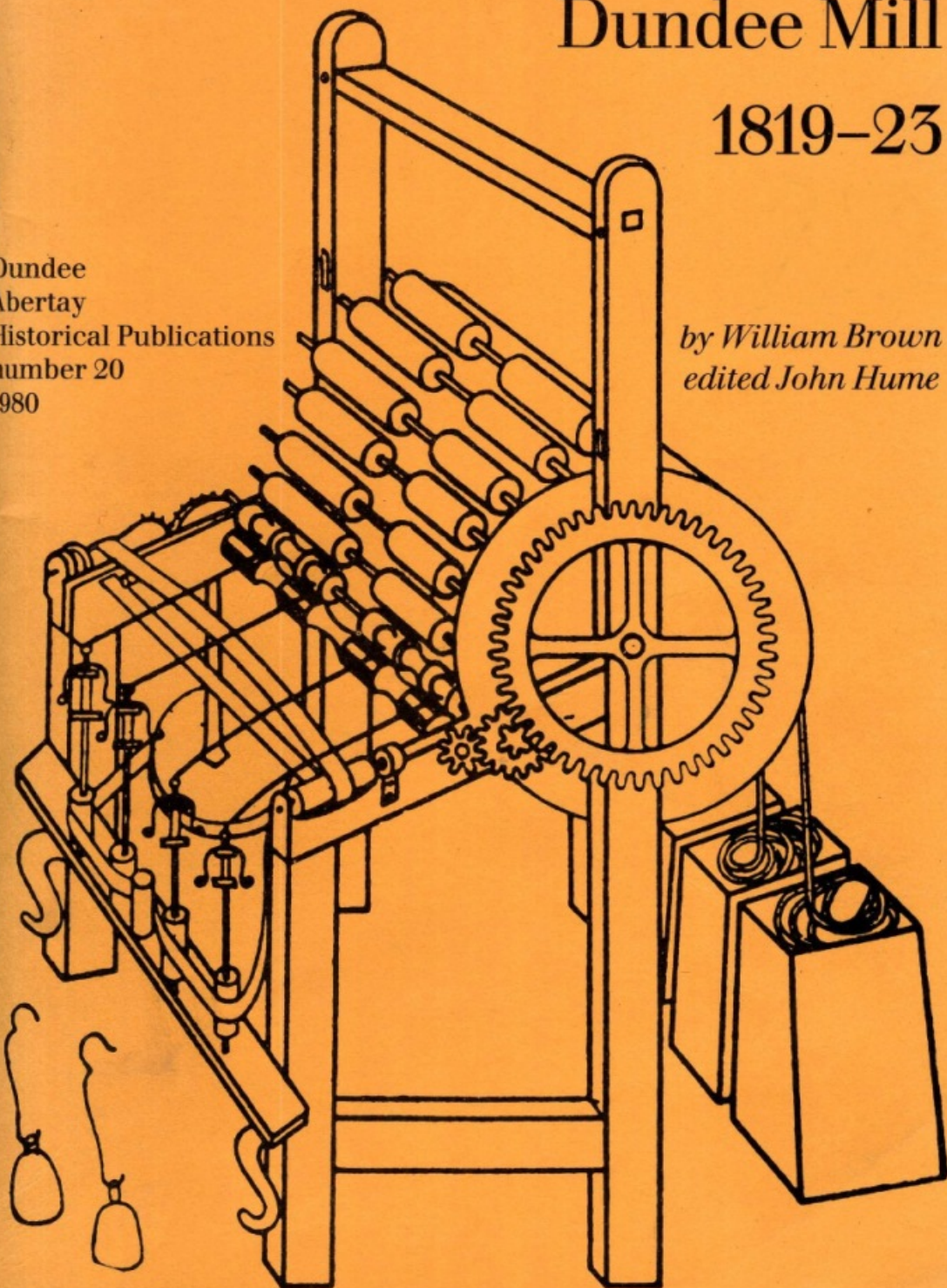


Early Days in a Dundee Mill

1819-23

Dundee
Abertay
Historical Publications
number 20
1980

*by William Brown
edited John Hume*



The Abertay Historical Society

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Early Days in a Dundee Mill 1819-23

*Extracts from the diary of
William Brown, an Early Dundee Spinner
edited by John Hume*

Dundee Abertay Historical Society
Publication Number 20 - 1980

Acknowledgements

The Abertay Historical Society must record its gratitude to Dr. J.R.L. Halley who was responsible for the very survival of the material for this publication. It was he who procured a typescript copy of the original manuscript of William Brown's Essays before it disappeared on the death of the owner. He presented a copy to Dundee University Library and brought it to our attention with the suggestion that it should be published. In addition, he has given us the benefit of his time and long experience in the textile industry to help us with several words and phrases whose meaning we were unable to discover in textbooks.

Certain limitations have been put on this edition by the loss of Brown's own notebook. It is impossible to be completely certain whether all the punctuation, spelling and figures are his or the typist's. At several points, the editors have had to use their discretion, where the context indicated more likely alternatives than the typescript version. Even worse, his sketches of different types of machinery, not copied when the typescript was made, have now disappeared for ever.

Despite these reservations, however, the Society considered that the document deserved a wider readership than those who have access to Dundee University Library and to the City of Dundee Archive and Record Centre, to which Dr. Halley has also presented a copy. We have to thank Mr. John Hume of the University of Strathclyde for undertaking the task of selection and comment.

Annette M. Smith
Honorary Editor
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INTRODUCTION

Dundee has been fortunate in the personal records left by its textile pioneers. Alex J. Warden, a Dundee merchant, published in 1864 *The Linen Trade Ancient & Modern* which contains the best nineteenth century history of a Scottish industry, prepared from personal recollections as well as from documents. Peter Carmichael, engineering genius behind the success of Baxter Brothers, wrote an autobiography which, edited by Enid Gauldie, forms a substantial part of *The Dundee Textile Industry 1790-1885* (1969). William Brown, whose *Essays* are published here for the first time, presented to the public his *Reminiscences of Flax Spinning* in 1861.

Of all the substantial accounts of the early Dundee linen trade, Brown's essays have in many respects the most appeal to modern man. For Brown was not concerned with retrospective analysis, and only to a limited extent was he putting on paper the everyday trivia of a mill-manager's life. His intention in writing the essays was "to improve the author of them in the knowledge of his business and to assist him in the management of it" and the entries have both coherence and clarity. They have as well freshness and immediacy. From them emerges a picture of a young man coming to terms with problems novel in a Dundee context, drawing inspiration from his knowledge of factory masters elsewhere, and adopting a cool, rational, scientific approach based on eighteenth century ideals. Yet his coolness is tempered by speculation, and Brown is revealed as a humane man, in no sense an exploiter of his workpeople, and sensibly rather than obsessively concerned with-profit and with innovation.

William Brown was the youngest of four sons of James Brown, a pioneer of water-powered flax spinning. His father operated Trottick, Friockheim and Arrat Mills, in rural Angus, before building the steam-powered West Ward or Bell Mill in Guthrie Street, Dundee, in 1806-7. This was a pioneering enterprise, largely of fireproof construction, with a twenty-five horsepower engine driving Leeds-made machinery.

According to Warden, the mill cost £17,000 and "for twenty years... stood unmatched in the town". It was not, however, the first steam-powered mill in Dundee. Two small-scale mills were built in the early 1790s, but both failed. In 1798, however, a tannery in Guthrie Street was converted to a mill by George Wilkie of Achlishie, near Kirriemuir, who installed a twenty horse-power Boulton and Watt engine to drive the machinery. This became known as the East Mill, and it was taken over by the three younger Brown brothers, the eldest, Andrew, remaining with his father at West Ward. The new proprietors almost immediately ran into a depression, and the mill was closed for some months in the autumn of 1810 and the spring of 1811. They had a struggle to keep going until 1816, but after that trade picked up, and the mill remained profitable until the mid 1820s depression.

William became manager of the mill in 1810. At first he had no responsibility for the commercial side of the business, and concentrated on production, which fascinated him. He was, according to Warden, the leader in making the improvements which rendered the spinning of tow a practical and commercial possibility. From the dates quoted by Warden it appears that Brown was involved in this development before 1814, and it certainly seems to have been virtually completed by the commencement of these essays. John Brown left the partnership in 1817, and it may have been the increased responsibility falling on William that stimulated him to jot down his ideas and comments.

Dr. Dennis Chapman's article "William Brown of Dundee, 1791-1864: Management in a Scottish Flax Mill" published in Explorations in Entrepreneurial History in 1952, which makes extensive use of Brown's own writings, also draws together other references to Brown's life. These indicate that the concern for the well-being of his workers which unobtrusively underlies many of the essays was carried into his later life. The partnership provided schoolrooms and teachers for young workers, and a newspaper room for older people. Great pains were taken to box in machinery and to ensure proper ventilation in the mill. Seats were provided in the spinning rooms and also an early form of "Music While You Work"; the foreman played the violin as he

walked up and down the factory floor on his supervisory duties. In general the workers seem to have been well satisfied. Chapman quotes the views of two female employers one of whom stated to the Factory Enquiries Commission that "there cannot be better employers" and the other "that she believed Messrs Brown the finest masters in this town". According to their evidence Brown gave sick relief and also kept employment open during sickness. Writing in the early 1860s Warden commented that "although Mr. Brown has retired from his favourite trade, he is still an enthusiastic spinner, and takes delight in witnessing the onward progress of mill spinning". This observation was echoed in his obituary, which commented "never during his long life-time did his enthusiasm for his favourite trade flag or falter" (1).

* * * * *

As might be expected in pieces written intermittently by a busy man, the essays contain a certain amount of duplication. In addition some of his observations are verbose, and technical comments are usually rather detailed for the general reader. The manuscript has therefore been rearranged, and summarised where appropriate to reduce it to a length suitable for publication. Neither Brown's accounts nor any sums of money he mentions have been adapted to modern usage. Readers are reminded that before decimalisation twelve pennies or pence (12d.) made one shilling (1/- or 1s.) and twenty shillings equalled one pound (£1).

John R. Hume
June 1979

1) Quoted by William Norrie in *Dundee Celebrities* (Dundee, 1873) 245.

PREFACE

Essays on Flax-Spinning and Remarks on the Management of East Mill, Dundee (1)

by William Brown, the Manager, 1819.

The chief object of these essays is to improve the author of them in the knowledge of his business and to assist him in the management of it. They are meant to be composed of such circumstances, occurrences, rules, regulations, descriptions and hints for improvements at East Mill, as may appear useful to be perused or remembered afterwards. It is evident that by means of such essays much useful information will be preserved which would otherwise be lost; and when it is considered that in the flax-spinning business nothing can be obtained from books, all from observation or enquiry only, the reading or writing of essays must be particularly useful to exercise the understanding and to refresh the memory. Without essays or something similar one's knowledge must necessarily be limited, but with them there can be no bounds to knowledge, and he who makes a right use of them will learn more in a few years than he who does not will learn in a lifetime. Surely all managers of extensive, well-conducted works must write much otherwise they could never establish order and discipline among their hands, nor improvement and regularity in the construction and arrangement of their machinery. These essays therefore will embrace everything of importance relating to the management of the East Mill and show not only a comprehensive state of it at different times but likewise many little circumstances regarding everyday transactions whether respecting machinery, hands, operations, or flax. If anything be wanting to make them either useful or entertaining, it is a taste in the author for carrying on, or a clear head for describing.

East Mill, March 11th, 1819.

1) Spinning, up to the winding of the thread, is carried out in a mill. The processes of starching the warps and weaving take place in a factory.

APOLOGY FOR MY WRITING

If this book should ever fall into the hands of persons given to literary criticism but unacquainted with the business of spinning, the great probability is that they will despise it as low and vulgar and call me everything but learned. To such persons I must here address a few words. My writings in point of style and composition I readily admit are inferior to most books given to the public by learned authors. To acknowledge this I count no dishonour, as I never intended my writings but for private use. Had I been a man of leisure I should have considered myself highly reprehensible for not producing something better, but as I am my case is different. My education when at school was at best but scanty not costing more than £50, and ever since my eighteenth year I have been almost closely occupied toiling in a ruinous mill. My writings have all been done in the merest snatches of time, and are rendered meaner still by the meanness of the language used in spinning. No book of consequence is published on the subject, so that I have had no opportunity of learning anything from others - a case almost entirely singular, few professions being without their books. Thus far I plead excuses for my style and composition; but as to the matter I hope I am not so faulty. In this my constant guide has been- truth, practice, and experience; and I have seldom inserted anything without previously considering it over and over, altering and correcting it. Vague theories, useless suggestions and doubtful propositions I have avoided, and I have never written anything to amuse or to mislead. From all which considerations, I hope my book will not be looked upon as entirely without merit but that it will be thought a tolerable performance of its kind.

1821.

THE MILL AND ITS WORKING

History of East Mill

This work was erected by Geo. Wilkie in the year 1799 (1). The buildings had previously been occupied as a Tanage (2), and most unluckily were converted into the spinning mill with too little alteration. The main body of the house was only 26 feet wide; others are 36. The doors, windows, stairs etc., were irregularly placed and the work in general but ill arranged. Some of the floors however, the roof, and most of the heavy machinery were uncommonly substantial, and have as yet suffered little from decay. The steam engine was constructed by the celebrated Watt and Bolton [sic] of Birmingham, and the spinning machinery for the most part made at the mill. Mr. Wilkie carried on the business irregularly, and it is said unsuccessfully for about 10 years, during which time trade was often bad, spinning machinery was but ill understood and ill managed, and for the steam engine nobody could lay a hand upon it but English engineers who had often to be sent for tho' little was the matter, and who created an immense deal of stoppage and expense. In September 1809 Mr. Wilkie sold the whole work with a towyard and dwelling house to the present proprietors for £11,500. The mill then contained 25 spinning frames of 30 spindles (3) each, 2 of 24 spindles, 7 carding engines, and some flax and tow roving frames all in a very poor state of repair. The steam engine also which was of 20 horses power, was in a ruinous state, the warehouses for the most part were nasty inconvenient hovels, and the roads and millyard scarcely passable for filth, mud and open drains. The new proprietors no sooner got possession than they set about making a reformation. They improved and almost renewed the steam engine; they enlarged and improved the carding room by throwing aside many superfluous shafts and pillars, and in general repaired the whole mill, laying out nearly £3000 addition to the original price. The repairs however on most of the machinery were but poorly and injudiciously executed owing to the ignorance of the workmen and superintendants; much money was wasted foolishly, and many things left undone that ought to have been done. In February 1810 the new proprietors commenced spinning and one of themselves, though quite inexperienced in the business, was appointed manager.

Owing to the want of hands, the insufficiency of the machinery, and the inexperience of the manager, little progress was made till the end of the year, by which time most of the frames had been got started; but by which time also trade had

1. *Warden gives the date 1798.*
2. *anglice - tannery*
3. *Throughout this work, spindle refers to a part of a machine on which roving or yarn is wound, and spyndle to a quantity of finished yarn, 14,400 yards in length.*

grown so bad, and the company had got so involved in pecuniary difficulties, that the whole was again stopped and for some months the doors were locked. In the spring of 1811 a second beginning was made and with the exception of a few turns of bad trade, the work has been steadily carried on since.

During 1812 and 1813 the daily performance of the mill was from 200 to 220 spyndles of yarn partly 3 and 6 lb flax, and partly 6 and 8 lb tow (1); twenty fiveframes were going and the expense amounted to about 10d per spyndle. The waste on the spinning of flax yarns runs from 8 to 10 percent and on tow from 16 to 20. In 1814 and 1815 trade being pretty good, the mill being tolerably well supplied with flax, and great part of it employed on heavy lint yarn the quantity of spinning per day ran from 240 to 260 spyndles, the expense still however standing about 10d per spyndle, and the waste as before. Various alterations were carried on and improvements attempted but nothing of importance took place. Spinning machinery in those days was less attended to in repairing than it now is, and hands were under less management and discipline.

During 1816-17-18 the mill being greatly in demand, and considerable rivalry existing among millspinners in general, great advances were made, and much substantial improvement executed at East Mill. In the spinning of tow yarn especially great improvements took place; they were effected partly by reducing the thickness of the carding, partly by using short-heads on the spinning frames (2) partly by keeping the machinery in better condition and partly by holding the hands in more regular order and discipline. The quantity of yarn now spun daily amounted to 350 or 360 spyndles, sometimes even upwards of 400; it was mostly 3 lb flax and 6 lb tow yarn, no heavy sizes as formerly (3). The expense did not exceed 6½d per spyndle, and the waste both on flax and tow was reduced one third. In estimating the expense, everything was included, but hackling and interest of money; and in calculating the waste, the neat difference was taken between the drest flax or tow and the bundled yarn. Correspondent to improvements in the quantity of tow, yarn of 6 lb per sple now almost superseded flax yarn of same weight, and cloth made from it in many cases passed without being known.

1) *Natural flax; as it came to the mill was a mixture of short and long fibres. The short fibres were removed by heckling (i.e. combing) as tow, leaving the longer fibres as flax or line, a term used to describe dressed flax, in a fit state for spinning. Flax yarn could be made finer and stronger than tow. When Brown began spinning, tow was almost worthless. His skill and care as a spinner eventually enabled him to produce in his mill a 'uniformly even tow thread, suitable for weaving into cloth.*

2) *'Using shortheads on the spinning frames' - in technical terms, reducing the drafting on the spinning frames. For the layman - shortening the distance between the upper and lower rollers.*

3) *Heavy sizes - heavy or coarse yarn.*

General description of East Mill

Its local situation possesses many advantages over others in the same trade. Dundee is the chief town in Scotland for the importation of flax and the manufacture of linens; it contains many hands bred to the Spinning business, several good engineers, and abundance of mechanics. Coals can at all times be easily had, and every other article is at command. Water indeed is sometimes scanty, and of a quality hurtful to the boilers of the steam engine, but a sufficient supply can at all times be got by making use of a pond.

In size the mill house is 98 feet long and 26 wide within walls, exclusive of room for the steam engine, and contains three floors and a garret. The house in general is clumsy, ill arranged and ill proportioned; its width is ten feet less than it ought to be; the doors, windows, stairs and partitions are irregularly placed; and the lower storey is sunk several feet below the level of the ground; the building however, the roofs, floors and pillars are very substantial, and nothing seems much decayed but the doors and windows. The lower flat is occupied with flax and tow preparing machinery; the second with spinning machinery and mechanics shops; and the third with reels, which require only one half of it. The steam engine house and boiler house are large and commodious; the warehouses numerous and capacious tho' clumsy and inconvenient; the heckling house and counting house good, and the roads and mill yard dry and roomy.

In extent of machinery the East Mill contains 25 spinning frames, each having thirty spindles; 15 of them are adapted for flax yarn, and 10 for tow. Of flax preparing machinery there are 4 double bell carriages (1) each employing two spreaders; four carriages of second drawing, and 8 carriages of 16 spindles of roving (2). Of tow preparing machinery there are 3 breaking and 10 finishing cards. The main cylinders of the breaking cards are each 3 feet in diameter and have two sheets of card cover upon them each two feet broad; the main cylinders of the finishing cards are each 3 feet in diameter, and have one sheet of card cover (3) upon them the breath (4) of which cards is 130 turns per

1) Double bell carriages : a bell was used to indicate the flax had reached a required length.

2) Drawing is the process in which the sliver, or loose rope of carded fibre, is drawn out and slightly twisted to reduce its diameter. The drawn fibre is then fed into a roving machine, which repeats the process, producing ravings from which finished yarn can be spun.

3) Card cover consisted in Brown 's time of leather into which fine steel pins or teeth had been inserted.

4) This must be a typing error. The passage describes the speed of revolutions of the cards, but we do not know what word Brown used.

minute, and of those of the finishing cards 150. Of roving machinery there are 28 spindles contained in 3 frames. The number of reels is 14, each holding 12 bobbins. The machinery is all driven by a steam engine of twenty horses power, with two boilers.

The steam engine in its present state may be said to be as well constructed and as substantial as any in Dundee. Its late repair by Jas. & Chas. Carmichael (1) put it almost on a footing with a new engine. No part of it is now thought deficient excepting the air pump, which is a little worn in the inside. The boilers were thoroughly repaired, one in 1816 and another in 1818, and as yet seem sound and strong; in short, the whole steam engine is in a comfortable state, and does its work with a moderate quantity of fuel.

The main horizontal shaft proceeding from the steam engine along the top of the lower flat, and its couplings wheels and drums are all substantial and in good condition, excepting the main coupling at the flywheel shaft which is thought to be rather in a decaying state, and which needs not be trusted for many years. The main vertical shafts, each of which drives four spinning frames, are all in good order and have no appearance of disrepair. The short shafts with their wheels, brackets, plumber blocks (2) and catches, which carry motion from the main vertical shafts to the spinning frames, are slender complicated things, fit only for being thrown aside, and replaced with something more simple and substantial.

The spinning frames for flax yarn are all on the old cylinder construction, divided into five parts or carriages each of which has a vertical shaft driven from a horizontal one below extending the whole length of the frame and receiving motion from the short shafts. On this vertical shaft is a light rim or pulley which gives motion, by means of belts, to the spindles, one belt to each couple of spindles. Top rollers are used on the cylinders for receiving holding the roves; and for preserving them in twist while drawing, intermediate ones rest on the front of the cylinders. The spinning frames for tow yarn are on the same construction, excepting that they have short roller heads in place of cylinders. These heads were lately erected, and are of the best construction and workmanship. The spindles of the tow frames are in tolerable order, but most of them being the original, are far from being good. The spindles of the flax frames are mostly new, and excellent of their kind. The length of the bobbins, both for flax and tow yarn is 21 inches inside, and 4 over ends; the breadth or diameter is 11 for flax, and 2J for tow. The flyers for flax yarn are 3j long and 2\ wide inside; for tow yarn 4 long

1) James Carmichael is one of the subjects of an earlier Abertay Historical Society Publication, No. 13. S.G.E. Lythe, J.T. Ward and D.G. Southgate, Three Dundonians.

2) Plumber of plumber blocks are bearings in which shafts run.

and 3 inside. The distance between the spindles, both on flax and tow frames is $3\frac{5}{8}$, some $3\frac{1}{4}$.

The bell carriages for flax preparing (1) are on the cylinder construction with pikes for holding the flax; the spreading table attached is $7\frac{1}{2}$ feet long; the machine is new, substantial and convenient. The second drawing and roving machinery is also on the cylinder construction, though without pikes, but being nearly twenty years old it is slender, ill proportioned and unhandy. In tow preparing machinery the breaking cards are modern and substantial, having cast iron framing, but are clumsy and inconvenient; their operating parts consist of a main cylinder, feeding rollers, cleaner, frizzer, doffer, drawing rollers and delivering rollers. These are not workers. The main cylinder acts upon the upper feeding roller. Two of the breaking cards have Steads patent card cover upon them, one No.2 No.16 another No 14; the third has a coarse common cover and all are in good order, little worse than new. The finishing cards are mostly old, slender and coarse; their operating parts however are tolerably well constructed, and the staves of the cylinders are in good condition. Like the breaking cards, they have no workers, nothing but the indispensable operating parts. Being old their main cylinders act against the lower feeding roller. The card covers being mostly the original, one of the common plain pointed kind, their quality is similar to what is still approved of; some having wrought at least sixteen years, are worn very short in the teeth and the teeth very slack in the leather, but with frequent sharpening and careful keeping they do the work almost as well as new ones. The cards, both breaking and finishing are closely boarded in all round with thin boards placed within half an inch of the points of the teeth; and at the ends of the cylinders within $1/16$ of the staves. The roving frames are all old and ill constructed, but being modernised as far as possible and kept in tolerable order, they do their work surprisingly well.

The following statement shows the number of hands employed in the whole and the particular parts of the work, and their weekly wages:

Flax preparers

1	overseer	£	0-16-0	
7	Spreaders 5/0		1-15-0	
7	rovers, frameminders, doubler etc and spare hand..		0-19-0	
15			3-10-6	(sic)
	Extra wages of spreaders 2/6d, of overseer 1/3		0-3-9	
		£	3-14-3	

1) Preparing flax for spinning involves scutching (cheating or breaking to separate the wooden parts from the fibre) and heckling (combing out the resulting strands of various thickness)₁ as well as drawing and roving. Carding is part of the process of preparing tow.

Tow preparers

1	overseer	£	0-17-0
1	tow carrier, a stout woman		0 -7-0
1	sweeper, picker		0 -4-6
6	feeders - boys from 10 to 14 years		0-18-0
12	rovers, card minders - boys		1-10-0
21			3-16-6

Extra wages of overseer 2/7

Prens (1) to boys 4/-		6-7
	£	4-3-1

Spinners

1	overseer		0-12-0
1	oiler, cleaner, belt-sewer		0 -8-0
2	rove piecers		0 -5-0
25	spinners		5-12-6
13	shifters, one to each 2 pas., some 2/-, 2/6d and 3/-		1-16-0
1	spare spinner		0 -4-6
1	spare shifter		0 -3-0
2	learners, wages equal to others absent		0 -0-0
46		£	9 -1-0

Extra wages - 25 spinners at 1d per spyndle for
what is spun above 9½ sps. p frame pr. day of flax yarn and 10½
p frame pr. day of tow yarn the frames in pairs - some rather
lower

	£	2-16-4
		0-7-0½
Overseer ⅓ of spinners	£	12-4-4½

Reelers

1	overseer	£	0-12-0
7	reelers at 4d a dozen, both lint and tow yarn		2-13-0
3	learners		0-12-0
1	bobbin carrier		0-3-6
12		£	4-0-6

1) Probably presents - rewards to casual labour.

Mechanics

1	general overseer	£	1-10-11
2	common mechanics, 17/- and 18/-		1-15-0
1	turner, an apprentice		0-10-0
1	Fireman		0-15-0
1	warehouseman, shop-keeper		0-10-0
1	yarn binder		0-13-0
1	porter, lamplighter etc		0-6-0
1	night watchman		0-4-0
1	clerk or errand runner		0-3-6
10		£	6-6-6

Abstract

15	flax preparers	£	3-14-3
21	tow preparers		4-3-1
46	spinners		12-4-4
12	reelers		4-0-6
10	mechanics etc		6-6-6
104		£	30-8-8

Besides the above there are 14 or 15 flax dressers constantly employed, but as the flax dressing is a separate business from the spinning no notice need be taken of them here.

There are also two general managers in the business, one for the providing of flax, disposing of yarn, keeping the business books etc, another for attending the spinning operations, providing hands and materials, paying wages, accounts etc. Both are partners of the company and secure salaries, the former a hundred pounds per annum and the latter a hundred and fifty. The firm of the company is James, John and William Brown. Their chief business is hire spinning, which requires less capital, and has less risk of bad debts than spinning flax on their own account. The prices for hire spinning during the last year ran from 9d to 10d per spynkle for 3 lb flax yarn, and from 10 to 11d for 6 lb tow yarn. There was also an allowance of 2/6 or 2/9 pr cwt for heckling. The parcels of flax received from the merchants stood in size from 3 to 15 tons.

The quantity of yarn spun by the mill from Whity (1) 1818 till Whity 1819 was 109,239 sps, most of it 3lb flax and 6lb tow. The number of working days during that time was just 313, but 7 were lost to the mill on acct of holidays and stoppages for repairs. In each of the remaining 306 the quantity spun averaged 357 sps., being at the rate of 14 7/25 sps pr frame pr day, each day containing 12 1/2 hours. Of flax yarn the quantity spun daily per frame stood rather under 14 sps and of tow rather above 15.

The Weekly Expense of Carrying on the Mill

From Whitsunday 1818 Till Whity 1819, averages as follows:

<i>Wages, as stated before</i>	£	30 - 8 - 8
<i>Coals, 10 1/3 tons @ 13/10</i>		7 - 3 - 0
<i>Green oil, nine pints @ 2/6</i>		1 - 2 - 6
<i>Whale oil (253 galls, £42 7 during the season)</i>		0 - 16 - 3
<i>Tallow 211 lbs @ 10d</i>		0 - 17 - 6
<i>Listing (1) for spinning frames 36 yds @ 2/4d</i>		0 - 7 - 6

Sundry articles paid weekly consisting:

ironmongery ware, foundry ware, tinsmith ware, blacksmith work for ordinary repairs, leather cloth, brass, wood, rollers, bobbins, rosin, chalk, soap, brushes, hemp, tar, rope, yarn, sandpaper, baskets, bricks, lime, tiles, stones, mason's work, slater's work, repairs on furnace flues, cleaning ditto, drink to men, dog's meat, packing for engine, whitening, black and white lead, lump lead

4 - 6 - 6

<i>Repair on steam engine</i>	£107	
<i>Repair on boiler</i>	42	
<i>New chimney</i>	36	
<i>New card cover</i>	27	
<i>New heads for six tow frames</i>	80	
<i>New causes (2) (6 doz)</i>	19	
<i>New card engine secondhand</i>	18	
	£329 by 52	6 - 6 - 6

<i>Managers' salaries</i>	£250	
<i>Fire insurance on mill</i>	42	
<i>Do. on warehouse and goods</i>	8	
<i>Feu duty on mill yard</i>	21 - 5 - 0	
<i>Do. on dwelling house, heckling house, garden</i>	9 - 13 - 0	
<i>Taxes on two overseers</i>	0 - 6 - 0	
<i>Cess on trade</i>	0 - 0 - 4	
<i>Taxes on one dog (3)</i>	0 - 0 - 8	
<i>Poor rates</i>	0 - 1 - 0	
<i>Subscription to infirmary</i>	0 - 2 - 2	
	£340 - 12 by	6 - 11 - 0
	52	
<i>Total Weekly expense.....</i>	£	57 - 19 - 5

-
1. *Belting*
 2. *Presumably cards*
 3. *The dog is mentioned later in reference to night-watching. Plan of Management, p. 35 and 48.*

The expense of spinning each spyndle of yarn stands @ 2/3 d. The different items are shown in the foregoing statement. Nothing else was incurred but shop rent and counting house expenses, amounting in all to about £15 which properly go to another account. It will be observed that a great sum was expended for extraordinary repairs and improvements on the mill. There was also a considerable sum paid for new spindles, flyers, spindle frames, etc., but this was paid with the weekly accounts. Interest of the capital advanced should perhaps form part of the expense of spinning, but no notice can be taken of it here. For tear and wear of machinery no allowance need be made, as the mill is growing better every day.

The quality of the yarn as it is presently made, both flax and tow, is not amiss. The flax yarn gives tolerable satisfaction, but is not thought superior to other people's. The tow yarn is reputed the best in the country.

The Conducting the Work

There are no fixed written rules to walk by, but the following general ones are commonly observed:

That the working hours of the mill be 12½ each day, beginning in summer at half past five in the morning, in winter at 6, stopping 45 minutes for diets ,at 9 and 2, and ceasing in the evening at half past seven in summer and 8 in the winter; all lost time arising from repairs, market days etc, excepting holidays, made up. That the hands excepting the men, be all kept under regular written or printed engagements, the engagements to be null if the work be stopped from bad trade or other circumstances. That the hands be all made to give regular and strict attendance and none to be paid for absent time. That as many of them as possible be kept on piece work, and the whole constantly held strictly at their duty. That bad ones be at all time quickly got rid of and replaced with good. That the wages be not squeezed down to the utmost, but rather kept up, to ensure a supply of good hands. That the mill in general to be kept clean, well aired and free of bad smells and to make it healthy, that it be whitewashed at least once a year. That the machinery be always kept in the best state of repair, and never allowed to want anything that may, consistantly with prudence, be deemed useful to it. One good mechanic must be constantly employed in the card room and another in the spinning room. That improvements and alterations in the machinery be constantly held in view, seeing that other mills are increasingly advancing in improvement.

Besides these and many more, there are numerous particular rules and regulations observed in carrying on the work, but this description not being a particular one, they cannot be described here.

The business of the general overseer, who is an experienced mechanic, is to conduct the department of flax spinning, the reeling of the yarn both flax and tow, the mechanical operations, and the steam engine; he also has charge of the keys of the mill and occasionally provides the wood, tools and other materials. All he does however is under the inspection and control of myself as general manager and he is employed chiefly for saving me part of the drudgery and giving me time for attending to the management and improvement of the tow spinning department with which he has nothing to do.

Facts, Maxims, etc.

- 1) There is nothing I am more aware and convinced of than that improvements will continue to be made in the art of spinning till the present state and system of machinery and management be entirely behind and unfit for use. Whoever, therefore, makes no effort to get forward either in leading or following will soon be outdone and ruined. But those that keep foremost are sure to make their fortunes.
- 2) Although the East Mill is destined to be sold off by the present company at the end of their contract in 1823, yet the method in which the work is to be conducted till that time as to repairs, enlargements or alterations must be exactly the same as if it were to be kept for 20 years longer. Holding this in view, I as manager will never need to hesitate or stagger about what I should do in proceeding with repairs, enlargements or alterations.
- 3) If the repairs, enlargements and alterations of East Mill continue to be executed in a judicious, skilful, liberal and substantial manner, the work will continue to improve, to grow more valuable and to maintain its character among mills; but if they fall off and be done in a slight, patched up sort of way, the work like its contemporaries Trottick (1), Bugton and some others, will soon fall into decay; and distress or ruin its proprietors, and in a few years end in wreck worth nothing.
- 4) In all thoughts of extending East Mill either in preparing or spinning machinery, the first thing to be considered is whether would the steam engine be able to drive any more and if able, how much; the second, whether if more frames were to be put in there is not a probability that all the spare power may by and by be needed for additional carding and preparing machinery in the way of improvements.
- 5) A steam engine, if overloaded, consumes more additional fuel, requires more additional repairs on boilers, furnaces, packings, etc. owing to the great heat of the parts and incurs more additional stoppages, attendance, etc. than are likely to be made up by all the advantages of overloading.
- 6) Within these three years past several new mills have started up in Dundee called little mills which have threatened and expected to outstrip and run down mills of a larger size and longer standing, but as yet they have been fully disappointed. Their proprietors calculated upon carrying them on at less expense making better yarn, spinning a greater quantity per frame, and making less waste, but in none of these have they surpassed East Mill and others. Any advantages they really possess over large old mills lie in their new planned machinery and simple arrangements, rendering them easier conducted and less expensive for repairs; but these advantages are in a

1) Now Trottick

great measure eaten up by the additional quantity of fuel they require owing to the smallness of their steam engines. Their only chance now of accomplishing their aim, in my opinion, lies in their availing themselves of the greater facility they have in improving the quality of their yarns. This is the only thing I am afraid of, and the thing I must be continually watching them in. If I can match them in quality of yarn, I shall have little to fear. In the meantime however they have met with a check, which, for a time at least, will prevent their attaining their aim, and I think though they continue their rivalry they will at any rate have a hard battle to fight. Public opinion is also now against them. Formerly it was for them.

7. In the hire spinning business the best managed mills have the best chance and the best right to get the best flax; and if they be careful to get the best, the worst mills must get the worst; and so suffer as they deserve, for bad mills are obliged to spin bad flax on the same or worse terms than good mills spin good flax.

8. The management of East Mill is vested in two of the partners, one for the mercantile department, and another for the spinning. Their powers for managing are chiefly discretionary, and each acts from his own private sense of duty. The parties repose great confidence in one another, dictation and control being out of the question. In all matters of importance however consultations are held and advice taken. The exertions of both are required to make the concern good; the neglect of but one to make it bad. If both perform their duty well, both are fairly and equally burdened with their respective departments. If one perform it ill he not only deprives his partner of dire profit, but throws an additional burden of management upon him, as for instance if the spinning manager mis-size the yarn, make it too coarse, or with too much waste, the mercantile manager is burdened with difficulties and vexations in disposing of the yarn, which do not proceed from his neglect but from his partner's. And, on the other hand, if the mercantile manager became negligent, provide bad flax, small parcels, or unsuited qualities, the spinning manager is burdened with difficulties and vexations in his department which would not have occurred had the mercantile manager done his duty.

9. Mill spinners nowadays are beginning to put more value upon their character for quality of yarn than they used to do. Good character they know is the means of getting their yarn always easily and readily disposed of, whatever be the state of the market, and of obtaining at all times a good price for it. Bad character they know is -the means of making the yarn difficult of sale in ordinary times, and in a flat time, quite unmarketable; and even though a good parcel occasionally happen to be spun, still it does not bring its value owing to its bad character. Mills nowadays are better known among the buyers of yarn than they were some years ago. Almost every mill now has its character attached to it by the manufacturers and weavers for good or bad yarn; and the good ones are run upon and praised probably bad ones are despised and neglected.

10) To maintain a good character a mill should be careful never to use bad flax, but always to get such stuff as will make good yarn. A bad parcel two or three times repeated, though at long interval, is enough to hurt the character of any mill, and whoever sells bad yarn under the guise of good, deceives and vexes his customer, and not only alienates them but makes them the means of alienating others. Most yarn buyers, indeed, see the yarn before they purchase it and they judge of it accordingly, but none of them can be sure how it is to turn out till they try it.

11) The means used at different mills to obtain good character are varied. Some pay the strictest attention to the providing of the flax, never accepting of such as does not appear to be of a superior quality; and if accidentally getting a bad parcel disposing of it and providing better. Some adopt the plan of picking all their flax, separating the bad from the good, and either selling the bad or spinning it into heavier yarn. Some stick closely to the alternative of dressing very hard. Some lay out great sums of money improving or renewing their machinery. Some use great endeavours to manage well and provide good hands with their old machinery and some treat and flatter the manufacturers; hence it follows that many attained the same end by different means.

12) On reflecting on the state of the spinning frames of East Mill I have often thought how is it possible for me, with these old complex things, to compete with my neighbours nowadays, most of whom have excellent, simple and substantial new ones. My reflection has been not a little distressing when I have viewed at the same time the enormous expense I would be put to to get new frames. But nevertheless I am not without hope that the old ones will yet do for a while. In the meantime I comfort myself with an idea I have for improving the straitness of my roves, both lint and tow, and if I effect this my yarn will be so even, and will need so little twist that the spindles of the frames may be driven much slower and at the same time the frames produce a much greater quantity of yarn.

Performance at East Mill from Whity. Till Marts(1).

As to Quantity Spun - During this half year 4 days have been lost on account of reduced times owing to bad trade, and 1 for a fast, so that there remain just 151 working days, each $12\frac{1}{2}$ hours long. The quantity spun stands 5705 spyndles, and there being 25 frames regularly at work, the average quantity per frame per day during the half year stands something more than 15 spyndles. This is the highest average, by nearly a spyndle, ever made at this mill, or indeed at any other in Dundee, and I question if it has even been surpassed anywhere, all things considered.

As to the Expense - The amount of expense during the half year stands £1332, which is made up of servants' wages, articles of all sorts, and labour for repairs and alterations, coals, oil, tallow, card cover, insurance, feu-duty, taxes, counting house and shop expenses, managers salaries etc. but no interest of sunk capital nor allowance for tear and wear. The expense on each spyndle thereby amounts to about $5/6-5/10d$, which may be thought rather high, but which must be remembered includes about £190 for outlay on improving the property, £125 for partners' salaries, £32 for new card cover, £16 for a new carding engine, and £14 for new heads to a tow spinning frame - in all £377 - equal to $1/4d$ per spyndle (2).

As to Quality of Yarn - The lint yarn is much upon a par as to quality with the yarn of other respectable mills; perhaps indeed the West mill has a shade of superiority in the spinning of 3 lbs., but for tow yarn of all kinds, none, excepting Russel mill have equalled East Mill by 2d or 3d per spyndle.

As to Size of Parcels (3) and Quality of Flax -

The quality of the flax has generally been good, and during this half year it has been had in much larger quantity than usual, tho' indeed there have been no less than 63 parcels - lint and tow, which is perhaps three times as many as any mill in Dundee has had. In general there have been 5 parcels carrying on at once - though sometimes 3 and sometimes 7.

1) *Martinmas.*

2) *Brown's arithmetic here seems to merit less praise than his spinning. If he means that £1332 was the cost of 5705 spyndles, the price per spyndle is nearer $4/8$ than $5/6$. Neither does £377 for that number work out at $1/4d$ per spyndle.*

3) *Parcels of flax seem to have varied in size - see also page 12.*

MANAGEMENT

The following extracts are concerned with the day-to-day management of the mill. It should be noted that Brown's instructions to himself are as detailed as those issued to his undermanager. The first reveals the influence of the first-generation factory masters on him, and also shows his sound grasp of industrial psychology. The others are reproduced at length as rare descriptions of the manner of organisation of a textile mill in the first phase of industrialisation.

Notes to Managers

Note 7th (1). A master or Manager of a Mill should be "chaste, temperate, modest and devout, scrupulously just in his ministrations and severely exact in the discipline of his hands; upon which he should know his glory and his success in a great measure depend". Hands in a Mill should always be kept busy. The more closely they are held at their work, the more comfortable they are. If allowed to leave their places they are continually sighing after something they have no business with and rendering themselves uneasy. It is mistaken humanity to indulge them in ease, idleness or play. When in fault they should be reprimanded first calmly then seriously then sharply. Great care should be taken to point out their faults and explain their duty to them. Young ones or beginners especially should have their business frequently pointed out and explained. There is scarcely anyone so backward or corrupt that may not be improved by unremitting attention and patient and persevering efforts on the part of the overseer.

The giving of orders and directions to servants is a thing that has to be practised in a Mill perhaps several hundred times a day and ought to be well understood; yet notwithstanding of its importance most people pay no attention to the manner of it. In giving orders no apology should be made however hard the order but great care should be taken not to demand anything that is ill-timed or unreasonable. If orders are given in a sensible, reasonable sort of way, the servant will likely do his utmost to fulfil them; but if given in a rude, ill-humoured way he will probably do but bare justice. Masters reap great benefit from having the art of making their servants interested in their work, exerting on all occasions their own ingenuity, being responsible in character for what they perform, enjoying their own merit and not being depressed and offended by sulky looks or harsh expressions. Masters who are properly up to

1) Not all Brown's 'Notes' of advice to managers have been reproduced, but the numbers given -in the original have been left in this edition.

the management of their hands are always welcome among them and their presence is agreeable; but those who rule by wrong methods are disliked and their absence is always earnestly wished for.

Note 8th. To become eminent in one's business one must in a great measure be an enthusiast. Managers of Mills are generally not enthusiasts but slaves in their business; they are urged on more by necessity than choice and are utter strangers to the delights and advantages of enthusiasm which it would be their interest and their happiness to cultivate. The brightest examples in the spinning profession are Marshall, Haddam, Leys, Owen (1) all of whom became eminent by their enthusiasm, rearing up immense Mills and creating for themselves amazing fortunes. Leys and Haddam lived for years in their Mill devoting their whole soul to it and bringing their concerns to the greatest perfection and extent. Marshall through a course of twenty years never ceased managing and improving and extending as he improved. Owen was always activated by motives of the keenest enthusiasm not only for perfection and extent of business but for the improvement and happiness of all those under his care.

1) John Marshall was the greatest of the Leeds flax-spinners. Thomas Leys and James Hadden were linen manufacturers and bleachers at Grandholm, Aberdeen from 1748, and were pioneers of flax-spinning there. Robert Owen, the social reformer, was managing partner of the Lanark Twist Company from 1800 to c. 1826. He was described in his own time as 'Prince of Cotton Spinners'.

*See W.G. Rimmer, Marshall's of Leeds, Flax-spinners, 1788-1886. (Cambridge, 1960).
Alexander Keith, A Thousand Years of Aberdeen. (Aberdeen, 1972)
J. Butt (ed.), Robert Owen : Prince of Cotton Spinners. (Newton Abbot, 1971).*

Instructions for the Undermanager of East Mill

The following instructions were given him last year in the form of a letter on his entering upon the management of a department of the work. He had been engaged as head mechanic of the mill and had sometimes acted as undermanager; but being about to commence on a new footing I thought proper to give him some particular written instructions that he might understand how to conduct himself. The same I now transcribe from my memorandum book as containing hints useful to be observed in the conducting of the works.

East Mill, January 2, 1818.

To John Reid,

As you are about to enter upon management of a department of the work I think proper to state a few things to you upon paper that you may have an idea how to conduct yourself so as to ensure good management and to prevent misunderstandings between us. The following are the principal things that I aim to put under your charges.

1. The steam engine.
2. The operation of flax preparing and spinning.
3. The reeling of the yarn, both flax and tow.
4. The mechanics workshop, so far as relates to the repairs of machinery to be under your charges; and also as to the cutting out and working of the different kinds of wood required in the work for bobbins, rollers, wherves (1), etc.
5. The providing engaging and managing of all the hands necessary for your department and the purchasing of all the articles and materials required for the mill, except the following which I am to attend to myself - coal, oil, tallow, lists, and greenwood. I am also to attend to the management of the tow preparing and spinning operations with which you are to have nothing to do unless at any time required.

In managing the steam engine you are just to carry on as you have been accustomed to do or to see done; attending regularly to and examining carefully every part of it, and seeing that the fireman do his duty in cleaning, firing, starting and stopping.

In the flax preparing department the following are the chief things that you will have to attend to and take into consideration.

1. The state of the drest flax; as to the proportions of long, short, light and dark; and as to the proper mixing and damping of same. You will also have to make yourself well acquainted

1) werve or wherve: a whorl or flywheel on a spindle.

with the quality of the heckling which you can best do by giving a regular attention every day at the opening of the bundles and examining every layer of it as it is taken off to be damped. All bad dressing to be laid aside and returned to the heckler.

2. The weigher's work; as to correctness of weighing, neatness of handling and sufficiency of quantity.

3. The spreader's work; as to its appearance on the table, whether free of crossed fibres and revelled (1) places, if kept broad under the hand and if drawn out to a small point at the end of the table; if it sink properly among the pikes of the cylinder, a circumstances much to be attended to, and as to its evenness in the sliver when examined at the doubling machine. This will have to be attended to several time a day and no pains spared to obtain an even sliver from the spreaders.

4. The doubler's work; as to the number of slivers in the boxes, whether they be regularly and carefully put in so as to come out again easily; whether sufficiently pressed in the boxes so as to make them hold as much as possible and whether the ends are neatly pieced.

5. The frame minder's work at front of the bell carriage; as to the shifting of the cans (2) precisely when the bell rings, and marking them, the proper number with chalk; as to the pressing of the sliver carefully down into the cans; and as to the keeping of the frames clean.

6. The frame minder's work at second drawing frame, and back of roving frame; as to the handling and piecing of the sliver, filling of the cans, which must always be made to hold as much as possible without hurting the sliver; keeping the cans always exactly opposite the conductors both before and behind the frame and avoiding the mixture of different parcels of flax which can easily be done by observing the impression of the rollers, fluted and plain, upon the sliver.

7. The rover's work; as to the expedition, shifting of bobbins, making as short an inside end as possible so that the rove may come easily and clean at the spinning frame; securing the outside end upon the full bobbin; marking the bobbins distinctly with chalk when different parcels of stuff are under operation; and as to the cleaning and picking of the frames.

8. The state of the waste and breakage at every machine and in every corner of the room.

1) revelled: *ravelled*

2) cans or carns: *cylindrical containers in which the carded sliver is coiled for transfer to the drawing frame. They were first used by Richard Arkwright in his cotton preparation machinery, patented in 1775.*

9. The drawing operation of all the machinery; as to the state of the top rollers, intermediate rollers, drawing rollers, and conductors; the two last will have to be particularly attended to as they are daily liable to be out of order and a small fault in any of them produces serious consequences to spinning. The drawing rollers should never be allowed to remain unrepaired after they begin to require a heavy pressure upon them.

10. The oiling of the machinery, especially the feet, necks, and tops of the spindles and the axles and journals (1) of the drawing rollers which are apt to get dry if not attended to. The axles require oil in proportion to the pressure on the levers and the feet of the spindles in proportion to the lightness of the belts. Both these must be carefully attended to and early means taken to make them and every other part of the machinery as easily driven as possible, by keeping the different parts clean, rightly set, oiled and in proper repair.

11. Oiling of the leather rollers, which must be done once a day by the overseer, who pours a small quantity of oil into the palm of his hand and applies it to the surface of the roller. This makes the leather last more 'than twice as long as it would otherwise do, and also enables the rollers to work with less pressure.

12. The general appearance of the room; as to the arrangement of the cans, boxes, bobbins, drest flax, waste etc. everything to be regularly kept in its own place.

13. Conversation with the overseer about the weight of the yarn, weight of the cans, attendance of hands, their diligence, obedience etc. Also about the forwardness of the work whether it be always in such a state that a spreader can easily be spared half a day at a time when anyone happens to be absent.

The foregoing are the principal things that have to be attended to in the flax preparing department. If they be daily brought into consideration there is no risk but the work will go on smoothly, and with satisfaction. If neglected everything will be vexation and confusion.

As to the state of the machinery, if anything be wanted concerning the size or dimension of any of the wheels, drums, rollers, pulleys, cylinders or conductions, or as to the draws or motions of any of the parts, you have only to call at the counting house where everything is to be found in a book kept for the purpose.

The following is the plan of operations for 3 lb flax yarn. The weight of the strike of flax made by the weigher is 27 drops (2). The same he divides into two parts as nearly equal

1) journal: a 'bearing in which a shaft rotates.

2) drop weight: one-sixteenth of an ounce.

as he can guess and delivers to the spreader, who divides each part into two new parts, one of which she spreads along the table at every stroke of the bell.

Eight slivers from the bell carriage are put to the second drawing frame, and six slivers from it to the roving frame.

A can taken from the bell carriage if correctly handled by the weigher and spreader should weigh 5 lb 14 oz. A small variation is indeed sometimes found in different kinds of flax but it never amounts to more than half an ounce.

The weight of the empty cans is 12 lb each exactly.

I stated that the weight of a strike of flax is 27 drops, but in the weigher's scales no more than 26 are ever used. By repeated trials it has been found that 55% strikes - the number required to a bell - weigh collectively from 5 lb 14 oz to 5 lb 15 oz - of course, the average weight of a single strike is 27 drops or thereabouts.

Variations in the weight of the yarn may generally be traced to some of the following circumstances:

1. To incorrectness in the weigher's work or apparatus.
2. To the spreaders not attending regularly to the bell in spreading. Neither of these however can produce great mischief while the overseer attends to the weighing of the cans and checks every inaccuracy he meets with, and while his empty cans, scales and weights continue right.
3. To incorrectness in the doubler's work, which if deficient in slivers may cause a reduction in the size or weight of the yarn.
4. To irregularity in the damping of the drest flax or the rooms. Slight damping either in preparing or spinning makes light yarn; and heavy damping makes heavy yarn as found by (1).
5. To double threads in the spinning. This circumstance more than any other tends to derange the size of the yarn. In every frame there is always a proportion of double threads made. The greater part are caused by mismanagement in the shifting of the bobbins. This will require a constant looking after to prevent the yarn from getting too heavy, and if at any time it does get

1)The transcriber left this space blank with a note that the word was , illegible.

too heavy, it will be necessary to examine a quantity of it minutely to see what proportion of double threads it contains before making any alteration in the preparing operations; but indeed any alteration there must certainly be very small, cautiously made, and done as a last resource. If any be made in the preparing when the fault lies in the spinning the consequences will be very bad indeed, and possibly no reduction effected in the size of the yarn.

6. To inaccuracies in the reeling. These are apt to happen by the reelers putting too much yarn into each cutt (1), which through fear of putting too little, they accomplish either by altering the screw and wheel, or by placing two bobbins on one pin. Or by their putting too little yarn into each cutt, which they are apt to do through laziness and inattention; the first makes the yarn appear too heavy; the last too light. The weight of the yarn may also be affected by the screws or wheels of the reels being out o'f order. The weighing of the yarn by the overseer, or the scales and weights he weighs which may likewise be incorrect and produce mistakes in the weight of the yarn; all these must be examined in cases of unsteadiness. Variations however in the size of the yarn are circumstances that will seldom or never occur if the general management of the work be good. A half ounce per spyndle, I reckon a considerable variation. Nothing is a better criterion whereby to judge of the merits of the manager than the steadiness or unsteadiness of the size of the yarn.

As to the management of the spinning room, I do not mean at present to enter into particulars. I must observe however that this part of the work will require considerable attention from you. Your chief aim should be to get the overseer to do his duty - the most difficult part of which is the management of the shifting (2). This will require your consideration every time you go into the room. The state of the waste and breakage is also of importance. You will likewise have to examine over all the frames frequently to see if they be kept clean, if they be rightly oiled, especially the spindles and drawing rollers; if the conductors and pressing rollers be in good order, and if the covers of the spindles be all closely screwed up. The intermediate rollers are liable to get out of their proper position, and will require frequent adjustment.

For your further information the following is a general plan on which I wish the work to be conducted.

1. To keep up a set of as good hands as possible throughout the work. This I wish particularly observed in regard to the spinners, to whom I would always be willing to

1) cutt : a division into which a "hank is tied during peeling. 300 yards make a cutt, out, or lea, the English term.

2) moving "bobbins

give liberal wages; others, to be kept as moderate as possible consistent with the state of the trade, and the plentiness or scarcity of hands.. Everyone to be held strictly at duty, and no one of bad habits allowed to remain longer in the work than she can be replaced with another. An outlook must always be had for new hands, both learned and unlearned, and .before taking them on, particular regard must be paid to their habits and character. Care must be taken to keep them always under engagement to the work and no engagement ever allowed to run out before being either renewed or a fresh hand provided. At present the set of hands in the mill is very good, most of them are under engagement till the end of the year, and all are tolerably satisfied with their situation. Under your management I trust the set will not be allowed to fall off nor any dissatisfaction to take place.

2. To keep the machinery constantly in the best state of order and repair. To effect this the first thing to be attended to is keeping always two experienced mechanics in the work - one for the spinning room and another for the carding room; and making them attend constantly to the repairs of the machinery. A turner must also be kept for doing the turnery business; but if he is unable to accomplish it all, part of it may be got done by other tradesmen in their own shops. The repairs of the flax preparing room to be done by either of the mechanics or the turner as may be found most convenient. Blacksmith work to be got from whatever blacksmith may be found to furnish it, best, readiest and cheapest. Wood, ironmongery ware and materials of every description to be procured of a quality rather inclining to good and dear than bad and cheap.

Although at present we consider two mechanics and a turner sufficient to keep the mill in good repair, an extra hand may be employed. I would wish that none of the machinery especially the spinning frames, should ever be so far run out as to need considerable repair. They should regularly and constantly be kept in such order as to do their work well and the mechanics should no sooner finish at one end of a room than they should begin at another however trifling the wear may be.

3. To endeavour by every means to obtain a large quantity of yarn from the frames daily. To effect this it will be necessary not so much to drive fast as by managing well, to make all the frames come as near up to the rate of their delivery as possible. If the medium be exceeded the effect is worse than if it were not reached. The great point is to hit the medium and if this be done the utmost is made of the work, and everything gives satisfaction. The hitting of the medium depends on the quality of the flax, the state of the machinery, the ability of the hands and requires daily consideration.

4. Concerning alterations or improvements in the management, machinery or operation of the mill, I have only to say that you will make it part of your business to bring everything to as much perfection as possible, consistent with

the convenience of the work, and the expenses attending it. It will be highly proper for you to take frequent opportunities of seeing what your neighbours are about in the way of spinning and making yourself acquainted with all their proceedings, especially such as are reputed good managers, and if you may think at any time to gain anything at a distance, I shall be glad to let you away for a few days paying your expenses and managing for you till your return. As to alterations and improvements however, they must always be second in consideration to the keeping of the mill in good order and managing well upon the present plan.

A desk is to be placed in the reeling room and a new book begun for keeping the accounts of the spinners and reelers work and waste, the weight of the yarn, the quantity spun etc. The overseer with your assistance will daily attend to it and it will be highly beneficial for you to spend a portion of time with it every day, examining and considering the state of the different hands' work and waste, comparing the one with the other, yesterday's work with today's and making yourself intimately acquainted with all their performances.

As it will be proper to have as distinct a separation as possible in the management of the lint and tow departments, it will be necessary that neither you nor I interfere much with one another's hands. If any of yours come to me for redress of grievances I shall refer them to you as their proper manager. I shall have no more to do with your hands than merely paying them their weekly wages which I as clerk shall do every Friday morning as usual.

Observe that I will be in the counting house regularly every forenoon at 10 o'clock; and that this is the time you must bring forward everything you may have to say about the work. If any hands are to be engaged, any disputes settled, any money advanced, or any proposals made, the same must be brought forward at 10 o'clock and at no other time of the day.

East Mill, June 4, 1819.

Letter to John Reid

To John Reid.

In addition to your present employment at East Mill I mean to commit to you the management of the tow spinning operations in Number 2. You will therefore commence with them immediately and I request you will use every endeavour you can to carry them on to as good account as possible making a large quantity of yarn a good quality and little waste at all the frames. For some time past the spinners at the tow frames have not been so attentive as I could have expected considering the lowness of their stints and the high wages they are making. I still think they might make less waste, less double yarn and better piecings. It rests with yourself to correct all deficiencies.

You have now under your charge all the hands and machinery about the Mill excepting what are in the tow preparing room. Hitherto I have taken some charge of providing and engaging the hands myself but I now commit it entirely to you excepting for the hands of the carding room; and you may either write the engagements yourself or make the clerk do it. A desk is to be placed for you in the Counting Room at which you may do all your writing jobs.

I declare myself well pleased with your method of conducting the work, your prudence and attention and am not insensible to the value of your experience and advice in the many alterations I have been carrying on of late.

East Mill, June 6th, 1820.

Of Order in Management

As will already be appreciated, Brown had a well-developed desire for system in management. He recognised that the maintenance of order required that he make a positive effort: "seeing how apt I have always been... to fall into confused and irregular ideas". His criterion of good management was:

"if... the mill performs steadily or on an average as follows; it being understood that the work be fully and regularly supplied with a fair quality of flax, heckled in the usual manner, and in tolerably large parcels:

Each frame on three or four pound flax yarn to spin daily, or in $12\frac{1}{2}$ working hours, $14\frac{1}{2}$ spyndles; each frame on 5, 6 or 7 lb flax yarn to spin 18 spyndles; each on six, seven or eight pounds tow yarn to spin $15\frac{1}{2}$ spyndles. The waste of the spinning of flax not to exceed six percent and on that of tow twelve percent... The quality of the yarn to be equal of any that comes to the Dundee market and the size to be but within $\frac{1}{60}$ th part, above or below, of the real intended size. The expense not to exceed $5\frac{1}{2}$ d per spyndle, the same including everything actually expended for carrying on, repairing, or improving the work, but not for enlarging it, nor for tear or wear of machinery or interest of sunk capital. The state of the machinery, houses, and property in general, to be kept up in as respectable, substantial a manner as at present, and things throughout rather in the way of growing better than of falling into decay. If all these be accomplished the management may be declared good".

In the following 'Plan of Management', he went into greater detail.

Plan of Management

The first and great object to be aimed at by the management of East Mill is profit. The chief requisites to profit are - a. good quality of yarn - a large quantity - little waste - moderate expenses - and a good state of the machinery. To ensure all these as far as possible it is necessary that the manager lay out his business into twelve different departments, each of which, from its peculiar nature, requires its own separate portion of attendance and consideration.

Departments:

- Warehouse department
- Heckling department
- Flax preparing department
- Flax spinning department
- Tow preparing department
- Tow spinning department
- Reeling department
- Mechanic department
- Storehouse department
- Improvement or alteration department
- Sundries department
- Countinghouse department

In the Warehouse Department the various things that have to be daily investigated by me as manager are as follows:

1. The undressed flax; as to what different parcels are on hand - whom they belong to - probable quantity in each parcel - kind of colour - quality - size of yarn intended for - fitness or unfitness for that size - picking out of coarse or damaged heads - quantity of pickings - stuffings - tare of matts (1), ropes etc.
2. The drest flax; as to what different parcels are on hand - whom they belong to - probable quantity in each parcel - kind and quality.
3. The tow; as to what different parcels are on hand - whom they belong to - probable quantity in each parcel - kind and quality.
4. The yarn; as to what different parcels are on hand - whom they belong to - what made from - whether correctly spun to the size.
5. The ropes, strings, waste and empty matts; as to what different parcels are on hand - quantity in each - whom they belong to - why not disposed of - likewise whether the arrangement of the various articles in the different warehouses be neat, regular, and distinct, and if the warehouses be kept clean.

In investigating this department I must be accompanied by the heckling overseer to assist and inform me as to the different

1) tare of matts: weight of covering

things to be examined and I must always endeavour to acquaint myself well with the quality of the different parcels of flax and tow I have to spin, the same being essentially necessary to my directing aright without chance of blunders, the general affairs of the work.

In the heckling department the following things require my daily investigation.

1. The books and accounts of the overseer - as to what different parcels of flax are in hand - the yields - the waste and the performance of the different workmen.
2. The quality of the dressing - as to the size and openness of the strikes - the fineness of the fibres - and the clearness from knots.

Occasionally I must acquaint myself as to the number of workmen employed - their characters - their attendance - the current wages - state of heckles - order of heckling house etc.

Flax Preparing Department, Flax Spinning Department and Reeling Department!

The conducting of these departments being committed to an assistant manager, I, as principal manager, have only to investigate them in a general way. My plan is to call my assistant daily into the counting house at a stated hour to examine his books and slates, question him concerning them, talk with him, give him further orders, and, if necessary, visit with him any part of the work that may be suspected deficient. Occasionally I must read over with attention the instructions for the assistant manager - the same being calculated to bring to my mind every particular of his duty.

Tow Preparing Department. In this department the following things require my daily investigation.

1. Tow in hand - the kind and the quality of each parcel - and what picking, mixing or moistening they require. - Also if the different parcels of tow be properly kept separate, so as not to be carelessly mixed, if each gets its due proportion of waste and brokage, and if the room be kept in good order throughout.
2. The feeders' work: as to correctness of weighing - and evenness and neatness of feeding, to be examined both on the cloth and in the sliver - very important.
3. The sliver carriers' work at front and back of all the cards and breakers: - as to the handling and piecing of the slivers - brokage of sliver - filling of cans - placing of same at the machines - and cleaning of rollers, brushes and conductors - each hand separately.
4. The sliver piecers' work at the back of all the roving frames: - as to the placing of the cans, handling and piecing of the slivers - and cleaning of the machine.
5. The rovers' work at the front of all the roving frames: as to the filling and shifting of bobbins - piecing of ends - cleaning of frames - and state of empty bobbins.

6. The sweepers' work: - as to the state of the floor, walls, ceiling and windows of the room, - and keeping the waste separate from the tow.
7. The oilers' work: - as to the state of main shafts, breaking cards and roving frames - whether the different journals have just enough and no more - if any oil is to be seen on the floor, or upon any part of the fixt machinery.
8. The state of the waste and brokage at every machine and in every corner of the room.
9. The performance of the breakers: - as to the quality of their work seen in the conductors - cleanness (1) of the different cylinders - state of rollers and conductors - tightness of belts and feeding cloths etc.
10. The same of the finishing cards.
11. The drawing operation of all the roving frames: - as to the state of the cylinders, top rollers, pressing rollers and conductors - state of spindles, fliers, bobbin boards, belts, and all other revolving gear.
12. The overseer's ideas as to the state of the different things above mentioned, how the hands are all behaving - their attendance, diligence, obedience, rewards, and punishments - weight of yarn - causes of variations etc.

Tow Spinning Department. In this department the following things require my daily investigation.

1. The spinners' work: - as to quantity of yarn spun by each couple of frames - quantity and state of waste made by same - state of shifting double yarns and pieces - state of empty bobbins - cleanness of frames.
2. The rove piecers' work: - as to keeping the frames constantly full of rove - manner of piecing - arranging and placing of bobbins, both empty and full throughout the room.
3. The sweepers' work: - as to the general cleanliness of the room - state of the sweepings, whether free from waste, brokage, etc.
4. The assistant overseer's work: - as to the oiling of the frames - cleaning of the primary parts of same - sewing of lists (2), their tightness and joining - cleaning and oiling of driving machinery - state of stores in the press - state of windows and shutting of window boards.

1) cleanness : a term used to describe the carding drum when the carded fibres have been removed and the waste 'cleared' by a roller.

2) lists : driving bands for spindle.

5. The state of the frames: - as to the pressing rollers, conductors, fliers, bobbins, bobbin boards, spindles, etc., whether they be all in sufficient working condition.

6. The overseer's duty: - as to his general alacrity and attention, his keeping the hands in proper subordination - their attendance, diligence, obedience, etc., who behaves well and who ill - quantity of work and waste made by each couple - rewards and punishments.

Mechanic Department. The business of this department is to acquaint myself daily with what jobs are under the hands of the mechanics, how they are executed, and what progress is making. Also to examine over all the machinery, consider it well, and fix upon what is most necessary next to be repaired.

Storehouse Department. The storehouses at East Mill are in a very scattered state, every outhouse, garret and bycorner being occupied with stores of some kind or another. My only method of investigating them is to visit them all once a day and bestow upon them the necessary thought as I go along. No... (1) contains the whale oil, green oil, tallow, some empty casks, and some parcels of green wood. No... contains leather, plaiding, lists, hemp, bobbins, chalk, rosin etc. The large press in the turning shop containing brass, patterns, ironmongery ware etc. The garrets of No... and No... contain wood of different descriptions, old iron, castings, etc.

Improvement or Alteration Department. As the art of flax spinning is still improving and improvable it is necessary that every mill manager devote a portion of his time to the cultivation of improvements. Should this be neglected the consequences must be disagreeable as one must necessarily be left behind by his neighbour. Improvements may be made in two ways; either by invention or by adoption. If invention is to be tried the best way of proceeding is - to understand the present machinery well, to be familiar with its imperfections, and to remedy them accordingly. If adoption is to be tried, the only way is to visit improved mills, to acquaint oneself with the nature of their improvements, and to adopt accordingly.

At present I have no particular method of proceeding with improvement further than attending to the above hints. One thing, however, I require to keep on mind and that is - that the success of a mill depends much more upon keeping the machinery in good order and managing well on the present plan, than upon pursuing and looking after what are commonly called alterations and improvements.

1) These numbers are missing in the typescript.

Sundries Department. Most of the things classed under this head do not require daily or even weekly investigation. The bare reading of them over once or twice a week is sufficient to give each individual its due thought and inquiry as I go along. The different things are as follows: - 1. Accidental fire -insurance etc; 2. Pilfering - night watching - dog etc; 3. Fastening of doors, windows, gates etc; 4. State of mill yard, water channels, ponds, etc; 5. State of houses, roofs, floors, doors, windows, etc; 6. State of necessities; 7. State of scales, weights, etc.

Counting house Department. Different books kept by the manager of East Mill besides business books are as follows: - 1. Daily work book; 2. The wages book; 3. The petty expense book; 4. The advance and deposit; 5. Agreement book.

A clerk is employed to keep the most of these books but every one of them requires careful examination, at set times, by myself. The daily work book which contains the particulars of all the spinning, reeling, waste, weight of yarn, quantity spun, different parcels etc. must be perused frequently every day and must be very familiar to me. The other books need but weekly examination. They must be gone through every Friday morning after the wages are paid; and at same time all accounts for articles used at the works must be examined, paid and folded up.

The great business of the counting house department, however, does not consist merely in attending to these few books. It is in the counting house that I must think, consult, and mature in my mind everything of importance that is done in the work. It is here that I must arrange all my plans, make all my bargains and agreements, settle all disputes, grievances, difficulties etc. And for the more regular conducting of these matters I must make a point of being always personally in the counting house from ten till eleven o'clock in the forenoon; at which time and at no other the people of the mill must be taught to bring forward their affairs, so that during the rest of the day I may have nothing to interrupt me when engaged at the other departments of the work.

On Business

In addition to the spinning department of the East Mill concern I have for the last six months had the sole management of the mercantile department. Now however circumstances having relieved me of this, I feel desirous to explain in writing some of the benefits I have derived from it. Before entering upon it I was alike ignorant of markets, of customers, of accounts and of book-keeping. Now I have a tolerable idea of all these: I am now pretty well acquainted with the method of finding out prices, of buying and selling of flax and yarn, the respectability of merchants and manufacturers, the method of keeping books and accounts, of collecting debts, of handling money and of avoiding errors, disputes and careless promises. I have likewise had the satisfaction by perseverance in fairness and candour of obtaining the confidence of most people I have dealt with though, to my vexation, some were inclined to be rather suspicious. Prigging and higgling I detested and seldom practised. Other advantages are my peace of mind will not now be disturbed with groundless fears and apprehensions respecting my partner's exertions in his business and the state of the Company's affairs. Formerly when I was ignorant of these things I could not help often thinking the worst of them. My acquaintance with the mercantile department will also be a considerable help to me in the management of the spinning for in conversing with my partner on business I will now at once apprehend what he means and what he wants and will be at no loss how to tell him what I mean and what I want.

Besides these advantages in the way of business I have likewise profited by having got acquainted with many of the merchants, manufacturers and others, few of whom I knew or was known to before. I shall now also conduct the Mill with less trouble than formerly for having been necessarily limited in my attendance I learned to become more effectual. I shall now likewise possess an agreeable feeling of independence which I was a stranger to before. For however well affected my partners and however little the chance of separation, still there was a possibility of my being thrown upon myself unprepared.

Having thus in some measure become acquainted with business I will now do well to use such means as may be effectual to retain it. For this purpose I must occasionally in the market days make the round of the whole shops and warehouses I am acquainted with; enquire into the prices and sales of goods, examine qualities and hear opinions.

November 1st, 1820

Copy of Letter to Messrs. B. & B., Dundee Regarding their Spinning Mill. (1)

Gentlemen..... According to my promise I proceed to make some observations regarding the present state and management of your spinning mill. I shall do so to the best of my judgment, and if anything be thought amiss or ambiguous in what I write I shall be glad to explain it afterwards.

It is evident that much mischief has arisen from errors fallen into in the erection of the work owing to the employing of unskilful persons in the making, ordering and placing of the machinery. Of about a dozen of spinning frames already in your mill there are no less than four different kinds, procured from as many different machine-makers all requiring different methods of treatment in carrying them on, and different sorts of tools to set and repair them with; whereas there should not have been above two kinds at most in the mill, to make the work at all manageable. Such a variety of machinery and some of it not of the most improved kind has a wonderfully bad effect towards hurting the size and quality of the yarns and of deranging the necessary order and regularity of the work. The evils resulting from the deficiency of water and the consequent mistiming of the hands, have also no doubt tended considerably to render imperfect the operations of preparing and spinning; but these will likely soon be removed by the completion of the new pond when I would expect some improvement in the making of the yarns even under the present Manager as his time will then be less divided and his attention less distracted with vexatious stoppages.

I do not recommend the throwing out any of the new spinning frames presently in the work, on account of their various deficiencies; I would rather put them in as good order as possible, and make the most of them. Indeed excepting Guild's old ones, the rest may be all made to perform tolerably well if under a skilful manager. Guild's would better be thrown out as soon as they can be replaced with substantial new ones but not till then.

The first and most necessary step to be taken at present is to procure a competent head manager for the work. If this were accomplished it would of itself be a remedy for most evils. The present manager, F.G., however anxious and willing to do well is evidently unfit; he neither understands the machinery nor can he keep up authority among the hands; he is not personally a mechanic nor can he make calculations on the operations and machinery; both of which are indispensable in the managing of a

1) According to Chapman, B. & B. were Bell and Balfour. Warden states that their mill, in Chapelshade, was started in 1821 and had 600 spindles, driven by a twelve horsepower steam engine. The fact that Brown was consulted in this way reflects on his reputation as a fair and competent manager.

mill. Any person you may employ as a Manager should be a regularly bred mechanic, experienced for several years in the management of some known mill in the neighbourhood, well recommended for abilities and steadiness, and willing to undertake the following duties as his daily business.

The Manager's duties:

- 1) To provide, engage and manage all the hands required for the work, viz. overseers, preparers, spinners, reelers, mechanics, foremen, etc.
- 2) To take charge of all the machinery about the work, comprising the steam engine, with its pipes, wells (1) and pumping apparatus. All the lint and tow preparing and spinning machinery; the reels turning lathes, shafts etc. These he is not only to see regularly and carefully oiled, cleaned and set but that they be kept always in a proper state of repair. He is also to take charge of what new machinery is required to be made at the work, and to instruct regarding what is to be ordered from machine-makers.
- 3) To take charge of all the operations of preparing and spinning, both lint and tow, from the receiving of the drest flax and tow into the mill to the delivering of the same in yarns of various sizes from the mill to the warehouses.
- 4) To provide or buy in all the articles and materials required for the repairing and carrying on of the work, viz. green oil - whale oil - tallow - leather lists - hemp - roller cloth - wood for bobbins - rollers and shafts - brushes - baskets - card-covers - wrights tools - ironmongery of all sorts - blacksmith and tinsmith articles- cast iron - brass and other foundry articles etc. etc. These he is either to purchase personally or by the clerk who is always to show receipts for whatever is purchased.
- 5) To superintend and direct the clerk in the paying the wages of the whole mill hands, which must be done every Friday morning before breakfast, previously arranging the pay lists and making everything correct so as to prevent complaints. In engaging the hands he is to regulate the rates of wages according to what he sees necessary for the work or what is given at other mills.
- 6) To keep the keys of the mill doors, store house and other places under his charge; to open the doors personally every morning and to lock them at night. He should reside at or near the premises.

1) wells: in this -instance, the hot well, a container which received the condensed steam from the separate condenser, and which was the source of boiler feed water, and the cold well, which was the tank surrounding the condenser.

7) He is not to work any with his own hands as a mechanic excepting when hindrance is likely to occur and then merely as a temporary help to the men. His time must be devoted entirely to managing; frequently every day visiting and inspecting all parts of the work and seeing that all the hands and machinery perform their respective duties. He is not to be charged with the management of the hecklers, the providing of coals, the making insurances, the weighing of flax, tow or yarn or the keeping of warehouses.

Besides the Manager of the mill it will be necessary to employ a clerk and a heckling overseer. The clerk's business will be as follows - to superintend the weighing, warehousing or carting of all goods coming to, or going from the work and keeping minute accounts thereof. To keep all the mill books regarding the quantity of yarn spun, the quantity of work performed by each hand or set of hands on piece - the quantity of waste made by the different spinners and reelers, and the absent time and extra time of all the hands. To make up the weekly pay lists - to procure change - to pay wages - to pay accounts - to sell waste, strings, dung etc. - to write engagements - to assist the Manager in purchasing and providing articles and materials for the work if required; and in general to do everything that may properly fall to his duty as clerk of a spinning mill. He is to settle cash with the Company once a week, always keeping a sum in hand for paying accounts.

The heckling overseer's business will be as follows: To provide, and manage all the hecklers required for the work - to keep the heckles and heckling houses in proper order - to weigh off the flax to and from the hecklers, keeping particular accounts thereof, showing the yields, waste etc. - to assist at receiving flax or tow into the warehouses - to pick or select the flax if required for different kinds of yarn - to pay the hecklers' wages, receiving money weekly from the clerk, and keeping accounts thereof - to keep the keys of the heckling house and warehouses, and to employ himself in heckling when not otherwise engaged. His weekly wages to be 2/- or 3/- higher than common workmen.

A good Manager, a clerk and a heckling overseer being appointed, and things got upon a sort of regular train, the next step will certainly be to get the work filled up with machinery. How this is to be best accomplished I am not at present prepared to say; but at all events it will be proper not to put in more than eight tow frames altogether into the work, as the preparing room is not adapted for holding cards for any more, if so many. The lint frames will not exceed twelve in number, making in all twenty frames of thirty sps. each, being the original number allotted for the work. This being fully accomplished and everything as it should be the mill ought then to perform nearly as follows:

12 frames on 3 lb. lint, yarn or any heavier size should spin weekly or in 78 hours	1,200 spys.
<u>8</u> frames on 5 lb. tow, yarn or do. do.	800 spys.
<u>20</u> frames should spin in 78 hours	<u>2,000 spys.</u>

The waste on the spinning of the lint should not exceed 9 per cent, on the tow 13½ per cent counting the exact difference between the bare drest flax or the tow and the weight of the yarn in the bundled state. The quality of the yarns of all kinds should be at least equal to what is common in the market made from similar materials. The size should be hit within one-fiftieth part, above or below, of the real intended size.

The following statement will show the number of hands required for the work, exclusive of hecklers and the particulars of the weekly wages, calculated by the present high rates:

1	Manager	£	2-0-0
1	Clerk	£	1-0-0
1	Fireman		15/-
1	Mechanic	£	1-0-0
1	Turner		18/-
1	Night Watchman		10/-
1	Lamp Lighter		8/-
1	Overseer for flax preparing and carding room	£	1-0-0
4	Lint Spreaders for do.	6/6d £	1-6/-
5	Lint Preparers for do.	4/- £	1-0-0
4	Tow Feeders	4/- £	16/-
6	Tow Preparers	3/6d £	1-11/-
1	Oiler		4/-
1	Sweeper		4/-
1	Spare Hand		4/-
1	Overseer for spinning room	£	1-2/-
20	Spinners for do. (present average 8/-)	£	8-0-0
10	Shifters for do. at 2/6d. and 3/6d.	£	1-10/-
1	Oiler for do.		6/-
1	Sweeper for do.		5/-
1	Rove Piecer		4/-
2	Spare Hands		12/-
1	Overseer and Yarn Binder for reeling room.	£	1-0-0
5	Reelers on piece work, reeling 1,500 per week at 4d. per dozen	£	2-2-0
3	Spare Reelers, Learners		12/-
1	Bobbin Carrier		5/-
76	Hands - receiving weekly	£	28-4/-

The following statement will show the total weekly expense and the different items thereof:

Wages for 76 Hands as above	£28. 4/-
Insurance - say £3,000 on the Mill at 21/- per ct. being per week.	12/-
do. - say £2,000 on Warehouses, Heckling Hs. and goods at 5/-	2/-
Taxes on Overseers, Poor Rates, Road Money etc.	4/-
Coal - say 13 tons Alloa Chews (1) costing at the Mill 12/6d. per ton	£ 8. 2/6d.
Green Oil - say 8 pints at 2/-	16/-
Whale Oil - say 1 ton per season - being per week	8/-
Tallow - say 12 lb. per week at 5d.	5/-
Articles and materials for whole repairs - allow weekly	£4.
	£43-13/6

Suppose the Mill to spin 2,000 spyndles per week the expense of spinning, exclusive of interest of first cost, will thereby stand about 5d. per spyndle. I reckon nothing for tear and wear of machinery as the work should always be kept up in as good order as if new.

There are some things I must yet mention regarding the welfare of the mill, which will depend entirely upon yourselves, and over which the manager can have little control. I think it as well to mention them, though it is possible you may be partly aware of them already. A spinning mill is a complicated and ticklish kind of concern, and however nicely arranged and anxiously cared for is extremely liable to fall into disorder. It ought therefore to be subject to the fewest possible Changes in every respect in the management; consequently it will be necessary never to have more than three different kinds of yarn making at a time - one of lint, and two of tow, or two of lint and one of tow; and these must be shifted as seldom as possible, say not oftener than once a month for each parcel. Were you to demand a great variety of yarns from your manager - suppose 100 spyndles of one kind today - 100 sps. of a different kind tomorrow - and 100 sps. of another kind some other day, you would infallibly soon throw the work into utter confusion. It will be necessary also to keep as steadily as possible on one kind of flax - not changing frequently from long to short, from soft to hard, and from strong to weak, but rather suiting the flax to the mill than the mill to the flax.

I would also recommend that the mill be kept as close and private as possible; for which purpose it will be proper to prohibit from setting a foot on the premises - strollers and idlers of all descriptions. If open gates and doors be allowed, the work will constantly be pestered with people from all

1) chews: small coal. 13 tons @ 12/6 p. ton : £7.16-8, but Brown does qualify the quantity.

quarters gazing about and hindring the hands. Even the hecklers, weavers, and others employed on the premises, must be forbidden entering the mill.

I also take it upon me to say that your own attendance on the work should be subject to regulation. It will be proper that one Partner only take any charge of the mill - the other visiting it but seldom, and never interfering with the manager in giving directions, making inquiries, or passing opinions. One Partner being appointed, it will be necessary that he have a stated time daily of visiting the work. The most suitable time for the manager would be every forenoon at 10 o'clock but any other hour will do if that is not convenient for the Partner. One hour a day I would reckon sufficient for the partner's attendance, at least after a proper manager is set going; a second visit in the evening might sometimes be useful. Should things be put upon this footing it will be indispensable to have a small counting house fitted up in some convenient place near the mill door. In this the manager and clerk must both have desks for their convenience in keeping accounts, engaging hands, and doing the other business of the mill. The Partner in his daily visits must resort to this counting house calling the attendance of the manager and clerk, examining over all the accounts of the preceding day's performance, and making such inquiries and remarks, and giving such instructions as may seem necessary; then he may go over all or any part of the work as he may think fit, accompanied by the manager, and making such further inquiries and remarks as may appear proper. Then, leaving the manager, he should see through the whole of the warehouses and heckling houses, accompanied by the heckling overseer, and making such remarks to him as the state of things at the time may demand.

It must be observed by the Partner that the manager be allowed full scope and power in managing, so that not only the hands may look upon him as their sole manager, but that he may be allowed the whole merit of conducting the work. A manager if on such a footing will do a great deal for his own personal character and credit. The Partner should never need to speak to or have anything to do with the hands, excepting in the case of prosecution. If any of the hands apply to him for redress of petty grievances, he must just refer them back to the manager, who they must be informed, has full power to settle all their differences.

There is one thing I must yet state before concluding. The spinning business with you being but a secondary business, it can scarcely be expected to turn out so well in every respect as if it were the principal. You need therefore not be disappointed with your mill and its manager tho' at times your yarn be not altogether so good in quality and quantity, your waste and expenses so moderate, and your yields so high, as you may sometimes hear of at other works, where the proprietors are experienced personal managers, and where they make spinning their sole business. I do think however, as I stated in a former page, that your yarns should be equal in quality to what are common in

the market, and that if you be at all fortunate in your choice of a manager, your work in general should perform to as good account and go on with as little trouble as the average of mills in the neighbourhood.

Wm. Brown. April 9th, 1822.

Answer

Dundee. 10th April 1822.

Mr. William Brown - Dear Sir,

We have received your favour of the 9th inst, and beg to express our obligations to you for the trouble you have taken and our thanks for the very clear Statement you have given us regarding the conducting of our mill. We shall endeavour to follow out your plan as far as we can, and not lose sight of the valuable information you have given us - it will be some time however before we can retrace our steps and get on a good footing, but we do not despair of ultimate success. We have fixed with I.R. - but he cannot come for a month or two hence but he will give a little superintendence in the meantime, and if other difficulties occur we may be obliged to give you further trouble. Meantime we remain very gratefully Dear Sir, Your obt. Servt.

Sy. B- & B-.

Disorder in Business

Brown's concern for order caused him much distress if he failed to maintain complete control of a situation.

The construction of a building in the millyard to serve as "a counting house, warehouse, lamp-house etc." disrupted his routine considerably. He was consulted about details of construction at awkward times, and his confusion was increased by his involvement in improvements to the structure and machinery of the mill itself, as well as his connection with two other mills, Dudhope and Lochee. The work in progress also distracted the mill workers from their routine. "One great object to be attended to in the management of a mill is to have everything as quiet and private as possible; there should be no temptations to gazing and stir and variety should be carefully hid from the sight of the hands".

The confusion arising from this, Brown felt had a serious effect on production. There was loss of quantity and quality; the best hands became dissatisfied; there were more accidents and broken machinery; all ultimately leading to unprofitability and ruin. To avert these evils, he recommended that specifications should be detailed, and that contractors should be "instructed or bound not to employ any but the quietest sort of men, who must be ordered to hold no conversation with the mill hands during erection". He reckoned that by fixing his attendance to twenty or thirty minutes a day he could reduce the effect on his own work to a minimum.

Night Spinning

Brown's comments on night spinning are of considerable interest, as textile mills have rarely been worked on a shift basis. It says much for his powers of organisation that he was able to carry on night work for so long as he did.

The night spinning experiment lasted from 2 January 1821 to 30 May 1823, a total of 748 working nights "being five more than the number of working days... the latter being curtailed by fasts and holidays". Each night contained "just 9¼ working hours, without intermission" apart from Saturday night and Monday morning, which contained only nine hours. This 66¾ hour week compared with a 78 hour day shift.

The total quantity of yarn spun was 105,550 spyndles of tow, mostly 6 lb, and 29,500 of lint, mostly 3 lb. There were from 300 to 350 spindles going constantly on tow and from 30 to 150 on lint, the latter being regulated entirely by the supply of hands. Brown reckoned that the quantity spun per spindle per hour was higher than during the day, though waste was estimated at 2% higher. The expense was about 7½d per spyndle - 4½d for wages, 1d for coal, 2d for oils, materials and repairs. The prices made varied from 1s to 1s 8d per spyndle for tow and 6d to 1s for lint yarn. The estimated "clear gain" was £3483.

There were no notable interruptions to the work. The management was exemplary in its attendance, but there were problems with the hands - "the women and girls have been more off work than the men, being less regular in their health and way of living. The boys have been fully irregular as the women, incessantly hurting themselves by roaming about during the day, and not taking regular sleep". The main difficulties lay, however, in the alterations going on in the mill, though "the principal cause of stopping the nights spinning lay not in the reduced state of profits... but in the scarcity of tow"... Brown's example was followed by several other works in the area though none of them made a success of it.

Brown confined' his attendance to one hour a night, going over the previous night's work with the night manager. This employee however, worked long hours. "He retired to bed at five in the morning - rose between one and two afternoon, joined his family in dinner at two - amused himself at the mill, not infrequently assisting at needful jobs till seven - then took a second meal - attended the mill at half past seven, continuing till five in the morning, taking refreshment of breakfast and beer at the works between three and four".

Defects in the yarn appeared, especially in the size of tow yarn. The overseers took a delight in quarrelling with each other over the causes of the deficiencies. Brown also suffered from his own obsessiveness. "I was often harassed with the disagreeable idea of mismanagement going on, pilfering, fire, waste, bad spinning, negligence in hands and accidents... certainly I often thought the profits of night spinning but a very sorry compensation for the trouble occasioned". He therefore concluded that despite its profitability, "Night spinning should not be commenced again without great caution and consideration... being at best a patch up sort of concern, extremely critical to manage, and requiring more than ordinary skill, prudence and perseverance to do any good with it".

* * * * *

On Night Spinning at East Mill

Origin

How the idea first arose I scarcely now remember. I had long before wished to make some money in this way but never until lately was the work in order for it; and the bad success of all others who had tried it deterred me from commencing till I had got my Mill in the best of order. The chief inducement towards it lay in the superior quality of my tow yarn, rendering the step at all an object. My yarn was 2d. per spyndle better than most others and I calculated to spin at an expense not exceeding 7d. per spyndle thereby leaving a profit nearly equal to the expense. I had little fear of others following my example for night spinning in ordinary cases would neither be profitable nor manageable.

Preparatory arrangements

Eight tow frames with their cards and roving frames being all the machinery I could hope to carry on with ease and success, I set about making up lists of the different sorts of hands required for the same and fixing rates of wages. Of all the plans of paying I could devise none seemed better than just to give liberal weekly wages without either stint or piece work. Spinners to get 7/-, reelers 6/-, feeders 5/-, carders 4/-, overseers 10/- to 15/-. For superintending I made choice of two men already at the Work, one for each half of the night. To each of these I proposed paying 2/- per week for every frame they started besides their ordinary wages. This was high encouragement but in doubtful matters I always choose the safest side for success. It next became a serious puzzle how to separate the yarn of the night from that of the day hands. This I resolved to do by getting new reels for the night hands placing the same in the spinning room beside the frames and making each set of spinners take away their own full bobbins at every stoppage. New oil cans, brushes, pickers, knives, etc. were provided for the night hands and put under their own lock and key. The hours of working were fixed to be from eight at night till six in the morning without intermission except on Saturday and Monday when from seven till half past eleven and from one until six. A pause of three minutes at eight and six was considered necessary for oiling the steam engine and separating the hands. No accidental hindrance was anticipated. At least none could be wrought for afterwards though it should occur. Hindrance in the day time was to be made up at diet hours. Written notice was given to the Insurance Company notwithstanding I had previously intimated my intention verbally.

These and several other little arrangements being completed (and they were all completed before the public knew one word of my intentions), I gave the superintendents lists of the different kinds of hands required with orders to procure them as soon as possible. Not to alarm people too much nor to create early opposition or speculation among other hands and mill spinners, I ordered the superintendents to give report that the night spinning was caused entirely by the necessity I should soon be under of removing one of my boilers for repair in which case I behoved either to spin a part during the night or suffer great loss from hindrance in the day. This was partly true. In one week hands enough were got for all the machinery, most of the spinners pretty good but the others rather indifferent. The report was no sooner spread than hands poured in from all quarters wanting work. Not one in ten however fit or learned. As for engaging them I felt myself rather at a loss for without engaging I could hardly expect success and with it I was not certain. The spinners and reelers I engaged for three months, the preparers on one month's notice. Such were the preparatory arrangements for night spinning. Nothing else occurred as needful to be done. Many things I expected to occur afterwards. I now proceeded to the commencement of it and summoned my hands to attend on the evening of January 2nd., 1821.

Commencement

At the hour appointed I and my superintendents waited the arrival of the hands. Till eight o'clock not one appeared and report went that most of them were drunk owing to the money I had lent them, and the New Year revel not being over. At this I felt mightily chagrined and vexed, but in less than fifteen minutes most of them appeared, and I had the pleasure of starting all the frames immediately. Slow-driving I considered a necessary help to begin with and I did not drive above 4/5th the usual speed. In the carding room some difficulties occurred in placing the hands. Several of them demurred at being put to certain places; the overseer and they were unacquainted with one another, and utter strangers to the room and machinery. My own personal interference, however, soon settled all difficulties, and the work seem fairly on the way to prosper. Throughout the night considerable defects appeared among the carding room hands as none had been accustomed to that nicety of feeding, piecing and handling of slivers and canns that I required; they made enormous lumps, excessive brokage, and many revelled canns, and the overseer, though never so willing, was but ill qualified to correct them. There then was a new task for me - to break in and instruct an overseer and a set of hands. Another unforeseen evil arose in the slowness of the motion, causing the cards and breakers so to choke as to require frequent picking. During the night a dreadful storm came on and sadly distressed the hands with cold; this, with total darkness, midnight advancing and dogs howling incessantly from unusual confinement caused but a dismal beginning to the night spinning. I went to bed but could not sleep, rose again and waited the return of morning, when at six o'clock I found only 60 spyndles of yarn as the night's performance from eight frames, when I expected 80. Two hands fell sick during night, the rest kept pretty well awake. In the morning the day spinners grumbled terribly on the disorder of their frames, but the day overseer, being well affected by five shillings I had given him, quashed all discontent.

Progress

During the first week considerable difficulties nightly occurred, both in the hands and arrangement; many of the hands failed to come forward, and some never came that were engaged, having only got their arels (1) to disappear. Numbers, however, constantly applied, and the work was kept forward. Great endeavours were made by myself and the superintendents to instruct the overseers and hands. I spent an hour or two amongst them every night and morning explaining their bad practices and showing them the way; bad ones were turned out, and better taken in; suitable places were allocated to suitable capacities, and no means left untried that could be thought useful. The oiling of the machinery, especially the main shaft and cards, became a critical matter; the lamps also required much more carrying out and trimming than was expected. The weather continued extremely dark, cold, and rainy; roads very wet; more than half the hands had got the cold and were coughing incessantly; one of the superintendents was entirely off work from indisposition

1) arels or arles: payment made on signing on fop work. of. the King's shilling.

and the other very ill. In short, the business was everything but pleasure till in a few days the weather grew mild, the roads dried, circumstances changed, perseverance continued - hands grew more steady, work increased - and in less than a fortnight the clear nightly income fully doubled the expense.

In the course of the third week, hands being more plenty than I expected, I started the whole twelve tow frames, and not infrequently produced 144 spyndles per night. The whole cost of spinning did not now amount to 6d per spyndle. Numbers of little difficulties still continued and there was still great need for care and perseverance, but no more machinery being now to start I had a near prospect of an abatement to my labours and I proceeded with alacrity to perfect, and to bring to a nicety that which had already cost me so much trouble but from which I had now the cheering prospect of an adequate reward.

January 20, 1821.

Notes

1. The night spinning in some respects is more simple and easily managed than the day spinning. No mechanics are working, nor repairs and alterations going on - no improvements to schemes - no hecklers to attend - no flax or tow arriving - no yarn sending off - no warehouses open - no strangers calling - no materials to provide, such as coal, oil, tallow, and thousands others - no money to pay away - no accounts to keep - no diet hours to interrupt business - all which prove serious burdens of the day spinning. The night spinning is even stripped of some of its seemingly indispensable parts, such as the picking and sorting of tow for the night supply - the same being done in the daytime - the cleaning and examining of some parts of the machinery the shifting of rollers and lists - the bundling of yarn etc. Thoughts have even been entertained of delaying all the reeling till daytime, the same supposed to cost but SO/- per frame for bobbins and these not lost.

2 The turning lathes being ready, new werves and other repairs can be executed, thereby preventing stoppage of frames in the daytime. Cards can be ground and repaired during the night which is often very useful.

3 Darkness is one of the geatest evils in night spinning. Were there no darkness there would be no difficulty. Moonlight is always useful and agreeable, especially on Saturday night and Monday morning. Gaslight would certainly be advantageous; it ought to be extended not only within but throughout the yard and outside the gate. At present lamps are kept in these places.

4 To prevent pilfering no communication is allowed with any person out of doors during the night; the principal gate is locked at nine o'clock and not opened till the day hands begin to arrive when a person is stationed at it with a lamp in his hand; a private door is used during night for indispensable communication. Provisions are all brought in with the hands and a small room is set apart for placing them in the hot water etc.

5. As to attendance, the worst is on Monday morning; although a person is sent to call on the hands still several keep back; they don't go to bed early enough on Sunday - those that don't go out attend better; the boys in general roam about the streets till about midnight - they like to get into work along with the foreman about eleven o'clock when they lounge about the furnace till starting, roasting potatoes etc., to have a place of resort would be very useful, but it would require to combine novelty with heat otherwise no one would go near it; the day hands also want a place to meet at - to prevent them ranging about the mill and millyard. It would be better to start the engines precisely on the exit of Sunday, rather than to delay till one o'clock as hands would have less chance of going to bed and those who came early would have shorter time to weary; likewise an hour would be gained. The attendance on Monday night is also somewhat deficient, part of the hands not going to bed on Monday morning; married women attend worst - their children are the great bar; they give them out to keep, but by doing so they create a threefold chance of absence, any of the parties being ill being a reason. Some married women keep their children in the mill all night laying them on beds of matts or yarn - this does pretty well, saving money and anxiety to the parents. Day sleeping in some instances has been found impossible from noisy children and neighbours - overseers have mostly quiet houses, manager especially who was provided beforehand - in an ordinary house his health and spirits would have been gone long ago. The overseers have all orders to attend early on Monday morning, half an hour before starting, to arrange everything in their rooms, to adjust lever weights, to oil the machinery, to supply bobbins, roves, etc., examine belts lamps, etc.

Fire and Insurance

In view of the great vulnerability of early textile mills to destruction by fire, Brown's concern for fire precautions is wholly understandable. His father had used 'fireproof brick and cast-iron construction for his West Ward Mill, but East Mill had wooden floors. Brown's notes on fire are under three headings: precautions against fire; methods of preparing for fire; and insurance.

Within the mill, he considered that the chief risk lay in the carding engines "from the great rapidity of their motions and their having much fibrous stuff about them". It was therefore essential to clean and oil them regularly. The same precaution was necessary in the spinning room, where the machinery could catch hold of anything "causing fire by the friction on .the framing or brackets". Lanterns should not be opened in the rooms, and he also reckoned it essential to keep "all the rooms as clean as possible and the walls and ceilings free of dust and cobwebs". Other dangers in the mill were: "sparks flying from the open lamps in the spinning and reeling rooms, either from the wicks being wet, or at blowing out, and spontaneous combustion of damp waste on the surface of large shafts and pillars there is generally a thin body of fine dry dust adhering slightly which is very easily set on fire and burns very readily". Brown also pointed out the causes of previous fires in other mills.

"Many mills have been burned down and many accidents have occurred from the carelessness or inadvertence of mechanics and others in working about the machinery with open lights. When Trottie Mill was burned down in the year 1799 it was owing to a mechanic letting a candle fall out of his hand when examining a card. Some years ago Mr. Smith's mill in Arbroath was set on fire in a similar way though in a less dangerous place. Two of his men were working at a spinning frame with an open candle one evening after the mill was stopped. The candle set fire to the dust lying on the frame and the flames soon spread from end to end of the machine".

Apart from internal risks, Brown noted the dangers from "vents of private houses taking fire in the neighbourhood - Sparks flying about; boys amusing themselves with fire on the streets or roads lightening, mobs, wilful mischievousness [sic] etc."

To combat the first, he ensured that all chimneys in the neighbourhood of East Mill were swept regularly.

In the event of fire, extinguishing equipment consisted of "a large cask full of water... in each room... with a bucket in it" together with two at the mill door, with two dozen "light handy buckets or pails" in a nearby store room. Brown set out written instructions for the overseers in the mill. These commenced with trying to extinguish the blaze, or at least to contain it, sending word to the fireman to stop the mill, removing so far as possible inflammable material from the room, and concluded with the organisation of bucket chains and sending for the insurance companies' fire-engines. Brown recognised the importance of preventing panic by not making "any sort of bustle or confusion" about firefighting but carrying on "as quietly and with as few words as possible". Apart from these regular means of coping with fire, he also considered "providing a parcel of large coarse sheets... about four square yards" to be applied wet to the fire. He also contemplated regular discussions with the fire-engine keepers which would "not only extend my knowledge of the different methods of putting out fires but would secure the goodwill and exertion of these men in case of need and all the expense would be but a glass of whisky". Other moves he considered were the acquisition of keys for the fire-engine houses, writing essays on fires in local mills, and seeking advice from London on methods of extinguishing fires.

Brown was insistent on the importance of insurance.

"This in East Mill is always attended to for the work is kept constantly insured to the full extent and in a reputable office. But besides insuring everything destructible by fire we ought likewise to insure at least a year's profit to cover lost time in erection. This would not cost ten pounds a year and might gain or save thousands".

His further notes on insurance are worth quoting in full.

On the Insuring of East Mill Against Fire

The proprietors of East Mill have always been in the practice of keeping their Works fully insured against loss by fire. This precaution is so obviously proper that it is needless to say anything on the propriety of it. All I have to do is to state such information as may be necessary towards effecting the insurance in a secure and valid manner so as that the payment may be readily forthcoming in case of damage.

The first thing to be done in the business of insuring is to find out a liberal and respectable Company to insure with. In Scotland there are several extensive houses in this line but some of them are thought troublesome and litigious in settling. London is the place for liberal and respectable Companies and it is there only that one may expect promptness and liberality in the settlement of his losses. The Globe Insurance Company has for some years past been the choice of East Mill and as yet there is no reason for a change. Notwithstanding its liberality however the insurance ought to be effected in as clear and legal a manner as possible. The premium demanded by this Company is as moderate as most others, it being 18/- per £100 and 3/- of Government duty, in all 21/- which has to be paid annually in advance. Every new receipt serves as a renewal of the insurance, the policy standing good many years. The following conditions of insurance are printed at the end of the policy and are necessary to be known by insurers.

1. If any misrepresentation takes place in the description of the buildings or goods proposed to be insured or if they are described in the policy otherwise than *as they really* are so that the same shall be charged at a lower premium than ought to be paid; or if particular circumstances of risk arising from the use of the building or the nature of the 'goods proposed to be insured shall not be specially mentioned in the policy, such insurances shall be of no force.

2. No loss or damage by fire happening by invasion, foreign enemy, riot, military or usurped power will be paid. Persons insured must give notice of any other insurance made on their behalf in the property insured at this office and cause the same to be endorsed on their policy, otherwise they will not be entitled to recover in case of loss. In case of death the policy may be continued by endorsement to the representatives of the party insured. No policy will cover ready money, books of accounts, notes, bills, bonds, tallies, engrossed or written deeds, or gunpowder.

3. Goods held in trust or in commission are to be insured as such otherwise the policy will not extend to cover such property.

4. All persons insured by this Company sustaining any loss or damage by fire are forthwith to give notice to the Company at their office in Pall Mall or Cornhill and as soon as possible after to deliver in as particular account of their loss or damage as the nature of the goods will admit of and make proof to the same by their oath or affirmation and by their books of accounts; or other proper vouchers as shall be reasonably required and shall procure a certificate under the hands of the Minister and Church-Wardens and of some reputable house-holders of the parish not concerned in such loss importing that they are acquainted with the character and circumstances of the person or persons insured and do note or verily believe that he, she, or they really and by misfortune without any kind of fraud or evil

practice have sustained by such fire loss and damage to the amount therein mentioned; and until such affidavit and certificates are produced the loss money shall not be payable; also if there appears any fraud or false swearing the claimant shall forfeit his claim to restitution or payment by virtue of his policy. In case any difference shall arise upon the claim made on the office such difference shall be submitted to arbitrators whose award shall be final.

Not more than £5,000 will be insured on one Mill or manufactory. The sum proposed to be insured must be specified thus :

1. On the building.
2. On the steam engine.
3. On the Mill wrightwork, including all standing and going gear.
4. On the clockmaker's work, carding and breaking engines mounted and in use and all immovable utensils.
5. On the stock in trade whether raw, under process or manufactured.
6. On the unfinished Mill work, machinery and such articles as are dismantled, wanting repair, are repairing, or not in use.

Persons proposing an insurance must furnish the Company with a plan and elevation of the premises and state forthwith the uses to which the different storeys are appropriated and the situations of the stoves. No drying stove used for drying wetted cotton, wool, hemp or flax will be insured nor any building adjoining thereto. The policy is declared void if the Mill is heated in any other way than by means of steam conveyed in iron pipes. Also if any lamps or candles be used therein, whether any carding, picking, blowing or other preparing process is carried on unless the said lamps are enclosed in glass lantern".

Besides 'the foregoing the policy contains some information respecting the constitution of the Company, its capital stock etc. but it would be needless to insert anything of that kind here. A perusal of the policy with all the receipts, letters, etc. connected with it is recommended in cases of doubt. It must be farther observed though not stated in the policy that if any alterations be made on the property after insurance so as to render the plans lodged incorrect, the same should be notified to the Company or a new plan sent. By letter from the insurance office dated September 1816, it was agreed that the temporary opening of lanterns for the purpose of lighting, snuffing and extinguishing within any part of the Mill should be permitted.

The following plan and elevation are made out agreeable to the conditions of insurance; references and descriptions are attached to them. The whole sum insured is £4,000 which is entered in the policy agreeable to instruction. (1)

1) The plan and elevation are unfortunately missing.

RELATIONS WITH EMPLOYEES

Apart from references to the work force scattered through the rest of the essays there are some specifically concerned with aspects of labour relations and the conditions of employees.

The queries and answers about the living and working conditions of the workpeople are revealing, and are complemented by the account of the appeal for the Dundee Infirmary. The accounts of wage and time reductions, common features of adjustment to depression, are unusually full. The hecklers' strike described illustrates a typical response to such moves and the limitations on the bargaining power of the factory masters in a dispersed and highly competitive trade. Problems such as this may have led Brown to pen the comment about subcontract employment, which contrasts with his generally humane attitude to his work force.

Queries Concerning Flax Spinning

1. Are the hands allowed to get into debt to their employers by money being lent to them, to purchase clothes, to lay in provisions, or for any other purpose ?
2. Are the wages paid more than once a month; and if not, what advances are made weekly, or are there any such advances ?
3. What rents are paid for houses 16 feet square, plastered on the walls and ceilings, with three beds, and a grate to each, and a little bit of garden ground ? If the houses be materially different, say whether they are better or worse and in what degree.
4. Do the unmarried girls lodge in families and how much do they pay per month for lodging and fire ?
5. Are any of the women allowed to go out of the mill during working hours to smoke tobacco or for any other purpose ?
6. Is any kind of food allowed to be brought into the mill ?
7. What are the terms on which heckler apprentices are usually taken ?

(The above queries came from Mr. Morton and I answered them as follows - October 16, 1819).

1. Of about 90 hands employed at East Mill there are generally from eight to twelve in debt to their employers. The sum given to each at a time never exceeds 20 shillings, seldom even 10 shillings, and none ever get any but on known pressing occasions. The money is repaid at the rate of a shilling or one and six per hand per week, and the whole sums advanced are never allowed to exceed £10. Were I to advance money to every hand that calls for it I would soon be out of pocket more than £100 and almost all the hands in the mill would be in my debt in a short time; but in place of giving them money when they ask it I generally tell them that they ought to provide beforehand for any contingency by allowing sixpence or a shilling a week of their wages to remain in my hands by way of stock. This however few of them attend to for I have never yet at any one time had more than nine or ten of them in arrears.

2. The wages are paid weekly, and no advances made between pay days.

3. In the neighbourhood of East Mill the rents paid by labourers and mechanics run from two to three pounds per annum for houses of two rooms, each room measuring 10 feet by 10, plastered on walls and ceiling, but without any garden ground, furniture, fixed beds, or grates. For houses such as you mention, with three beds, and a grate to each, I can say nothing, as none of that description are to be had here.

4. The unmarried girls employed at East Mill and other mills in Dundee, who do not lodge with their parents, generally take lodgings with private houses where they pay from three and six to four shillings per week, for bed, board, fire and washing. Of this description of persons, however, the number is but small; most of the girls employed in mills in Dundee live with their parents to whom they pay from 2/6 to 3/6 per week for bed, board and washing, finding body clothes and other necessaries for themselves.

5. Occasionally the hands in the preparing rooms leave their work for a few minutes during working hours when the roves are in a forward state, but those in the spinning rooms are never

6. allowed to go out between diets. Few of the hands here smoke tobacco, and those who do are not allowed to do it in the mill. (One of my rooms has no Jakes (1) in it; of course, the women must get out occasionally).

7. Tea is often brought into the mill in the afternoon, and I do not hinder it, for it is a refreshing draught to those who are weakly; it exhilarates them and makes them work with renewed vigour all night after. No kind of food nor beer is ever prohibited; spirits I never need to prohibit.

1) See *Improvements to East Mill*, p. 65.

7) No apprentice hecklers are taken at East Mill and I am not acquainted with the terms of those taken by master hecklers in Dundee.

Charity in Hands of East Mill

I have several times with great pleasure observed the readiness with which the hands of East Mill have come forward to assist their neighbours or acquaintances in distress. Not infrequently upon being solicited, have they raised the sum of 12/- or 15/- collecting it amongst themselves in pennies or twopences, and giving it to people in distress. But the chief thing they have ever done in the way of charity is a subscription they lately entered into for the Dundee Infirmary and which amounted to £5. 15/- given by about 70 individuals. The idea of this was taken from a similar thing done by the hands of a mill in Aberdeen and which I saw mentioned in a newspaper. To get it forward I proposed it first to the overseers and then through them to the hands. It was got on with great readiness, each giving about a day's wages to it and handing in the money immediately after getting their weekly pay. The motives that induced them to it were, first, that most of them at the time were making good wages by their extra work and could without much difficulty spare a little; second, that they were perfectly aware of the usefulness and neediness of the institution, how beneficial it had been to the public and to some of themselves, and how soon and much it might be so again; third, how honourable a subscription would be, as it would appear in the newspapers and be taken notice of by the public, and perhaps be the means of bringing forward the hands of other works to do a similar deed. The subscription took place on the 11th June and appeared in the newspapers on the 18th.

East Mill. July 2nd, 1819.

Reduction of Wages

Owing to the badness of trade, the little prospect of a revival, the plentiness of hands, the highness of wages etc, a reduction was some weeks ago meditated by the mill spinners of Dundee, and was last week carried into effect. Wages during the bypast two years have been gradually advancing, not so much on account of good trade, or a scarcity of hands, as of improvements in the operations of spinning, thereby causing an increase of wages, as the hands were all on piece work, and the rates never altered. At East Mill the weekly wages of all the hands, excepting hecklers, before the reduction amounted to £31; now they amount to only £26. The following is a statement of the reduction.

25 spinners - their tasks being raised, some 18 some 21 sps pr. week	£	2	1	6
1 overseer of spinning room			5	
1 overseer of carding room			4	
1 overseer of flax prepg-room			2	
7 spreaders			5	
9 reelers - reduced from 4d per dozen to 3d, say			15	
1 yarn binder - reduced fm 9/10th of a penny to d pr ble			2	
1 fireman			2	
2 mechanics			4	
1 turner			1	6
1 tow carrier			1	6
1 oiler of spg-room			1	6
Supernumeraries discharged -			15	6
	£	5:	0:	0

By this statement it will be seen that only about one half of the hands have suffered a reduction of wages. The carders, rovers, shifters etc. could bear nothing as their wages were already moderate. If, however, a greater falling off should take place in the trade they must bear part, as provided for in their engagements; and those already reduced must suffer a second reduction. In this event the amount of weekly wages may be brought down to £20 and no interference made with the validity of the engagements.

The hecklers are now working at 2s per cwt. Some months ago they were at 2/6 - say, for 3lb yarn.

The rates of wages presently given at East Mill are as follows Under Manager 30/- per week and house. Overseers of spinning-room, carding-room and flax preparing-room 16/- each, of reeling-room 12/- Mechanics 16/- Spinners about 5/6d. Reelers about 7/- being 3d per dozen, either lint or tow. Shifters, card-feeders, rovers etc. from 2/- to 3/-. Fireman 13/-. Warehouseman 10/-. W.B.

East Mill, July 6th, 1819.

Reduction of Working Hours at East Mill

On the 26th. curt, owing to the badness of trade the working hours were reduced from twelve and a half to eight per day. The work now commences in the morning at half past five, stops half an hour at breakfast time and gives up in the afternoon at 2 o'clock. The hands get just two-thirds of their former wages, all of them agreeing to the alteration without prejudice to their engagements. The mechanics still continue their usual time, this being a favourable opportunity for their getting forward with repairs.

Trade just now is extremely flat. The prices for hire spinning are lower than ever they were. In Dundee 3lb flax yarn has been spun in considerable quantity at 6½d per spyndle and 6lb tow at 7d. The prices at this Mill for parcels presently going on are 6½d for 6 and 7lb flax and 8d for 6lb tow. No other kinds are to be got though they were to be spun at 6d per spyndle. In the neighbourhood of Arbroath the current prices are 4½d. for 5 and 6lb flax, 6d for 3lb and same for 6 and 8 tow yarn. Some 3lb at 5d.

East Mill. July 28th., 1819.

August 6th. - commenced again on full time.

Memorandum Regarding Hecklers

September 21st. 1822. Intimated to the hecklers a reduction of 6d. per cwt. on their wages commencing 30th September reducing from 3/- per cwt. down to 2/6d. The workmen after some days deliberation refused accepting and on the 30th all struck work. The following Mills joined together in urging the reduction: West Mill, East Mill, Tay Street Mills, Dens Mill, Mr. Baxter's Mill and Glammis Mill; Mr. Halley and Mr. Scott followed in two weeks. Bell and Balfour did not join on account of wanting drest flax. None of the petty master hecklers in the town joined. The Mills in Fifeshire continued to give 3/-; six in Montrose and neighbourhood the same; those at Arbroath 2/6d. to 2/9d. besides an allowance for drawing shorts. At Aberdeen a general pause took place as at Dundee.

Before the reduction was announced masters confidently expected that the workmen would be forced to accept. Trade has previously fallen off considerably. Hecklers seemed in abundance and the stocks of drest flax at most Mills were great. But all these were not sufficient. The men were no sooner off work than remittances of money flowed into their Society here from hecklers in all quarters of the country. Though one hundred and twenty men had struck in Dundee and perhaps as many in Aberdeen none of them seemed in the least distressed; part of them indeed got employment at dressing hemp in Dundee which had of late become a brisk trade. And at digging potatoes which at the time happened to be in season. The hecklers' Society all throughout the country acted with vigour and supported members. Even the petty master hecklers in Dundee assisted and encouraged the men no doubt with a view to raise the price of tow which from their great stocks on hand would be a considerable advantage to them. Provisions were very cheap and credit easily obtained in shops all of which contributed to render easy a long standing out. Most of the Mills were supplied with drest flax for at least four weeks and part of them to prolong their supply put some of their lint frames upon tow preparing for them in the night time; but after the lapse of three weeks the men seemed as careless of employment as ever and no appearance of their returning.

At Aberdeen numbers of heckling machines, women and apprentices had been set to work and notwithstanding such formidable proceedings the hecklers continued obstinate allowing Mr. Maberly's Mill at Broadford wholly to stand from want of drest flax rather than give in.

At Dundee some of the Mill spinners were now of opinion that the hecklers would not submit even though the Mills should be stopt. In Fifeshire no co-operation had taken place on the part of the masters. At Arbroath and Montrose old rates were continued. Remittances from these places flowed in weekly to Dundee and all things considered it was thought prudent by some of the masters to employ the men again at former wages. The first to call them back was Mr. Blyth who issued orders to them on Saturday, 19th. October. Mr. Baxter of Glammis was reported to have done the same. West Mill, East Mill and Dudhope Mill gave orders on Monday 21st.

Tay Street Mills held off some days; but it may be remarked that they continued to employ some petty hecklers in the town during the stoppage though at what rates I don't know. Mr. Chalmers employed a good many for himself to supply country Mills at 3/-. Some masters were of opinion that the hecklers if submitted to would demand 3/6d. for heckling; that this was erroneous appears from the readiness with which the men returned to their work on being called. At E.M. twenty-two out of twenty-five made their appearance in three hours after notice issued. Though only two or three were spoken to. No sooner were the men at East Mill employed than the Tay Street Company and some others accused J. & W.B. of rashness in calling them back. J. & W.B. were of the opinion that the men would not have been exhausted for many weeks to come and that even though the Mill had been stopt no impression would have been made on the men as was proved to be the case at Broadford Mills. Some flax spinners urged the necessity of stopping Mills altogether rather than submit. This certainly would have been imprudent unless general throughout Scotland. Had a few in Dundee done so, they alone would have suffered all the disadvantages while the Mills in other places would not only have suffered no trouble but even have availed themselves of stocking their Mills with better hands at our expense and likewise have got higher prices for their yarns during the stoppages, besides steering clear of the blame and odium arising among servants and others for attempting to lower wages. The stoppage, short as it was, had a bad effect on some Mills by raising the price of tow in which article there was great speculation owing to the starting of Mills in the night time. J. & W.B. might have kept off their men seven or eight days longer from their stock of drest flax but as they considered the men could stand out longer, it was useless to continue lessening the stock of tow in the market; and it would have served no good purpose to harass the men to the utmost without effect.

The want of success in this attempt of the flax spinners arose from the erroneous opinions some formed and boldly asserted regarding the state of trade and the circumstances of hecklers at the time. Wages had been accustomed even in the best of times to rise by 3d. per cwt. To take them down by 6d. and the times not extremely bad at once enraged the men and united them firmly in striking and standing out. If 3d. only had been asked no opposition would have been shown, the men having hinted so before stopping; but masters were fixed and confident. In fact their proceedings were rash and imprudent in more respects than one. They did not even think it necessary to call upon one another but in very limited number. Several were consequently unprepared with drest flax and could not stop their hecklers who, of course, supported others who struck; others came into the measure too late to do good and there was a general misunderstanding and distrust throughout the whole.

To ensure success next time a longer preparation must be made; correspondence must be held with flax spinners in all quarters of the country, stocks of drest flax and tow must be prepared to serve six weeks or any length of time that may be thought necessary; all the works must give intimation on the same day to their hecklers without a week's notice as

usual, no such thing being given by the men. It must be well ascertained that all the flax spinners have sufficient stocks of drest flax and tow and pledges must be got from everyone agreeing to employ no journeymen during the stoppage; and in case of the men standing out till the expiry then the whole works to be stopt.

Extract from Notes to Managers

Note 6th. In some English Mills the overseers of rooms find hand for themselves, paying them out of their own pockets and making the best bargain they can with them. On this plan they drive economy of hands to the utmost pitch employing and teaching many new cheap ones, squeezing down wages to the lowest fraction and giving each hand as much work as she can possibly do and enforcing the most rigorous attendance and attention; thereby doing the business of a room not only at lower rates of wages, but also with a considerably less number of hands. On this plan masters have much less trouble themselves and nothing can more effectually tend to keep down the rates of wages in general. But to adopt the plan here would be attended with considerable difficulties at first owing to the unsteadiness of everything concerned. Fluctuations in trade and wages, changes of flax or tow, variations in the size of the yarns, alterations on the Mill or machinery etc. would all tend to throw the thing into confusion. Fresh bargains would require to be made with the overseer once every six months at least. When at the same time he would require to settle all the hands he needed to make sure of his speculation. The plan might be tried with one room at first making such a bargain as that the overseer would have something more than common wages for himself. Afterwards the idea to be extended as circumstances encouraged.

IMPROVEMENTS TO EAST MILL

As stated in the introduction, East Mill had been converted from a tannery, as far as one can judge at minimal cost. Brown's sensible and practical approach to improving the amenities of his works shows him at his best, combining economy with utility. The account of the improvement of the jakes is a classic of early sanitary improvement.

It was not only the mill that received attention. He also felt the need to ensure that the yard was kept tidy and clean. Fortnightly sweeping, and the keeping of materials - especially coal - in neat piles, he considered to be adequate. The water channel had been enlarged and covered, but there was one trouble spot by the chimney "where a bank of sand is apt to gather which must be cleared away every year in October". However, he suggested that the reason for this might sometimes be a blockage outwith the mill yard.

Improvements on the Mill Yard

Having lately completed a plan I have long had in view and which I have been gradually executing during the bypast three years of improving the Mill yard I now sit down to write a few words on the subject.

In the year 1810 when I commenced Manager of the Work I found the Mill yard in a most disgraceful state from filth, wet, open drains, old ponds, ruinous necessaries, old dykes, rotten gutters, etc. and in the middle of it an awkward looking house was situated for shaking tow in, communicating with the Mill by a long wooden entry quite intersecting the yard and presenting an appearance truly mean and ugly. From all this and from the many by-corners occasioned nothing could be expected but dampness, bad air, bad smells, and every uncleanness; no person could cross the yard without suffering disagreeable guffs (1), disgusting sights, wet feet etc. and none could pass in the dark without being in danger of broken limbs or a ducking.

The effects on the health, comfort and temper of the Manager and hands must have been very bad and no doubt all had been much hurt and degraded by it, for what could be more hurtful and degrading than for human beings to live almost constantly among human stink. They might no doubt have been habituated to it so as not to observe it nor much to think it hurtful but human beings will insensibly grovel like swine if gradually brought to it by custom. The bad air was not confined to the yard alone. It reached

1) guffs: unpleasant smells

also into the Mill and all the houses round about entering by the doors and windows and filling the rooms with its disgusting nuisance; I have often seen the hands while at work holding their noses with their aprons till the gusts abated; and as for strangers, I have many times felt ashamed to take them through the Work supposing they must have thought me devoid alike of money and of taste.

Such being the state of the Mill yard in 1810 I would instantly have begun a reformation upon it but from want of money and other circumstances I could get nothing done for a number of years. At last however I began and carried through gradually, taking down the tow house, altering and covering the water channels, removing the old necessities and fitting up new ones, levelling and making up the ground, enlarging and renewing the entry door, taking down old dykes, removing the coal yard, lessening and new forming the pond, removing an outside stair, fitting up a new pump, putting new sluices into the water channels etc., all of which cost many a pound, but which being accomplished gradually were but better felt. Now when the job is finished the Mill yard presents a spacious area fifty yards by twenty yards, dry, fresh, healthy and convenient, such as is not to be seen at any Mill, alike pleasing to the Master and the hands, and calculated to make a good impression on all who see it. And though it has cost above one hundred pounds is surely worth at least one thousand pounds either for keeping or for selling.

On the Jakes at East Mill

As it is of the greatest importance to the health and comfort of the hands to have the Jakes of the mill so constructed and so kept as to be void of bad smells I have of late been making some alterations and improvements on them and mean here to give a short account of them.

The importance of having the Jakes in the inside of the rooms and cleanly and convenient needs no explanation; it is sufficiently evident. The difficulty, however, of making such things seems considerable since scarcely any mill is without bad smells in some way or other arising from the Jakes; even the finest of mills where costly patent Jakes are used are not without defects but no wonder mills are deficient in this respect where such a number of hands are employed. Many private houses where only a single family is kept are suffering in a similar way from imperfections in the Jakes. I have long been plagued with bad ones in this mill and have often despaired of making them free of smell but now I have almost accomplished my wish and am highly pleased at having done so notwithstanding all the trouble it has cost me. Originally the construction of the Jakes at East Mill was very indifferent, but a slender wooden shade close upon the outside of the mill, 5ft square, reaching from top the bottom, and containing a seat in each room from which the filth fell down to the ground bespattering the walls as it fell and forming a horrid heap below. The great fault of this erection was that not being close it gave too free a passage for air through the fabric, thereby permitting constant fumes of stink to pass off in all directions and the people in the upper flats had it in their power to play tricks on those below by wetting and dirtying them. It was likewise a clumsy, rotten looking structure on the outside, quite disgusting and disgraceful.

The improved Jakes as they now stand are very simple, convenient and free of smell. In each room a small door is opened through the wall at a corner, on the outside of which a wooden box or closet is placed projecting only 9 ins. over the wall with a seat in it no larger than holds a single person. Below the seat a sort of wooden funnel is placed, from which proceeds downwards to the ground a square wooden pipe 4 ins. wide at the upper end and 5 at the lower, widening gradually all the way down which conveys the dung to the bottom and which neither chokes nor can send out any smell. There being 3 flats in the mill, the three pipes stand all nearly alongside each other and come close together at the bottom about 10 ins. above the ground and the dung falls down to the lower ends where it meets with a heap of earth, ashes or any other stuff that's fit for being mixed amongst it and which closes up the openings of the pipes to prevent a draught of air getting up and passing into the rooms. To conceal the heap of dung and to prevent bad smells rising from it and spreading in the yard or passing into the mill by open doors or windows, a substantial airtight house encloses the heap at lower ends of pipes and keeps everything snug and close. To keep the pipes clear within, nothing further is required than a

bucketful or two of water thrown down each of them once a day, in doing which the seats and funnels are carefully washed and cleaned. The dung below is cleared away every morning, while at the same time fresh earth or ashes are put in. The quantity of dung made per week is about a cartload which being much mixed sells at only 4/-. If any smell arise in future and be troublesome either in the mill or out-of-doors some part of the apparatus must be out of order or some person committing mismanagement.

East Mill, June 30, 1819.

Description of Improvements and Expenses Involved

The following account is reproduced in full on account of the information it contains on material and labour costs in the building and metal-working trades:

An Explanatory account of the expense of some alterations and improvements on East Mill, lately executed for the purpose of enlarging the Flax and Tow preparing rooms, and making them more commodious, airy, and substantial. - November 1819.

Mason-work - Building spreading room at north wing including gable of north warehouse, which formerly was of slabs - pr. contract with A. Robertson	£15.	0	0
Do. Flooring new spreading room - 580 sq. ft. per contract at 4½ d.	£10	17	6
Do. Underbuilding, paring, and evening the walls of spreading room, roving room and carding room 160 ft. long by about 3 ft. high - making drains along inside walls, altering and repairing the pump-well - making stair at carding room door, laying flags, renewing two windows on west side, pointing outside wall, - boring holes for bolts - building a bit to north side of carding room wall to keep out water, breaking out opening between roving and spreading room, completing water channel, bases for two pillars laying floor of roving room, etc. etc.	£10	12	0
Wright-work - Roofing, sarking, lathing etc. spreading room, two new windows, fitting in old windows and door etc. per acct. D. Reid	£25	0	0
Do. New window shutters - painting windows, new panes to old windows, hatchway board, work at double beams. D. Reid.	£2	12	6
Slater - Slating 3 roods 7 yds. new spreading house, furnishing 2300 slates, nails, plaster, carr. etc. per D. Mearns acct.	£15	5	0
Plasterer - Roof of spreading room, 11½ yards at 5d, walls 119½ yds at 3½d - pr. T. Haggart's acct.	£3	7	0

Blacksmiths' and Mechanics' - Iron for shafts, double refined:	£11	6	0
71 stones 12 lb at 3/4 - pr. W. Whyte's acct.			
Wood for two dormants 27 feet at 1/11	£2	12	0
Do. door lintel at roving room, 21 ft at 2/3 £ 2. 7.-	£2	7	0
Forging five large shafts - pr. G. Smith	£3	0	0
Bolts for dormants, plumber blocks, jumpers, drills for coupling, pins, cutteralls, keys, punches, bolts for brackets, plates for drums, wedges, etc., per G. Smith	£5	10	5
Foundry - two pillars for carding room, ea. wg 834 lbs. (plumber blocks, couplings, covers, bevel wheels, washers, sockets, rings for two new drums)	£10	11	0
Mechanics - Two hands, constantly employed 14 weeks fitting up 70 feet long new shafts, pillars, dormants, beams, etc., making window shutters, fitting in doors, removing machinery, altering driving motions, making new drums, etc	£21	14	0
Labourer - removing about 160 cubic yards rubbish from flax preparing and carding room cutting trench at west end of mill and filling same up with clay to prevent inside water, shifting stones sand gravel etc. per P. Campbell, A. Ross, and Mr. Hill - wages 1/6-2/- per day	£4	19	0
Cartages of earth, sand, clay, stones, etc.	£1	17	0
Do. shafts, wood, etc.		7	4
Stones - 12 loads from Lochee, 6d, carriage of same £1	£1	0	0
Drink to masons, and mechanics at night work, say, £2	£2	0	0
Wood for staves to two new drums for main shaft £ 2. 4. 10	£2	4	10
Lime-six bolls (1) at 4/3	£1	5	6
Stones for bases to two pillars 5/-	£	5	5
Stones - 146 feet pavement for roving room - 3½d	£2	2	7
Sand - four loads	£	6	0
Fitting up door and two windows opposite pump well - per D. Reid	£2	2	0
Fitting up turning lathe etc. in carding room for the mechanic who attends cards - including shears, heads, driving motion, grindstone, vice, viceboard, bench, enclosure and flooring	£40	0	0
Fitting up hatch-way box, between flax preparing and spinning room	£5	0	0
Breaking out and making new window in turning Shop	£3	0	0
Plastering carding room and roving room	£4	0	0
	£224	7	8

1) boll: about six bushels

The advantages gained to the mill from this outlay of £224. 7. 8 are as follows: - the carding room is increased in size about 80 square yards, and 26 feet added to the length of the main shaft, which is now ready with drums upon it for any purpose that may be wanted, whether to give more room to the present machinery or to accommodate additional. This is a great acquisition and will no doubt be soon turned to advantage for nowadays the success of spinning depends greatly upon improvements, and most improvements require additional room. Any new arrangements that may in future be necessary for the tow preparing machinery of East Mill can now be executed on the shortest notice, and without trouble or confusion, whereas formerly the want of room and of driving shafts acted as a most serious barrier. Another acquisition to the carding room by the late alterations is that the room is now almost completely secured against water. Formerly, in rainy weather the water issued through the walls in such quantities, owing to the height and sponginess of the ground outside, that the whole floor was soon covered over and the hands obliged to have thick planks laid for them to walk upon at their work. This was a most unpleasant thing and often produced incalculable confusion and vexation among the hands.

The carding room is now one complete uniform room 96 feet long by 26 feet wide with plainly one line of substantial main shafts along it. It has two outer doors and is all well lighted except a bit at the west end which is rather dark but which will answer very well for some purposes. The room, being a sunk storey, is rather deficient in some respects, but upon the whole is not amiss, as dampness agrees very well with the operations of spinning.

As to the flax preparing room the advantages gained by the late alterations lie, not so much in having obtained more space, as in having got better arrangements and more substantial apparatus. Formerly the driving machinery was very complicated and very much in the way; the floor of the spreading room was completely worn out; and that of the roving room awkward from being on different levels; the entry door was narrow, wet and dirty; the rooms low and confined in the roof; there was no jakes; the stance for the drest flax was at a great distance from the spreaders and from the entry door; and the roving frames were far from the second drawing frame, and quite out of the overseer's sight. Now, everything is the very reverse, and although the room is yet rather divided and unshapely in itself, a better arrangement for the machinery can hardly be conceived; and if dampness be an advantage it can always be had in abundance.

Other advantages resulting from the late alterations are: -the pump well at the mill door is clean and improved, and made extremely useful to all the hands employed about the mill, and its water is the only water in the neighbourhood fit for food and washing. This water comes from a sandbank on the south side of the mill, issuing from the bottom of the bank on a surface of clay and running through a small drain across the carding room to the well, as may be seen in a figure or a ground

plan of the mill to be hereafter inserted in these pages (1). The property both outside and inside, is much improved in appearance, as everything complicated, slender or dirty, is taken away, and the ground, at entry doors made flat, dry and of easy access.

Notwithstanding so much money has just now been laid out on the flax and tow preparing rooms, still there remain several things more to be done to them before they be quite complete; still the carding room, and flax roving room remain unplastered; still the floor of the carding room remains partly unlaidd with pavement; still there is very poor apparatus for conveying the roving bobbins to and from the spinning room; still there are no presses nor store rooms, no black hole (2) for the boys etc. ; but in the meantime things must remain as they are; enough has been done in one season in the way of improvements; and the day. is now so short that alterations on houses cannot be carried on with propriety. The jobs already done have given me such an inconceivable deal of troubles and have drawn my attention so much from my other duties that it is high time to desist for a while; after what I have done I feel great pleasure, however, both as it rids me of much trouble in managing and puts me more of a footing with most of my neighbours which I was most anxious to be, as I do sincerely dislike inferiority in any respect; and now being equal I have a fair chance of being superior !! W.B.

November, 1819.

Brown went on to specify improvements proposed for the following season which could "be effected with comparatively little trouble and expense" and "make such a happy change upon the appearance and value of the work". These consisted firstly of the enlargement of the spinning room by moving the turning shop and inside stair. The construction of an outside stair would also open up the upper flat for reeling, turning and yarn binding. He also proposed to convert most of the second flat of the north wing into a stores room for spare parts and materials. Finally he suggested plastering and white-washing the carding and flax roving rooms and so finishing them as "to make them cleanly, decent and agreeable to the eye".

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1. *One of the sketches whose loss we can only regret.*
 2. *Black holes for the boys: possibly places where the boys could spend their breaks and eat their 'pieces'. Had Brown not devoted so much time of his improvements to the Jakes, one might have assumed that the "Black holes" were privies.*

After the alterations were complete, in April 1820, Brown reflected on them with some satisfaction. By the expenditure of nearly £350, drawn from revenue, without increasing operating expenses, he had, he believed, much reduced the degree of skill and the amount of time required in management. He proposed to use the time made available to investigate the possibility of improvement of the spinning process. Most importantly, he reckoned the conducting of the work might now be entrusted to a hired Manager (1) and no great risk incurred of inferiority in the management..."hence my present cause of self gratulation". But his complacency was short-lived. Three years later he wrote:

"Who knows what they have to encounter? I have been more plagued and perplexed since writing the above with the insufficiency of the mill house than can be imagined. Doors, windows, floors, partitions, walls, drains, ceilings, slot hatchways, foundations etc have all been tumbled down or falling into ruin upon me. Water in all quarters has troubled me, wind problems me and drift distresses me... this is one of the worst houses ever built".

Brown did, however, recover his equanimity and his enthusiasm, as is indicated in his obituary, on his death in 1864.

THE STEAM ENGINE AND MACHINERY

The Steam Engine

This was ordered from Boulton and Watt in 1798 by George Wilkie. It cost £750, and developed a nominal twenty horsepower at forty-three revolutions per minute. The cylinder was twenty-three and three-quarter inches in diameter, with a stroke of five feet. The engine was of Watt's patent sun-and-planet type and was the largest Watt engine in Scotland at the time of its construction. It was also the first engine supplied by Boulton and Watt to a Scottish flax mill. Some time before the Browns purchased the mill the original wooden beam of the engine was replaced in iron (1).

As the engine was the sole prime mover its reliability was of great concern to Brown, and as coal was expensive in Dundee its economy had to be looked to. By the time Brown started his diary the engine was - like the mill - getting on in years and throughout the period covered it gave considerable trouble. Brown's approach to these problems illustrates very clearly his rational approach as a manager.

The first mention of the engine is an early one. When the engine" was under repair Brown seized the opportunity to examine the boiler and its setting, and the chimney. He produced dimensioned sketches (2) showing the passages available for air and smoke. The chimney had at that time just been renewed. The old chimney was "far too small being only fifteen inches by thirteen inches wide and forty-two feet high". Its replacement was "twenty-four inches by twenty four inches wide and about fifty-five feet high". It was "built of the very best rubble mason work" strengthened by "eight layers' of bindings" made of iron bars, and cost £40. The disadvantage of the old chimney had been considerable. Only the best coal could be used, and the power from the engine had often proved inadequate. As against this, the necessity of nursing the engine and boiler led to low fuel consumption.

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1. *Ms engine list in Boulton and Watt Collection, Birmingham Reference Library.*
 2. *These sketches were presumably in the original ms.*

Shortly after, the engine itself was reconditioned. "The old nozzles, side pipes, valves, spindles, rods, lifters and crankshaft" were replaced "with new ones on an improved plan made by Messrs. J. & C. Carmichael". The work took four days and cost £110. The fittings were designed to suit an enlarged engine, presumably to give a reserve of power for possible extensions to the machinery in the mill.

That these improvements were worth while is shown in a note dated 1 July 1819:

Expense of Fuel for Steam Engine

Some days ago a cargo of Alloa great coal containing 57 tons and costing in the mill yard £40.10/- was finished after lasting 39 working days, each 12½ hours long. The quantity used per day thereby averaged 29 cwt. 1 qr. and the cost 20/9d. During the parcel 14430 spyndles of yarn, partly 3lb flax and partly 6lb tow were spun, which makes the expense on each spyndle for fuel about 2/3 of a penny. This may be looked upon as very moderate considering that scarcely any mill in this country works upon less than a full penny per spyndle; some in Dundee I know are 1½d, which is more than double that of East Mill. How pleasing it is to see things turning out this way at this work, now when the new chimney is in use - a thing which everybody predicted would be hurtful to the fuel but which is certainly not so. But to what, it will be asked, is the circumstance owing, that the engine requires less fuel now than formerly, for now it requires at least one ton less per week. This I answer by saying that less fuel is required partly on account of the new chimney which prevents much stirring of the fire and partly on account of the new valves which let much less of the steam escape. It will also be asked, why is East Mill less expense per spyndle for fuel than other mills for it is at least ¼d per spyndle less. This I say is owing not to anything in the steam engine but to the general management of the mill. Every machine in it, whether card or frame, is so conducted as that it produces work almost equal in quantity to the rate of its delivery and thereby little power is wasted; whereas in other mills the machines produce far below the rate of delivery thereby wasting a great deal of power. In some mills the cards and frames produce only three quarters of their delivery. In East Mill they produce 19/20ths. But as nothing was ever so improved as not to be susceptible of further improvement, so am I not to rest satisfied with what I have already done. I have therefore just now begun to try the effect of two boilers to

the engine and when that is finished and no additional coal consumed, I am to try the effect of fuel 2/6d or 3/- per ton cheaper, but all I need say at present is that another essay must finish the subject.

July 1st., 1819

Account of Accident in Steam Engine at East Mill Dundee on 15 September, 1823.

Brown made detailed notes on this accident, commenting that "the nature and circumstances attending accidents in steam engines ought to be correctly ascertained and carefully remembered for the advantage of future management".

The cause of the incident was cracking of the planet wheel. This was partly of old extent; Brown suggested that the cracks had been in the casting as made. The wheel broke up and part fell down, jamming the rest: the connecting rod immediately fractured, and the piston "was dashed up and down with great violence in the cylinder so long as the fly wheel and carding engines continued by their momentum to work the valves which they did at least ten or twelve revolutions of the wheel". This resulted in another break in the connecting rod; in the wreckage of the parallel motion; in the bending of the piston and air pump rods. No-one was present, as the fireman was at the coal yard. Fortunately the cylinder and air pump were undamaged. As there were spare sun and planet wheels to hand the repair was accomplished in five and half days. "About a dozen of men were employed fourteen hours a day besides a few during night bringing forward the connecting rod pattern; all of them exerted themselves to their utmost". The repair cost about £40 and the loss by the stoppage £60. "The hands got full wages during the time: to have curtailed them would have annulled their engagements".

Notes on Various Alterations and Repairs on Steam Engine

After the accident damage had been repaired the engine was found both less powerful and less steady than formerly. Carmichael's engineers were not helpful. "One of them recommended for us to persevere for a while and we might perhaps latterly succeed in bettering ourselves a little - the other declared that we had no alternative but to order a new engine!" Brown's immediate response was to reduce the load on the engine by overhauling and adjusting the heavy machinery: this proved only marginally effective. Onlookers were as nonplussed as he about the cause of the deficiency.

Brown had at first steered clear of altering the engine, but "after inspecting it all over as carefully as I could" he decided to make detail alterations, and considered the use of "stronger steam" to increase the power of the engine. To take charge of these largely experimental modifications he appointed his principal mechanic, removing the responsibility for the engine from the head manager of the mill. The mechanic was to spend all his time on the project and to "provide all materials, assistance and workmen that might be necessary".

At the start of the experiments, the engine could only manage twenty-one to twenty-three strokes per minute instead of the steady twenty-five required as a minimum. To boost the speed to that level was the object: "anything short of this we considered would be a failure and anything above it high success". The first expedient tried was to use "stronger steam" by increasing the height of the feed pipes to the boilers. The first stage of the increase was from three and a half pounds per square inch to five, but the height was raised to allow of seven pounds per square inch. This alteration, which took nearly two weeks, raised the speed as required, but the engine was still unsteady, and the fuel consumption rose excessively. The next phase involved a thorough overhaul of the boiler fittings, and was followed by experiments with the lifting apparatus for the engine valves. After a thorough overhaul, with the valves re-set to lift a little sooner,

"a wonderful acquisition of power and smoothness of motion was immediately the consequence to the engine".

The speed could then be comfortably raised to twenty-seven to twenty-eight strokes a minute. An overhaul of the governor, the installation of a pipe from the cold water pump to the boilers, refitting the cylinder head, the installation of a device to disengage the valve gear, and the connection of a revolution counter completed the work on the engine. The opportunity was then taken to improve the engine-house. These modifications were nearly complete when first one of the links in the parallel motion gave way and then cracks were observed in the new planet wheel. After repairs had finally been completed Brown commented with obvious relief that the engine "is now as efficient and free of faults as most in Dundee; its recovery is in fact nothing short of triumph considering the state it was in before". The whole project had cost "not less than £50" and it had taken more than two months to complete. It was indeed a triumph of cautious, careful management.

Subsequently problems were encountered in the transmission 'of power from the engine to the new spinning frames. The system adopted - a vertical shaft from the engine driving horizontal shafts through level gearing - was standard at the time, but was later replaced for new construction by rope transmission, largely on account of problems described in this account.

Imperfections in Driving Shaft as Fitted up at East Mill

A complete set of new spinning frames being put into the work, a new arrangement of driving shafts was consequently required. None of the plans commonly in use was applicable to the local situation and of course something new behoved to be invented. Various schemes were suggested, but the simplest and best, everything considered at the time, seemed to be the mode that was executed. The room in which the shafts were placed was 96 feet long by 26 wide containing 20 frames of 50 spindles each, placed in a single row with the driving pulleys close to the wall on one side. The shafts were constructed as follows.

A single line of about 90 feet long, in ten lengths or pieces, was placed along the top of the room, directly over the drawing ends of the spinning frames, situate exactly at right angles with the horizontal cylinders of the frames, but nine feet higher, centre to centre. On this shaft which moved at $181\frac{1}{2}$ turns per minute drums of 20 inches diameter were put for driving the frames, giving motion by belts half crossed downwards to the horizontal cylinders. The brackets and other fixtures for supporting the shaft were of the most accurate and substantial kind. The shaft itself was made of good malleable iron $2\frac{1}{2}$ inches square with journals $2\frac{1}{2}$ diameter by 3 long. In short, everything about it was so accurate and complete that its journals when in motion required oil only once a day, and no shake or vibration of the smallest consequence ensued, even at the outmost speed.

Motion was communicated to this shaft from the steam engine as follows: first - by the main horizontal shaft of the mill, projecting out in a straight line from the flywheel shaft, making 48 turns per minute; second- by a vertical shaft 14 feet long, driven by bevel wheels from the first length of the main horizontal shaft reaching the top of the spinning room and making $59\frac{1}{2}$ turns per minute. Third- by a cross horizontal shaft, driven from the vertical, also by bevel wheels, making $123\frac{1}{2}$ turns per minute, and driving the 90 feet shaft making $181\frac{1}{2}$ per minute. The brackets and fixtures of the vertical and cross shaft were chiefly attached to the floor above the spinning room, and tho' strongly bound with wood and iron were by no means so steady and firm as could have been wished, the floor springing and yielding in some degree every time the wheels turned round.

The different faults and imperfections of these shafts when put to work were as follows: first - there was a constant and regular jerking or inequality in the motion, given by them to the spinning frames, causing such an irregularity in the motion of the spindles that the drag or temper of the bobbin was thereby rendered excessively harsh and irregular, alternately a jerk and falling off in the speed, attended with a swell in the noise of the spindles, distinctly heard at the frames, causing great injury to the spinning and some waste of power and machinery. These evils were at first attributed to imperfections in the couplings of the long shaft, especially as the faults were greatest towards the extremity of the shaft, but on finding that the jerks on the drag counted only about 120 per minute while the speed was $181\frac{1}{2}$ turns,

it was concluded to lie somewhere else. The cross shaft being examined it was found that its revolutions or rate of speed exactly corresponded with the jerks at the spinning frames, thereby showing the cause to lie in it, cause and effect appearing in their true light. Certainly this cross shaft was not so firm a fixture as it ought to have been but whether its defects were caused chiefly by the yielding of the fixtures or by faults in the form or hinging of the wheel, or part both, I am not certain. Suffice it to say that the evils produced were most hurtful to the spinning and had they been allowed to remain, would no doubt have entailed a permanent evil on the work to the extent of 30 or 40 spyndles per day on the quantity spun, or £200 per annum on the profits. Second - the thundering noise created by the rapid motion of the large wheels on the different shafts proved a very serious inconvenience to the work. In the spinning room it was loud beyond all other noise, rendering it scarce possible for persons to speak to one another in a way to be understood. Orders and directions to overseers and hands could not be given with that perspicuity and agreeableness which was desirable; voices had to be raised and faces distorted, so that ill humour was occasioned and looks and language was misunderstood to the great annoyance of all concerned and the injury of the work. Third - the vibration of floors and pillars occasioned by the rapid motions of the heavy shafts and wheels was no small evil to the concern. At that part of the room where the vertical and cross shafts were placed the floors, both above and below, vibrated so considerably that the spinning frames seemed in a constant tremulous motion. The bad effects of this on the frames in throwing the different arbors and spindles off their proper line and so bending the necks and journals in their brasses, must have amounted to something, besides the bad effect of rendering irregular that delicate part of the operation - the drag of the bobbin and so wounding the spinning in its most tender part. Fourth - the oiling and inspecting of the shafts also became an awkward piece of business several times a day. None of them could be got at without using a ladder, which had to be frequently lugged through passage of the room, jostling and deranging the spinners and sometimes knocking against the lamps, frames or baskets. The oil also often dropped down from the brackets and boxes upon the spinners, dirtying and annoying them. Fifth - the vertical shaft from its being situate in the middle of a passage proved a considerable obstruction there, rendering it scarce possible for the spinners and shifters to avoid frequently jostling one another about it and also preventing the overseer, mechanics and manager from having free access to oversee, repair and inspect. The drawing belts also running so openly and loosely up at the ends of the frames, occupied a good deal of room and closed the passage between the frames at one end altogether. They were besides, so many of them in the room, a conspicuous irregular looking object, not at all consistent with that plainness and simplicity which ought to be the characteristic of a spinning. Sixth - the risk of stoppage occasioned by the driving of so much machinery from one train of shafts and wheels was by no means proper, any single wheel giving way causing a total stoppage of the mill. Indeed, the rapidity of the motion was alone a source of self-destruction to the wheels, even though the burden had been ever so light. The wheel of the farther end

of the cross shaft and the one on the long shaft moved at the rate of 11 miles per hour, calculating at their circumference, which was surely cause enough both for noise and friction. Such a rapidity of motion in heavy wheels must never again enter into any scheme or plan of mine for improvement. One half the speed is quite enough. Wheels in my opinion, might be put to such a velocity as quickly to destroy themselves even without any burden. Speaking of wheels, however, I must be understood to mean those only made at Dundee and neighbourhood where they are generally very bad, quite inferior to what are made in Glasgow, Leeds or London.

The foregoing are the chief imperfections and disadvantages attending the method of driving now described, and which are so considerable that every exertion was made to have them annulled as soon as possible, and supplanted with something better. The plan now adopted answers sufficiently well, possessing none of the faults above mentioned, nor even any other in their room, as far as has yet been observed; but a more particular description must be the subject of another essay. The loss occasioned by discontinuing these faulty shafts amounted to about £50 in lieu of which I am however possessed of additional knowledge, caution and experience, deeply impressed on me by the much serious trouble, reflection, and urgent invention, consequent on the failure of the old and the hasty fitting up of the new.

July 7, 1823.

On the Management of the Steam Engine

The following notes are largely concerned with minutiae, but do shed much light on the engine and boilers, and illustrate the trouble Brown and his mechanic took to understand the working of the engine and its boilers. The two boilers already referred to were made and installed in 1821-2. Each was fourteen feet long, five wide and six deep. The first weighed fifty four and a half hundredweight, and cost £136 5s, and the other fifty three hundredweight and cost £95 8s. The difference in cost was due to the employment of rolled plate for the latter in place of hammered plate, which was considered superior. "The thickness of the plate is pretty even all over, being about 1 of an inch; the best and thickest was picked for the bottom, and thinnest for the top".

Water supply posed a problem, as the only stream was small and muddy. By controlling the times at which water was admitted to the pond the worst of this evil could be averted, but the boilers still required cleaning every three or four weeks when the water was muddy. The safety valves were of the deadweight type, and Brown noted the importance of having them steamtight. To give a possible pressure of seven and a half pounds per square inch the top of the feed pipe was sixteen feet eight inches above the surface of the water in the boiler. Occasionally, "sometimes twice or thrice a week, sometimes twice or thrice a month, and sometimes twice or thrice a quarter" trouble was encountered with priming, i.e. the carry over of water into the cylinder. This retarded the speed of the engine for "fully half an hour at a time" and damaged the packing, as well as clogging the valves. Brown noted that priming was associated with muddy water, and suggested that "some simple apparatus might be constructed for the mouth of the steam pipe to keep off the water and yet admit the steam".

So far as the engine itself was concerned, Brown described the difficulty encountered in determining the clearance between the piston and the bottom of the cylinder.

The quarter of an inch recommended by Messrs Carmichael proved inadequate when the engine was under load and had to be increased in two stages to nine-sixteenth of an inch. The alteration was effected by raising the centre of the beam.

There is an interesting comment on the effect of steam jacketing in the engine - a standard Boulton and Watt feature.

"It has been ascertained by experiment at East Mill that if the steam be excluded from the casing the speed or power of the engine is reduced 1/12th part, tried with the engine fully burdened. It is therefore of consequence to attend to this point-though at the same time it is necessary to prevent a waste of steam by keeping the lower cock too open".

The cylinder was twenty four inches in diameter, giving a nominal twenty and a half horsepower "reckoning 22 square inches to a horse power". Brown noted that the internal surface was "extremely good" and reckoned that "it may last another twenty years yet". The piston had three hollow spaces in it, which were originally filled with stone, but on 29 May 1823 this was replaced with pieces of plane tree covered with an iron plate. The new packing was expected to last for five or six years.

Brown's recognition of the importance of the valves has already been mentioned. He notes here that "the best point for lifting however is not easy to find by rule, not being a settled matter among engineers" though they agreed that steam should be admitted before the end of the stroke to cushion the piston. Boulton and Watt's rule was that the valves should begin rising when the centre of the crank pin was distant from the centre point or turn to the extent of one and a half inches for every twelve inches of length in the stroke. Browns remarks on this, however, were as follows:

"This rule may be very good as a general guide but for particular use it is scarce satisfactory.... In all cases rule must give way to trial... as no calculation can be made to ascertain the extent of giving or yielding of the parts in course of working... It is a fact that some weeks ago when the valves were altered to lift one 54th part sooner an increase of power to the extent of at least two strokes upon 24 was instantly gained".

He noted that though there was no shock at the valve motion when the engine was unloaded, at full load the shock was considerable. The valves were five inches in diameter, one fifth the diameter of the steam cylinder "which is the common proportion". They rose one and a half inches. The steam pipe was six inches in diameter.

Brown recognised that the governor was vital to the efficient working of the engine and pointed out that "a little deficiency in it, though scarce visible, might cost the work hundreds per annum... it ought to regulate the engine to within one eighth of a stroke a minute above or below the speed set at. Small variations in strength of steam or burden ought to produce no visible variation on the speed". The governor on the engine was not rebuilt to cope with the increased speed: instead a weight was attached to "impede its expansion, which answers extremely well".

To ensure that the engine was well looked after, Brown continued to entrust its management to the principal mechanic, "with a fireman under him to manage the fires, to oil and clean, start and stop the engine". The mechanic "is sensible that his credit as a manager depends entirely upon the state in which he keeps the engine generally, compared with the state of others about the town", though to keep him up to the mark Brown himself daily inspected the engine.

Breaking and Scutching

Though Brown was from time to time forced to interest himself in the steam engine and in the transmission of its power within the mill, his most systematic concern was the machinery for preparation and spinning of flax and tow. There is only one passage in the diary relating to breaking and scutching, the first stage in flax preparation, and this concerns an experiment made at East Mill on 8 October 1819 "in the presence of 20 or 30 gentlemen, mostly flax spinners" with Mr. Samuel Hill's patent machinery tried against a "common scutching mill". Hill's equipment consisted of a breaker "the whole purpose of which is to break or bruise the woody part of the dried plant, and make it ready for scutching", and a rubber "the whole object of which is to soften or split the fibres of the flax". Mr. Hill's patent incorporated a scutching machine, but this was not demonstrated.

In the experiment, "twenty pounds of good flax in the stem, water steep and dried" was divided into two parcels. Mr. Hill's portion was divided into sixty three handfuls. After treatment in the breaker which took nineteen and a half minutes, and employed two men, there were five and a half pounds of fibre left for scutching. This was, in the absence of Hill's scutcher, pulled through a coarse heckle, beaten with a hand scutcher and put again through the breaker; "all these however proved very imperfect scutching". Treatment of the remaining material in the rubber took about half an hour, and occupied two men. This refined the fibre "to a considerable degree", leaving thirty three ounces, as compared with twenty four ounces obtained from the common scutching mill. The two samples were then heckled, with the following results :

Longs and shorts by scutching mill	17 oz.	by Mr. Hill	18 oz.
Second tow " " "	4oz	" " "	4½oz
First Tow " " "	2¼oz	" " "	6½oz
Heckling waste " "	¾oz	" " "	4oz
	<hr/> 24oz		<hr/> 33oz

The longs from Hill's sample were considerably finer, fit for 1½ lb. yarn, those from the Common-scutched fibres for 2 lb. A pound of each was spun by hand into fine yarn, but unfortunately Brown did not record the result. The remaining tow was "much fouler" in Hill's process, but rather finer. Hill's process was reckoned by Brown to increase the value of the produce. An experiment was also tried with hemp in the rubber, which was "made considerably finer". Brown concluded that the rubber was particularly useful, stating that "if not attended with too much expense, /it/ ought to be applied to the softening and refining of all flax before being spun... A machine of this kind is very much wanted, and is a great desideration in flax spinning".

Hill's invention is not mentioned by Warden or in Peter Carmichael's autobiography, and is therefore unlikely to have been taken up widely.

Carding

The operation of carding, a preliminary to tow spinning, gave Brown considerable problems. He found it very difficult to obtain consistent results from carding machines of basically identical type. Carding, a means of making an irregular mass of fibres into loose untwisted rope of parallel fibres suitable for spinning, was a treatment applied only to tow. There were two stages in the carding process, breaking and finishing. In both, the fibres were fed through spiked rollers on to a large cylinder covered with short wire teeth set in leather. The fibres were drawn between the teeth on the cylinder and those on a smaller roll, the frizzier, and on a closely-fitting cover, and finally removed by another small roll, the doffer, in the form of a fine sheet which when drawn through a hole, or conductor, assumed a rope form, and was then coiled into cans. The main problems encountered in carding were uneven thickness over the width of the cylinder and the formation of lumps and snags.

Brown's constant concern was to bring the carding engines up to a uniformly high standard of performance, with the dual aim of making the production of good quality yarn easier and of reducing the level of supervision required in the card room. He found that simple experiment cured most problems, though sometimes a good deal of ingenuity was required. In January 1818 he carried out a series of experiments on a breaker card which was producing a "very lumpy, ridgy and ill-carded sliver". He eventually cured the problem, by careful adjustment, noting the effect of each modification before tackling the next. He subsequently suggested modification of carding engines to prevent accumulation of dust, and went so far as to contemplate blowing air into the card. The operation of the frizzier was a constant problem, and he was unable to arrive at a satisfactory explanation of its operation. He noted that its function of clearing the cylinder "is an easy process, any bungling workman can accomplish that; but to do it in a masterly manner is quite another thing - a subject that deserves attention".

By 1819, he seems to have solved the problems of the frizzier, and turned his attention to other aspects of card operation. On 27 May 1819, for example, he found that by bringing the feeding rollers closer together on a finishing card the performance could be much improved, and on 29 May noted that uneven air currents were "productive of wonderfully bad effects upon the carding". He paid correspondingly close attention to the boarding-in of the card "merely having examined minutely the best cards in the Work and having made the worst as nearly like them as possible". He also found that the setting of teeth both on the main cylinders and the cover was critical.

In order to raise the overall level of performance in the card room he had one mechanic constantly employed repairing the cards, taking the responsibility for detail improvements. Brown, however, kept his customary interest alive, and shared in the frustrations as well as the successes, being moved at one stage to note:

"In human works though laboured on with pain
A thousand movements scarce one purpose gain".

After he had solved the worst problems, Brown continued to study the improvements, noting, for example: "The best working cards... have the finest frizzlers; the worst have the coarsest". "One card... seems to work well from the length and thinness of the teeth of its doffer... The tow is drawn through the teeth as through a heckle and the fibres are very much straightened and laid alongside each other". "The feeding rollers of the breakers are too weak, they bend to a lump of tow; and when they do so other lumps slip through unbroken and the performance is much hurt". In a copy of letter to an unidentified young man, date 30 August 1819, Brown referred to an attempted innovation:

"I have lately created a card at this work of a much smaller size than any I have yet seen. Its main cylinder is only sixteen and a half inches diameter (1), doffer and frizzier only seven inches. I use it as a breaker... its motion is three hundred per minute and it seems easily driven".

1) The more usual size was about three feet in diameter

He commented, however, that "it is rather faulty" though he attributed its deficiency to the use of an old cover. Brown also found on experiment that the relative speeds of frizzier to main cylinder and of feeding rollers to feeding cloth were critical. Even where there was no obvious defect in the performance in the card room, Brown was willing to experiment. He went on to look at feeding rollers, commenting that the size of rollers and speed of feed had been "for many years past" stabilised, but suggesting that "It is proper that a few simple experiments be tried to put the matter to the test. The feeding part of the operation I consider a very important one for forming quality of work and I am sure no person has yet been guided by any good theory or principle in the constructing of feeding rollers". He accordingly varied the size of rollers, and the number of teeth. He concluded that teeth were unnecessary on the feed rollers if cleared rollers were added to prevent the lapping of fibre round the feed rollers. He also tried feeding a thick body of tow slowly and a thin body quickly on to a breaker card, and found that thick, slow feeding gave much better results.

This careful experimentation does much to explain Brown's success as a spinner.

Spinning

As outlined in the description of East Mill (p. 8 - 12) the linen spinning frames were of Kendrew & Porthouse's type (1). This was the first machinery successfully applied to flax spinning, but it required considerable modification before it was an effective rival to hand processing. There is little in print about the development of the Kendrew & Porthouse frame, and Brown's comments are therefore particularly valuable. Brown's key role in the creation of an economically attractive tow-spinning process has already been mentioned; unfortunately the essays do not shed much light on this work which was probably virtually complete, apart from his experiments with carding, by 1819.

Brown's active interest in spinning frames started off modestly with experiments on improved lists, as the driving bands for the spindles were termed. Woollen lists were then standard, but proved troublesome, both from the point of view of supply - they were made at a distance from Dundee - and because they were liable to stretching and even breaking. The direct cost of repairs was estimated as 5s a week, plus a loss of not less than two spindles of yarn a day. Even when in reasonable condition they were difficult to keep tight. Linen lists were tried, but though cheaper than wool at 1½d per yard as against 2d - 3d, were no better. Brown therefore tried leather, cutting the pieces from a "common cow hide" and stretching them before fitting. The cost was reckoned as 5½d per yard, but they had an expected life of about two years, based on experience with roving frames. There is no further mention of this experiment. In 1818 Brown was contemplating spinning direct from the carded sliver, without roving, for heavy yarns. This would have the advantage of reducing the number of joins, and keeping the fibres moist. For this purpose he reckoned that cylinder spinning frames would be

1) See the cover drawing

necessary (not the modification with pairs of small cylinders). There is no indication in the essays that he tried out this idea.

Much more radical was Brown's decision to replace all the spinning frames in the mill. As the intention had been to terminate the copartnery in May 1823 and then to sell off the mill, it was obviously senseless to invest in new frames. One of the partners, however, sold out in January 1822 and the new copartnery of Brown and another decided to install new frames. The initial intention was to buy thirty-six spindle frames, but Brown found that they would not fit the existing room. He therefore decided on fifty spindle frames. This was a radical change. According to his own account "no size beyond 36 spindles had ever been approved of. Some of 40 spindles had been tried but generally disliked". Brown reckoned, however, that "Public disapprobation... is not always a correct guide", and on investigation found no firm basis to the objection. He then had to decide whether to order the frames from a machine-maker or to build them himself. As the delivery time quoted was long, he chose the latter course, believing that despite having to fit up a shop at a cost of about £100, he "would not only have the machinery sooner ready, more to my mind in its plan, and of better workmanship, but that I would have it considerably cheaper, from saving the expense of the high rented premises, the costly power, and the profits of the machine makers".

The plans were drawn up and patterns made by 27 May 1822. The frames were completed by December 1823, at a cost of £1263 2s 5d. Each frame cost:

Wages	£	18	2s	6d	
Malleable iron work	£	15	11s	7d	
Cast iron	£	14	3s	11d	
Brass	£	4	1s	3d	
Spindles	£	12	0s	10d	
Ironmongery	£	1	3s	0d	
Wood	£	4	0s	0d	
Power, rent etc.	£	2	17s	9d	
Patterns (half cost)	£	0	10s	0d	
	£	72	19s	6d	(1)

1) The editor makes this sum £72-10-4. Brown's addition comes to £72-19-6. Unfortunately, we cannot tell whether the addition or the typescript is at fault.

The cost per spindle of 29s 2d compared with about 40s per spindle for Dundee-made spindles, or 30s per spindle for Leeds-made (plus 3s for extras). Apart from the saving in cost, Brown reckoned that the frames were superior in "the size, strength and position of the parts, the general simplicity, the easy access and safety from danger". He noted especially the "mode of communicating motion from the horizontal cylinder to the drawing rollers" as being "entirely new, and for cheapness, safety, quietness, easy keeping, easy repairing and easy changing of speed... greatly superior to any other"... He was not entirely self-satisfied however, and noted a number of design faults. Generally he was in favour of construction on the premises.

Brown commented on the wages paid to the machine-makers as being "rather high, trade being brisk, and men in great demand. Common journeymen had from 18s to 21s per week". Some of the work was paid by the piece, when the men earned 24s-30s a week. The spindles were sub-contracted, two hundred and fifty to J. Smith, one hundred and fifty to J. Renny, and three hundred each to J. Taylor & Co and 'Leeds'. Though the Leeds spindles cost only 8s 6d as opposed to the 10s charged by Taylor & Co, Brown commented that "it is doubtful to trust to great orders being honourably executed in that quarter".

As usual, Brown considered that he could make improvements in the management of the work, suggesting for instance that it would be better to have a smithy on the premises and that the greatest possible number of hands should be employed, and machines put in hand, as possible. He calculated that a squad of ten men would make ten frames of fifty spindles each in six months.

During the completion of the frames Brown made experiments using iron for pressing rollers instead of wood, and made a six weeks trial. He found that under normal circumstances the iron roller was just as good; but with poor quality it "had to be totally laid aside". He also experimented with the drawing apparatus on tow spinning frames, allowing the twist to run up between the rollers, which he found more satisfactory.

Other machinery

About eight per cent of the lint and fourteen per cent of the tow used in spinning was waste, and the reclamation of fibre from this by product exercised Brown. He described first a wool teaser, consisting of a rapidly rotating cylinder covered with steel pikes about an inch long with feeding rollers. He also mentions a cleaning machine used in Monifieth, which had no feed rollers and operated on a batch system. There is no indication that either device was used in East Mill.

VISIT TO LEEDS IN 1821

Brown's account of his visit to Leeds is his longest essay, and as a description of Dundee's great English rival in the flax trade is of considerable importance. It is therefore reproduced here in full. His analysis of the state of the trade, and particularly of relative advantages, is penetrating, and his diagnosis that Leeds would be overtaken as a centre of linen manufacture by the Dundee area proved accurate.

Information Regarding Flax Spinning at Leeds, 1821

The flax spinners of Leeds have long been looked upon as superior to the Scotch in the business of spinning. Whether they really are so however is as yet by no means certain. Various Scotch spinners have at different times visited Leeds for the purpose of informing themselves regarding that point but as yet, nothing satisfactory seems to have been obtained. With a view to satisfy myself I lately made up a book of questions appropriate to the subject and repaired to Leeds where I arrived on the 7th September and stopt till the 13th. I was extremely scanty in acquaintances and introductions and my hopes of success were by no means sanguine knowing that the English spinners are remarkably tenacious but being accustomed to visit Mills for information I had a tolerable idea how to proceed in order to gain what little was likely to be gained. I now collect from the jottings of my memorandum book the substance of what I saw and learned arranging it in the most methodical way I can.

1) As regards the extent of flax spinning in Leeds. This I considered of importance to know as it is useful to have an idea where the business has chiefly taken root and where it is most likely to flourish and extend. Flax spinning is as yet pretty much scattered all over the island but like most other great manufactures it will no doubt in time as it advances to perfection settle itself more in some particular districts leaving all the rest to employ themselves in whatever is more suitable to their local habits and situation. In applying for information regarding extent I had recourse to some of the oldest machinery makers in Leeds as the persons most likely to be informed but such was their disparity of ideas that I had considerable difficulty in bringing their different statements nearly to agree. They had not been accustomed to such calculations before and of course their first thoughts were very crude and incorrect. My first endeavour was to find out the number of frames and spindles in each Mill but this I soon found impossible from the great uncertainty of the persons who were with me. My only resource was to get at the extent of the different steam engines and to calculate from that. This I at last found to amount 565 horses power contained in nineteen different Mills.

Each horse power in Leeds is reckoned to drive two frames or sixty-four spindles with the requisite quantity of machinery for preparing. There are therefore in Leeds altogether 1130 frames or 36,160 spindles. Each spindle is reckoned to produce daily or in twelve hours fourteen leas or cuts of yarn as a fair average of all kinds both of lint and tow. The total quantity of yarn spun daily in Leeds is therefore 2,531 English bundles or 10,546 Scotch spyndles. The kinds of yarn commonly spun are 2 and 3 lb. lint and 4,5,6 and 7 lb. tow. One Mill (Mr. Marshall's) spins a considerable quantity of 40 lea or 1 1/5th lb. lint yarn and 14 to 16 lea tow yarn.

The following is a statement of different Mills in Leeds made up by myself and others in ascertaining the total extent. It may be of use in future visits to Leeds. The figure denote horses power.

Mills	Owners	Steam Engine Horse Power
4	Mr. Marshall	234
1	Mr. Benyon	136
2	Mr. Brusk	78
1	Titley, Tathams & Walker's	50
1	Moses Atkinson's	36
1	Mr. Harris	30
1	Mr. Land	18
1	Mr. Westley	24
1	Mr. Colbeck (or Holdsworth)	24
1	Mr. Hammond	15
1	Mr. Brown	12
1	Joseph Moir & Co.	18
1	Grimshaw and Gardiner	8
1	Mr. Brownridge	6
1	Mr. Bowes	6
		<hr/>
		695
Deduct for unused engines 60 h.p.		
..... 70		130
		565

Leeds is the principal town in England for flax spinning. It is a place of great population containing not less than 80,000 inhabitants. Its principal manufacture however is not in flax but wool. The Mills for spinning wool are greatly more extensive and important than those for spinning flax. Dundee compared with Leeds is far short in extent of flax spinning, its proportion in power being only as 150 to 565. Each horse power however in Dundee produces 25 spyndles per day whereas in Leeds it produces only 19. This difference is caused chiefly by the greater twist given to the yarn in Leeds. Dundee in extent of flax spinning may therefore be reckoned equal to about one-third that of Leeds.

The whole extent of flax spinning in England as nearly as I could ascertain by a rude calculation I made at Leeds amounts to 1,670 horse power. In Scotland it stands pretty nearly 1300

---- so that calculating the difference of produce per horse power

the quantity of yarn spun in each country is much about the same. It is worthy of observation that in England scarcely any extension has been made within the last two years either in new erections or in the enlargement of old ones; whereas in Scotland a very considerable increase has taken place in both ways. In England no spirit of extension or improvement is at present afloat while in Scotland everybody engaged in the business is either meditating on additions and improvements or really making them.

2) General remarks on Mills at Leeds. Under this head I mean to place a variety of information regarding the general appearance and construction of these Mills, occasionally comparing them in a brief sort of way with those of Scotland. My first business in proceeding to examine them was to view a number of them externally. This I did at my own leisure interrupted by no person whatever as I neither required leave nor introduction. I viewed the works carefully and by questioning different persons in the neighbourhood I came to learn a good deal about them. The persons I questioned were generally plain labouring men whose appearance pleased me and it was agreeable to see the readiness with which they imparted what they knew. I contrived by beginning with certain sorts of questions to let them have the honour of instructing me which so pleased their talking propensities that some of them launched out at great length on the nature of the Mills telling me everything they knew about them. I attended to their discourse occasionally putting questions to them and guiding them to the proper objects to talk upon for my information. So that by repeated interviews I furnished myself with a good many hints even previous to my entering a single Mill door. I shall here attempt to state the different notes I thus learned. The Mills are not situated in any particular district of the town but rather scattered pretty equally over-all. The principal ones standing towards the western extremity. Most of them are built of brick and are from three to six storeys high. They are covered with blue slates of a very large size brought from Wales. The garret rooms seem mostly in use for machinery for they are covered with skylights. Scarcely any of the Mills are fire-proof and excepting one or two of Mr. Marshall's and one of Mr. Benyon's they are old, irregular looking houses seemingly much disfigured with alterations and additions. Some of the smaller ones are even made out of a range of old dwelling houses and are extremely mean and inconvenient. The windows are differently constructed from those in Scotland each being an entire piece suspended in the middle by pivots fixed in the side framing and opening outward at the top and inward at the bottom regulated by a string. This is certainly cheaper and simpler than the Scotch way with sashes, ropes and pulleys but not so convenient and handsome.

The warehouses and heckling houses, like the Mills, are by no means well arranged or commodious. They are built of brick and tile and are of all shapes and sizes. The Mill yards likewise are without any sort of order being crowded with heaps of old wood, old casks, broken wheels, shafts and other lumber. The coals also

are by no means handsomely put up. The enclosures, gates, roads and entries are not at all respectable and the doors and windows are neither painted nor carefully kept. The interior of the Mills in some degree partake of the faults of the exterior. Few of them are without some defect or other in the height, length, width or shape of the rooms; and where irregularity exists in the building, complication and confusion must be the consequence in the machinery shafts and belts must be running in all directions and cards and frames standing in all positions. In Leeds this is certainly much more the case than in Scotland. The general arrangement of the machinery is also in some respects different. The cards and tow preparing machinery are not always placed on the ground floor as in Scotland but in the third, fourth or fifth flats and in many cases even in the garrets where there is scarce room for them to stand upright and where the complication of driving machinery and the want of accommodation must be very conspicuous. The reeling rooms also are often at an awkward distance from the spinning frames, situate as many of them are in an outhouse or a distant wing.

The spinning rooms are generally most cared for in the arrangement of the works, everything else - carding, reeling and preparing - being made subservient to them. The rooms in general are much larger than those in Scotland, some of them containing from sixty to eighty frames or from twenty to thirty cards and employing several overseers each. Upon the whole the general construction of the Mills in Leeds is in my opinion by no means so simple, regular and complete as that of most Mills in Scotland and that being the case one great obstacle is certainly interposed to their surpassing us for a long time in the business of spinning.

Under the head of general remarks I have yet to state a number of things I learned on inspecting the exterior of the Mills. The steam engines used for spinning flax in Leeds are much larger than those in Scotland, their average size being thirty horses power while in Scotland it is only about eleven. This circumstance operates materially in favour of the Leeds Mills for large engines are proved to furnish power much cheaper than small ones. In Dundee a six horse engine is found to require about double the proportion of fuel to a twenty horse. From this it may be inferred that the Leeds engines are fed upon two-thirds the fuel of the Scotch engines in quantity (half is the exact proportion but granted to be two-thirds). And if it be calculated that the coals in Leeds are only two-thirds the cost of coals in most parts of Scotland, the one being about 8/- and the other 12/- per ton at the furnace door, it appears that the expense of fuel for engines in Scotland is fully double that of Leeds or in the proportion of nine to four. Large engines also are rather less expensive for packing, oil, attendance, repairs and interest of money so that upon the whole power for spinning in Leeds may be reckoned at little more than one-third the cost of that in Scotland. This indeed looks like a serious evil but still it must be remembered that in Leeds a horse power spins only three-quarters of the yarn of a horse power in Scotland owing to hard twisting and slow driving so that all things considered the Scotch Mills may be reckoned just about double the expense of the Leeds

Mills for power. Contrasting engines of equal size however the difference is not so great, the Scotch being only to the English as nine to eight.

The steam engines in Leeds are generally in better order than those in Scotland. The large ones belonging to the principal flax spinners are all in the highest state of perfection in every respect. The smaller ones belonging to the inferior Mills are not at all equal to the large. The finest engine in Leeds is one of seventy horse power belonging to Mr. Marshall made by Fenton, Murray and Company. It is certainly very fine indeed; the length of its stroke is eight feet and it moves at 18 strokes per minute thereby giving a speed of piston considerably beyond any in Dundee. The fly wheel is on the crank shaft, weighs fourteen tons and is thirty feet diameter. There are five boilers, four of which are constantly on work. The smoke is almost perfectly consumed by the admission of cold air behind the furnace when feeding. A woman is kept for cleaning this and the rest of Mr. Marshall's engines. The engine houses are frequently washed and the floors nicely sprinkled with a kind of yellow sand common in Leeds. There are still several engines in Leeds with sun and planet wheels and I heard of one with wheels of that kind of an elliptical form for equalising the speed of the piston. I saw one with elliptical wheels for working the valves in place of eccentric blocks which seemed to answer very well.

The boilers of steam engines in Leeds are generally fitted up in a different way from those in Scotland. They are covered over the top with brick arches for confining the heat. A space of six inches is left between the arches and the boiler. The heat is certainly well confined in this way for the bricks above don't feel disagreeably warm to the bare hand. No house or roof is put over these boilers; the feeding apparatus and pipes are seen from the streets. The steam pipes are mostly covered with plaister and wrapt with canvas to confine the heat. The chimneys of the steam engines in Leeds are generally double the height of those in Dundee. Most of them are one hundred and twenty feet high, some one hundred and forty-five and none below one hundred. Law prescribes a certain height in order to carry off and dissipate the smoke but I did not learn what it was. The limits I understand are regulated by the neighbouring houses not by the Mills themselves. The chimneys are built of brick and are all furnished with lightening conductors. Bore holes for supplying steam engines with water have of late years come very much into use at Leeds. Some of them go down the amazing depth of three hundred feet - their width is from three to four and a half inches. The water arises in them to within twenty feet of the surface where it is reached by the pump which is placed in a built well about thirty feet deep. One bore hole of four and a half inches diameter is said to supply a twenty horse engine without cooling or returning one drop. The water procured from them is of a sulphurous quality and is found excellent for boilers. On first coming up it emits a gas which readily takes fire at a candle. It is always abundantly cold and clean and however much the bore holes be used they never fail nor choke up. Boring is a trade in Leeds and costs from 10/- to 15/- per foot. They screw piece to piece

till they reach the water going through clay, coals and rock of different kinds and so hard are some of the substances they pass through that they some times work whole days without making a single foot. The most extraordinary thing regarding these bore holes is the amazing quantity of water they supply. This is accounted for from the nature of the situation, the ground being low all immediately about Leeds and rising all around. Private families are now making use of this water in preference to any other and some use it as a medicine. Its taste is more nauseous than the water of Pitkeathly.

River water is in great abundance in Leeds for steam engines, but so muddy, and so much spoiled with dye stuffs and chemical mixtures as to be almost unfit for use. The mill owners were driven to the invention of boreholes by the mere dirtiness of the river water. Cooling ponds or reservoirs are not very common in Leeds. The only ones I saw were Mr. Marshall's which are very extensive. He has two, each measuring an acre, and the depth about three feet of water. They are situated 150 yards from the mills and are separated from them both by public roads and private property. The water is conveyed to and from the mills by large cast-iron pipes. The method of using these ponds is to run all the warm water into the farthest one during the daytime, and then to let it come by slow degrees into the other, night and day. The water did not seem to be warm as little steam was rising from it. These ponds were very handsome, each forming a square and both lying close together; their embankments are of clay, and the water stands higher than the surrounding level, the water being all forced into them by pumps. They are much exposed to the public and have no doubt suffered injury, for tickets with threatening notices are put up all around them. Were high walls erected about them it would be unfavourable to the cooling as they would prevent the wind from sweeping along the surface, which is the speediest agent for carrying away the heat.

The hands employed in the Leeds mills are nearly the same in manner, dress and appearance as those of Scotland. I observed them several times dispersing from the mills and took notice of them. A greater proportion of them seem to be young boys and girls of from nine to twelve years of age. In general they are not so stout and healthy as the Scotch - scarcely one of them to be seen of a ruddy complexion. They are certainly more comfortably lodged, their houses are but two storeys high and each family occupied a whole house. Cooking and eating in the lower flat or room and sleeping in the upper. They seem remarkably clean, and few are without neat and substantial furniture. The streets, roads and lanes are however, as irregular, narrow, wet and dirty as any in Scotland. In passing some mills on Sunday I heard knocking of hammers within, and learned that it is quite common to repair on Sundays. Indeed, tradesmen in most parts of England don't stick at doing a bit of work on that day.

Gas lights are in general use among the mills in Leeds and are an acquisition enjoyed by them much more than by the Scotch mills. The particulars of their advantages over oil or candle I did not learn, but they are universally allowed to be considerable.

Oil-gas is now beginning to be used. At Mr. Westley's mill I saw an apparatus for oil-gas which cost but £80 and furnishes from 60 to 70 lights. Mr. Westley stated that the consumpt of oil for gas was but 1/6, that of oil for lamps counting an equal light. The apparatus seemed very simple and compact, occupying not more than four square yards and standing beside the fireman, who seemed to have charge of it. It was made by Messrs Neilson and Scarth, Fulbreck, near Leeds, makers of gas apparatus.

I have thus stated everything I can bring to mind regarding the general construction and arrangement of the mills in Leeds. I now proceed to say something of the spinning machinery and spinning operations in these mills, drawing my remarks from what I saw in different works I got admission to and from what I learned of different persons I conversed with. I shall place my information under several distinct heads, beginning with: Remarks on flax preparing machinery. In Leeds there are only two modes or plans of flax preparing machinery in use, viz the Gill plan and the roller-carriage plan; each with its varieties. The Gill plan, though only of a few years standing, seems to be nearly as much in use as the other. There is no machinery on the cylinder or Darlington principle in use. The roller-carriage plan seems to be nearly on the same footing as what is known in some of the Scotch mills; the slivers are made rather thinner and broader and the number of chances is much greater, there being not less than nine or ten slivers put to each side of second drawing machine, whereas in Scotland five or six are thought enough. There is no such thing as a fourth drawing operation in Leeds, nothing but first, second and third or roving. The draw or draught of the machines, the body of stuff passing through them, and the thickness of the slivers and roves I considered to be fully greater than what is common in Scotland. The handling and spreading of the flax, the piecing of the slivers, and the holding of the stuff on the machines, I thought fully as slack and careless as any I had seen at home.

Regarding the Gill machines, I have little to say as I did not see much of them. They are chiefly confined to the largest mills which are inaccessible. The inferior mills have almost all tried them but few have approved. I saw some at work, and by no means considered them an improvement. I do not think they hold or draw the fibres any more perfectly than plain rollers or cylinders skilfully set. There is this argument in their favour, however, that the best mills have all adopted them, and are said to consider them an improvement. Whether they will continue to do so, however, is rather doubtful. One gentleman told me that Mr. Marshall, the great leader of flax spinning in Leeds, is beginning to throw them aside in some parts of the process and to substitute them with the old roller carriages. The true state of the matter I will not pretend to explain.

There are two kinds of Gill machines in use - the one with long, trough tables, and the other with short, bell carriage tables. The former is preferred at Leeds. The methods of working, the draws, velocities, and slivers are much the same as

in the roller-carriage plan. The flax preparing machinery in Leeds is generally driven faster than that in Scotland; some of the roving frames I observed running at a prodigious rate.

Mr. Garside's patent spreading machine is in use in a few of the smaller mills. I took notice of it in Mr. Hammond's. The spreader sits upon a stool at the side of the machine, and spreads the flax, not upon a plain stationary board as usual, but upon a revolving piece of smooth leather, similar to the feeding cloth of a card, about nine inches broad and three feet long over the double, moving forward as fast as she can spread and delivering the sliver singly, and indrawn into a cann by means of a pair of plain wooden rollers. It is driven by a narrow belt, two inches broad, and has a catch for starting and stopping commanded by the spreader's foot. Mr. Hammond was highly pleased with this little machine, had adopted it through all his work, and preferred it far to Gills. The spreaders were also fond of it, and it was pleasing to see seven or eight of them all sitting snugly in a row spreading the flax without moving out of the bit. Mr. H. spoke of the greater certainty of examining the spreaders' work by this than by any other method and he really thought they made better work on a revolving surface than on a stationary one. The quantity also, he considered, materially better. The yarn he was sure was equal to any made with Gills and although he wanted 7/8th of the plys or chances, no additional drawing machine being substituted, he did not consider any disadvantage on that account. It is curious indeed that this simple machine should thus serve for a Gill frame or roller-carriage - things costing five times the money and requiring ten times the power.

Spreaders in Leeds perform less work than spreaders in Scotland. The latter do about 120 lb per day for 3 lb yarn whereas the former do only about 90. Whether this difference arises in the speed of spreading or in the thickness I did not learn. Dividing or weighing the flax into stricks (1) or hand-fuls previous to spreading is partially practiced in Leeds. Spreaders wages are regulated by the quantity of work performed so much per hand averaging about 6/6 per week, similar to the average in Scotland.

Remarks on tow preparing machinery in Leeds. The tow preparing machinery of Leeds is much more of one kind than that of Scotland. In Leeds the carding engines are almost all of the following description. The main cylinder is 36 inches diameter and 26 inches broad striking upwards at the feeding rollers, with two sheets or pieces of cover upon it, each ten inches wide, circular flexibles, common workers and clearers, driving chiefly by chains, fluted metal rollers for drawing and delivery with bristles brushes upon them; no boards or boxes below the cylinder, scarcely any above excepting round the frizzer. The speed of the main cylinder or swift never exceeds 100 turns per minute, the slivers delivered very fast and thin - no double carding or

1) Stricks: alternative version of strikes

breaking - one woman weighs and feeds to each machine, performing about 90 lbs per day for 5 or 6 lb yarn. The method of feeding is to shake up the weighed strike of tow with both their hands into the form of a fleece about nine inches broad and 30 inches long, and then to lay it as equally over the feeding cloth as possible, arranging it with her fingers without the help of any sort of stick or tool. The card cover seems generally finer and thicker set than what is common in Scotland. The machines throw off a considerable quantity of fibre below, owing to their not being closed in, but this is thought rather advantageous than otherwise, as it rids yarn of much of the coarser fibres and dirty particles.

Cards of this description, if of good workmanship, well fitted up, and well pegged, perform to as good account, and produce as good yarn as any in Scotland, but it is more difficult to make them do so, owing to the greater complexity of the machines, the greater difficulty of keeping them in order and of feeding them well at all times. The chief objection to single carding in my opinion is the difficulty of feeding; the chief advantage of double or treble carding I think is the ease of feeding. Most of the cards I saw in Leeds were working but poorly, much choked and wrapt with stuff, and otherwise in bad order. The quality of their performance was certainly not superior to Scotch carding in general. Were it not for their delivering such an extremely thin body and giving such a number of thin plies to each rove or thread I do think their yarn would be lumpy.

Tow roving frames. The construction of these frames differs from the Scotch in the heads or drawing apparatus being placed horizontally instead of vertically; and in the holding apparatus consisting of two or three pairs of fluted iron rollers in place of one pair of plain wooden or padded ones. This difference is immaterial, either kind being good or bad according as it is skilfully or unskilfully set. The draw is generally about three to one with four or five slivers to each rove. The speed and twist are similar to those of Scotch frames. The state of the canns, bobbins, rollers, tow boxes, etc., was by no means superior to the same in Scotland. The wages of card feeders and rovers are from 5/- to 6/- per week.

Remarks on spinning frames in Leeds. The most common and approved size of spinning frames is 32 spindles per side, each side having four lengths of roller arbors with couplings. The heads are all on the common roller construction, consisting of one line of holding or receiving rollers, two lines of intermediate holding rollers, and one line of drawing rollers, the latter being generally about three inches diameter. The pressures used in Leeds are generally much lighter than those in Scotland the rove not being held near so hard in twist, and the spinning being mostly done wet. The spindles are driven from lists from horizontal wooden cylinders about eight inches diameter. Each side has a cylinder for itself, the plan of using one cylinder for two sides not being approved of in Leeds. The distance between the cylinder centres and the spindle centres is only 22 inches. The spindles, fliers and bobbins are but little

different from those in Scotland; the framing grating (1) and binding are generally but about half the strength - the English being adapted entirely for light pressures and slow driving while the Scotch are calculated for any pressure and any speed. The draw of the flax frames for 3 lb yarn is generally about 18 to 1, of the tow frames 8 or 9 to 1. The twist of the yarn is considerably greater in Leeds than in Scotland, the former being 11 or 12 turns per inch on 3 lb yarn, whereas the latter is only seven or eight. On all other kinds the same proportion is observed. The heads of the tow spinning frames are all on the roller construction, and the twist of the rove is very well kept on by a line of intermediate rollers, each couple of roves having its own bearing intermediate roller, which seemed to hold pretty tightly. The most common and approved method of driving spinning frames, is by belt from parallel drums in the room below, same as is generally adopted in Scotland. But there is another way which is gaining some ground in Leeds - and which is very much in use in the wool mills, viz by Universal Guides. These are merely two neat cast-iron pulleys, about 10 inches diameter and three inches broad, each with flanges on its outsides attached to a neat cast-iron frame in which they not only perform their rotatory motion, but regulate their own position so as to conduct the belt from a horizontal direction, or a direction nearly horizontal, to a vertical direction or a direction nearly vertical - thereby giving ready motion from main shaft of a mill to the horizontal cylinders of the spinning frames - things situate on different planes but at right angles. The great advantage of this mode of driving is its quietness and sweetness - but it is supposed to produce rather more friction from the rapidity of its motion and the many journals consequent upon it. It has a considerable advantage over the other way, however, in having a much longer belt, more elasticity, and the means of readily tightening at any time. The lists used for driving spindles in Leeds are similar to those in Scotland; but I observed in some mills - one list is made to drive a whole side of 32 spindles. It is wrapt alternately round cylinder and spindles till it go over the whole side, then conducted back to the driving end by means of two carrying pulleys situate about 30 inches above the horizontal cylinder. By this plan all parts of the list are said to be alike tight -lumps or joinings are avoided, unless trouble is caused in breaking and preparing. In Joseph Moir's mill I saw a number of frames with the horizontal cylinders placed close behind the spindles - the one cylinder being situate ten inches higher than the other, and each giving motion to the farther off side. The chief object of this was the saving of room, which it did at the expense of convenience. It was also intended partly to suit the shape of old frames that had formerly been wrought with a leather belt and binders, which it certainly did, but I think the plan of one cylinder would have answered much better in this case.

1) grating: we have not been able to discover the meaning of this word. It may have been mistyped but Dr. Halley could not suggest any replacement in this context.

Host of the yarn made in Leeds, tow as well as lint, is spun wet; the water is communicated to the thread in the common way, by a trough and sponge acting on the pressing roller. The spinners prefer wet spinning to dry not only as it spins safer but as it suits the weaver better. All dry spinning is done with fluted drawing rollers - the flutes are mere lines, not exceeding $\frac{1}{24}$ th deep, and fully $\frac{1}{10}$ th of an inch distant - the chief object is saving of power, less pressure being required and consequently less friction being created. There is also a little saving of brass and journals. No temper bands are used in Leeds - the drag being all accomplished by cloth washers below the bobbins, which is thought the more perfect way. The spinning frames in Leeds are generally in bad repair, at least $\frac{1}{2}$ of them. The spindles are extremely out of order - most of the drawing rollers, the conductors, and sponges however are pretty much cared for.

The average quantity of 16 lea or 3 lb lint yarn spun per spindle per day of 12 hours in Leeds may be stated at 14 leas or cuts - about the same quantity of 8 lea or 6 lb tow yarn -and other kinds in proportion. In Scotland those quantities are about doubled, but in Leeds one spinner manages two sides or frames as universally, and I think fully as easily as one manages a single side in Scotland - so that in this particular it is difficult to say which has the advantage. The shifting of the bobbins in Leeds is all done by sets of young hands, who stop the machine in shifting. The wages of spinners in Leeds seldom or never vary from 6/- per spinner per week for two sides of 64 spindles. No mill gives more or less for good or bad hands -no piece work - no engagements but on two weeks notice - no money advanced - wages paid weekly - masters universally retain one week's wages in hand - masters put little value on old trained spinners, as green hands are easily trained to slow driving -young ones are kept helping in each alley - and shifters soon become spinners. In some mills slow driving is carried to such a pitch that one spinner manages 120 or 128 spindles with the assistance of one little helper - the principle here acted upon is - drive slow and you will have less brokage in an inverse proportion - a spinner that spins at the rate of 14 cuts per spindle per day with 30 spindles will spin at the rate of 10[^] cuts per spindle per day with 60 spindles, and with the same ease so that she will do about half more work with slow driving or with 60 spindles in place of 30. Drive one quarter slower and a spinner will manage double the number of spindles with the same ease.

Reeling. The method of reeling in Leeds is very little different from that in Scotland. Each reel has 12 spindles, and these spindles, for the most part, are on the running construction. Each is supported in its place by two slight iron rails or bars, one for carrying the spindles, and the other for keeping it vertical - they are about four inches apart. The great advantage of running spindles is that the bore of the bobbins is not injured in the common way - and likewise that less power is required for driving. Alongside each spindle is a vertical pin for directing the thread to the reel, and this pin is fixed in a rod or bar,

which is moved by machinery from the rail, for forming the different leas or hanks of yarn. This is an excellent improvement - not only as it saves the reeler of a good deal of attention and trouble, but as it does the work much more regularly. Reelers in Leeds are paid per bundle and earn from 7/- to 7/6 per week, working 12 hours per day. They don't work so hard as Scotch reelers. The yarn table of England is as follows: The reels are partly two yards and partly three yards in circumference - 300 yards make one lea - 10 leas make one hank - 20 hanks make one bundle. A lea is exactly equal to a Scotch cut, and a bundle to four and one sixth spyndles.

Heckling. The price of heckling in Leeds stands generally one half higher than in Scotland, the former being at present at 4/6 and the latter 3/- per cwt for all kinds of Baltic flax dressed for 3 lb yarn and the yields similar. Two or three of the principal mills dress their flax by machines - the chief advantage of which is the getting rid of troublesome hecklers. The machines are superintended by boys and do the work at about the same expense, and to the same perfection as hand heckling. No access is allowed to the works where the heckling machines are used, and of course I did not see any of them - but their outline is simply as follows - five or six common heckles are placed on the circumference of a wooden cylinder of about three feet diameter and moving at the rate of 20 turns per minute - the flax is held to the points of the heckles in small handfulls screwed up between two iron plates fixed to the framing of the machine and turned from side to side as the flax requires it. The machine, exclusive of heckles, costs about £20 and Mr. (1) of Leeds has a patent for it.

Management of hands. In general the hands in Leeds are not under better discipline than in Scotland. Excepting Mr. Marshall's and a few more, the others are under no sort of methodical arrangement whatever. Marshall's have very particular instructions set before them which are as particularly attended to. I tried to procure copies but could not succeed - so strict are the instructions that if an overseer of a room be found talking to any person in the mill during working hours he is dismissed immediately - two or more overseers are employed in each room, if one be found a yard out of his own grounds he is discharged. No overseer is allowed to touch a tool or shift a pinnion with his own hands, on pain of dismissal - everyone, manager, overseer, mechanics, oilers, spreaders, spinners and reelers have their particular duty pointed out to them, and if they transgress, they are instantly turned off as unfit for their situation. Not so with the other mills - there, few rules are laid down and as few attended to - the hands are allowed to roam about from place to place and from window to window without control - the overseers are lazy and the managers and masters ineffectual. In Marshall's every man chases his business - in the others every man's business chases him. The result is striking - Marshall has made hundreds of thousands -

the others, excepting two or three, have become bankrupts and are leading their life in the midst of dust, waste, confusion, dirt and discontentment.

Expense of spinning. The expense of spinning in Leeds is very little different from that in Scotland - particular items may indeed vary considerably, but the total is nearly the same. Several mill masters stated to me that their total expense amounted to about two shillings per bundle, or sixpence per spyndle, which includes all wages, repairs, coals, oil, carriages of flax and yarn, mill managers, clerks and counting house expenses - but not rent of mills, interest of money, or wages of hecklers - they may be reckoned fully higher than in most mills in Scotland, and I dare say it is, for I do think the difference leans to the Scotch side. Leeds possesses no local advantage over Dundee and other coast towns in Scotland in the way of expense - if it has its coals cheaper, it has its flax dearer - the flax spinners of Leeds have mostly all their flax to bring from Hull, a distance of 60 miles, creating an expense of fully 20/- per ton for canal dues, besides the expense and disadvantage of dealing with such a distant market. Marshall's mills, I have no doubt, spin at a penny or 11d per spyndle cheaper than the others owing to better arrangements, better keeping, and greater extent.

Flax and yarn. Baltic flax of all sorts is used in Leeds and forms threequarters of the consumpt. Dutch and English flax supply the rest, and are generally used for the finer sort of yarns and for threads. The Baltic flax is all imported at Hull chiefly by Hull merchants, who sell it to the Leeds spinners at prices similar to those of Dundee - the quality is also similar. A few of the Leeds spinners import their own flax but far the greater number either purchase it from the Hull merchants or spin for hire to the neighbouring manufacturers. In the supply of foreign flax, Dundee, from its direct communication has considerably the advantage over Leeds. I reckon this advantage more than equal to the superiority Leeds possesses in the way of coal.

The prices of yarn in Leeds, as in Scotland, vary in different mills - most of the mills sell their yarn not manufacture it. It is all sold by the bundle of 200 leas or cuts or 4 1/6th Scotch spyndles. At several mills I visited, lint yarn made from 12 hd. or D.C. flax (1), yielding from 50 to 52 - as in Scotland, was selling at 14/- per bundle of 14 lb avoirdupois -nine months credit. This is called 16 lea yarn, but in reality it is 14 lea or 31 lb per spyndle - the 16 lea or 3 lb yarn in Leeds is mostly all made thus heavy. The above price is as near as possible the price in Scotland for same kind. Of tow yarn I saw quantities made from mixed 12 head or D.C. tow selling at 13/6 per bundle of 24 lb this was 9 lea or 5 2/3 yarn, and its price per lb stands rather below 7d - while in Scotland yarn made from same tow and of same size would bring 7½d, being proportionately superior in quality. Of other kinds I learnt little - heavier and lighter sizes were reckoned less profitable -Marshall's yarn brings about 6d per bundle higher than any other in Leeds - it is better drest and better spun, and always commands a sale.

1) 12 hd. or D.C. flax: we have been unable to identify these terms.

The manufacturers of Leeds and its neighbourhood are generally men of considerable capital. They are pretty particular in their choice of yarn - some of them apply tests before purchasing to try the strength - the plan is to cut off exactly one yard of the yarn, carefully preventing the twists from being altered, and tie it single to a weight of seven pound, try if it will raise it - if the thread break it is deemed insufficient. When first told of this plan I could not believe that a single thread of 3 lb yarn was sufficient to raise 7 lb - and saying so, Mr. Hammond immediately tried it, and of about a dozen threads only one succeeded. It is a very vague and evidently tedious method of effecting such a purpose.

The waste on spinning is not less in Leeds than in Scotland. On asking Leeds spinners what waste they make - they do not reply eight or nine per cent as in Scotland, but one twelfth or 1/13th part. The ordinary waste on lint spinning in Leeds, from what I saw and learned is about 1/10th, that is - out of 10 lb of drest flax they make 9 lb of yarn. They do not consider wet spinning to be any advantage in the way of waste - rather the contrary - for they are obliged to dry it in very considerably. The waste on tow spinning I learned to be about 1/6th or 16½% - no wonder it stands high considering the openness of the cards. The waste on both lint and tow may be stated at 21 higher in Leeds than in Scotland - which is equal to ½d per spyndle or 20/- per ton.

Hire spinning is pretty much practiced in Leeds - the reason that this is - many of the spinners lost their capitals after the war in 1815 and were thereby disabled from purchasing flax on the common terms of three or four months credit and selling their yarns at nine months. The price of hire spinning is lower in Leeds than in Scotland - the former being 3/- per bundle or 8 2/3d per spyndle for 3 lb lint yarn while the latter is 4/- per bundle or 1/- per spyndle in place or 13d or 14d. The hire spinners were crying out heavily on the badness of the times, while in Scotland the times were remarkably good.

Profits on spinning in Leeds, I reckon, are considerably lower than in Scotland - owing to the additional expense of heckling - equal to 20/- per ton on the flax - the disadvantages of the distant flax market - from higher wastes of spinning - the prices of poor yarn being rather lower - longer credits - greater capitals required for slow driving - the expense of spinning being a little higher - the hire spinning prices standing lower - all which, though apparently of little consequence individually, bear seriously on the profits. Some years ago the Leeds spinners surpassed the Scotch in almost every particular, but as the Scotch have improved and the English have not, the case is now the reverse. Most of the Leeds Mills were performing to as good account ten years ago as at present and most of them, I think, will be performing to as bad account ten years hence as ten years ago. Not so with the Scotch mills - they have for some years been keenly engaged on improving and I think will continue to do so. From this I anticipate an increase in spinning in Scotland and a decrease in England.

I must be understood, however, to allow that Mr. Marshall and one or two more in Leeds keep equal to the Scotch and probably will continue to do so. Mr. Marshall's great success and prodigious extension are said to have arisen from the indefatigable perseverance, and great abilities of himself and the late Mr. David Wood, who were constantly in cooperation for improvement - but as the latter is now off the stage, and the former closely following, it is not impossible that the immense (1) may be past its meridian.

I must now be bringing to a close my long account of the Leeds mills. I do not regret the trouble and expense I was at in visiting Leeds and procuring this information, neither do I now repent the many tedious hours I have had in bringing to mind and in writing these pages; however, imperfect and unsatisfactory they may be, I still look upon them as much better than total ignorance, and I hope that if ever I visit Leeds again or any such place I shall be fully qualified for as minute and correct investigation as can be wanted. It would be profitable next time I visit Leeds to confine my investigations chiefly to Mr. Marshall's works - should satisfaction be got there the rest of Leeds would be of little importance. To a person wishing to be eminent in flax spinning the investigation of Marshall's works could not fail to be useful and interesting. These works are the most extensive and best regulated of the kind' in Britain and their eminence has been entirely brought forward by the exertions of a single person viz old Mr. Marshall, who has thereby raised himself from a humble individual to possess an income of not less than one hundred thousand pounds per annum. I would do well to acquaint myself particularly with his personal character and habits through life - his education - his abilities - his capital at beginning - the prudence or rapidity of his career in extending-the different checks he met with - his method of experimenting and executing improvements in the machinery and organisation - his method of interesting able people in his service - and, at great length, the present state of all his mills and machinery with their train of managers, clerks, overseers and hands.

November 1821.

1) Missing in typescript

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