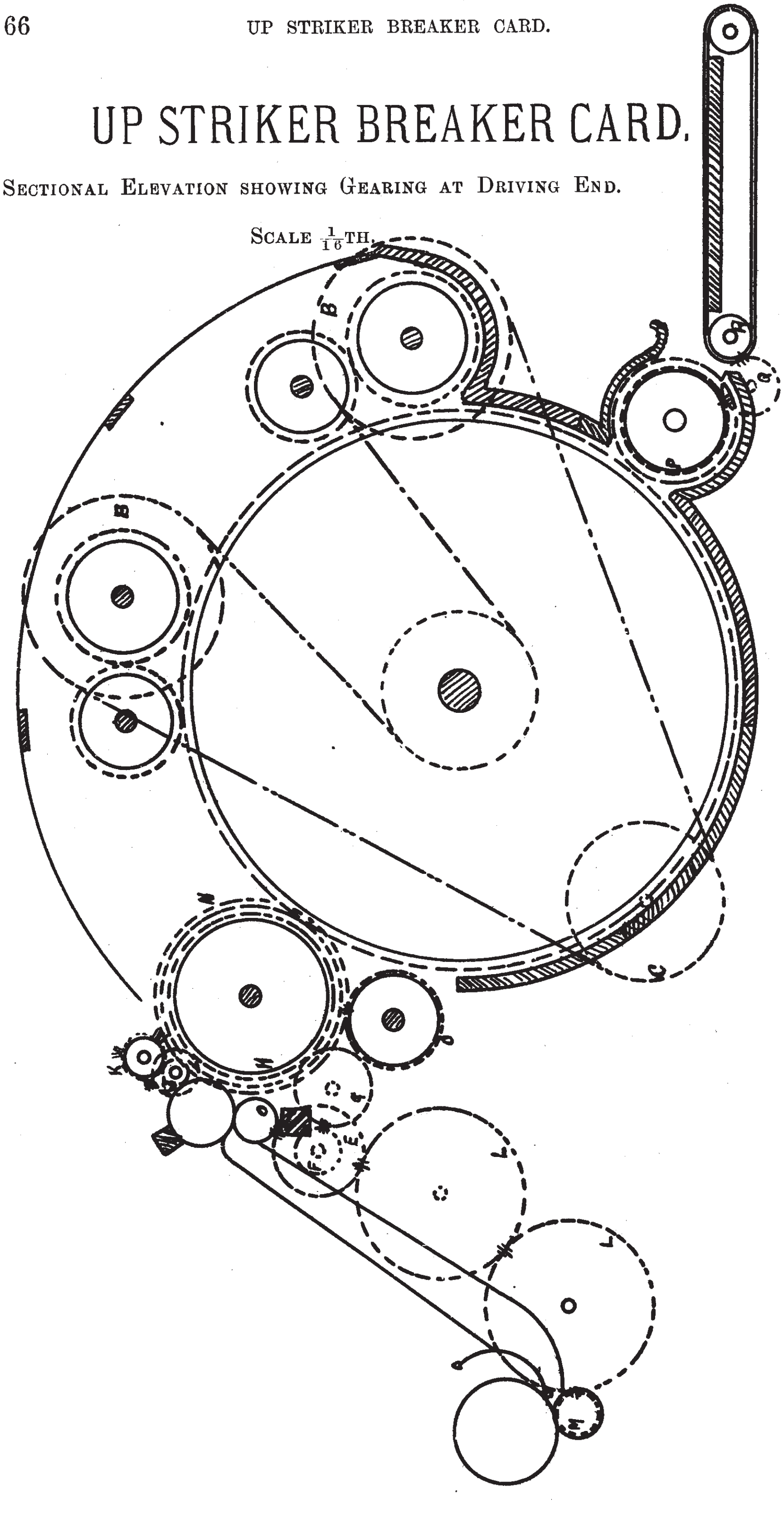
The illustrations of Up Striker Breakers have been put in for reference. I have not thought it necessary to describe them.

NOTE.—For Particulars of Covering see page 111, and page 120 for Drafts, &c.

UP STRIKER BREAKER CARD.

Sectional Elevation showing Gearing at Driving End.

Scale $\frac{1}{16}$th.



UP STRIKER BREAKER CARD.

Sectional elevation showing gearing at opposite end to driving pulleys.

SCALE $\frac{1}{16}$th.

(For Diagram see page 68).

A	Drawing roller wheel, ...	66 teeth.
BBB	Intermediates, ...	75 teeth.
C	Changes on cylinder end, ...	20 to 60 teeth.
D	Intermediate, ...	54 teeth.
E	Stud wheel, ...	58 teeth.
F	Stud pinion, ...	20 teeth.
G	Stud wheel, ...	120 teeth.
H	Changes, ...	20 to 60 teeth.
I	Feeder wheel, ...	120 teeth.
J	Doffer wheel for driving workers, ...	88 teeth.
K	Stud wheel, ...	96 teeth.
L	Stud pinion, ...	64 teeth.
MM	Workers wheel.	92 teeth.
N	Intermediate between workers, ...	116 teeth.

DRAFT ARRANGEMENT—

$$\frac{4 \times 58 \times 120 \times 120}{66 \times 20 \times 30 \times 10\frac{1}{2}} = 8{\cdot}03 \text{ draft.}$$

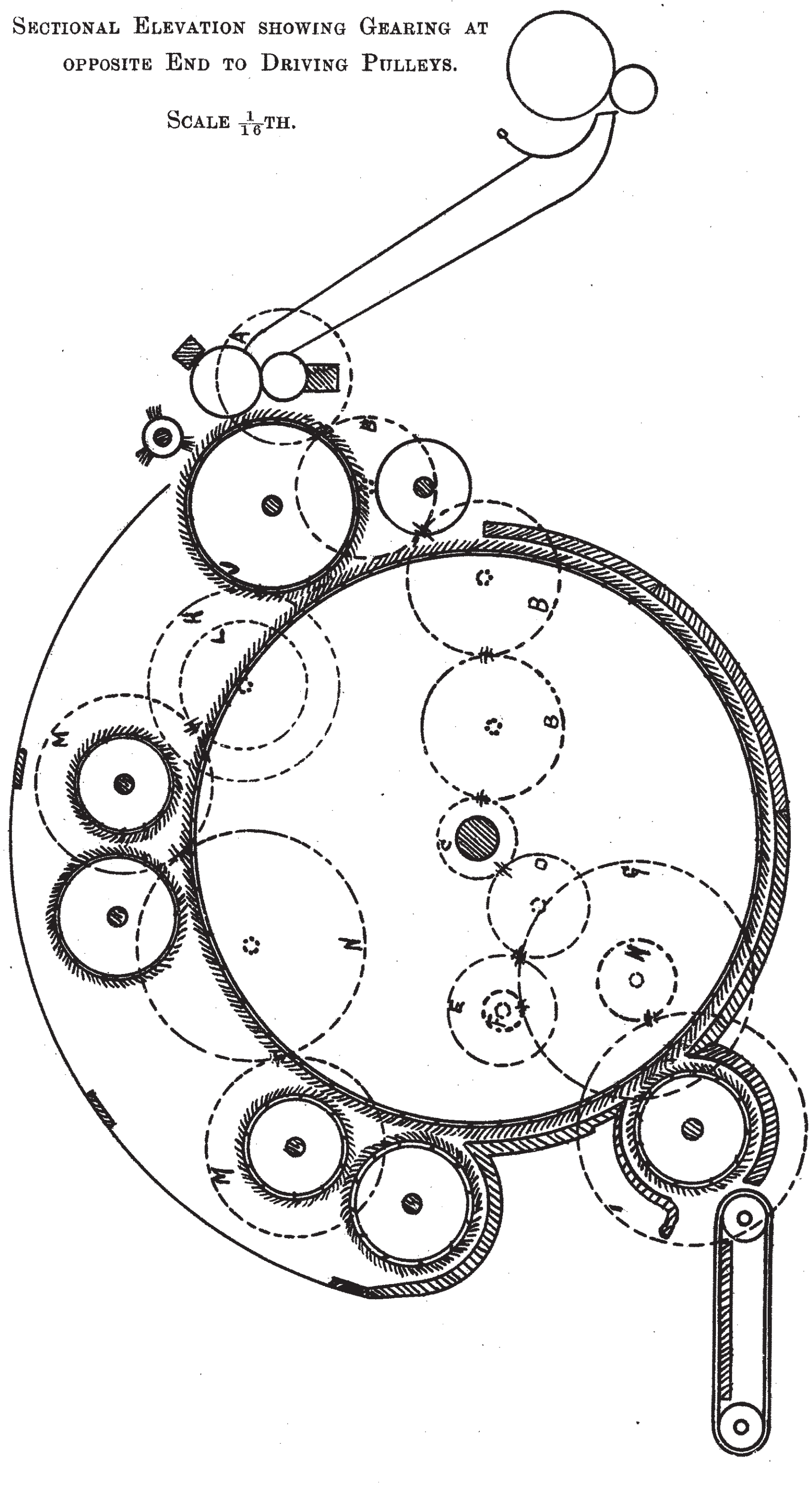
$$\frac{4}{66} \times \frac{58}{20} \times \frac{120}{\text{C.P.}} \times \frac{120}{10\frac{1}{2}} = 241{\cdot}039 \text{ Constant No. for draft.}$$

NOTE.—The Breakers are used for Sacking Wefts.

UP STRIKER BREAKER CARD.

Sectional Elevation showing Gearing at opposite End to Driving Pulleys.

Scale $\frac{1}{16}$th.



SINGLE DOFFER FINISHER CARD.

Sectional elevation showing gearing at end opposite to driving pulleys.

SCALE $\frac{1}{16}$th.

(For diagram see page 70).

A	Changes on cylinder end, ...	20 to 60 teeth.
B	Intermediate, ...	74 teeth.
C	Stud wheel, ...	104 teeth.
D	Stud pinion, ...	32 teeth.
E	Intermediate, ...	66 teeth.
F	Drawing roller wheel, ...	75 teeth.
G	Stud wheel carrying changes, ...	96 teeth.
H	Changes, ...	20 to 60 teeth.
I	Feeder wheel, ...	96 teeth.
J	Feeder wheel for driving sheet roller, ...	46 teeth.
K	Sheet roller wheel, ...	48 teeth.
L	Doffer wheel for driving workers ...	84 teeth.
M	Stud pinion, ...	64 teeth.
N	Stud wheel, ...	72 teeth,
OOOO	Worker wheels, ...	90 teeth.
P P	Intermediates between workers, ...	84 teeth.
Q	Intermediate between workers, ...	96 teeth.
R	Worker wheel for driving tin roller, ...	70 teeth.
S	Tin roller wheel, ...	62 teeth.
T	Worker wheel for driving tin roller, ...	75 teeth.
U	Tin roller wheel, ...	84 teeth.
V	Mitre for driving end delivery roller, ...	30 teeth.
W	Mitre on end delivery roller, ...	30 teeth.

DRAFT ARRANGEMENT—

Feed Roller, $4\frac{1}{8}''$ diameter.

$$\frac{4'' \times 104 \times 96 \times 96}{75 \times 32 \times 28 \times 4\frac{1}{8}''} = 13{\cdot}83 \text{ draft.}$$

$$\frac{4'' \times 104 \times 96 \times 96}{75 \times 32 \times \text{C.P.} \times 4\frac{1}{8}''} = 387{\cdot}258 \text{ Constant No. for draft.}$$

Feed Roller, $4''$ diameter.

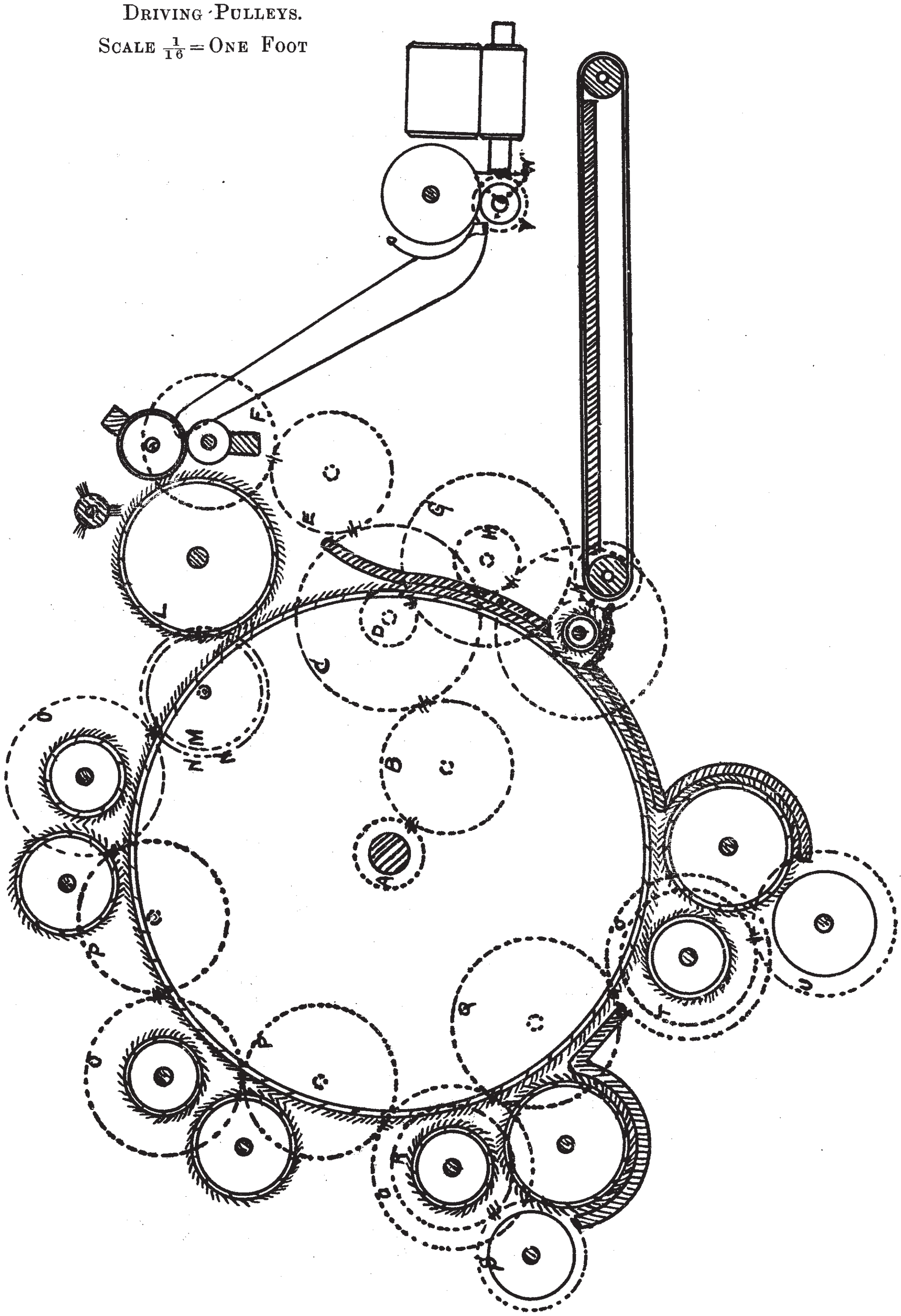
$$\frac{4'' \times 104 \times 96 \times 96}{75 \times 32 \times 28 \times 4''} = 14{\cdot}26 \text{ draft.}$$

$$\frac{4'' \times 104 \times 96 \times 96}{75 \times 32 \times \text{C.P.} \times 4''} = 399{\cdot}359 \text{ Constant No. for draft.}$$

SINGLE DOFFER FINISHER CARD.

Sectional Elevation showing Gearing at end opposite to Driving-Pulleys.

Scale $\frac{1}{16}$ = One Foot



SINGLE DOFFER FINISHER CARD.

Sectional elevation, showing gearing at driving end.

SCALE $\frac{1}{16}$th.

(For Diagram see page 72).

A	Swift pulley, ...	14″ dia.
B B	Stripper pulleys, ...	15″ dia.
C C	Stripper pulleys, ...	18″ dia.
D	Stretching pulley, ...	14″ dia.
E	Drawing roller pinion, ...	24 teeth.
F	Intermediate, ...	56 teeth.
G	Stud wheel, ...	60 teeth.
H	Stud pinion, ...	28 teeth.
I I	Intermediate, ...	84 teeth.
J	Delivery roller pinion, ...	22 teeth.
K	Doffer wheel, ...	84 teeth.
L	Stud wheel for driving brush, ...	24 teeth.
M	Stud pinion, ...	12 teeth.
N	Brush wheel, ...	24 teeth.

Speed of Cylinder, 180 revolutions per minute.

$180 \times \frac{14}{18} = 140$ revolutions of Nos. 1 and 2 strippers per minute.

$180 \times \frac{14}{15} = 168$ revolutions of Nos. 3 and 4 strippers per minute.

Speed of Cylinder, 193·68 revolutions per minute.

$193{\cdot}68 \times \frac{14}{18} = 150{\cdot}64$ revolutions of Nos. 1 and 2 strippers per minute.

$193{\cdot}68 \times \frac{14}{15} = 180{\cdot}76$ revolutions of Nos. 3 and 4 strippers per minute.

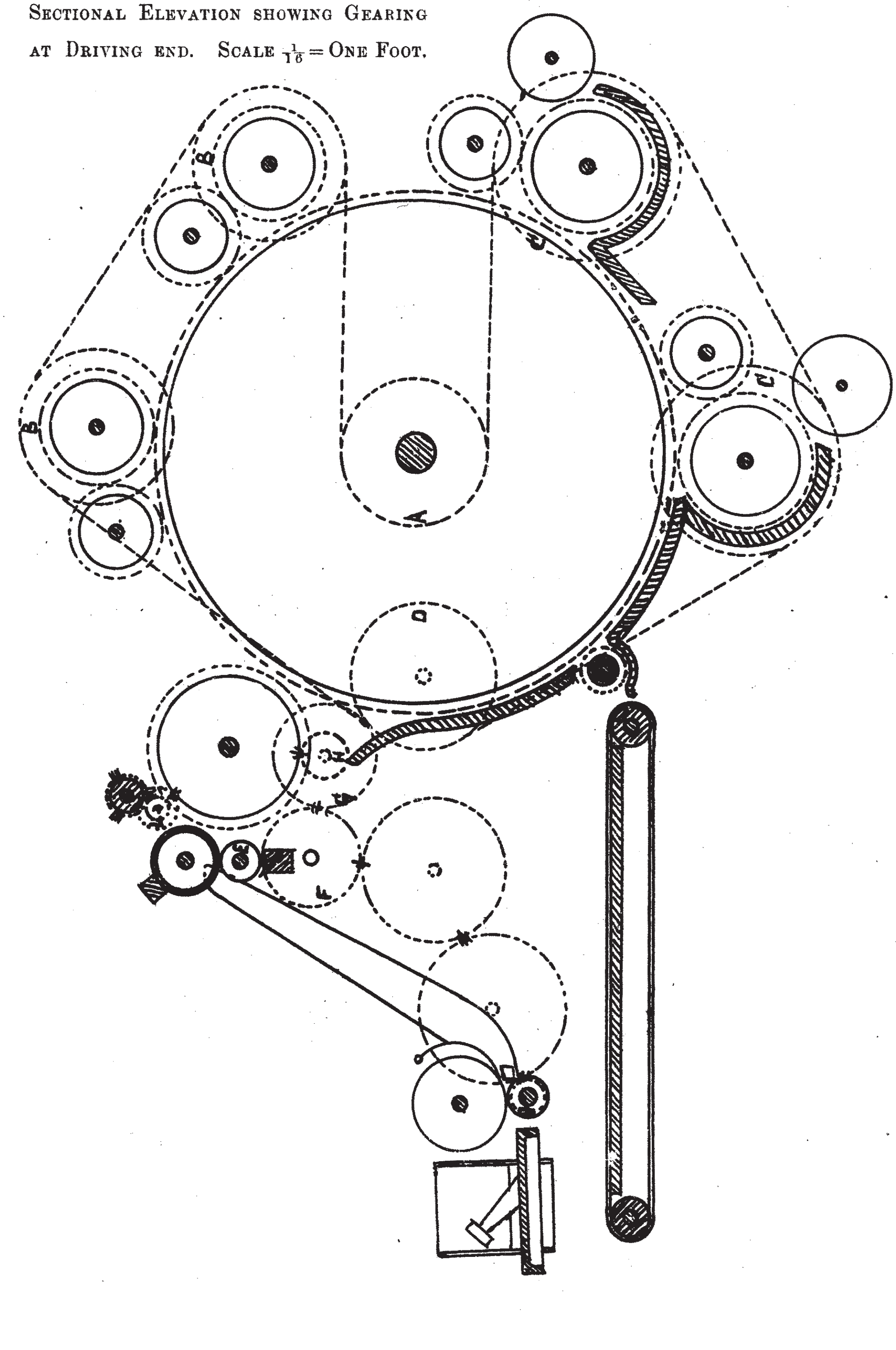
Length of Feed Cloth, 14 feet.

Breadth ,, ,, 2 ,, 9 inches.

Two Feed Cloths are required for one finisher—should be made of plaiding, about $\frac{3}{16}$″ thick.

SINGLE DOFFER FINISHER CARD.

Sectional Elevation showing Gearing at Driving end. Scale $\frac{1}{16}$ = One Foot.



DOUBLE DOFFER FINISHER CARD.

Sectional elevation showing gearing at opposite end to driving pulleys.

SCALE $\frac{1}{18}$TH.

(*For diagram see page 74*).

A	Changes on Cylinder end, ...	26 to 42 teeth.
B	Intermediate, ...	72 teeth.
C	Intermediate, ...	90 teeth.
D	Intermediate, ...	63 teeth.
E	Top drawing roller wheel, ...	80 teeth.
F	Intermediate between drawing rollers, ...	80 teeth.
G	Bottom drawing roller wheel, ...	76 teeth.
H	Stud wheel carrying changes, ...	138 teeth.
I	Changes, ...	26 to 42 teeth.
J	Feeder wheel, ...	144 teeth.
K	Feeder wheel for driving sheet roller, ...	43 teeth.
L	Sheet roller wheel, ...	32 teeth.
M	Doffer wheel for driving workers, ...	112 teeth.
N	Intermediate for driving workers, ...	72 teeth.
O O O	Worker wheels, ...	110 teeth.
P P	Intermediates between workers, ...	130 teeth.
Q	Worker wheel for driving tin roller, ...	138 teeth.
R	Tin roller wheel, ...	78 teeth.
S	Mitre for driving end delivery roller, ...	30 teeth.
T	Mitre on end delivery roller, ...	30 teeth.

DRAFT ARRANGEMENT—

Feed Roller $4\frac{1}{4}''$ diameter.

$$\frac{4 \times 138 \times 134}{76 \times 20 \times 4\frac{1}{4}} = 12{\cdot}03 \text{ draft.}$$

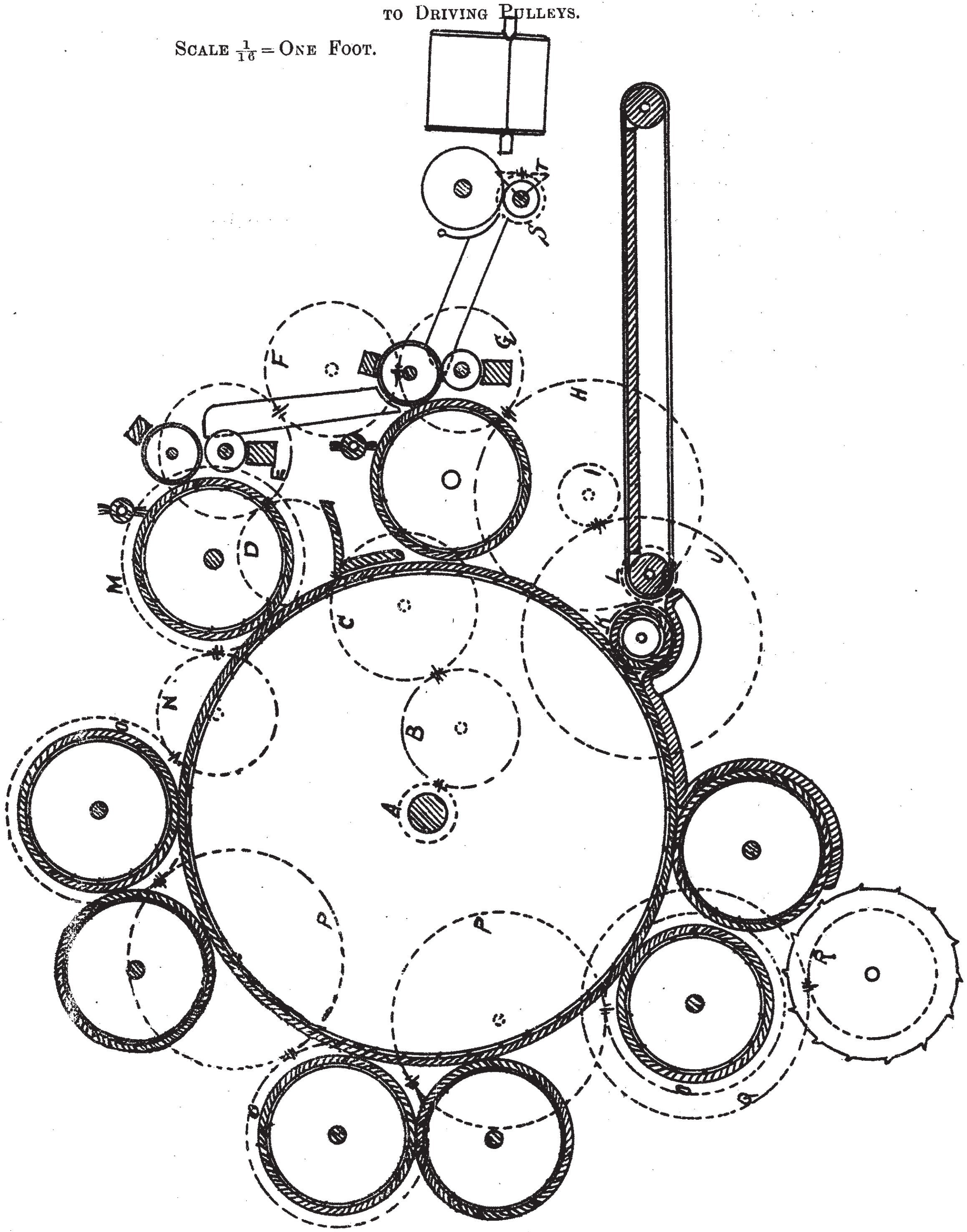
$$\frac{4 \times 138 \times 134}{76 \times \text{C.P.} \times 4\frac{1}{4}} = 246{\cdot}092 \text{ Constant No. for draft.}$$

NOTE.—C.P. = Change or Draft Pinion.

DOUBLE DOFFER FINISHER CARD.

SECTIONAL ELEVATION SHOWING GEARING AT END OPPOSITE TO DRIVING PULLEYS.

SCALE $\frac{1}{16}$ = ONE FOOT.



DOUBLE DOFFER FINISHER CARD.

Sectional elevation showing gearing at driving end.

SCALE $\frac{1}{16}$TH.

(*For diagram see page 76*).

A	Swift pulley, ...	11″ dia.
B B B	Stripper pulleys, ...	24″ dia.
C	Stretching pulley, ...	12″ dia.
D	Top drawing roller pinion, ...	24 teeth.
E	Stud wheel, ...	54 teeth.
F	Stud pinion, ...	25 teeth.
G	Intermediate between doffers, ...	70 teeth.
H H	Doffer wheels, ...	88 teeth.
I I	Doffer wheels for driving brushes, ...	44 teeth.
J J	Intermediates, ...	30 teeth.
K K	Brush wheels, ...	24 teeth.
L	Bottom drawing roller pinions, ...	24 and 25 teeth.
M	Intermediate, ...	108 teeth.
N	Delivery roller pinion, ...	23 teeth.

Speed of Cylinder 185 revolutions per minute.

$185 \times \frac{11}{24} = 84{\cdot}79$ revolutions of Strippers per minute.

Length of Feed Cloth 7 feet 3 inches.

Breadth of „ 2 „ 9 „

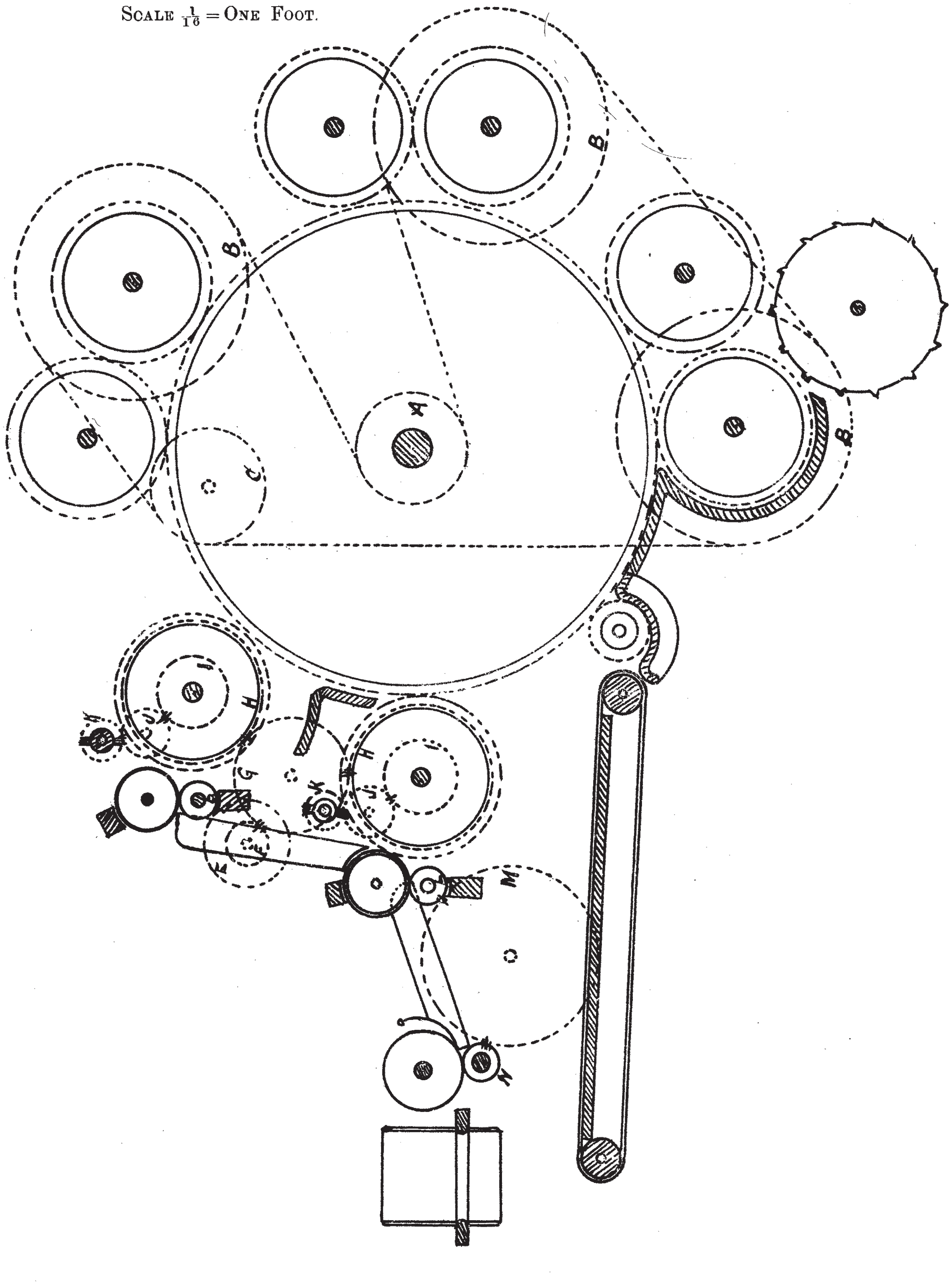
Two Feed Cloths are required for one finisher.

The Feed Cloths of Double Doffer Breaker and Finisher should also be made of plaiding $\frac{3}{16}''$ thick.

DOUBLE DOFFER FINISHER CARD.

SECTIONAL ELEVATION SHOWING GEARING AT DRIVING END.

SCALE $\frac{1}{16}$ = ONE FOOT.



UP STRIKER FINISHER CARD.

Sectional elevation showing gearing at opposite end to driving pulleys.

SCALE $\frac{1}{16}$th.

(*For diagram see page 78*).

A	Drawing roller wheel, ...	66 teeth.
BBB	Intermediates, ...	75 teeth.
C	Changes on cylinder end, ...	20 to 60 teeth.
D	Intermediate, ...	54 teeth.
E	Stud wheel, ...	58 teeth.
F	Stud pinion, ...	20 teeth.
G	Stud wheel, ...	120 teeth.
H	Changes, ...	20 to 60 teeth.
I	Feeder wheel, ...	120 teeth.
J	Doffer wheel for driving workers, ...	88 teeth.
K	Double intermediate, ...	60 teeth.
LLL	Worker wheels, ...	72 teeth.
MM	Intermediates between workers, ...	84 teeth.

DRAFT ARRANGEMENT—

Feed Roller, $10\frac{1}{2}''$ diameter.

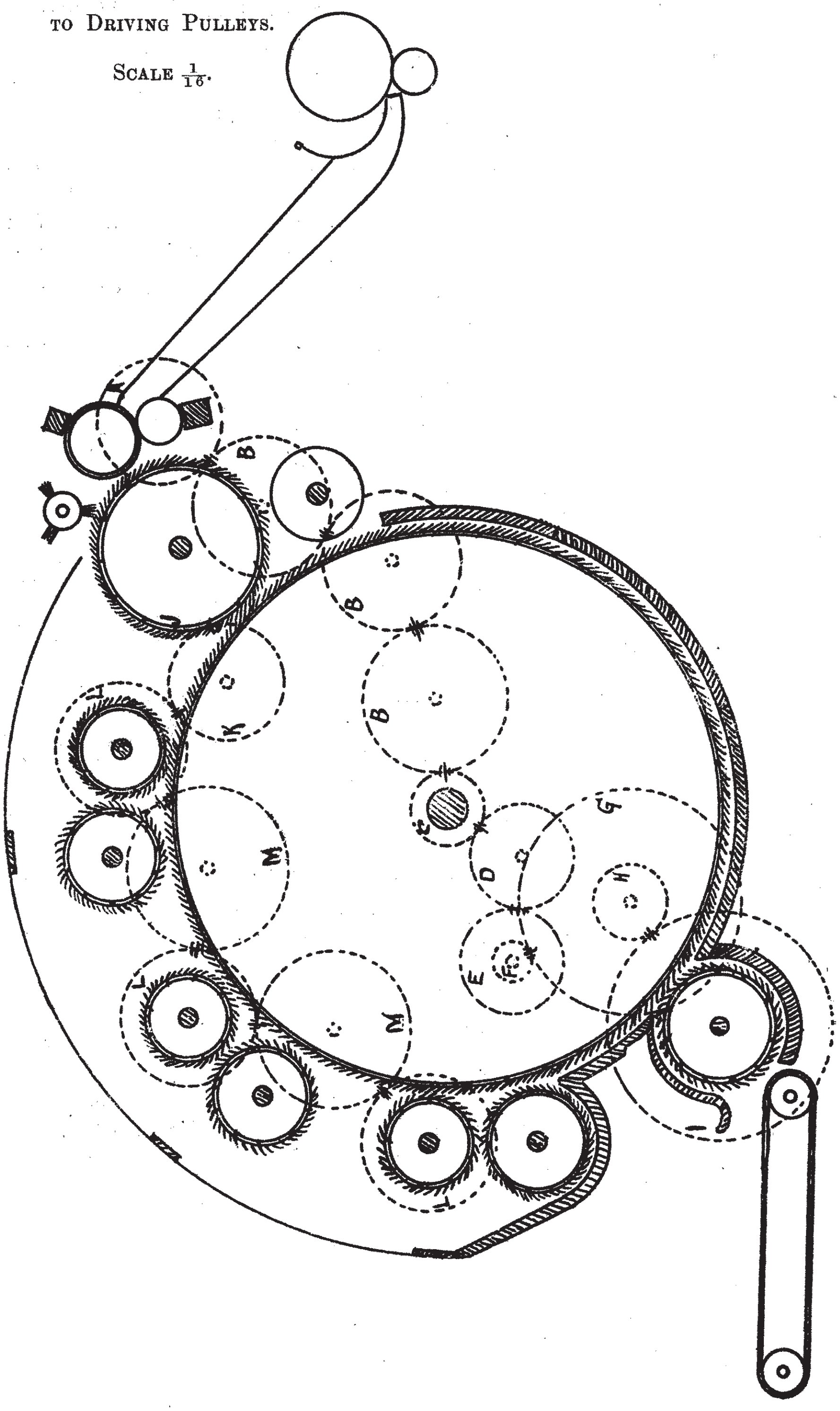
$$\frac{4 \times 58 \times 120 \times 120}{66 \times 20 \times 30 \times 10\frac{1}{2}} = 8{\cdot}03 \text{ draft.}$$

$$\frac{4 \times 58 \times 120 \times 120}{66 \times 20 \times \text{C.P.} \times 10\frac{1}{2}} = 241{\cdot}039 \text{ Constant No. for draft.}$$

UP STRIKER FINISHER CARD

SECTIONAL ELEVATION SHOWING GEARING AT OPPOSITE END TO DRIVING PULLEYS.

SCALE $\frac{1}{16}$.



UP STRIKER FINISHER CARD.

Sectional elevation showing gearing at driving end.

SCALE $\frac{1}{16}$th.

(*For diagram see page 80*).

A	Swift pulley.	16″ dia.
BBB	Stripper pulleys, ...	14″ dia.
C	Stretching pulley, ...	14″ dia.
D	Drawing roller pinion, ...	24 teeth.
E	Stud wheel, ...	54 teeth.
F	Stud pinion, ...	28 teeth.
G	Intermediate, ...	42 teeth.
H	Doffer wheel, ...	88 teeth.
I	Stud wheel, ...	24 teeth.
J	Stud pinion, ...	12 teeth.
K	Brush wheel, ...	24 teeth.
LL	Intermediate, ...	90 teeth.
M	Delivery roller pinion, ...	22 teeth.
N	Doffer wheel for driving tin roller, ...	104 teeth.
O	Tin roller wheel, ...	52 teeth.
P	Feeder wheel for driving sheet roller, ...	78 teeth.
Q	Intermediate, ...	40 teeth.
R	Sheet roller wheel, ...	32 teeth.

Cylinder, 180 revolutions per minute.

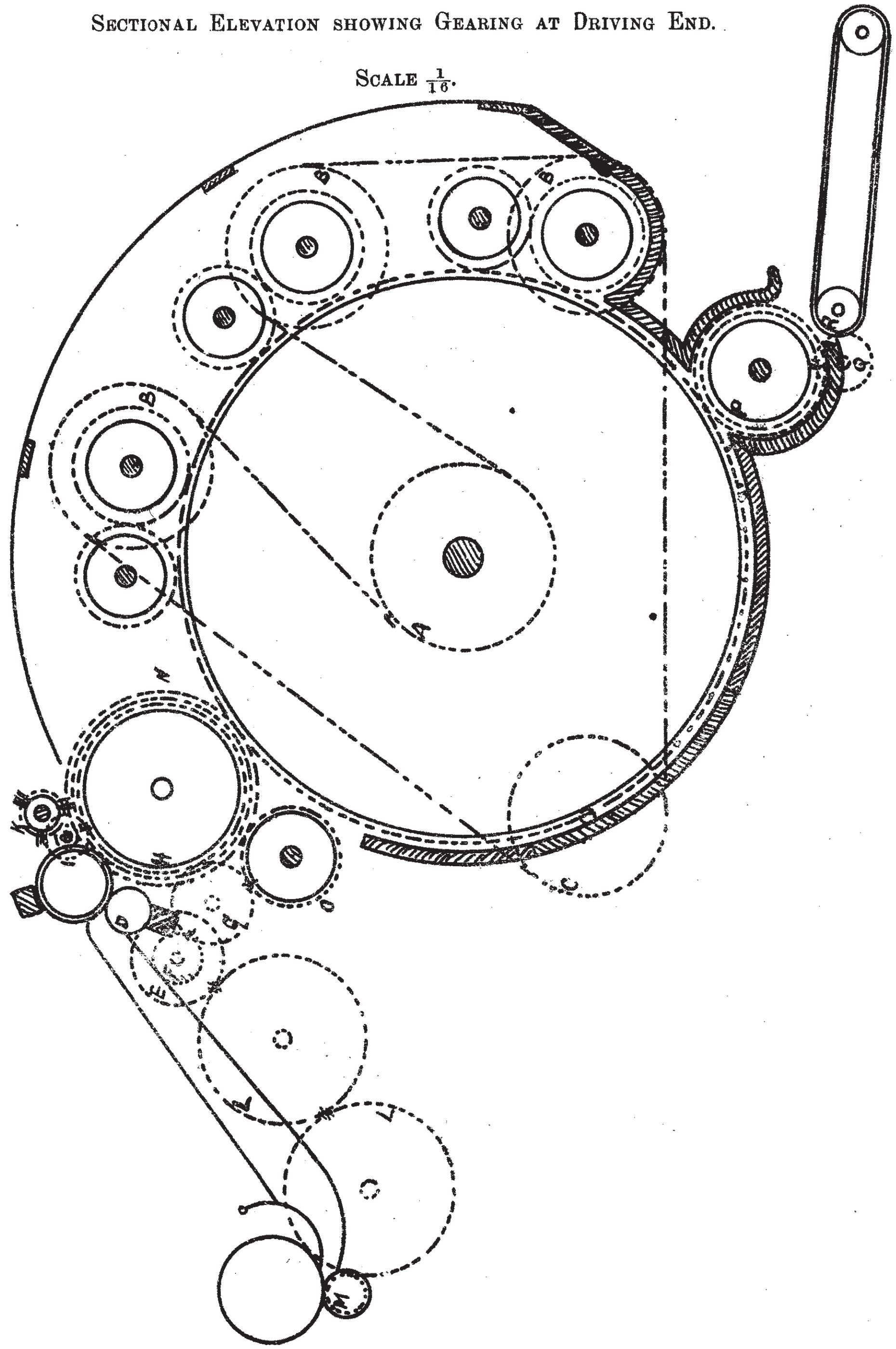
$180 \times \frac{16}{14} = 205{\cdot}71$ revolutions of stripper per minute.

NOTE.—For particulars of Covering see page 111, and page 120 for drafts, &c.

UP STRIKER FINISHER CARD.

SECTIONAL ELEVATION SHOWING GEARING AT DRIVING END.

SCALE $\frac{1}{16}$.



SPECIFICATION AND SPEEDS OF FINISHER (SINGLE DOFFER).

Cylinder 6′ × 4′, 4 Workers, 4 Strippers, 1 Doffer, Doffs with leather rollers.

Speed of Cylinder 180 revolutions per minute.

Pulleys, ...	24″ diameter,	6″ broad,	2¼″ bore.
Pulleys driving Strippers, ...	14 ,,	4 ,,	2¼ ,,
Pulley Seats on Nos. 1 and 2 Strippers,	1½ ,,		
,, ,, ,, 3 and 4 ,,	1¼ ,,		
Wheel Seats on Workers, ...	1¼ ,,		
,, ,, Doffer ...	1¼ ,,		
,, ,, Feeder, ...	1¼ ,,		
,, ,, Drawing Roller,	1¼ ,,		
,, ,, Delivering Roller,	1¼ ,,		
,, ,, Tin Rollers, ...	1¼ ,,		

NOTE.—These diameters are taken from a Fairbairn Specification.

	Under wood.	Over wood.	Over staves.	Centre to Centre of pins	Over staves.	Centre to Centre of pins.
Cylinder ring, ...	43½″ dia	48″ dia.	49⅛″ dia.	49 13/32″ dia.	154·33 cir.	155·21 cir.
Nos. 1 and 2 Stripper rings,	8½ ,,	11 ,,	12 ,,	12 7/32 ,,	37·69 ,,	38·38 ,,
,, 3 and 4 ,, ,,	7 ,,	9 ,,	10 ,,	10 7/32 ,,	31·41 ,,	32·10 ,,
Worker, ... ,,	4¼ ,,	7 ,,	8 ,,	8 5/16 ,,	25·13 ,,	26·11 ,,
Doffer, ... ,,	11 ,,	14 ,,	14⅞ ,,	15 5/32 ,,	46·73 ,,	47·61 ,,
Feeder rings (Iron) ...	2½ ,,	——	3¾ ,,	4⅛ ,,	11·78 ,,	12·95 ,,
Tin Rollers, ...	10 ,,	=31·41 cir. and 8″ dia. = 25″·13 cir.				
Drawing Roller, ...	4 ,,	=12·56 ,,				
Delivering Roller, ...	4 ,,	=12·56 ,,				
Plaiding Roller, ...	4 ,,	=12·56 ,,				

Cylinder Pinion 50 teeth, $1\frac{1}{2}''$ bore.

Cylinder $49\frac{13}{32}''$ diameter at centre of pins = 155″·21 circumference.

180 × 155·21 = 27937·80 inches = 2328·15 feet, surface speed per minute.

Feed Roller $4\frac{1}{8}''$ diameter at centre of pins = 12″·95 circumference.

$$\frac{180 \times \overset{\text{Cyl. Pin.}}{50} \times 32 \times 32}{104 \times 104 \times 90} = 9{\cdot}46 \text{ revolutions of feed roller per minute.}$$

9·46 × 12·95 = 122·5070 inches = 10·2089 feet, surface speed per minute.

Nos. 1, 2, 3, and 4 Workers, $8\frac{5}{16}''$ diameter at centre of pins = 26″·11 circumference.

$$\frac{180 \times \overset{\text{Cyl. pin.}}{50} \times 33 \times 26 \times 84 \times 46}{75 \times 60 \times 84 \times 72 \times 90} = 8{\cdot}49 \text{ revolutions of workers per minute.}$$

8·49 × 26·11 = 221·6739 inches = 18·4728 feet, surface speed per minute.

Nos. 1 and 2 Strippers $12\frac{7}{32}''$ diameter at centre of pins = 38″·38 circumference.

Pulleys driving Strippers, 14″ diameter.

„ on end of „ 18 „

180 × $\frac{14}{18}$ = 140 revolutions of Nos. 1 and 2 Strippers per minute.

140 × 38·38 = 5373·20 inches = 447·76 feet, surface speed per minute.

Nos. 3 and 4 Strippers $10\frac{7}{32}''$ diameter at centre of pins = 32″·10 circumference.

Pulleys driving Strippers 14″ diameter.

„ on end of „ 15 „

180 × $\frac{14}{15}$ = 168 revolutions of Nos. 3 and 4 Strippers per minute.

168 = 32·10 = 5392·80 inches = 449·40 feet, surface speed per minute.

Doffer $15\frac{5}{32}''$ diameter at centre of pins = 47″·61 circumference

$$\frac{180 \times \overset{\text{Cyl. Pin.}}{50} \times 23 \times 26}{75 \times 60 \times 84} = 14{\cdot}23 \text{ revolutions of doffer per minute.}$$

14·23 × 47·61 = 677·4903 inches = 65·4575 feet, surface speed per minute.

Drawing Roller 4″ diameter = 12″·56 circumference.

Cyl. Pin.

$180 \times \frac{50}{75} = 120$ revolutions of drawing roller per minute.

$120 \times 12{\cdot}56 = 1507{\cdot}2$ inches $= 125{\cdot}6$ feet, surface speed per minute.

Delivering Roller 4″ diameter = 12″·56 circumference.

Cyl. Pin.

$\frac{180 \times 50 \times 23}{75 \times 24} = 115$ revolutions of delivering roller per minute.

$115 \times 12{\cdot}56 = 1444{\cdot}40$ inches $= 120{\cdot}36$ feet, surface speed per minute.

Plaiding Roller 4″ diameter = 12·56 circumference

Cyl. Pin.

$\frac{180 \times 50 \times 32 \times 32 \times 46}{104 \times 104 \times 90 \times 48} = 9{\cdot}07$ revolutions of plaiding roller per minute.

$9{\cdot}07 \times 12{\cdot}56 = 113{\cdot}9192$ inches $= 9{\cdot}4932$ feet, surface speed per minute.

No. 1 Tin Roller 10″ diameter = 31·41 circumference.

Cyl. pin.

$\frac{180 \times 50 \times 23 \times 26 \times 84 \times 46 \times 84}{75 \times 60 \times 84 \times 72 \times 90 \times 76} = 9{\cdot}38$ revolutions of No. 1 tin roller per minute.

$9{\cdot}38 \times 31{\cdot}41 = 294{\cdot}6258$ inches $= 24{\cdot}5521$ feet, surface speed per minute.

No 2 Tin Roller 8″ diameter = 25·13 circumference.

Cyl. Pin.

$\frac{180 \times 50 \times 23 \times 26 \times 84 \times 46 \times 73}{75 \times 60 \times 84 \times 72 \times 90 \times 60} = 10{\cdot}32$ revolutions of No. 2 tin roller per minute.

$10{\cdot}32 \times 25{\cdot}13 = 259{\cdot}3416$ inches $= 21{\cdot}6118$ feet, surface speed per minute.

Feed Roller - - -	$\frac{180 \times \text{cyl. p.} \times 32 \times 32}{104 \times 104 \times 90}$	= ·189349 Constant No. for revolutions per minute.
Nos. 1, 2, 3, and 4 Workers	$\frac{180 \times \text{cyl. p.} \times 23 \times 26 \times 84 \times 46}{75 \times 60 \times 84 \times 72 \times 90}$	= ·169802 ,, ,,
Nos. 1 and 2 Strippers -	$\frac{180 \times \text{cyl. p.}}{18}$	= 10·0 ,, ,,
Nos. 3 and 4 ,, -	$\frac{180 \times \text{cyl. p.}}{15}$	= 12·0 ,, ,,
Doffer - - - -	$\frac{180 \times \text{cyl. p.} \times 23 \times 26}{75 \times 60 \times 84}$	= ·284761 ,, ,,
Drawing Roller - -	$\frac{180 \times \text{cyl. p.}}{75}$	= 2·4 ,, ,,
Delivering Roller - -	$\frac{180 \times \text{cyl. p.} \times 23}{75 \times 24}$	= 2·3 ,, ,,
Plaiding Roller - -	$\frac{180 \times \text{cyl. p.} \times 32 \times 32 \times 46}{104 \times 104 \times 90 \times 48}$	= 181459 ,, ,,
No. 1 Tin Roller -	$\frac{180 \times \text{cyl. p.} \times 23 \times 26 \times 84 \times 46 \times 84}{75 \times 60 \times 84 \times 72 \times 90 \times 76}$	= ·187676 ,, ,,
No. 2 ,, ,, - -	$\frac{180 \times \text{cyl. p.} \times 23 \times 26 \times 84 \times 46 \times 73}{75 \times 60 \times 84 \times 72 \times 90 \times 60}$	= ·206593 ,, ,,

	Cylinder Pinion 40 Teeth.		Cylinder Pinion 42 Teeth.		Cylinder Pinion 44 Teeth.		Cylinder Pinion 46 Teeth.		Cylinder Pinion 48 Teeth.		Cylinder Pinion 50 Teeth.		Cylinder Pinion 52 Teeth.		Cylinder Pinion 54 Teeth.		Cylinder Pinion 56 Teeth.		Cylinder Pinion 58 Teeth.		Cylinder Pinion 60 Teeth.	
	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs.
	Feet.		Feet.		Feet.		Feet.		Feet.		Feet.		Feet.		Feet.		Feet.		Feet.		Feet.	
Speed of Cylinder per minute.	2328·15	180	2328·15	180	2328·15	180	2328·15	180	2328·15	180	2328·15	180	2328·15	180	2328·15	180	2328·15	180	2328·15	180	2328·15	180
,, Feed Roller ,,	8·1735	7·5739	8·5821	7·9526	8·9908	8·3313	9·3995	8·7100	9·8082	9·0887	10·2169	9·4674	10·6255	9·8461	11·0342	10·2248	11·4429	10·6035	11·8516	10·9822	12·2603	11·3609
,, Workers ,,	14·7782	6·7920	15·5171	7·1316	16·2560	7·4712	16·9949	7·8108	17·7339	8·1504	18·4730	8·4901	19·2119	8·8297	19·9508	9·1693	20·6897	9·5089	21·4286	9·8485	22·1676	10·1881
,, Nos. 1 & 2 Strippers ,,	447·76	140·	447·76	140·	447·76	140·	447·76	140·	447·76	140·	447·76	140·	447·76	140·	447·76	140·	447·76	140·	447·76	140·	447·76	140·
,, Nos. 3 & 4 ,, ,,	449·40	168·	449·40	168·	449·40	168·	449·40	168·	449·40	168·	449·40	168·	449·40	168·	449·40	168·	449·40	168·	449·40	168·	449·40	168·
,, Doffer ,,	45·1914	11·3904	47·4509	11·9599	49·7103	12·5294	51·9702	13·0990	54·2297	13·6685	56·4892	14·2880	58·7487	14·8075	61·0082	15·3770	63·2681	15·9466	65·5276	16·5161	67·7871	17·0856
,, Drawing Roller ,,	100·48	96·0	105·504	100·8	110·528	105·6	115·552	110·4	120·576	115·2	125·60	120·0	130·624	124·8	135·648	129·6	140·672	134·4	145·696	139·2	150·72	144·0
,, Delivering Roller ,,	96·29	92·0	101·108	96·6	105·922	101·2	110·737	105·8	115·552	110·4	120·36	115·0	125·181	119·6	129·996	124·2	134·810	128·8	139·625	133·4	144·44	138·0
,, Plaiding Roller ,,	7·5970	7·2583	7·9768	7·6212	8·3566	7·9841	8·7366	8·3471	9·1164	8·7100	9·4963	9·0729	9·8761	9·4358	10·2559	9·7987	10·6359	10·1617	11·0157	10·5246	11·3955	10·8875
,, No. 1 Tin Roller ,,	19·6495	7·5070	20·6319	7·8823	21·6145	8·2577	22·5968	8·6330	23·5794	9·0084	24·5620	9·3838	25·5444	9·7591	26·5270	10·1345	27·5094	10·5098	28·4920	10·8852	29·4743	11·2605
,, No. 2 ,, ,,	17·3357	8·2781	18·2024	8·6920	19·0692	9·1059	19·9360	9·5198	20·6028	9·9337	21·6695	10·3476	22·5363	10·7615	23·4081	11·1754	24·2699	11·5893	25·1367	12·0032	26·0084	12·4171

The speeds under this pinion are fractionally different in some cases from those already given, caused by the calculations being made on a more extended decimal.

CYLINDER PINION 50 TEETH.

The speed of the Feed Roller to the Cylinder is as	1	to	227·8724
,, Workers ,,	1	,,	126·0297
,, Nos. 1 & 2 Strippers ,,	1	,,	5·1995
,, Nos. 3 & 4 ,, ,,	1	,,	5·1805
,, Doffer ,,	1	,,	41·2140
,, Drawing Roller ,,	1	,,	18·5362
,, Delivering Roller ,,	1	,,	19·3432
,, Plaiding Roller ,,	1	,,	245·1639
,, No. 1 Tin Cylinder ,,	1	,,	94·7866
,, No. 2 ,, ,,	1	,,	107·4390
,, Workers to Nos. 1 and 2 Strippers	1	,,	24·2386
,, ,, to Nos. 3 and 4 ,,	1	,,	24·3273

The speed of the workers can be changed without affecting the other roller speeds as under :—

Speed of Cylinder × Cyl. Pin. × 23 × 26 × 84 × Worker change pinion.

$$\frac{180 \times 40 \times 23 \times 26 \times 84 \times \text{change pinion}}{75 \times 60 \times 84 \times 72 \times 90} = \cdot 14765 \text{ Constant No. with a 40 T. Cylinder Pinion.}$$

$$\frac{180 \times 42 \times 23 \times 26 \times 84 \times \text{C.P.}}{75 \times 60 \times 84 \times 72 \times 90} = \cdot 15503 \quad \text{,,} \quad 42 \quad \text{,,}$$

$$\frac{180 \times 44 \times 23 \times 26 \times 84 \times \text{C.P.}}{75 \times 60 \times 84 \times 72 \times 90} = \cdot 16241 \quad \text{,,} \quad 44 \quad \text{,,}$$

$$\frac{180 \times 46 \times 23 \times 26 \times 84 \times \text{C.P.}}{75 \times 60 \times 84 \times 72 \times 90} = \cdot 16980 \quad \text{,,} \quad 46 \quad \text{,,}$$

$$\frac{180 \times 48 \times 23 \times 26 \times 84 \times \text{C.P.}}{75 \times 60 \times 84 \times 72 \times 90} = \cdot 17718 \quad \text{,,} \quad 48 \quad \text{,,}$$

$$\frac{180 \times 50 \times 23 \times 26 \times 84 \times \text{C.P.}}{75 \times 60 \times 84 \times 72 \times 90} = \cdot 18456 \quad \text{,,} \quad 50 \quad \text{,,}$$

$$\frac{180 \times 52 \times 23 \times 26 \times 84 \times \text{C.P.}}{75 \times 60 \times 84 \times 72 \times 90} = \cdot 19195 \quad \text{,,} \quad 52 \quad \text{,,}$$

$$\frac{180 \times 54 \times 23 \times 26 \times 84 \times \text{C.P.}}{75 \times 60 \times 84 \times 72 \times 90} = \cdot 19933 \quad \text{,,} \quad 54 \quad \text{,,}$$

$$\frac{180 \times 56 \times 23 \times 26 \times 84 \times \text{C.P.}}{75 \times 60 \times 84 \times 72 \times 90} = \cdot 20671 \quad \text{,,} \quad 56 \quad \text{,,}$$

$$\frac{180 \times 58 \times 23 \times 26 \times 84 \times \text{C.P.}}{75 \times 60 \times 84 \times 72 \times 90} = \cdot 21409 \quad \text{,,} \quad 58 \quad \text{,,}$$

$$\frac{180 \times 60 \times 23 \times 26 \times 84 \times \text{C.P.}}{75 \times 60 \times 84 \times 72 \times 90} = \cdot 22148 \quad \text{,,} \quad 60 \quad \text{,,}$$

SETTING OF FINISHER ...	Shell to Cylinder, ...	$\frac{1}{4}''$
	Feed Roller to Shell, ...	$\frac{3}{16}$
	,, Cylinder, ...	No. 16
	No. 1 Worker to Cylinder, ...	,, 14
	,, 2 ,, ,, ...	,, 16
	,, 3 ,, ,, ...	,, 16
	,, 4 ,, ,, ...	,, 16
	,, 1 Stripper, ,, ...	,, 16
	,, 1 ,, ,, ...	,, 16
	,, 3 ,, ,, ...	,, 16
	,, 4 ,, ,, ...	,, 16
	Between Workers and Strippers, ...	,, 16
	Doffer to Cylinder, ...	,, 10
	,, Drawing Roller, ...	,, 10

SPECIFICATION OF PINS.

		Pitch.	Staves.	Rows.	Pins.	Size of Pins.	Length of Pins out.
Cylinder, - -	71″ × 48″	$\frac{7}{16} \times \frac{7}{16}$	120	9	55	No. 15, $\frac{7}{8}''$	$\frac{9}{32}''$
Feed Roller, -	71 × $2\frac{1}{2}$	$\frac{3}{8} \times \frac{3}{8}$	4	8	186	,, 14, $1\frac{1}{8}$	$\frac{3}{8}$
No. 1 and 2 Strippers,	71 × 11	$\frac{7}{16} \times \frac{7}{16}$	30	7	82	,, 14, $1\frac{1}{8}$	$\frac{7}{32}$
,, 3 and 4 ,,	71 × 9	$\frac{3}{8} \times \frac{3}{8}$	36	7	63	,, 15, $1\frac{1}{8}$	$\frac{7}{32}$
,, 1 and 2 Workers,	71 × 7	$\frac{3}{8} \times \frac{3}{8}$	30	7	63	,, 14, $1\frac{1}{2}$	$\frac{5}{16}$
,, 3 and 4 ,,	71 × 7	$\frac{5}{16} \times \frac{5}{16}$	30	8	75	,, 15, $1\frac{1}{2}$	$\frac{5}{16}$
Doffer, - - -	71 × 14	$\frac{5}{16} \times \frac{1}{4}$	34	11	140	,, 16, 1	$\frac{9}{32}$

Pulleys, 24″, Cylinder Pinion, 50 Teeth, Stripper Driving Pulley, 14″ diameter, 10 ends into 1.

$$\frac{4 \times 104 \times 96 \times 96}{75 \times \underset{\text{C P.}}{32} \times \underset{\text{C.P.}}{28} \times 4\frac{1}{8}} = 13{\cdot}8306 \text{ draft.}$$

$$\frac{4 \times 60 \times 84}{23 \times \underset{\text{C.P.}}{26} \times \underset{\text{dia. of doff.}}{15\frac{5}{32}}} = 2{\cdot}2243$$ draft between doffer and drawing roller. This draft is only necessary for the delivery of material between doffer and drawing roller, but is not required in working out the draft between the feed and drawing rollers.

Change Pinions	20	22	24	26	28	30 T.
Drafts	2·8916	2·6287	2 4096	2·2243	2·0654	1·9277

$$\frac{4 \times 104 \times 96 \times 96}{75 \times \underset{\text{C.P.}}{30} - \underset{\text{C.P.}}{4\frac{1}{8}}} = 413{\cdot}08095$$ Constant No. for draft with a 30 T. change pinion on

$$\frac{4 \times 104 \times 96 \times 96}{75 \times \underset{\text{C.P.}}{32} - \underset{\text{C.P.}}{4\frac{1}{8}}} = 387{\cdot}25818$$,, ,, 32 ,,

$$\frac{4 \times 104 \times 96 \times 96}{75 \times \underset{\text{C.P.}}{34} - \underset{\text{C.P.}}{4\frac{1}{8}}} = 364{\cdot}47828$$,, ,, 34 ,,

$$\frac{4 \times 104 \times 96 \times 96}{75 \times \underset{\text{C.P.}}{36} - \underset{\text{C.P.}}{4\frac{1}{8}}} = 344{\cdot}22949$$,, ,, 36 ,,

$$\frac{4 \times 104 \times 96 \times 96}{75 \times \underset{\text{C.P.}}{38} - \underset{\text{C.P.}}{4\frac{1}{8}}} = 326{\cdot}11215$$,, ,, 38 ,,

$$\frac{4 \times 104 \times 96 \times 96}{75 \times \underset{\text{C.P.}}{40} - \underset{\text{C.P.}}{4\frac{1}{8}}} = 309{\cdot}80654$$,, ,, 40 ,,

DRAFTS.

Change Pinion on	CHANGE PINIONS ON.										
	20	22	24	26	28	30	32	34	36	38	40 T.
30 Teeth	20·6540	18·7764	17 2117	15·8877	14·7528	13·7693	12 9087	12·1494	11·4744	10·8705	10·3270
32 ,,	19·3629	17·6026	16·1357	14·8945	13·8306	12·9086	12·1018	11·3899	10·7571	10·1910	9·6814
34 ,,	18·2239	16·5671	15·1865	14·0183	13·0170	12·1492	11·3899	10·7199	10·1243	9·5915	9.1119
36 ,,	17·2114	15·6467	14·3428	13·2395	12·2939	11·4743	10·7571	10·1243	9·5619	9·0586	8·6057
38 ,,	16·3056	14·8232	13·5880	12·5427	11·6468	10·8704	10·1910	9·5915	9·0586	8·5816	8·1528
40 ,,	15·4903	14·0821	12·9086	11·9156	11·0645	10·3268	9 6814	9·1119	8·6057	8·1528	7·7451

Note: There is no page 88.

SPECIFICATION AND SPEEDS OF FINISHERS (Single Doffer).

Cylinder 6′ × 4′—4 Workers, 4 Strippers, 1 Doffer, Doffs with leather rollers.

Pulleys, ...	24″ diameter,	6″ broad,	$2\frac{1}{4}$″ bore
,, ...	,,	,,	,,
,, ...	,,	,,	,,
Pulleys driving Strippers, ...	14 ,,	4 ,,	$2\frac{1}{4}$,,

Pulley Seats on Strippers $1\frac{1}{2}$″ dia.

Wheel ,, workers $1\frac{1}{4}$

,, ,, doffer $1\frac{1}{4}$

,, ,, feeder $1\frac{1}{4}$

,, ,, drawing roller $1\frac{1}{4}$″

,, ,, delivering ,, $1\frac{1}{4}$

,, ,, tin rollers $1\frac{1}{4}$

*	Under wood.	Over wood.	Over staves.	Centre to Centre of pins.	Over staves.	Centre to Centre of pins.
Cylinder Ring, ...	$43\frac{1}{2}$″ dia.	48″ dia.	49″ dia.	$49\frac{5}{16}$″ dia.	153·50″ cir.	154·90″ cir.
Nos. 1 and 2 Stripper Rings, ...	$8\frac{1}{2}$,,	11 ,,	$11\frac{7}{8}$,,	$12\frac{1}{8}$,,	37·30 ,,	38·09 ,,
Nos. 3 and 4 ,, ...	7 ,,	9 ,,	$9\frac{7}{8}$,,	$10\frac{1}{8}$,,	31·02 ,,	31·80 ,,
Worker ,, ...	$4\frac{1}{2}$,,	7 ,,	8 ,,	$8\frac{5}{16}$,,	25·13 ,,	26·11 ,,
Doffer Rings, ...	11 ,,	14 ,,	$14\frac{7}{8}$,,	$15\frac{3}{16}$,,	46·73 ,,	48·10 ,,
Feeder ,, ...	$2\frac{1}{2}$,,	— ,,	$3\frac{5}{8}$,,	4 ,,	11·38 ,,	12·56 ,,

Tin Rollers 10″ diameter, 31·41″ circumference, and 8″ diameter = 25·13″ circumference.

Drawing Rollers 4″ dia. = 12·56 ,,

Delivering Rollers 4″ = 12·56 ,,

Plaiding Roller 4″ = 12·56 ,,

*Note.—These diameters are from my own measurements. They differ, however, very little from a Fairbairn Specification.

Cylinder Pinion 50 teeth, $1\frac{1}{2}''$ bore.

$$\frac{163 \cdot 1 \times 28\frac{1}{2}}{24} = 193 \cdot 68 \text{ revolutions of cylinder per minute.}$$

Cylinder $49\frac{5}{16}''$ diameter at centre of pins = 154·9″ circumference.

193·68 × 154·9 = 30001·032 ins. = 2500·086 ft.— surface speed per minute.

Feed Roller 4″ diameter at centre of pins = 12·56″ circumference.

$$\frac{\overset{\text{Cyl. Pin.}}{193 \cdot 68 \times 50} \times 32 \times 32}{104 \times 104 \times 90} = 10 \cdot 18 \text{ revolutions of feed roller per minute.}$$

10·18 × 12·56 = 127·8608 ins. = 10·65 feet—surface speed per minute.

Nos. 1, 2, 3, and 4 Workers, $8\frac{5}{16}''$ diameter at centre of pins = 26·11″ circumference.

$$\frac{\overset{\text{Cyl. pin.}}{193 \cdot 68 \times 50} \times 23 \times 26 \times 84 \times 46}{75 \times 60 \times 84 \times 72 \times 90} = 9 \cdot 13 \text{ revolutions of workers per minute.}$$

9·13 × 26·11 = 238·3843 ins. = 19·86 ft.—surface speed per minute.

Nos. 1 and 2 Strippers $12\frac{1}{8}''$ diameter at centre of pins = 38·09″ circumference.

Pulleys driving strippers 14″ diameter. Pulley on end of strippers 18″ diameter.

$$\frac{193 \cdot 68 \times 14}{18} = 150 \cdot 64 \text{ revolutions of Nos. 1 and 2 strippers per minute.}$$

150·64 × 38·09 = 5737·8776 ins. = 478·1564 ft.—surface speed per minute.

Nos. 3 and 4 Strippers $10\frac{1}{8}''$ diameter at centre of pins = 31·80″ circumference.

Pulleys driving strippers 14″ diameter. Pulleys on end of strippers 15″ diameter

$$\frac{193 \cdot 68 \times 14}{15} = 180 \cdot 76 \text{ revolutions of Nos. 3 and 4 strippers per minute.}$$

180·76 × 31·80 = 5748·168 ins. = 479·014 ft.—the surface speed per minute.

Doffer $15\frac{3}{16}''$ diameter at centre of pins = 48·10″ circumference

$$\frac{\overset{\text{Cyl. Pin.}}{193 \cdot 68 \times 50} \times 23 \times 26}{75 \times 60 \times 84} = 15 \cdot 32 \text{ revolutions of doffer per minute.}$$

15·32 × 48·10 = 736·8920 ins. = 61·4076 feet—surface speed per minute.

Drawing Roller 4″ diameter = 12·56 circumference.

Cyl. Pin.

$$\frac{193{\cdot}68 \times 50}{75} = 129{\cdot}12 \text{ revolutions of drawing roller per minute.}$$

$$129{\cdot}12 \times 12{\cdot}56 = 1621{\cdot}7472 \text{ ins.} = 135{\cdot}1456 \text{ feet—surface speed per minute.}$$

Delivering Roller 4″ diameter = 12·56 circumference.

Cyl. Pin.

$$\frac{193{\cdot}68 \times 50 \times 23}{75 \times 24} = 123{\cdot}74 \text{ revolutions of delivering roller per minute.}$$

$$123{\cdot}74 \times 12{\cdot}56 = 1554{\cdot}1744 \text{ ins.} = 129{\cdot}5145 \text{ feet—surface speed per minute.}$$

Plaiding Roller 4″ diameter = 12·56 circumference.

Cyl. Pin.

$$\frac{193{\cdot}68 \times 50 \times 32 \times 32 \times 46}{104 \times 104 \times 90 \times 48} = 9{\cdot}76 \text{ revolutions of plaiding roller per minute.}$$

$$9{\cdot}76 \times 12{\cdot}56 = 122{\cdot}5856 \text{ ins.} = 10{\cdot}2154 \text{ feet—surface speed per minute.}$$

No. 1 Tin Roller 10″ diameter = 31·41 circumference.

Cyl. pin.

$$\frac{193{\cdot}68 \times 50 \times 23 \times 26 \times 84 \times 46 \times 84}{75 \times 60 \times 84 \times 72 \times 90 \times 76} = 10{\cdot}09 \text{ revolutions of No. 1 tin roller per minute.}$$

$$10{\cdot}09 \times 31{\cdot}41 = 316{\cdot}9269 \text{ ins.} = 26{\cdot}4105 \text{ feet—surface speed per minute.}$$

No 2 Tin Roller 8″ diameter = 25·13″ circumference.

Cyl. Pin.

$$\frac{1936{\cdot}8 \times 50 \times 23 \times 26 \times 84 \times 46 \times 73}{75 \times 60 \times 84 \times 72 \times 90 \times 60} = 11{\cdot}11 \text{ revolutions of No. 2 tin roller per minute.}$$

$$11{\cdot}11 \times 25{\cdot}13 = 279{\cdot}1943 \text{ ins.} = 23{\cdot}2661 \text{ feet—the surface speed per minute.}$$

	Cylinder Pinion 40 Teeth.		Cylinder Pinion 42 Teeth.		Cylinder Pinion 44 Teeth.		Cylinder Pinion 46 Teeth.		Cylinder Pinion 48 Teeth.		Cylinder Pinion 50 Teeth.		Cylinder Pinion 52 Teeth.		Cylinder Pinion 54 Teeth.		Cylinder Pinion 56 Teeth.		Cylinder Pinion 58 Teeth.		Cylinder Pinion 60 Teeth.	
	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs.	Surface Speed.	Revs.
Speed of Cylinder per minute,	Feet. 2500·086	193·68	Feet. 2500·086	193·68	Feet. 2500·086	193·68	Feet. 2500·086	193·68	Feet. 2500·086	193·68	Feet. 2500·086	193·68	Feet. 2500·086	193·68	Feet. 2500·086	193·68	Feet. 2500·086	193·68	Feet. 2500·086	193 68	Feet. 2500·086	193·68
Feed Roller ,,	8·5294	8·149	8·9559	8·556	9·3824	8·964	9·809	9·371	10·2353	9·779	10·66	10·186	11·0883	10·593	11·5148	11·001	11·9412	11·408	12·3677	11·816	12·7942	12·223
Workers ,,	15·9	7·308	16·696	7·673	17·491	8·038	18·2861	8·404	19·0811	8·769	19·8761	9·135	20·6712	9·500	21·4662	9·865	22·2613	10·231	23·0563	10·596	23·8513	10·962
Nos. 1 & 2 Strippers ,, 14″ pulley	478·1564	150 64	478·1564	150·64	478·1564	150·64	478·1564	150·64	478·1564	150·64	478·1564	150·64	478·1564	150·64	478·1564	150·64	478·1564	150·64	478·1564	150·64	478·1564	150·64
,, ,, ,, 13″ ,,	444·0024	139·88	444·0024	139·88	444·0024	139·88	444·0024	139·88	444·0024	139·88	444 0024	139·88	444·0024	139·88	444·0024	139·88	444·0024	139·88	444·0024	139·88	444·0024	139·88
Nos. 3 & 4 ,, ,, 14″ ,,	479·014	180·76	479·014	180·76	479·014	180·76	479·014	180·76	479·014	180·76	479·014	180·76	479·014	180·76	479·014	180·76	479·014	180·76	479·014	180·76	479·014	180·76
,, ,, ,, 13″ ,,	444 8184	167·856	444·8184	167·856	444·8184	167·856	444·8184	167·856	444·8184	167·856	444·8184	167·856	444·8184	167·856	444·8184	167·856	444·8184	167·856	444·8184	167·856	444·8184	167·856
Doffer ,,	49·1261	12·256	51·5824	12·868	54·0387	13·481	56·4951	14·094	58·9514	14·707	61·4078	15·320	63·8641	15·932	66·3204	16·545	68·7768	17·158	71·2331	17·771	73·6895	18·384
Drawing Roller ,,	108·1164	103·296	113·5223	108·4608	118·9281	113·6256	124·3339	118·7904	129·7397	123·9552	135 1456	129·12	140·5514	134·2848	145·9572	139·4496	151·3630	144·6144	156·7688	149·7792	162·1747	154·944
Delivering Roller ,,	103·6116	98·992	108·7922	103·9416	113·9727	108·8912	119·1533	113·8408	124·3339	118·7904	129·5145	123·74	134·6951	128·6896	139·8757	133·6392	145·0563	138·5888	150·2369	143·5384	155·4175	148·488
Plaiding Roller ,,	8·174	7·81	8·583	8·2	8·991	8·591	9·400	8·9815	9·809	9·372	10·2183	9·7625	10·627	10·153	11·035	10·5435	11·444	10·934	11·853	11·3245	12·262	11·715
No. 1 Tin Roller ,,	21·135	8·0748	22·192	8·4785	23·249	8·8822	24·306	9·2860	25·362	9·6897	26·4191	10·0935	27·476	10·4972	28·533	10·9009	29·590	11·3047	30·646	11·7084	31·703	12·1122
No. 2 ,, ,,	18·620	8·8916	19·551	9·33618	20·482	9·78076	21·413	10·22534	22·344	10·66992	23·275	11·1145	24·206	11·55908	25·137	12·00366	26·068	12·44824	26·999	12·89282	27·930	13·3374

Pulleys 24″ diameter, Cylinder Pinion 50 teeth.

The speed of the Feed Roller to the Cylinder is as	1 to 234·529	The speed of the Delivering Roller to the Cylinder is as	1 to 19·302
,, Workers ,,	1 ,, 125·783	,, Plaiding Roller ,,	1 ,, 244·667
,, Nos. 1 & 2 Strippers (14″ pulley) ,,	1 ,, 5·228	,, No. 1 Tin Cylinder ,,	1 ,, 94·631
,, ,, 13″ ,, ,,	1 ,, 5·630	,, No. 2 ,, ,,	1 ,, 107·415
,, Nos. 3 & 4 Strippers 14″ ,, ,,	1 ,, 5·219	,, Workers to Nos. 1 & 2 Strippers 14″ pulley	1 ,, 24·056
,, ,, 13″ ,, ,,	1 ,, 5·620	,, ,, ,, 13″ ,,	1 ,, 22·338
,, Doffer ,,	1 ,, 40·712	,, ,, Nos. 3 & 4 Strippers 14″ ,,	1 ,, 24·1
,, Drawing Roller ,,	1 ,, 18·499	,, ,, ,, 13″ ,,	1 ,, 22·379

Feed Roller - - -	$\frac{193 \cdot 68 \times \text{Cyl. pin.} \times 32 \times 32}{104 \times 104 \times 90}$	= ·20,373	Constant No. for revs. per min.	
Nos. 1, 2, 3, and 4 Workers	$\frac{193 \cdot 68 \times \text{C.p.} \times 23 \times 26 \times 84 \times 46}{75 \times 60 \times 84 \times 72 \times 90}$	= ·18,270	,,	,,
Nos. 1 and 2 Strippers -	$\frac{193 \cdot 68 \times \text{C.pin.}}{18}$	= 10·76	,,	,,
Nos. 3 and 4 ,, -	$\frac{193 \cdot 68 \times \text{C.pin.}}{15}$	= 12·912	,,	,,
Doffer - - - -	$\frac{193 \cdot 68 \times \text{C. pin.} \times 23 \times 26}{75 \times 60 \times 84}$	= ·3064	,,	,,
Drawing Roller - -	$\frac{193 \cdot 68 \times \text{C.pin.}}{75}$	= 2·5824	,,	,,
Delivering Roller -	$\frac{193 \cdot 68 \times \text{C.pin.} \times 23}{75 \times 24}$	= 2·4748	,,	,,
Plaiding Roller - -	$\frac{193 \cdot 68 \times \text{C. pin.} \times 32 \times 32 \times 46}{104 \times 104 \times 90 \times 48}$	= ·19,525	,,	,,
No. 1 Tin Roller -	$\frac{193 \cdot 68 \times \text{C.p.} \times 23 \times 26 \times 84 \times 46 \times 84}{75 \times 60 \times 84 \times 72 \times 90 \times 76}$	= ·20,187	,,	,,
No. 2 ,, ,, - -	$\frac{193 \cdot 68 \times \text{C.p.} \times 23 \times 26 \times 84 \times 46 \times 73}{75 \times 60 \times 84 \times 72 \times 90 \times 60}$	= ·22,229	,,	,,

The Speed of the Workers can be changed without affecting the other parts of the Finisher as under :—

(Speed of Cylinder × Cyl. Pin. × Worker × Change Pinion.)

$\frac{193{\cdot}68 \times 40 \times 23 \times 26 \times 84 \times \text{Change Pinion}}{75 \times 60 \times 84 \times 72 \times 90}$	$= {\cdot}16{,}887$	Constant No. with a	40	T. Cylinder Pinion.
$\frac{193{\cdot}68 \times 42 \times 23 \times 26 \times 84 \times \text{C.P.}}{75 \times 60 \times 84 \times 72 \times 90}$	$= {\cdot}15{,}681$	,,	42	,,
$\frac{193{\cdot}68 \times 44 \times 23 \times 26 \times 84 \times \text{C.P.}}{75 \times 60 \times 84 \times 72 \times 90}$	$= {\cdot}17{,}476$	,,	44	,,
$\frac{193{\cdot}68 \times 46 \times 23 \times 26 \times 84 \times \text{C.P.}}{75 \times 60 \times 84 \times 72 \times 90}$	$= {\cdot}18{,}270$	,,	46	,,
$\frac{193{\cdot}68 \times 48 \times 23 \times 26 \times 84 \times \text{C.P.}}{75 \times 60 \times 84 \times 72 \times 90}$	$= {\cdot}19{,}064$	,,	48	,,
$\frac{193{\cdot}68 \times 50 \times 23 \times 26 \times 84 \times \text{C.P.}}{75 \times 60 \times 84 \times 72 \times 90}$	$= {\cdot}19{,}859$	,,	50	,,
$\frac{193{\cdot}68 \times 52 \times 23 \times 26 \times 84 \times \text{C.P.}}{75 \times 60 \times 84 \times 72 \times 90}$	$= {\cdot}20{,}653$	,,	52	,,
$\frac{193{\cdot}68 \times 54 \times 23 \times 26 \times 84 \times \text{C.P.}}{75 \times 60 \times 84 \times 72 \times 90}$	$= {\cdot}21{,}447$	,,	54	,,
$\frac{193{\cdot}68 \times 56 \times 23 \times 26 \times 84 \times \text{C.P.}}{75 \times 60 \times 84 \times 72 \times 90}$	$= {\cdot}22{,}242$	,,	56	,,
$\frac{193{\cdot}68 \times 58 \times 23 \times 26 \times 84 \times \text{C.P.}}{75 \times 60 \times 84 \times 72 \times 90}$	$= {\cdot}23{,}036$	,,	58	,,
$\frac{193{\cdot}68 \times 60 \times 23 \times 26 \times 84 \times \text{C.P.}}{75 \times 60 \times 84 \times 72 \times 90}$	$= {\cdot}23{,}830$	,,	60	,,

REVOLUTIONS AND SURFACE SPEEDS UNDER DIFFERENT WORKER AND CYLINDER CHANGE PINIONS.

Cylinder Pinion.	WORKER CHANGE PINIONS.																	
	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	
40 Teeth.	5·71932	6·03706	6·3548	6·67254	6·99028	7·30802	7·62576	7·9435	8·26124	8·57898	8·89672	9·21446	9·5322	9·84994	10·16768	10·48542	10·80316	11·1209	Revolutions.
	12·44428	13·13563	13·82698	14·51833	15·20968	15·90103	16·59238	17·28373	17·97508	18·66642	19·35777	20·04912	20·74047	21·43182	22·12317	22·81452	23·50587	24·19722	Surface Speed in Feet.
42 "	6·00516	6·33878	6·67240	7·00602	7·33964	7·67326	8·00688	8·34050	8·67412	9·00774	9·34136	9·67498	10·00860	10·34222	10·67584	11·00946	11·34308	11·67670	Revolutions.
	13·06622	13·79212	14·51803	15·24393	15·96983	16·69573	17·42163	18·14753	18·87343	19·59934	20·32524	21·05114	21·77704	22·50294	23·22884	23·95474	24·68065	25·40655	Surface Speed in Feet.
44 "	6·29136	6·64088	6·99040	7·33992	7·68944	8·03896	8·38848	8·733800	9.08752	9·43704	9·78656	10·13608	10·48560	10·83512	11·18464	11·53416	11·88368	12·23320	Revolutions.
	13·68895	14·44944	15·20994	15·97044	16·73093	17·49143	18·25193	19·01243	19·77292	20·53342	21·29392	22·05442	22·81491	23·57541	24·33591	25·09640	25·85690	26·61740	Surface Speed in Feet.
46 "	6·57720	6·9426	7·3080	7·6734	8·0388	8·4042	8·7696	9·135	9·5004	9·8658	10·2312	10·5966	10·962	11·3274	11·6928	12·0582	12·4236	12·789	Revolutions.
	14·31089	15·10594	15·90098	16·69603	17·49108	18·28613	19·08118	19·87623	20·67128	21·46633	22·26133	23·05643	23·85147	24·64652	25·44157	26·23662	27·03167	27·82672	Surface Speed in Feet.
48 "	6·86304	7·24432	7·62560	8·00688	8·38816	8·76944	9·15072	9·532	9·91328	10·29456	10·67584	11·05712	11·4384	11·81968	12·20096	12·58224	12·96352	13·3448	Revolutions.
	14·93283	15·76243	16·59203	17·42163	18·25123	19·08083	19·91044	20·74004	21·56964	22·39924	23·22884	24·05844	24·88805	25·71765	26·54725	27·37685	28·20645	29·03606	Surface Speed in Feet.
50 "	7·14924	7·54642	7·94360	8·34078	8·73796	9·13514	9·53232	9·92950	10·32668	10·72386	11·12104	11·51822	11·91540	12·31258	12·70976	13·10694	13·50412	13·90130	Revolutions.
	15·55555	16·41975	17·28394	18·14814	19·01234	19·97654	20·74073	21·60493	22·46913	23·33333	24·19752	25·06172	25·92592	26·79012	27·65431	28·51851	29·38271	30·24691	Surface Speed in Feet.
52 "	7·43508	7·84814	8·26120	8·67426	9·08732	9·50038	9·91344	10·32650	10·73956	11·15262	11·56568	11·97874	12·39180	12·80486	13·21792	13·63098	14·04404	14·45710	Revolutions.
	16·17749	17·07624	17·97499	18·87374	19·77249	20·67124	21·56999	22·46874	23·36749	24·26624	25·16499	26·06374	26·96249	27·86124	28·75999	29·65874	30·55749	31·45623	Surface Speed in Feet.
54 "	7·72092	8·14986	8·57880	9·00774	9·43668	9·86562	10·29456	10·72350	11·15244	11·58138	12·01032	12·43926	12·86820	15·29714	13·72608	14·15502	14·58396	15·01290	Revolutions.
	16·79943	17·73273	18·66603	19·59934	20·53264	21·46594	22·39924	23·33254	24·26585	25·19915	26·13245	27·06575	27·99905	28·93236	29·86566	30·79896	31·73226	32·66556	Surface Speed in Feet.
56 "	8·00712	8·45196	8·89680	9·34164	9·78648	10·23132	10·67616	11·12100	11·56584	12·01068	12·45552	12·90036	13·34520	13·79004	14·23488	14·67972	15·12456	15·56940	Revolutions.
	17·42215	18·39005	19·35795	20·32585	21·29374	22·26164	23·22954	24·19744	25·16534	26·13323	27·10113	28·06903	29·03693	30·00482	30·97272	31·94062	32·90852	33·87641	Surface Speed in Feet.
58 "	8·29296	8·75368	9·21440	9·67512	10·13584	10·59656	11·05728	11·51800	11·97872	12·43944	12·90016	13·36088	13·82160	14·28232	14·74304	15·20376	15·66448	16·12520	Revolutions.
	18·04409	19·04654	20·04899	21·05144	22·05389	23·05634	24·05879	25·06124	26·06369	27·06614	28·06859	29·07104	30·07349	31·07594	32·07839	33·08084	34·08329	35·08574	Surface Speed in Feet.
60 "	8·5788	9·0554	9·5320	10·0086	10·4852	10·9618	11·4384	11·9150	12·3916	12·8682	13·3448	13·8214	14·2980	14·7746	15·2512	15·7278	16·2044	16·6810	Revolutions.
	18·66603	19·70304	20·74004	21·77704	22·81404	23·85104	24·88805	25·92505	26·96205	27·99905	29·03605	30·07306	31·11006	32·14706	33·18406	34·22106	35·25807	36·29507	Surface Speed in Feet

SETTING OF FINISHER ...	Shell to Cylinder, ...	$\frac{1}{4}''$
	Feed Roller to Shell, ...	$\frac{1}{16}$
	,, Cylinder, ...	No. 16
	No. 1 Worker to Cylinder, ...	,, 14
	No 2 ,, ,, ...	,, 14
	No. 3 ,, ,, ...	,, 16
	No. 4 ,, ,, ...	,, 16
	No. 1 Stripper, ,, ...	,, 14
	No. 2 ,, ,, ...	,, 16
	No. 3 ,, ,, ...	,, 16
	No. 4 ,, ,, ...	,, 16
	Between Strippers and Workers, ...	,, 16
	Doffer to Cylinder, ...	,, 14
	Doffer to Drawing Roller, ...	,, 10

SPECIFICATION OF PINS.

Cylinder - -	$71'' \times 48''$	$\frac{7}{16} \times \frac{7}{16}$	120	9	55	No. 14	$\frac{7}{8}''$
Feed Roller - -	$71 \times 2\frac{1}{2}$	$\frac{3}{8} \times \frac{3}{8}$	4	8	186	,, 14	$1\frac{1}{8}$
No. 1 Stripper -	71×11	$\frac{7}{16} \times \frac{3}{8}$	30	7	82	,, 14	$\frac{7}{8}$
No. 2 ,, -	71×11	$\frac{7}{16} \times \frac{3}{8}$	30	7	82	,, 14	$\frac{7}{8}$
No. 3 ,, -	71×9	$\frac{3}{8} \times \frac{3}{8}$	36	7	63	,, 15	$\frac{7}{8}$
No. 4 ,, -	71×9	$\frac{3}{8} \times \frac{3}{8}$	36	7	63	,, 15	$\frac{7}{8}$
No. 1 Worker -	71×7	$\frac{3}{8} \times \frac{3}{8}$	30	7	63	,, 13	$1\frac{3}{8}$
No. 2 ,, -	71×7	$\frac{5}{16} \times \frac{5}{16}$	30	8	75	,, 14	$1\frac{1}{4}$
No. 3 ,, -	71×7	$\frac{5}{16} \times \frac{5}{16}$	30	8	75	,, 14	$1\frac{1}{4}$
No. 4 ,, -	71×7	$\frac{5}{16} \times \frac{5}{16}$	30	8	75	,, 14	$1\frac{1}{4}$
Doffer, - -	71×14	$\frac{1}{4} \times \frac{1}{4}$	34	11	140	,, 16	1

FINISHER.

Pulleys 24″, Cylinder Pinion 50 Teeth, Stripper Driving Pulley 14″ diameter, 10 ends into 1.

$$\frac{4 \times 104 \times 104 \times 90}{75 \times \underset{\text{C.P.}}{32} \times \underset{\text{C.P.}}{32} \times 4} = 12{\cdot}675 \text{ draft.}$$

$$\frac{4 \times 60 \times 84}{23 \quad \underset{\text{C.P.}}{26} \quad 15\tfrac{3}{16} \text{ dia. of doffer}} = 2{\cdot}2197 \text{ draft between doffer and drawing roller.}$$

This draft is only necessary for the delivery of material between doffer and drawing roller, but is not required in working out the draft between the feed and drawing roller.

Change Pinions	20	22	24	26	28	30 T.
Drafts	2·8856	2·6233	2·4047	2·2197	2·0611	1·9237

$$\frac{4 \times 104 \times 104 \times 90}{75 \times \underset{\text{C.P.}}{30} \; \underset{\text{C.P.}}{—} \; 4} = 432{\cdot}64 \text{ Constant No. for draft with a 30 T. Change Pinion}$$

$$\frac{4 \times 104 \times 104 \times 90}{75 \times \underset{\text{C.P.}}{32} \; \underset{\text{C.P.}}{—} \; 4} = 405{\cdot}6 \quad ,, \quad ,, \quad 32 \quad ,,$$

$$\frac{4 \times 104 \times 104 \times 90}{75 \times \underset{\text{C.P.}}{34} \; \underset{\text{C.P.}}{—} \; 4} = 381{\cdot}741 \quad ,, \quad ,, \quad 34 \quad ,,$$

$$\frac{4 \times 104 \times 104 \times 90}{75 \times \underset{\text{C.P.}}{36} \; \underset{\text{C.P.}}{—} \; 4} = 360{\cdot}533 \quad ,, \quad ,, \quad 36 \quad ,,$$

$$\frac{4 \times 104 \times 104 \times 90}{75 \times \underset{\text{C.P.}}{38} \; \underset{\text{C.P.}}{—} \; 4} = 341{\cdot}557 \quad ,, \quad ,, \quad 38 \quad ,,$$

$$\frac{4 \times 104 \times 104 \times 90}{75 \times \underset{\text{C.P.}}{40} \; \underset{\text{C.P.}}{—} \; 4} = 324{\cdot}48 \quad ,, \quad ,, \quad 40 \quad ,,$$

DRAFTS.

Change Pinions on	CHANGE PINIONS ON.										
	20	22	24	26	28	30	32	34	36	38	40 T.
30 Teeth	21·632	19·6636	18·0266	16·64	15·4514	14·4213	13·52	12·7247	12·0177	11·3852	10·816
32 ,,	20·28	18·4363	16·9	15·6	14·4857	13·52	12·675	11·9294	11·2666	10·6736	10·14
34 ,,	19·087	17·3518	15·9058	14·6823	13·6336	12·7247	11·9294	11·2276	10·6039	10·0458	9.5435
36 ,,	18·0266	16·3878	15·0222	13·8666	12·8761	12·0177	11·2666	10·6039	10·0148	9·4876	9·0133
38 ,,	17·0778	15·5253	14·2315	13·1368	12·1984	11·3852	10·6736	10·0457	9·4876	8·9883	8·5389
40 ,,	16·224	14·749	13·52	12·48	11·5585	10·816	10·14	9·5435	9·0133	8·5389	8·112

LAP MACHINE.

End elevation showing driving end.

SCALE $\frac{1}{8}$th.

(For Diagram see page 100).

A	Friction disc for driving bowl, ...	28″ dia.
B	Bowl sliding on vertical shaft, ...	$6\frac{1}{2}$″ dia.
C	Bevel pinion on vertical shaft, ...	16 teeth.
D	Bevel wheel on stud pinion, ...	60 teeth.
E	Stud pinion, ...	12 teeth.
F	Wheel for driving bobbin, ...	84 teeth.
G	Rack pinion, ...	11 teeth.

LAP MACHINE.

End elevation showing end opposite to driving pulleys.

SCALE $\frac{1}{8}$th.

(For Diagram see page 100).

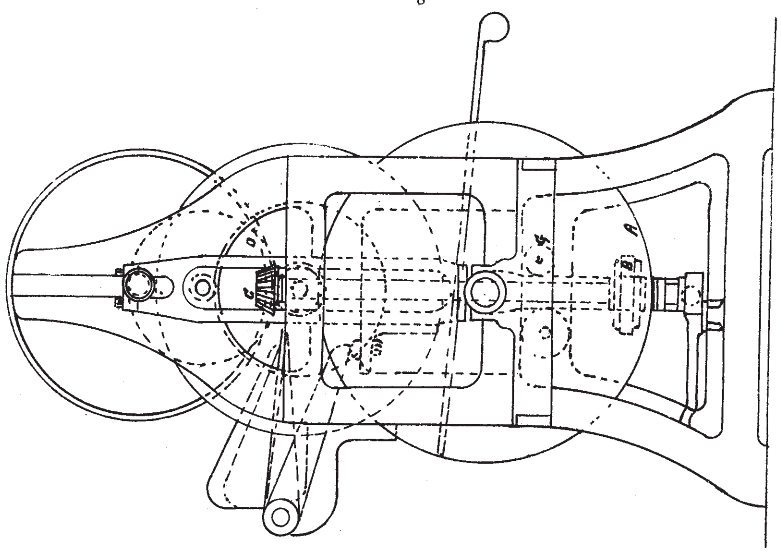
A	Rack pinion, ...	11 teeth.
B	Wheel on rack pinion shaft, ...	100 teeth.
C	Pinion on hand wheel, ...	14 teeth.
D	Worm wheel for ringing bell, ...	90 to 100 teeth.

Speed Pulleys, ...	300 revolutions.
Friction Plate, ...	28″ diameter.
,, Ball, ...	7″ ,,
Bevel Pinion, ...	16 teeth.
,, Wheel, ...	60 teeth.
Spur Pinion, ...	12 ,,
,, Wheel, ...	84 ,, on ball.

LAP MACHINE.

End Elevation showing Driving End.

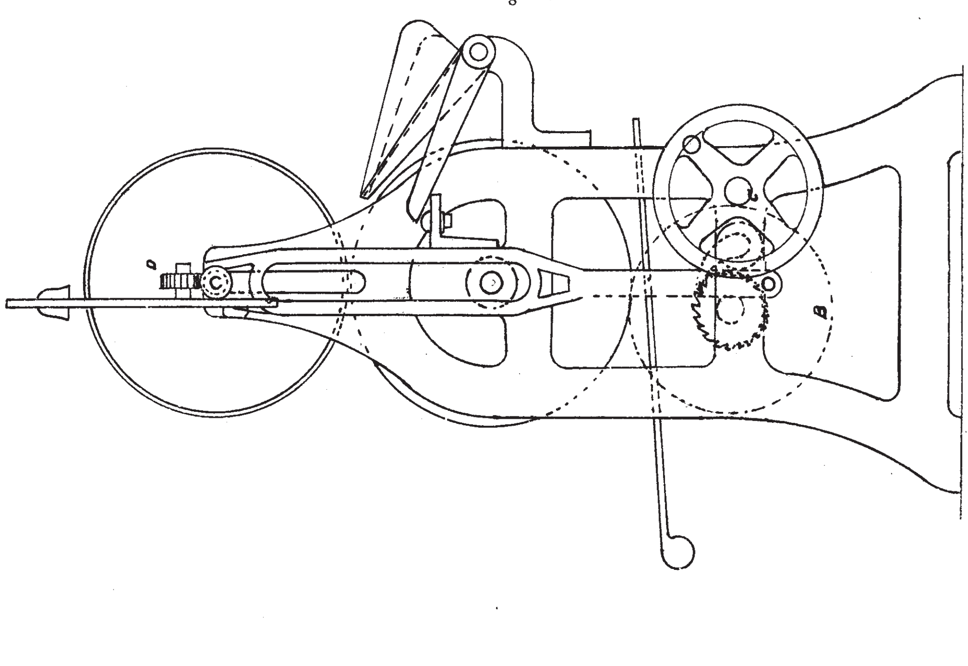
Scale $\frac{1}{8}$th.



LAP MACHINE.

End Elevation showing End opposite to Driving Pulleys.

Scale $\frac{1}{8}$th.



DIMENSIONS OF CARD CYLINDERS AND ROLLERS

According to a Fairbairn Specification

SINGLE DOFFER BREAKER CARD.

NAME OF ROLLER.	Dia. over the wood.	Dia. over the staves.	Dia. to centre of pins.
		′	′ ″
Cylinder	4 ft.	4—1$\frac{3}{8}$	4—1$\frac{11}{16}$
Feeder	9 ins.	10$\frac{1}{8}$	10$\frac{1}{2}$
2 Workers	7 ins.	8$\frac{1}{8}$	8$\frac{1}{2}$
2 Strippers	11 ins.	12$\frac{1}{8}$	12$\frac{3}{8}$
Doffer	14 ins.	15	5$\frac{5}{16}$

SINGLE DOFFER FINISHING CARD.

		′ ″	′ ″
Cylinder	4 ft.	4—1$\frac{1}{8}$	4—1$\frac{13}{32}$
Feeder	2$\frac{1}{2}$ ins.	3$\frac{3}{4}$	4$\frac{1}{8}$
1st and 2nd Workers ...	7 ins.	8	8$\frac{5}{16}$
1st and 2nd Strippers ...	11 ins.	12	12$\frac{7}{32}$
3rd and 4th Workers ...	7 ins.	8	8$\frac{5}{16}$
3rd and 4th Strippers ...	9 ins.	10	10$\frac{7}{32}$
Doffer	14 ins.	14$\frac{7}{8}$	15$\frac{5}{32}$

DOUBLE DOFFER BREAKER CARD.

		′ ″	′ ″
Cylinder	4 ft.	4—1$\frac{3}{8}$	4—1$\frac{11}{16}$
Feeder	18$\frac{1}{2}$ ins.	19$\frac{5}{8}$	20
Workers	14 ins.	15$\frac{1}{8}$	15$\frac{1}{2}$
Strippers	14 ins.	15$\frac{1}{8}$	15$\frac{3}{8}$
1st Doffer	14 ins.	15	15$\frac{5}{16}$
2nd Doffer	14 ins.	14$\frac{7}{8}$	15$\frac{5}{32}$

DOUBLE DOFFER FINISHER CARD.

		′ ″	′ ″
Cylinder	4 ft.	4—1$\frac{1}{8}$	4—1$\frac{13}{32}$
Feeder	4 ins.	5$\frac{1}{4}$	5$\frac{5}{8}$
1st Worker	14 ins.	15	15$\frac{5}{16}$
1st Stripper	14 ins.	15	15$\frac{7}{32}$
2nd and 3rd Workers ...	14 ins.	15	15$\frac{5}{16}$
2nd and 3rd Strippers ...	14 ins.	15	15$\frac{7}{32}$
1st Doffer	14 ins.	14$\frac{7}{8}$	15$\frac{5}{32}$
2nd Doffer	14 ins.	14$\frac{7}{8}$	15$\frac{1}{8}$

DETAILS OF COVERING.

(Recommended by Fairbairn).

SINGLE DOFFER BREAKER CARD FOR WARPS.

NAME OF ROLLER.	No. of w.g.	Total length of pins.	Pitch of Pins.	Length of pins out.
		"	" "	"
Cylinder	12	1	$\frac{5}{8}$ and $\frac{5}{8}$	$\frac{5}{16}$
Feeder	12	$1\frac{1}{2}$	$\frac{7}{16}$ and $\frac{7}{16}$	$\frac{3}{8}$
2 Workers	13	$1\frac{1}{2}$	$\frac{7}{16}$ and $\frac{7}{16}$	$\frac{3}{8}$
2 Strippers	13	$1\frac{1}{4}$	$\frac{1}{2}$ and $\frac{1}{2}$	$\frac{1}{4}$
Doffer	14	$1\frac{1}{8}$	$\frac{3}{8}$ and $\frac{3}{8}$	$\frac{5}{16}$

SINGLE DOFFER FINISHER FOR WARPS.

		"	" "	"
Cylinder	14	$\frac{7}{8}$	$\frac{15}{32}$ and $\frac{15}{32}$	$\frac{9}{32}$
Feeder	13	$1\frac{1}{8}$	$\frac{13}{32}$ and $\frac{13}{32}$	$\frac{3}{8}$
1st and 2nd Workers ...	13	$1\frac{1}{2}$	$\frac{13}{32}$ and $\frac{13}{32}$	$\frac{5}{16}$
1st and 2nd Strippers ...	13	$1\frac{1}{4}$	$\frac{15}{32}$ and $\frac{15}{32}$	$\frac{7}{32}$
3rd and 4th Workers ...	14	$1\frac{1}{2}$	$\frac{3}{8}$ and $\frac{3}{8}$	$\frac{5}{16}$
3rd and 4th Strippers ...	14	$1\frac{1}{8}$	$\frac{7}{16}$ and $\frac{7}{16}$	$\frac{7}{32}$
Doffer	15	1	$\frac{11}{32}$ and $\frac{11}{32}$	$\frac{9}{32}$

SINGLE DOFFER FINISHER FOR WARPS.

		″	″ ″	″
Cylinder	15	$\frac{7}{8}$	$\frac{7}{16}$ and $\frac{7}{16}$	$\frac{9}{32}$
Feeder	14	$1\frac{1}{8}$	$\frac{3}{8}$ and $\frac{3}{8}$	$\frac{3}{8}$
1st and 2nd Workers ...	14	$1\frac{1}{2}$	$\frac{3}{8}$ and $\frac{3}{8}$	$\frac{5}{16}$
1st and 2nd Strippers ...	14	$1\frac{1}{8}$	$\frac{7}{16}$ and $\frac{7}{16}$	$\frac{7}{32}$
3rd and 4th Workers ...	15	$1\frac{1}{2}$	$\frac{5}{16}$ and $\frac{5}{16}$	$\frac{5}{16}$
3rd and 4th Strippers ...	15	$1\frac{1}{8}$	$\frac{3}{8}$ and $\frac{3}{8}$	$\frac{7}{32}$
Doffer	16	1	$\frac{5}{16}$ and $\frac{1}{4}$	$\frac{9}{32}$

SINGLE DOFFER BREAKER FOR WEFTS.

		″	″ ″	″
Cylinder	11	$1\frac{1}{8}$	$\frac{3}{4}$ and $\frac{3}{4}$	$\frac{11}{32}$
Feeder	11	$1\frac{1}{4}$	$\frac{1}{2}$ and $\frac{1}{2}$	$\frac{13}{32}$
2 Workers	12	$1\frac{5}{8}$	$\frac{1}{2}$ and $\frac{1}{2}$	$\frac{13}{32}$
2 Strippers	12	$1\frac{1}{4}$	$\frac{1}{2}$ and $\frac{1}{2}$	$\frac{9}{32}$
Doffer	13	$1\frac{1}{8}$	$\frac{7}{16}$ and $\frac{7}{16}$	$\frac{11}{32}$

SINGLE DOFFER FINISHER FOR WEFTS.

		"	" "	"
Cylinder	13	1	$\frac{1}{2}$ and $\frac{1}{2}$	$\frac{9}{32}$
Feeder	12	$1\frac{1}{4}$	$\frac{7}{16}$ and $\frac{7}{16}$	$\frac{3}{8}$
1st and 2nd Workers ...	12	$1\frac{1}{2}$	$\frac{7}{16}$ and $\frac{7}{16}$	$\frac{5}{16}$
1st and 2nd Strippers ...	13	$1\frac{1}{4}$	$\frac{15}{32}$ and $\frac{15}{32}$	$\frac{7}{32}$
3rd Worker	13	$1\frac{1}{2}$	$\frac{3}{8}$ and $\frac{3}{8}$	$\frac{5}{16}$
3rd Stripper	14	$1\frac{1}{8}$	$\frac{7}{16}$ and $\frac{7}{16}$	$\frac{7}{32}$
Doffer	15	1	$\frac{3}{8}$ and $\frac{3}{8}$	$\frac{9}{32}$

DETAILS OF COVERING

DOUBLE DOFFER BREAKER CARD FOR WARPS.

NAME OF ROLLER.	No. of w.g.	Total Length of Pins.	Pitch of Pins.	Length of Pins out.
		"	" "	"
Cylinder	12	1	$\frac{5}{8}$ and $\frac{5}{8}$	$\frac{5}{16}$
Feeder	12	$1\frac{1}{4}$	$\frac{7}{16}$ and $\frac{7}{16}$	$\frac{3}{8}$
2 Workers	13	$1\frac{1}{2}$	$\frac{7}{16}$ and $\frac{7}{16}$	$\frac{3}{8}$
2 Strippers	13	$1\frac{1}{4}$	$\frac{1}{2}$ and $\frac{1}{2}$	$\frac{1}{4}$
1st Doffer	14	$1\frac{1}{8}$	$\frac{3}{8}$ and $\frac{3}{8}$	$\frac{5}{16}$
2nd Doffer	15	1	$\frac{11}{32}$ and $\frac{11}{32}$	$\frac{9}{32}$

DOUBLE DOFFER FINISHER FOR WARPS.

		"	" "	"
Cylinder	14	$\frac{5}{8}$	$\frac{15}{32}$ and $\frac{15}{32}$	$\frac{9}{32}$
Feeder	13	$1\frac{1}{8}$	$\frac{13}{32}$ and $\frac{13}{32}$	$\frac{3}{8}$
1st Worker	13	$1\frac{1}{2}$	$\frac{13}{32}$ and $\frac{13}{32}$	$\frac{5}{16}$
1st Stripper	13	$1\frac{1}{4}$	$\frac{15}{32}$ and $\frac{15}{32}$	$\frac{7}{32}$
2nd and 3rd Workers ...	14	$1\frac{1}{2}$	$\frac{3}{8}$ and $\frac{3}{8}$	$\frac{5}{16}$
2nd and 3rd Strippers ...	14	$1\frac{1}{8}$	$\frac{7}{16}$ and $\frac{7}{16}$	$\frac{7}{32}$
1st Doffer	15	1	$\frac{11}{32}$ and $\frac{11}{32}$	$\frac{9}{32}$
2nd Doffer	16	1	$\frac{5}{16}$ and $\frac{5}{16}$	$\frac{1}{4}$

DOUBLE DOFFER FINISHER FOR WEFTS.

		"	" "	"
Cylinder	15	$\frac{7}{8}$	$\frac{7}{16}$ and $\frac{7}{16}$	$\frac{9}{32}$
Feeder	14	$1\frac{1}{8}$	$\frac{3}{8}$ and $\frac{3}{8}$	$\frac{3}{8}$
1st Worker	14	$1\frac{1}{2}$	$\frac{3}{8}$ and $\frac{3}{8}$	$\frac{5}{16}$
1st Stripper	14	$1\frac{1}{8}$	$\frac{7}{16}$ and $\frac{7}{16}$	$\frac{7}{32}$
2nd and 3rd Workers ...	15	$1\frac{1}{2}$	$\frac{5}{16}$ and $\frac{5}{16}$	$\frac{5}{16}$
2nd and 3rd Strippers ...	15	$1\frac{1}{8}$	$\frac{3}{8}$ and $\frac{3}{8}$	$\frac{7}{32}$
1st Doffer	16	1	$\frac{5}{16}$ and $\frac{1}{4}$	$\frac{9}{32}$
2nd Doffer	17	1	$\frac{1}{4}$ and $\frac{1}{4}$	$\frac{1}{4}$

SPECIFICATION OF SINGLE DOFFER BREAKER AND FINISHER STAVES.

The following specifications of single doffer breaker and finisher staves are given as an example of what is actually working, and also to show the student the *correct manner* in which to state the particulars of breaker and finisher covering.

It will be observed that this covering is not quite so fine as that shown on the previous pages, which is recommended by Messrs. Fairbairn, Naylor, Macpherson, & Co., Ltd. My experience, however, is that it is fine enough for breaker and finisher producing sliver for hessian warps and wefts.

Breaker, 6′ × 4′ cylinder.
Cylinder cover, 71″ × 48″; $\frac{5}{8}$″ × $\frac{9}{16}$″ pitch.
3 rounds of 41 staves each.
123 staves, 7 rows, 38 pins, No. 12—1″.

Feeder cover, 71″ × 9″; $\frac{7}{16}$″ × $\frac{7}{16}$″ pitch.
3 rounds of 12 staves each.
36 staves, 6 rows, 54 pins, No. 12—1$\frac{1}{4}$″.

(2) Stripper covers, 71″ × 11″; $\frac{1}{2}$″ × $\frac{1}{2}$″ pitch.
3 rounds of 15 staves each.
45 staves, 5 rows, 47 pins, No. 13—1″.

(2) Worker covers, 71″ × 7″; $\frac{1}{2}$″ × $\frac{3}{8}$″ pitch.
3 rounds of 10 staves each.
30 staves, 7 rows, 47 pins, No. 12—1$\frac{5}{8}$″.

Doffer cover, 71″ × 14″; $\frac{3}{8}$″ × $\frac{5}{16}$″ full, pitch.
3 rounds of 17 staves each.
51 staves, 8 rows, 63 pins, No. 14—1$\frac{1}{8}$″.

Finisher, 6′ × 4′ cylinder.
Cylinder cover, 71″ × 48″; $\frac{7}{16}$″ × $\frac{7}{16}$″ pitch.
3 rounds of 41 staves each.
123 staves, 9 rows, 54 pins, No. 14—$\frac{7}{8}$″.

Feeder cover, 71″ × 2$\frac{7}{16}$″; $\frac{3}{8}$″ × $\frac{3}{8}$″ pitch.
3 rounds of 4 staves each.
12 staves, 8 rows, 63 pins, No. 14—1$\frac{1}{8}$″.

(2) Stripper covers, 71″ × 11″; $\frac{7}{16}$″ × $\frac{7}{16}$″ pitch.
3 rounds of 15 staves each.
45 staves, 6 rows, 54 pins, No. 14—$\frac{7}{8}$″.

(2) Stripper covers, 71″ × 9″; $\frac{7}{16}$″ × $\frac{7}{16}$″ pitch.
3 rounds of 12 staves each.
36 staves, 6 rows, 54 pins, No. 14—$\frac{7}{8}$″.

(2) Worker covers, 71″ × 7″; $\frac{7}{16}$″ × $\frac{3}{8}$″ pitch.
3 rounds of 10 staves each.
30 staves, 7 rows, 54 pins, No. 13—1$\frac{3}{8}$″.

(2) Worker covers, 71″ × 7″; $\frac{3}{8}$″ × $\frac{5}{16}$″ pitch.
3 rounds of 10 staves each.
30 staves, 8 rows, 63 pins, No. 14—1$\frac{1}{4}$″.

Doffer cover, 71″ × 14″; $\frac{5}{16}$″ × $\frac{1}{4}$″ pitch.
3 rounds of 17 staves each.
51 staves, 11 rows, 75 pins, No. 16—1″.

SPECIFICATION OF DOUBLE DOFFER BREAKER AND FINISHER STAVES.

Breaker, 6′ × 4′ cylinder.
Cylinder cover, 71″ × 48″; $\frac{3}{4}$″ × $\frac{3}{4}$″ pitch.
3 rounds of 41 staves each.
123 staves, 5 rows, 31 pins, No. 12—1$\frac{1}{16}$″.

Feeder cover, 71″ × 18$\frac{1}{2}$″; $\frac{7}{16}$″ × $\frac{7}{16}$″ pitch.
3 rounds of 23 staves each.
69 staves, 6 rows, 54 pins, No. 12—1$\frac{1}{4}$″.

(2) Stripper covers, 71″ × 14″; $\frac{1}{2}$″ × $\frac{1}{2}$″ pitch.
3 rounds of 17 staves each.
51 staves, 5 rows, 47 pins, No. 13—1″.

(,,) Worker covers, 71″ × 14″; $\frac{3}{8}$″ × $\frac{3}{8}$″ pitch.
3 rounds of 17 staves each.
51 staves, 64 rows, 13 pins, No. 13—1$\frac{3}{4}$″.

Doffer cover, 71″ × 14″, $\frac{3}{8}$″ × $\frac{3}{8}$″ pitch.
3 rounds of 21 staves each.
51 staves, 7 rows, 63 pins, No. 14—$1\frac{1}{8}$″.

Finisher, 6′ × 4′ cylinder.
Cylinder, 71″ × 48″, $\frac{5}{8}$″ × $\frac{5}{8}$″ pitch.
3 rounds of 41 staves each.
123 staves, 6 rows, 38 pins, No. 14—$\frac{7}{8}$″.

Feeder cover, 71″ × 14″, $\frac{3}{8}$″ × $\frac{3}{8}$″ pitch.
3 rounds of 5 staves each.
15 staves, 8 rows, 63 pins, No. 14—$1\frac{1}{8}$″.

(3) Stripper covers, 71″ × 14″, $\frac{3}{4}$″ × $\frac{3}{4}$″ pitch.
3 rounds of 17 staves each.
51 staves, 4 rows, 32 pins, No. 14—$\frac{3}{4}$″.

(,,) Worker covers, 71″ × 14″, $\frac{3}{8}$″ × $\frac{3}{8}$″ pitch.
3 rounds of 17 staves each.
51 staves, 9 rows, 94 pins, No. 16—1″.

(2) Doffer covers, 71″ × 14″, $\frac{1}{4}$″ × $\frac{5}{16}$″ pitch.
3 rounds of 17 staves each.
51 staves, 9 rows, 94 pins, No. 16—1″.

NOTE.—All the rollers are 71″ long over the staves, the cylinder cover is also 71″ over the staves; this is owing to the flange of cylinder ends being $\frac{1}{2}$″ thick.

The staves are all made in three lengths. This is more convenient than when they are made in two. If any accident happens to the covering, it can often be repaired with much less trouble.

It is of the utmost importance that the covering of cards should be well and carefully screwed on to the cylinder and the other rollers. If a stave gets loose, much damage may and often is done when this happens.

All the staves should be made of the very best beech that can be had, thoroughly clean, free from knots, and well seasoned; should be in stock at least three years.

All the rollers of breakers and finishers should be picked and brushed thoroughly with a steel reenge once a week.

The "shrouding," that is the cast iron plate at both ends of cylinder, should always be kept as close as possible, say barely $\frac{1}{16}$th clear; this also helps to keep the ends of all the roller covers clean.

Dimensions of screws used to fix on staves—screws for wood—

Cylinder staves,		No. 16—$1\frac{3}{4}''$
Feeder	,,	No. 16—$1\frac{1}{2}''$
Stripper	,,	No. 16—$1\frac{1}{2}''$
Worker	,,	No. 16—$1\frac{1}{2}''$
Doffer	,,	No. 16—$1\frac{1}{2}''$

Finisher feed roller screws are $1\frac{1}{2}'' \times \frac{3}{8}''$ for iron.

As the staves on the covering of the breakers and finishers is a matter of great importance, and is not very easily understood by the beginner, I have thought it best to explain this by an illustration of the different staves. This will very readily bring before the eye of the student the pitch of pin, the angle to pitch, &c., of the staves, the specification of staves in each case being marked upon the illustration. It must be borne in mind, however, that a great many different opinions are held by men of experience as to what is the best specification for breaker and finisher covering, and on this subject we will not attempt to dogmatize. Without doubt there is a great difference of opinion on this as well as upon many other points in connecticn with jute machinery; and so little has been written upon the subjcct, that it has not been possible to gather up practical men's opinions as to what has been generally found to be best, and thereby form a general rule for the course to be adopted; and if more had been written on jute machinery, it would have been better for the general good of all concerned—better for the man of experience, as well as for the young men engaged in learning their business.

DETAILS OF COVERING.

UP STRIKER SINGLE DOFFER BREAKER FOR WEFTS.

NAME OF ROLLER.	No. of w.g.	Total length of pins.	Pitch of Pins.	Length of pin out
Cylinder	11	$1\frac{1}{8}''$	$\frac{3}{4}'' \times \frac{3}{4}''$	$\frac{11}{32}''$
Feeder	11	$1\frac{1}{4}$	$\frac{1}{2} \times \frac{1}{2}$	$\frac{13}{32}$
2 Workers	12	$1\frac{5}{8}$	$\frac{1}{2} \times \frac{1}{2}$	$\frac{11}{32}$
2 Strippers	12	$1\frac{1}{4}$	$\frac{1}{2} \times \frac{1}{2}$	$\frac{9}{32}$
Doffer	13	$1\frac{1}{8}$	$\frac{7}{16} \times \frac{7}{16}$	$\frac{11}{32}$

UP STRIKER SINGLE DOFFER FINISHER FOR WEFTS.

Cylinder	13	$1''$	$\frac{1}{2}'' \times \frac{1}{2}''$	$\frac{9}{32}$
Feeder	12	$1\frac{1}{4}$	$\frac{7}{16} \times \frac{7}{16}$	$\frac{3}{8}$
1st and 2nd Workers ...	12	$1\frac{1}{2}$	$\frac{7}{16} \times \frac{7}{16}$	$\frac{5}{16}$
1st and 2nd Strippers ...	13	$1\frac{1}{4}$	$\frac{15}{32} \times \frac{15}{32}$	$\frac{7}{32}$
3rd Workers	13	$1\frac{1}{2}$	$\frac{3}{8} \times \frac{3}{8}$	$\frac{5}{16}$
3rd Strippers	14	$1\frac{1}{8}$	$\frac{7}{16} \times \frac{7}{16}$	$\frac{7}{32}$
Doffer	15	1	$\frac{3}{8} \times \frac{3}{8}$	$\frac{9}{32}$

COVERING FOR JUTE SNIPPER.

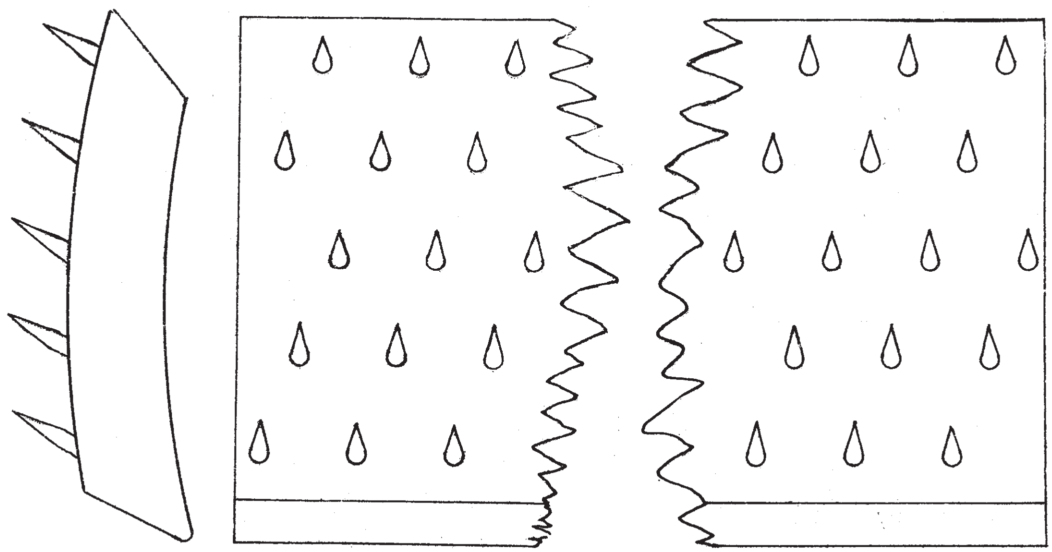
Two Cylinders (Upper and Lower) with 4 Sheets of Staves each.

1st Sheet	...	38	staves,	2	rows,	8	pins,	No	$9—1\frac{3}{8}$.
2nd ,,	{	30	,,	3	,,	7	,,		$10—1\frac{3}{8}$.
				3	,,	11	,,		$12—1\frac{3}{8}$.
3rd ,,	{	30	,,	10	,,	22	,,		$14—1\frac{1}{8}$.
				15	,,	21	,,		$16—1\frac{1}{8}$.
4th ,,	...	30	,,	20	,,	78	,,		$18—\frac{7}{8}$.

BREAKER COVERING.

Stripper Cover 71″ × 11″; $\frac{1}{2}$″ × $\frac{1}{2}$″ pitch,

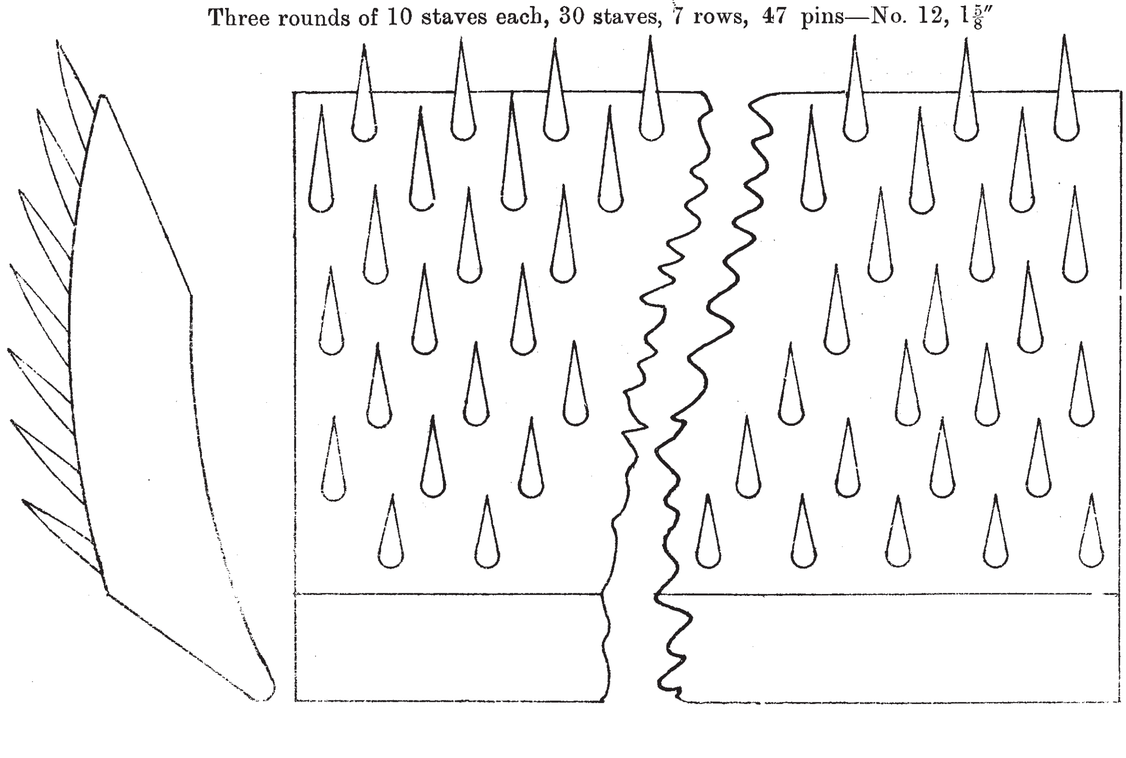
Three rounds of 15 staves each, 45 staves, 5 rows, 47 pins—No. 13, 1″



BREAKER.

Worker Cover 71″ × 7″; $\frac{1}{2}$″ × $\frac{3}{8}$″ pitch.

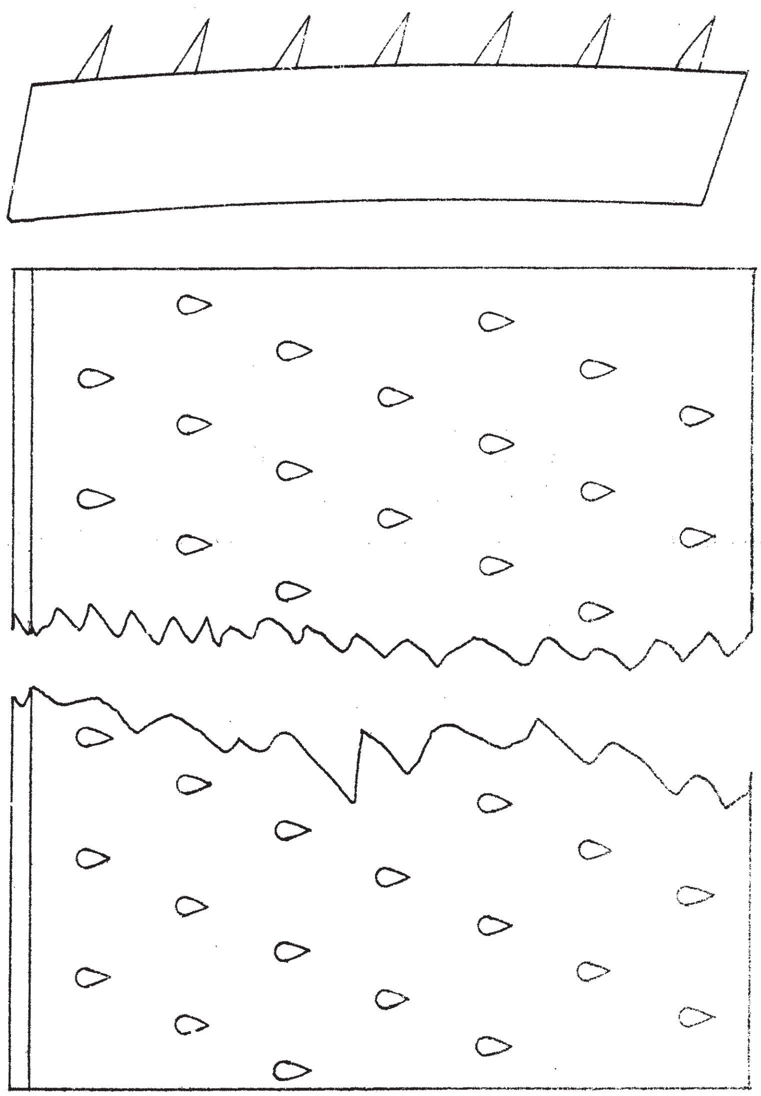
Three rounds of 10 staves each, 30 staves, 7 rows, 47 pins—No. 12, 1$\frac{5}{8}$″



BREAKER.

Cylinder Cover 71″ × 48″; $\frac{5}{8}$″ × $\frac{9}{16}$″ pitch.

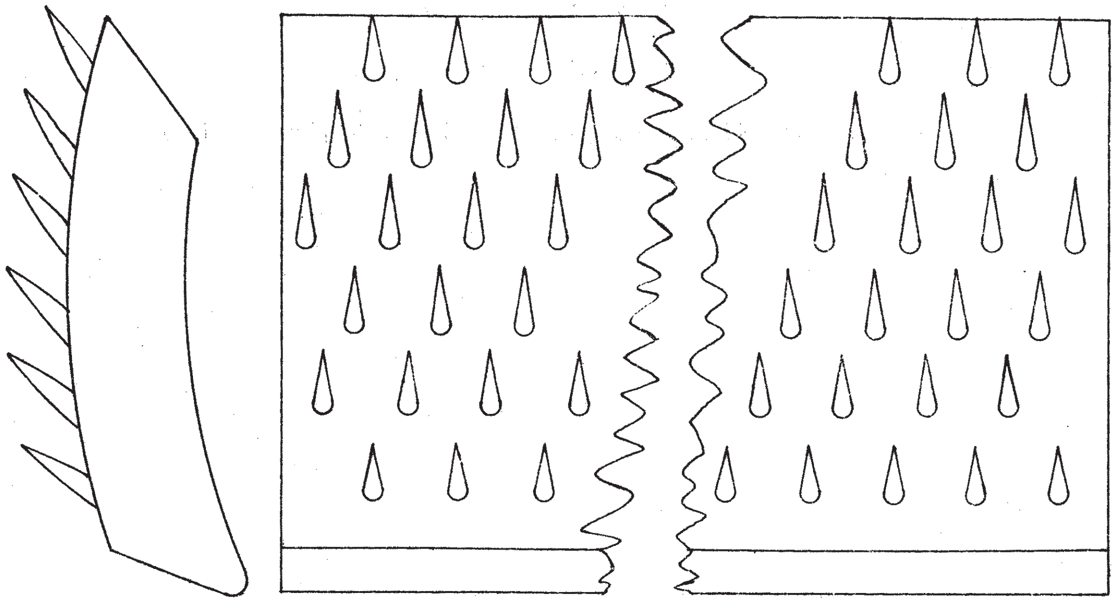
Three rounds of 41 staves each, 123 staves, 7 rows, 38 pins—No. 12. 1″.



BREAKER.

Feeder Cover 71″ × 9″; $\frac{7}{16}$″ × $\frac{7}{16}$″ pitch.

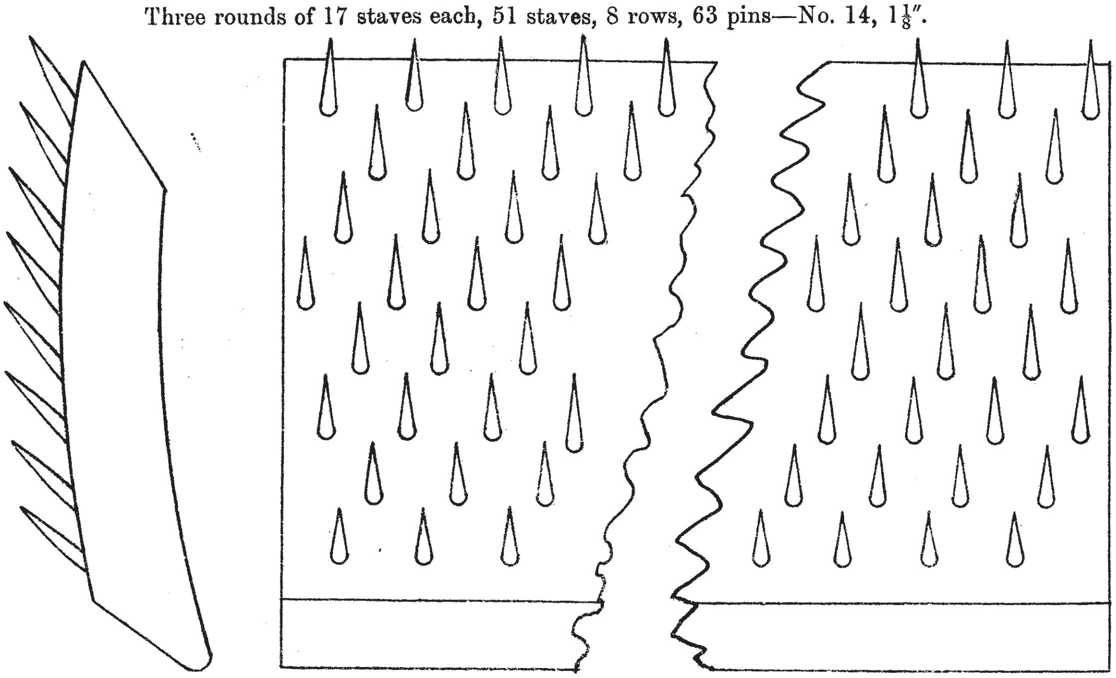
Three rounds of 12 staves each, 36 staves, 6 rows, 54 pins—No. 12, 1¼″



BREAKER.

Doffer Cover 71″ × 14″; ⅜″ × $\frac{5}{16}$″.

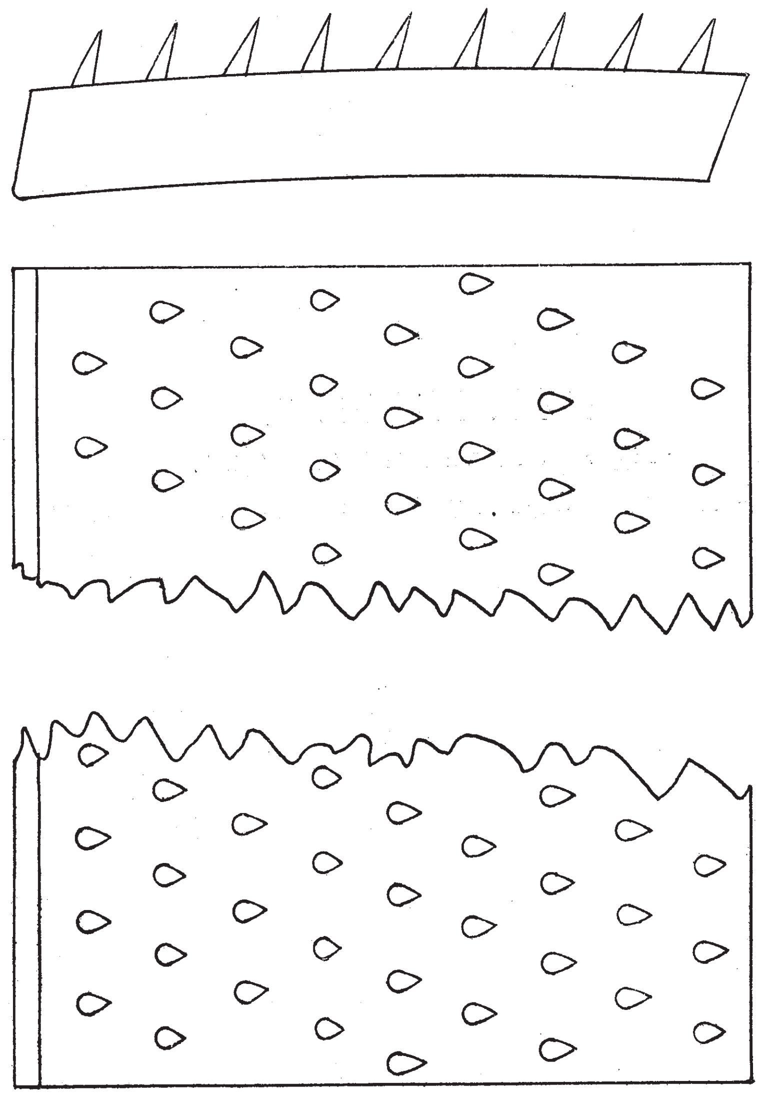
Three rounds of 17 staves each, 51 staves, 8 rows, 63 pins—No. 14, 1⅛″.



FINISHER.

Cylinder Cover (Single Doffer) 71″ × 48″; $\frac{7}{16}$″ × $\frac{7}{16}$″ pitch.

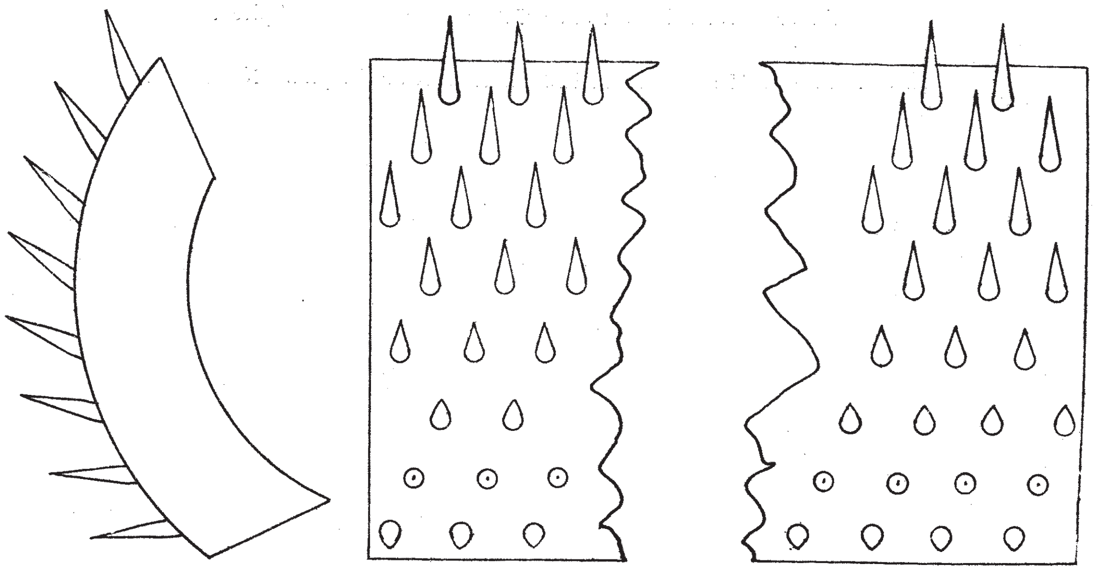
Three rounds of 41 staves each, 123 staves, 9 rows, 54 pins—No. 14, $\frac{7}{8}$″.



FINISHER.

Feed Cover 71″ × $2\frac{7}{16}$″; $\frac{3}{8}$″ × $\frac{3}{8}$″ pitch.

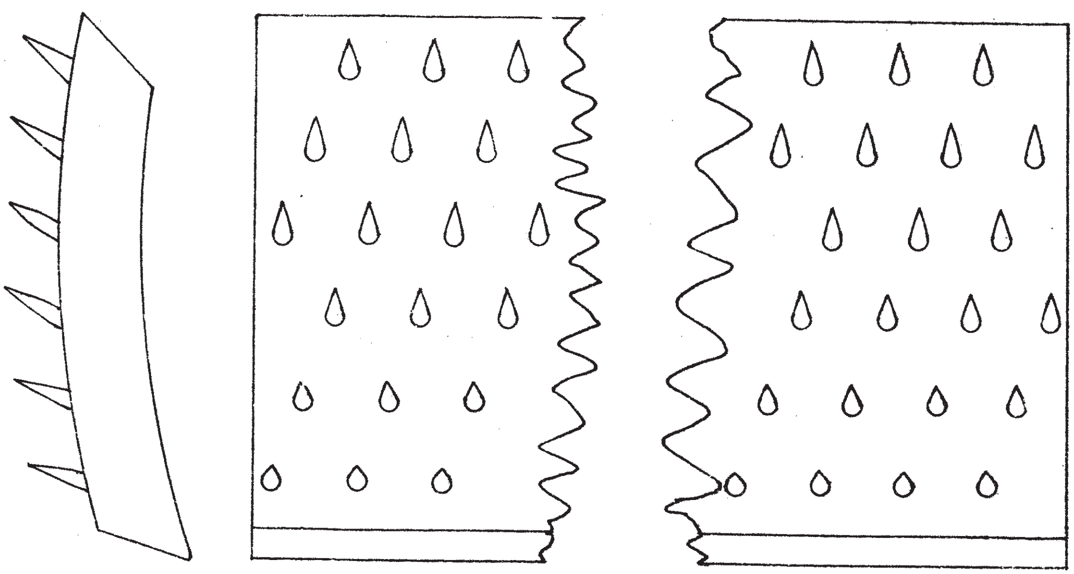
Three rounds of 4 staves each, 12 staves, 8 rows, 63 pins—No. 13, $1\frac{1}{8}$″.



FINISHER.

Stripper Cover 71″ × 11″; $\frac{7}{16}$″ × $\frac{7}{16}$″ pitch.

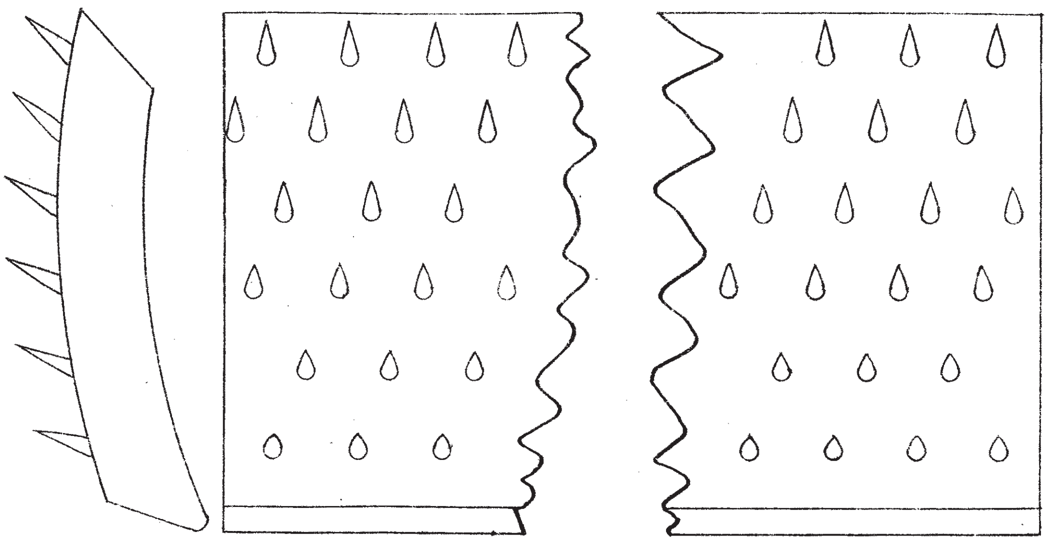
Three rounds of 15 staves each, 45 staves, 6 rows, 54 pins—No. 14, $\frac{7}{8}$″.



FINISHER.

Stripper Cover 71″ × 9″; $\frac{7}{16}$″ × $\frac{7}{16}$″ pitch.

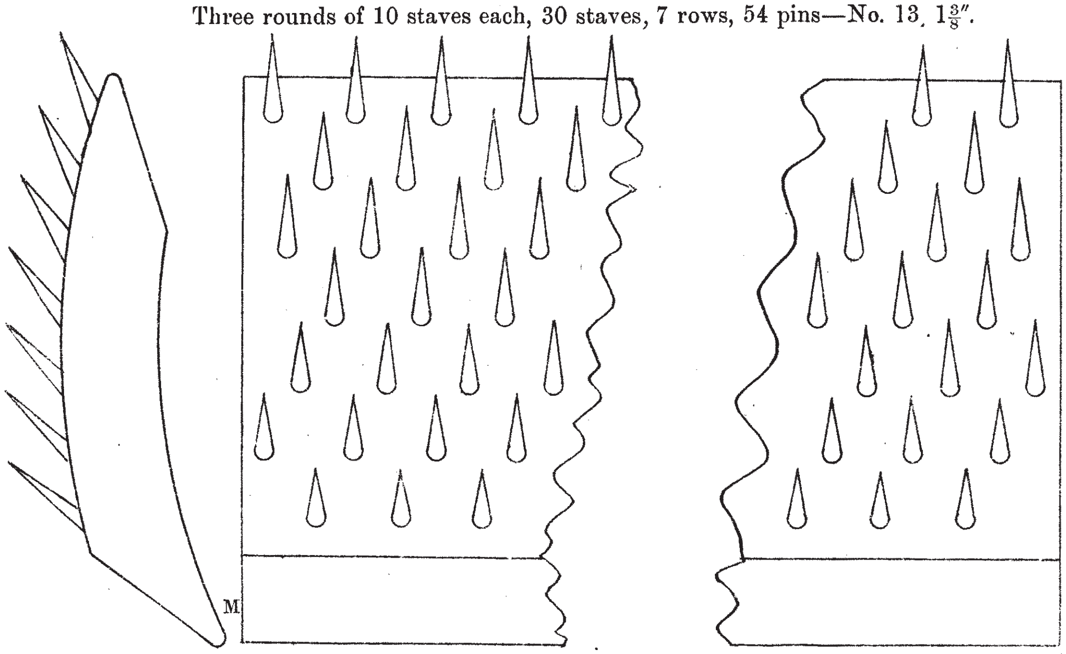
Three rounds of 12 staves each, 36 staves, 6 rows, 54 pins—No. 14, $\frac{7}{8}$″.



FINISHER.

Worker Cover 71″ × 7″; $\frac{7}{16}$″ × $\frac{3}{8}$″ pitch.

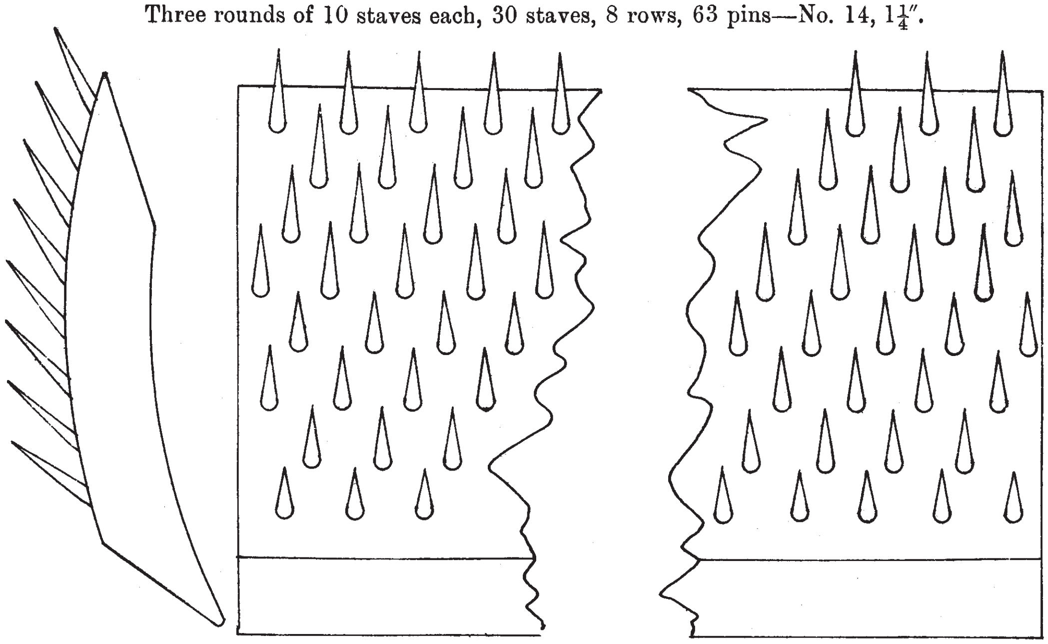
Three rounds of 10 staves each, 30 staves, 7 rows, 54 pins—No. 13, $1\frac{3}{8}$″.



FINISHER.

Worker Cover 71″ by 7″; $\frac{3}{8}''$ × $\frac{5}{16}''$ pitch.

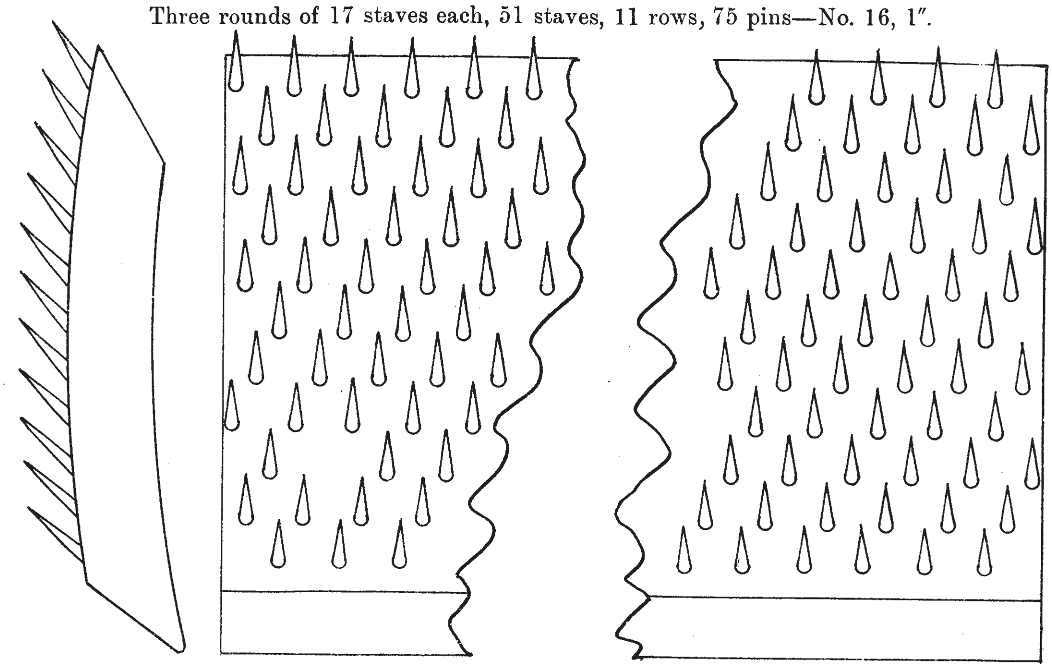
Three rounds of 10 staves each, 30 staves, 8 rows, 63 pins—No. 14, $1\frac{1}{4}''$.



FINISHER.

Doffer Cover 71″ × 14″; $\frac{5}{16}''$ × $\frac{1}{4}''$ pitch.

Three rounds of 17 staves each, 51 staves, 11 rows, 75 pins—No. 16, 1″.



GENERAL INSTRUCTIONS AS TO SETTING* OF BREAKER AND FINISHER CARDS FOR HESSIAN YARNS.

Breaker.

Distance between feed worker and shell ...	No. 15 W.G.
Shell of cylinder, $\frac{3}{8}''$	
Feed roller cylinder	,, 14 ,,
1st worker	,, 11 ,,
2nd worker	,, 12 ,,
2 strippers	,, 16 ,,
Doffer	,, 15 ,,
Drawing roller	,, 10 ,,
Pressing roller, 1″ off cylinder.	

Finisher.

Shell—the usual distance is $\frac{3}{16}''$ to $\frac{1}{4}''$ off cylinder.	
Feed roller from cylinder and shell ...	No. 15 W.G.
2 workers	,, 12 ,,
2 ,, ...	,, 14 ,,
4 strippers	,, 16 ,,
Doffer	,, 17 ,,
Drawing roller, 1″ off cylinder.	
Leather roller	,, 10 ,,

In the case of double doffer cards, the only difference would be that on the breaker the bottom doffer would be No. 14 W.G., and top doffer No. 15; and on the finisher card the top doffer No. 16, and bottom doffer No. 17. When the quantity passed over a breaker is more than 12 tons, and over a finisher more than 6 tons, per week, the distance of pin points of rollers from cylinder should be rather greater than indicated.

*Note.—Card "Sets" are pieces of steel plate usually about 12 inches long and 3 inches broad, and should be stamped No. 10, 12, 14, 16, &c., according to their thickness B.W.G.; if Worker and Stripper are to be set No. 16 between, use No. 16 set, and so on.

UP STRIKER BREAKER CARD.

Drafts.

$$\frac{120 \text{ feeder wheel} \times 120 \text{ stud wheel} \times 58 \text{ stud wheel} \times 4'' \text{ dia. of drawing roller}}{20 \text{ change} \times 20 \text{ stud pinion} \times 66 \text{ drawing roller wheel} \times 10\tfrac{1}{2}'' \text{ working diameter of feeder}} = 12.$$

Speeds of Workers.

$$\frac{52 \text{ change} \times 24 \text{ drawing roller pinion} \times 28 \text{ stud pinion} \times 88 \text{ doffer wheel} \times 64 \text{ stud pinion} \times 190 \text{ revs. of cylinder}}{66 \text{ drawing roller wheel} \times 54 \text{ stud wheel} \times 88 \text{ doffer wheel} \times 96 \text{ stud wheel} \times 92 \text{ worker wheel}} = 13{\cdot}5.$$

13·5 revs. per min. × 29·8″ working circumference = 33·5 ft. per min

UP STRIKER FINISHER CARD.

Drafts.

$$\frac{120 \text{ feeder wheel} \times 120 \text{ stud wheel} \times 58 \text{ stud wheel} \times 4'' \text{ dia. of drawing roller}}{20 \text{ change} \times 20 \text{ stud pinion} \times 66 \text{ drawing roller wheel} \times 10\tfrac{1}{2}'' \text{ working diameter of feeder}} = 12.$$

Speeds of Workers.

$$\frac{40 \text{ change} \times 24 \text{ drawing roller pinion} \times 28 \text{ stud pinion} \times 88 \text{ doffer wheel} \times 190 \text{ revs. of cylinder}}{66 \text{ drawing roller wheel} \times 54 \text{ stud wheel} \times 88 \text{ doffer wheel} \times 72 \text{ worker wheel}} = 19{\cdot}9.$$

19·9 revs. per min. × 26·7″ working circumference = 44·3 ft. per min.

DRAWING FRAMES.

Drawing Frames.—After the carding processes comes the drawing. In an ordinary hessian yarn system there are two drawings usually called first and second drawings. The cans taken from the finishers are put up at the back of the first drawing, and so many of them are run into one at the front of the first drawing—usually four ends are run into one. The cans from the front of the first drawing are put up at the back of the second drawing, and so many are again run into one at the front of the second drawing—usually two ends are run into one here, but at both drawings more are often put up, never less for the making of hessian yarns.

So far as the material passing over the drawings, the most important point is to see that the gills are not overloaded—that is, that the sliver is well down through the gill pins. You should always see the points of the gill pins if you wish a level sliver at the front of the drawing, and this will also ensure a level and regular spun rove. No matter how well the jute has been carded, if the drawing gills are overloaded, irregular and lumpy spun rove will follow. Two kinds of first drawings are illustrated, and the particulars of gear and speed are given. The circular first drawing is not very much used now in Dundee at least; why it has been laid aside I have never been able exactly to understand, as it could do a large amount of work and do it well without much mechanical attention, and was a machine easily managed by the worker. From its general compactness and the small space occupied by it, I have an impression it will come back again.

The First Drawing, now most in use, is the push bar drawing, and there is no doubt it has been a great success. It may be driven at any speed within reason; but it must not be too heavily laden, or the fibre will incline to slide over the points of the pins. With a light load, so that the gill pins will go well up through the material, it will make a thorough job, and do a fair quantity per day of 10 hours—say from 30 cwt. to 35 cwt.—with two heads. It works best with a single end over each gill, and the four ends run into one at the front. This, however, is of course a matter of opinion, and sometimes of convenience in the arrangement of the work to be done. Two heads are sufficient for a 56 spindle roving.

The gill bars of the push bar drawing are actuated by pinions. When the bars are working, so many of them are in the teeth of these pinions, the others both above and below not actually into the wheels, are being pushed along by the others as they pass out of the teeth, hence, the name push or slide drawing. To keep the bars tight upon the top is imperative, and a pinion and coupling has been arranged for on this machine, so that if the bars wear a little slack this slackness can be taken off. The success of the push drawing has been owing to the bars rising up straight at the back, and they do this nearer to a spiral drawing than any other drawing we have had before, consequently the less slackness you allow to get upon the bars, the nearer the perpendicular will the gill bar pins rise through the sliver at the back end, which is the great point to be desired.

As there is no intricate work about the arrangement for actuating the gill bars, simply four pinions with teeth into which the end of the bars move, it only requires to de kept *clean*. It has become very popular.

The Second Drawing, or, as it is sometimes called, the finishing drawing, is usually a spiral drawing—so called from the gill bars being actuated by screws. To the speed of a spiral drawing or roving there is a limit beyond which it is impossible to go. No finishing drawing will make such a level sliver as a spiral drawing—that is the result of my experience; many others hold a different opinion, however. The push bar drawing is being adopted as a second drawing, but as I have not worked them as such, would rather not express an opinion of its merits as a finishing drawing. The screws, wipers, slides, &c. require careful attention, so that the heads of gill bars are kept upon the "pitch." To possess a thorough knowledge of the screws of spiral drawings and rovings, and to be able to keep them running on the "pitch" without any tampering with the "pitch pin," is about the best test of the fitness of a mill mechanic for his work; and all apprentice mill mechanics should make it their business to thoroughly master this, as without a thorough knowledge of this they will never be the master of their trade, of a mill mechanic for his work; and all apprentice mill mechanics should make it their business to thoroughly master this, as without a thorough knowledge of this they will never be the master of their trade.

Two heads of a spiral drawing are sufficient for a 56 spindle roving, 10″ × 5″ pitch, but many people prefer three heads to a roving. If you have three heads in your second drawing to each roving, this will necessitate the second drawings being at right angles to the first drawings, and, of course, in line with the rovings, and this means you will have to drive the second drawings with belts over a universal guide. The arrangement, either as regards the floor space or driving arrangement, never seems so direct and complete as when the breakers, finishers, and drawings are in parallel lines, and the rovings at right angles to the second drawings.

A second drawing of two heads is able to produce sliver for a 56 spindle roving, 10″ × 5″ pitch, making 30 cwt. to 35 cwt. of rove in 10 hours.

Here we may explain what is meant by the gill bars going off the "pitch." The gill bars of any drawing or roving, except, of course, rotary drawings and rovings, are driven by a small pin, called the *"pitch" pin. If the bars do not move easily, either from some mechanical defect or from the gill bars getting jammed by a lump of jute, or a "choke," as it is termed, this pitch pin will break; the gill bars of the head which has gone out of order will cease to move, while the other head or heads will continue to work as before. The head which has ceased working, owing to the breakage of the "pitch pin," will not work until this pin has been renewed, and the obstruction removed; and the smaller the pitch pin is in diameter the better, as it will do the less damage to the gill bars when it breaks easily than if it requires an unnecssary amount of obstruction to break it, and the smaller the pin you can work with is the real guarantee that the screws, wipers, slides, &c., are mechanically in good order, and also thoroughly clean.

Pitch Pin for Push Bar Drawing.—This pin works both heads of the drawing, and should not be more than No. 8 Birmingham wire gauge second drawing pitch pin, which works only one of the drawing heads, should not be more than No. 10 B.W.G., and the roving pitch pins No. 15 B.W.G. If you work with these pins, there will not be much wrong with the gill bars before you will know it.

*See page 162 for illustration of "pitch pin" arrangement.

The number of gill bars in circular drawings is		-	52
,,	,,	one head of push bar is	32
,,	,,	,, spiral second drawing is	21
,,	,,	,, roving is -	22

The "cans" from the second drawings should be put up in setts of eight a time at the back of the roving.

DRAWINGS.—Sometimes the drawing rollers and pressing rollers are made "hard to hard"—by that term is meant that both surfaces of the rollers are metal—but the most common method employed is that the pressing roller is covered with leather. If the rollers are hard to hard, they are both fluted with a round top and bottom flute, and the flutes work into one another; and we may remark here, in passing, that, for the purpose of calculation, a round top and bottom fluted roller 2½ in. diameter is always taken at 3 in. diameter. This, as will be readily understood, is owing to the depth of flutes making the circumference of roller longer than if with plain flutes. Leather-covered pressing rollers on a round top and bottom fluted roller are often used in first drawings; but usually leather pressing rollers, either in drawings or rovings, work upon a drawing roller with V flutes, or scratch flutes, as they are sometimes called.

DRAFT PLATE WITH DRAFT PINION AND DRAFT ATTACHED TO MACHINE.

Push Bar Drawing—

Draft.		Pinion.
2½	...	96
3	...	80
3½	...	68
4	...	60
4½	...	53
5	.	48
5½	...	44
6	...	40
6½	...	37

Circular Drawing—

Draft.		Pinion.
3	...	60
3½	...	52
4	...	45
4½	...	40
5	...	36
6	...	30
6½	...	28
7	...	26

Second Drawing Spiral—

Draft.		Pinion.
5	...	64
5½	...	58
6	...	53
6½	...	49
7	...	46
7½	...	43
8	...	40
8½	...	38
9	...	36
9½	...	34
10	...	32

DRAWING DRAFT ARRANGEMENTS.

First Drawing—Push Bar.

Speed Pulleys 180 revolutions per minute; pulley pinion 34 teeth.

Draft arrangement—hard-to-hard rollers—

*(3″) $\frac{2\frac{1}{2} \times 56 \times 74 \times 50 \times 23 \times 32}{80 \times 20 \times 34 \times 39 \times 40 \times 1\frac{5}{16}} = 3{\cdot}3$ draft.

*(3″) $\frac{2\frac{1}{2} \times 56 \times 74 \times 50 \times 23 \times 32}{\text{Change pinion} \times 20 \times 34 \times 39 \times 40 \times 1\frac{5}{16}} = 264{\cdot}9$ Constant Number for draft

First Drawing—Push Bar.

Speed Pulleys 180 revolutions per minute.

Draft arrangement—Leather rollers on round fluted roller or plain fluted roller.

$$\frac{2\frac{1}{2} \times 76 \times 74 \times 50 \times 23 \times 32}{56 \times 19 \times 34 \times 39 \times 40 \times 1\frac{5}{16}} = 3{\cdot}9 \text{ draft.}$$

$$\frac{2\frac{1}{2} \times 76 \times 74 \times 50 \times 23 \times 32}{\text{Change pinion} \times 19 \times 34 \times 39 \times 40 \times 1\frac{5}{16}} = 222{\cdot}5 \text{ Constant Number for draft.}$$

*In the calculations remember remarks as to round top and bottom fluted rollers *versus* plain or V fluted rollers.

First Drawing Circular.

Speed Pulleys 240 revolutions per minute—pulley pinion 28 teeth.

Draft arrangement—hard-to-hard rollers—

($3\frac{1}{2}$″) $\frac{3'' \times 18 \times 120 \times 27 \times 15}{22 \times 18 \times 52 \times 15 \times 3''} = 3{\cdot}30$ draft between drawing roller and retaining roller.

($3\frac{1}{2}$″) $\frac{3'' \times 18 \times 120 \times 27 \times 15}{22 \times 18 \times \text{c.p.} \times 15 \times 3''} = 171{\cdot}8$ Constant Number for draft.

First Drawing—Circular.

Speed pulleys 240 revolutions per minute.

Draft arrangement—leather rollers on round fluted roller or plain fluted roller.

$$\frac{3''}{18} \times \frac{18}{18} \times \frac{120}{52} \times \frac{27}{15} \times \frac{15}{3''} = 3{\cdot}46$$ draft between drawing roller and retaining roller.

$$\frac{3''}{18} \times \frac{18}{18} \times \frac{120}{\text{Change pinion}} \times \frac{27}{15} \times \frac{15}{3''} = 180$$ Constant Number for draft.

Second Drawing—Spiral.

Speed Pulleys 170 revolutions per minute—pulley pinion 28 teeth.

Draft arrangement—leather pressing roller on a plain or V fluted roller.

$$\frac{2\frac{1}{2} \times 35 \times 68 \times 69}{43 \times 25 \times 25 \times 1\frac{15}{16}} = 7{\cdot}88 \text{ draft.}$$

$$\frac{2\frac{1}{2} \times 35 \times 68 \times 69}{\text{Change pinion} \times 25 \times 25 \times 1\frac{15}{16}} = 339{\cdot}03$$—Constant Number for draft.

ARRANGEMENTS OF WHEELS FOR CALCULATION OF SPEED OF GILL BARS IN DRAWINGS AND ROVINGS.

Driving Shaft, 160 revolutions per minute,—see plan.

Drum Push Bar Drawing,			16″
Pulleys	,,	,,	14″
Drum Circular	,,		21″
Pulleys	,,	,,	14″
Drum Spiral		,,	16″
Pulleys	,,	,,	16″

Thus—

1st Push Bar Drawing Pulley Pinion, 34 teeth.

$160 \times \frac{16}{14} = 182\frac{6}{7}$, say 180 speed of pulleys.

$180 \times \frac{34}{56} \times \frac{20}{74} \times \frac{34}{50} = 20{\cdot}08$ revolutions per minute = speed of Gill Bar Shaft, upon which is Gill Bar Wheel, into which the bars work. This wheel has 17 teeth.

$180 \times \frac{c}{56} \times \frac{20}{74} \times \frac{34}{50} = {\cdot}590$ constant number for speed of Gill Bars.

$17 \times 20{\cdot}08 = 341{\cdot}36$, speed of Gill Bars per minute.

This is a fair speed. With this speed this drawing will take sliver from a finisher producing 35 cwt. per 10 hours.

Breaker Draft, say, about 13/13½.
Finisher ,, ,, 14/14½.
Dollop, 32/33 lbs.

1st Circular Drawing Pulley Pinion, 32 teeth.

$160 \times \frac{21}{14} = 240$ revolutions of pulleys per minute.

$240 \times \frac{32}{78} \times \frac{18}{120} \times \frac{52}{110} =$ almost 7 revolutions of Gill Bar Wheel per minute.

$240 \times \frac{32}{78} \times \frac{18}{120} \times \frac{c}{110} = {\cdot}134$ constant number.

Number of teeth or spaces for bars in Gill Bar Wheel 52.

$52 \times 7 = 364$ Drops of Gill Bars per minute.

With same arrangement as to Breaker, Finisher, Dollop, &c., this drawing will take from a finisher producing 35 cwt. per day.

Then—

2nd Spiral Drawing—pulley pinion 30 teeth.

$160 \times \frac{16}{16} = 160$ revolutions of pulleys per minute.

$160 \times \frac{30}{35} \times \frac{19}{19} \times \frac{21}{14} = 205\frac{5}{7}$ speed of Gill Bars per minute.

$160 \times \frac{\text{Change}}{35} \times \frac{19}{19} \times \frac{21}{14} = 6{\cdot}85$ constant number.

This drawing, with two heads at this speed on bars, and with a 7½ draft, will take the production from either of the 1st drawings, Push Bar, or Circular.

NOTE.—The relations of speed between the retaining roller and gill bars on a Screw Gill Roving are the same for 200/250 lbs. rove as for 60/70 lbs. rove.

Then—

Roving—Drum, 25″; Pulleys, 18″.
Twist pinion, 35″ on $2\frac{1}{4}$″ rollers.
Grist ,, 35″.
Rack ,, 17″.
Traverse ,, 28″.
Weight of rove, $72\frac{1}{2}$/75 lbs. per spindle.

With this arrangement roving will produce 28/30 shifts = 35 cwt. in 10 hours.

In this case particulars are given previous to working out speed of gill bars, as the speed of bars depend on these particulars.

$160 \times \frac{25}{18} = 222{\cdot}2$. Say 225 revolutions of main shaft of roving per minute.

$225 \times \frac{35}{60} \times \frac{38}{35} \times \frac{22}{22} \times \frac{24}{16} = 213{\cdot}5$ speed of gill bars per minute.

$225 \times \frac{\text{Twist pinion.}}{60} \times \frac{38}{35} \times \frac{22}{22} \times \frac{24}{16} = 6{\cdot}10$ constant number.

$225 \times \frac{44}{22} \times \frac{21}{14} = 675$ speed of spindles per minute.

SPEED OF DRAWING ROLLER BY SPEED FROM SHAFT DRIVING ROVING PULLEYS.

$160 \times \frac{25}{18} \times \frac{35}{60} = 129{\cdot}6$ revolutions of drawing roller per minute.

Engine, 10 hours = 600 minutes.

$129{\cdot}6 \times 600 = 77760{\cdot}0$ revolutions of drawing roller in 10 hours.

$77760 \times 7{\cdot}06 = 548985{\cdot}60$ inches in 10 hours.

$\frac{548985{\cdot}60}{36''} = 15249{\cdot}6$ yds.

$\frac{15249{\cdot}6}{14400} = 1{\cdot}05$ spyndles per spindle in 10 hours by engine.

This roving arrangement produces 35 cwt. of rove at $72\frac{1}{2}$/75 lbs. per spyndle, by 56 spindles, 10″ × 5″ pitch.

35 cwt. = 3920 lbs.

$\frac{3920}{75} = 52{\cdot}26$ spyndles of rove at 75 lbs. per spindle from 56 spindles.

$\frac{52{\cdot}26}{56} = {\cdot}933$ spyndles per spindle actual in 10 hours.

11·1 per cent. difference between engine and actual production.
Engine production, 1·05
Actual ,, ·933
,, Difference, ·117

1·05 : 100 : : ·117 : Answer, 11·1.

Pitch of Gill Bar Screws for Second Spiral Drawings and also Spiral Rovings.

The screws for these drawings and rovings, made by Messrs Fairbairn, Naylor, & Macpherson, are always cut a certain number of threads per inch, so that they are not always measurable by an $\frac{1}{8}$th or $\frac{1}{16}$th.

In the Second Drawings—

Top screws have $1\frac{3}{4}$ threads per inch.
Bottom ,, 0·8 ,, ,,

Rovings—

Top screws have 2· threads per inch.
Bottom ,, 0·8 ,, ,,

If you observe the working of gill bars in the second spiral drawing, you will notice that there are most frequently 14 gill bars in the top screws of drawing and 7 in the bottom screws; sometimes there will be 15 in the top and 6 in the bottom; and frequently one will be halfway between. The distance from where the gill bar rises to where it descends is $8\frac{1}{4}$ inches.

Pitch of top screws, $1\frac{3}{4}$ per inch.
Top screw, $8·25 \times 1·75 = 14·43$
Bottom ,, $8·25 \times 0·8 = 6·6$

Total, 21. gill bars in a head of 2nd drawing.

Roving, 10′ × 5″ spiral.
Top screw, $7·875 \times 2· = 15·75$
Bottom ,, $7·875 \times 0·8 = 6·3$

Total, 22·0 gill bars in one head of roving.

NOTE.—For illustrations of Drawing and Roving Screws, see pages 144 and 158.

PATENT CIRCULAR DRAWING FRAME.

Sectional elevation showing gearing at driving end.

SCALE $\frac{1}{8}$TH.

A	Driving pinions, ...	36, 39, & 42 teeth.
B	Delivery roller wheel, ...	78 teeth.
C	Delivery roller pinion, ...	17 teeth.
D	Intermediate, ...	80 teeth.
E	Drawing roller pinion, ...	18 teeth.
F	Stud wheel for driving brush, ...	46 teeth.
G	Stud pinion for do.	12 teeth.
H	Brush wheel, ...	80 teeth.
I	Wheel on shaft for driving circle, ..	24 teeth.
J	Wheel on circle, ...	110 teeth.
K	Retaining roller wheel for driving brush, ...	18 teeth.
L	Intermediate for do.	18 teeth.
M	Brush wheel, ...	18 teeth.

Arrangement of Wheels for calculation of speed of gill bars—

$$\frac{240 \times 32 \times 18 \times 52}{78 \times 120 \times 110} = 7 \text{ revolutions of gill bar wheel per minute.}$$

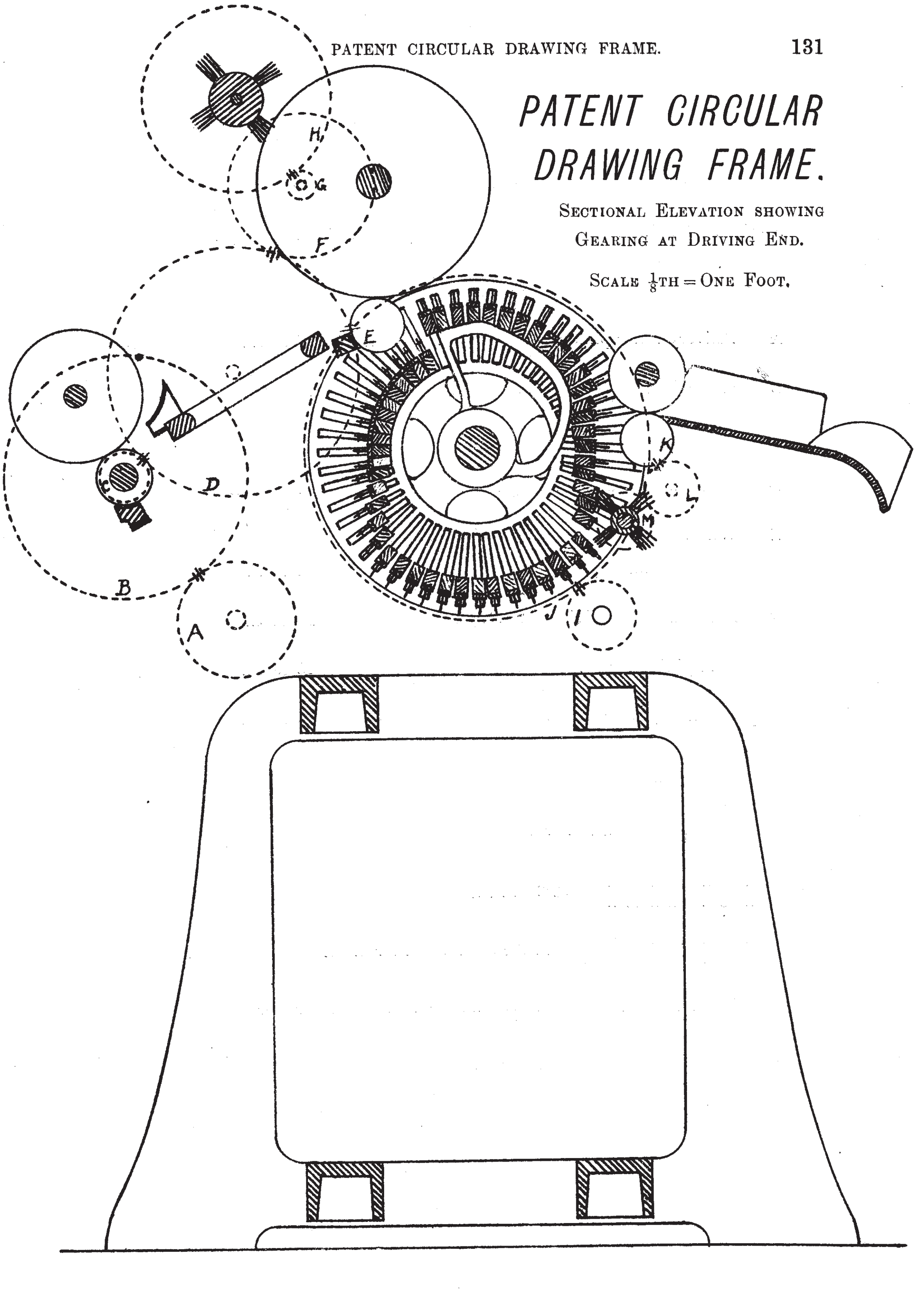
$$\frac{240 \times 32 \times 18 \times \text{C.P.}}{78 \times 120 \times 110} = \cdot 134 \text{ constant No. for speed gill bars.}$$

Number of spaces for gill bars in gill bar wheel 52; therefore, $52 \times 7 = 364$ drops of gill bars per minute.

PATENT CIRCULAR DRAWING FRAME.

SECTIONAL ELEVATION SHOWING GEARING AT DRIVING END.

SCALE $\frac{1}{8}$TH = ONE FOOT.



PATENT CIRCULAR DRAWING FRAME.

Sectional elevation showing gearing at end opposite to driving pulleys.

SCALE $\frac{1}{8}$TH.

A	Delivery roller pinion, ...	17 teeth.
B	Stud wheel, ...	120 teeth.
C	Draught changes, ...	26 to 60 teeth.
D	Wheel on circle for driving fallers, ...	110 teeth.
E	Wheel on shaft for driving circle at pulley end, ...	24 teeth.
F	Stud wheel for driving retaining roller, ...	27 teeth.
G	Stud pinion for do., ...	15 teeth.
H	Retaining roller wheel, ...	15 teeth.

DRAFT ARRANGEMENT—

Pressing Rollers hard to hard.

$$(3\tfrac{1}{2})\ \frac{3 \times 18 \times 120 \times 27 \times 15}{22 \times 18 \times 52 \times 15 \times 3} = 3{\cdot}30 \text{ Draft.}$$

$$\frac{3 \times 18 \times 120 \times 27 \times 15}{22 \times 18 \times \text{C.P.} \times 25 \times 3} = 171{\cdot}8 \text{ constant No. for draft.}$$

Pressing Rollers—leather covered on a plain or V fluted roller.

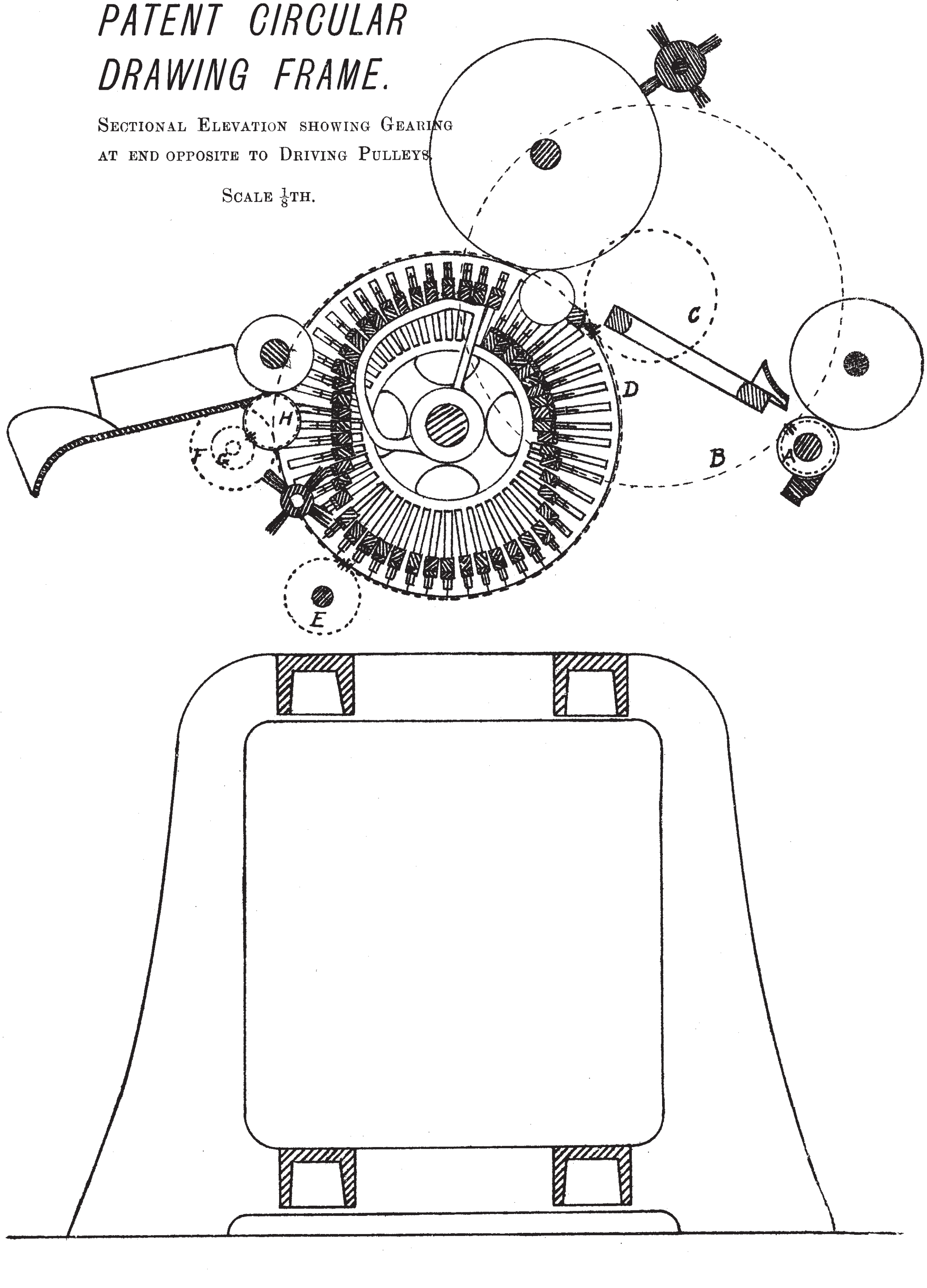
$$\frac{3 \times 18 \times 120 \times 27 \times 15}{18 \times 18 \times 52 \times 15 \times 3} = 3{\cdot}46 \text{ draft.}$$

$$\frac{3 \times 18 \times 120 \times 27 \times 15}{18 \times 18 \times \text{C.P.} \times 15 \times 3} = 180 \text{ constant No. for draft.}$$

PATENT CIRCULAR DRAWING FRAME.

SECTIONAL ELEVATION SHOWING GEARING AT END OPPOSITE TO DRIVING PULLEYS.

SCALE $\frac{1}{8}$TH.



PATENT PUSH OR SLIDE DRAWING FRAME.

Sectional elevation showing gearing at driving end.

SCALE $\frac{1}{8}$th.

A	Driving pinions,	... ...	30, 34 & 38 teeth
B	Stud Wheel, ...	... ...	70 teeth.
C	Stud pinion, ...	... ...	19 teeth.
D	Short shaft wheel,	... ...	78 teeth.
E	Short shaft pinion,	... ...	34 teeth.
F F	Faller shaft wheels,	... ...	50 teeth.
G	Intermediate,	... ...	62 teeth.
H	Draught changes,	... .	34 to 80 teeth.
I	Stripping roller pinion,	... ...	26 teeth.
J	Intermediate,	... ...	100 teeth.
K	Delivery roller pinion for driving stripping roller, ...	... ...	38 teeth.
L L	Retaining roller pinions,	... ...	22 teeth.
M	Intermediate, ..	... ...	24 teeth.

DRAFT ARRANGEMENT—

Hard to hard pressing rollers—

$$\frac{\overset{(3'')}{2\frac{1}{2}} \times 56 \times 74 \times 50 \times 23 \times 32}{56 \times 20 \times 34 \times 39 \times 40 \times 1\frac{5}{16}} = 3{\cdot}9 \text{ draft.}$$

$$\frac{\overset{(3'')}{2\frac{1}{2}} \times 56 \times 74 \times 50 \times 23 \times 32}{\text{C.P.} \times 20 \times 34 \times 39 \times 40 \times 1\frac{5}{16}} = 222{\cdot}5 \text{ constant No. for draft.}$$

Pressing Rollers—Leather covered on a plain or a V fluted roller—

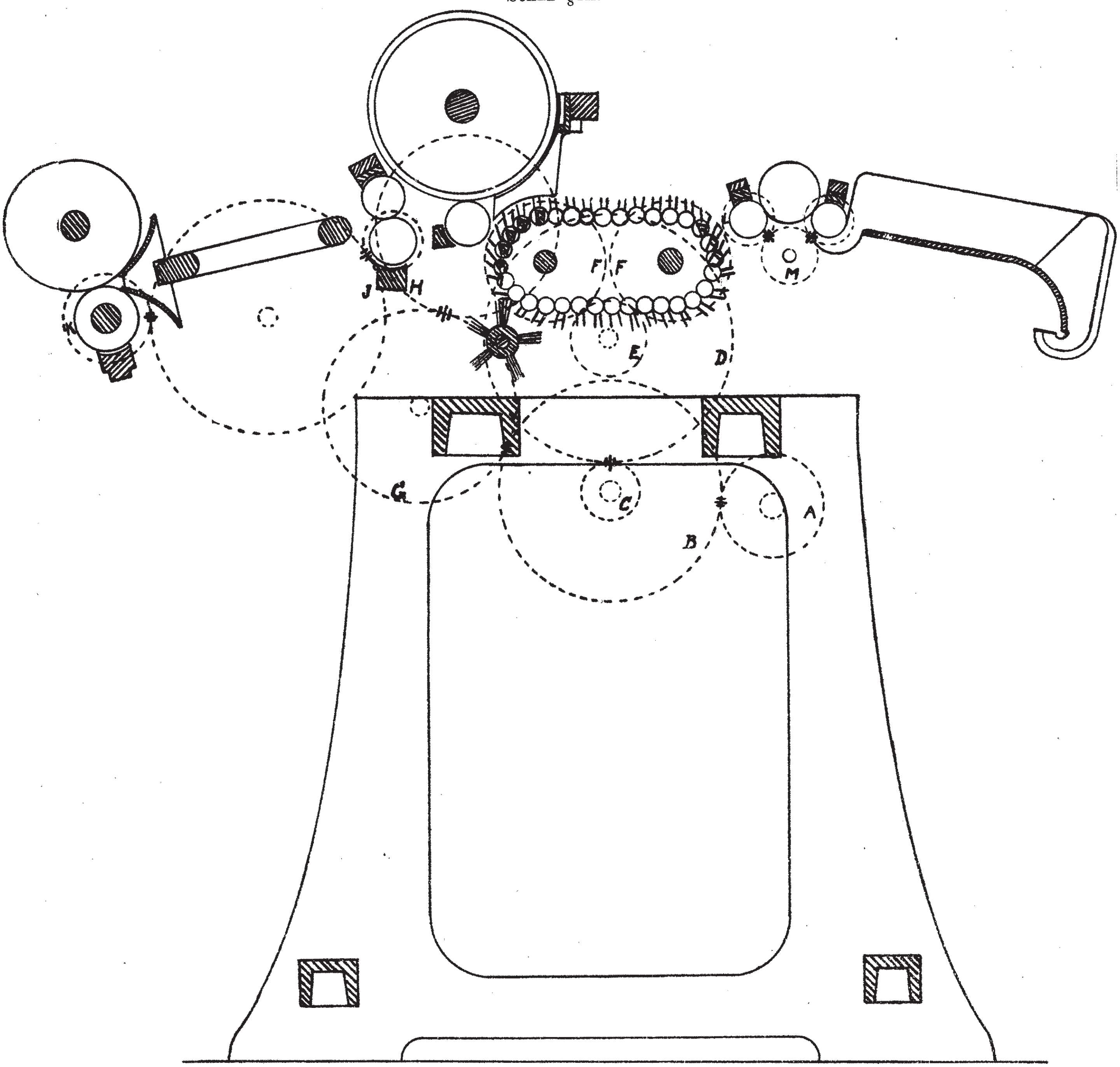
$$\frac{2\frac{1}{2} \times 76 \times 74 \times 50 \times 23 \times 32}{80 \times 19 \times 34 \times 39 \times 40 \times 1\frac{5}{16}} = 3{\cdot}3 \text{ draft.}$$

$$\frac{2\frac{1}{2} \times 76 \times 74 \times 50 \times 23 \times 32}{\text{C.P.} \times 19 \times 34 \times 39 \times 40 \times 1\frac{5}{16}} = 264{\cdot}9 \text{ constant for draft.}$$

PATENT SLIDE DRAWING FRAME.

Sectional Elevation showing Gearing at Driving End.

Scale $\frac{1}{8}$th.



PATENT PUSH OR SLIDE DRAWING FRAME.

Sectional elevation showing gearing at end opposite to driving pulleys.

SCALE $\frac{1}{8}$th.

A	Retaining Roller wheels,	... ...	32 and 33 teeth.
B	Stud wheel,	... ...	40 teeth.
C	Stud pinion,	... ...	23 teeth.
D	Intermediate,	... ...	64 teeth.
E	Faller shaft pinion,	... ...	39 teeth.
F	Stud wheel,	... ...	33 teeth.
G	Stud pinion,	... ...	23 teeth.
H	Brush wheel,	... ...	36 teeth.
I	Drawing roller pinion,	.. ..	28 teeth.
J	Intermediate,	... ...	130 teeth.
K	Delivery Roller pinions,	... ...	37 and 38 teeth.

Arrangements of Wheels for calculation of speed of gill bars—

$$\frac{{}^{*}180 \times 34 \times 20 \times 34}{56 \times 74 \times 50} =$$ 20·08 revolutions of gill bar shaft upon which is gill bar wheel 17 teeth into which bars work.

Then $17 \times 20{\cdot}08 = 341{\cdot}36$ speed of gill bars per minute.

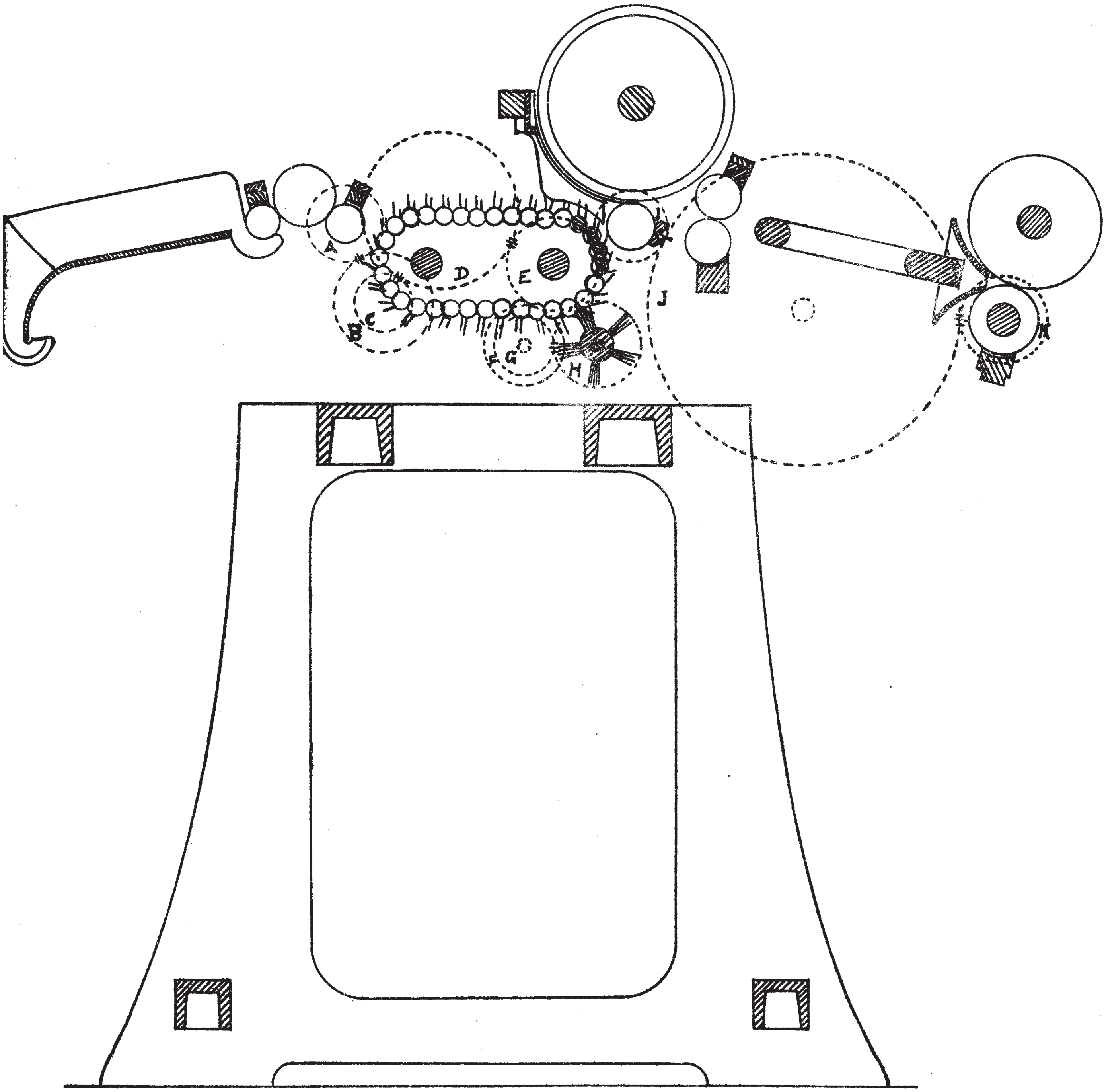
$$\frac{180 \times C. \times 20 \times 34}{56 \times 74 \times 50} = {\cdot}590$$ Constant Number for gill bar shaft.

*NOTE..—Speed Pulleys 180 revolutions per minute.

PATENT SLIDE DRAWING FRAME.

SECTIONAL ELEVATION SHOWING GEARING AT END OPPOSITE TO DRIVING PULLEYS.

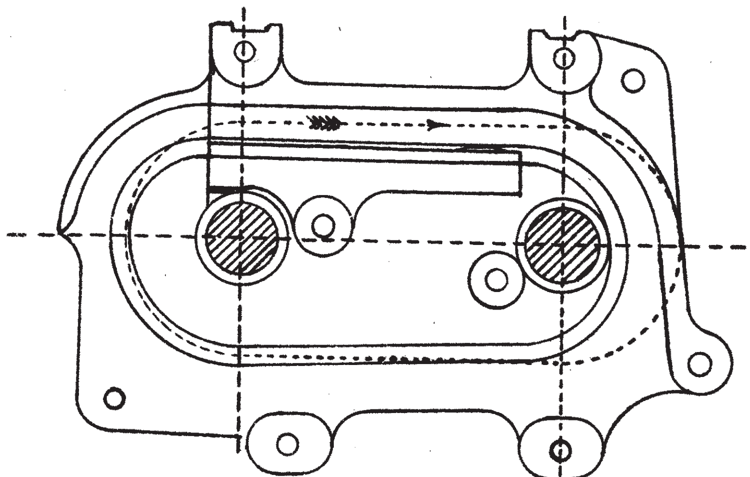
SCALE $\frac{1}{8}$TH.



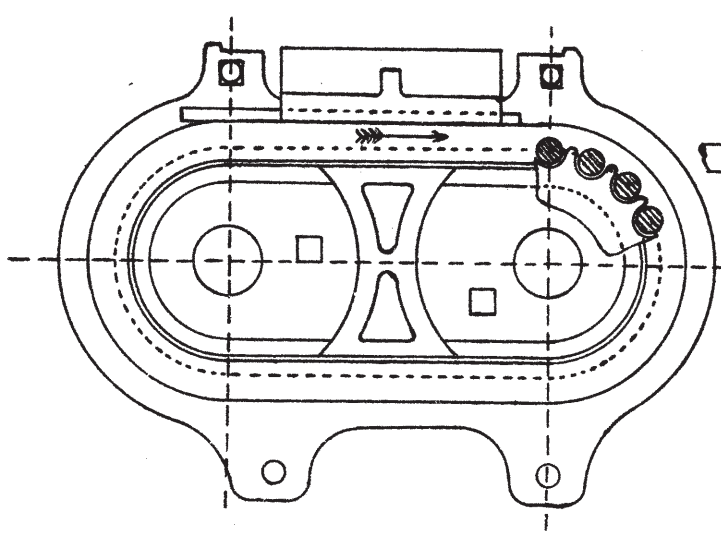
SLIDE FOR PUSH BAR DRAWING.

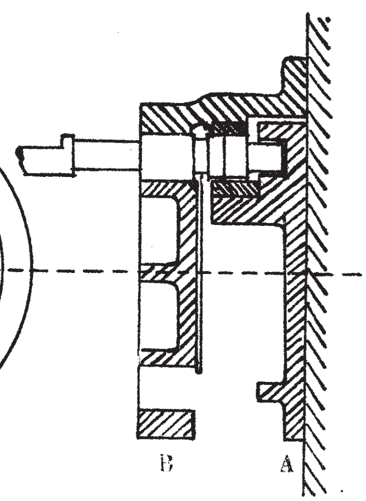
Scale 3″ to One Foot.

Elevation of Guide Plate "A" for pins on gill bar cranks.



Elevation of Guide Plate "B" for gill bars.

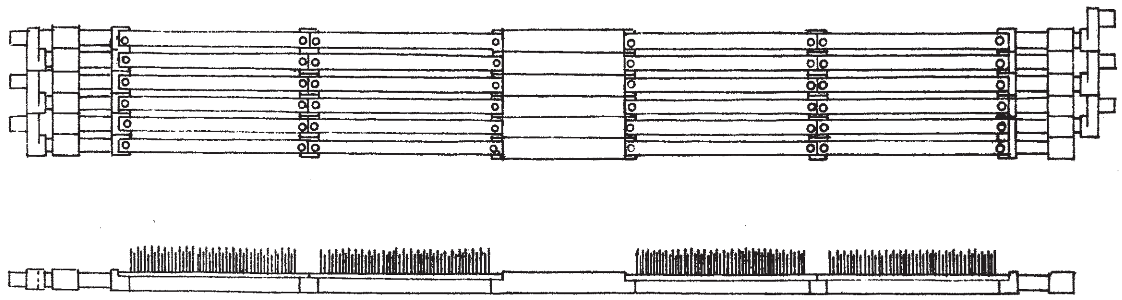


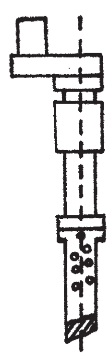


Sectional Elevation.

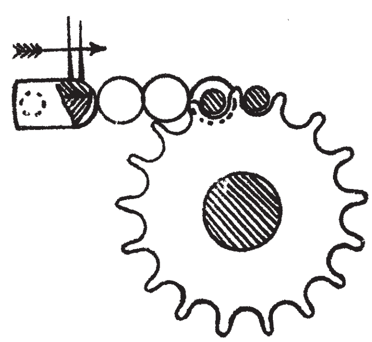
GILL BARS FOR PUSH BAR DRAWING.

SCALE $\frac{1}{8}$TH.





Gill Bar.



Elevation of Pinion and Cross Section of gill bar.

SPIRAL DRAWING FRAME.

Sectional elevation showing gearing at end opposite to driving pulleys.

SCALE $\frac{1}{8}$th.

A	Back shaft pinion, ...	25 teeth.
B	Intermediate, ...	25 teeth.
C	Stud wheel, ...	68 teeth.
D	Stud pinion, ...	25 teeth.
E	Retaining roller wheel, ...	69 teeth.
F F	Retaining roller pinions, ...	24 teeth.
G	Intermediate, ...	24 teeth.
H	Wheel for driving single back shaft (separate for each head,)	19 teeth.
I	Wheel on single back shaft, ...	19 teeth.
J	Bevil for driving screws, ...	21 teeth.
K	Bevil pinion on bottom screw, ...	14 teeth.
L	Drawing roller pinion for driving delivery roller, ...	41 teeth,
M	Intermediate, ...	88 teeth.
N	Delivery roller pinion, ...	56 teeth.

DRAFT ARRANGEMENT—

Pressing Rollers—Leather covered on a plain or V fluted roller—

$$\frac{2\frac{1}{2} \times 35 \times 68 \times 69}{43 \times 25 \times 25 \times 1\frac{5}{16}} = 7{\cdot}88 \text{ draft.}$$

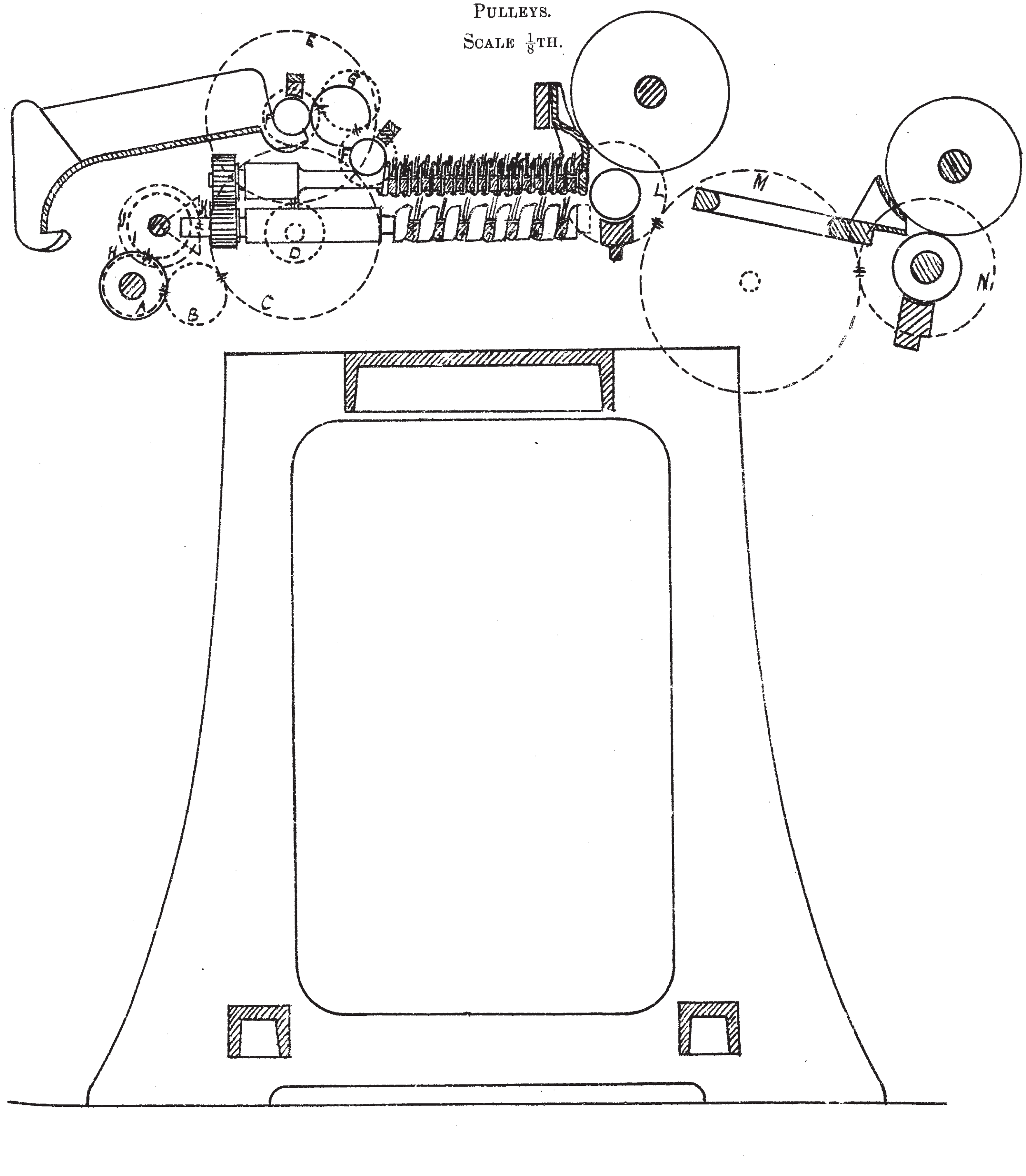
$$\frac{2\frac{1}{2} \times 35^{*} \times 68 \times 69}{\text{C.P.} \times 25 \times 25 \times 1\frac{5}{16}} = 339{\cdot}03 \text{ constant for draft.}$$

* If this pinion is a 34, 329·606 will be constant No.

SPIRAL DRAWING FRAME.

Sectional Elevation showing Gearing at end opposite to Driving Pulleys.

Scale $\frac{1}{8}$th.



SPIRAL DRAWING FRAME.

Sectional elevation showing gearing at driving end.

SCALE $\frac{1}{8}$th.

A	Draught Changes, ...	32 to 64 teeth.
B	Intermediate, ...	80 teeth.
C	Driving pinion, ...	24 teeth.
D	Intermediate, ...	32 teeth.
E	Back shaft pinion, ...	34 teeth.
F	Wheel for driving single back shaft (separate for each head), ...	19 teeth.
G	Wheel on single back shaft, ...	19 teeth.
H	Bevil wheel for driving screws, ...	21 teeth.
I	Bevil pinion on bottom screw, ...	14 teeth.

Arrangement of Wheels for calculation of speed of gill bars—

$$\frac{{}^*160 \times 30 \times 19 \times 21}{35 \times 19 \times 14} = 205 \text{ speed gill bars per minute.}$$

$$\frac{160 \times \text{C.P.} \times 19 \times 21}{35^* \times 19 \times 14} = 6{\cdot}85 \text{ constant No. for gill bars.}$$

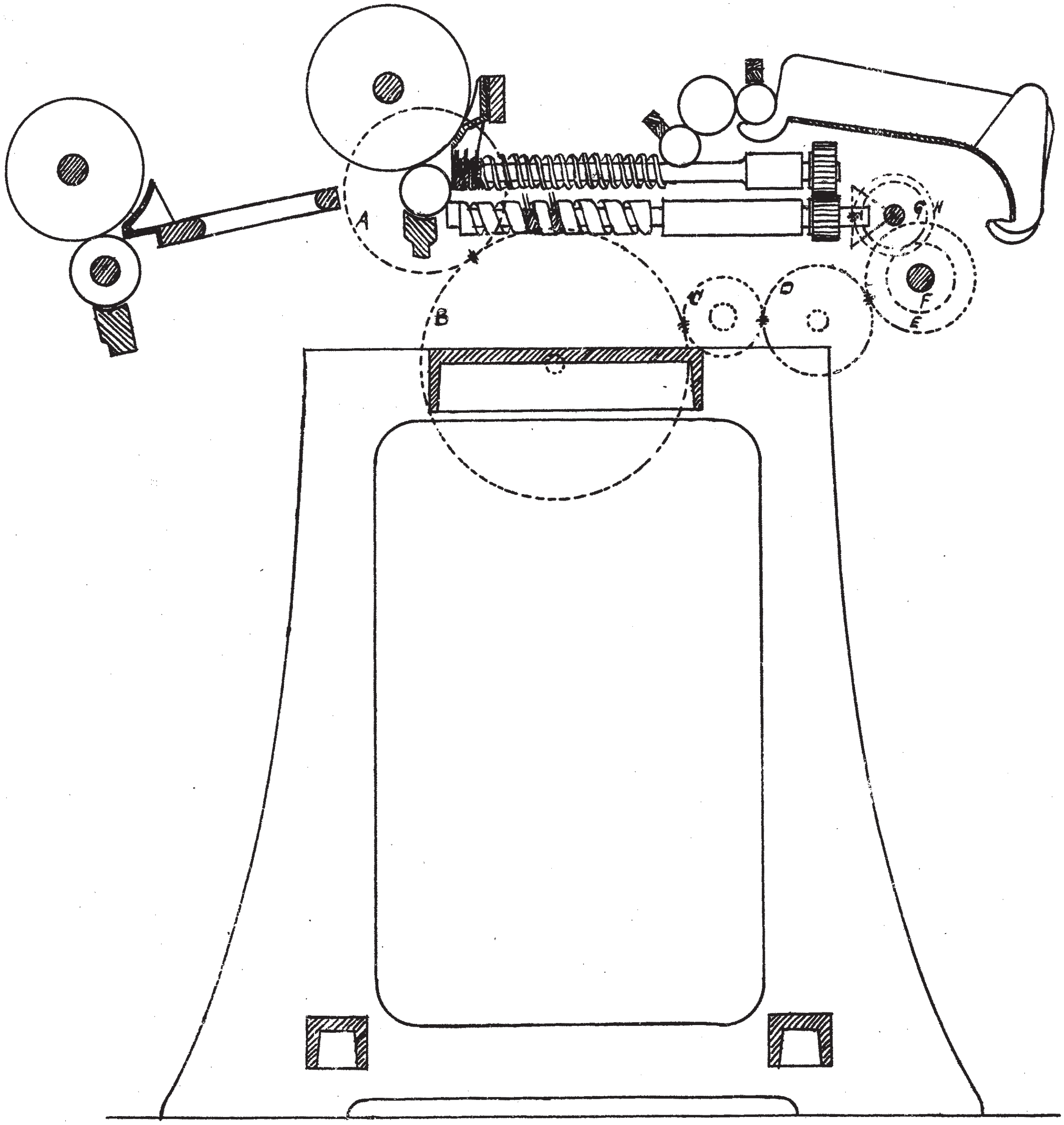
* If this Pinion is a 34, 7·05 will be constant No.

*NOTE—Speed of Pulleys 160 revolutions per minute.

SPIRAL DRAWING FRAME.

SECTIONAL ELEVATION SHOWING GEARING AT DRIVING END.

SCALE $\frac{1}{8}$TH.



BEND AND SCREWS.