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THE GROWTH OF TEXTILE FACTORIES IN DERBYSHIRE DURING THE EIGHTEENTH CENTURY.

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A Dissertation submitted for the degree of Master of Arts.

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THE GROWTH OF TEXTILE FACTORIES IN DERBYSHIRE DURING THE EIGHTEENTH CENTURY.

INTRODUCTION

"From hence leaving Nottinghamshire, the west part abounding with lead and coal, I cross'd over that fury of a river called the Derwent, and came to Derby, the capital of the county. This is a fine, beautiful, and pleasant town; it has more families of gentlemen in it than is usual in Towns so remote, and therefore here is a great deal of good and some gay company ..... Derby, as I have said, is a town of gentry, rather than trade; yet is populous, well built, has five parishes, a large market place, a fine town house, and very handsome streets .... The trade of the town is chiefly in good malt and good ale...."(1)

Thus DEFOE in his 'Tour' describes Derby before the Eighteenth Century economic changes had altered its face and reputation from genteel to industrial. DEFOE in the 1720's clearly does not regard either the town of Derby or the county as being in any way remarkable for manufactures, although he does relate an anecdote concerning

"a curiosity in trade worth observing, as being the only one of its kind in England, namely, a throwing or throwster's mill, which performs by a wheel turn'd by the water: and though it cannot perform the doubling part of a throwster's work, which can only be done by a handwheel, yet it turns the other work, and performs the labour of many hands". He adds, "Whether it answers the expense or not, that is not by business." (2)

(1) Defoe D : "A Tour Through the Whole Island of Great Britain." (1724-7) Everyman Edition pp.155-157

(2) ibid. p.156

Yet for all this the central position of Derbyshire in the early years of the Industrial Revolution is assured :

ENGLAND	SPINNING MILLS
Lancashire	41
Derbyshire	22
Nottinghamshire	17
Yorkshire	11
Cheshire	8
Staffordshire	7
Westmorland	5
Flintshire	3
Berkshire	2
Surrey	1
Hertfordshire	1
Leicestershire	1
Worcestershire	1
Pembroke	1
Gloucestershire	1
Cumberland	1

(3)

This table prepared in 1788 relates only to cotton textile mills, and leaves out of account the silk industry, though this would not be extensive enough to alter the relative positions of the counties in any significant manner. Several places other than Derby became centres of silk production: London, Stockport (4 factories in 1770) Macclesfield, where in 1761 nearly 2,500 workmen were employed in the manufacture of thrown silk;(4) but the silk industry never became comparable in size or in the changes it effected, to that of cotton.

(3) Colquhoun P : "An important crisis in the Callico and Muslin Manufactory in Great Britain explained." found in Mantoux P. "The Industrial Revolution in the Eighteenth Century." p.248

(4) Mantoux P. op. cit. p.196

In addition, Derbyshire's importance in the early stages of the Industrial Revolution is enhanced by the fact that the factory system was begun in Derby itself with the establishment of JOHN LOMBE'S Silk Mill, and consolidated when ARKWRIGHT and his partners made their momentous decision to build a cotton mill at Cromford, in the Derwent valley in 1771.

The reasons for the pre-eminence of Lancashire and Derbyshire in this field are not hard to find. The main motive power of the early factories was water. Wherever streams were swift and powerful enough to drive a water wheel, wherever this flow was as constant as could be reasonably expected, then there would mill-owners establish their factories. Add to this the technical necessity for a humid atmosphere to spin fine cotton yarn, to be found most of all on the Western reaches of the Pennines; then the localization of the industry is apparent. It is true that the essential conditions of water power could be found in many other districts as well. Between 1785 and 1800 a not inconsiderable number of factories were set up in a large number of counties.(5) These were probably set up following the success of northern manufacturers, but did not bring extensive consequences.

The mills themselves, as buildings, have important consequences, for it was on LOMBE'S Silk Mill that later factory owners based their designs. It set the trend for the factories put up by ARKWRIGHT and STRUTT, and these were copied in all essential points by the manufacturers outside Derbyshire.

(5) See table on previous page.

STRUTT, himself, as is later discussed, made some important contributions to mill design, attempting to lessen the dangers of fire which plagued the early factory owners. In the field of factory design, therefore, Derbyshire has a most important contribution to make in the period under study.

The early factories are remarkable also because they had a deliberately created sense of community under the patriarchal eye of the factory owner, similar to the Owenite Factory community at New Lanark. The Social aspects of the early factory system are particularly well brought out when the Derbyshire mills are examined.

In addition JOHN LOMBE'S Silk Mill provides an excellent example of the variation in capitalistic organization that one finds in the first half of the eighteenth century. In 1760 the woollen manufacture had very few of the technical characteristics of modern industry. It was widely dispersed throughout the country - in Derby though the wool traders had nearly all gone by the end of the seventeenth century,(6) the need for woollen yarn for the stocking frames kept the industry alive - and even within the main clothing districts the bulk of the industrial workers lived scattered among the small villages rather than aggregated in the large towns. Cloth manufacture was still a handicraft, carried on in domestic workshops without power driven machinery. Yet already the industry was subject to a

(6) Richardson W.A. : "Citizen's Derby" p.119

considerable degree of capitalistic control.

The independence of the woollen weavers was greatest in the Yorkshire clothing district, where they commonly owned their house and land, as well as their looms and working materials. But even in the West Riding the supply of raw material and the disposal of the finished product was already under capitalistic organization.(7) In the older clothing district of the West Country the capitalistic control was much more definite. There the organization of the industry was dominated by the merchant clothier, who purchased the raw wool and arranged for it to be carded, spun, woven, fulled and dressed by the domestic workers. These domestic workers might be nominally independent craftsmen, but in reality they were not far removed from the status of wage earners. As yet the majority of the weavers worked in their own loom shops; but here and there, as had already happened in the sixteenth century, clothiers employed ten or twelve weavers under one roof in a rudimentary manufactory. In the East Anglian worsted district the master clothiers are said to have been a veritable aristocracy, with the manners of gentlemen and with trading connections which extended to South America, India and China. These master clothiers had control over the later stages of manufacture and marketing. The preparatory stages of combing and spinning were, in that district, under the control of a special class of middlemen, the master combers, who employed

(7) Mantoux P. op. cit. pp. 62-4

"putters out" to distribute the wool among the country workers.

A similar growth of capitalistic organization had already occurred in the Lancashire textile districts. By the middle of the eighteenth century, and probably earlier, the majority of the workers in the woollen, linen, fustian, and cotton manufactures of Lancashire were organized under a capitalistic system, though they remained domestic workers. The framework knitters of the London and Derby districts were necessarily under capitalistic control from the beginning; for their trade was based on the operation of comparatively elaborate and expensive machinery. This was much more strongly the case in the silk-throwing industry, where power driven machinery and a fully fledged factory system had already been introduced into Derby during the first quarter of the century.(8)

Derbyshire thus presents a unique view of the development of the factory system and the textile industry, a development whose relics have been to a large extent preserved; for in many parts of Derbyshire original mills or partly original ones, can still be seen.

(8) Mantoux P. op.cit. pp.64-6
Fitton and Wadsworth "The Strutts and the Arkwrights 1758-1830" p.58.
Unwin : "Samuel Oldknow and the Arkwrights

CHAPTER II

THE EARLY MILLS.

The character of Derby's industries had begun to change from about the time when Queen Anne came to the throne, when a few stocking-frames were set up. Up to that time most of the inhabitants were engaged in crafts of one sort or another - glove-makers, cord-wainers (shoemakers), maltsters, etc:

SUMMARY OF TRADE AND INDUSTRY 1693

Handicrafts

Raw material	Firms No.	Kinds
Leather	48	5
Textiles	58	8
Metals	23	6
Wood	7	2
Food	18	2
Fat	1	1
Clay	8	1
	163	25

Trade Retail	Firms No.	Kinds
Food	53	3
Drink	121	2
Clothing	39	4
House-goods	15	4
	228	13
Wholesale		
Textiles	4	2
Building	43	4
Professional	43	5

(1)

From this we can see that the production of ale was the most important industry, in fact there was an ale-house to every 35 people in the town.

(1) Richardson W.A. "Citizen's Derby" (1949) pp 116-8

It would seem that the retail trade viz. bakers, butchers, grocers and publicans probably employed the most people, though it is difficult to be certain since no actual figures are available and the number of firms is our only guide. In addition there was no sharp line between craftsmen and retailer. The typical business was a small workshop where the goods made were sold to the customer from the bench or acrows a counter in front of the workmen. This makes numerical calculations extremely difficult.

At this time the town had 4,164 people living in 694 houses, and the total number of separate businesses was 455, so that about 2 out of every 3 houses had a shop or a work-shop - the family living of course, in the house. (2)

But this ancient pattern of production and trade was disturbed by the entrance of the stocking trade. In 1588 a Nottinghamshire curate WILLIAM LEE had invented a mechanical stocking knitter worked by hand. The stockinger worked at home, often helped by his children. He might own a frame, more often he rented it from the hosiery merchant who supplied the yarn. This trade brought at least three new occupations to the town, the stockinger who used the frame, the frame smith who made it; the 'sinker-maker' who made the strips or sinkers to push between the needles to form loops. All these were skilled craftsmen.

Hardly had this begun than a THOMAS COTCHETT a Derby Barrister, now an old man, brought in 1702, some Dutch silk

(2) Ibid p.118

machines into Derby. Needing a millwright to erect the machines, COTCHETT employed GEORGE SOROCOLD (c.1628-1717), who had in 1690 been employed by the town council in order to improve the Town's water supply. He had built a floating wheel, which rising and falling with the river level pumped river water into a large tank in a local churchyard. (3)

COTCHETT'S Mill, 62 feet long by 28 feet wide was on the North end of the island in the Derwent behind Full Street. The stream was bridged, and the lane going down to it was known as Silk Mill Lane. The brick mill had twelve "handsome windows" in each of the three storeys which held the machinery. An attic above served as a store. The four Dutch machines had in all 1,340 spindles and 8,410 bobbins, driven by a water-wheel 13½ feet in diameter.

A description of the mill written in 1739 recounts :

" (this) building..... contains 3 storeys, the upper of which is a garret made use of as a lumber room, has 6 dormant windows in the roof, in the other two storeys are 8 double Dutch mills, 4 in each storey, all in complete working order with 148 spindles in each mill... The West front of this bridge is brick and has 12 handsome windows in each storey, the east front is a studded wall covered with plaister work and windows in 2 rows the whole length of the bridge" (4)

(3) Ibid p.111 See also F.Williamson "George Sorocold of Derby" in Derbyshire Archeological Journal vol. new series 1936 (1937)

(4) William Hutton "A history of Derby from the remote ages of Antiquity to the year 1791" p.198

Two main processes were carried out in this building; "throwing" the silk, or, translated into cotton terms, spinning; and "doubling". This latter process is "where a combination of two or more threads (is made) by laying them together without twisting to achieve greater strength and thickness. The number varies generally from 3 to 12. This in the 18th Century was generally a hand process." (5)

The doublers sat opposite the spinners or throwers along the east wall, six to each mill, whilst the spinners were arranged along the west wall working on 8 double-dutch mills, 4 to each floor, driven by a 29 ladle water-wheel 13 feet six inches in diameter. It will be seen that these two operations had very different requirements as far as the building was concerned. The "throwing" mills needed strength and stability to carry their weight and reduce vibration, while the doublers needed as much light as possible in order to manipulate the silk threads. SOROCOLD apparently overcame this problem by building the west wall in solid brickwork which was only pierced by the twelve windows, six to each storey; while the east wall was "a studded wall covered with plaister work and windows in two rows the whole length of the building." (6)

Where COTCHETT obtained his machinery and how is a mystery, but his enterprise was a failure and he went bankrupt. It failed partly because he only had one engine which was not sufficient to

(5) Penny Magazine April 1843 "A day at the Derby Silk Mill".

(6) Shepherd W.D. ; "Early Industrial Buildings" Chapter 1

drive all the machines on account of the insufficient bearings of the time, where three were actually necessary; and partly because the Dutch machines were by no means reliable in operation, and an apprentice of his - JOHN LOMBE - was quick to see this and conclude that Italian machines were the answer. Thus we have LOMBE'S famous two years industrial espionage in Italy.

Throughout the 17th Century silk throwing had been a hand operation, though a skilled silk thrower could manage more than one spindle at a time. (7) London merchants imported the raw silk in skeins or hanks called "slips" from the Ottoman Empire, various parts of Italy, India and China. Silk thread which was produced by British hand throwsters was alleged to be useful only as "shute" or weft, although in 1732 a London company of silk throwers were claiming that their hand throwsters could make silk thread which was suitable for warps. (8) Fine thrown silk suitable for warp threads (called "organzine") had for the most part to be imported from Italy, a fact which rankled a mercantilist parliament. Several varieties of silk fabric which were becoming increasingly fashionable among English ladies in the late 17th Century had to be made entirely from Organzine, i.e. the finest silk thread, and in this the English silk industry was technically unable to compete. (9)

(7) Chaloner W.H. : "People and Industries" Chapter 1 p.9
(8) Ibid p.9.
(9) Cooke Taylor, R.W. "Introduction to a History of the Factory System". p.358

In 1607 VITTORIA ZONCA had published in Padua his "Nova Teatro di Macchine e edificii", (10) which gave detailed engravings of intricate machines for throwing silk by water power in a large factory; though this was not perfected until 70 years or so after its first invention. The book was widely known in Italy, and ran to three editions, the final one appearing in 1656. But the details of the practical working of these machines remained a closely guarded state secret of the Kingdom of Sardinia, where according to an M.P., PERRY, speaking in the House of Commons in 1732, one of them had been built and kept at work for many years. (11) He maintained also that Sardinia had a monopoly of organzine silk made in this fashion though another set of mills is known to have been in operation in Bologna by 1718. (12)

ZONCA'S book gave detailed engravings of silk throwing machinery, but there is no evidence to suggest that his invention was practicable on a large scale, or that no improvements had taken place during the 17th Century to produce the type that JOHN LOMBE found in Italy.

The Lombe family had been settled in Norwich where in the late 17th Century HENRY LOMBE followed the trade of worsted weaving. His eldest son by his first wife, later SIR THOMAS LOMBE was born in 1685. HENRY LOMBE married a second time and died in 1695 leaving his widow to bring up his four sons, two by eac h

(10) Mantoux P : "The Industrial Revolution in the 18th Century" p.194.

(11) Chaloner : op cit. p.9

(12) Ibid p.9

marriage. At the turn of the century Thomas was sent to London, and in 1707 the Mercers Company of London admitted him to its fellowship and he became a freeman of the city in the same year. As a mercer he imported silk from Italy and prospered. He was soon an Alderman of the Bassishaw ward in the City of London and owed his knighthood of July 8, 1727 to the fortunate accident that he happened to have been chosen sheriff in the year of George II's accession to the throne.

Thomas' half brother John had been born in 1693 and been employed as an apprentice in COTCHETT'S mill in Derby. He had "a head well-turned for the mechanics".(13) He had already formed opinions on the weaknesses of COTCHETT'S mill and his brother, as an importer of silk would be fully aware that the rise in prices caused by the need to levy higher customs duties during the wars with LOUIS XIV which ended in 1713, and the economic dislocation caused by the wars, had given rise to the need for home industries to satisfy the demand for fine silks. Between them they came to the conclusion that the Italian secret of throwing fine silk must be stolen from them. Therefore in 1716 the journey to Italy was undertaken by JOHN LOMBE. He went to Leghorn where the Lombe's traded through their silk purchasing agents. In Italy Lombe's task was that of "penetrating the secrets of the water-driven silk throwing factories and their machines." (14) He must have had some courage as well as resource, for he knew that such an enterprise carried in event of discovery,

(13) Hutton op cit p.196

(14) Ibid p.196

the death penalty according to Sardinian law. Later when SIR THOMAS LOMBE was attempting to persuade Parliament that his patent should be renewed, he exhibited to a committee of the House of Commons a copy of the edict which stated that anyone disclosing or attempting to disclose the secrets of organizine manufacture was liable to be punished by death, as a proof of the real danger incurred by JOHN LOMBE.

WILLIAM HUTTON'S traditional and highly coloured account of LOMBE'S adventures in Italy and his precipitate flight and final hypothetical murder must here be discounted. SIR THOMAS in his patent specification of Jan. 3 1719 merely claimed that : "..... by constant application of endeavour for several years past, and by employing a great many agents and workmen both here and in foreign parts, I have at very great expense and hazards brought into this country the art of making the three capital engines." (15)

In any event John returned safely in 1717, and with money lent by THOMAS he took of COTCHETT'S mill, adding new buildings on oak piles. George SOROCOLD was again called in to supervise the extension of COTCHETT'S enterprise. THOMAS the following year obtained a patent for fourteen years, and soon after work began extending the mill built on an island in the River Derwent. LOMBE had agreed with Derby Corporation for the lease of this island for the rent of £8 per annum. (Warner : p.201)

(15) Warner : "Silk Industry in the U.K. Its origin and development." p.204

The situation of the island which was about 540 feet long and 152½ feet wide at its broadest, favoured the air of secrecy which surrounded the enterprise. Even DEFOE in 1724-6 was only able to give the minimal amount of information, padding his account with an anecdote of how GEORGE SOROCOLD fell into the mill sluice, caught up in the large wheel was flung onto the apron without a hurt.(16)

LOMBE'S silk mill was more ambitious than CROTCHETT'S mill, and its design was no doubt influenced by the warehouses erected at the continental seaports, and the Italian silk mills that LOMBE had seen on his travels.(17)

The mill was approached via Silk Mill Lane "always clean even in the depth of winter"(18) which led to a bridge linking the island to the town. On the second pier of the bridge stood "two handsome stone pillars fourteen feet high to which are hung a pair of near iron gates nineteen feet high and ten feet wide."(19) These gates are preserved in Derby at present, though moved to their present position adjacent to the Public Library. These gates opened out onto a courtyard on the right of which was built the Doubler's Shop and on the left was built the warehouse.

The Doubler's Shop was T-shaped, the leg being 139 feet long 18 feet wide and about 41 feet high containing 3 storeys. The shop was erected on oak piles 16 to 20 feet long driven into the soft soil of the island by means of an engine made for that purpose.(20)

(16) Defoe D. "A Tour through the whole island of Great Britain" (1724-7) Everyman Edition. op. cit. pp.155-7

(17) Shepherd. op. cit. Chapter 1 (The cost of the building was about £30,000 - Hutton op. cit. p.198

(18) Description is taken from a description of the Silk Millin the original handwriting of Wm.Wilson of Leeds partner with Samual Lloyd 1738-1753 to be found in Derby Ref. Library's collection of papers on Silk Mill.

(19) Shepherd : op. cit. Chapter 1

(20) Chaloner : o;. cit. p.14

In the shorter arm of the T was the 'Compting House", so constructed that it overlooked two of the Doublers' Shops at once. The longer arm of the T had three storeys each storey being one large room. The tiled roof was hidden by a parapet (WILSON calls it 'battlements'.) Under the two storeys of the shorter arm were cellars and a brewhouse,which presumably served the same purpose as the modern factory canteen, resuscitating the workers with beer instead of tea.

The Doublers' first requirement was adequate light, therefore each storey had "51 windows to the East and the same to the West..... these are but small sash windows, being only 3 feet 7 inches high and 20½ inches broad, but being set regular cause the East and West fronts to look beautiful." (21) There was sufficient space for 306 doublers in these rooms, one at each window; though by the late 1730's perhaps only half this number were employed. (22)

On the other side of the courtyard was the warehouse with its tower, complete with "a bell for calling works people to business" the diameter of which was 14½ inches and depth 13 inches. " (23) This building contained warehouses, sorting rooms carpenters' room and other offices.

A passage way underneath the tower led directly to another mill of five storeys known as the "Italian Works". Here again

(21) Wilson op cit
(22) ibid
(23) ibid

the building was erected on "piles doubly plank't" off which stonework was built 4 feet wide, turned to form 13 arches on the east and west fronts. The shallow pitched roof was strongly framed and covered with lead 10 pounds to the square foot. This building was 110 feet long, 39 feet wide and about 55 feet high. Each floor was lit by a row of 14 sash windows each 6 feet high and 3 feet 2 inches broad - 70 windows to each front.

The power to the machinery was supplied by SOROCOLD'S 23 feet diameter undershot wheel with 42 ladles which drove in the three upper storeys 78 Italian winding engines while on the two lower storeys it powered "8 filatoes or spinning mills and 4 tortoes or twist mills." (24)

Adjoining this building at the north end was the "Old Shop" - the old mill of THOMAS COTCHETT, and close to this a compting house "which overlooked the lower shop, and both the rows of doublers" together with the manager's seven roomed house. This completed the establishment.

The buildings and the machinery were not completed until 1721, so that while the new buildings and the machinery were in course of construction, JOHN LOMBE began to assemble and train workers by hiring various rooms in Derby, and particularly the Town Hall, where he erected temporary machines which were turned by hand. Even with the help of the new machines, doubling or twisting together two or more of the threads obtained by throwing, had to be performed by hand so that the labour force required

(24) ibid

was considerable.[25] Unfortunately, there does not seem to be any material which can give us any idea of the costs of this enterprise. Chaloner mentions the round figure of £30,000 as the probable total cost, but this does not bring us very much closer to an estimate of the constructional costs involved.

On Nov. 20 1722 JOHN LOMBE died, rumour had it that he had fallen victim to Italian poison, the full tale of doubtful authenticity is given in HUTTON. The mill was now the sole property of THOMAS, who was not skilled in the technical aspects of silk manufacture and now had no-one to advise him.

In 1724 before the mill was in full production the King of Sardinia had prohibited the export of raw silk. Therefore LOMBE tried TURKISH and Levantine raw silk, but he could not make good organzine with these materials. Raw silk from South China was tried, and was found to be as satisfactory as the Italian product, but the East India Company which had a monopoly of the China trade kept it at such a high price that LOMBE was forced to find other sources. He then turned to American silks during the 1730's though supplies were difficult. It is not surprising then that the quality of his organzine in general was not as high as the Italians, though he continually strove to improve it; but LOMBE'S prices were extremely competitive reducing the price per pound by 5 or 6 shillings from 27 shillings to between 21 and 22 shillings per pound.[26]

(25) Chaloner op cit p.14

(26) Hertz G.B. "The English Silk Industry in the 18th". (English Historical Review 1909)

Inferiority in the quality of his product led to complaints. One PETER LEQUEUX, a Hugenot silk weaver, gave evidence early in 1732 that he had often reason to complain to LOMBE that the organzine from his mill was defective. He admitted however, that LOMBE'S machines had reduced in price and added that of late LOMBE'S quality had equalled the best that Italy could produce.(27) It is what we would expect. At first, with supplies difficult, the labour force relatively unused to the new machinery, and with no-one to aid him in mastering the technical difficulties present in working up new machinery after the death of his brother, LOMBE must have found the quality problem in mass production an extremely tough one. It says much for LOMBE'S skill as a factory organizer that he was able to solve these difficulties.

The silk arrived at the mill in the form of a thread, for the silk worm secretes silk through two small holes near the head, the two threads twisted into one; so that the silk cocoon which the worm forms is made up of a continuous thread. In this way silk manufacture differs from that of cotton which comes in short fibres. Generally speaking one floor of the mill was devoted to some particular department of silk manufacture.(28) In some floors the machinery employed was worked by children - generally girls; in others elder girls or women were used.

(27) Warner op cit p.205

(28) Ensuring description taken from a supplement to the Penny Magazine of April 1843.

There were of course, men and boys, but a large number of those employed were females.

The hanks of raw silk brought into the mill would be of various colours and texture, since Chinese silks are whiter than either Bengal, Italian or Persian. (29) The operations on the silk would differ in complexity according to purpose, some only wound and cleaned, others wound, cleaned and twisted once; others wound, cleaned, doubled and twisted once; others wound, cleaned, twisted, doubled and twisted again. Therefore, the main operations were winding, cleaning, doubling, twisting or 'throwing' plus a few subordinate operations.

The old mill of COTCHETT'S was concerned with the winding side of the process. The machines were arranged in rows leaving a clear passage on either side of the room. The bobbins on which the hanks or skeins were wound were 4 to 5 inches in length. The silk was stretched over a hexagonal frame whose circumference equalled the circumference of the hanks of raw silk. These frames called "Swifts" varied in size because naturally the silk varied in size also. The Swifts were also adjustable to allow for small differences in dimensions. One bobbin to each swift revolve on a horizontal axis, the swift rotating just by the pulling force of the thread. A moving eye ensured that the thread was wound onto the bobbins equally. Women and girls were occupied in adjusting the different parts of the apparatus, removing the fully wound bobbins, replacing them with empty ones, and fitting new hanks to be wound.

(29) Hutton op cit p.207

In the Italian works the 'throwing' part of the process could be seen. The machines were ranged one behind the other in two rows. To every machine there were a set of bobbins whose axes were horizontal, and another set whose axes were vertical; the twisting or throwing taking place whilst the thread passed from one bobbin to another. The vertical bobbins did not revolve, but were placed on spindles which together with a kind of eye or loop were fastened to the stationary vertical bobbin. When the machine started the thread wound itself round the vertical bobbin by the rotation of the loop called the 'flyer' whilst twist was given to the thread at the same time. The faster the flyer rotated vis a vis the horizontal bobbins the greater the twist, so that the silk thrower could vary the degree of "hardness" by varying their relative speeds. The speed of the horizontal bobbins was regulated by the superintendant of the department; thus regulating the relative velocities which the two movements had to each other. But once this was done, women and girls could attend the machines, replacing the lower bobbins when emptied, and the upper ones when filled and joining the ends of broken threads.

Doubling on the other hand was in the 18th Century, a hand process. Its function was to strengthen the silk thread, and achieve greater thickness, by laying the threads together without twisting them: the number of threads varying from 3 to 12. Women, sitting on low stools, had in front of them small wheels which were manually turned. By their sides were small frames with as many bobbins as there were threads to be doubled together.

From each bobbin a thread end was taken, knotted together, passed through a loop and then attached to the wheel which was then turned. Often these threads were thereafter twisted by similar machines to those already employed for single threads. Some twisting was done by hand, however, generally for the thicker varieties of silk. This was done by a large wheel turned by hand with on one face of the wheel about a dozen hooks arranged in a circle. Threads of silk were fastened to these hooks and the other ends of the threads were carried to the distant end of the room by boys. At that end of the room they were attached to a machine "capable of travelling slowly along the floor". The handle was turned, the hooks therefore rotated, and the threads twisted round each other. "The silk twisting is, however, effected with great quickness; and the little boys are incessantly engaged running to and fro, attaching and detaching the remote ends of the silken threads. We were informed that this running amounts to as much as 30 miles per day....."(30)

The silk was then either dyed or bleached, and scoured to remove gum, which meant boiling for 3 to 4 hours in strong soap and water, rendering the silk soft and glossy. It was then washed in clear water and was ready for weaving.(31)

To keep the silk in condition a "fire engine" sent warm air to the rooms, though HUTTON says it was just a "common stove"

(30) Penny Magazine.

(31) The description found in the Panny Magazine is of a later date than Lombe's ownership, but accounts show that the factory had changed little either in techniques or layout see Mantoux p.197

Sorting and packing were done in special rooms.

WILLIAM HUTTON was an apprentice in this factory and his description is interesting though perhaps bitter. Work began at 6 a.m., and though very young children were not employed, the harshness of the discipline necessary to secure good work was to HUTTON an intolerable feature of this factory's life, The overseer was far too free with his cane, a punishment which HUTTON recalls.(32) There was a high labour turnover - "many hundreds" left the mill whilst HUTTON was there, though this was by no means unusual in 18th Century factories. Respectable artisans considered factory work as mere casual employment for "the lowest description of people". On the other hand two of the clerks befriended HUTTON, and the general manager on one occasion bought him a new hat. It is true however, that HUTTON when small was forced to wear blocks under his shoes to make him tall enough to do his work.

Derby's mayor and corporation were by no means pleased with LOMBE'S activities, complaining that the mill deflected labour from the towns' woollen and hosiery trades. They also complained illogically that LOMBE'S enterprise had prevented poor labourers and their families migrating from Derby, thus increasing the poor rates.(33) They were however, powerless. LOMBE prevented other manufacturers from using his machines by threats of legal action; textile manufacturers in other trades in Blackburn, Manchester and Stockport, as well as the silk

(32) Hutton op cit p.194
(33) Richardson op cit p.128

manufacturers of Leek (Staffordshire) and Macclesfield (Cheshire) petitioned Parliament with their case, Factories were planned at Stockport even before the patent expired, though LOMBE himself had barely solved the problem of good production runs when the date of the patent's expiry (Sept 9, 1732) approached.(34)

Wishing, as ARKWRIGHT was later to follow, to extend his monopoly by extending the patent for a further 10 years, LOMBE petitioned Parliament to this effect. He pointed out that technical difficulties prevented him from enjoying the reasonable profits he deserved as the country's benefactor. This caused a fair amount of argument. SIR THOMAS ASTON, M.P. for Liverpool opposed LOMBE'S petition on the grounds that LOMBE had acquired a vast trade and therefore vast riches. His riches have been assessed at £80,000 in 1732,(35) but NATHANIEL PATTISON, a leading figure in the silk industry, and a close friend of LOMBE told a select committee of the House of Commons in 1765 "that the notion which prevailed of SIR THOMAS getting his fortune by his mills..... was a mistake".(36)

On the grounds of public policy, the Chancellor of the Exchequer decided that LOMBE'S machines could not be restricted and that in order to recompense him for the loss of profits involved, Parliament would grant him £14,000; on condition that LOMBE allowed a perfect working model of the machine to be placed before the public. On collecting the money, LOMBE had a celebration in the mill, but not until 2 months after his death (Feb. 26, 1739) were instructions given to make models of these

(34) Chaloner op cit p.17.
(35) Hutton op cit p.203
(36) Chaloner op cit p.17

capital engines. Fragments of these models can now be seen in the South Kensington Science Museum.

Whatever profit LOMBE did make from his silk manufacture, he died a rich man - a fortune of between £120,000 and £150,000 was divided between his widow and two daughters, with the proviso that the principal servants of his mill were to be rewarded to the value of £500 or £600. Shortly after, his wife DAME ELIZABETH LOMBE, agreed to sell the mill and the remainder of the lease to RICHARD WILSON JUNIOR of Leeds for the very small sum of £3,800 after a number of unsuccessful attempts to dispose of it through the columns of the "Daily Advertiser".(37)

Although factories were planned on LOMBE'S principles at Stockport, and even though several employers who appeared before the Parliamentary Inquiry into the Silk Industry in 1765, were employing between 4 and 8 hundred persons, the silk industry never held an important place as an industry in England.(38) The excessive high price of raw silk, aggravated by the SARDINIAN King's refusal to allow even its export, plus the competition of French and Italian industries, were the main reasons. The lack of real protection for the infant industry, although several times demanded by silk manufacturers, led to periodic crises which stunted its growth. With this technical progress came to a halt.

In spite of this the mechanization of silk manufacture made a very vivid impression on people who had never seen anything

(37) Records of Derby Museum and Reference Library.
(38) Mantoux op cit pp 195-6

of the kind before. DANIEL DEFOE and DR. JOHNSON were impressed if rather bewilded. (39) They were seeing the first modern factory, a heralder if not initiator of the industrial revolution, having the modern characteristics of large scale production, viz: production by power driven machinery, workers to work for fixed hours on machines whose pace dictated to the operative and not vice versa, mass output, and the specialized functions of the operatives.

After RICHARD WILSON JUNIOR of Leeds had bought the mill from DAME ELIZABETH LOMBE, the mill changed hands a number of times, being used right up to 1890 when it was destroyed by fire.

(39) Defoe D. op. cit. pp.155-7

CHAPTER III

THE STRUTT MILLS

If in LOMBE'S silk mill we can see the first signs of the coming industrial revolution, in the mills of JEDEDIAH STRUTT we can see this great economic and social change in full swing. For "JEDEDIAH STRUTT like RICHARD ARKWRIGHT, has his place on the roll of the classical inventors and industrial organizers of the Eighteenth Century. He was the inventor of a process which greatly expanded the hosiery industry, by making of ribbed stockings by machine instead of by hand. He became one of the backers and partners of ARKWRIGHT in his first spinning factories, and he founded a cotton spinning firm that became the largest in the country."(1)

JEDEDIAH STRUTT was the second of three sons of WILLIAM STRUTT, a small farmer and maltster and was born July 26 1726 at South Normanton close to Alfreton in Derbyshire. Framework knitting was the only industry in this small village. The Strutts were a strongly non-confirmist family, and when Jedediah was apprenticed at the age of 14 to a wheelwright in Findern, a village close to Derby he entered a true stronghold of dissent, for this village had one of the largest nonconformist academies in the country. Whether he attended the school or not, he was left with an urge to self-improvement and also with personal contacts which were later to prove helpful. At 21 he left for Leicester, and 8 years later he married an old Friend, ELIZABETH WOOLLAT after a prolonged and erratic courtship. The year

(1) Fitton and Wadsworth :"The Strutts and the Arkwrights" 1758 - 1830 p.1

previously, an uncle, a farmer at Blackwell, died leaving STRUTT the stock of his farm. STRUTT, therefore began married life as a farmer but he lived in hosiery manufacturing country. Its centres were Nottingham, Leicester and Derby, but it was spread through nearly all the villages. The stocking frame was based on an invention of WILLIAM LEE, but since that time (1588) the frame had not been adapted successfully to ribbed hosiery, which was still handmade. It was by solving this problem that STRUTT made his first industrial contribution. Legends have grown around the invention, (2) which basically consisted of a separate set of barbed hooks operating vertically among the horizontal needles of the frame, taking the loops from the latter and reversing them so as to make a rib stitch. This was in about 1756. The next year STRUTT tried to start as a putter-out of hosiery, getting in touch with the various hosiers in the district. His wife then essayed to borrow money from her old master but failed; and STRUTT therefore journeyed to London taking specimens of his ribbed hose both cotton and worsted. London hosiers were however, discouraging about the idea of a patent, so that STRUTT aided now by his wife's family, the WOOLLATS, sought a partnership elsewhere. In 1758 a partnership was drawn up between STRUTT and WOOLLAT with JOHN BLOODWORTH and THOMAS STAINFORD, two of the largest hosiers in Derby. A patent for the machine was granted in 1759 after apparently, one previous unsuccessful attempt.

(2) Pilkington J : "A view of the present state of Derbyshire" (1789) Vol.II p.173
Henson : "The Civil, Political and Mechanical History of the Framework Knitters". Vol. I pp.258-9

The partnership lasted until June 1762, when it was dissolved by common consent, leaving STRUTT and WOOLLAT in sole possession of the property after payment of appropriate compensation to the other partners.(3)

The hosiery business grew, the London connection established with the partnership, expanded and the firm had its agent there. STRUTT had found a new backer - SAMUEL NEED, a wealthy Nottinghamshire hosier who was also a strong non-conformist. The Strutt-Woollat partnership was able to acquire a silk mill and warehouse in Derby, though details of this mill are not extant. We know that the mill employed weekly wage-earners; and that the wage bill ranged between £12. 10. 0 and £15 a week in 1781, but that by 1786 it had risen to £17 and £18.(4) The mill was continually being extended and in 1785 another mill was built at the Morledge in Derby. There seems to be little reference to machines. In 1782 THOMAS CRANE was paid £21. 6s. for "2 engines" i.e. silk throwing engines, and a further £21. (5)

In 1781 SAMUEL NEED was paid £1150, which possibly indicates the end of the partnership, but in any case he died in April of the same year. In March WOOLLAT had received £600 and payment of 5 guineas a week, which seems to indicate that STRUTT was taking over the business.

There was a frame shop in Derby, and a recurring weekly item

(3) Fitton and Wadsworth : op cit p.38
(4) ibid p.53
(5) ibid p.53

in the accounts for stocking makers' wages. But by the end of the century the firm sold its frames and concentrated on yarn spinning, so that its connection with the hosiery trade ceased.(6)

It will be seen that as the business grew the hosiery knitting side grew correspondingly less important. The partnership with RICHARD ARKWRIGHT led to a greater concentration on yarn spinning, and it is in connection with this trade that the famous STRUTT and ARKWRIGHT mills were established.

The partnership with RICHARD ARKWRIGHT will be discussed in detail later,(7) at this point we wish to deal with those spinning mills which were STRUTT'S peculiar concern during the life of the partnership, namely the Derby, Belper and Milford mills.

The STRUTTS were always a specialized firm of spinners concerned mainly with hosiery yarns, while the other big firms such as ARKWRIGHT and OWEN, spun for the cotton piece-goods markets and for yarn export, or specialized in fine counts like McCONNEL and KENNEDY at Manchester and HOULDSWORTH at Glasgow. STRUTTS' were mainly concerned with the Midland trade, though they did good business in Manchester through their agent there. At Derby however, they did for a time enter the general trade.

"MR. WILLIAM STRUTT the younger (the eldest son) is endeavouring to transplant the manufacture of calicoes into the town and its neighbourhood. He employs 112 looms, 40 of which are within the town".(8)

(6) Felkin W. "A History of the Machine Wrought Hosiery and lace Manufacturers" 1867 p.94
(7) Chapter Four
(8) Pilkington J. op cit Vol.II p.176

He also, embarked on mule-spinning at Derby and built the 'Calico Mill' later referred to as the Derby Mill. William Strutt's son credited him with being among the earliest pioneers of the self-acting mule - before 1790; "but we believe that the inferior workmanship of that day prevented the success of an invention which all the skill and improvement in the construction of machinery in the present day (1831) has barely accomplished."(9

By the 1780's great interest had been aroused in the use of cast iron in building and constructional work, and STRUTTS interest in this new and promising development can be seen in a letter written in Spring 1789 to SAMUEL OLDKNOW, then planning his Mellor Mill in Derbyshire.

"...a man has got a patent for making iron bridges cheaper than those of stone and has prepared a plan for one over the Schulkill in America, - but I suppose you will not wait. Indeed, if we are to wait for the perfection of every proposed improvement, this age is so improving we should all sit still and do almost nothing".(10)

However, STRUTT was not concerned with bridges of iron. His mind was turning over the practicability of using iron in the construction of his mills. Recently great stir had been created by the construction of the Palais Royale in Paris, with a cast iro framework - an event which no doubt would have influenced STRUTT, impressed as he was with the destruction by fire of ARKWRIGHT'S mill at Nottingham (1781). On October 29, 1792 a JOHN WALKER

(9) Derby Mercury Jan. 12 1831
(10) Unwin : "Samuel Oldknow and the Arkwrights". (1924) p.222

wrote to him from Ashbourne on enquiries he had made in Paris. "I am afraid I shall have more difficulty in getting you the drawings than I was aware of. As soon as I received your letter I wrote to an English architect in Paris for them. But 3 days before I left London a Frenchman who had made his escape informed me that the massacres of the 2nd September had driven him to England as they did all ye English, and notwithstanding my enquiries I cannot learn where he is ... Previous to your letter I had ordered one of each sort of hollow bricks of which the arches are composed, to be sent to me, and I expect soon to hear of their being arrived in London... Unluckily I only saw the building the evening before I left Paris, so that I have not so perfect a recollection of the plan as I should have had, had I reviewed it at my leisure. However, perhaps I will give you as good a description as I can, least perchance I should not be able to obtain drawings at all.

The building of the Palais Royale seems to me to be about 24 feet wide, the iron bars supporting the arches are about 4 feet from each other....

My friend, ye architect, has brought into London a quantity of Paris Plaister, and has got a Parisian to shew the method of using it. Here the plaister is burnt with wood, but there is a method of burning it with coals; I scarcely reoollect the contrivance though I think it is not a very difficult one...

The roof of the Palais Royale is of framed iron, with a large sort of hollow bucks to fill up the panes."(11)

(11) From "A memoir of William Strutt" authorship uncertain, in Derby Public Library.

Since so much timber was used in the mills where naked candles were the only method of illumination other than daylight, in rooms full of cotton fibre, the risk of fire was very great. Once a fire started it was virtually impossible to put it out before the whole mill was gutted, so that the large number of fires in the early textile mills comes as no surprise.

The final stimulus towards a solution of this problem came in 1791 with the destruction of the Albion Mills in London, the most advanced industrial building of the day. At any rate in 1792 WILLIAM STRUTT made a fresh approach to the problem, in trying to eliminate timber from the building as far as possible, and where he was not able, to protect it by covering with fireproof material. His son wrote in the "Derby Mercury"

"He was the first person who attempted the construction of fire-proof buildings on a large scale in the country, and with the most perfect success. The great improvement made of late years in the formation of castings in iron have given great facilities to this mode of construction, which is now very extensively in use."(12)

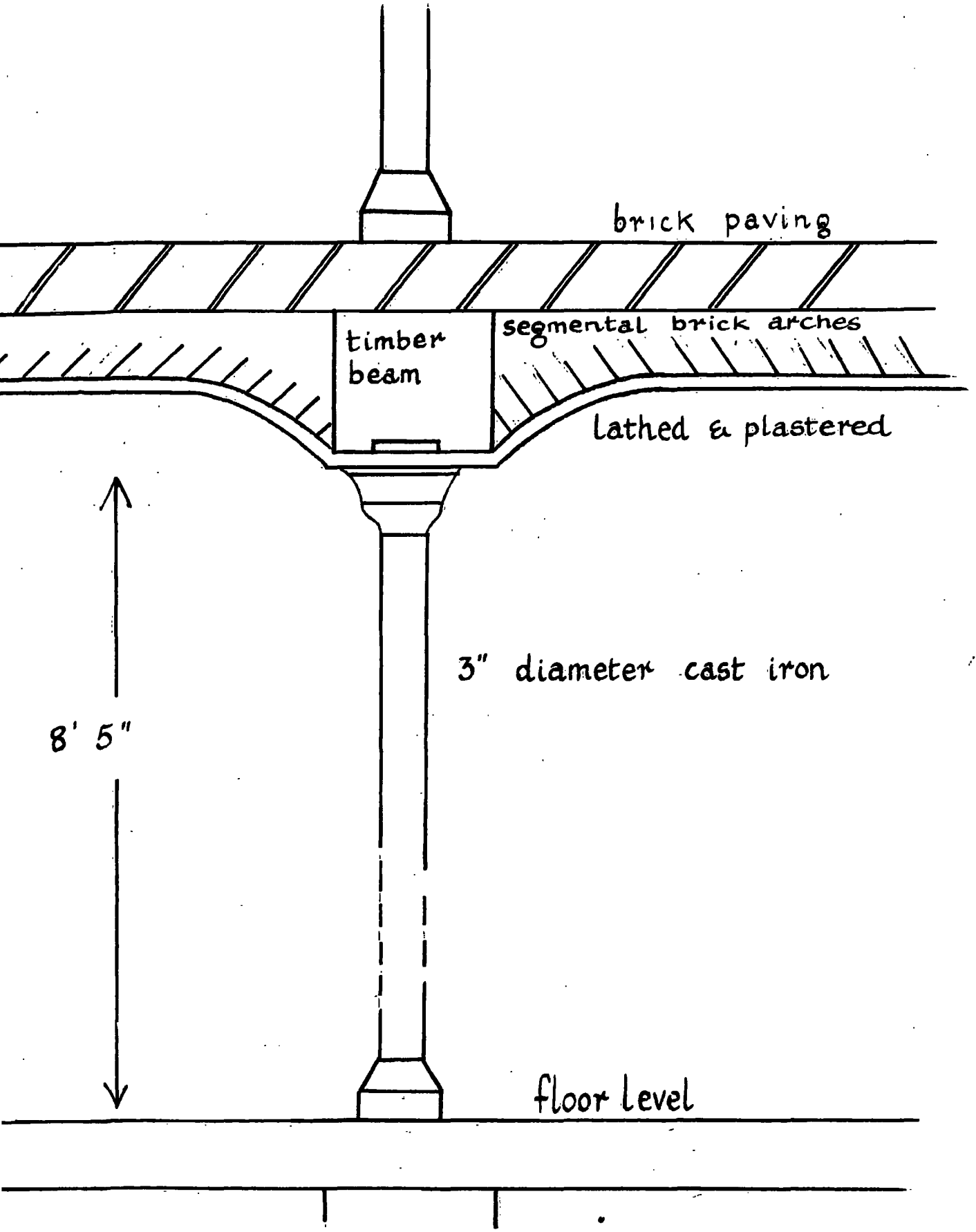
The site was placed in the middle of Derby on the West bank of Markeaton brook, now covered by a street. It was six storeys' high, the main building being 110 feet seven inches long, 30 feet 9 inches wide, with brick external walls 22½ inches thick up to second floor level, then 18 inches thick up to fourth floor level, the remainder being 13½ inches including the parapet.(13)

(12) Derby Mercury Jan.12 1831
(13) Shepherd W.D. : Early Industrial Buildings Chapter 2

The floors were in the form of segmental brick arches bearing on heavy timber beams approximately 9 feet apart, supported on 2 rows of cast iron columns running down the length of the rooms. To protect the timber beams, the exposed face was lathed and plastered, presumably with gypsum plaster, obtained locally, and the arrises were covered with sheet iron. It is clear from a plan made by BOULTON and WATT in 1806 for the installation of gas lighting in Strutts Derby Mill, that the beams used were about 12 inches wide.(14) Although no details were given it is clear that the beams were of timber for in 1853 there was a fire in the loft of the mill reported in the 'Derby Mercury'. The report states that the mill "differs in the construction of its floors from modern fire-proof buildings, the arches being formed by pot cylinders, about 7 inches long and 3 inches in diameter... the girders instead of cast iron are of Baltic fir, cased in iron."(15)

The Derby Mill thus stands as an important milestone in the history of structure, the first real break with the tradition established by LOMBE'S silk mill 70 years before. It was not long before cast iron beams were used as a substitute for timber. The first known example of this improvement is to be found in a mill at Shrewsbury built in 1796. CHARLES PAGE (1752 - 1822), a friend and correspondent of STRUTT, was directly responsible for this, the first iron framed building in England.(16)

(14) ibid Chapter 2
(15) Derby Mercury : July 20 1853
(16) Shepherd W.D. : op cit Chapter 6

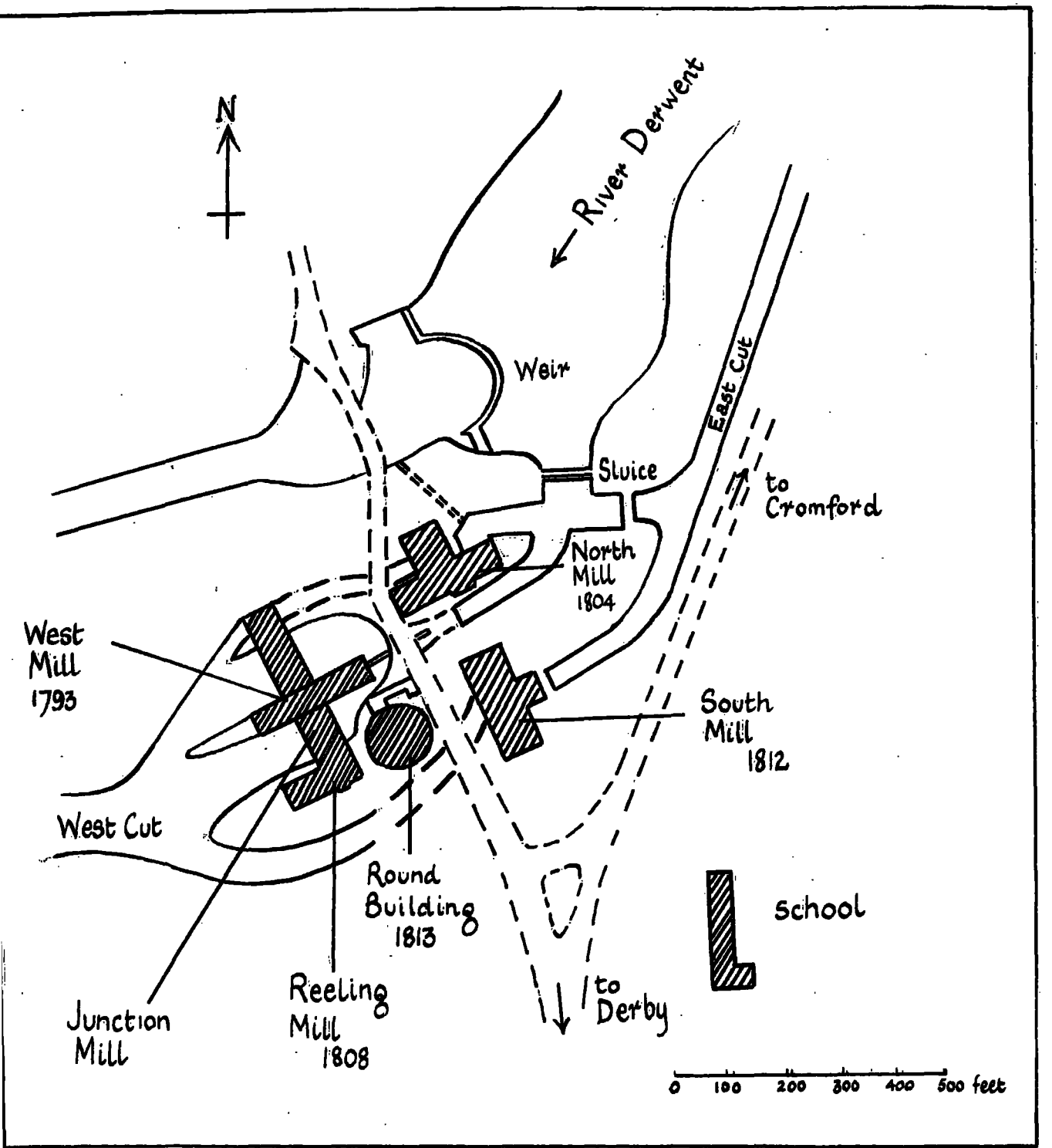

brick paving
timber beam
segmental brick arches
lathed & plastered
3" diameter cast iron
8' 5"
floor level

Parallel to these developments came the work of BOULTON and WATT, whose rotary steam engine initiated further developments in mill construction - the Albion Mill, Blackfriars Bridge being one, Philips, Wood and Lees' mill at Salford being another (1799 - 1801), actually powered by a WATT engine and probably designed by BOULTON and WATT.(17)

The partnership between STRUTT and ARKWRIGHT had begun to bring prosperity to them by 1776, shortly after ARKWRIGHTS' carding patent, for it was then that the Cromford extensions were made and STRUTT started his building at Belper. The precise relationship of the partnership to these ventures is unknown. It has been commonly assumed that it covered Nottingham, Cromford, Belper and Milford, as well as Birkacre in Lancashire in 1777. It would seem however, that STRUTT most probably financed Belper and Milford himself.(18)

Belper, a small village, lay seven miles north of Derby on the east bank of the Derwent. There was already some domestic industry - a colony of nailers. The first cotton mill there began work in 1778. Already by that time STRUTT had bought further property at New Mills or Milford, a mile and three quarters nearer Derby. STRUTT bought a nucleus of buildings there which were advertised at the time as an iron works. According to PILKINGTON in 1789 (19) STRUTT had by then 2 mills at Belper, one at Milford and 2 at Derby. There were at

(17) ibid Chapter 2
(18) Fitton and Wadsworth : op cit p.77
(19) Pilkington J : op cit.Section covering the parishes and deaneries of Derbys.



William Strutt's Mills at Belper

this time 16 mills in Derbyshire, the largest concentration of mills on the ARKWRIGHT principle in the country.

Place	No. of mills	Owner	River
Cromford	2	Arkwright	Cromford Slough (tributary)
Bakewell	1	"	Wye (tributary)
Wirksworth	1	"	Ecclesbourne (tributary)
Matlock	2	"	Derwent
Belper	2	Strutt	"
Milford	1	"	"
Derby	2	"	"
Darley (Derby)	1	Evans	"
Tansley	1	"	" (Tributary)
Calver	1	"	"
Lea	1	Nightingale	(tributary)
Wilne	1	"	Derwent (20)

At any rate, at approximately the same time as STRUTT was developing the Derby side of the business, he began in conjunction with his son WILLIAM to extend his interests at Belper. The new mill he built there, called the "West Mill", was not completed until 1795 and did not commence production until the following year, perhaps owing to the trade crisis of 1793.(21)

The building was similar to the Derby mill, in that although it was not iron-framed, iron and protective sheet iron was used extensively throughout, plus the use of hollow earthenware pots about 4 inches in diameter in the ceilings of the building. FITTON and WADSWORTH quote from an eighteenth century chronicle (22) which describes the mill.

(20) ibid
(21) Fitton and Wadsworth : op cit p.205
(22) Britton and Brayley "The Beauties of England and Wales" Vol. III (London 1802) p.530

"The principal of these mills (the one in question) is 200 feet long, 30 feet wide and 6 storeys high, and like that we have described at Derby is considered as fire-proof, the floors being constructed with brick arches and paved with brick. The two water-wheels which work the machinery in this building, are remarkable as well for their magnitude, as for their singularity of construction; one of them being upwards of 40 feet long and eighteen feet in diameter; and the other 48 feet long and 12 feet in diameter. As it was impossible to procure timber sufficiently large to form the axles or shafts of these wheels in the usual mode of structure, they are made circular and hollow, of a great number of pieces, and hooped like a cask; one of the shafts is between 5 and 6 feet in diameter, and the other between 8 and 9." (23)

Since not all the accounts have survived it is impossible to estimate the total cost of labour employed in building the West mill. However, "between March 1793 and September 1797 (by which time the mill had started working) £4,688. 19s. 1¾d had been spent on its construction. If this was the total sum, with its floor area of 33,500 square feet, the cost came to just under 3d per foot super, or roughly 25 per cent more than that of a 5 storey timber-framed mill erected in 1794-5 at Leeds for JOHN MARSHALL. (24) This sum does not include money spent on water-wheels and wheelhouses for which almost £630 was spent on a

(23) Fitton and Wadsworth : op cit p.207

(24) ibid p.210

wheel alone, built almost entirely from oak: whilst between 1794 and 1797 £1,142 had been spent on the Cut, walls and bridges, bringing the total cost to £6,461. Many of the materials came from STRUTT'S own estates, but the amounts of stone, timber and other building materials required could not be fulfilled solely from this source. The more important items in the accounts for building the West mill are to be found in FITTON and WADSWORTH, (25) for example :

	£	s	d
3 labourers altering scaffold poles	2	8	0
Woods-iron workmanship for 2 standards and a waller for drawing materials up to floors	1	10	0
Masons and labourers making scaffolds	6	7	0
Brags and nails used for braces and scaffolding		5	10
36 beams for 3 floors 30 feet long and 12¾ inch square 1224 feet cube. 31½ do. for 3 floors 38 do. and 13 inch square 1404 feet do. 6 short beams next gable end 30 feet cube = 2658 feet @ 21d	232	11	6

The power for this mill was originally supplied by 2 water wheels, but by the end of the century the mill was powered by 3 wheels, the smaller of the original ones having been replaced by 2 wheels each 15 feet long and 21½ feet in diameter, built mainly from wrought and cast iron and designed by T.C. HEWES, a Manchester engineer and mechanic.(26)

In 1797 JEDEDIAH STRUTT died at the age of 70. The firm therefore passed into the hands of his son WILLIAM, though

(25) ibid pp.207-10
(26) Davies D.P. "A New Historical and Descriptive View of Derbyshire" (1811) pp 346-7

WILLIAM as we have seen was in charge of the Derby developments and had been in virtual control of the Belper developments for a considerable period before his father's death.

In 1803 JEDEDIAH'S second timber-framed mill of 1784-6 was destroyed by fire.

"About 3 o'clock this morning a most tremendous fire broke out in one of the large cotton mills belonging to Messrs. Strutt at Belper ..... which raged with incredible fury, and in a few hours destroyed it, and all the valuable machinery, water wheel, etc. The loss will be immense as no part of the property is insured." (27)

The mill known as the North mill, was quickly rebuilt and started working towards the end of 1804. In it WILLIAM STRUTT adopted and improved Bage's beams and revealed himself as a designer of the highest calibre.(28) The newmill, iron-framed throughout had five storeys and an attic. It was 127 feet long, 31 feet wide and 63 feet high. A wing was 41½ feet by 34 feet. A description of the mill written in 1812-13 appears in REES'S "Cyclopaedia". The writer spent some time at Belper and was given facilities for drawing and describing the works. The following is a summary of his remarks.

The mill :: The side and end walls are built up as usual with the usual doors and windows in them. The several floors are composed of brick arches with a very small rise and a 9 foot span. The arches spring from iron columns, erected one upon another through the whole height of the mill. They are connected

(27) Derby Mercury Jan.13 1803
(28) Shepherd W.D. op cit Chapter 6

by cast iron beams or girders, one of which extends from the top of every column to the next. In an opposite direction to these girders, each pair of columns is tied together across the arch, by a wrought iron bar, which has an eye at each end, to be hooked over the tops of the columns. This resists the lateral thrust of the arch. Thus though every floor is formed of a system of arches, like a bridge, yet the lateral strain of each is supported by iron ties, so that each arch stands by its own supports; independent of its neighbours. The arches are only of one brick thickness, and are covered over at the top by a floor of paving bricks to make a flat surface above, the haunches of the bricks being filled by rubbish. The iron ties across the arches are concealed within the brickwork of the arch. The roof is of cast iron. The space between the two columns in the roof forms a small room, which is used as a schoolroom for the workpeople on Sunday.

The mill contains 15 arches in length. The floors are continued beyond the end wall by 2 additional arches, giving a small room on each floor, which is occupied by the counting house, staircase and the stove which warms the mill in winter, and also a crane for drawing up the goods to the machines on the various floors. The wing which consisted of six arches, projects from the middle of the mill. The width, both of the mill and the wing, is composed of 3 lengths of arches, having 3 iron girders that they rise from, and 2 columns to support them. The arches on the ground floor, or cave of the mill are supported by very strong piers, instead of iron columns. These piers are founded very

firmly in the earth, and every precaution taken to prevent their subsiding under the great weight they have to carry. The columns of the first floor are erected immediately on the tops of these piers.

The Hoist : This was driven by the Mill's power and had been adopted in all STRUTT'S mills. It was manipulated by a boy who rode in a seat on the top of the cradle and pulled the guide ropes. The bobbins were sent up in little frames mounted on wheels and, thus wheeled along by little children to the crane, were drawn up or let down without any hard labour. This was probably the invention of WILLIAM STRUTT.

The Stove : This was placed in the space below the staircase. It was an iron vessel inverted over a fire, the smoke escaping by a flue behind into a chimney. The air was then brought in a current to strike upon the external surface of the vessel, and thus warmed rises up through flues into every part of the building where it was admitted in any quantity at pleasure by registers, regulated to produce an agreeable warmth, but, as the warm air escaped again with a draught through a proper ventilator, there was nothing of closeness. This principle was later adapted for hospitals and houses.

Power and Drive : The motive power came from the water-wheel which was under the wing of the mill. The wheel was 18 feet in diameter and 23 feet long. Its size was so great that no cast iron girder could be thrown across strong enough to support the arches, so a strong stone arch was put in, fortified by 2 strong iron bolts. The arches of the wing immediately over

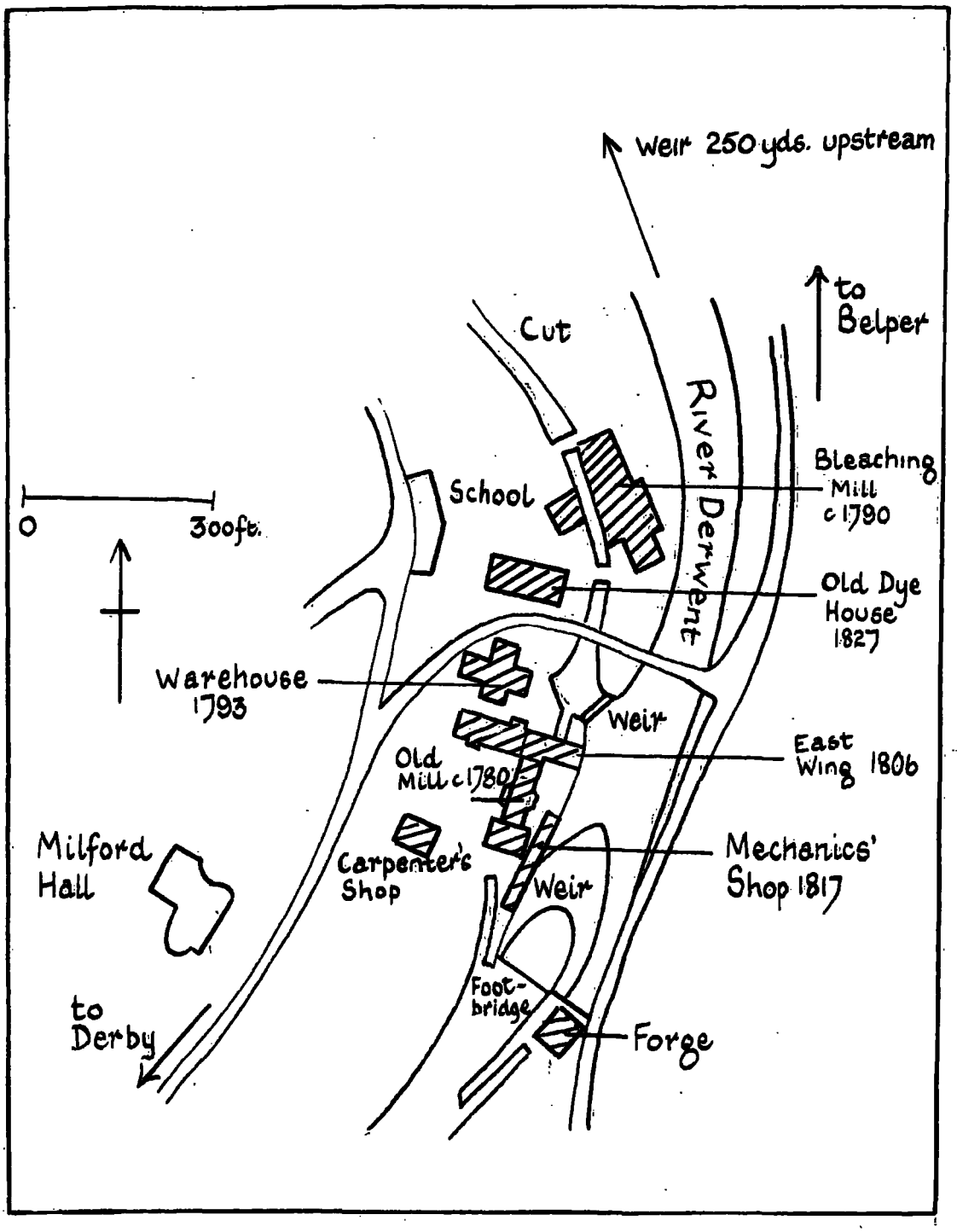
the water-wheel were of hollow pots. Pots were also used to build the arched floor of the roof.

The driving system came from the water wheel and turned a vertical shaft running up to the top of the mill. It also turned a horizontal shaft extending the length of the mill. On this beneath every arch was a bevelled wheel turning another vertical spindle. On this the main spindles of the spinning frames were fixed.

The two lowest floors contained the spinning frames, 28 on each floor, and 12 more in the 2 floors of the wing - in all 4236 spindles. The third and fourth floors contained three rows of carding engines - 64 breaking cards and 72 finishers - turned by a horizontal shaft over the machines. The wing had 16 drawing and 4 stretching frames. The fifth floor had reeling, doubling and twisting frames. (29)

In spite of periodic setbacks in trade the STRUTTS maintained a high constructional activity. As explained above, the North mill was rebuilt in 1803-4, but in addition the four-storey Milford Warehouse, in 1792, the structural details of which are in all probability identical with those at Derby. Completed in 1793 and known as the Cruciform Building, this was very recently demolished by the English Sewing Cotton Company, to whom it belonged. An article in the "Guardian" of 22nd Feb. 1964 recorded its demise. It had been up to that date the oldest surviving example of JEDEDIAH and WILLIAM STRUTT'S work, and the earliest existing fire-resistant mill, and was a

(29) Rees A : "The Cyclopaedia; or the Univeral Dictionary of Arts, Sciences and Literature." Article on Manufactureof Cotton.



Strutt's Mills at Milford

monument of unique interest in the evolution of modern design. It had arch floors, iron columns and beams of Baltic fir 12 inches square plastered on their underside, the wooden skewbacks supporting the arches were cased in thin sheet iron, and the beams spanned 9 feet.

In 1805-6 the firm built the 5-storey east wing of the Old mill at Milford, and converted the two lower floors of the Old mill into fire-proof construction, rising brick arch floors and a central row of iron columns. A South wing was added sometime during the Napoleonic War. The six-storey Belper reeling mill was built 1807-8 and at a slightly later date this was linked to the West Mill by the Junction Mill.(30) In 1810-11 the first Belper mill (of 1776-8) was demolished to make way for the present South Mill 1811-12. This still stands and has five storeys and an attic, and is 118 feet long and 40 feet wide. The ground storey is of stone and those above of brick. The mill, with its well-lit and neat interior of remarkably modern appearance fittingly represents the culmination of WILLIAM STRUTT'S work in the 20 years following the design in 1792 of the first fire-resistant mill.

In Belper also is a curious building known as the Round Mill, built over the period 1803-13 and which commenced working in 1816. The massive stone built mill, clearly owed much to the ideas of SAMUEL and JEREMY BENTHAM, the latter was a friend of WILLIAM STRUTT, who would therefore be familiar with the Panoptican idea over which Bentham wasted so much of his

(30) Information given by English Sewing Cotton Co.

substance.[31] It is divided into 8 segments and the overlooker at the centre, like the spider in the heart of his web, could see everything that happened in them. BENTHAM held this 'simple idea in architecture' to be of special use in prisons. The plan he thought could be extended from prisons to factories, madhouses, hospitals and even to schools. It did however, enable the overlooker to shut off any segments should a fire occur by closing the doors and letting the fire be tackled without involving the rest of the building.

The power aspects of the Belper and Milford mills were complex. The Derwent is a large but capricious river, very subject to changes of level and to floods. It called for extensive works to oversome these handicaps, Those at Belper were on a particularly large scale.

"The great weir is a semicircle, built of very substantial masonry, and provided with a pool of water below it, into which the water falls. On one side of the river are three sluices, each 20 feet wide, which are drawn up in floods, and allow the water to pass sideways into the same pool, and on the opposite side is another such sluice, 32 feet wide. The water is retained in the lower pool by some obstruction which is experienced by running beneath the arches of a bridge; but the principal fall of the water is broken by falling into the water of the pool, beneath the great semi-circular weir. The water which is drawn off from the mill-dam above the weir passes

(31) Bentham J. "Introduction to Principles of Morals and Legislation".

through 3 sluices, 20 feet wide each, and is then distributed by different channels to the mills, which are situated at the side of the river, and quite secure from all floods.(32)

The water rights for these mills were jealously guarded. In 1789 JEDEDIAH STRUTT, fearing that the proposed Cromford Canal would interfere with the level of water in the Derwent, joined with the EARL OF HARRINGTON, the mayor and the burgesses of the borough of Derby and THOMAS EVANS another millowner, in an unsuccessful petition to the House of Commons against the passing of the Cromford Canal Bill.

"I thought it necessary to go to my father to talk with him about Belper weir. He thinks if the Bill is likely to pass such a clause should be introduced as will impower all the owners of weirs to raise them at particular seasons, making compensation for the injury that may be done and that this compensation the proprietors of the canal should defray.

My father is quite angry at the stupidity of LORD STANHOPE about the horizontal wheels. He thinks somebody should contradict his argument and urge the failure of horizontal windmills as a reason sufficient to demonstrate the absurdity of such a scheme. Besides the works on the river are of too much consequence to run the risk of untried schemes - the experiment should be made and approved before any reasoning can be made of it".(33)

(32) Rees A. : op cit. Article of Water

(33) A memoir of Wm. Strutt. Letter of Joseph Strutt to his brother William.

It can be seen that the STRUTTS - JEDEDIAH and WILLIAM were able to make a unique contribution to the development of mill design, most notably in their efforts to make their mills as fireproof as possible. In a sense this account has been artificial in that no mention has been made yet of ARKWRIGHT, whose partnership with JEDEDIAH STRUTT was to result in the Cromford Mill and many others after that. This will be dealt with in Chapter Four. The social conditions within the mills will be dealt with in Chapter Six.

Chapter Four

RICHARD ARKWRIGHT

"ARKWRIGHT'S name is one of the few which from the beginning shone like stars in the twilight which has long surrounded so many of the events and personalities of economic history. In him tradition sees not only the prototype of the great manufacturer, made rich by his own toil and his own inventions, but the true founder of the modern factory system. About 1830 he became the hero of political economy and even literature did not despise him. CARLYLE has sketched a vivid picture of this 'plain, almost gross, bag cheeked, pot bellied Lancashire man, with an air of painful reflection, yet also of copious free digestion ..... O reader, what a historical phenomenon is that bag cheeked, pot bellied, much enduring, much inventing 'barber'! French Revolutions were a-brewing: to resist the same in any measure imperial Kaisers were impotent without the cotton and cloth of England; and it was this man that had to give England the power of cotton' "(1)

ARKWRIGHT was born at Preston on December 23 1732, and his rise to fame and wealth is a well-known if poorly documented story. It will serve our purpose if it is but briefly noted here. He was the youngest (the thirteenth) of a large and poor family, and was apprenticed to a barber and wig-maker whilst still young. In 1750 he set up in Bolton as a barber and showed an early propensity for cut-price barbering. He soon saw that

(1) Mantoux P. op cit. P.220 quotation from Carlyle's 'Chartism' Chapter 8

there was a need for wigs whose colours not being natural, would still be permanent. He is therefore credited with the discovery of a "valuable" chemical process for dyeing hair and as a result became fairly prosperous.(2)

Whilst travelling around Lancashire in order to buy the hair of country girls, he heard of the shortage of cotton weft and of the efforts to make a spinning machine to spin faster.

The cotton workers were working in their own cottages and ARKWRIGHT'S job was to visit these cottages to buy hair. He would see and hear of the cotton workers' troubles; the weavers idle and the need for a faster method of spinning. All this is clear enough. But as soon as ARKWRIGHT becomes involved in trying to devise such a machine himself the whole picture becomes doubtful and confused. He would have heard of the machine invented by JOHN WYATT in 1733 and improved by LEWIS PAUL, for spinning by rollers. These two men working in Birmingham had met with little success and had therefore allowed the patent to lapse. Using this as a basis, ARKWRIGHT began experiments of his own. But shortly before a THOMAS HIGHS had begun in his own village of Leigh in conjunction with a clock-maker JOHN KAY of Warrington, to build a roller spinning machine. In the famous trial later HIGHS declared this to be in 1767.(3) In 1768 ARKWRIGHT managed to obtain the services of KAY to help him construct his own roller spinning machine, and it would be

(2) Crabtree J.H : Richard Arkwright p.14
see also McCulloch : "Memoir of Sr.R. Arkwright"
7th edition of Encyclopaedia Britannica; and
Mantoux p. op cit. pp. 220-234

(3) Mantoux P. op. cit. p.228

impossible to imagine that ARKWRIGHT did not know of HIGHS' activities or indeed be familiar with the technical intricacies since KAY would very probably incorporate many of them as he constructed ARKWRIGHT'S machine. In addition ARKWRIGHT'S second wife came from Leigh.(4) We have therefore, a great deal of circumstantial evidence to conclude that ARKWRIGHT'S invention was not original. There is however, much dispute over this point. McCULLOCH (5) maintains that since no-one contested ARKWRIGHT'S 1769 patent until 1781, twelve years later and six years after the second patent, it cannot be held that ARKWRIGHT pirated the invention, since otherwise he would have been contested from the first. MANTOUX thinks this not surprising when we bear in mind the character of THOMAS HIGHS, who he claims was a born inventor, "a simple uneducated mechanic, working by instinct, at home only in his workshop, and knowing nothing of business." But MANTOUX'S source of reference is GUEST who at one point ascribes the spinning jenny also to HIGHS which makes him a rather suspect reference.(6)

However, MANTOUX'S lucid and rational account is persuasive and perhaps nearest the truth, particularly when ARKWRIGHT'S character becomes more clearly delineated. Solid doubt over ARKWRIGHT'S claim to have invented a roller spinning machine must remain.

ARKWRIGHT and KAY secretly began the construction of such

(4) Guest R : "The British cotton Manufacturers" p.18
(5) ibid., op cit.
(6) Mantoux P. op cit. p.230

a machine aided financially by a publican and house painter called JOHN SMALLEY. This machine was made in 1768 in a room adjoining the Free Grammar School at Preston. The next year ARKWRIGHT took out a patent valid for fourteen years. The original model of the machine is preserved in the Science Museum at South Kensington. "As far as we can judge it is very like the machine invented in 1733 by JOHN WYATT and improved by LEWIS PAUL. A wheel sets in motion four pairs of rollers of increasing rapidity of rotation. The top cylinder of each pair is covered with leather, whilst the lower one is ribbed or grooved lengthwise. After it has gone through the rollers whose progressive acceleration stretches it more and more, the thread is twisted and wound on vertical spindles. Generally speaking, this machine differs from that of WYATT only in its details. These trifling differences cannot explain ARKWRIGHT'S triumphal success in a line where more ingenious men than he had been hopeless failures. His success was due to his business capacity, of which he gave proof almost at once."(7)

He had realized the possibilities of mass-production and he had the will to let nothing stand in his way to achieve his ambition even his own fairly prosperous barber's shop. This he sacrificed to the invention. His overwhelming need was capital, but he needed also surety that his machine could produce without the fear that it might be destroyed. Spurred by the destruction of HARGREAVE'S Jenny by an enraged mob, he moved to Nottingham,

(7) Mantoux. P. op cit. pp.222-3

where he rented rooms in a suburb called Hockley. SMALLEY'S enterprise had left him - faced with mounting bills he withdrew from association with ARKWRIGHT, who turned them to the local bank of WRIGHT BROTHERS who supported him for a year, but then by the end 1770, realizing that ARKWRIGHT was not producing enough profit to warrant their support, they withdrew. They did, however, put ARKWRIGHT in touch with SAMUEL NEED, a stocking weaver and JEDEDIAH STRUTT. There is some doubt as to the exact sequence of events here, the partnership can be said to have begun somewhere in the years 1770 and 1771. A second patent was taken out and the decision taken to develop the invention on a larger scale. The Nottingham mill was hardly larger than that established by PAUL and WYATT in Birmingham, 30 years before. The machines were driven by horse-power - the patent specification of 1769 had been limited to this - but it was an expensive and inefficient means of power. His 'engines' were driven by horses harnessed to a gin wheel which was a kind of windlass or crane fitted onto a vertical shaft. A driving belt passed from the great wheel to the spindles. The horses were harnessed and walked slowly round in a circle, each circuit turning the spindles 30 to 50 revolutions.(8)

The decision to go to Cromford and apply water power to machinery still far from perfect was one of the turning points in the history of the factory system. The use of water as motive power must have been obvious. STRUTT was a silk manufacturer and familiar from his youth with LOMBE'S famous Derby Silk mill

(8) Boswell-Taylor : Arkwright (They served Mankind series).

which in the sixties was being copied in other places.[9] The idea of a factory system based on water power was in the air, although we must recognize the daring of the experiment. NEED and STRUTT had to be prepared to risk a good deal of capital in backing ARKWRIGHT'S invention and creating his factory community.

To the present day eye it seems strange that, in a country so full of strongly flowing streams, the partners should have hit on so remote a place as Cromford. It had no communication by water, and only poor links by road with ports through which its raw material came and the selling points for its product. It was over fourteen miles from Derby, twenty-six from Nottingham and nearly forty-five from Manchester. BURDETT'S fine county map of 1762-7 [10] shows how different the country round Cromford appeared from what it does today. The turnpike from the North of England to Derby and London, ran some miles away on the east - through Brassington - and is now a mere by-road. The direct route between Cromford and Derby ran over the moorlands : the valley road, now A.6, did not exist until 1820. The uplands were unenclosed moor and the roads near Cromford were unturnpiked. But its remoteness was a distinct advantage in the eyes of the partners. ARKWRIGHT was fully aware of the dangers of mob violence, and he may well have been influenced by this fear when building Cromford.

(9) Wadsworth and Mann :"The Cotton Trade and Industrial Lancashire 1600 - 1780" p.305

(10) Derby Museum : a revised version 1789 can be found as a frontespiece to Pilkington op.cit Vol. 1.

The planning of the mills shows this. The group of buildings were arranged in the shape of a pentagon, enclosing a courtyard which only had one entrance from the road on the South side; whilst the buildings at the rear were built into a rocky bank which descends steeply on the other side to the River Derwent. In the courtyard was a small building which could be used as a blockhouse to guard the entrance gates directly opposite, There were no windows in the outside walls to the ground floor or the first floor, the lowest windows being on the second floor about twenty-five feet above ground level. It was in fact more like a fortress than a factory.(11)

The water for the Cromford mill came from a stream, reputedly never frozen, which issued from the lead mines, and joined the Derwent near Cromford bridge. DAVIES(12) describes the stream as warm, but FAREY was sceptical. "It seems more natural to refer the circumstance (of its not freezing) as far as it is true, to the great depth and narrowness of the valleys, preserving the temperature longer than in more open situations.(13 The Mill was built at its confluence. There was no pre-existing village of any size and, one would suppose, no labour force ready to hand except what could be gathered from the neighbouring countryside or imported. A village had to be built, the first of the cotton factory villages which were to change the Northern landscape in the next hundred years.

(11) Shepherd op cit. Chapter 1
(12) Davies op. cit. p.91
(13) Farey J. : "General View of the Agriculature of Derbyshire" (1811) Vol.1 p.487

The first contemporary reference to Cromford is in the 'Derby Mercury' of December 13, 1771. The partners advertised for clockmakers and a Smith, and offering employment to weavers and to women and children. The labour force was being collected. It reads :

"Cotton Mill, Cromford, 10th December 1771.
Wanted immediately, two journeymen, clockmakers, or others that understands Tooth and Pinion well: Also a Smith that can forge and file - Likewise 2 woodturners that have been accustomed to wheelmaking, spole turning, etc. Weavers residing at the mill may have good work. There is employment at the above place for women, children, etc and good wages.

N.B. a quantity of box wood is wanted. Any person whom the above may suit will be treated with by Messrs. Arkwright and Co. at the Mill, or Mr. Strutt in Derby."

Shortly after ARKWRIGHT wrote to STRUTT giving him a progress report on the Cromford developments which gives us something of the spirit of the experimental period.

"Cromford Marh. 2d 72

Sir,

Yours yisterday came to hand together with a bill from Mr.Need value 60 lb. I have sent a little cotton spun on the one spindle, and find no difficulty in geting it from the bobbin and Dubeld and Twistd in the maner you see it at one operation. One hand I think will do 40 or 50 lb of it in one day from the bobins it is spun upon, that is in the new whay. I am sertain of it ansuaring and

one person will spin a Thousand Hanks a Day so that wee shall not want 1/5 of the hands I first expected nothwithstanding the Roaveing takeing so few. I see Great Improvements every day, when I rote to you last had not thorowly provd the spining; several things apering I could not acount for sinse then has proved it - I have made made trial to twist it for Velverets and what they do with five operations I can do with one that is duble and twist it redey for wharping at one time, first they reel, second wind, third duble, fourth twist, 5 wind redey to wharp, and all these done one thread at a time except twisting. Shold like you to try a little of this hard in a ribd fraim; I think it shold not be whet but beate. Plais to send the solfte to Mr. Need. One has a slacker throw then the other, naither of them perfect, but shold like see a stocking or part of one, pray bring a little with you. Mr. Need spakes of wanting Thos. Bell and a turner but cant see what they whant Thos. for. I spok to Coniah and dar say he willcom if he was properly aployd to or they might get a man from Hibisons but there is no person at the mill that will pyt themselves out of their whay to be of aney servis except teas Mr. Needs hart out with a continual want and uneasiness. As to sending aney hand from hear I cant think of doing, for where they get a shilling cleair there shall in a few months 40, I am posative. If Mr. Need thinks best can go one or two days pr. wheek to Nottingham and shall Shortly suply them with Roaveings from near if wee cant 2000 hanks a day which I am sertain I can in four months at the outside, and now as solfter can be spun faster than hand, stocking yarn will ansuar best and will be dubled with very little expence - At the mill they whant cards

puting on Andrew might do that as it required no greate judgement, but I supose he is a deal taken up in those looms and the profits of wich will scairsly pay whare house room. If he can be got to wheave by the Pees or yard and out of the mill shold sune set that plase in better order but while he is in it is scairsly posable except he has his own whay no good will be don with justis or him, and what I sade to George is what I shold say again it whas unraisenable. In a few weeks shall move for wee can do without them all. It is onley seting an other pair of cards etc, hear wee have begun of them. Shold like to know if aney acount is come from Hallifax lately; He has sent som other cards but not the quantety I rote for and no Letter or bill with them. Shold Rite to Mr. N. but has not time and wold when I do send to send some twe threds solft and as even as silk. I am sertain I can make the first fraim, I have hands to make three frames in a fortnet. I shall be done you may depend upon it, but I whant somebody to look after the spining etc. I have rote to Kay yesterday; if he will not com can you think of somebody. A younge man was hear this wheek sade he had spoke to you; this is his riteing I send enclosed. What do you think of him, he seemes a likely person but has all to lern. I am afraide no man will know all that I shold expect they might. Richd has hit upon a method to spin woostid with Roulers, it is quite sertain and only altering shape - that is Round on one side and flat on the other so that the twist gets under or betwixt them at a sertain time. It will ansuar I am sertain. Querey, will not cotton make whipcord as good as silk, properly twisted. It may be don all at onst from the bobins. Pray rite to Mr. N. what he

thinks best. I cant think of stoping this concern near as that at Nottingham is not nor ever will be aney thing in comparison to this. There is hands to be got there and if he wold have mee com over I shall, but not take aney from hear. I asked Mr.Whard to get me some let pipes to bring the water into the mills; They are coninually fetching. It might be Brought in the Rooms. Wold it not be best to fix a crank to one of the lying shafts to work a pump or Ingon in case of fire. Bring the belts with you. Desire Ward to send those other hooks and allso some sorts of Hangins for the sashes he and you may think best and some good latches and catches for the out doors and a few for the inner ons also and a large knoker or a Bell to First door. I am Determined for the feuter to get no persons in to look at the works except spining. The man Mr.Whard Bot the Ash board from, calld for his money and says he will send the other shortly. I am tired with riteing so long a letter and think you can scairsley reed it. Excuse haist. and am hours etc. R.Arkwright."(14)

Behind the erratic spelling and grammar, ARKWRIGHT'S enthusiasm and confidence in the venture is apparent. Although his claim to be an original inventor may be doubted, there can be little doubt that as an 'improver' he was of the highest calibre. The letter shows that his special skill was organization; to organize his machines in such a way as to cut his labour costs and yet achieve a large increase in productivity. For this he had the skill of finding labour saving methods which clearly comes through in the letter. He see 'Great Improvements every Day' but not only in the narrow field of cotton spinning. His mind is brimming with ideas about the use of his yarn, even though his production methods

(14) Facsimile of the original can be seen in Birmingham Public Library

were still far from perfect. Ideas not only in hosiery, but in the whole range of cotton fabrics, from calicoes to fustians, and he looked forward to worsted.

Particularly interesting is the insight the letter gives into ARKWRIGHT'S entrepreneurial abilities. Basically he is very optimistic as to the future of the Cromford enterprise : 'I cant think of stoping this Concern hear as that at Nottingham is not nor ever will be aney thing in comparison to this...' His ability to 'think big' was the essential factor behind the rapid growth of his interests. But there is also a hard determination to let nothing prevent Cromford from making the impact he thinks it should. Hence he will not consider allowing any of his own labour force to be transferred to NEED at Nottingham. There is in this letter a peremptory tone towards NEED who seems to be the sceptical partner who was content rather to concentrate on making a success of the Nottingham mill rather than to dissipate energies at Cromford, which at that stage must have been more of an experimental machine shop than a properly equipped spinning factory. And NEED was supplying the money.

ARKWRIGHT has no doubts that the productivity of the Cromford mill will allow for high wages '... for where they get a shiling cleair there shall in a few months 40, I am posative'. Wages were in fact high at Cromford,† but ARKWRIGHT was fully aware of the need for incentives in production.†

The letter is full not only of grand visions of what

† see Chapter 6
† see Chapter 6

Cromford will shortly be doing, but also a domineering will, which, allied with clear objectives leads ARKWRIGHT to peremptory requests. 'Wold it not be best to fix a crank to one of the lying shafts to work a pump or ingon in case of fire. Bring the belts with you. Desire Ward to send those other locks...'. Tempting visions there were, but ARKWRIGHT'S grasp of the detailed needs of his works is impressive.

Clearly ARKWRIGHT is the controller of affairs at Cromford: 'I am afraide no man will know all that I shold expect they might.' Although dependent on NEED and STRUTT for capital, and to a certain extent for technical knowledge, ARKWRIGHT is the one who manipulates his factors of production to his best advantage and provides the driving force behind the concern. It was to remain so. To judge by his incessant travelling in later life to and from his factories, and indeed, by what we understand of his character, he was hardly the kind of person who would delegate responsibility. ARKWRIGHT was no easy man to work for.[8] This fits in with the development of all the early textiles factories. Although they were often founded by partnerships, it was usually one man who took upon himself the planning of the enterprise and provided the driving force behind it. He was not only a planner but a production engineer in a rudimentary millwright form and directed the small day to day occurrences in his mill as well.

A great number of poorlpeople were attracted to Cromford in view of the good wages offered - better than it was possible

[8] see Chapter 5

to earn in domestic industries. Shortage of labour does not appear among the initial difficulties at cromford[15]. The machinery seemed to claim most attention from the partners who strove to improve it in details and obtain a large output with as little hand labour as was possible. Among the spinning frames trouble arose from the cotton rovings "licking" the top, leather covered draught rollers. The bottom rollers being of wood and fluted were unaffected; the cotton should have come between these rollers without wrapping its fibres around the top series.[16]

JEDEDIAH STRUTT had a simple remedy - he rubbed the leather rollers with chalk or whitening, and the trouble ceased.

The partners next tackled the carding engine which prepared the cotton for treatment in the roving and spinning frames. The machine possessed several defects which appeared capable of amendment, and ARKWRIGHT devoted a great deal of time to these until he had found remedies. His ambition was to patent the whole spinning process including older inventions than his own. Thus in 1775 ARKWRIGHT took out his second patent, the very long and obscure text of which was to give rise to endless difficulties. It described several distinct inventions of varying importance, and of which some seemed to be described in deliberately obscure language. The most important were the carding machine, the crank and comb, the roving frame, and the feeder. MANTOUX describes these.

(15) Crabtree J.H. op. cit. p.37

(16) Felkin W. "A History of the Machine Wrought Hosiery and Lace Manufacture." (1867) p.90

"The carding machine consisted of three cylinders of different diameters covered with bent metal teeth. The first, with teeth bent in the direction of its revolution caught up the cotton fibres. The second revolving in the same direction but much faster, carded the fibres by contact with the third, whose teeth and motion were in the opposite direction. The crank and comb completed the carding machine, by detaching the carded cotton in such a way that it came off as a continuous sheet. As its name indicates it was a kind of comb fitted to an elbow - shaped joint, which at regular intervals, came into contact with the teeth of the third cylinder and thus disengaged the cotton without tearing it. The roving frame was a machine which turned the ribbon of carded into a cylindrical strand slightly twisted on itself and ready for conversion into thread. Its structure resembled the spinning machine, but it was simpler, and the acceleration between one pair of cylinders and the other was much less. Instead of winding itself off on spindles the cotton went into a revolving cone, which gave it the necessary twist. Finally the feeder was nothing but a band of material in perpetual revolution which carried the raw cotton to the carding machine as it was fed to it by a sloping hose. We venture to go into all these details, at the risk of incurring the cciticism of the experts, in order to show what part machinery already played in the cotton industry. We see that as early as 1775 textile machinery had developed into a system, the interdependent parts of which were able to perform

all the successive operations of the industry, save the last and most difficult, that of weaving."(17)

There can be no doubt that ArkWRIGHT did make certain improvements in the preparatory stages of cotton manufacture. But on the other hand the claims that appeared in the famous law suits which followed the 1775 patent could hardly be complete fabrications. At the trial of 1785 witnesses claimed that the feeder had been invented in 1772 by the Quaker JOHN LEES of Manchester, the crank and comb was HARGREAVES', and the carding machine was almost identical with the one for which DANIEL BOURNE had taken out a patent in 1748. As for the roving frame its cylinders were borrowed from HIGH'S spinning machine, and its conical box revolving on a vertical axis had been used by BENJAMIN BUTLER since 1759.(18)

It is perhaps unlikely that all these developments were pure thefts on ARKWRIGHT'S part. For instance concerning LEE'S feeder apron, CRABTREE (19) maintains that the great difficulty was delivering the cotton from the doffer cylinder. Briefly, loose cotton was spread uniformly on the apron. This was conveyed towards the main cylinder which picked off the cotton, carded the fibres and passed them to the doffer cylinder. The problem of delivering the cotton from this cylinder was an obstinate one for all inventors of carding and combing machinery. After many experiments ARKWRIGHT settled on a rod equal in length to the width of the doffer, with a line

(17) Mantoux C. op. cit. pp.225-6
(18) Mantoux P. op. cit. p.232
(19) ibid. op. cit. p.39

of needle points inserted at close intervals. By connecting a small crank motion with the lateral mechanism of the machine, he obtained a rising and falling movement of this needle comb. What he wanted was to dispense with the human hand in stripping the cotton from the doffer. The comb did this perfectly by taking off the fibres in its downward movement, and leaving them on its upward turn, when the doffer revolved a little further and the comb descended again to repeat the stripping. Thus a continuous roving was assured, the wide curtain of loose cotton being gathered through a funnel into one thick band and deposited in a tin can prepared for it behind the carding machine. Thus CRABTREE claims these to be ARKWRIGHT'S own solutions to the mechanization of the preliminary stages in cotton spinning. On this it would seem certain inferences are possible. On the one hand if indeed these developments were his own, then why did he obscure them in the vague and difficult language of his second patent ? The plea he put forward in 1782 when he addressed a petition to Parliament was that it was couched in vague terms in order to prevent foreigners from profiting by such an inexhausible source of wealth. The truth of this is arguable. Certain it seems that since ARKWRIGHT slipped in several articles relating to real or pretended improvements of the water frame, hoping thus to extend the validity of his first patent (due to expire in 1783); his motives were not altruistic. In effect his two patents of 1769 and 1775 gave him exclusive ownership of the water frame and the accessory inventions, though he could authorize their

use by other persons who had to pay a stipulated royalty.

On the other hand, if ARKWRIGHT was pirating the inventions of others, the obscurity of the patent is explained, and his role seems to be essentially that of an entrepreneur overcoming the production difficulties implicit in the introduction of new machinery and anxious to keep competition to a minimum. His resourcefulness and drive were his great assets in this sort of problem,(20) whilst claims to present him as an inventor are clouded with ambiguities.

ARKWRIGHT'S success is the true standard of his achievement. His claims to be a great inventor are very doubtful though we have seen that as an 'improver' and organizer of the means of production he had great abilities. It was however, plainly absurd to compare him either to NEWTON or to NAPOLEON.+ He was however, the first who knew how to make the most out of machinery, building it up into a system which not only made him very wealthy but provided an example to others. In order to raise the necessary capital for his enterprises he formed and dissolved partnerships in such a way that he maintained his control over the mills, and by doing so showed his remarkable business acumen. In order to set up these large factories, to engage and train the labour force to a new kind of work in a new kind of environment, to enforce the strict discipline necessary in the workshops, he needed an immense amount of energy and organizational ability not often met with. Few other inventors

(20) letter to J.Strutt, quoted above.

+ Ure : The Philosophy of Manufactures pp.16 & 252

had this kind of ability, and without it a new industrial system could never have been created.

The spinning frames reached, under his guidance, such a state of perfection and comparative safety, that children could operate them under supervision of a "tackler", who was to remedy mechanical breakages. The spindles were arranged in sets or systems of four, and so connected with the driving straps that if a thread broke, the set of spindles containing it could be lifted by a hand lever, and stopped until the thread was pieced. Meanwhile all the other parts of the frame could be kept in motion. Any set could be made stationary at once by lifting its lever, and children could quickly become adept at the operation of lifting and piecing.

The Cromford Works did not begin to return profits on their £12,000 investment until 1774 - three years after the establishment of the mill. By this time ARKWRIGHT was able to supply the yarn for the stocking manufacture with ease, and he began to accumulate stocks of yarn which he considered as useful as the linen warps then in use in Lancashire.(21) His productivity advantage over his competitors was enormous. After 1774 he was able to supply every kind of cloth manufactured in Great Britain at very reasonable prices. Rapidly Cromford's position as an appendage of the NEED and STRUTT business, supplying thread for making stockings, changed into a dynamic business in its own right.

(21) Smelser N.J. : "Social Change in the Industrial Revolution". p.91

In 1773 ARKWRIGHT and his partners set up weaving workshops in Derby, where for the first time, the manufacture of pure cotton calicoes was undertaken.(22) His profits were very large and he was already becoming one of the richest commoners in England. In 1784 the difference between the price of yarn and the price of raw cotton, giving the sum covering expenses and profits, was 8/11 per pound.(23) Given that ARKWRIGHT was virtual monopolist to 1781 in the mass production of roller spun yarn, his profits over that period must have been enormous, especially when it is realized that he could undercut Lancashire spinners with ease. By 1797 this margin had dropped to 4/2 per pound. By 1812 it was only 1/-.

When he died, ARKWRIGHT left about £500,000, an almost unheard of sum for a commoner.(24) Normally we would expect a gradual levelling off of profits. ARKWRIGHT, himself, however, was careful to prevent this decrease by monopolistic control. Thus he was keen to protect his patent by token improvements.(25) By virtue of such tactics he compelled the Lancashirespinners to submit to his dictation.

"For several years he fixed the price of cotton twist, no-one venturing to vary from his prices."(26)

Following his carding patent, 1775, ARKWRIGHT confidently began to expand his concern. The partnership with STRUTT was

(22) Mantoux P. op. cit. p.224
(23) Smelser N.J. : op.cit. p.92 (footnote)
(24) Mantoux P. op. cit. p.238
(25) Smelser N.J. : op.cit. p.92
(26) ibid. op. cit. p.92

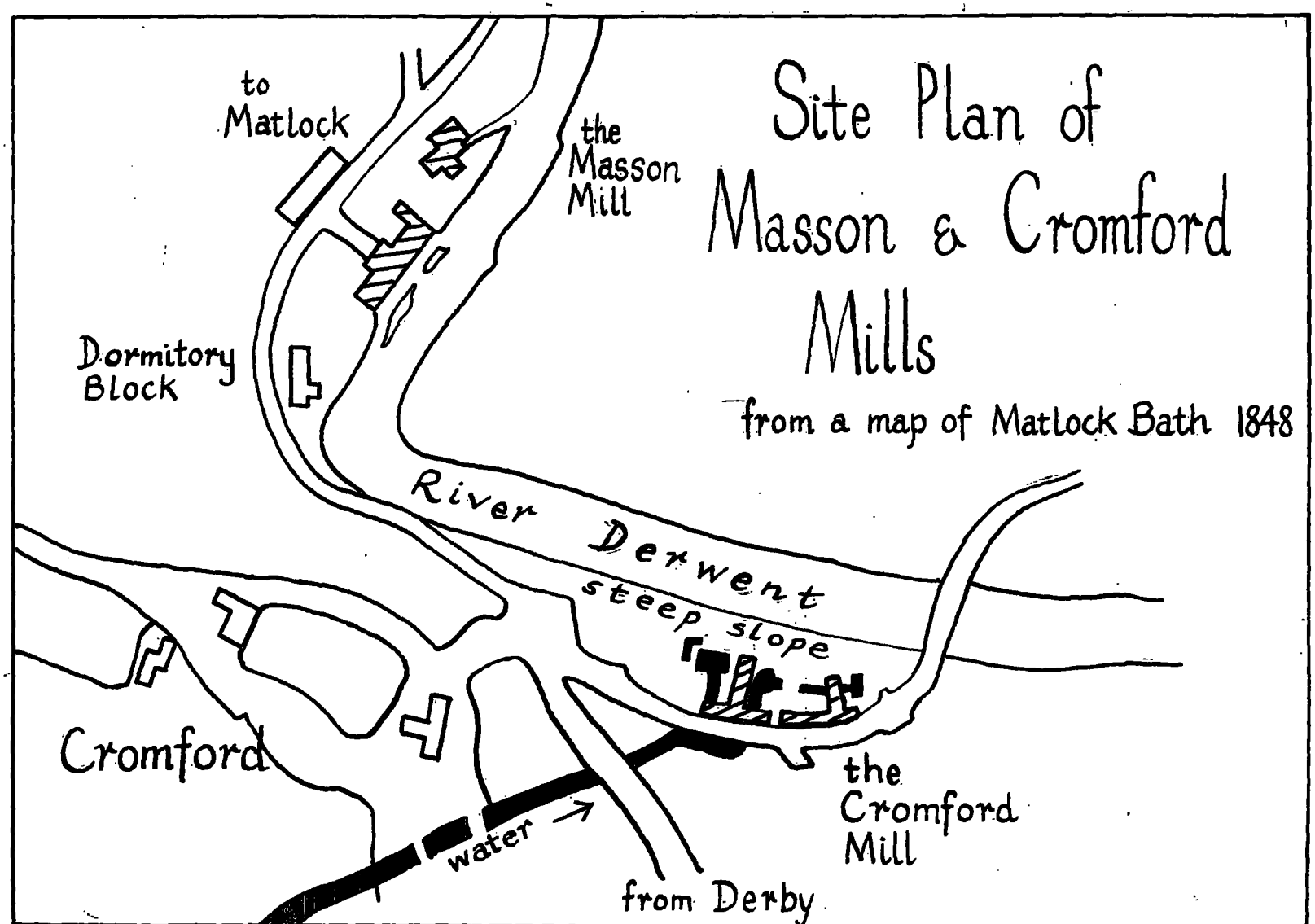
weakening. In 1774 JEDEDIAH'S wife had died whilst he was in London awaiting Parliamentary action concerning the Calico Act. STRUTT became ill, and he did not begin to recover his health until March 1775.(27) In the meantime ARKWRIGHT had gone ahead with his patent, and there is no mention of STRUTT in the various stages of the patent or in any of the trials.(28) ARKWRIGHT was a domineering, self-sufficient man, and in his relations with his partners he was not easy. Rich and confident, his impecunious days in Nottingham were forgotten. On July 2 1775 STRUTT'S elder daughter, then 16, writes to him in London :

"Mr. ARKWRIGHT came here on Wednesday night and brought his daughter a very pretty letter from her brother and - would you think it - a very elegant little watch whitch he bought for her at Manchester - on thursday morning they sett off from here to Birmingham my sister and Miss Arkwright in genteel riding dresses and provided with pen and ink and memorandum books that they may see, which writes the best journal. They seemd very happy and I hope they will have a deal of pleasure. They talk'd of going to France and the whole town believes they are gone there, but everybody thinks they will not like it. I suppose you will see them before you receive this."(29)

Thus we gain a glimpse of new-found prosperity.

In 1776 extensions were made to Cromford, which was the same period when STRUTT began to build in Belper.(30) The following year 1777, ARKWRIGHT began his factory at Birkacre, near

(27) Fitton and Wadsworth op. cit. p.76
(28) ibid. op. cit. p.76
(29) ibid. op. cit.p.77
(30) See Chapter 3


Site Plan of
Masson & Cromford
Mills
from a map of Matlock Bath 1848
to
Matlock
the
Masson
Mill
Dormitory
Block
River Derwent
steep slope
Cromford
the
Cromford
Mill
water
from Derby

Chorley; still however, in conjunction with the partners STRUTT and NEED. It was his first mill outside Derbyshire and Nottinghamshire, and it received the special attention of the rioters against machinery in 1779. The fear of this riot was such that ARKWRIGHT placed Cromford in a state of seige. A letter appearing in the 'Derby Mercury'(31) describes his preparations :

"In your last you expressed some fear of the mob coming to destroy the works at Cromford, but they are well prepared to receive them should they come there. All the Gentlemen in this Neighbourhood being determined to support MR. ARKWRIGHT, in defence of his Works, which have been of such utility to this Country, Fifteen hundred Stand of small arms are already collected from Derby and the Neighbouring Towns, and a great Battery of Cannon raised of 9 and 12 pounders, with great plenty of Powder and Grapeshot, besides which upwards of 500 spears are fixt in Poles of between 2 and 3 yards long. The spears and Battery are always to be kept in Repair for the Defence of the Works and Protection of the Village, and 5 or 6,000 men, miners etc can at any time be assembled in less than an Hour by signals agreed upon, who are determined to defend to the very last Extremity, the Works, by which many Hundreds of their Wives and Children get a decemt and confortable livelihood."

No-one molested the building though BIRKACRE was effectively destroyed.

(31) October 22 1779

In November 1777 ARKWRIGHT made enquiries of BOULTON and WATT for a steam engine to raise water for the water wheel. No order followed, but in 1780 when there were two mills at Cromford, the supply of water from Cromford Slough being probably inadequate, ARKWRIGHT did buy an 8 horse power engine.

He further expanded when he built another mill at Wirksworth which is briefly noted in PILKINGTON :

"For carrying on the latter branch of manufacture a mill has been erected by SIR RICHARD ARKWRIGHT, from which nearly two hundred persons derive their support."(32)

He began building a large mill in Manchester completed in 1780, the buildings alone of which could hold 600 workmen and according to the usually reliable PILKINGTON, cost over £4,000. This was followed by factories at Bakewell and Matlock. Of Bakewell PILKINGTON notes : (1789)

"A few years ago a machine for spinning cotton was erected here by SIR RICHARD ARKWRIGHT, which affords employment to about three hundred hands. He has given it to his son, who resides in a house adjoining to the works."(33)

Of Matlock he says :

"It is a very large handsome building - The erection of this work and other improvements of art have considerably injured the natural beauty of the dale. Those, who are pleased with viewing picturesque scenes will wish, that they could have been conveniently placed in any other situation."(34)

(32) ibid. op. cit. Vol. 2 p.300
(33) ibid. op. cit. Vol. 2 p.416
(34) ibid. op. cit. Vol. 2 p.312

In the full flood of cotton's rapid expansion after 1779, ARKWRIGHT kept pace. At the end of 1783 he was financing SAMUEL OLDKNOW in his newly started muslin manufacture - a loan of £3,000 at 5 per cent[35] - and in 1784 his Scottish projects in partnership with DAVID DALE were beginning. The capital he needed for such projects was beyond the scope of NEED and STRUTT. He, however, was able to find other partners, and skilfully limited their rights. "He along was present everywhere, took part in every concern, and in fact, managed them all."[36] In spite of the difficulties of the famous trial defending his patents, in 1784 the New Lanark Mills were opened, and he converted the old Nottingham Mill to steampower.

Cromford remained his headquarters. He built his castle not far from his works. He had bought most of the land round Cromford including the manor. He spent £3,000 in clearing away a huge rock from the site of the house, roads had to be blasted, gardens laid out, trees planted, and a prospect designed.[37] JEDEDIAH was less ambitious, and was no lover of the new gothic architecture. He built his house at Milford in the main street, a neat and dignified building.

Contemporary judgements on ARKWRIGHT were not inclined to be favourable. He was admired for his achievement both as the architect of a great personal fortune and as one who opened up new riches for the country (though Parliament was much less

(35) Unwin G : "Samuel Oldknow and the Arkwrights". pp. 16 - 17

(36) Mantoux P. op. cit. pp. 226-7

(37) Britton and Brayley op. cit. pp. 517, 521-2

helpful to him than it was to BOULTON AND WATT), but he was feared for his aims. He boasted that he would pay off the national debt, and he is credited with the idea of buying up all the cotton in the world in order to make an enormous profit by the monopoly. Many people thought that when asthma cut short his life at the age of 59 in 1792, that this was none too soon. His Knighthood was given when he presented a loyal address to George III on the King's escape from assassination. ARKWRIGHT was then High Sheriff of Derbyshire - a post he performed with elan and ostentation.

"His name will always be associated with the beginnings of the modern factory system. At the end of the eighteenth century all the factories in Lancashire and Derbyshire were built in imitation of his establishments. 'We all looked up to him," said SIR ROBERT PEEL. He knew it, and seemed deliberately to try and lead the way in hard work and limitless ambition. He worked ceaselessly all day and often part of the night. He had to travel constantly in order to supervise his many factories, and worked on the road in his post chaise, drawn by four horses, which were always driven at top speed." (38)

(38) Mantoux P. op. cit. p.234

CHAPTER FIVE

THE GROWTH FACTORS

Chapter Four has dealt with RICHARD ARKWRIGHT and the establishment of the Cromford Mill. We have seen that once the experimental stage was over the mill, under its owner's astute direction, soon became extremely profitable and led to the establishment of further mills both in and out of Derbyshire. The growth of this business in so rapid a manner was a result of the coincidence of many factors - prosperity in the cotton trade generally, removal of trade restrictions, monopolistic practices bringing high profits, and a sufficient supply of capital. These factors are of great interest in exploring the growth and development of the textile industry during the last quarter of the Eighteenth Century, and from this point of view Derbyshire offers in the partnership of STRUTT and ARKWRIGHT, an outstanding example.

The first problem that the partnership turned to concerned their position under the law. An act of 1720 prohibited the "use or wear in Great Britain of any printed, painted, stained or dyed calico". It also banned the use of any printed or dyed material consisting wholly or partly of cotton. Hence goods made of linen weft and cotton warp could not be used if printed or dyed. Calicoes dyed blue, muslins, and fustians were exempted from the Act, which fortunately was not strictly enforced. The "Manchester Act" of 1736 made it legal to wear or use "any sort of stuff made of linen yarn and cotton wool,

manufactured, printed, or painted with any colour within the Kingdom of Great Britain provided that the warp thereof be entirely of linen yarn.(1) Thus fustian manufacture was permitted, though the prohibition on pure cotton goods was not lifted. The cotton industry had thus secured a relaxation for goods of flax warp and cotton weft, a relaxation which by custom (or subterfuge) came to cover the great bulk of the industry's production, and even it is probable the growing part of it that used hand spun cotton twist for warps. Technically, however, from 1736 only half cotton material was free to be made (subject to the threepence a yard excise over and above a previous threepence a yard duty by an old Act of Parliament.(2)

The machine-spun twist from ARKWRIGHT'S patent machines was now entering the calico printing trade and was meeting with trouble from the excise men. In Lancashire where, it seems, the letter of the law may have been winked at, the new printed calicoes were allowed through at the threepence per yard duty, but in London they were charged at the proper sixpence per yard. Lancashire in general held aloof from Cromford, preferring to spin their own weft on jennies on which there was no royalty. Convinced however, that the rapid accumulation of yarn could not long be tolerated, ARKWRIGHT and his partners built a factory specifically for calico at Derby. Even by 1773 with Cromford hardly in full production the partners probably had in mind an application for redress by legislation. On Feb. 25, 1774

(1) Crabtree J.H. op. cit. p.51
(2) Wadsworth and Mann. op. cit. Chapters 6 & 7

their petition, from RICHARD ARKWRIGHT and Company of Nottingham Spinners of Cotton and manufacturers of British White Stuffs, was presented to the Commons. It pointed out the varying duties charged and that orders for their goods had been countermanded. It continued;

"..... the Petitioners assure themselves, The said manufacture if not crushed by so heavy a Duty as Sixpence a yard, will rapidly increase, and find new and effectual employment for many Thousand British Poor, and increase the Revenue of this Kingdom, and that it is probable that such warp, made of cotton which is manufactured in this Kingdom will be introduced in the Room of the Warps before used, made of Linen Yarn (great Part of which Linen yarn is imported ready-spun from Foreigh parts) in making Lancashire Cottons, in regard Cotton Goods so made wholly of Cotton will be greatly superior in quality to the present Species of Cotton Goods made with Linen Yarn Warps, and will bleach, print, wash and wear better, and by means thereof, find further Employment for the Poor."(3)

ARKWRIGHT requested that :

"leave might be given to bring in a Bill for ascertaining the rate of duty on the said white cotton stuffs, wholly made of cotton wool, and manufactured within the Kingdom of Great Britain, when printed, painted, stained or dyed at threepence per yard only, and for the free vending, wearing and using by all persons in apparel, household stuff, furniture, or otherwise;

(3) Fitton and Wadsworth op.cit p.70

any sort of the said cotton stuffs."[4]

STRUTT had gone to London to further the petition, which had not been pressed sufficiently and had been allowed to lie on the table; but the bill had its second reading on May 17, its third on June 1, was passed by the Lords without amendment and received the royal assent on June 14.[5] ARKWRIGHT had meanwhile made a proposal to distinguish British from foreign cloth. His suggestion that the cloth was to be woven with three blue threads along each selvedge and to bear the stamp 'British Manufactory' at each end, was embodied in the Act; the penalty for counterfeiting this mark was death.

Later on, ARKWRIGHT, involved in the legal intricacies of prolonging his patent rights, coloured this legislative episode in order to substantiate his claim to be the injured benefactor of his country. He levelled accusations of jealousy at the Lancashire manufacturers who were even obstructive when his firm was engaged in trying to free the industry from the restrictive Acts of 1720 and 1736. MANTOUX points out [6] that small manufacturers indeed, regarded the 1736 Act as a means of ridding the industry of undesirable competition in the form of ARKWRIGHT. But it does not seem that they organized any opposition to the partners' petition; and from that time on cotton was able to develop freely.

(4) Mantoux P. op. cit. p.225
(5) Fitton and Wadsworth op. cit. p.71
(6) ibid. op. cit. p.224

Year	British Calicoes in Yds.	Foreign Calicoes
1775	56,814	2,111,439
1776	103,147	1,783,422
1777	201,253	1,947,570
1778	385,930	1,913,004
1779	656,245	1,342,744
1780	1,143,043	1,071,775
1781	2,318,972	1,194,495
1782	2,635,155	964,897
1783	3,578,590	770,992 (7)

The figures clearly show the effect of this Calico Act on the home industry and its effect on the imports of foreign calicoes.

ARKWRIGHT having, in conjunction with his partners, placed his trade on a sound legal footing, then sought to maximise the benefit to himself of the rapidly growing market for cotton goods, by monopolistic practice. On December 16, 1775 he took out a second patent covering a series of inventions in carding, drawing and roving, claiming to be "the first and sole inventor thereof." (8) As has been indicated, ARKWRIGHT slipped into this highly confusing and controversial patent, 'improvements' to his water frame, hoping that in this way he could extend his first patent, due to expire in 1783, and at the same time 'sew up' the whole spinning process. It was an ambitious move, but one which we can be fairly certain that STRUTT in London mourning the death of his wife, would have had little part in.

But no less anxious than ARKWRIGHT to take advantage of the boom in the cotton trade were a host of small Lancashire

(7) Fitton and Wadsworth op. cit. p.75

(8) Ccabtree J.H. op. cit. p.52

manufacturers who began to erect many factories in that area. Both the water frame and the jenny were dependent on the carding engine, and it was, in spite of the importance of the water frame, the small carding factory preparing cotton for home spinning on jenny or wheel and the small jenny factories, which was the commoner type. It was these that were spreading rapidly over Lancashire and were finding ARKWRIGHT'S carding patents an obstruction to their progress which in many cases they felt obliged to ignore. With their doubling and twisting machines, they were formidable rivals.(9) The infringements of ARKWRIGHT'S patents were probably substantial,(10) but in view of the situation this is hardly surprising. There was the pressure of rapid expansion, and also jealousy of ARKWRIGHT'S position. He had by 1780 between 15 and 20 water frame factories either owned personally or in conjunction with his partners, or proprietors paying him royalties for permission to use his machine.(11) Unfortunately we have little information on the value of these royalties save the statement of a spinners' apologist of 1780, that, the machines when sold were erected "at the rate of £7000 for every 1000 spindles."+ Spinners in Lancashire and elsewhere therefore began to use ARKWRIGHT machines which embodied detailed differences which would then be evading his patent specification. It took some hardihood to stem this tide.

(9) Wadsworth & Mann. op. cit. pp.492-4
(10) Daniels : "The Early English Cotton Industry" p.92
(11) Smelser N.J : op. cit. p.91
+ Fitton and Wadsworth op.cit.p.93

In February 1781, ARKWRIGHT opened his offensive. Three spinners who had infringed his carding patent, submitted. But this only led to organized resistance against ARKWRIGHT by the Lancashire manufacturers who were convinced that he was the tyrant of the cotton trade. In June he launched proceedings against nine, but lost the first case that came to trial in the Court of the King's Bench. It was against a small spinner at Halsall, near Ormskirk, COLONEL MORDAUNT.

The consequence of defeat was that the trade was thrown open; the carding patent had been invalidated; the spinning patent would last only until July 1783. Arkwright then turned to other means. He had before him JAMES WATT'S success in 1775 in securing an extension by a special Act of Parliament of his patent of 1769. ARKWRIGHT believed his patent to be equally as important as WATT'S, and since WATT had been granted a 25 year prolongation of his patent rights, ARKWRIGHT hoped for no less. He therefore presented a case to Parliament pleading as special considerations, his services to mankind in the way of employment and greater production of yarn, the cost of the invention to him, and the wickedness of the Lancashire manufacturers. The petition asked for an act to consolidate his patents and extend the 1769 patent to 1789.

But Parliament did not act on this request. The following year 1783, he made another attempt. The Manchester manufacturers roused its members, a counter petition was organized, and ARKWRIGHT was again defeated.

Although these parliamentary rebuffs may have seemed

critical to ARKWRIGHT'S personal ambitions, to the unprejudiced observer, his business expansion was still rapid. But he remained unappeased. In February 1785 he took up again his claim to the 1775 patent. The defendant this time was his nearest Derbyshire neighbour PETER NIGHTINGALE of Lea, whose factory was less than two miles from Cromford, and with whom he had landed transactions. Aided by JAMES WATT, who no doubt feared that the destruction of ARKWRIGHT'S patent might lead to the same treatment for his, ARKWRIGHT won his case.

Manchester was thrown into turnoil. Immediately a movement crystalized to reverse the verdict on the grounds that the carding patent was insufficiently specified, and that ARKWRIGHT was not the inventor of the spinning machine. After an interesting trial his patents were made public.(12) Insofar as ARKWRIGHT'S claims to the inventions may have been dubious and his specifications inadequate, the Lancashire manufacturers were right to insist that the royalty payments be laid aside; the industry could not grow at the necessary rate whilst ARKWRIGHT controlled prices and supply as he was able to for some time; but on the other hand their reactions to him were often exaggerated and unrealistic. "Certainly the government had not shown ARKWRIGHT the extraordinary favour that it had shown for instance, BOULTON and WATT, the manufacturers of Steam engines, who enjoyed an unchallenged monopoly under patent from 1769 to 1800.(13)

(12) Discussion of pros. and cons. occurs in Mantoux P. pp.229-232

(13) Smelser N.J. : op.cit. p.95

The partnership meanwhile had come under heavy strain and was finally dissolved. The signs of strain had come quite early on whilst Cromford was being established, since there is some reason to believe that ARKWRIGHT was impatient of the cautiousness of NEED. At that time STRUTT was the more enthusiastic partner. But as the Cromford mill became established, and ARKWRIGHT'S ambition to expand, STRUTT being of a less aggressive temperament began to drift apart from his partner.

To pin point the actual dissolution of the partnership is however, more difficult. "On April 14, 1781 SAMUEL NEED died at his lodgings in Bread Street, Cheapside, 'advanced in years and after a very long illness' and 'said to have died immensely rich.' With his death the cotton partnership seems to have come to an end."(14)

The close liaison between STRUTT and ARKWRIGHT had been broken in 1774 when Mrs. Strutt had died and JEDEDIAH fell so ill that he did not return from London where he had been waiting on Parliament until late autumn. By this time ARKWRIGHT had prepared his 1775 patent which was finally sealed on December 16 1775. In it there is no mention of STRUTT, and there was no mention of him in any of the later trials. Since STRUTT'S mechanical ability was of a very high order, and since he had been closely connected with the early experimental years of Cromford, we can only assume that the partnership was by this time more or less broken. ARKWRIGHT'S rapid expansion and his

(14) Fitton and Wadsworth : op.cit. p.81

bitter war against the rest of the trade did not concur with the views of the upright non-conformist JEDEDIAH, who wrote for his own epitaph, though it never became inscribed :

"Here rests in Peace Jed. S - who without Fortune, Family or friends raised to himself a fortune, family and Name in the World - without having wit had a good share of plain Common Sense - Without much genius enjoyed the more substantial blessing of a Sound understanding - With but little personal pride despised a mean or base action - With no ostentation for Religious tenets and Ceremonies he led a life of honesty and Virtue - and not knowing what would befall him after death, he dyed resigned in full confidence that if there be a future State of retribution it will be to reward the Virtuous and the good.

This I think is my true Character.

J. Strutt." (15)

A letter of 1773 written by STRUTT probably to JOHN SMALLEY, ARKWRIGHT'S manager and a partner at Cromford, is of interest :

"Read yours and am sorry to find matters betwixt you and Mr. Arkwright are come to such extremities. (It is directly contrary to my disposition) and wonder he shoud persist in giving you fresh provocations. I said what I coud to persuade him to oblige you in any thing that that was reasonable and to endeavour to live on good terms at least and my wife has said a great deal to him (and what can I do more I cannot stop his mouth nor is it in my power to convince him) nor when I come to

(15) ibid. op. cit. p.108

consider the matter seriously and the circumstances I am at a loss to think what we can do about it, you must be sensible when some sort of people set themselves to be perverse it is very difficult to prevent them being so. We cannot (stop his mouth or prevent his doing wrong) prevent him saying ill-natured things nor can we regulate his actions, neither do I see that it is in our power to remove him otherwise than by his own consent for he is in possession and as much right there as we. Nay further suppose we was to discharge the Man that has been the occasion of all this he may say he shall not be discharged and if they two agree what could we do to pretend to that by compulsion that we ..... (unfinished) (16)

There is obviously here a certain impatience of ARKWRIGHT'S domineering ruthlessness. In spite of all this, there was no personal breach. The two families, ARKWRIGHT'S at Cromford, STRUTT'S at Milford and Derby, continued on close terms, and their children, who had grown up together, remained in the friendliest association.

The association between these two men had brought about a veritable revolution in the structure of trade and industry in Derby during the latter half of the eighteenth century.

SUMMARY OF TRADE AND INDUSTRY
IN DERBY ABOUT 1800

Factories :	Firms	No. of factories
Textiles	9	39
Food	4	40
Metal	8	12

(16) ibid. op. cit. pp.75-6. The words in brackets are crossed out.

Factories :	Firms	No. of factories
Chemical	5	7
Clay	4	2
Stone	2	8
Miscellaneous	1	2
	33	110

Handicrafts :	Firms	No. of men
Leather	7	118
Textiles	7	233
Wood	10	38
Metal	9	53
Stone	1	7
Miscellaneous	4	9
	38	458

Retail ::	Firms	No. of Men
Food	7	109
Drink	2	137
Clothing	9	85
House Goods	8	42
	26	373

Wholesale :	Firms	No. employed
Textiles	3	5
Wood	1	3
Food	3	26
Metal	3	4
	10	38

BUILDING	8	81	
TRANSPORT	1	8	
FINANCE	7	35	
PROFESSIONAL	12	131	(17)

(17) Richardson W.A. : op.cit. p.164

Thus the most outstanding characteristic since 1693 (18) is the great development of factories, now numbering over a hundred, and employing twice as many people as all other groups - silk throwing alone needing 1,500 hands. The factory trades created new occupations. Cotton spinning needed wood bobbins, hence wood turning, and employed 200 women picking raw cotton. The canals called for warfingers who handled the goods brought by barge, and caused a barge builder to set up.(19)

The STRUTTS and the ARKWRIGHTS had this great impact on Derbyshire's economy because of the period of rapid expansion in the cotton industry to which they themselves contributed no mean share. The expansion was at such feverish pace that its like had never been known or repeated since. One likely cause of this is that the Lancashire manufacturers, after their long but finally successful war with ARKWRIGHT, had developed an exaggerated awareness of opportunities for expansion and consequently pushed the development of the new factory system faster than would have been expected. Whatever the causes, " capital and labour rushed to this manufacture in a torrent ... all classes of workmen in this trade received extravagantly high wages; such as were necessary to draw from other trades the amount of labour for which the cotton trade offered profitable employment."(20)

The cotton trade had been fluctuating and then expanding before this.

(18) See table Chapter 1.

(19) Richardson W.A. op.cit. p.165

(20) Baines E : "History of the Cotton Manufacture in Great Britain " (1835) p.214

COTTON IMPORTS FROM 1701 TO 1764
IN SELECTED YEARS IN POUNDS.(lbs)

1701	1,985,868	
1701 - 5	1,170,881	
1710	715,008	
1720	1,972,805	
1730	1,545,472	
1741	1,645,031	
1751	2,976,610	
1764	3,870,392	(21)

These figures only approximate the level of output, for during the eighteenth century there were no measures of stored raw cotton and other working capital (which were no doubt significant, given the long distances and slow transportation). The figures are representative in a sense, however.

The widening of the foreign market for British goods in the eighteenth century led to a gradual increase of exports before 1750 and their rapid growth after that date, as shown by the following table. Domestic demand was rising though perhaps less dramatically.

EXPORTS OF COTTON PIECE GOODS EVERY
TEN YEARS 1699 - 1769 in (£)

1699	13,138	
1709	5,182	
1719	7,853	
1729	9,605	
1739	14,324	
1750	19,667	
1759	109,358	
1769	211,606	(22)

(21) Baines E : op.cit. p.215

(22) Wadsworth and Mann. op. cit.p.146

1750 is substituted for 1749 because the latter was an abnormal year since the African trade had not recovered from the war. The figures are extremely unreliable but probably illustrate the general trend of exports.

Average Annual Consumption of Cotton in Great Britain
1698 - 1770

	pounds (lbs)
1698 - 1710 (1705 missing)	1,095,084
1711 - 1720 (1712 ")	1,476,107
1721 - 1730 (1727 ")	1,505,273
1731 - 1740	1,717,787
1741 - 1750	2,137,294
1751 - 1760	2,759,916
1761 - 1770	3,681,904 (23)

From 1771 and 1775 however, the average level of cotton imports had risen to 4,764,589 lbs and between 1776 and 1780 6,766,613 lbs.(24) These figures reflect the influence of the Jenny and the Water Frame. In 1773 ARKWRIGHT and his partners had built the Derby calico mill. The Belper mill began in 1776. By 1780 ARKWRIGHT and his partners had such extensive interests that their factories contained about 30,000 spindles, each capable of spinning 12 hanks of 24's in a week. By 1782 the value of their concerns totalled £200,000, and the number of their employees 5000.(25)

BAINES (26) calculated that between 1781 and 1791 imports

(23) Wadsworth and Mann. op. cit. p.170
(24) Smelser N.J. op. cit. p.91
(25) Guest Rop. cit. p.31; Daniels op.cit.p.100
Wadsworth and Mann. op. cit. pp.489-90
(26) ibid. op. cit. p.348

of cotton had increased by 320%. This was reflected in the prices of imported raw cotton, which having dropped slightly since 1782, jumped in 1786, and then gradually began to fall again.

It is hardly to be wondered at that "numerous mills were erected, and filled with "water frames", and profits were 'unequalled'.(27)

The cotton mills of the Derwent valley became one of the wonders of the Peak. The Spas of Derbyshire were greatly favoured by tourists. The visitor to Buxton or Matlock would vary his shudders at Poole's Cavern or High Tor, with head-shaking or admiration over ARKWRIGHT'S mills. He might exclaim with JOHN BYNG in 1790 that to the tourist "these vales have lost all their beauties; the rural cot has given place to the lofty red mill and the grand houses of overseers; the stream perverted from its course by sluices and aqueducts, will no longer ripple and cascade"(28). Or he might rise to ERASMUS DARWINS lyrical heights of praise (though DARWIN was perhaps biassed being a friend of WILLIAM STRUTT). He might be stirred by the romantic sight of the blazing lights of the mills at night - even BYNG admitted them to be 'luminously beautiful'. Benevolence might be touched by the sight of crowds of young children all saving the poor rates by earning their own living; by the chapels and Sunday Schools provided for the spiritual welfare and the market and inn for the temporal support of the

(27) ibid. op. cit p.214

(28) Byng J. (ed Andrews) "The Torrington Diaries) 1781-94" p.251

new community. For Cromford and Belper, like New Lanark and Mellor after them, were new communities, and in their stone and brick built cottages, not uncomely. They were not precisely a new phenomenon. Iron masters and coalowners had had to provide in some fashion for their labour in remote parts of the country; landowners had had their model villages. But the patriarchal factory village made an appeal to the sense of order and benevolent feudalism of that age. They were, and it is easy to forget this today, a quite deliberate creation on the part of private individuals. The factory, the weirs and drains, the machine shop, the houses, the roads and bridges, the inn, the truck shop, the church and chapel, the manager's mansion; all were devised by and grew up under the owner's eye. Most of the work was done by direct labour, just as was the machine building in the mechanics' shop. The labour had to be attracted and held. The idealized community which ROBERT OWEN thought he had invented at New Lanark was not much different from those at Cromford and Belper that had preceded it. The Derbyshire factories were the first model for the cotton industry.

CHAPTER SIX

Social conditions in the mills.

We have dealt with the growth of the mills, and the factors which contributed towards this growth. Now we wish to turn to the conditions that the eighteenth century worker would find within the mills in Derbyshire. It is however, difficult to provide a general picture because the information available centres on the two big industrialists of Derbyshire, namely STRUTT and ARKWRIGHT, and it would seem certainly, that they were by no means typical employers.

Both STRUTT and ARKWRIGHT experienced in common with nearly all the early cotton manufacturers, great shortage of labour. The early mills were in general situated in remote areas which presented difficulties in recruiting labour. Furthermore there was a general resistance to entering factory employment, partly because as we have seen it was considered suitable employment only for the lowest grade of worker,(1) partly because recruitment of women and children into new factories tended to upset traditional family arrangements, and partly because in the case of weavers, it was not profitable to do so. Consequently much early factory labour, and this was certainly true of STRUTT and ARKWRIGHT, was a casual compromise between full-time labour, and part-time semi-agricultural labour.

"...the casual, transient character of the early factory population is seen... in the readiness with which workers were transferred from one occupation to another, sometimes within

(1) Chapter 1

the mill, sometimes outside... Agricultural workers had found domestic industry a profitable method of employing their spare time in the slack winter months; and the industrial workers had, from time immemorial deserted their looms or frames during the summer to help with the harvest...this looseness of differentiation persisted in the country districts for some time after the introduction of the factory system."(2)

Owners met this crisis in labour supply in a number of ways. Irish labour was successfully imported into such centres as Glasgow and Paisley. Some Scottish entrepreneurs in Lancashire probably encouraged labourers to migrate from Scotland by paying their cost of transportation.(3) In general it seems it was the roving and dissolute characters who sought work in the early mills.

The most widespread solution lay in the recruitment of child labour from the parish workhouses in the large towns. The old apprentice system was maintained formally intact, with an indenture of the traditional seven years or more, with the master presumably providing housing, clothing, food, and a certain amount of religious and educational training. Clearly this method of employment was economically irrational from certain standpoints. Wages were low, but this was counter-balanced in part by cost of maintenance. Furthermore, the troublesomess of the half-hearted commitment for the apprentices' welfare must have been a source of continuous distraction from the

(2) Redford A. "Labour Migration in England 1800 - 1850" pp.19-21.
(3) Redford A. op. cit. pp. 131, 118.

economic management of the mill. And finally, the employment on the basis of indenture, prevented the employer from discharging apprentices even in times of slack business.

The reasons for the apprenticeship system of child labour in mills of that time are usually given that the machinery required simple attentiveness rather than skill, and that the factory owners desperately needed cheap labour.(4) However, the continuing system of apprenticeship owes its existence also to the fact that it was not yet the subject of dissatisfaction in the minds of millowners in the late eighteenth century. Because apprenticeship had not been widely discredited, the system seemed a reasonable basis on which to recruit labour. Had it been at the core of the institutional bottlenecks of textile production, it undoubtedly would not have been adopted on such a large scale by the early manufacturers.(5) They probably would have relied on other methods - recruiting the casually unemployed, the foreign, and the transient in the first period of factory labour, and their offspring in later generations. This in fact did occur later on.(6) The largeness of scale of parish apprenticeship should not however, be exaggerated. After examining the evidence from several factories REDFORD (7) concluded that

"the apprentices, even in country mills, were not usually

(4) Mantoux P. op. cit. p.410
(5) Ashton T.S. "The Industrial Revolution" p.115
(6) See Unwin G : op. cit. Chapter XI
(7) ibid. op. cit. p.25

more than one third of the total workers employed, and were often not more than one - quarter."

There is no evidence that either STRUTT or ARKWRIGHT took parish apprentices like OLDKNOW, though they may have taken individual apprentices from parish overseers. At Cromford, ARKWRIGHT could draw on the families of the lead miners of the area, just as at Belper, STRUTT could draw on those of the nailers, a tough and rather demoralized lot of domestic workers who survived there well on into the nineteenth century.(8)

Today the English Sewing Cotton Company's mills at Belper, Milford and Matlock Bath draw their female labour in part from Derbyshire mining villages a dozen or so miles away, the workers coming in by bus. The eighteenth century factories had a narrower range, but even so workers would still come in from a radius of four or five miles.

ARKWRIGHT was advertising in 1771 for clockmakers, a smith, and woodturners - all for machine-making - and for women and children.(9) Both he and STRUTT were constantly advertising for labour in the following years. Thus in 1776 Cromford was asking for

"Several Carpenters, Joiners, Labourers, etc. Also a good Forging Smith."(10)

This was for the building of the second Cromford mill. To build this ARKWRIGHT apparently dismantled an old corn mill, for

(8) Farey J. op. cit. VOL. III p.508
(9) Chapter 4
(10) 'Derby Mercury' August 23, 1776

he advertised

"the materials of a large water corn mill, consisting of two Pair of French, one Pair of Black, and two Pair of Peak or Grey Stones, a large undershot water wheel, and good shaft, also one large upright shaft, spur wheel, cog wheels, etc, etc."(11)

In 1781 he was advertising :

"Wanted at Cromford....Forging and Filing Smiths, Joiners and Carpenters, Framework-knitters and Weavers, with large families. Likewise children of all Ages; above seven years old, may have constant employment. Boys and young men may have Trades taught them, which will enable them to maintain a Family in a short time. Two or three young men who can write a good hand are also wanted.

By personal Application at the Cotton - Mills Particulars may be known."(12)

Large families were highly desirable in the eyes of ARKWRIGHT.

In 1785 there was a remarkable event in connection with labour needs reported on May 12 1785 in the 'Derby Mercury'.

"A few days since, between 40 and 50 North Britons, with Bagpipes and other music playing, arrived at Cromford, near Matlock Bath, from Perth in Scotland : These industrious Fellows left that place on account of the Scarcity of Work, were taken into the service of RICHARD ARKWRIGHT, ESQ; in his Cotton mills and other extensive Works, entered into present Pay, and provided with good quarters. They appeared highly pleased with the

(11) ibid. April 12, 1776

(12) ibid. September 20, 1781

reception they met with, and had a Dance in the evening to congratulate each other on the Performance of so long a Journey."

But if there was not pauper apprenticeship at Cromford and Belper, there was ordinary apprenticeship and long-term living. The contemporary newspapers have frequent advertisements for runaways from cotton mills. In 1777 there was

"....committed to the House of Correction at Derby, one JOHN JEFFERIES, a Gunsmith, of Cromford for the space of one Calendar month; and to be kept to hard labour and corrected, he being charged by Mr. Arkwright, Cotton Merchant, with having absented himself from his Masters Business, without leave, (being a hired Servant for a year) and likewise been guilty of divers misdemenors and misbehaviour."(13)

The contracts could be with adults, since in 1784 three runaways from ARKWRIGHT'S Wirksworth mill were sought after : one 24, another 27 and the third 28 with still 2 years to serve.

The number of employed at the ARKWRIGHT and STRUTT mills may be told with reasonable accuracy. In the mid-70's Cromford employed about 500 workpeople (14), though this increased in the early 1780's with the opening of the Masson Mill at Matlock Bath. The Wirksworth mill was working by 1780 and by 1789 almost 200 people were employed there.(15) The Bakewell mill managed by his son also named Richard, had at that time about 300 employees, whilst STRUTT at Belper employed 600.(16) ARKWRIGHT did not expand his Cromford interests much further, but the

(13) ibid. November 14,1777
(14) ibid. September 19,1776
(15) Pilkington J. op. cit. Vol.II p.300
(16) ibid. op. cit. Vol.II pp.237 and 416

STRUTTS' at Belper kept on consolidating and expanding particularly under WILLIAM STRUTT, and by 1802 reached 1200 - 1300 employees.(17)

It is difficult to say how far STRUTTS' early labour force was made up of children and adolescents, and how much of adults. A cotton mill was always in part, on a family basis. The adult with children from distant parts found work there, but so did the established villager, who although perhaps a lead miner at Cromford or a nailer at Belper, sent his children to the mills. Certainly however, particularly in the first 30 or 40 years after the building of Cromford the amount of child labour in nearly all processes was very large.

These children worked in factories where night and day working was the characteristic feature. Philanthropic opinion might be against it, but the hours of work though long, were actually less for children, than they were to become under the single shift system before its statutory regulation. According to a contemporary tourist,(18) the Cromford mill in 1776 or 1777 employed about "200 persons' chiefly children, " who worked "by turns, night and day." Another mill "as large as the first is building here, new houses are rising round it, and everything wears the face of industry and cheerfulness." It would seem that the children were involved in the spinning which was at Cromford generally done at night, and also the preparation

(17) Britton J. and Brayley E.W. op. cit. Vol.III p.531
(18) Bray W. : "Sketch of a Tour into Derbyshire and Yorkshire". (1778) p.119

(i.e. carding, roving etc) which was done during the day. According to the evidence given by JEDEDIAH STRUTT? Jr. in 1816, the day was split into two shifts of 12 hours; six hours before dinner (12 noon to 1 p.m.) and six hours after this. Each of these periods included time for breakfast and for tea. The day at Cromford thus began at 6 a.m., though in the winter it was changed to 7 a.m. (19) This division of the day and night into four periods had an ancient precedent, for it had been used by LOMBE in his Derby Silk Mill.

In an advertisement in the 'Derby Mercury' of September 20 1781 the partners were asking for children from the age of seven. This was early enough by modern standards but nothing remarkable then. Domestic industry had taken children from their being able to crawl.(20) Many mills took children at an earlier age. It was perhaps the night work which was the least acceptable part of factory life from an eighteenth century child's point of view. RICHARD ARKWRIGHT, JR said that in his mills for 22 years to 1816 he had employed 164 boys at night, they

"got extravagant wages, and were extremely dissipated, and many of them had seldom more than a few hours sleep."(21)

It was remarked that Derby children suffered from meagre living - the town was "the seat of ill-health and premature decay."(22) On the other hand many people believed that

(19) Fitton & Wadsworth op. cit.p.226
(20) Clapham, Sir J.H. "An Economic History of Modern Britain : The Early Railway Age.1820-1850"pp.565-6
(21) Fitton and Wadsworth op. cit. p.226
(22) Richardson W.A. op. cit.p.167

children should not be kept in idleness, but should be forced to work as soon as they were capable to keep them from mischief.

There was however, some change of opinion in the cotton trade on this point, towards a later start to factory life, the interim period being used to teach the elements of literacy. Thus at the end of the eighteenth century consciences had become somewhat tendered, and children under 10 in ARKWRIGHT and STRUTT mills at least, were not employed.

But during this period it is clear that there was no lessening of the hours worked by children. This was by no means a one sided question of exploitation on the part of the employer. On the contrary, the twelve hour day was sanctioned by working class tradition. Many children, especially the youngest entered the mill at the express wish of their parents. Managers before the Commissioners investigating conditions in the cotton mills after the Napoleonic Wars, often claimed that any children under 10 in the factories were employed by their own parents, or were the children of widows.(23) The child would do the menial tasks of gathering waste cotton, cleaning machinery; or if designated as a future spinner, he became a piecer, mending broken threads for a number of years. He was trained to spin until 17 or 18 when he finally became a spinner. The spinner would often pay the children who were his assistants from his own wages, so that the employer might not deal with the assistants at all.

(23) Smelser N.J. : op.cit. p.189

Thus the system perpetuated the traditional values of training children under parental authority for an occupation. Little wonder then, that the conditions of child labour did not offend spinners interviewed by Factory Commissions in 1833.

All this complicated any limitation of children's hours, particularly because the peculiar technology of the industry required an attendant and several assistants to work together continuously on the machinery. At the same time it was feared that any limitation of the hours of child labour would occasion the complete dismissal of children - a prospect which would at once lower the family income and destroy the traditional ties between adult and child labour.(24)

The STRUTTS particularly, were enlightened paternalistic employers, whose feeling of responsibility towards the welfare of their employees, was of a very high order. They were willing at the end of the century to consider a raising of the minimum age of admission to 12, with a ten hour day and two hours schooling, But they were aware of the dilemma of its consequent effect (since payment was by piece) on the family income.

"The reduction of time from twelve hours to ten, and the consequent reduction of wages, would have a most serious and lamentable effect on the working class, as well as bring a great injury to the master. Everything should be done to enable the working class to procure sufficient food and clothing, and the

(24) ibid, op. cit. p.269.

comforts of life, and then there is some chance of making some moral improvement, but it is very difficult to instruct and improve the hungry and naked, and those who are degraded into pauperism (against their own will too)."(25)

They were also aware naturally enough, of the fierce competition of rival manufacturers who were not so scrupulous over workers' welfare, and whose only criterion was cost.

Among the most widely discussed characteristics of the early factory system is the moral character of the masters. Usually the factories are divided into types, those run by brutal heartless capitalists who flogged their employees, especially the apprentices,(26) and those run as 'model' communities by humanitarian masters. Yet one of the aspects of the factory system which struck the outside observer was its power of private jurisdiction designed to control the employees. This concern with factory discipline was a salient feature of both types of factory management.

One of the great defects of the domestic system which preceded the establishment of factories, had been, from the standpoint of the entrepreneur, the dissatisfaction with the discipline of the workers. The viewpoint here was an economic one - the need to regulate a vital factor of production. But there was also a feeling that the working populace once aroused were synonymous with the 'mob'. Most factory managers had some

(25) Fitton and Wadsworth op.cit.p.229 quote from Factories Inquiry.

(26) Mantoux P. op. cit. p.480-6
Ashton T.S. op. cit. pp.113.f
Hammond J.L. & B. "The Town Labourers" Col.1 pp.30-47

experience of this; ARKWRIGHT did, for his Birkacre Factory near Chorley was destroyed by the West Lancashire Handworkers.(27) In addition the transient and probably deviant character of many of earlier adult labourers had to be overcome, and at first it probably was quite true that the factory employee was generally the lowest type of labourer. Finally managements felt obliged to exert some moral control especially over apprentices, a tradition which stemmed from the middle ages.

The cruel manufacturers approached the problem of discipline in a primitive and direct manner. Often this was encouraged by the structure of incentives. A vicious and most reprehensible practice existed in those days of paying overseers or overlookers of the mill according to the quantity of work they could turn off in the week or month, an incentive to long hours of labour which caused frequent cases of overworking and cruelty. Neither STRUTT nor ARKWRIGHT used this system. Their concern was much more humanitarian. STRUTT, a strong non-conformist, was like OWEN and OLDKNOW, more concerned with improving the moral habits of the working populace in matter of orderliness, punctuality regularity and temperance. OWEN believed he was making a home, so did SAMUEL GREG the Younger, in order that they would lose.

".....by degrees that restless and migratory spirit which is one of the peculiar characteristics of the manufacturing population and perhaps the greatest of all obstacles in the way of

(27) Chapter 4

permanent improvement among them." (28)

And Owen :

"Within the mills everything was punctiliously kept. Whenever I visited them with my father, I observed that he picked up the smallest flecks of cotton from the floor, handing them to some child near by, to be put in his waste bag.

'Papa', said I one day, 'what does it signify - such a little speck of cotton ?'

'The value of the cotton,' he replied, 'Is nothing but the example is much. It is very important that these people should acquire strict habits of order and economy' " (29)

At Mellor, OLDKNOW'S mill, the following notice appeared in 1797 :

"WHEREAS The Horrid and impious Vice of profane CURSING and SWEARING - and the Habits of Losing Time, and DRUNKENNESS, - are become so frequent and notorious; that unless speedily checked, they may justly provoke the Divine Vengeance to increase the Calamities these Nations now labour under.

NOTICE is hereby given, That all the Hands in the Service of SAMUEL OLDKNOW working in his mill, or elsewhere, must be subject to the following RULE : That when any person, either Man, Woman or Child is heard to Curse or Swear, the same shall forfeit One Shilling - And when any Hand is absent from Work, (unless unavoidably detained by Sickness, or LEAVE being first obtained) the same shall forfeit as many Hours of Work as have been lost;

(28) Smelser N.J. op. cit. p.106
(29) ibid. op. cit.p.106

and if by the Job or Piece, after the RATE of 2.6d. per Day. - Such Forfeitures to be put into a Box, and distributed to the Sick and Necessitors, at the discretion of their Employer."(30)

STRUTTS were great 'improvers' in this sense and regarded the problem of factory discipline as inseparable from moral precepts. The STRUTTS' list of 'forfeits' for 1805 - 1813 is worth scrutiny both for the moral paternalism it shows, and in addition the difficulty that a millowner had in keeping his labour force together :(31)

"1. Absence from Work without leave.
(e.g.) Leaving without giving notice
Leaving before notice was expired.
Running away.
Being off at a Heage Feast with a pretence of being ill.
Off without leave with soldiers.

2. Theft of Mill Property.
(e.g.) Having waste found on her
Stealing a pair of pincers.

3. Destruction or Damage of Mill Property.
(e.g.) Breaking a Thermometer.
Breaking a gallows iron.
Stuffing a stove tunnel up.
Putting good cotton in the dust.

4. Failure to do work as Required.
(e.g.) Leaving her machine dirty.
Weighing sorto wrong and being saucy when told of it.
Making large quantity of waste.

5. Failure to comply with Mill Discipline.
(e.g.) Idleness and looking through window.
Making noises in counting house.
Throwing bobbins at people.
Telling lies to Mr. Jedediah.
Using ill-language.
Encouraging hands to disobey their master.

(31) The full list can be seen in Fitton and Wadsworth op. cit. pp.234-237.
(30) Unwin G. op. cit. p.198

6. Misconduct outside Working Hours.
(e.g.) For putting Josh. Haynes' dog into a bucket of hot water.
Receiving potatoes off Martha Booth which she had stolen from home.
Stealing gun flints."

This does not show how much a worker could lose. At the end of each quarter he received the Quarterly Gift Money, a sixth of his earnings paid in cash at the end of each Quarter. But he could forfeit this for any misconduct without a moment's notice. The following examples from Fitton and Wadsworth provide this information.

		Forfeit	Gift Money	
John Sandon	Spinner	18/6	18/6	For throwing roving bobbins through window into cut.
Mary Hall	Picker	2/3	5/10½	Refusing to go to spin.
Joseph Lievers	Workman	2/6	31/5	Off 1 day without leave.
Mary Buckley	Picker	2/-	7/10½	Ill behaviour (32)

Furthermore the length of engagement shortened. At first one year, it became three months, an added weapon of the employer to enforce discipline. The STRUTTS also in conjunction with other mill owners in the area agreed not to take on people unable to produce a satisfactory testimonial from their old employer.

"Walter Evans to the Botts of Tutbury.
December 14 1787.

We are informed that some children named BENNETS and GARRATTS who left us a little time ago are employed at Tutbury as also JAS ALLEN'S family. We also have had many hands who said they came from Tutbury, offered at Darley (where EVANS' mill still

(32) ibid. op. cit. pp. 237-8

stands) and we had employed some, we believe except FREEMAN whom we refused until he brought a character from you. From experience we are well satisfied it is a very impolitic measure for different mills, particularly neighbouring ones, to employ hands from each other without bringing a character from their last place. We do not know any mill but yours that would employ hands from us. Messrs. Strutt of New Mills and Belper have empowered us to offer from them as well that no person shall be employed from them or from Tutbury without a written character provided you will do the same to them and us letting people now employed continue where they are, it appearing to us that when your people know that they will not be employed at these mills it will probably damp their spirit of tramping."(33)

It is therefore interesting to note the reasons given for handing notice to terminate employment at STRUTTS' mills between 1805 - 1812.

	Males	Females
Left for other occupations	78	82
Leaving Belper or Milford	2	14
Insufficient earnings	2	12
Dissatisfied with Mill Work	3	9
Pregnancy and health	1	147
Miscellaneous	3	14
	89	278

(34)

Later records show that between the same dates

"1600 workpeople left the mills with or without giving the required three months notice. Assuming that some 1300

(33) ibid. op. cit. pp.238-9
(34) ibid. op. cit. p.232

persons were then employed at Belper and Milford, the labour turnover must have been in the region of 16 per cent per annum.(35)

Writers on wages in the cotton industry have complained of the difficulties of their task, because

"machine is always replacing machine: women replace men and children replace women, " (36)

and because of the inaccessibility of materials. This is unfortunately, especially true of the eighteenth century. Of the general picture it would seem that the factory operatives' wages were better and fluctuated less than others in the working classes, often because of the augmented earnings of women and children. An inaccurate estimate by EDEN was that the manufacturing labourer's average wage was about 16/- in 1797 ;

"but...they rarely work on Mondays, and ... many of them keep holiday two or three days in the week. Women earn from 6/- to 12/- a week; their clear weekly earnings may be stated at 8/-. Children of 7 or 8 years old can earn 2/- a week; of 9 or 10 years 4/- a week."

G.R. PORTER † however, does not confirm this :

"According to ARTHUR YOUNG'S calculations, the average had been 7s. 6d a week from 1767 to 1789, 10s a week from 1799 to 1803; then under the influence of the famine prices of the great war, they rose to 12s in 1804 and 1810".

Spinners of finer counts would command higher wages. In

(35) ibid. op. cit. pp.239-40

(36) Clapham, Sir.J.H. "An Economic History of Modern Britain." p.550

† G.R. Porter The Progress of the Nation ed. by F.W. Hirst. pp.47-8

1806 they earned 33/3 a week, which rose in 1810, but fell to the earlier level between 1814 and 1822.(37)

The same scantiness of material makes the more specific picture of Derbyshire wages levels as epitomized by STRUTT and ARKWRIGHT, equally difficult to ascertain. Almost all mill workers were on piecework, however low paid, as were some of the adult 'in' and 'out' workers. An immense amount of book-keeping and calculation must have been involved but it would seem that the records have been mostly lost.

The earliest of the STRUTTS' wage accounts, to be found in FITTON and WADSWORTH,(38) is not of great use here, since it does not include wages of spinners, but only of reelers and pickers, making it harder still to come to any overall view, even if we accept the rough estimates of EDEN. It would seem that between 1789 and 1787 the overseer was receiving an average wage of about 7/6 for a 13 hour day, 6 day week. Another record shows an average wage of about 4/9 between the same period, though this man was an ordinary reeler, and working a 72 hour week. Again these figures are not very useful because they are wages paid for time rather than for piece.

To the weekly wage rate was added payment for overtime at 1d per hour for millhands and at 2d an hour for overseers. Few millhands worked more than the usual 72 hour week. From the wages came deductions, for absence from work, and for most work-people, rent and goods. In addition some borrowed money from

(37) Smelser N.J. op. cit. p.213
(38) ibid. op. cit. pp.244-5

the STRUTTS and paid back a few shillings each week. Harrassed as were all millowners by the shortage of cash, the workers would receive in toto no more than one sixth of the whole amount of money earned at Belper and Milford in a typical quarter,[39] so that the economy of these mills was based on truck or rents.

At some stage like OLDKNOW,[40] the STRUTTS may have used a token system to replace actual money. ARKWRIGHT issued Spanish silver dollars countermarked at the Soho Mint "Cromford, Derbyshire", and valued at 5/- and 4/9. At the turn of the century other millowners were using Spanish dollars, half ecus, Charles II bawbees and so on.

The greater part of the workpeople's earnings must have gone on foodstuffs and coal, and a variety of miscellaneous goods and services supplied to them by the STRUTTS. Contemporaries were impressed by the dwellings erected by many of the country factory masters :

"The cottages throughout Derbyshire are much better provided with habitations than they commonly are in the Southern Counties of England, and they generally keep them in neat and in better order.... the vast numbers of neat and comfortable Cottages which have been erected by the late SIR RICHARD and by the present MR. RICHARD ARKWRIGHT, by MESSRS. STRUTTS, MR. SAMUEL OLDKNOW and numerous others of the Cotton Spinners and manufacturers for the accomodation of their multitudes of workpeople, must have had a great influence on the general style

(39) ibid. op. cit. p.246
(40) Unwin G. op. cit. pp.179-193

and condition now observable in the cottages." (41)

URE (an apologist for the factory system) maintained that

"there is not a better or more certain mode of benefiting a country village than by establishing a cotton factory in it" (42)

On the other hand it must be remembered that both the STRUTTS and the ARKWRIGHTS were exceptional employers, whose sure position in the industry made them more aware of responsibilities towards their employees.

These factory communities were not all drabness. In September an annual festival of 'candlelighting' took place, when as in 1776, about 500 workmen and children, led by a band and a boy working in a weaver's loom, paraded from the mills round the village, where they were watched by a large crowd: On returning to the mills they were given buns, ale, nuts and fruit, ending the evening with music and dancing. On the same day ARKWRIGHT gave a feast to over 200 workers who, during the summer had erected another large cotton mill 120 feet long and 7 storeys high. They were

"regaled with a large quantity of strong beer, etc, yet the Day was spent with the greatest Harmony imaginable." (43)

Again in 1778 according to annual custom, the workpeople were entertained by the owners. A song to the tune of 'Roast Beef of Old England' was rendered

"in full chorus amongst thousands of Spectators from Matlock Bath and the neighbouring towns ..... the evening was

(41) Farey J. op. cit. VOL.II p.21
(42) Ure A: "The Philosophy of Manufacturers"(1835)p.342
(43) 'Derby Mercury' September 19 1776

concluded by a Ball, which Mr. Arkwright gave at his own House, to the neighbouring ladies and gentlemen, at which the company was very numerous and brilliant."(44)

The partners were no strangers to the arts of industrial incentive. ARKWRIGHT evidently not only gave monetary rewards to his workers, but gave distinguishing dresses to the most pfoductive, man or woman. LEWIS PAUL in his Northampton factory had provided a precedent for this by promoting rivalry by the allurement of handkerchiefs,(45) but typically, ARKWRIGHT went one better. He also gave two Balls a year to the workmen and their wives and families with a weeks Jubilee at the time of each ball. He was seemingly aware that unmitigated labour brought diminishing returns to the industrialist. He gave lavish bonuses. ARKWRIGHT, according to the 'Derby Mercury':

"has generously given to 27 of his principal workmen, twenty seven fine milch cows, worth from 8/- to 10/- each, for the service of their respective Families."(46)

The STRUTTS may have been more cautious in this respect though like good Whigs, though scarcely good Radicals, they celebrated the centenary of the Glorious Revolution in October 1788, and at Belper;

"amongst the provisions a Sheep was roasted whole; and several Barrels of Ale and other Liquors were drank, and the Day was spent with much Festivity."(47)

(44) ibid. September 25 1778
(45) Wadsworth and Mann. op.cit. p.437
(46) ibid. July 24 1783
(47) ibid. October 30 1788

The STRUTTS sound non-conformists, were particularly concerned with the spiritual welfare of the communities they had established. STRUTT built a Unitarian chapel at Belper in 1782 and another at Milford a little later. Already at Cromford there existed a chapel built by the partners, though ARKWRIGHT being Anglican, presumably would have nothing to do with it. In any case he began to build a Church there which was not completed until 1797 after his death, and in his will he bequeathed to its minister £50 a year 'for ever'.

Religion and education were indissoluble in the view of the non-conformists like STRUTT, and the Wesleyan movement brought in its wake a remarkable wave of enthuisiasm for Sunday Schools which had the double advantage of being a cheap solvent for vice and ignorance. At Derby JEDEDIAH STRUTT responded in October 1784 by building one,(48) and ARKWRIGHT followed at Cromford the following year. STRUTT then established another at Belper in the August of 1785 :

"We hear from Belpar that Mr. Strutt has, (with a Liberality which does Honour to the human Heart) entirely at his own expense, instituted a SUNDAY SCHOOL for the Benefit of All the Youth of both Sexes employed in his Cotton Mill at that town; and provides them with all necessary Books, etc, for learning to read and write. This school was opened on July 3, and 120 Scholars have already been admitted - An example worthy of imitation by all whom Providence has blessed with Affluence. The Propriety of these

(48) Wadsworth and Mann October 14 1784

Institutions, in Speculation, did not admit of a single Doubt, but since their Utility has been so amply demonstrated by Practice, it becomes the Duty of every Thinking Person, in this Age of Refinement, Luxury and Vice, to hold forth an assisting Hand, to stop the Tide of Immorality, which threatens speedily to Deluge 'the land of Liberty' ".(49)

These schools were of course, the only means of education for the factory children. They worked twelve hours a day for six days a week and on the seventh had compulsory church and school.

By this time the factory communities were well established. The more one looks at the difficulties that confronted ARKWRIGHT and STRUTT in the 1770's and 1780'2 the greater their achievement appears.

PROFESSOR REDFORD has shown (50) that the labourers at that time showed great reluctance to submit to factory discipline, and as a result there was a migratory and often disreputable factory population. Faced with this difficulty the ARKWRIGHT and STRUTT communities, though patriarchal from a twentieth century viewpoint, were to the eighteenth century highly successful both to the owners and in general to the factory workers.

(49) Wadsworth and Mann. August 25. 1785

(50) Redford A. Op. cit. pp.18-22

CONCLUSION

By the end of the Napoleonic wars the STRUTTS had become one of the largest consumers of raw cotton in the country. They were an established, respected firm whose progress gives a lie to the widespread notion that the pioneers of the Industrial Revolution were interested only in becoming rich as quickly as possible. On the question of how much money these mill owners were able to make there is unfortunately, no record. The present English Sewing Cotton Company which is an amalgam of the two firms the STRUTT'S and the ARKWRIGHT'S, has no records of the profits made by the two businesses during the period under study. The same is true for LOMBE'S Silk Mill. The records, such as they were, and we have no means of knowing how complete these might be, were housed in the Guildhall in Derby, but unfortunately they were destroyed by fire in 1840. The loss of such records prevents the presentation of a complete picture of the Eighteenth Century textile factories in Derbyshire, and contrasts strongly with the quite considerable amount of technological data, which is available.

Similarly as has been noted,(1) there is also a lack of information concerning the costs of construction of these mills. We have seen (2) that LOMBE'S Silk Mill represented an investment of about £30,000, but there seems to be no information available which would enable some breakdown of this figure into more meaningful terms to be made.

(1) Chapter 2

(2) Chapter 2

There is perhaps more information here when we some to the STRUTT and ARKWRIGHT mills. On the west mill, Belper, a fireproofed building, we have seen that the total cost of this mill was £6,461 or about 25 per cent more than that of a five-storey timber-framed mill erected in 1794-5 at Leeds.(3) Over the county border in Nottinghamshire there was a cluster of small early mills. The Pleasley mills in which THOMAS OLDKNOW was a partner, were founded in 1794-5 with a capital of £4,200.(4) The time period is however, all important. Between 1771 and 1774 Cromford cost the partners about £12,000,(5) though when the partners were engaged in trying to free their industry from the prohibitions of Parliament, STRUTT in his plea said :

"The Petitioners had expended upwards of £13,000 on the said manufacture ....."(6)

But what does this figure cover ? At the time the partners were not only engaged in developing their Cromford works but also the Calico mill in Derby.(7) Would this figure include money invested to improve the Nottingham works ? This would seem probably unlikely, judging from the fact that at this stage STRUTT and ARKWRIGHT were working closely together, whereas NEED tended to be out on a limb in Nottingham. But further than this it is impossible to go. Between 1774 and 1781

(3) Chapter 3
(4) Fitton and Wadsworth op. cit. p.93
(5) Chapter 4
(6) Fitton and Wadsworth op. cit. p.71
(7) Chapter 4

a further £18,000 was invested by ARKWRIGHT in his businesses. When BIRKACRE was burnt down in 1779 by rioters, contemporary reports estimated the loss at £5,000 and when the same fate befell Nottingham, £6,000 was the figure mentioned.

The loss of the STRUTT and ARKWRIGHT accounts thus leaves a serious gap in our knowledge of these mills, for even the figures mentioned are by no means verifiable and unless accompanied by a detailed breakdown, give us no insight into the costing of the mills.

In other ways however, a satisfactory amount of information is to be found. Any journey through Derbyshire would bring to view some at least of the mills which have been described, perhaps modified and converted, but sometimes hardly altered from their original eighteenth century form. Unfortunately many of the original mills are being demolished, the most recent being JEDEDIAH STRUTT'S fine Milford cotton mill which was pulled down in February 1964. The mill had such historical interest that a survey was conducted by the Science Museum, South Kensington, where many items - including a complete scale model - are to be preserved.

In the mill they found a chapel and reading room to improve the lot of the workers, and also a prison where offending workers could be chained in wooden stocks. Cubby holes were built into the walls where child labourers could snatch a few hours' sleep. The survey also found and preserved gas fittings, patent locks and self opening doors, and even the

clock in the mill tower built in 1808 was taken to London.

These early industrial buildings were built in traditional materials - stone, brick and timber, but from the start they had a character of their own, being designed for the requirements of the machinery they housed. Power was usually supplied by water wheels and transmitted by long horizontal shafts, to the rows of machines. It was not practical to have extremely long shafts, however, partly due to inefficient bearings, and so the machines were accomodated on a number of floors, the horizontal shafting being driven by a vertical drive from the water wheel. The width of the building was thus determined by the limitations of the materials used in the construction and the general need for natural light.

Artificial light was obtained from tallow candles, a factor which accounts for the high incidence of fires among the early mills. The STRUTT'S efforts to make the mills fireproof by using segmental brick-arched floors, was the first real break with traditional construction. Their early mills had been very much on the lines of the Derby Silk Mill established earlier in the century by JOHN LOMBE. But their solution to the problem of fire in cotton factories was their own contribution to the development of industrial buildings. Improvements to this method resulted in the first iron-framed mill being built at Shrewsbury in 1797, where segmental arches were sprung from cast iron beams supported on cast iron columns. This became the accepted system for all first class mill construction, although rolled iron eventually replaced cast iron in the last quarter

of the Nineteenth Century. However, this system was not basically altered until the introduction of a reinforced, concrete-suspended floor.

On Derby and the county these cotton mills effected a major transformation, such that whereas at the commencement of the century Derby was scarcely a commercial centre at all, at the end it was a textile centre comparable with any in Lancashire. This brought a profound change in the social system. At the end of the Seventeenth Century the vast majority of the people worked in small workshops where the goods made were sold direct to the customer across a bench or counter. About two out of every three houses had a shop or workshop. The only items exported were gloves and malt. In earlier days malted barley had to be dried by lighting straw. Now coke was used, which increased the demand for coal, and 3,000 cart loads a year were brought to the town mainly in boats down the River Trent.(8) By 1800 the factory system was all important. There were over a hundred mills employing twice as many people as all other groups. Textiles had become the leading manufacture, though the silk mill had declined somewhat, feeling the competition from rival firms. The factory trades created new occupations and engineering was an important new comer to the industrial scene; One firm began to build steam engines, another using Derbyshire lead, started the manufacture of lead sheet, pipes and chemicals.

(8) Richardson W.A. op. cit. p.119

In the case of the STRUTT and ARKWRIGHT mills it is true to say that they were in a very real sense, communities. Indeed they were among the best examples that the Industrial Revolution produced. This would however, be much less true of the smaller factory owner, whose continually changing factory population would not allow the growth of any established community.

As some Eighteenth Century observers saw, the new factory communities were a praiseworthy step forward to the ultimate perfection of man. With few exceptions almost all the diarists and travellers of the period who passed through Derbyshire, were at once amazed and gratified by the changes effected by the system. It appealed to their sense of order by the close juxtaposition of cottage to factory, carefully laid out under the paternal eye of the factory owner. The regulations and discipline that this involved was a merit in their eyes, deeming the poor unstable and liable to roam the country dispirited and demoralized. It pleased them to note that the workers were now under a fixed routine of hours, instead of the days spent at the alehouse in the slack periods under the old domestic system. Their hearts warmed to see the children so readily employed, and to see them troop of on a Sunday to the Sunday Schools established by the benevolence of the factory owner. The attacks on the conditions within the mills were in general a Nineteenth Century occurrence.

In many ways the working classes in Derbyshire would not

have found the new factory system intolerable,[9] though its new disciplines rankled, and would probably have experienced a better standard of living under STRUTT and ARKWRIGHT than under the domestic system. On the other hand, the worst effects of the factory system would have been found in the factories of the smaller manufacturer who was more prone to exploit the employee than the more established concerns. Here unfortunately investigation is difficult because of the paucity of information. We have seen [10] that another gap in our knowledge was the structure of wages. Again the loss of the STRUTT and ARKWRIGHT accounts is crucial for the only commonly accepted point of commentators on Eighteenth Century wage levels is the variability of wages from district to district.

The Textile industry is the precocious child of the Industrial Revolution. It matured at an amazing rate, so that when LOMBE'S mill began production in 1721 we already have a modern factory with its automatic tools, its continuous and unlimited production, and the narrowly specialized functions of its operatives. This was however, in a sense a false start. It heralded the Industrial Revolution, but it did not begin it. The essential features of the modern factory system are to be found at Cromford when in 1773 ARKWRIGHT'S mill began full scale production.

Perhaps the great fascination of the textile industry lies here - its remarkably rapid growth from cottage industry to

(9) Chapter 6
(10) Chapter 6

the familiar pattern of the great industrialist's factory surrounded by the cottages of his workers. Certainly the mills built by Derbyshire's great textile manufactufers are far from ugly additions to the landscape.

Their grey stone and handsome proportions have blended into the scenery to an extent that they have given Derbyshire a distinctive character which is not displeasing.