The typology of industrial buildings with reference to the steel trades in Sheffield, 1750-1900

by
Williams, Alan Owen

University of Sheffield
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Glossary and synonyms

Relating to Sheffield's industrial buildings, and equivalent terms in modern usage.

(preferred terms in **bold**).

arston
Hearthstone in a grinding wheel, where the grinders would sit and smoke for recreation.

assnook
The space under a fire grate (derived from 'ass'=ashes, 'nook'=corner or space).

bands, see **wheel bands**

bar steel, see **cementation steel**

blister steel, see **cementation steel**

box, see **chest**

casting furnace, see **cast steel furnace**

casting house, see **melting shop**

casting shop, see **melting shop**

cast steel; crucible steel; refined steel
The product of Huntsman's crucible melting furnace, made by melting blister steel in refractory crucibles and pouring the molten metal into an *ingot mould*. See chapter 1.

cast steel furnace; crucible furnace; hole; melting-furnace; casting-furnace
Induced draught air furnace used to melt *cementation steel* in crucibles, devised by Benjamin Huntsman. Sometimes used to describe the entire building, more usually termed a 'cast steel shop' or 'melting furnace'. See chapters 1, 2.

cast steel shop, see **melting shop**

cave hole, see **cellar**

cellar; cave hole
The vaulted basement of a *cast steel furnace* housing the furnaces and their ash-pits, and providing a sufficient supply of air. Sometimes used for the manufacture and drying of crucibles, then 'pot-cellar'. See chapters 1, 2.

cementation steel; blister steel; bar steel
The product of the *cementation furnace*, consisting of carburised bar iron suitable for manufacture into a variety of metal wares. Processed by *tilting* to make shear steel. See chapter 2.

cementation [steel] furnace; converting furnace; pot furnace; steel-house
Reverberatory furnace similar in appearance to a glass furnace and used in the production of *cementation-* or *blister steel* from bar iron, by the absorption of carbon from charcoal. See chapter 2.

chamber floor, see **chambers**

chambers, chamber floor, garret
The upper floors of a premises. More specifically, the top floor of a grinding wheel, often in the roofspace, used to house lighter trades usually with power taken off the main drive shafts. See chapter 4.

chest; pot; coffin; box
The rectangular sandstone or firebrick vessel inside a *cementation furnace* and used to house the iron bars to be 'converted' into steel. Sometimes called a 'coffin' due to its size and shape. See chapter 2. The use of the term 'pot' can lead to confusion with *crucibles*.

clay house, see **clay place**

clay place; clay house
Space in a cast steel shop where clay is dried and stored before use. Often behind the furnace flues to make use of the waste heat of the furnaces. See chapters 1, 2.

coffin, see **chest**

collar
Term given to a *wheel band* when it became tangled with the machinery.

converting furnace, see **cementation furnace**

crozzle
The vitrified waste product from the top of cementation furnace chests after firing, usually consisting of *wheelswarf*. See chapter 2.

crucible, pot
A metallurgical vessel, specifically in Sheffield a specially prepared fireclay or Stourbridge clay container capable of withstanding the heat of a *cast steel furnace*, devised by Benjamin Huntsman. See chapters 1, 2.

crucible furnace, see **cast steel furnace**

crucible shop, see **melting shop**

crucible steel, see **cast steel**

cutler's hearth; hearth; cutler's shop
Room or building in which a cutler worked, with a charcoal fired hearth and bench with anvil, stithy, etc. Sometimes used to describe the hearth itself.

cutler's shop, see **cutler's hearth**

cutler's wheel, see **grinding wheel**

drum
A broad timber or metal wheel fixed to the main drive shaft of a grinding wheel around which the *wheel bands* of grinding *troughs* were looped to transmit power from the engine. See chapter 4.

end
another name for a *hull*, usually in the older water-powered *grinding wheels*.

fire-grate, see **grate**

fire-room, see **grate**

firing-hole
Place for introducing fuel to a furnace, in Sheffield used especially to refer to the sunken openings at either end of a *cementation furnace*. See *Webster's Technical Dictionary*, *OED*; chapter 2.

firing-shed, see **iron house**

forge hammer, see **tilt hammer**

gannister; ganister; muck; muckite
Highly refractory stone found locally to Sheffield and used to line cast steel furnace holes and for other high-temperature metallurgical processes. Originally collected from the surface of sandstone paved roads, a commercially produced variety was known colloquially as 'muck' or 'muckite'. See Barraclough (1984) vol. 2; chapters 1, 2.

garret, see **chambers**

goight, see **goit**

goit; goight
Also termed a 'race' (as head-race and tail-race), a channel of water usually diverted from a river to serve a water-powered works. See chapter 4; Crossley (1989).

grate; fire-grate; bars; fire-room
In a *cast steel furnace*, the iron support under the *crucible*, consisting of loose round-section bars laid upon two fixed iron bars, the former capable of being moved from inside the *cellar* to release the coke around the crucible at a moment's notice. 'Fire-room' referred to the recess into which the grate was built, Sanderson (1855) p. 454. See chapters 1, 2.

grinding wheel; cutler's wheel; wheel
The term 'wheel' did not refer to the grindstone or water wheel itself, but the building that housed the stones. 'Steam wheel' was the early terminology distinguishing from water wheels. Sometimes also called 'mills', often when sawmills, etc. incorporated (as 'Castle Mills').

grindlecoke; grindlecowk
A worn out *grindstone*, sometimes used for building purposes. See chapter 4.

grindle stone, see **grindstone**

grindstone; grindle stone; stone
The heavy local stone used by grinders to sharpen steel edges, with a central hole usually cut by the grinder to fix it upon the bearings of a *trough*.

hearth, see **cutler's hearth**

hole, see **cast steel furnace**

horsing
Timber structure behind a *grindstone* at which the grinder sat at his work. Often chained down to the *hull* floor to offer some protection against breaking stones.

-house
As a suffix '-house' was commonly used for sheds (iron-house), and for other non-manufacturing uses (counting-house, warehouse).

hull
A room in a grinding-wheel, usually accommodating five to six grinders on *troughs*.

ingot mould; moulds; ingot; ingate
Cast-iron mould used in the production of cast steel ingots. Confusingly, the term 'ingot' is sometimes used for the mould.

iron house; steel house (often used for the furnace itself); shed; firing-shed
The shed-like building within which cementation furnaces were sometimes housed, to provide shelter for iron bars and to their firing-holes. Sometimes also sleeping quarters for the furnace-men during their long attendances. See chapters 2, 3.

manufactory, see **works**

melting furnace, see **cast steel furnace**

melting shop; casting shop; casting house; crucible shop; cast steel shop
The building in which a number of *cast steel furnaces* are housed, with space for the casting of molten steel into *ingots*.

moulds, see **ingot mould**

muck, muckite, see **gannister**

outrages, see **rattening**

-place
As a suffix '-place' was interchangeable with '-house', used particularly as 'clay place', 'coke place' (sometimes the latter called 'coke-hole' or 'coal-hole').

pot furnace, see **cementation furnace**

pot, see **chest** or **crucible**

pot house; pot room
The space in a cast steel shop where crucibles are made, usually a dedicated room with specialised equipment and large areas of shelving for drying the 'pots'.

pot room, see **pot house**

rattening; outrages

A type of unofficial discipline within a trade union or combination and carried out anonymously by its members, usually involving minor 'punishments' such as the removal of *wheel bands* or tools, but occasionally resulting in violent episodes. See Pollard (1971).

refined steel, see **cast steel**

shed

Applied to generic structures intended for storage or shelter, of lightweight construction, or with one or more open sides. '-shed' used interchangeably with '-house' and '-place' (coke shed). Also 'Firing-shed' used for the building housing cementation furnaces, and providing shelter for the firing-holes at one or both ends, and 'Lighting-shed' (or lightening-) adjacent to cast steel furnaces, probably used for annealing crucibles and preheating ingot moulds.

shop

A generic term for any manufacturing premises, even fairly large ones. The present-day commercial shop was called a 'sale shop', and consequently the term 'workshop' is less frequently encountered as there was no need to distinguish it from a 'sale shop'
As a suffix, 'shop' was used in names such as 'casting-shop', 'forge-shop', etc.

steel-house, see **cementation furnace** or **iron house**

stone, see **grindstone**

swarf bins

Low walled repositories for wheelswarf constructed in the *wheel yards* outside grinding wheels. Identifiable in plan as rectangular or curved enclosures. See chapter 4

teeming

The act of pouring molten steel from a *crucible* into the *ingot mould*, to form *cast steel.* See chapters 1, 2.

tilt hammer; tilt; forge hammer

A heavy hammer for forging iron and steel, originally water powered. For a short period, the term 'steam tilt' was used, and the mechanism turned by means of rotative steam engine. These were superseded by Nasmyth-type steam-hammers.

tilting

The process of forging metal using a mechanically powered *tilt hammer*.

trough, trow

The place in a *hull* at which a grinder worked, usually comprising a cast-iron housing in which the *grindstone* turned, timber *horsing*, and other powered equipment used in polishing and buffing metal wares. See chapter 4.

trow, see **trough**

wheel, see **grinding wheel**

wheel bands, bands

Long belts of leather that took power off the main drive shaft of a grinding wheel via the *drum* to the spindle of the grindstone. See chapter 4.

wheelswarf

the yellow sludgy waste product formed by grinding on a wet stone, collected in *swarf bins* and used to seal the tops of cementation furnace *chests*. See chapter 4.

wheel yard

The external space outside a grinding wheel, where grinders would prepare their stones, deposit waste products such as *wheelswarf*, and spend recreational time. See chapter 4.

works; manufactory; '-place'; '-yard'

The most common nineteenth century form of name for an industrial premises, covering anything from a single function to a whole complex. General exemptions include premises used only for tilting, grinding.

Sources:

The Sheffield Dialect, Bywater (1839) p. vii

Webster's Technical Dictionary

Oxford English Dictionary

Bradley (1999) pp. 4-7

Graphical conventions used in this thesis

In making the plans and illustrations that accompany this thesis, various conventions have been adopted to allow comparison of buildings and sites to scale and at a similar resolution. Due to the various levels of detail to which different types of drawing are plotted, and the presentation techniques particular to each category, an outline of the custom conventions follows.

Site plans

These have drawn at a nominal scale of 1:500, convenient for its relationship to the smaller metric scales used in the other drawings (1:200, 1:100, 1:50) and also in being the scale adopted by the 1890s 'first edition' Ordnance Survey plans (and subsequently the Goad fire insurance plans). Wherever possible they are printed at this scale, or where impracticable 1:1000 for better comparison with other drawings. The current OS Landline scale of 1:1250 is not used.

The plan outline of a building is shown with a heavy line, while a lighter weighting is used for internal partitions, divisions or junctions between buildings. Heavy dashed lines are used to represent building thresholds open to the elements (e.g. canopies, open sheds). Standard dashed lines indicate paths, kerbs, thresholds, and other overhead or landscape features (e.g. areas of planting, beams of travelling cranes, etc.)

Underpasses or archways are a common feature of many sites, and are indicated by standard lines with a dashed cross inscribed.

Tone and colour are used in various ways, accompanied by a key or description, including consistent use of blue for water and green for fields or landscaping. The extents of a site are represented either by heavy red outlines or by a general pink fill.

Building uses and descriptions are referenced by number, with a corresponding key. Topographical features and street names are printed on the plan.

Isometric site drawings

Isometric projections have been adopted to augment the more subjective contemporary topographical views of works, and to represent structures and sites not recorded visually elsewhere. Comparisons of contemporary prints with the reconstructed scale projections reveal much about the way these buildings were perceived in their time, and the extent to which their appearance and layout are idealised by the documentary evidence.

Projections are made on a base drawing derived from the scale site plans prepared as above. These are plotted to a true isometric scale of 1:500, so the actual measured length along the planes of projection is proportional but not equivalent to that in plan and elevation. Although final images are traced by hand, overall accuracy is generally within 500mm (adequate for the presentation scale). Building features and apertures are resolved to an appropriate level of detail, and as precisely as information permits.

In most cases, more than one source has been used in the reconstruction of the volumes and features of the buildings depicted. In the absence of pictorial evidence, buildings that can be reasonably reconstructed on the basis of their typological characteristics are represented as simply as possible, with a minimum of detail (e.g. fenestration, chimneys). Where no typological inference can be made, buildings are represented in plan outline only, rendered without tone in order to distinguish them from flat site features (i.e. paths, rails, kerbs).

Generally, the plan is oriented so that the formal 'front' of the building or site is at the left foreground, aligned with the respective isometric plane. Only in cases where important features would be obscured by this orientation is an alternative adopted (e.g. Huntsman's Coleridge Road works).

Shadows are projected according to the standard architectural convention, incident on the front elevation (i.e. from an angle of 45 degrees in all three planes, or from the top left, behind the observer). In practice, this means that the apparent source of light is to the top left of the drawing (at infinity), running parallel to the plane of the paper. Note that, for simplicity, only attached shadows are shown (as opposed to cast shadows, which tend to overcomplicate the image). This simple modelling is intended primarily to assist in the differentiation of volumes, rather than as a depth cue.

The site area under the immediate occupation or use of the works is rendered a pale uniform tone, to distinguish it from the surrounding properties or public streets.

Orthographic drawings and re-drawings

As mentioned above, sections, elevations and building plans are drawn to metric architectural scales of 1:50, 1:100, 1:200. Detail drawings may be presented at scales of 1:10 and 1:20. Where drawings are adapted from imperial or surveyors' scales, or required to fit within the format of the thesis, non-standard scales are occasionally adopted.

Orthographic drawings, whether plotted from CAD data or traced by hand, are resolved to an appropriate level of accuracy dependent on the scale of presentation. Where the condition of an original drawing or map precludes its use as illustrative material, redrawing may be necessary. In such cases, the drawings are clearly labelled 'redrawn by the author', and generally retain all discernible features and emphasis of the original, at the same or similar (in cases of imperial measurements) scale. Redrawings may also be made for the purpose of

visual analysis, or comparative plans representing the stages of a building's / site's development.

Survey drawings are based on field measurements taken by the author (or otherwise as credited) and plotted to scale. Where field measurements are used as the basis of a reconstruction, this is indicated by the descriptive title. Reconstructed field measurements from the Fairbank Collection of surveyors' papers constitute a special case, and are covered in the following appendix, 'Survey techniques used by the Fairbanks'.

Elsewhere, reconstructions may be based on a number of sources of differing scales, dates and levels of accuracy. Numerically recorded values (areas, lengths) are often used in conjunction with map information; partial building plans with more comprehensive (often more recent) Ordnance Survey plans; bills of quantities with site plans or residual building geometries. In these cases, scales are chosen appropriate to the primary sources, which may require the use of other scaled information beyond normally accepted tolerances (most usually Ordnance Survey maps). Where drawings contain information resolved beyond the intended scale, they may be labelled 'schematic'. If scaled drawings depend upon circumstantial geometric assumptions, typological precedent, or the judgement of the author, they are in all cases termed 'hypothetical reconstructions', or where accuracy may be reasonably corroborated, simply 'reconstruction'.

In some cases, human figures are added to assist in the reading of scale, particularly where common architectural features–windows and doors, for example–are disproportionate to those commonly found in domestic construction (e.g. melting shops).

Background detail, rendered in the finest weights of line, is used to represent elevational detail or structures located behind the principal sectioned volumes (e.g. chimneystacks, outbuildings, perimeter walls). Where dashed, detail lines represent hidden features such as staircases, flues or cellars.

Solid walls, sections and poché are rendered in a uniform tone or colour for clarity. In section, cut fabric and the ground level are both indicated by a consistent fill; foundation details may be represented in outline. In elevation, ground level is indicated by a simple heavy black line.

Shadow projection is used selectively in cases where it may be an aid to interpretation, either in distinguishing inside and outside, or as a depth cue. Differentiation of materials by tone or colour is governed by the same criteria.

Annotations

To prevent drawings and diagrams becoming obscured by text, numbers are used to refer to functions and features in plan and presented in an accompanying key. This allows more information to be provided than would otherwise be possible in a small format. Contextual

labels such as street names, rivers, landscape features, etc. are included as text. In the case of sequential development drawings, one master key is used for all instances of the plan, inserted alongside the first instance of its appearance.

Survey techniques used by the Fairbanks

The Fairbank firm of surveyors, although operating from the middle of the eighteenth century, used methods and equipment that were well established over one hundred years before. Like most practising surveyors, they deprecated the use of the theodolite and plane-table, favouring the simple methods of chain and azimuth surveying circle.[1] Gunter's chain of four perches divided into 100 links had simplified the surveyor's job by enabling decimal calculation of areas, and became the standard equipment of land surveyors in the seventeenth century.[2] The Fairbanks also used their own metric system for building surveys, dividing the yard into 100 sub-units thereby dispensing with the use of feet and inches.

Chain survey

The basis of chain surveying is trilateration, analogous to triangulation (setting out points by means of triangles) but without the measurement of angles. Where the lengths of all three sides of a triangle are known, the relative locations of its corners can be found either by geometric construction on the drawing board, or by mathematical calculation.[3]

In some cases where full trilateration was not possible, the Fairbanks would resort to what might be called 'quadlateration' with a check line in one corner. This tended to be used in built-up areas where the size of survey or obstacles to direct measurement posed problems.

Compass traverse survey

This method was used for the larger land surveys, with linear distances measured by chain and angular bearings by compass. The Fairbanks were well aware of the variance of the earth's magnetic field, and the margin of error this introduced, and usually took measurements to form a closed polygon.[4] This way, closure errors were corrected by distributing the difference across all of the bearings. In the Fairbank field books, this type of survey is identifiable by the presence of compass bearings (i.e. 25°10'NE).

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[1] Ayres (1998) pp. 28-33.
[2] Chilton (1957-59) pp. 111-129.
[3] A similar practice, based on Pythagoras' 3-4-5 triangle, had been used since antiquity for setting out right angles with a knotted string
[4] On their 1808 town plan, the north arrow includes the margin of error recorded at the time of the survey, with the caption 'Variation of the Needle 24°.6'.30"'.

For setting out plots, 'arrows' (foot-long metal skewers with a loop-hole in the top for a fabric marker) were used to mark its extents, and taller poles with flags on top for marking station points.

Graphical conventions

Chain lines: The beginning and end nodes of a chain line are customarily marked by a hollow circle, in order to distinguish the unbroken chain line from a landscape feature. Zero point is usually not annotated, while measurements relating to features along the chain line (including the position of offsets) tend to be written parallel with the line's length, oriented according to the direction in which the line was to be read.

Trilateration: A group of three interconnected chain lines, some or all of which may extend beyond the 'triangle' formed. Both ends and intersections of chain lines are marked by hollow circles; only the contextual continuation of measurements indicates whether or not a chain line ends at an intermediate node.

Offsets: Perpendicular offsets from a chain line are never indicated by a drawn line, but only a numerical dimension written perpendicular to the chain line, so that the beginning of the chain is below and the end above. Where the chain line is coincident with a landscape feature or the face of a building (i.e. zero distance), this is nevertheless represented by a gap with the number '0'. Non-perpendicular measurements that do not constitute a chain line in their own right are shown by a dashed line running from the intersection with the chain line or landscape / building feature to the destination point. Dimensions are parallel with the dashed line.

Running dimensions: Following good surveying practice, the Fairbanks used running dimensions wherever possible. In cases where measurements were taken serially, they are distinguished by the insertion of '+' symbols between successive individual dimensions.

Ownership boundaries: Boundaries often appear as landscape features, even if undefined in reality; to avoid confusion, fence walls are differentiated by appearing as double lines (often the width of the wall is inscribed within its thickness).

Building hatch: Lined hatch patterns take on a variety of meanings in Fairbank surveys, depending on their type, direction and scale. Most commonly found is the single diagonal hatch, universally denoting built fabric and concentrated towards the edges of structures. Distinct premises adjoining one another along a street are often represented by alternating the direction of the hatch. Elsewhere similar hatch patterns are allocated to buildings belonging to the same owner. Where a particular structure is the object of the survey, it may be represented by cross-hatching. Less commonly, an absence of hatching in an otherwise hatched survey drawing may indicate an open or dilapidated structure (e.g. the portico of the Norfolk Street chapel; Huntsman's first furnace). As hatch was used for the convenience of

the surveyor, it is often applied sparingly and only where necessary to identify building from landscape.

Units: Sometimes one survey would contain two or more different units. The primary units of a survey are rarely stated explicitly, but are usually easily identifiable by context (building surveys in metric yards, land surveys in links and perches). Secondary units are usually confined to particular areas of the survey and identified by an abbreviated suffix or word (Ft, Feet; Sq Yds etc.) in each and every case.

External references: Throughout the Fairbanks' work, extensive use was made of the library of information collected by the firm over the years. Textual references in the title of a survey or within the drawing itself often point to external sources from their past collection, or related pages within the same volume. Where the constraints of the page or an excess of detail curtail the extents of a drawing, its continuation is often to be found on the following page (with minimal duplication of lines and dimensions) or as an inset on the same sheet space permitting.

Method of reconstruction

- Begin with the principal chain lines–identify by length, start points (circular nodes), trilateration.
- Set out major triangles, or fix longer lines with check line; any incomplete measurements are examined for bearings or relationships to known fixed features (rivers, other buildings, etc.) that may have been measured elsewhere.
- Plot offsets of major features.
- Check fundamental survey structure against any corresponding OS plans (1:1056 scale 1850 edition if possible) for accuracy.
- Plot remaining offsets and other measurements (sides of buildings, etc.). Where assumptions have been made (regularity of orthogonal buildings, lengths of 'equal' parts, implied measurements, etc.) check against any supporting evidence (OS plan, other surveys, field remains).
- Transfer other information, such as cardinal points (on older surveys, located centrally to the page margins) hatch patterns, ownership names (noting position of words–often used to indicate extent of property), street names, land areas.

Journals and diaries relating to Sheffield

(Year of visit followed by publication. Those with major industrial content marked *.)

Defoe, 1724-1727.

Young, Arthur, 1770 (Young 1770).

Bray, William, 1777 (Bray 1783; based on Young).

Sullivan, R J, 1778 (Mavor 1798).

*La Rochefoucauld Brothers, 1785 (see Scarfe 1995 *Innocent Espionage*).

Skirne, 1795(?) (Skirne 1795).

*Hatchett, Charles, 1796 (Raistrick 1966)

'A Gentleman of the University of Oxford', 1797 (Mavor 1798).

*May, J G, 1814 (Henderson 1968).

*Fischer J C: 1814, 1825, 1827, 1845, 1846, 1851 (Schib 1951, *Tagebuecher*).

*Escher, Bodmer, May, de Gallois, 1817 (Henderson 1968).

*Eichthal, Gustave d', 1828 (Ratcliffe / Chaloner 1977).

*Phillips, 1828(?) (unpublished; Sanderson's company magazine *House of Saben*).

*White, William, 1858(?) (White 1858).

Other sources

Goodwin, E, 1764 (*Gentleman's Magazine* vol. 34 April 1764 pp. 157).

Engels, F, 1844 (Engels 1845).

The Builder

Novels

Samuel Roberts, *Tom and Charles* (1835) 2nd ed.

Reade, *Put Yourself in his Place* (1870).

Dickens *Hard Times* (not based on Sheffield, but he had visited the town, and satirised the characteristics common to many British industrial towns).

Chronology of significant industrial premises

[italicised = outside of Sheffield]

Where known, date ranges indicate construction period of works. Otherwise dates represent the (earliest known) beginning of work at a particular site.

date	*proprietor*	*name of premises*
c.1709	Shore, Samuel	Furnace Hill Steel Furnaces
1751	Huntsman, Benjamin	Worksop Road furnaces (6 holes)
1761	*Boulton, Matthew*	*Soho Works, Birmingham*
1764	Cutlers' Company	Scotland crucible furnace (4 holes)
1766	Love & Spear	Gibraltar crucible furnace (3 holes)
1769	*Wedgwood, Josiah*	*Etruria factory*
1785-6	Proctor & Beilby	Park Steam Wheel
1789	Joseph Ward & Co.	Cleakham Steam Wheel
1793	Kenyon & Frith	Ponds Forge Mills
1802	*Peter Stubbs*	*Warrington*
1803-5	Proprietors	Soho Grinding Wheel (Coulson Crofts Steam Wheel)
1814-20	Naylor & Sanderson	West Street Steel Works
1818-20	Beckett & others	Union Grinding Wheel
1819	Butcher, W & S	Eyre Lane Works
1823-25	Greaves, William	Sheaf Works
1824-25	Ibbotson, W & G	Globe Works
1826-	Naylor Vickers	River Don Works (Millsands)
1832?	Marshall	Castle Grinding Wheel (Tower Wheel)
1832	Fairbank	Proposed Thomas Street Wheel (unbuilt)
1845-	Johnson & Cammell	Cyclops Works (first in Don Valley)
1849-	Thomas Firth & Sons	Norfolk Works

1851	Mappin	Queen's Cutlery Works (converted from coach factory)
1851	Jonathan Beet, Sons & Griffith	Agenoria Works
1857	Bessemer *et al.*	Bessemer Works, Sheffield
1862-66	Vickers	River Don Works (Brightside)

Appendix 1.1

Huntsman's steel purchased from the Fell trade

Source: Barraclough (1984) vol. 2, author's conversions.

year	*cwt*	*tons*	
1748	1.13	0.06	[127 lb.]
1749	11	0.55	
1751-55	c. 40	'just over 2 tons'	
1757-58	41.5	2.08	
1758-59	67	3.35	
1759-60	61.25	3.06	
1760-61	53.25	2.66	
1761-62	72	3.60	(at this time, Robsahm claims annual production was 8 tons p.a.)
1762-63	54.75	2.74	
1763-64	93.75	4.69	
1764-65	194	9.70	

Steel purchased from the Cutlers' Company

1767 (23 May)	4.5	0.23
1768 (10 Feb)	25+3.5	1.43

In 1805, iron intake was 50 tons (by this time he was converting and selling his own steel).

The sharp rise in iron purchases which began with 93.75cwt in 1763-4 and rose to 194 cwt in the following year may have simply reflected Huntsman buying an increasing proportion of his iron from the Fells.

Appendix 1.2

Huntsman's origins

The publication of Samuel Smiles' account of Huntsman's life (Smiles 1863) brought much hitherto unknown material into circulation. Smiles claimed that his account was written 'with the assistance of [Huntsman's] descendants', but unfortunately provided little supporting documentary evidence.

Perhaps most contentiously Smiles believed that Benjamin Huntsman's parents were German immigrants, who 'had settled in [England] only a few years previous to his birth.' This assertion can, however, be shown to be incorrect. Benjamin's father, William, was born around 1673 in Epworth, North Lincolnshire (film no. 452050) while his mother, Mary Nainby, was from a Quaker family residing in Brigg, twenty kilometres to the east (born c.1677 and married in Calstrop or Castlethorpe c.1698, film no. 458215).

While it has not, as yet, been possible to trace William's ancestors, clues to the origins of the family can be found in the patterns of geographical distribution extracted from records relating to individuals sharing the Huntsman name. The following analysis is based on almost 1000 records available on the International Genealogical Index (at www.familysearch.org), which have been categorised by date, place-name and district.

It is generally difficult to demonstrate family connections of occupation-based names such as Huntsman, but in the case of the Lincolnshire Huntsmans, a peculiar statistical pattern emerges.[5]

Of all the Huntsman records for England from the sixteenth to nineteenth centuries, over half (52.8%) were from the two neighbouring counties of Yorkshire and Lincolnshire. Particular concentrations occur in the villages of Brantingham (93 records) and Epworth (46) in Lincolnshire and about the towns of Doncaster and Sheffield. While the majority of the Yorkshire records postdate Benjamin's residence there, many of those from Lincolnshire date back to the seventeenth century. Of particular interest is the Brantingham cluster, the largest in the country outside of London (142). Almost all are from the seventeenth and eighteenth centuries, and many contain an unusual variant of the name, 'Hunsman'. In total, 30% of the Brantingham records contain this spelling. Moreover, all 27 seventeenth century records are in the name of Hunsman, the oldest of which relates to the marriage in 1644 of one Bartholomeus Hunsman of South Cave, a small village just over two kilometres to the northeast of Brantingham. Peppered around this village are place names that suggest a

[5] Hulme pointed out that 'The name Huntsman indicates the office of the man in charge of the hounds and stable belonging to a corporation or an individual' and that 'to suggest that all Huntsmans are derived from a common stock is too absurd to need refutation.' Hulme 1943-45 p. 41.

connection to the Hunsmans – Hunsdale Farm, High Hunsley (a village, now depopulated), Hunsley House, Little Hunsley, Low Hunsley Plantation.[6]

Although no direct genealogical connection has been made to the Brantingham Hunsmans, the name itself may indicate a relationship. A watch made by Benjamin was said to bear the inscription 'B. Hunsman', while his son William's 1781 bankruptcy records are in the name of 'Hunsman'.[7] Despite this, the more common 'Huntsman' was generally used.

A longcase clock made by Benjamin Huntsman is known to have belonged to the Ferguson family of Walkington, Yorkshire from 1750; this is the next village along from High Hunsley and constitutes further evidence that he had a personal connection with the area.[8]

Even more significantly, is the marriage in 1705 of Thomas Huntsman of Elloughton with Brough, Yorkshire and Jane Nainby of Brigg, just seven years after the marriage of William Huntsman (Benjamin's father) and Mary Nainby of Calstrop (Castlethorpe, near Brigg; see above).[9] Circumstances suggest that William and Thomas were brothers, strengthening the Epworth - Brantingham connection (Elloughton is less than a mile from Brantingham).

Two records for a Thomas Hunsman of Brantingham have been found, one christened 26 Dec. 1677 (father Robert Hunsman, mother Mrs. Robert Hunsman) and the other Thomas S Hunsman born (or christened, according to another record) 6 Feb 1686 (father Robert Hunsman). Either of these may have been William's brother. In all, there are seven children with Robert Hunsman as the father's name, none called William, but including an Elizabeth, Anne, John – all names featuring in the subsequent Epworth Huntsman generations. Their mother was called Katherine, and Benjamin's brother named his children Elizabeth, Catherine, William. While these are common names for the time, it was also usual for families to be parsimonious in the allocation of names.

The family were probably of northern European origin, from the Netherlands or Germany. There is a particular concentration of the name 'Hunsman' in Westphalia, although it may have been derived from the more common 'Hansman' found throughout Flanders, the Netherlands and Germany (as in 'Hansa', denoting towns of the Hanseatic League) and may have arrived in England as late as the seventeenth century. It has been plausibly suggested that Benjamin's grandfather may have been one of the Dutch labourers who were employed by Cornelius Vermuyden in the drainage of Hatfield Chase and the Isle of Axholme around 1626, although from this date it is more likely to have been his great-grandfather.[10]

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[6] Of the twelve occurrences of the name Hunsman occurring outside Brantingham, most are male marriages, traditionally held in the bride's parish, and christenings of the resulting children. It is possible that many were from the Brantingham family.
[7] The watch is kept at the Ashmolean Museum, Oxford; see Hulme (1943-45) p. 48, pl. II. For the bankruptcy notice see *The Gentleman's Magazine*, May 1781, vol. 51, p. 244; also chapter 1.
[8] Web reference: www.bgantiqueclocks.com/longcase_pages/clockc98.htm (June 2002).
[9] Hulme (1943-45) p. 48.
[10] This was situated about 25 km to the southwest of Brantingham; see Hulme (1943-45) p. 47, correspondence from Mr. Rhys Jenkins.

Bartholomeus Hunsman (of the oldest record, married at South Cave 28 Nov 1644 to Isabella Baley) is the most likely common ancestor and original immigrant – his forename was one frequently found in the Netherlands at the time.[11]

Plotted onto a plan of England the pattern of residence becomes clear. [fig. 1.81] Over one-sixth (17.2%) of all English Huntsmans came from within 15km (9.3 miles) of South Cave / Brantingham, over one-fifth (21.8%) from within 25km and almost one-third (29.2%) from within a circle of 30km radius as the crow flies (18.6 miles, or approximately one day's walk), although this does not account for the geographical barrier of the Humber Estuary.

There is clearly potential for further work in this area. Even by the time of Baine's 1823 Directory, the category 'Professions and Trades' for North Frodingham includes an entry for 'Huntsman, Rob[er]t', a blacksmith. It may also bring to light facts about the organisation of the family firm, such as the likelihood of Benjamin having employed a member of his sister-in-law's family as apprentice.

In 1725 Huntsman took on an apprentice, Davey William Harrison, at an unusually high premium of £20 (that of his first apprentice had been £4).[12] He may have been a friend of the family, as Benjamin's brother William married a Faith Harrison in 1738. It would also be interesting to determine whether there was any connection with the clock-making Harrisons, as John was born in Foulby (aka Feuby) in Yorkshire in 1693, his family moving to Barrow-upon-Humber (about twenty miles from Epworth, ten from Brantingham) about four years later, where he trained first as a carpenter. Still more tempting is the potential for a technological connection between the watchmaker Benjamin Huntsman and his close contemporary John 'Longitude' Harrison. It is not known whether Harrison's important H4 chronometer benefited from the improved watch-spring technology introduced with Huntsman's crucible steel, or even whether there was a family connection between the Huntsmans and the Harrisons.

[11] There is also a record for an Anna Huntsman of South Cave born c.1679 and Elizabeth Hunsman of Kirk Ella, christened 29 Nov 1694, father Bartholomew Huntsman.
[12] Hulme (1943-45) p. 37.

Appendix 1.3

Huntsman letters from the Boulton Archive, Birmingham

SCL Archives PhC 373 (transcribed by the author).

Letter 1

To Mr. Benjm. Huntsman in Sheffield — Birmgm. Janry. 19th 1757

Respd. Friend

I Recvd. thy favour of ye 20th of Decemr. & have agreeable thereto sent Pr. Weston ye carrier ye underneath Goods wch. are of ye newest Pattns. & hope will meet wth. thy Approbation. I have Chargd. them at ye lowest price & because thou shalt have them upon as good terms as any man I will allow the £10 Pr. Ct. Disct. I am in no immediate want of Steel but when thou hast any of a proper size & quality for me & an oppertunity [sic] of sending some thou mayst, but should be glad to have it a little tougher than the last wch. is a Quality our workmen complain it wasts [*sic*] much; & of consequence have a great deal of wast. Let it be mostly of ye middle size.

I hope thy Philosophick Spirit still laboureth within thee & may it soon bring forth Fruit usefull to mankind but more perticularly [sic] to thy Selfe is the sincere wish of thy

Obliged Friend MB

Letter 2

Mr. Boulton — Sheffield 7 July 1769

Resp. Fr[ien]d

I have rec'd yours this day as I was gone from home could not ans[wer] you sooner. I will send ye the Steel on Mond[a]y fortnight & my Son will send you a few Slabs for Buttons on Mond[a]y next [illegible] with due respect y[ou]r obliged friend

B Huntsman

Letter 3

Mr. Mattw. Boulton Sheffield 1 Sep. 1781

Esteem'd friend

As I am now at Liberty & begin[n]ing my steel manufactory again though[t] it proper to write to a few friends & Request there [*sic*] orders & there friendship by Recommendg. my steel to their friends as I have improved my Roll'd steel & steel for Toys so that it will not Rust so soon as steel made by other Steelmakers w[hi]ch will make the goods more saleable abroad & of great advantage to the Manufactors.

Should you be kind to send me a small order you'l[l] be satisfied w[ith] the Quality & beauty of my steel[. Y]ou are the first person I have wrote to upon this subject nor should I wish to sell steel of the above Q[uali]ty to any other merchant [in] Birming[ha]m. If you think well to make a Tryal it hardens very well. When its convenient shall be very thankfull to Receive a letter from you & remain truly ye obliged friend

Wm. Huntsman

The price of my steel will be 4.4.0 for 112w

Letter 4

Mr Mathw. Boulton Sheffield 4 May 1788

Esteem'd Friend

I take the liberty of writing to you to make an offer of serving with my fine steel for the Manufactory into fine goods the Quality of my steel you are no Stranger too [*sic*] & make no doubt though the price is more than what some other people sell for you'd find it as much superior in its Q[uali]ty & the goods much better when finish'd my steel will not rust nor speck so soon as other steel should be glad to receive your order for a Quantity for Tryal either Roll'd or Tilted for dies, beds & punches &c. as I will Serve you upon the most Reasonable terms I do my other friends you may have what Quantity you please & with Regard to payment shall only desire to [illegible] in a Year I sell a great deal of small forg'd Round Square & Flat drawn [bars] all if you [illegible] any yourself in ye Manufactory shall be thankfull if you'd recommend me to any of your friends A few lines from you will Be Greatfully acknowledge [*sic*] by your Assured friend

W Huntsman

fine Cast Steel Roll'd for the Birming D lb

Manufactory----------84/ for 112

Do. drawn square from 2 Inch Down to 1/4 In.----------84/ for 102

Do. Do. flat from 6 Inch to 3/8 & the thickness in proportion

as you may send some orders shall deal with your as w[hi]ch all mark [illegible] each piece of steel will be mark'd B.HUNTSMAN my markd hath been often Counterfated [sic] & Inferior sold for mine but the workman begin to find out the fraud.

Letter 5

To Mr Mattw. Boulton Sheffield 29 Sep 1791

Esteem'd Friend

I am this day facd. with yours of the 26 Jul & for answer inform you that your order for 1 ton of my fine Cast 1[1/4?] Inch thick & 2 1/4 br[oa]d which be put forward & sent as soon as possible. The great want of water at the mill am fearfull will hinder If Rain Comes shall [forward?] your order in 14 days & shall at all times Endeavour to Tender you my best service [illegible] further and will Oblige yr. Assured frd.

B Huntsman.

Letter 6

To Mattw. Boulton Esq. Sheffield 13 Sep 1794

Esteem'd Friend

shall take in Kind if you'l send me a Neat Japan'd silver mounted tea Kitchin it is for a very good Friend of mine I should wish to have such a one as you think the best & Neatest the sooner you order it to be sent me the more agreeable it will give me pleasure to Receive your orders & to Render ye Every Service in my power I purpose sending you a sword blade which you may mount as you please & shall be Glad of your opinion of [illegible] as am of opinion no person's steel will Exceed I am with due respect truly ye obliged frd.

B Huntsman.

The Sword blade will send on Thursday by the Coach.

[Note: The Huntsman ledger p. 67, 30 Sept. 1794, contains the related entry: 'By a tea urn omitted'.]

Appendix 1.4

Huntsman's land interests

Late eighteenth century

1751-1767 No evidence, although little reason to doubt this is different to the following.

1767 'Burgesses Land Held by B. Huntsman under Wm. Fullard' seems to be a very narrow strip just over the width of the cottage frontage, including original furnaces and running all the way to the back lane. (This is perhaps redolent in the 'garden' plot still distinguished by the 1819/20 survey.)

1772 Lease agreement for House. No areas given and no specific mention of furnaces, but from the context and names given, it is possibly the same property as the above. On the 1767 survey John Tyler is given as the owner of the site and cottage later to be Huntsman's Row; In the 1772 indenture he is referred to as 'John Tyler late of Attercliffe aforesaid Forgeman deceased' and succeeded by his son James.

1781 on William's bankruptcy, Thomas Gunning only took 0a 0r 13p (393 sq yds) of property, namely the extensions and grinding mill between the Burgesses land and William Crapper's. Clearly of very limited use for commercial production, and therefore more likely to be an award in lieu of unpaid debts.

1795 Jan 19 land occupied = 2a 3r 12p [13,673 m^2] (same until 1800; first mention of land area; RB)

1800 land occupied = 3a 3r 9p (same until 1806; RB) This is probably the 1a 0r 9p previously occupied by Mark Mexon, for which the rates were paid by Huntsman but separately itemised.

1806 land occupied = 5a 3r 25p (2a 0r 16p more; same until 1810, after William's death; RB) This is increased by almost the quantity later transferred to S. Foley.

1810 land occupied = 5a 3r 15p (same until 1815; RB)

1811 enclosure additions to John Huntsman = 0a 0r 29p (from: Paulus (1907) p. 46, 'Award no. 32'; also gained 1, 0, 27 land on Attercliffe Common - 'a strip off Greenland Engine Road' 'Award no. 89'; also p. 66 land held by John & Francis = 5a 3r 15p).

1815 April 3 land held = 4a 0r 15p (1a 3r 0p less; RB).

1815 valuation for rate, land held = 4a 0r 7p.

[calculation from 1819 Fairbank plan, based on digitised 1850 OS plan = 4a 0r 6.4p]

1816 Jan 8 land reduced to 1a 3r 38p (with 2a 0r 17p transferred to S. Foley).

No further rate book references to land areas until 1840 April 16, total 5a 2r 9p.

However, 1820 plan suggests ownership of 4a 0r 6.4p as above (including 'house, orchard, garden and road' occupied by William Bailey).

1819 Attercliffe map 12

owner	occupant	plot no.	description	area (a. r. p.)
Francis Huntsman	*Willm Bailey*	*319*	*House, orchard, garden and road*	*1, 0, 26*
"	*In hand*	*320*	*House and pleasure ground*	*0, 1, 30*
"	*In hand and others*	*321*	*Ten houses, steel furnace, warehouse, stable and yard*	*0, 2, 15*
"	"	*322*	*Upper and Lower Levick Croft*	*1, 2, 30*
"	"	*323*	*Garden*	*0, 0, 14*

[my total of above = 3a 3r 35p; 11 perches difference from calculated value]

30 November 1818:

41 F. Huntsman [note] £1 3s 7½d received £1 15s 7d

add– 9a 0r 27p £11 19s 0d 11s 11½d

11 January 1819: note alongside Huntsman 'Lindley', rate still £1 15s 7d.

1 February 1819: rate back to £1 3s 7½d.

see A176 [CA13-1] (1819) Attercliffe rate survey.

Darnall

	proprietors	occupiers			
XXII	*Francis Huntsman*	*Ralph Linley*	*132*	*Ant Hill Close*	*3a 2r 32p.*
			133	*Darnall Common*	*5a 1r 35p.*

Mid-nineteenth century

CB 1634 (n.d.) Ref to the Plan of the Estates of the 12 Capital Burgesses [no clear date, but probably early 19th century]

Attercliffe cum Darnall a. r. p. rent

Held from year to year

478		*Narrow Field*	*0, 3, 25*	
480	*Francis Huntsman*	*Bradley Nook*	*3, 2, 15*	*16,-,-*
481		*Pitt Lane*	*2,0,34*	

[the associated plan seems to have been lost]

These areas have all been identified with reference to field boundaries as shown on the 1850 OS plan, in all cases the margin of error being less than 1%. This was possible by the use of scanned Ordnance Survey data.

'Narrow Field' is almost certainly the land occupied by Huntsman's wharf, which can be identified in the 1859/60 rate books as the 'Grass field' of extent 0a 3r 24¾p (almost exactly as above; only 0.17% difference).

The wharf is first mentioned in the rate of 21 June 1840, gaining its warehouse by the 4 August 1843.

The previous rate of 16 April 1840 gives Huntsman's land as 5a 3r 9p, having a rateable value of £16 15s 0d (relatively close to the sum total area of Bradley Nook & Pitt Lane).

The wharf ceases to be listed in the rate of October 1860 [purchased for the SYRC railway extension] with the subtraction of 0a 3r 24.75p of land, from 4a 2r 25¾p, as listed in RB389B (April 1860) leaving 3a 3r 1p (see below 'Bradley Nook' in 1859).

Total is still 3a 3r 1p on 6 January 1866.

'Bradley Nook' must be the area of fields behind Huntsman's works, not including the grounds of the works or house which were separately listed in RB389A May 1859, as:

[house] *1a 2r 9.5p*

[works] *0a 1r 39.25p*

...

[weigh house] *0a 0r 34p*

...

[grass field] *0a 3r 24.75p*

[grass field] *3a 3r 1p*

All are verifiable using the digitised 1850 OS plan.

On the plan, the most likely area for Bradley Nook comes out at 3a 2r 14p [14532 m²], being the three clearest fields combined (this is only 0.17% different to the measured area).

('John Bradley of Darnall ... Wheelwright' is mentioned in the lease of 1772 [PhC 445(c)] for a cottage, barn, smithy & garden & well in Attercliffe; also signed and sealed in his presence. The association of the name Bradley is further evidence for the suggestion that the 1772 lease is for Huntsman's house and works – confirmed as occupying the fields including 'Bradley Nook'.)

In the May 1859 rate, a second 'Grass field' of 3a 3r 1p probably represents the same field plus a portion to the northeast. [fig. 1.82]

MB422 pp. 2, 7, distinguishes between 'Long Bradley' and 'Short Bradley' [both?], along Bradley Nook Road. Long Bradley is probably the field to the west of the works and gardens and south of the Weigh House; Short Bradley the field behind the works; the Back Lane (which gave its name to 'Back Lane Bridge') is probably Bradley Nook Road (see 1850 OS plan).

'Pitt Lane' is very close in area to the combined works and house area (not including weigh house) based on the 1819 ownership boundary and not including those parts which constitute Bradley Nook. On the CAD plan the area is 2a 0r 33p. (0.28% difference). [fig. 1.83]

Each of the areas corresponds very closely to the rate book measurements, and shows that the bulk of Huntsman's land was 'held from year to year' of the Twelve Capital Burgesses. The Burgesses names for the land appear to refer to the original field names.

Other land acquired by Francis on a piecemeal basis (e.g. the Weigh House furnace) does not seem to be included, perhaps as a result of his purchasing the freeholds?

'Helliwell Sicks'

CB 1581

William Huntsman had an interest in this land from 1807. (An indenture of 12 & 13 June of which he was the fourth part; and was the plaintiff in a fine of Trinity Term 47th George 3rd).

CB 1579-1585

In the large indentures of 1855-7 the three closes of the Helliwell Sicks are included. The total sum involved was £1439,17,4 and interest. [CB 1585 (12 Jan 1857) indenture; CB1579-85 (1855) Fulwood/Attercliffe lands, plan 25 March 1871; also SCA CB864 to Henry Holmes, upper and lower Helliwell Sick from 21 June 1848.]

MB422 p. 3, 'Helliwell Sicks' occupied by 'Edwd. Pass'.

Abstracted sources for Huntsman's land (with plans unless otherwise stated)

Not including rate books, Fairbank surveys.

Bagshawe 297 (n.d.) p. 20, nos. 15a & b. William Huntsman, Balm Green, occupant of a house and some vacant ground.

CA13-1 (1819) Attercliffe rate survey, also includes Darnall.

CA VA3 (1840) Attercliffe valuations, Paul Bright and William Unwin. (No plan).

CB864 (1848), to Henry Holmes, upper and lower Helliwell Sick from 21 June 1848.

CB 1579-1585 (1855-57) Large indentures of land, amounting to a total of £1439 17s 4d with interest (see CB 1585, 12 Jan 1857); also Fulwood/Attercliffe lands (1855), plan 25 March 1871.

CB 1634 (n.d.) 'Ref to the Plan of the Estates of the 12 Capital Burgesses'

'Attercliffe cum Darnall. Held from year to year ... Narrow Field ... Bradley Nook ... Pitt Lane'. (The associated plan seems to have been lost).

FBC FB 267 (1846) p. 23 'Darnal–Sketch of the premises there adjoining the Burgesses property where the encroachments are supposed to have been made viewed with Mr. Huntsman 30 July 1846'. (No plan; an unidentified and implicit reference to Huntsman's land).

FBC MB422 (between 1828 and 1842), 'Sketches of part of the Estates of the 12 Capital Burgesses', p. 2, Attercliffe: fields in Fras. Huntsman's possession – 'Prior Rue', 'Long & Short Bradley' (along Bradley Nook Road; 'Prior Rue' is on Worksop Road, close to canal and bridge); p. 3, 'Helliwell Sicks', now under Edward Pass; p. 7, Francis Huntsman's land at 'Long Bradley'; p. 15, note that Francis' leases expire at Michaelmas 1842, estd. £20, at 14 year leases (therefore from 1828?); other miscellaneous notes.

FBC MB435 (n.d.) p. 12, Land of J & F Huntsman, bounded by land of the Duke of Norfolk and John Deakin.

MD 3938 (c.1859). 'Huntsman & others' property on Attercliffe road, adjacent to site facing Chapel street (4645 *sq yds*).

MD 3941 (27 Feb 1868). Lease of a dwelling on Sheffield to Rotherham turnpike road (Attercliffe road?), annual rent £18, other names included.

SYCRO 548/B 1/32 'Deed .. of absolute sale [to Benjamin Huntsman] ... of four undivided sixteenth parts or shares of [the Wicker Tilt] ... for £1700'. Also see plan at 1/41.

SYCRO 141/B (1842) second reel, Valuation of the Township of Ecclesall Bierlow, Shepherd, Fowler and Robinson, Sheffield, plan no. 296. Huntsman named as the owner of 2 tenements and 6 houses on Greystones Road (these still exist).

TT111 (12 Aug 1867) Deed for the widening of Lady's Bridge (Huntsman's property on corner to north, with buildings).

YWD 1430, 1475 [Younge Wilson Deeds] Greystones property as above, beginning 15 & 16 July 1811 (Agnes Huntsman widow) until 16 Jan 1850.

YWD 976 (1898) Papers of Attercliffe Estate Co. including some leases and conveyances of small pieces by Benjamin Huntsman.

Units

Acre = 4046.9m² = 4840 *sq yds* = 4 roods = 160 perches

Rood = 1011.7m² = 1210 *sq yds* = 40 perches

Perch = 25.29m² = 30.25 *sq yds*

Appendix 1.5

Huntsman's Attercliffe works from the 1859 rate books

Source: RB389A, First rate, May 1859, pp. 93-4.

Owner / occupier: Francis Huntsman.

Description	*Extent (a r p)*	*Gross estimated rental (£ s d)*	*Rateable value (£ s d)*
Dwelling house		36,8,-	
Out kitchen		9,2,-	
Stable & carriage house		4,15,-	50,10,-
Hen roost		2,6,-	
Gardener's shop		-,10,-	
Wire poultry cage		1,-,-	
Vine house, hot bed			
+ Brick summer house			
Yards, pleasure grounds			
Gardens & orchard	1,2,9½	12,-,-	12,-,-
Ornamental grounds			
Steel manufactory	-,1,39¼		
2 Converting furnaces		50,-,-	
Charcoal place		8,11,9	32,10,-
Iron warehouse			
Steel warehouse		11,2,-	
Office [=counting house]		5,2,-	

Smith shop		1,13,-	
Smith shop		3,7,6	45,10,-
Sheds, stables [+ cowhouse]		3,3,-	
Melting furnace		25,16,-	
Clay room			
Melting furnace 12 holes		6,-,-	
Pot room, scrap place			
Coke place			
Chamber over cottage		1,12,-	2,7,6
Yard & out buildings		1,16,-	
Garden		-,16,-	-,16,-
Wharf & warehouse	-,-,34	5,11,-	4,3,3
Melting furnace			
Steel & pothouse		20,-,-	
Coke house			
			32,13,6
Iron warehouse			
Converting furnace		25,-,-	
Yard			
Grass field [=land by wharf]	-,3,24¾	10,-,-	10,-,-
Grass field	3,3,1	11,1,8	11,1,8
			TOTAL: 202,-,-

Appendix 2.1

Bills of quantities relating to the Cutlers' Company crucible steel furnace

All measurements of length are in decimalised yards unless otherwise stated [0.9144m].

R = rood (of c.7 square yards)
F = foot

FB 26 pp. 6-7

The Corporation Steel Furnace in Scotland slating by G. Blagdin 26/11/1763

					£ s d
17.60 by 10.25		at 3'6"0 per Bay		198.00 or 3.96 at 3"6"0 per Bay	13"1"4¼
	100				
Walling:	Front	by 5.70	280.89		
	Back	taken half a yd.			
	Ends	below the			
	&	threshd.			
2 G[able] Ends each 7.14 by 3.25			23.20		
Chimney Pipe 9.97 at 2/ per yd.					0"19"11¼
Fence Walls, to the East side 18.20 by 4.00			75.40		
		.65			
to the West side ranging in a line with the face of the coping of the lower pt. & taken the same depth as the lower corner		24.00 by 4.55	109.20	504.81 or 72.115 at 12"6 per R	45"1"5¼
above that line betwixt the two ramps		9.25 by .83	7.87		

from the upr. Ramps the corner above the same line	3.25 by 2.60	8.45	
To the Front 13.20 by 3.92 at 13"6 per Rood		51.74 or 7.39 at 13"6 per R	4"19"9
		Examd.	£64"2"5¾
		Levelling the yard according to agreement	10"10"0
			£74"12"5¾

FB 26 pp. 82-83

Clay House & Pot House at the Steel Furnace in Scotland

~~Roof~~ Carp[n]. work 2/3/1764

				£ s d
Roof Framing	9.45 by 4.53 at 3/ per Square	42.80	3.85 at 3/–	
Side Trees	1490 by 65 by 60	5.81		
	1490 by 56 by 60 at 1"2	5.00		
	1460 by 65 by 62 per F	5.88		
	1460 by 65 by 62	5.88		
		2.57		
Spars	19 each 4.53 at 3D per yard		86.07 at 3D	1"11"6
Top Pann 29.18	28.35 by .50 by .31 at 1"2 per F .83		4.52	
Bottom Penn 9.72	9.45 at 4 per yard .29		9.72	
2 Doggs each 3.75			7.50	
Lintels over the door 3.80	at 4 D per yard		3.80	
Other Lintels 5.05			5.05	
			26.07 at 4	0"8"8¼
3 two light windows at 1"2 per Light				0"3"6

Door Case	3"6			0"3"6
Door 2.04 by 1.16 at 2"8 per yard			2.36	
Great Gates 2.74 by 3.62 @ 2"8 per yard			9.91	
			12.27 at 2"8	1"12"8½
Heart Trees 8.10 by	63 by 32 slabbed at 1"6 per F		3.13 at 1"6	0"4"8¼
	58			
Rails	20.00 at 3½ per yard		23.22 at 3½	0"6"9¼
	3.22			
Top Rail	4.00 at 6 D per yard		4.00	
Upright piece in the Middle 2.87 at 6 per yard			2.87	
			6.87 at 6 per yd	0"3"5
Posts 12.00	by 1.40 by .64 at 1"4	21.50 at 1"4		1"8"8¼
12.00				
2 Spurns within Ground each 3.00 by 66 by 66		@ 1"2 per F	12.67	
Middle piece in Ground 2.50 by 66 by 66			11.08	
			30.78 at 1"2	1"15"10¾
Window shutts each 1.24 by 1.01 @ 2"0			at 2"0	
wood & workmanship			3.75 at 2"6	0"9"11½
				£8"10"3
				3"6
				£8"13"9

FB 26 pp. 92-93

Clay House & Pot House in Scotland brickwork by G. Blagdin 13/3/1764

Front 9.27 by 2.70	BL @ 2/	25.02	64.6 or 9.23	0"18"5½
End 3.90 by 3.90		15.21	at 2/0 per Rood	
Partition 3.50 by 3.90		13.65		
On the Back Wall 9.27 by 1.16		10.75		
Chimney Pipe 5.75 at 1/ per yard				0"5"9
Slating 9.35 by 4.95 .50	at 4D per yard	50.95 at 4D yd.		0"16"11¾
Paving 8.80 by 3.36 at 3D per yard		29.56 at 3D per yd.		0"7"4½
Facing a Threshold	3D			0"0"3

In the Steel Furnace

4 Furnaces below the Grates each 1.72 at 1"7 per yard		6.88	
Do. above the Grates to the Floor	each .77 at 3"2 per yard	3.08 at 3"2	0"9"9
4 Chimney Pipes above the Furnaces each 10.47 at 1"7 per yd.		41.88	3"17"2¼
Stone Wall for a Foundation to the Chimneys 5.60 by 2.15 @ 3"6 per Rood	12.04 or 1.72 at 3"6		0"6"0
Wall in front of the Arch 5.60 by 2.35 BL	13.16	30.04	0"8"6¾
& 4.13 by .77 before the Grates	3.18	or 4.29	
Walls for the Arch to spring on 6.85 by 2.00 BL at 2/ per R	13.70	at 2/	
Arch 4.30 by 2.40 at 2"6 per R	10.32 or 1.47 at 2"6		0"3"8[?]
7 Steps at 6D per Step			0"3"6
Paving over the Arch 4.10 by .53 & 1.50 by 1.20 at 3 D per yd.	2.17+1.80=3.97 at 3		0"0"11
			£7"14"11½

FB 26 pp. 94-95

The Cave Hole digging 6.65 by $\frac{3.25+3.30+3.00}{3}$ by 1.85	39.12 × 4½	0"14"8
	at 4½ D per yd.	
		£8"9"7½
		3"6
		£8"13"1½

Appendix 2.2

Street numbering from trade directories

The uncertainty and frequency of change in street numbering before the mid-nineteenth century presents difficulties to the identification of sites, and their continuity, through sources such as the trade directories and rate books. This problem is particularly acute in non-commercial parts of towns, where industrial premises constitute a less formal street frontage.

An attempt to remedy the situation in Sheffield was made in 1818, through the Police Commissioner's Act; but even by 1833, it was lamented that the relevant clause 'which empowers the commissioners *to name the streets and number the doors*, has not yet been carried into effect...'[13]

The table below presents the results of an attempt to systematise the known numbering systems for Scotland Street, undertaken in order to confirm the location of the Cutlers' Company cast steel furnaces, among other sites, and demonstrates the often inconsistent use of street numbers and the problems involved in their use. Note, for instance, that Blake & Son (the famous type-founders) retained their old street number (60) after the changes of 1825, and continued to use this for some considerable time afterwards.

Continuity of occupancy is assessed on the basis of occupant's name, trade or building name, while indirect associations are presented as footnotes. Doubtful or erroneous numbers are given in square parentheses.

Name of occupant (occupation)	*Date of trade directory*				
	1774	1797	**1822**	1825	**1841**
Micklethwaite (tailor)		2			
Hobson, Joseph (shoemaker)		4			
Deakin, Widow (scissorsmith)		8			
Hellefield, Samuel (victualler)		10			
Barnard & Co. (penknife)	[2][14]	16			
Smith, Henry (victualler)		17			[33][15]

[13] White (1833) p. 74.
[14] Barnes, Thos. (penknife)
[15] Lee, John (victualler: Crown Inn)=also 31 Grindlegate; 39 Scotland street in 1839.

	1774	1797	1822	1825	1841
Love & Spear (merchants, factors & steel refiners)		19			[39][16]
Hancock, Henry (pen & pocket knife)	5[17]	25			
Hawkesworth, Widow (grocer)		27			
Parkin, Thomas (cutler)	8	30		12[18]	
Parkin / Wilson (victualler: Hussar)		31	31	13	51[19]
Hall, Joseph (razorsmith)		32			
Cornthwaite, Septimus (victualler: Hussar)			32		
Barker, Joseph (baker)		33	33[20]		
Smith, J (engraver)			34	16	
Constantine, R. (Britannia metal)			34	16	
Barker, William (baker)				17	59
Cartwright, Edward (penknife)		41			
Crookes, Jonathan (penknife)	4[21]	50			
Allen, Thomas (butcher)			52		
Bartram, James (inkstand, powder flask, etc.)		57			
Marsden, Benjamin (penknife)			58	41	
Blake & Son (steel, file)	X	60[22]	60	60[23]	
Hall, Thomas (penknife)		61		–[24]	
Staniforth, Thomas			61		
Bingham, Samuel (baker)		62			
Shepherd, John (penknife)			63		
Alsop, Thos. (penknife)			65	47	
Greaves, Thomas (tailor)			65		
Haywood, Thos (grocer)	X	66	66	49[25]	

[16] Borough [Debtor's] Gaol: Waterfall, John (chief gaoler)
[17] Hancock, Charles (spring knife)
[18] Parkin, Benjamin (spirit merchant)
[19] Wilson, Geo. (victualler: Hussar)
[20] Knapton, Jno. (baker)
[21] Crooks, Jonathan (spring knife)
[22] Blake, Thomas (filesmith)
[23] Retained old number
[24] Hall, Matthew (penknife) Hall's Yard, Scotland street
[25] Haywood, Thos.

	1774	1797	1822	1825	1841
Heiffor, John (razor)			68	51	
Bradbury, William (victualler: Globe)			69		
Gray, Jonathan & Son (saw maker)			70	[42]	
Barrat, John (victualler: [Old] Turk's Head)		75	75[26]	59[27]	108[28]
Roberts, John (scissorsmith)			77		
Widow Pryor (victualler)		78			
Housley, Geo. (victualler: Fortune of War)			79	62	102[29]
Hellefield, Samuel (victualler)		84			
Hudson, Benj. (penknife)			87	71	
Beard, Ann (butcher)			88		
Timm, John (tailor)		88			
Wainwright, John (druggist)			90	73	
Allcard, James (grocer, dealer in china, glass, etc.)		89		74	
Wortley, Jno. (grocer)			91	76	
Peace, Joseph & Son (filesmiths)		92	92	78	
Marshall, Martin (saw-maker & merchant)			95	80	
Bryant, Rev. Thomas		100			
Crossland, R. (cabinet maker)			108		
Dunn, William (table knife)		109			
Revil, Joseph (pocket knife)		110			

[26] Wood, John (victualler: Turk's Head)
[27] Eyre, Benj. (victualler: Old Turk's Head)
[28] Skelton, W. (victualler: Old Turk's Head)
[29] Booker, J. (victualler: Fortune of War)

Appendix 2.3

Moxon on the varieties and uses of steel

Source: Moxon, Joseph (1703) *Mechanick Exercises: or the doctrine of handy-works...*, third edition, London: Dan. Midwinter and Tho, Leigh, at the Rose and Crown in St. Paul's-Church-Yard.

British Library: 1651/976.

[p. 57]

Of several sorts of Steel in common use among Smiths.

The difficulty of getting good Steel makes many Workmen (when good hap they light on it) commend that Country-Steel for best, from whence that Steel came. Thus I have found some cry up *Flemish-steel*, others *Swedish, English, Spanish, Venice*, &c. But according to my Observation and common Consent of the most ingenious Workmen, each Country produces almost indifferently good and bad; yet each Country doth not equally produce such Steel, as is fit for every particular purpose, as I shall shew you by and by. But the several sorts of Steel, that are in general use here in *England*, are the *English*, the *Flemish*, the *Swedish*, the *Spanish* and the *Venice-steel.*

The *English-steel* is made in several places in *England*, as in *Yorkshire, Gloucestershire, Sussex*, the *Wild of Kent*, &c. But the best is made about the *Forrest of Dean*, it breaks Fiery, with somewhat a course Grain. But if it be well wrought and proves sound, it makes good Edge-tools, Files and Punches. It will work well at the Forge, and take a good Heat.

[p. 58] The *Flemish-steel* is made in *Germany*, in the Country of *Stiermark* and in the *Land of Luyck*: From thence brought to *Colen*, and is brought down the River *Rhine* to *Dort*, and other parts of *Holland* and *Flanders*, some in *Bars* and some in *Gads*, and is therefore by us call'd *Flemish-steel*, and sometimes *Gad-steel.* It is a tough sort of Steel, and the only Steel us'd for Watch-springs. It is also good for Punches; File-cutters also use it to make their Chissels of, with which they cut their Files. It breaks with a fine Grain, works well at the Forge, and will take a welding Heat.

I cannot learn that any Steel comes from *Sweden*, but from *Dantzick* comes some which is call'd *Swedish-steel*: It is much of the same Quality and Finess [sic.] with *Flemish-steel.*

The *Spanish-steel* is made about *Biscay*. It is a fine sort of Steel, but some of it is very difficult to work at the Forge, because it will not take a good Heat; and it sometimes proves very unsound, as not being well *curried*, that is well wrought. It is too quick (as Workmen call it) that is, too brittle for Springs or Punches, but makes good fine Edg'd-tools.

Venice-steel is much like *Spanish-steel*, but much finer, and Works somewhat better at the Forge. It is us'd for Razors, Chirurgion's Instruments, Gravers, *&c.* Because it will come to a fine and thin Edge. Razor makers generally clap a small Bar of *Venice-steel* between two small Bars of *Flemish-steel*, and so Work or Weld them together, to strengthen the back of the Razor, and keep it from cracking

[p. 59] There is another sort of Steel, of higher commendations than any of the forgoing sorts. It is call'd *Damascus-steel*; 'tis very rare that any comes into *England* unwrought, but the *Turkish-Cymeters* are generally made of it. It is most difficult of any Steel to Work at the Forge, for you shall scarce be able to strike upon a Blood-heat, but it will *Red-sear*; insomuch that these *Cymeters* are, by many Workmen, thought to be cast Steel. But when it is wrought, it takes the finest and keeps the strongest Edge of any other Steel. Workmen set almost an inestimable value upon it to make Punches, Cold-punches, *&c.* of. We cannot learn where it is made, and yet as I am inform'd, the Honourable Mr. *Boyl* [sic.] hath been very careful and industrious in that enquiry; giving it in particular charge to some Travellers to *Damascus*, to bring home an Account of it: But when they came thither they heard of none made there, but were sent about 50 Miles into the Country and then they were told about 50 Miles farther than that: So that no certain Account could be gain'd where it is made. *Kirman* towards the Ocean affords very fine Steel, of which they make Weapons highly priz'd; for a *Cymeter* of that Steel, will cut through an Helmet with an easie blow. *Geog. Rect. fol.* 279.

The Rule to know good Steel by.

Break a little piece of the end of the Rod, and observe how it breaks; for good Steel breaks short of all Gray, like frost work Silver. But in the breaking of the bad you will find some veins of Iron shining and doubling in the Steel.

Appendix 2.4

Construction of converting furnaces at John Walker & Co.'s Wicker steelworks (1832)

Source: SCA Walker Deeds 634, John Fowler's notebook, p. 1. Transcribed in unpublished MA thesis of Timmins (1977) p. 100, table 3:8.

Pulling old one [cementation furnace] down	£20	0s	0d
Mr. Chadwick for building	£90	0s	0d
Hobson for plumbing	£15	4s	3d
Hudson for slating and slates	£20	15s	0d
Wilde joiner	£43	16s	7d
Fox for lime	£14	4s	9d
Two pair pots	£24	0s	0d
Vault arch stones, stays, etc., fire bricks and clay			
Smith 30,000 red bricks			
Total:	£228	0s	7d

Appendix 2.5

W & S Butcher's steelworks at Globe Works (c.1852)

Source: SYCRO 141/B Flockton valuations (c.1852) p. 213.

'Valuation of Freehold Property forming part of Globe Works belonging to the Sheffield & Hallamshire Bank Co. and occupied as Steel Works by Messrs. Butcher.

1960 [square] yards of Land	686	0	0
House & Warehouse	180	0	0
22 Melting Holes [each] 10 0 0	200	0	0
Building & Cellar to do.	150	0	0
Warehouse & Shed opposite	150	0	0
Warehouse next Melting Furnaces	150	0	0
4 Cupolas with Pots & Vaults complete			
3 at 75 0 0 }	225	0	0
1 at 50 0 0 }	50	0	0
Building over 2 of do.	300	0	0
Charcoal Shed & Fence	100	0	0
Rent 140 per annum			
	2191	0	0

Appendix 3.1

J C Fischer's visit to Sandersons' West Street works in 1845

The Swiss steelmaker Johann Conrad Fischer was well known throughout Europe having independently established his own crucible steel-making business. In the interests of business he made several visits to Sheffield beginning in 1814 when he first made the acquaintance of the Huntsman family. His experience and authority placed him in a unique position to comment in detail on Sanderson's large West Street steel manufactory, which he visited in 1845. Charles Sanderson in particular seems to have been on friendly terms with Fischer, aware of the mutual benefits to be gained by the exchange of experiences, and therefore perhaps more willing to divulge detailed information. The episode regarding Sanderson's high coke consumption in comparison to that of Fischer's furnaces, provides an insight to the informal methods of technology transfer otherwise invisible to the historian.

A previous translation by W O Henderson (1966) pp. 157-158, contained a number of technical errors,[30] particularly in relation to the Sheffield steel-making processes. Efforts have been made in the present translation to reflect the terminology that Fischer would have encountered in Sheffield steelworks, while also more closely following the style of Fischer's notes.

31 July 1845.

...I traveled from Leeds to Sheffield from one o'clock in the afternoon...and after lunch I went to my old friends Messrs Sanderson. Messrs Sanderson and Company are the largest cast steel manufacturers in Sheffield, for they have 36 melting furnaces [the number 36 is probably an error in transcription] and 6 cementation furnaces to convert the Swedish iron into steel before they melt it down.

As I anticipated, I received a very warm welcome from old Mr. Sanderson, with whom I once traveled twenty years ago from Chesterfield to Sheffield, and he showed me around the whole works, which is not the case for everybody.

First we went to the cementation furnaces, of which one had just been lit and the other was in full swing. Each of these furnaces has two chests, each filled with about 160 *centners*[31] of Dannemora iron, and three fires. That is to say, the flame reverberates at the front of the chest, then in between both chests, and then up the back wall and plays generally on the

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[30] Some of these mistranslations were questioned by Barraclough (1984) vol. II, appendix 17, but unfortunately he did not have access to the original German, so let Henderson's text stand.

[31] The centner is a Germanic unit of mass, roughly equivalent to the UK hundredweight [1 cwt. = 50.8kg]. Hanway (1762) vol. 1, p. 408, equated the centner (as used in Dantzig) to 120lbs [54.4kg]; Ure (1875) vol. I, p. 756, gave the value of a Zollverein centner as 110.231 lbs. [50.0kg] in his *Dictionary of arts, manufactures and mines*. Percy (1864) p. 837, gives 18 (Styrian) centners = 1 ton English [1 centner = 56.4kg]

arch, through the exhaust flues into the chimney. Mr. Sanderson consented to open a so-called eye for me. That is, a little stopper of fireproof clay on the front wall of the furnace, pulled out so that I could see the play of the flames and estimate the [degree of] heat inside the furnace which, it seemed to me, had not yet reached its maximum, which incidentally the appearance of which in light or in dark weather is very deceptive.

From there we went into the steel-casting shop. For twenty years, indeed I might say for [the last] fifty years since Huntsman essentially brought his process into action, absolutely nothing has changed. It is the same furnaces, the same crucibles, [und sie werden kalt wie warm], with the only difference that the latter are filled and fed through funnels.

The teeming [Giessen] was done very carefully. Of the first two crucibles to be teemed (every furnace has two crucibles, holding about from 30 to 35 pounds of steel) one had a small hole in it and over half the steel had run out. The teemer poured the steel that still remained in the crucible, very understandably, into the other, as no crucible is full when it comes out of the furnace, because they have quite flat, thick lids; and then they are filled in a gentle stream and very carefully held in the middle of the iron mould. From the second furnace, which was shortly opened, both crucibles were good and were teemed in the same way. Three men perform the casting process. The first lifts out the crucible and carries it to the receptacle which stands buried to half its height in the ground. The second worker grips the crucible with a pair of tongs, whilst the third worker pushes away the crucible lid with a pointed iron bar and then uses a small scoop to pull away the few pieces of slag that are floating on top.

As several baskets of coke stood next to the melting furnaces, so I asked Messrs. Sanderson how much coke he would need to melt a *centner* of steel, which he then told me. I thought, however, that I had misunderstood him, and repeated the question, which he answered the same as he had the first time. Now I was amused. I then told him what on average I needed at my facility, as he cried out three times: You beat us! You beat us! You beat us! One reason, among many others, and just as important, led him directly to the cause of their high consumption, whose validity he immediately appreciated.

Appendix 3.2

Naylor and Sanderson's West Street site areas

The following calculations demonstrate the use of rate book data in conjunction with spatial sources, in this case to derive a picture of the earliest site layout of Naylor and Sanderson's steelworks. It is important to note that, according to convention, the earlier separate values of warehouse, cellars and land were abstracted to a single entry in later books (and the reference to 'land' omitted), so that the subsequent rate for 'land' refers to an additional plot.

As the rateable value of land depended on its area, the ratio of the two charges equals the ratio of the plot areas; thus the area of the earlier plot may be derived from its ratio to the later, known site area. The results are corroborated by contemporary measurements of the warehouse, the street frontage of which equals that of the hypothetical plot (to the nearest unit of measurement); this suggests that the warehouse was originally designed to fit within a continuous terrace of building, only later evolving into a standalone structure within the enlarged steelworks site.

Note that in calculating the site area, half of the area of the adjacent roads serving the site must be included (see, for example, the schedule of areas on SheS 1308L). West Street itself, being a public highway and therefore not part of the estate was discounted.

Examples of rate book entries before and after the steelworks expansion:

Rate book RB150, Item 2 (17 Feb 1815) p. 34, 'West Field–Naylor Sanderson–WH [warehouse] 14/10 Sellor [cellar] 1/5 Land 1/9 [total:] 16/3'.

Rate book RB166, Item 2 (27 June 1818) p. 39, 'Naylor & Sanderson–WH & cellers -/16/3 Land -/6/9'.

Calculations:

Rate book charges for land (at 1s in the £).

In 1815: 1s 9d = 21d

Added in 1818: 6s 9d = 81d

Ratio: 3.86

Areas including half the roads (Holland St./Orange St. as SheS 1308L).

Site area: 3169 square yards (2650 m^2)

Area of half of Holland Street: 310 square yards (259 m^2)

Area of half of Orange Street: 247 square yards (206 m^2)

TOTAL: 3726 square yards (3115 m^2)

Areas from CAD digitisation of 1850 Ordnance Survey data.

Total site area: 3059.3 m^2

Area A: 633.9 m^2

Area B: 2425.4 m^2

Ratio: 3.83

Percentage difference of ratios: 0.78%

Appendix 3.3

Letters from Charles Pickslay to Michael Faraday

Held by the Royal Institution. From the transcript of Hadfield (1931) pp. 132-136.

Letter 1

MESSRS. STODART & FARADAY.

Gent^{n},– I sometime since read with considerable interest your essay on the alloys of Steel & being convinced that some of them might be introduced with great advantage into our own manufactory, for the various descriptions of Cutlery as well as for the fronts of Stoves and Fenders I determined to make an experiment in the large way with Steel & Silver and if the price of the alloys do not prohibit them with Platina and Rhodium, but as the success of the experiment depends upon 'a faithful and diligent attention on the part of the operator' which I could not insure unless I superintend it in all its processes I deferred it until we had erected some new workshops we were building, they are now nearly complete & we shall soon be able to have the Steel made & the article finished on our own premises. The whole process of Casting, Forging, Hardening, & Grinding will be carried on under my own inspection or of one of my partners.

Will you have the goodness to inform me if any further instructions are necessary than those published in the Rep^{y} of Arts for Jan^{y} 1823 and where the alloys are to be obtained on the best terms & the price. In return we shall have great pleasure in presenting you with fenders made of the improved Steel if it succeeds to our expectation.

I am, Gent^{n}

Your obd. Hble. Ser^{t}.

C. PICKSLAY.

SHEFFIELD, *April* 14, 1824.

Letter 2

From: GREEN, PICKSLAY & CO.

To: MR. FARADAY.

Green, Pickslay & Co. have great pleasure in informing Mr. Ferrady [sic] that they have made a great number of experiments with the alloys, recommended by him, and find the Steel greatly improved by them; they send a specimen alloyed with silver, Iridium, and Rhodium, which they consider the best that they have produced, these alloys with some valuable practical hints, have been furnished by Mr. Johnson, No. 79 Hatton Garden[32]; the Report of the Forgers is that the steel works better under [p. 134] the Hammer than any they have before used, and likewise hardens in a much superior manner.

Green, Pickslay & Co. beg Mr. Ferrady's acceptation of a pair of Rasors made from this Steel. They will have great pleasure in sending other Specimens of Cutlery &c as they continue their experiments.

In pencil } Ironmongers,
not the same } High Street,
handwriting } Sheffield.

Letter 3

SHEFFIELD,

Nov. 16, 1826.

SIR,– We continue our experiments with the alloys much to our own satisfaction, but greatly to the annoyance of some of our Neighbours, who wish to avail themselves of your important discoveries, but have not the spirit to incur the necessary expense.

I enclose you a Newspaper, in which you will observe, an attack upon our Peruvian Steel. We must however admit the writer has cause (from the conduct of some other manufacturers) to draw the inference he has done.

I send you a rasor, marked 'Silver Steel,' it is made of the commonest Steel that can be produced, the Person who forged it informs me, he makes a great quantity, of the same

[32] Hadfield noted that 'the business in precious metals is still carried on at this address by Messrs. Johnson, Matthey & Co., Ltd., and on a very extensive scale'.

quality all marked 'Silver Steel.' We therefore deem it prudent to keep the alloys we use secret, for should we publish them, the same Persons who mark 'Silver Steel' on such spurious articles as the blade sent, would not hesitate to assert that they used the same alloys as we did, and thus bring it into disrepute.

At the same time we shall be happy to give you confidentially any information you may wish, but for the reason stated, you will agree with us it is not desirable to make it public.

We beg your acceptance of a pair of Peruvian steel scissors, that you may judge what Polish it will receive. The Grinders were very much prejudiced against it, but now admit it bears a finer colour, than any other that comes into their hands.

I remain, Sir,

Most respectfully,

Yours ob^{t}. hble. Serv^{t}.

CHAS. PICKSLAY.

M. FARADAY Esq^{re}

Royal Institution.

Appendix 3.4

A visit to the Sheaf Works in 1851

Extracted from the diary of J C Fischer (author's translation).

Source: Schib (1951) pp. 723ff.

Fischer paid a visit to the Sheaf Works in 1851, during what was to be his final tour of England. The works had recently passed into the hands of Thomas Turton, whose acquaintance Fischer had already made in 1845, visiting the firm's Bower Spring works (Schib, op. cit., pp. 528), so on this occasion the Swiss industrialist was given unfettered access. The account is of particular interest for its description of the various stages in Turton's comprehensive steel spring making process, just one year after its transfer from the previous ownership of Greaves, the pioneer of integrated steelmaking in Sheffield.

July 8.

I went to the cast steel manufacturers, Messrs. *Turton* and *Sons*, with whom I happen to be in friendly relations, and who, together with a very large quantity of files, also make many springs for railway carriages. One cannot believe, what a market there is for this article! Their springs seemed to me better than Cammell's. These gentlemen are themselves involved with the work, and those springs that were tested before me bore the heavy trials perfectly. The eye of the gentleman makes the horse fat! Proverb.

Mr. *Turton* was not in the foundry in Bower Spring, but in the so-called Sheaf Works where they have the rolling mills and hammers, not far from the River Don, which drives Huntsman's tilt. I had not expected to find such an extensive factory. The number of workshops, among which can be found grinding wheels, tilt hammers, file cutting shops, forges, etc., runs to 73 based on the numbers written upon their doors. Several offices are occupied by clerks.

Mr. Turton wanted to leave shortly, to visit his seriously ill brother in London, and so as he went past the porter (no proper factory in England is without one) he said 'when this gentleman (pointing to me) visits, he should be allowed to look around all of the workshops freely'.

He accompanied me to my lodgings, where I went to lunch, and he went to the station for the journey to London. In the afternoon, I made the most of his offer, going first into the hammer shop. The stroke of the hammers is short but very rapid, which is extremely sensible because under a fast hammer, due to the force of the blow, the steel remains hot for longer than under

a slow one where the hammer is heavier and the stroke longer. The hammers and anvils have inserted crosses or faces of 'chilled' cast iron. Their forge fires [*Strekfeuer*] did not seem to me as good as Huntsman's, insofar as the coals or coke in them did not attain the high degree of ignition, as they did there. I still wanted to go to the pot making shop [*Potterworks*] after I had made still another route via the rolling mill, but being too tired and too late for this further walk, I contented myself with writing today's notes.

Appendix 3.5

William Flockton's valuation of the Globe Works (1845)

Source: SYCRO 141/B pp. 138-139.

Valuation of some Leasehold Property situate near St. Phillip's Church belonging to the *Assignees of Mess*^{rs} *Ibbotson called The Globe Works.*

To be Sold in One Lot.

[schedule of areas on p. 138]

[p. 139]

Gentlemen,

Agreeable to the Instructions of your Manager I have very carefully examined the Land and Buildings situate near Shales Moor known by the name of The Globe Works. I have also made a detailed *Valuation of the Prop.*^{y} *and land [illegible] a plan of the same. In ordinary* Valu^{ns}. it is gen.^{y} considered sufficient to give the total amount of value, but in a peculiar case like this involving a great mass of prop.^{y} including some very indifferent Buildings the whole of which have been Erected from time to time to provide accommodation for the increasing Trade of one Firm and consequently only suitable for a Business nearly of the same kind and extent it appears necessary to furnish you with some explanatory remarks. The chances of meeting with a customer who could occupy such extensive & varied premises as Globe Works are I fear very remote and it is my opinion that if the Property is disposed of in one Lot subject to the present Leases no very large sum beyond the value of the Buildings, Materials & Machinery will be realised by the sale. Understanding from Mr. Waterfall that other parties besides the Bank are concerned with the Property I think you will perhaps best advance the Interests of the Bank by bringing it to the Hammer in one Lot & should no satisfactory offer be made it appears to me advisable for the Directors to purchase the whole being in possession of the Leasehold together with the Freehold, will I apprehend enable you to turn both to a much more profitable account than if the Freehold & Leasehold remain divided as at present. The whole of the Buildings & Machinery will not I fear fetch more than £4000 or 4500£ and reasonable doubts may be entertained whether the smaller sum will be realised. If however the Directors become the owners a different result may be expected. In that case I should recommend that the whole of the buildings be put in repair and the unfinished ones completed. I should divide the property into Four Lots bring it into the Market and sell the Freehold Land with the Buildings & Machinery. I find from the leases that one plot of Land is Rented at 2^{d} and the other at 2½^{d} per yard with a power to make them Freehold in payment of

20 years Rent this power you have exercised and the Freehold became yours at a Cost of £2158.10.0. Building Land in the neighbourhood is now letting at 4^{d} & 4½^{d} per yard consequently the Site of Globe Works was taken at about one half the present price of Land. Should the Directors think well to adopt my suggestion the Result may probably be as follows.

D^{r}. The Estate		C^{r}.		
Purchase of Land	2158.10.0	Lot 1	Buildings Machinery	4200.0.0
			4233 yards of Land $^{6}/_{8}$	1410.0.0
D^{o} Buildings & Mach.^{y}	4000.0.0	Lot 2	Buildings	500.0.0
			1528 yards of Land $^{6}/_{8}$	509.0.0
Rep^{g} & finish^{g} Buildings	1060.0.0	Lot 3	Buildings Machinery	1400.0.0
			2774 yards of Land $^{6}/_{8}$	925.0.0
Probable gain to the	4245.10.0	Lot 4	Buildings	1500.0.0
Bank			2882 yards of Land $^{6}/_{8}$	960.0.0
	11404.0.0			11404.0.0

So that there is a reasonable prospect of the Bank realising upwards of £4000 more by disposing of the Freehold Land & Buildings in Lots than by allowing the Buildings to be sold subject to the existing Leases.

The Build^{s}. on Lot 1 are suitable for a Manufacturing Mercantile concern on a large scale includ^{g}. Engine power with Grind^{g}. Wheels & Steel Works.

The Build^{gs}. on Lot 2 may be adap^{d}. for any of the Sheff^{d}. Trades the large space of vacant G^{d}. in front pres^{g}. an oppor^{y}. for Erec^{n}. of Ware^{s}. & add^{l}. Workshops.

The Buildg^{s}. on Lot 3 are adap^{d}. as far as they go for a Manufac^{y}. with all its branches worked by Steam Power [illegible] Works The vacant Land presents abundant space for the Erection of numerous add^{n}. Buildgs.

The Build^{gs}. on Lot 4 are laid out for the Steel Trade for which they are admirably adapted and as premises of this description are in request just now a customer would soon be forthcoming.

I am Gent.

your most obed^{t}. servant

William Flockton

Sheff^{d}. July 30 1845

To the Directors of the Sheff^{d}. & Hallamshire Bank.

Appendix 3.6

Sale plan of the Globe Works, Sheffield (1883)

SCL Local Studies, Sale plan 11 December 1883.

[description only, no plan known to exist.]

Particulars and Plan of

VALUABLE AND EXTENSIVE

FREEHOLD WORKS,

situate on

PENISTONE ROAD, SHEFFIELD,

called

"THE GLOBE WORKS"

MACHINERY, TRADE FIXTURES, MARKS, AND GOODWILL

Of the MANUFACTURING CUTLERY BUSINESS carried on by Messrs. UNWIN & RODGERS, LIMITED.

MR. WILLIAM BUSH

Has received instructions to OFFER for SALE BY AUCTION,

AT HIS MART, EAST PARADE, SHEFFIELD,

TUESDAY, DEC. THE 11TH, 1883,

Subject to Conditions, the following Lots:-

LOT 1. - THE FREEHOLD WORKS,

Called or known by the name of "THE GLOBE WORKS," situate on Penistone Road, Sheffield, with the ENGINES and BOILERS, FIXED PLANT, TRADE FIXTURES, and MACHINERY thereon, the Site whereof contains 4,703 superficial Square Yards, or thereabouts.

The Works consist of several Blocks of Buildings, well built of stone and brick, and have an extensive frontage to Penistone Road, and a short frontage to Cornish Street.

They comprise Show Rooms and Offices, Warehouses numerous Workshops, Grinding Wheels three stories in height; Engine-house, Boiler Shed, Stabling, Carthouse, and other Buildings.

The Right of taking Water from the River Don for a term of 50 Years from September, 1872, subject to the payment of a yearly sum of £10, and of conveying such Water to the Works, subject to the payment of the yearly sums of £4, 10s., and 5s., by way of acknowledgement, as now enjoyed by the Vendors, will be included in the sale.

THE MACHINERY

Consists of one 40-H.P. BEAM ENGINE, one 12-H.P. ENGINE, three large BOILERS, large WROUGHT IRON WATER TANKS, and SHAFTING and DRIVING GEAR for about 30 Grinding Wheels and Workshops, &c.; also

A PLOT OF LAND,

Containing 380 Superficial Square Yards or thereabouts, situate in Cornish street, near to the said Works, and abutting upon the East on the River Don, and on the West upon Cornish Street, held upon Lease for the term of 500 years, from the 25th March, 1879, at the yearly Ground Rent of £25, and sub-let (subject to the right of laying pipes for supplying the said Works with Water from the River Don) for the term of 99 years, from the 25th day of March, 1879, at the Yearly Rent of £27 10s., and now in the occupation of Mr. Theaker.

This Lot will be sold subject to a Mortgage upon the said Works of £11,000.

The Purchaser of this Lot will have the option of purchasing the loose Machinery, Working Tools, Office Furniture, &c., at a valuation.

[lots 2-5 are registered corporate marks and names of UNWIN and RODGERS, etc.]

Appendix 4.1

Sources for the development of steam-power in Sheffield

General abstractions of selected sources were have been published by Pollard (1959) p. 53; Lloyd (1913) pp. 157, 179, 443; and Linton, Ed. (1956). Primary evidence can be found in both manuscript and printed forms.

The printed list of 1794 (see Crossley, 1989) includes three engines alongside the 83 water-powered wheels on Sheffield's rivers. From other sources it can be shown that this number comprised the first engine of Proctor and Beilby in the Park, a large 80 horsepower engine at Kenyon's Ponds Steam Wheel and the ill-fated Cleakham Steam Wheel of Ward & Ellis.

Flavell (1996) estimated that by 1797 there were six steam engines at work in the metal trades in Sheffield (Bailey & Co. at Park Wheel; Kenyon at Ponds Wheel and rolling mill; Hague & Parkin at Gibraltar; Smith & Oates' silver rolling mill in the Wicker; two engines operated by Ward & Ellis at Cleakham Wheel and rolling mill), although the number used for grinding still stood at three.

In one of the earliest trade directories issued by White (1833) it is stated that there were 'now upwards of twenty steam wheels in the vicinity', providing space for 'more than three-fourths of the grinders'. White's publication appeared at the beginning of a period of prosperity and expansion that was to see this number double in just a few years.

Soon after, Holland (1837) pp. 242-243, recorded that 'It is exactly fifty years since the first steam-engine grinding wheel was erected on the east side of the Sheaf; there are now at least fifty engines at work in the town, which, rating their average power very low, namely 35 horses–and some of them are 50, 60 and even 80 horse power!–would give an increase to our effective manufacturing agencies of at least the effort of 1750 horses!'

A report in the *Sheffield Independent* of 15 April 1854 suggested that of the 109 steam engines connected with the cutlery trades, 40 were used for grinding (45 cutlery and tools; 19 silver; 5 handles–totalling 1712 hp). There is good reason to consider this figure an underestimate: three years later J C Hall (1857)–intimately acquainted with the town's grinding trades, and with no reason to exaggerate their extent–claimed 80 steam wheels. The same figure was given by the Royal Commission report by J E White (1865) although it was admitted that no survey had been made, so it is likely that the evidence was based on Hall's earlier research.

Coincidentally, Hall published revised figures in the same year, now counting 132 steam wheels in total (Hall, 1865). These figures are largely in accord with the overall take up of steam engines for all purposes; the House of Lords' Commission on Railways of 1835 was

informed that 76 engines were at work in the town, with another two soon to be completed. A decade later the number was given as 100, 'Millowners' (1845) p. 10, while G L Saunders (1860) in *Town and Country* stated there to be 406 engines in the employ of 311 proprietors, amounting to 6286 hp.[33] Ten years later the Factory Returns reported 433 engines, the first signs of a slowdown and prompted in part by the availability of new engine technology, particularly the Otto gas engine.

To augment the published sources, the author's survey of rate book and valuation data has enabled some of the gaps in the record to be filled, giving a clearer indication of the particular periods of growth. Until the end of the Napoleonic Wars, the number of engines remained small; each new steam wheel represented a significant outlay and consequently contributed disproportionately to the town's grinding capacity. By 1820, a number of smaller engines had joined the large public wheels, boosting the total to around 12 or 13. Towards the end of the major boom of the 1830s, the Fairbanks' valuation surveys included 38 steam wheels (1837-38).

Estimates of the number of men employed in steam-powered grinding wheels appeared in two contemporary reports almost four decades apart. Knight (1822) p. 87, stated that in 1819 about 2,500 men occupied troughs in the town's steam wheels; by 1857 this figure had doubled to 5,000 according to Hall (1857) p. 22.

By 1908, the town's steam wheels numbered 300, in contrast to the eight remaining water-powered sites (Linton, 1956) Sheffield's traditional wheels had been in decline since the introduction of the steam engine, from 133 in 1770 (Lloyd, 1913, pp. 179, 443), to 83 in 1794 and only 16 in 1857 (Hall, 1857).

These findings have been presented in graphical form [fig. 4.67], demonstrating the exponential growth of steam wheels from the late eighteenth century until the beginning of the twentieth. The improvement and availability of steam-power over this long century has much in common with the so-called 'Moore's Law', which predicted the doubling of computing power every eighteen months, that has held true since 1965.

The following table is an abstraction of the steam and water-power of Sheffield's wheels based on Pollard (1959) p. 53, table 5, with additions by the author. Sources as in the text above. Figures for 1805 based on the author's calculations.

[33] SCL Local Pam 50, no. 5.

	Water-power		Steam-power	
	Wheels	Troughs	Wheels	Troughs
1770	133	896	----	----
1794	83	1,415	3	320
1805	**----**	**----**	***5**	***668**
1841	40	----	50	----
1857	16	----	80	----
1865	32	----	132	----
1908	8	----	300	----

Thus in 1770 there were 133 waterwheels with 896 troughs; by 1794, 83 wheels with 1415 troughs and 3 new steam wheels with 320 troughs between them; by 1805 Crooks Croft Steam Wheel (later the Park Wheel, 10 hulls) had 100 troughs, the Cleakham Wheel c.100, Pond Mills (24 hulls) 120 troughs, the Shilo or Nursery wheel c.84 troughs and the newly-erected Soho Wheel between 250 and 264 troughs. In total this amounted to at least 668 steam-powered places in just the five principal wheels, almost half of the total capacity of Sheffield's rivers at their height.

It therefore appears that the steam engine overtook the waterwheel as the principal prime mover of grinding wheels in Sheffield by the first decades of the eighteenth century, earlier than has been suggested by previous research.

Appendix 4.2

Calculation of power from engine dimensions and performance

The Fairbanks, in order to more objectively compare the power of steam engines and waterwheels for the purpose of ascertaining rateable value, made calculations from first principles based on their own observations of the engines.

Josiah Fairbank's notebooks contain several lengthy extracts transcribed from contemporary works on steam power, particularly John Farey's (1827) *A Treatise on the Steam Engine*, from which many of the necessary formulæ were culled.

Comparisons with waterpower extended to calculations of the volume of water required to feed steam engine boilers and in the engine for condensing. Much of this research was to prove valuable in 1832, when Josiah Fairbank proposed the construction of a public wheel designed by himself, and supplied by a reservoir fed by a small stream (see chapter 4).

Measurements of power were always considered a means to an end, and more specific quantitative values can often be found in Fairbank's notebooks. In general, one horsepower was considered sufficient to drive one and a half heavy troughs for edge tool grinding, or four light stones.[34] Such figures, while approximate, are a useful guide to the capacity of grinding wheels. The Park Wheel, for example, with a corrected engine power of 43 horsepower, was said to have driven 100 troughs (over two floors). Assuming an equal number of heavy and light troughs on ground and first floor respectively, the required power would have been:

(50x0.67)+(50x0.25)=46 hp

suggesting that such a configuration would have been workable in practice.

It is also worth noting that early steam engines were generally capable of producing half as much power again over their rated value (i.e. 20 hp becomes 30 hp), as the pressure on the cylinder (when friction had been taken into account) could be raised to 10 or even 11 lbs./sq. in.[35] To the thrifty industrialist, therefore, the temptation to buy a smaller engine and run it above the given power would have been considerable; for this reason, horsepower values should be treated with caution when used as a guide to workshop capacity.[36]

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[34] SCA FBC NB25 (1828); NB34 (1831); CP-25-(32).
[35] Farey (1827) pp. 486, 576. Therefore the engines observed by Fairbank must have been working well above their intended power (10 lbs./sq. in. as opposed to 8.68 lbs./sq. in. (p. 366) or 6.91-6.94 lbs./sq. in. (table p. 574).
[36] Available evidence supports this practice: at Drabble & Sanderson's Ebenezer Works, a 10 hp engine drove 22 heavy troughs, which by Fairbank's guide would have needed 14.7 hp (47% over). The 21 heavy and 60 light troughs of Wells' Wheel (not including circular saws and buffing room) were powered by a 25 hp engine, instead of the calculated 29 hp (16% over). The larger public wheels show a lesser tendency to exceed their stated power (figures for the Union and Soho wheels come out as 65.8 and 53.6 respectively; each had a nominal engine power of 60 hp). An 1835 plan of Rodgers' works (SheS 753) shows 49 troughs (including 3 heavy) and a 24 hp engine; as only 13.5 hp would have been necessary for grinding, it may be assumed that the remaining 10.5 hp would have provided power to the extensive cutlers' workshops on the site.

Farey (1827) p. 440, gives the power of a steam engine in horsepower to be:

Force in pounds × space in feet through which the engine acts per minute ÷ 42017

i.e. cylinder of 23¾ diameter at a force of 6.94 lbs./sq. in. acting through 215 ft./min.

= 23.75^2

= 564 circular sq. in. × 215 × 6.94

= 121273 × 6.94

= 841638 ÷ 42107

= 20.04 hp

Farey (1827) p. 574 also gave a table of the proportions to which Boulton & Watt's engines were constructed under patent, against which the Fairbanks' measurements may be compared. Common dimensions included:

	cylinder diam.	stroke length	strokes per minute
10 hp double-acting rotative	17½in	4ft	25
20 hp (most standard size)	23¾in	5ft	21½
40 hp	31½in	7ft	17½

(The earliest rotative engines as used in London breweries, and rated at 10 hp, were single-acting with a 24in diameter cylinder and 6ft stroke at 18 strokes per minute.)

The Park steam engine fits the table, but is equivalent to the model called 40 hp; not 35 hp as quoted by Fairbank (perhaps the early date of this engine places it before the standardisation of Boulton & Watt's dimensions, as was the case of the 50/53 hp engine discussed by Farey). Later practice of shortening the stroke while increasing cylinder diameter led to variants on the original table, such as the Pond Mills engine of 80 hp of 44 inch diameter with a 7-foot stroke.

Additional definition, from Thomson (1812) Book III, p. 414:

'In Newcomen's engine the pressure did not exceed 7lbs upon every square inch; in Watt's it amounts to 12lbs. Let the radius of the piston be s, then its surface is s^2, and of course the whole pressure upon the piston in lbs. is $12s^2$. Let L be the length of a stroke of the engine, as the best engines work both in going down and in coming up, to obtain the work done in lbs. we must multiply $12s^2$ by 2L. The product, or $24s^2$L, is the work done per stroke. If we multiply this by the number of strokes in a minute, we get the work done per mintue in lbs. Mr. Watt estimates the amount of the work done by his engines by calling them machines of so many horse power, supposing that a horse is capable of raising 33,000lbs to the height of one foot in a minute.

An engine of 40 horse power burns 11,000lbs of Staffordshire coals in 24 hours, which amounts to 275lbs for every horse power. For every bushel (or 84lbs) of Newcastle coals consumed by such an engine it will raise 30 millions of lbs one foot high, or it will drive 1,000 cotton spindles with all the requisite machinery'.

Appendix 4.3

Articles for the Government of the Proprietors of the Soho Engines

SCL Local Studies, Local Pamphlets

The following text is transcribed from an extremely scarce pamphlet, containing perhaps the only surviving rules relating to the management of a public grinding wheel. The main body of the text was abstracted from the deed to which all of the Proprietors were bound, probably dating to the beginning of the business in 1805. It was probably intended as a guide for the increasing number of new shareholders in the wheel. To this end, a final note introduced a transfer fee of one guinea per share, payable only by 'strangers' to the business.

In conjunction with records of construction, committee meeting minutes, rent books, lists of share ownership and transfers, this document helps to give a vivid impression of the origins and day-to-day management of one of Sheffield's most characteristic building types.

[p.1]

Articles for the Government of the Proprietors of the Soho Engines, Bridge Street, Sheffield.

Abstracted from the original deed signed by the Proprietors.

Sheffield. Printed by J. Montgomery, Iris Office. 1809.

[p.2]

Articles of Agreement, &c.

That the property in the said premises of each subscriber shall be held in shares, of which, each subscription of fifty pounds shall constitute one share; and that all shares in the said concern shall be saleable, and may be transferred at the pleasure of the first and every succeeding holder or holders thereof, but not in parts less than one full share for each part, provided that a preference in purchasing any share or shares shall at all times be given by the holder or holders, and to that end no share shall be sold except to such holder or holders, until notice shall be given at one of the General Meetings, to be held as after mentioned, of such share being on sale, and any holder or holders offering within [p.3] one week next after such General Meeting to become the purchaser of such share or shares on sale, shall be entitled thereto, unless some other person shall within the same time be willing to, and shall actually give a more valuable consideration for such share or shares on sale.

That no sale or transfer of any share in the said concern shall be good, until an entry shall have been ma[de] thereof, in the book or books to be kept for that purpose by the Committee appointed, or to be appointed as after mentioned.

That when the said wheel or wheels, and engine or engines, with all the requisite machinery, gear and apparatus, shall be completed, the troughs, or working places to be contained in the said wheel or wheels, shall be let from time to time for the best reasonable price or prices, and generally the most profit that reasonably can, shall be made of all the premises, and the money arising therefrom, (after first paying all such expenses as shall be incurred from time to time in servants' wages, coals and other materials for continuing at work the said wheel or wheels, and engine or engines, and for repairs of the [p.4] premises, and all necessary outgoings,) shall half yearly on the first Monday in May, and the first Monday in November, in every year, be divided, and paid amongst, and to the respective holders of shares, from time to time, in a just and fair proportion.

That the holders of shares in the said concern shall have at all times a preference of recommending tenants of troughs, or working places, in the said wheel or wheels either from amongst their own workmen or otherwise.

All business to be done and carried on by a Committee of nine holders of shares, to be changed once at least in every year; and that the same Committee shall keep proper books of account, and therein make entries of all receipts or payments, and such other dealings and transactions as shall be requisite to show at all times the state and progress of the said concern. And the said Committee shall have power, and are hereby authorised to make such rules and orders for the government of the said concern (not being repugnant to the true intent and meaning of these presents,) as they shall think fit and proper, [p.5] with penalties and forfeitures for the non-observance of rules and orders, or any of them; all which rules and orders when made and approved as after mentioned, shall attach, as well as the rules and articles in these presents, contained upon all the shares in the said concern, and together with the same rules and articles herein contained, upon all holders of the same shares. And that in like manner every succeeding Committee shall have continuance, and be a Committee until the first Monday in June next succeeding their appointment as a Committee. Provided, that any five Members of any Committee, but no less number, shall be competent to act as the whole of the Members of such Committee. And further, that any Member of any Committee, may, at a General Meeting, (having special notice for at least two days to attend such Meeting) be removed for misconduct, or other reasonable cause, by the ballot of a majority of the holders of shares present at such Meeting, in which case another shall be at the same Meeting chosen by a like majority, to fill the place of such removed member [p.6] of the Committee; and in like manner in the case of death of any member, or his resignation, or incapacity to act, or of any cause by which a vacancy shall happen, the place in the Committee shall be filled by such other share holder as shall be chosen in the manner aforesaid, at the next, or then present general Meeting (as the case may be), after such

vacancy shall happen. And further, that any person who shall have served on one Committee shall be eligible to serve on any succeeding Committee. Provided also, that no such rules or orders as may be made by any Committee as aforesaid, shall be binding, until approved at some general Meeting by a majority of holders of shares present at such Meeting, and that it shall require the like approbation to repeal or alter any rule or order once established.

It is especially agreed, that in case any dispute or difference shall arise between, or amongst any holders of shares, in the said concern, touching the true construction of any article or clause contained in these presents, or any other matter which cannot be decided by reference to any article herein contained, nor by any rule [p.7] or order to be made, as hereinbefore mentioned, the subject matter of every such dispute or difference, shall first be referred to the Committee, and if they shall not decide the same, then to the members present at some general Meeting, and if a determination shall be made by either of them, the same shall be binding on the parties in difference.

That no suit at law or in equity shall be commenced by any share holder against any other or others of the share holders, for any matter or thing in any wise concerning the said intended wheel or wheels, engine or engines, and premises, or the mode of conducting, or carrying on the same, paying subscriptions, receiving rents, dividing profits, or concerning the true construction of any article or clause herein contained, or any rule or order to be hereafter made, as aforesaid, until the same shall have been submitted to such Committee in the first place, and to a general Meeting in the next, nor in case a determination shall be made by them, or either of them, of the matter submitted as herein before mentioned.

[p.8]

June 19, 1807.

At a general Meeting of the proprietors, it was resolved unanimously, That for all shares sold after the 29th September, the purchaser should pay 10s. 6d. each share, for the transfer; and that the seller and purchaser should come together to the treasurer and ratify the same.

January 23, 1809.

At a general Meeting of the proprietors, it was resolved, That for all shares sold contrary to the articles, no transfer shall be made, or title given; and also that the first dividends paid on such shares, after such breach of the articles, shall be forfeited to the concern.

FINIS

[p.9]

At a General Meeting of the Proprietors held at the House of Mr. Bibbs, May 1, 1809,

IT WAS UNANIMOUSLY RESOLVED,

I. That the Treasurer shall be elected by the Share-Holders every year, and shall be responsible to them.

II. That Mr. T. NOWILL is re-elected Treasurer for the present year.

III. That three Members of the old Committee continue on, and that six new ones be appointed by the Share-Holders every year.

IV. That every Stranger who becomes a Share-Holder shall pay One Guinea transfer for each Share, to the Treasurer.

V. That the Engines be further insured in the Sheffield Fire Office for 2000*l.* on the Wings.

Appendix 4.4

Extracts from the minutes of the Soho Grinding Wheel

[author's comments in square brackets]

Sources: SCA MD709, MD717.

SCA MD709

1820 July 3 One heavy & one light Trow for 25 Guineas. 17 Guineas for the heavy one & 8 for the light.

1820 Aug. 5 Agreed to repair boiler.

1822 Nov. 8 New Stack should be immediately built & completed in the ensuing Spring by the best Workman ...

1826 Aug. 3 ... a new Waggon Boiler should be ordered ...

1826 Aug. 21 New boiler plates recd. Aug. 30th of Agent for Butterley Co. [Mr. Hayward proposed that the iron for the new boiler be had of the Butterley Iron Company, and seconded by Mr. Swailes.]

1827 Feb. 1 Old boiler now in disuse be sold for the best price ... Advertisements published in the Sheffield papers 'stating its capabilities'

1827 Nov. 1 That in place of a board floor destroyed by fire the Sunday morning previous [Oct. 28th] a Fire Proof floor be laid down & the expences [sic] above the allowance from the Norwich Union Fire Office be paid by the proprietors according to the recd. estimates of Messrs. Thackeray & Perkins.

Thackray's estimate of Iron work & screws ... for fire proof floor – £65

Perkins' estimate of the brick work for arches & wood arches [etc.] to build upon – £30 [total:] £95

Estimate of board flooring to deduct. – £39

Total sum to be paid by the proprietors – £56'

1828 Nov. Resolved unanimously that a Gas lamp be put up immediately in the yard nearest the Town between the two boilers ... also that the doorway to that yard be walled up & one cut in the Gates.

1829 May 4 George Smith to commence Sep 25 paying at rate of 5.5.0 per Ann. for yard quarterly & give or take a quarters notice.

1830 Jan. 7 George Smith gave notice to give up the occupancy of the Wheel Yard on 25 March.

1830 Dec. 27 The upper gates be removed to the Corner of Bridge Street by Wostenholme for the sum of £4.10.0.

1831 June 2 [Went to see Mr. Woolhouse's saw grinders' room in order to fix a properly regulated price for saw grinders.]

1831 July 10 [Agreed on saw grinding alterations and] declined making any more heavy room at present, there be a probability of the Places being occupied to better advantage.

1832 Dec. 26 Committee meetings [now at wheel] at 6pm instead of 3 as before until 8, & the wheel run until 5.

1833 March 25 That the committee look at the Rooms which Jos. Moore wishes to have altered. The gates of the wheel shall be locked or bolted within one hour of the engine being shut down every night & that boards be placed at each end & side of the wheel with a copy of the above. ... That a notice shall be posted up for the North end of the Yard for a Raff Yard or Stone Yard to be attended to immediately by around the 4th of April.

1833 Good Friday. Meet at wheel relative to the division of rooms & the repairs of the boiler & other business.

1833 April 29 In consequence of an accident with the engine which happened this morning it was thought by the committee advisable to take the opinion of Mr. Cavill along with Mr. Thackray as to the cause. The opinion of the above persons is that the accident might arise from the connecting rods not being sufficiently strong. But the exact cause of such accident they cannot ascertain or assign.

1833 May 6 Tenters to pay more attention to cleanliness of the Engines & Wheel in general. That 2 windows be put out in the Engine House. ... Building a number of small shops or other businesses tenements [?] upon the land from the Bridge to J. Corker's House ...

1833 Aug. 9 Mr. William Unwin the Architect be requested to prepare plans & specifications of a number of shops to be erected to the front of Coulston St.

1833 Sept. 5 Engine house roof be reslated. All the other roofs sufficiently repaired with the Blue slate to be taken off the engine house roof.

1834 June 5 That it is expedient that an Office be erected in Colson St. for the transaction of all business connected with the establishment.

1834 July 8 Resolved: That the committee be empowered to build offices adjoining the engine tenters house in Coulston Street, the expenses of which shall not exceed the sum of £130-0-0.

1834 Aug. 7 Resolved: That Henry Clarke's tender of £138 for building the offices adjoining the wheel in Coulston Street according to the plans and specification made and prepared by W & C Unwin be accepted. (Jno. Ward / John Hattersley / W K Gregory / Edw. Unwin)

1834 Nov. 6 To purchase of green cloth, a range & 12 Winston chairs for new office.

1834 Dec. 26 At a meeting of the Committee held for the first time in the New Office on the Soho Wheel premises ... [To investigate relative cost of running 'present pistons' and 'metalic [sic] pistons']

1835 Apr. 2 Resolved: That the roofing of the engine house be postponed for a few months. ... That Messrs. Shanks / Barr be employed to put in a metallic piston with no. 2 engine & do. into a stuffing box ...

1835 Apr. 17 [Transcript of the agreement with Andrew Shanks & Robert Barr to replace a piston within one month with] one of the Best Metalic Pistons 31 1/2 inches in diameter warranted to work well together with a new piston rod 9 1/2 feet long & 3 inches diameter weighing 225 lb. ... [to pay] sixpence per lb. for the Rod and twenty shillings per inch for the piston ... [according to Farey, this dimension of cylinder is found in 40 hp B&W engines; table p. 574]

1835 July 7 At a meeting of the committee called especially to consider the propriety of dividing the two large chambers in No. 2 Engine into five rooms. ... Resolved: Unanimously that B. Taylor be employed to do the brick work for the division of the two large rooms, on the same terms as he divided the large rooms in No. 1 Engine and that Mr. Webster be contracted for making 3 doors and door cases for them. [?] Unwin to purchase a sufficient quantity of timber for bond timber for the partition walls at some of the wood yards cut up ready for use.

1835 July 25 [Transcript of Agreement to reslate engine house roof for sum of £28,0,0.]

1835 Aug. 6 [Transcript of Agreement to make] another Metalic piston similar to the one put down for the Soho W. C. ...

1835 Nov. 5 [Set up committee] for purchasing a new Patent Weighing Machine of the best & most approved principal.

1835 Dec. 3 Resolved: That Mr. Hutchinson be employed to make & put down a weighing machine if he will do it for £40.

1836 Nov. 3 That the office be papered & painted & a new clock fixed therein ...

1837 Feb. 2 Trial [or 'Treat'?] with Messrs. Vickers for the purchase of a sufficient supply of water for the steam engines – in the mean time to make all necessary inquiry relative to other supplys [sic] – Messrs. Vickers having asked a 40 years purchase upon the advanced Water Rent viz. £21-0-0.

[More relating to this transaction not included here.]

1837 Aug. 3 That George Truman be allowed at his own expense to raise his wood warehouse on the Co.'s land a story higher & if the Co. should ... require him to give up possession of the land ... he shall be allowed to take away all the old materials.

MD717

1838 May 4 That two shops be built at the end of the Wheel next the river for the use of Mr. Holdsworth and other tenants occupying chamber room to lay their wood in, and that all the Wood partitions be removed & replaced with brick ones, And that the Entrance to the chambers over that part of the Wheel fronting to Bridge Street & originally only one story high be from the steps at that end next the river. ... The alteration now making in the Hull next the Engine house on the left hand going into the lower yard for Mr. Woodhouse of Rockingham St. Table Knife Manuf[acturer]. was also looked at and app[r]oved of. Thos. Nowill.

1839 March-April [Talk of repairing the 'Old Round Boiler'.]

1839 June 6 [Gas pipes to be extended from the present lamp in the Weigh House Yard into the Engine House & into the dark passages on either side of the Boilers – gas to be supplied by the New Company.]

1839 Dec. 26 That the Treasurer be requested during the ensuing spring to cause the new Long boiler to be covered with bricks, and a dwarf brick wall with strong stone coping to be erected on each side thereof, so as to form a depository for Wheelswarf & rubbish – Also to pave that part of the Yard, lying between the Walls and the Wheel, similar to what has lately been done in the other yard on each side of the boilers. And that he be further empowered to cause two small shops to be erected for the use of the Wood Turners on land adjoining the Shops occupied by Mr. Holdsworth & Mr. Shepherd if in the opinion of the Committee at any future meeting the same shall be deemed available.

1842 March 28 Meeting of the Committee held at Bridge St office 6 O clock pm. Resolved That in consequence of the Fire which broke out on the North West side of the Wheel on the 17th of March instant the estimated loss sustained being about £100 beyond the amount for which it was insured. That No Dividend be paid to the Shareholders this Quarter.

That £5-0-0 be presented to the Committee appointed to receive Subscriptions on behalf of the Occupiers and Tenants who lost their Tools by the Fire above referred to. William Simpson.

1842 June 2 Committee Meeting. Resolved That the Chamber Floor over the Room which was burnt down be made fireproof and that the outer wall be built 2 feet 6 inches in advance of the Building adjoining in order that all the troughs therein may be made 3

deep. –

That Mr Charles Unwin be requested to prepare a plan and specification of the intended new erection in place of that burnt down in March last and that Tenders for the work be obtained with as little delay as possible to be submitted to the Sub-Committee.
That the Sub-Committee be requested to superintend the erection above referred to. – William Simpson.

[Now paying dividends again.]

1842 Dec. 26 Resolved. That Messrs Simpson, Ryder, Philip Unwin and the Treasurer be respectfully requested to act as a Committee to insure the Wheel in some respectable Insurance Office for two or three thousand Pounds as to them may appear best and that with as little delay as possible.

[on 3 Dec. 1840 had Resolved that the Soho Wheel be insured in the York and London Assurance Office for £2000 ... the annual amount of Insurance and duty being £8-10-0 viz. Insurance £5-10-0 Duty £3-0-0. John Ryder.]

[1844 Feb. 1 Fire as reported by Engels (1845) p. 266.]

1844 Feb. 15 Mr Charles Unwin having prepared Plans & specifications for the restoration and improvement of the North West Wing of the Wheel – The Chamber floors to be Fire Proof Brick Arches and the Roof Laths & Spars Wrought iron & cast metal – the cost of the whole exclusive of machinery being estimated at £1100 ... [to borrow £1000 on mortgage or otherwise ...]

1844 Feb. 29 Special G. M. Resolved unanimously ... to borrow £1000 on security of the company's Title Deeds and the Committee to give their promissory Note of hand as a Collateral Security for the said principal sum of £1000 and interest for purposes named in the circular ...

1844 March 25 Resolved that after ... deliberation it is the opinion of this Meeting that it would not be desirable to lay out so large a sum of money in re-building & improving that part of the wheel lately destroyed by Fire as was contemplated by a resolution passed at a special meeting of the Committee held on the 29th Feb last – and that in lieu thereof it be put into the same state as it was when first built – the cost of which is estimated about £350.

1844 May 9 Resolved That the plan proposed by Mr. Unwin for renovating the destroyed part of the Soho Wheel be adopted with the provision that three of the Hulls be divided into six and that the different parts be offered for competition.

1844 May 16 Resolved that Messrs. Frith [?] & Stothards tender of £120 for mason & bricklayers work be accepted.
– that Mr. Robt. Wildes tender of £85-13-0 for Carpenter and Joiner work be accepted
– " " Bernard Seale " £16-0-0 " Plumbing & Glazing

– " " Mr. Jno Rhodes " £5-5-0 " painter work

– " " Abm. Law's " £44-14-0 " slaters work

1844 May 20 [Mr. Wilde's tender up to £93-0-0; Mr. G. Harrop at 91-15-0 accepted instead.]

1844 Aug 5 [Mr. Geo. Timmon 'unceremoniously proceeded to pull down the warehouse & premises erected on the Comp[any's] land some years ago'; threaten him with legal action if not settled.]

1844 Dec. 5 Resolved That a stone wall 4 yards height similar in strength and appearance to that built round the New Gas Company's works in Effingham Street be immediately built in place of the brick wall now standing between the premises occupied by George Timmon and those of Mr. Horne the said wall to be built across the lane called Pear Street and a pair of gates to be placed in the said wall opposite to Bower Street – the estimated cost of the whole being about £30.

1845 Jan. 30 [More wall building; as before, but not hammer-dressed; bricks removed from here and added to height of wall adj. Bridge Street from office as far as bricks will allow towards Iron Bridge. £40-0-0.]

1846 Sept. 28 That the Sub-Committee be authorized to build a shop or shed about 14 ft by 14 yards at the north end of the west wing of the wheel to be let to John Jepson if they can agree with as to terms.

1847 Sept. 27 Mr Charles Unwin reported that he had examined the injure done by Fire on the morning of Friday the 17th Sept instant in James Thompson's Hull and that he valued the same at £21.

1850 Oct. 28 W&J Galloway of ... Manchester ... to make & fix one of their patent smoke consuming boilers 30 ft long by 7 ft diameter at a cost of about £240. [Within 2 weeks.]

1851 June 5 ENGINE No. 1 NEXT BRIDGE STREET ought to be replaced with a new one & its present condition is dangerous to work. [Galloway and Davy to make quotes.] ... Messrs. Davy Bros. report that they would replace No. 1 Engine with one the same as Mr. Walker's at Globe Works for £780. Messrs. Walker Eaton & Co. report that the Engine is working up to 80 Horse power but give no estimate as to the probable cost of replacing it.

1851 June 30 Resolved that the whole of the Bridge Street side of the Wheel be re shafted with iron shafting and that estimates be got ...

1852 March 29 To put up 2 new boilers of Galloway's patent in front yard ...

1853 Feb. 3 [To undertake negotiations with the 'Corporation to take the land & premises for the approaches to the New Bridge'.]

1853 Apr. 4 An accident having happened to No. 1 Engine of a serious nature, this meeting was called for the purpose of inspicting [sic] and deciding upon what steps should be

taken. [Davy Bros. to be requested to inspect the broken engine & report to Comm. tomorrow night at 7 o clock. ... Arrange witn tenants of No. 2 Engine ... arrangements for working. ... Cannot pay dividends promised 28 March last.]

Appendix 4.5

Notes from the Fairbank papers relating to the Soho Wheel

SCA NB31 (c.1834) p.10

From information rec^{d}. from — Simpson Agent for the Soho Grinding Wheels on Colson Crofts it appears that:

		£	s	d
No. 1 Engine				
Works	85 Light troughs at 8 gus	714	0	0
	6 Heavy do. at 17 gus	107	2	0
	2 Scale Stones in all £36	36	0	0
No. 2 Engine				
Works	84 Light troughs	705	12	0
	9 Heavy do.	160	13	0
And there are 5 rooms without Troughs which let for 12 Gus each on the average	}	63	0	0
		£1786	7	0

Out of w^{ch}. sum the wear & tear of the Engines & other machinery belong^{n}. to the concern & the coals for them with interest on the Capital sunk thereon must be deducted –

SCA NB25 (c.1829-30) p. 106

Colson Crofts Grinding Wheels.

I am informed by a grinder there that there are 264 troughs at these Works of different sorts.

There are 32 hulls on the Ground floor each containing 6 troughs	=	192
And 12 Hulls on the Chambers ea 6 do.	=	72
	Make	264 Troughs

There are two Steam Engines of 30 HP ea. ['of 70 horse power' deleted] and they reckon 16 hulls to one Engine – but as one cannot say how many troughs of a given sort an Engine of this kind can turn – He says they pay as a rent 8 Gus per Troughs for Penknife grinding & 17 Gus per trough for Table knife grinding & they have every they found them except the stones & straps even Coals to warm the rooms.

Appendix 4.6

Steam-powered grinding wheels built on 'greenfield' sites by 1840

Greenfield	*Brownfield*
Smith: Sidney Street	Elliott: Sylvester Wheel
Turner: Suffolk Works	Dewsnap: Arundel Street
Sykes: Sykes Wheel	Rhodes: Sheaf Island
Rawson: [unnamed wheel]	Darwin: Ponds Works
Frith: Bees' Wax Wheel	Kenyon & Frith: Ponds Forge Mills
Proctor & Beilby: Old Park Wheel	Wostenholm: Broad Street, Park
Greaves: Sheaf Works	Stuart/Spear & Jackson: Savile Works
Proprietors: Soho Wheel	Brownell: Walk Mills
Whitham: Bridge Street	Marshall: Castle (Tower) Wheel
Leather?/Chadburn: Nursery Wheel	Steer: Castle Hill
Hunter: Talbot Works	Rodgers: Sycamore Street
Beckett and others: Union Grinding Wheel	Frost: Millsand Mills
Marsden: Pilot Works	Dunn: Kelham Wheel
Drabble & Sanderson: Ebenezer Works	Crowley & Pearson: Kelham Works
Ward, Ellis, Ellis: Cleakham Wheel	Gallimore: Bridge Street
Ibbotson: Globe Works	Longden: Phoenix Foundry, Furnace Hill
Stuart & Smith: Roscoe Place	Hoole: Green Lane
Ryalls: Doncaster Street	Horrabin: Red Hill
Wells: Wells' Wheel	Smith: West Street
Oakes: Washington Place	Davenport: Rockingham Steam Wheel
	Hudson & Clarke: Union Foundry. Furnace Hill

uncertain—Atkin & Oxley: Howard Street

uncertain—Mosely: West Bar

uncertain—Younge & Smith: Nursery Street

uncertain—Smith: Sheldon Row

uncertain—Radcliff: Love Street Works

Appendix 4.7

Evidence relating to steam power in Sheffield in 1835

Source: *Sheffield and Rotherham Railway. Minutes of Evidence taken before the Lords Committee to whom the Bill, intituled "An Act for making a Railway from Sheffield to Rotherham, both in the West Riding of the County of York," was committed.*

SCL 385 SSTQ

The evidence was used as the basis of the figures published by Porter (1836) p. 301.

[For clarity, the witnesses' responses have been indented.]

[p.3] Die Lunae, 6o Julii 1835.

The Earl of HAREWOOD in the Chair.

...

[p.6] SAMUEL WINGFIELD is called in, and examined as follows:

(Mr. Sherwood.) You are a Clerk in the Employ of Naylor, Hutchinson, and Co.?

Yes.

Have you made any Calculation of the Number of Converting Furnaces in the Town of Sheffield?

Yes, I have.

State the Number of them?

(Mr. Serjeant Merewether.) Is that founded on your own Knowledge?

Yes.

You have seen them?

Yes.

And know them?

Yes.

(Mr. Sherwood.) Have you visited the Furnaces to make this Statement to their Lordships?

Yes.

Give to their Lordships the Number of Converting Furnaces?

Fifty-six.

Now the Buildings containing the Furnaces for moulting Steel; what are their Number?

Sixty-two.

There are Sixty-two Buildings?

Yes.

Now give the Number of Furnaces?

554.

Of Furnaces for converting Iron into Steel there are Fifty-six.

Yes.

What Number of Steam Engines have you found?

Seventy-six at work, and Two not finished.

Have you adopted any Measures to ascertain the Power of those Seventy-six Steam Engines?

From the Proprietors, if they were on the Premises, and if not, from the Engine Tender.

(Mr. Serjeant Merewether.) From Information you have received?

Yes.

Have you yourself visited each of those Engines?

Yes, with the Exception of Two. I know they are in existence; I have seen the Engines; I did not on those Occasions go there.

(Mr. Sherwood.) What is the Average Power of the Seventy-four Engines?

Eighteen-and-a-Quarter-Horse Power.

Mr. Serjeant Merewether objects to the Evidence.

(Mr. Sherwood.) Did you inquire on the Spot the Power of the Engines?

Yes.

[p.7] Now give me the Power; if you made it on the Spot, state the Result?

The Power of Seventy-four Engines amounted to 1,353.

The Evidence is objected to by Mr. Serjeant Merewether as hearsay Evidence.

(By a Lord.) Did the Owners communicate it?

Yes; I can give the Names.

(Mr. Austin.) You saw the Owners in all Cases; but some were the excepted Cases, those that the Engineers gave?

Yes.

Mr. Austin contends, That this disposed of the Objection, it not being hearsay, the Witness having acquired his Information as to the Construction of Power of the Machine from a proper Quarter.

Mr. Crowder is heard in answer.

Their Lordships suggest, That the Counsel should not pursue the Evidence; which Suggestion is adopted by the Counsel.

The Witness is directed to withdraw.

Mr. WILLIAM VICKERS is called in, and examined as follows:

(Mr. Austin.) Mr. Vickers, do you live in Sheffield?

Near Sheffield.

Are you a Merchant there?

Yes.

What is the Name of the Firm?

Naylor, Hutchinson, Vickers, and Co.

What Line of Business are you engaged in?

As Merchants, and Steel Manufacturers and File Manufacturers.

How long have you been engaged in that Trade?

In learning and prosecuting of it at Intervals, Twenty Years.

What is the staple Trade of the Town of Sheffield?

It is the Manufacture of Steel, of Hardware, Tools, Files, Saws, Razors, and all Kinds of Cutlery.

Iron, Horns, or Bones are used in the manufacture of all the various Parts of those Articles?

Yes; large Quantities of Horns, Bones and Iron.

Are Steam Engines used as applicable to those Manufactures?

Very considerably.

To a considerable Extent?

Yes.

Do you know what are the Number of Steam Engines in the Town of Sheffield?

I know from sending the last Witness for the Purpose of ascertaining the Fact; I sent the last Witness for the Purpose of ascertaining that Fact.

Have you Steam Engines yourself?

I have several.

How many?

Three.

What is the Average Power of those Three?

About Twenty-eight-Horse Power; the Town Mill is Forty-Horse Power, the Dun Steam Engine is Thirty-six-Horse Power, and the Albion Mill is Twenty-four-Horse Power.

[p.8] Are you acquainted with any other Engine in the Town?

I am, with nearly the whole of them; I have seen most of them from Time to Time at different Times.

[p.33] Die Martis, 7o Julii 1835.

The Earl of HAREWOOD *in the Chair.*

The Counsel and Parties are ordered to be called in.

Mr. SAMUEL JACKSON *is called in, and examined as follows:*

(Mr. Pollock.) Where do you reside?

At Sheffield.

What firm are you engaged in?

The firm of Spear and Jackson.

What branch do they pursue?

Manufacturers of Steel and Saws, and various Kinds of Hardware.

Is yours an extensive Manufactory?

It is.

How long have you been engaged in it?

Fourteen Years.

Do you consider Sheffield the Seat of the Cutlery Manufacture?

It is, for all England.

Is there a considerable Quantity of Conversion and Casting of Steel in Sheffield?

It forms a very important Branch of the Trade of the Town.

And that extends of course to edged Tools and Files and other Articles of Manufacture?

It does.

Of course, there are a great many Steam Engines in Sheffield for the Purpose of conducting those Manufactories?

A great many.

Have you any Notion how many?

There are Seventy-four Steam Engines.

Is your House an exporting House?

Altogether, or nearly so.

To what Place do you export?

To the United States of America, and to most Parts of the Continent of Europe.

To France and Germany?

France, Germany, and Belgium are the principal Parts.

Appendix 4.8

'The Causes and Prevention of the Sheffield Grinders' Disease' by Dr J C Hall

Excerpts from Dr J C Hall (1865) *The Trades of Sheffield as Influencing Life and Health, more particularly File Cutters and Grinders. Read before the National Association for the Promotion of Social Science, October 5th, 1865.* Second edition. London: Longmans, Green and Co., Paternoster Row.

Source: SCL Local Pamphlets vol. 3, no. 7.

[p.11]

THE CAUSES AND PREVENTION OF THE SHEFFIELD GRINDERS' DISEASE.

Grinders are divided into three classes:- 1. *Dry Grinders, using only the dry stone.* 2. *Mixed, or those who partly grind on the wet, and partly on the dry stone.* 3. *Wet Grinders.* The Grinder carries on his work in a building called a wheel. The first steam-grinding wheel was erected in 1786, when grinding became a separate branch of trade.

WHEELS AND HULLS.

At the present time there are about 164 Wheels in and near Sheffield. Of these 132 are steam and 32 water wheels. There are 8 water wheels on the Sheaf, 2 on the Don, 7 on the Porter, 6 on the Loxley, 8 on the Rivelin and 1 at Whirlow.[37] In each wheel are a number of rooms which vary in size and the number of grindstones they contain. In these the Grinders work. As a general rule wet grinding, and the heavier branches of the trade are carried on down stairs; and the lighter branches in the rooms on the upper stories. There are however many exceptions to this rule, and it is no uncommon circumstance to see wet and dry grinders working in the same room. The heavier branches of grinding include saws, scythes, table knives, machine knives, edge tools, files, &c., &c. The lighter branches are spring knives, (pen and pocket knives,) razors, scissors, forks, spindles, needles, &c., &c. Needle grinding is principally carried on at Hathersage, a village some few miles from Sheffield. A considerable number of men are employed in grinding glass.

The rooms in which the grinders work in the various wheels are called "*hulls*," the literal meaning of which is a *stye*. A visit to many of these places would convince you, Sir, and every member of the National Association for the Promotion of Social Science, that a more happy or appropriate appellation could not possibly be selected. In [p.12] each room are placed a

[37] This may not, possibly include every wheel - as many old houses have of late years been devoted to this purpose. It is hardly necessary to state that in sanitary and other requisite requirements many of such places are totally unfitted for grinding.

number of "*trows*" (troughs), more or less in proportion to its length. Some rooms will have ten, some not more than two or three. The trough, which is made of cast metal, is received into the floor of the room and contains the water in which the grinding stone revolves. When the stone is run dry, the water is removed from the trough. Each trough has several divisions - one for the stone, one for the glazer, the lap, and the polisher.

The *Glazer* is a wooden wheel, which varies in size from four inches to four feet in diameter: it is covered with leather. This is "dressed" over with glue and emery, and when this application hast set the surface is rubbed with emery-cake, which is a composition of emery and bees'-wax.

The *Lap* is a wooden tool faced with lead, on which the sides of penknives, the sides of razors, and the flat sides of the better finished scissors are rubbed to give them a flat surface. The effect of this will at once be evident to any one who has a first-class Sheffield knife, on comparing the pen with the pocket blade, or a razor with a table knife.

The *Polisher* is placed at the back part of the hull. It is smaller in size than the wooden wheel already described. It is covered with leather, and made to revolve much more slowly than either the grinding stone or the glazer. If it revolved rapidly the blades either of the knives or the razors that were undergoing the process of polishing, would become heated, and the fine temper of the steel destroyed. Although the glazer revolves with no little rapidity the paste with which it is covered prevents this effect. A dry powder, called by the workmen "*crocus*" (an oxide of iron), is used for polishing. Boys, who are apprenticed but too frequently to the lighter branches of the grinding trade at from nine to twelve years of age, are first put to polishing the different articles. *I found a boy at work in a wheel last week, engaged in polishing, aged only seven.* In my visits to wheels, I have frequently met with young boys with coughs, shortness of breath, and lungs extensively diseased, *who have never ground*, but who have been injured by this process of polishing, about which I shall presently have some remarks to make.

The *Drum*. In the back part of each room is a drum or wheel of large dimensions, which is set in motion by the steam-engine, and to it the grinding stones, glazers, and polishers are attached by the "wheel-bands," which are broad leather straps. The connection between the different wheels and the drum can be effected or discontinued in a moment with the utmost facility by putting the bands on or off. Each drum ought to be protected by a rail.

Grinding Stones. - A large portion of the grinding stones are brought from the neighbourhood of Wickersley and Dalton, a few miles from Sheffield. The whitening stones, used for smoothing articles before glazing, are brought from the Brincliffe-edge quarries, about a mile from the town. In grinding a razor both the dry and wet stones are employed. I will therefore, describe the process of making a razor, in order to show the effect this trade has on the health and lives of those employed.

MAKING A RAZOR.

The razor is first forged out of a bar of steel, It is then sent whilst in the soft state to the grinder, who shapes it *on the dry stone* into the [p.13] required pattern. After the razor has been "*shaped*," it is returned to the forge to be "file cut" and "marked;" the mark stamped upon it is very frequently that of some distant firm, it may be in Glasgow, London, or some other town. The razor next undergoes the process of hardening and tempering, after which it is once more brought to the wheel and ground to an edge on the wet stone. It is then "lapped," on a tool the exact size of the stone on which it has been ground. The back and end of the tang is glazed. The whole blade is then wiped very clean, and highly polished with crocus. It is now sent to the hafter who places it in the scales (*handle*). The razor is then made ready for use by being "set" or sharpened.

In order to find out the exact quantity of steel dust of necessity created in the process a razor undergoes on the dry stone, Mr. John Wilson, (a very well-educated and most intelligent pen-blade grinder - and one for whom I have personally the highest respect,) - in himself a living example of what a grinder ought to be, and what he might be if he would, and who has worked for many years for the celebrated firm of J. Rodgers and Sons, Cutlers to Her Majesty, made, at my request, the following experiment, the result of which is shown in the annexed table.

Table showing the Weight of a Dozen Razors in the different stages of their Manufacture.

[col. 1] *Shape of Razor. - Quill Backs.*

Weight.	lbs.	oz.
12 Razor Blades forged in the rough	2	4
12 Razor Blades, shaped	1	15
12 Razor Blades, finished	1	10

Loss in shaping 5 ounces per dozen, principally on the dry stone.

Loss in grinding on the wet stone, 5 ounces per dozen.

[col. 2] *Shape of Razor. - Swaged Backs.*

Weight.	lbs.	oz.
12 Razor Blades forged in the rough	2	0
12 Razor Blades, shaped	1	15 [corrected to '10' in ink]
12 Razor Blades, finished	1	8

Loss in shaping, 6 ounces per dozen (dry.)

Loss in grinding, 5 ounces per dozen (wet).

In shaping a dozen large razors on a stone seven inches in diameter, the stone would be reduced nearly one inch.

To grind a razor to the proper shape great friction is required; razor backs are for the most part round and the pressure during the shaping is so great that no wet stone could sustain the rolling friction; the stone would soon become uneven like a hammer-stone, and so pulverised, that after shaping four or five blades, the workman would be unable to hold the blade on the stone. *Forks, razors, table knife-bolsters, scissors, shanks, and needles*, undergo the rolling process and consequently, require the dry stone. Spring knives five and twenty years ago were ground on a dry stone.

This process has been superseded, and these knives are now I am happy to say, all ground on the wet stone, which is made to revolve with great rapidity. In shaping razor blades on the dry stone, a number of red hot particles of steel fly about in all directions. From these "Motes," as they are called by the grinders, the eyes were at one time constantly injured, and in some instances permanently lost. This danger is now obviated by wearing large spectacles of ordinary window glass. The protection they afford is obvious, for on examination after they have been a short time in use, the glasses are found spotted all over by the sparks of heated steel. But even this precaution is not taken by all - a razor grinder told me only last week, he did not use the "specs" because his eyes were so good.

[p.14]

DRY GRINDING, HANGING, AND RACING STONES.

It is in dry grinding that the workmen are exposed to by far the greatest danger. The dust which is created by the stone and steel fills the room in considerable quantities, and when grinding scissors or forks two or three deep without a fan, those who sit behind throw a large quantity of dust on those who sit in the front. But it is not only in grinding that dust ascends. Much of the evil resulting from the trade of a grinder, and this remark applies alike to dry and wet grinding, proceeds from "hanging" and "racing" the stones. The stones are received at the wheel from the quarry in a rough state.

The grinder first drills a hole through the centre, and fixing it on the axle places it in the trough. It is then made to revolve slowly in order that the steel which is used in the process of racing may bite.

With this bar of steel the asperities of the stone are removed and their surface rendered level and smooth. During the operation, which frequently lasts half an hour, the rooms are

unavoidably filled with dust; the dust also arises in dense clouds when the sides of the "trow" are swept after the process of racing is over. It is easy to protect the nose and mouth with a light handkerchief during this process; but the precaution is seldom taken. On my asking a file grinder at the Union Wheel a week or two ago, when collecting materials for this paper, and who I found racing a stone and covered with dust, why he was thus exposing himself to causes certain to induce a disease that would quickly bring him to a miserable death, he replied, "*we know all about it Doctor, but we never give it a thought.*" Much dust also, arises in glazing and polishing; the amount will depend in some measure on the nature of the glaze used. The glazing of forks is the most injurious. Almost all the grinding stones are now fitted with plates and screws, instead of as formerly, only with wedges: the number of accidents from the breaking of the grinding stones are, at present, much less frequent than when the old plan was in operation. The saw grinders at one time were often very seriously injured from the breaking of the stones when they were at work. The large size of the stones, and the weight and length of many of the saws they have to grind, will easily account for this branch of the trade, being more dangerous from the breaking of the stones, than when the articles are smaller and lighter.

DIFFERENT CLASSES OF GRINDERS.

It has been intimated already that grinders may be divided into dry, wet, and mixed. Forks, needles, brace bits, and spindles are ground entirely on the dry stone, and in addition, table knife bolsters, shanks, shaping razors, "humping" scissors, &c., &c., all require the dry stone to be employed. Some trades never use the dry stone: for example, saws, files, sickles, table knife blades, edge tools, scythes, &c., are only ground and glazed. There is also a numerous class of grinders who work for the most part on the wet stone, and who are employed in grinding engineers' tools, engravers' tools, engravers' steel plates, hammers, fenders, fire irons, stove grates, busks for stays, candlestick-bottoms, nippers, garden-shears, hoops, &c.

Fork Grinders work on a dry stone, and their calling is perhaps more destructive than any of the grinding trades. The present number of men employed is about 150. Personal inquiries at the various wheels [p.15] induce me to conclude the present condition of these men is no better than when a fork grinder told me, some years ago, "I shall be 36 next month, and you know that is getting old for a man at our trade;" and when I found the average age of the men only 28. Individual instances may be found of fork grinders much older than this man, but it is nevertheless an undoubted fact that many fork grinders miserably perish before the age of 30. Take for example a boy of *ten*, (and at that early age many of them go into the wheel,) at the age of 21 his expectation of life, supposing he continue to work at his trade without a fan, would certainly not exceed 14 years. Now at 21 the probable expectation of life is 39 years; so we see, that these unfortunate men are exposed to influences which rob them of 25 years of existence - to that extent deprive their wives and families of the benefit of their labour, and fill the union poors'-houses with widows and fatherless children. There is no more melancholy

object than a fork grinder, looking prematurely old and dying from the dust inhaled in his trade - no object more deserving of our pity, as we see him often crawling to his hull to labour when altogether unfitted by the grinders' disease for his calling - "his poverty and not his will consents." In this condition, a day or two a week, he grinds for a few hours; inhales additional dust, and in order to obtain bread, increases the disease which already is rapidly destroying him.

Razor Grinders. - From the statements published a few weeks ago by the Committee of the Razor Grinders' Union, it appears there are 290 workmen employed in grinding razors, and 81 boys under 21.

Ages.	*Persons.*	*Ages.*	*Persons.*
21 to 25	83	50 to 55	9
25 to 30	57	55 to 60	8
30 to 35	36	60 to 65	3
35 to 40	35	65 to 75	1
40 to 45	29		
45 to 50	29		

The above table may be left without a word of comment, to tell its own tale.

Scissors Grinders. - These men work partly on a wet and partly on a dry stone. The most destructive part of the work of a scissors grinder is when giving the rounded form to the blade, and which is called humping.

There are at the present time some 250 men employed in this calling. Some years ago, I found the average age of all then living to be 32. A few weeks ago I [vi]sited 86 scissor grinders when at work in the different hulls. I took down the age of each man at work, and found the average to be only 31 years. I took the same day the average of 40 razor grinders and found it only 31 years and six months. These men were at work on the dry stone, and a majority of them either had no fan or a fan that was almost useless. Others had a fan, and were working with dry grinders who had no fan. One man with a good fan was humping scissors, but received the dust from a grinder on either side of him who was shaping razors.

File Grinders use only the wet stone. 250 men are at present employed.

[p.16]

Saw Grinders employ the wet stone. There are at present 220 men and 60 boys.

Table Blade Grinders are not so numerous as a few years ago. Many have gone to America, and from the low prices obtained few boys have been apprenticed. At present there are 660 men and 170 boys.

[38]*Spring Knives*, 650 men and 200 boys have been returned to me by the Secretary of the Union, as the number at present engaged in this branch of grinding.

Saw Grinders (wet), 220 men, 60 boys.

Scythes (wet), men and boys 60.

Sickles (wet), 72 men, 30 boys.

Edge Tools and Wool Shears, 230 men and boys.

If to these we add the grinders of surgeons' instruments, engineers' tools, jobbing grinders, needle grinders, &c., it will be found that in and out of the different unions there are 3,090 men, and 1,073 boys - total, 4163 men and boys employed in grinding, dry, wet, and mixed. I have tested the accuracy of my former return sufficiently to say that the average ages of all the fork grinders living does not exceed 29. Scissors grinders, 32; edge tool and wool shear grinders, 33; table knife grinders, 35. The ages of all the razor grinders have already been given. I regret to be obliged to say that there is but too much truth in the remark once made to me by a young man aged 26, a fork grinder, - "*he reckoned in about two more years at his trade he might begin to think about dropping off the perch*," adding "*you know a fork grinder is an old cock at thirty.*" On taking down the ages of all the grinders, wet, mixed, and dry, at one of our largest wheels, I found the average 34; boys under 21 were excluded from this calculation. There can be no difference now; all the same adverse influences are still in operation, and sickness and premature deaths will continue until the causes producing them are removed. Taking the returns of the ages of the grinders who had died at some of the wheels, from their club books, I found it to be 43, 40, 40, 41, 38 1/2. Taking the deaths at the wheel of Messrs. J. Rodgers & Sons, for some years past (1850 to 1865, wet and dry grinders,) the average age was 49 - of the dry grinders only 43. At the Union Wheel, from 1859 to 1864, the return including both wet and dry grinders, shows the average age at death to be only 46. But even these death rates may mislead us, if we do not remember that both of these wheels are *first-class*, and that as a rule it is only the more prudent and better class of grinders who belong to such provident societies.

Men who work in the country, as a rule, are more healthy than those who grind at the wheels in the town; and as a body they are more temperate. One of the most healthy branches is saw grinding. Many saws are ground at the water wheels on the picturesque streams around Sheffield; and, as a rule, the men have not to work so many hours a day as some of the other branches. Again, the trade is too heavy to admit of boys coming into it at a very early age. No

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[38] When my book was published in 1857, on the Grinders' Disease. I returned 685 men and 600 boys, under Spring Knife Grinders. Mr. Broomhead the Secretary to the Union informs me that of late years only Grinders' Sons have been allowed to enter the trade, hence the diminution. The same remark will apply to others of the grinding trades.

boy is recognised by the Saw Grinders' Union under the age of 14. The men [p.17] stand at their work, and consequently the lungs are not so compressed as when the grinder, sitting on his horsing, bends forward for so many hours each day, in other branches of the trade about to be described.

THE CAUSES WHICH PRODUCE THE GRINDERS' DISEASE.

The cause of this disease is first, the irritation produced by the metallic and gritty particles inhaled in grinding and also in "hanging" and "racing" the grinding stones; and next, the constrained position in which they labour, and which is unfavourable to the free actions of the respiratory organs; to this must be added, the working for many hours in a badly ventilated room. When at work the grinder mounts what he calls his "horsing." This is a low narrow wooden seat. His elbows rest upon his knees, and his head, particularly when employed on very small articles, is bent over the stone. This position is a very injurious one, and when long continued is calculated, unquestionably, to induce pulmonary congestion. In many of the branches - table knife grinding for example, the men often work in the coldest weather very thinly clad - their handkerchiefs off; their shirts open and their chests fully exposed; and this too, in a room every bit of glass from the windows of which has been removed, that the light might not be obstructed by the splashing of the dirty water from the grinding stones. The floors of such hulls are generally of mud, and always wet, dirty and uncomfortable. The men perspire freely at their work and in this condition often leave the hull, and without putting on additional clothing, lounge about the yard in the open air, even when the weather is very cold. Inflammation of the lungs, pleurisy, rheumatic fever, and diseases of the heart are not infrequent among them. I have seen many young boys suffering from grinders' disease arising from the dust inhaled in polishing; and in dry grinders very often before the age of twenty, evidence is present of the existence of this fearful affection. I had a patient at the Public Hospital last week, a grinder aged 22 - on enquiring what was the matter with him he said "I grind razors and have got what I shall never get *shut on*" (rid of).

He began to work at 11 and never had used a fan. Both lungs were affected by the grinders' disease, but not nearly to the extent I have seen them, even in younger men than this poor fellow. At the commencement of the disease the breathing is difficult - more particularly when walking up a hill, going up stairs, or ascending the steps leading to the upper hulls in which they work. At this early stage, the shoulders are often elevated, in order to relieve the distress occasioned by shortness of breath. The disease quickly increases; and day by day, makes certain progress in all dry grinders, working without the protection of the fan. The digestive organs become impaired, the breathing is more and more short and oppressed - the face has a dirty white aspect - the countenance is indicative of much suffering - he stops to cough in the street as he crawls to his work - supporting himself against the walls. They all complain of a dry sensation in the throat and tell you "they feel screwed up" and that something is so tight across their chests they cannot breathe. The cough is at first dry but after a time there is a

good deal of expectoration which at first is frothy, and indicative of irritation. If asked by my medical friends to give them a brief *resume* of the physical signs of the Sheffield Grinders' disease - I would say - those of bronchitis and dilated bronchi in some cases - in others, of emphysema or of consolidation, and, lastly of excavation. I have had several photographs prepared by Mr. Caloe of some sections of the lungs of those who have died from Grinders' disease. Also some drawings of the sputa in wet and dry grinders under my care, as seen with the microscope, and which Mr. Tuffin West has made for me. (Some beautiful illustrations were here handed round for the inspection of those present.) And now, I come lastly to consider how this terrible disease may be prevented.

[p.18]

PREVENTION OF THE SHEFFIELD GRINDERS' DISEASE.

This Disease was formerly almost unknown, and for this reason. Until the year 1786, when the first steam wheel was erected, grinding wheels were built upon the banks of rivers in and near Sheffield; and water being the power employed, it will at once be obvious that the grinder would have many interruptions to his trade and that to grind day after day as the grinders now do, was then impossible, and many of them were makers as well as grinders of Cutlery. Nor was this all. By the old regulations of the Cutlers' Company, passed in the reign of Elizabeth, it was provided, "*that no person engaged in the said manufacture, either as a master, servant, or apprentice, shall perform any work appertaining to the said science or mystery of Cutlers for eight and twenty days next ensuing the 8th day of August in each year; nor from Christmas to the 23rd day of January, upon pain and forfeiture, for every offence found and presented by twelve men of the said fellowship of the sum of Twenty Shillings. No person occupying any wheel for the grinding of knives to allow any work being done during the holiday months: penalty as before.* When grinding became a separate branch of trade, the hours were no longer limited, and then, it would appear, that the fearful effects, on the animal economy, of constantly inhaling particles of steel and grit day after day, began to develop themselves. This then leads me to a first practical suggestion for alleviating the condition of the Grinders, viz., to *diminish the hours of labour*; and the most effectual way to do this is to abolish "Saint days," as the first days of the week are called by these men, and which are spent by but too many of them in drunkenness and intemperance. What is the result? They crowd into three or four days the labour that ought to be distributed over the whole week, and many soon find, to their cost, the folly of such proceeding. It is a notion in some of the hulls that a drunken grinder often lives the longest. This is a very great mistake. Intemperance has hurried hundreds of these men into their graves. I almost invariably find that, so soon as the liver becomes affected, the chest symptoms are aggravated: and that when the liver fails to discharge its functions, a comparatively slight amount of disease in the lungs of the grinder, will cause far more distress and difficulty in breathing, than even in lungs more extensively diseased, when this organ acts properly. By limiting the hours of labour, time would be

afforded for out of doors pursuits, for exercises which would bring the different muscles of the body into play, and prevent, especially in the young, some of the effects which result from bending over the wheel when at work. I have to day in my study, Mr. Samuel [p.19] Sharpe, a razor grinder, at the union wheel: he is now 48, strong and healthy, he has never suffered from the grinders' disease, he began to work at eleven, and he justly expressed the opinion that "*grinding takes most hold of young boys.*" Mr. Sharpe has always used a fan, and will not work in a hull with dry grinders who are not so protected. He does not believe in "Saint days," and works on an average about 38 hours a week. It would be well therefore, 1, *to limit the hours of labour both in boys and men.* 2, *wet and dry grinders ought on no pretence be allowed to work in the same hull.* After what I have already said, the reason for this will be all too obvious to require additional remark. 3, *to oblige the owners of all wheels to provide a fan for every dry grinder, and to see that this fan is always kept in proper working order.* On this point I wish to make a few observations, to which I invite the serious attention of all who may hear or read what I have to say in support of this - to my mind, absolutely necessary requirement. I propose that the *owner of the wheel and not the grinder*, should provide the fan and see that it works properly. If the grinders are left to provide it for themselves, so reckless of life, so careless and indifferent are many of the fork, scissors, and razor grinders, that I am certain they will never provide it for themselves. Let me give some evidence in proof of this. In one hull I found a man shaping razors with a first class fan. There was much dust - the fan was not working, he had not taken the trouble to affix the band, and that necessary act would have taken perhaps half a minute. In another hull, a scissors grinder had a good fan, and spoke to me of its "wonderful advantages" - "if they cost a hundred times as much as they do, they are worth it - no dry grinder can live without them" - and yet this man permitted razor grinders to work without a fan on his right hand and on his left, and to cover him with their dust. In another hull, in which five dry grinders were at work the fans had not been used for three weeks - the wheel band was wrong - and yet these men went on destroying themselves, rather than do the wheel band a quarter of an hour's work - all that was requisite to set the fan in motion. A most intelligent scissors grinder, Mr. Wreaks, who has now left the trade, at which he began to work when only *nine*, told me "he always used a fan." He once offered to five scissors grinders who worked in the same hull with him, to put up a fan at his own cost, and to take the price of it from each by instalments of one shilling a week. They one and all refused his kind offer. I found, hull after hull, in which scissors, razor, and fork grinders, are now working (September, 1865) without fans, - some are working in a very confined space without them, two and three deep. One man, a scissors grinder, told me, "it was not worth while to get one for the bit of time he should have to live." I only found one fan in all the hulls I visited attached to the polishing machinery. I think that where polishing is carried on, a fan ought always to be in use. I visited one hull in which an intelligent man at one end had put up a fan for each "trow," and for which he charged each fellow-workman a penny a week; the man working next to him had paid his penny for the fan, but having been too idle to fix a box, it was useless. Others I found with a fan fixed but not at work, because "*they did not like the*

noise;" and I have many times been told by dry grinders "the trade was full enough as it was, and that if the men [p. 20] lived longer it would be so full there would be no getting a living at it." What can I say to such men? - to dry grinders working without a fan - why this - if there ever was a trade more poisonous than the fabled valley of the upas - more slow in its effects it is true, but equally deadly with the inhaling of the atmosphere of the celebrated Grotto del Cani, it is that of a fork, a razor, or a scissors grinder, who works, without employing the effectual means for his preservation which the fan affords; if bent on destroying yourselves thus recklessly, have the honesty to prevent others, the poor little boys, many of them your own sons, from entering the trade without a warning - write therefore, over the doorway leading to your infernal hulls

"ALL HOPE ABANDON YE WHO ENTER HERE;"

we do not use the fan, and without this protection your destruction after a few years misery and suffering is certain. The entrance to a dry grinders' hull, without a fan, I say emphatically is unmistakably the gate which leads to certain death!

A good fan will cost from £1 10s. to £3, or £5, but after what I have stated, I think all present will agree with me, that the *owner* of the wheel must be by law compelled to provide a fan as an absolutely necessary portion of the machinery of a wheel where dry grinding is carried on; and that he *must be held responsible* for having this fan always at work and in proper order. A small additional sum could be added to the weekly rent of the hull; which would not exceed one penny.

The fan is on the principle of a winnowing machine, and with a flue properly constructed, leading from each of the different stones in each room, the dust can most effectually be driven out of it, and both the particles of grit and metal which arise in grinding, and the dust created in glazing and polishing removed. I went last week into one of the rooms used for razor grinding at the wheel of Messrs. J. Rodgers and Sons, where many men were at work shaping razors; there was no dust, nor was I inconvenienced in the slightest degree, during the half hour I remained. Had the fan not been at work, I know by experience that I should soon have felt most uncomfortable. One of the men told me the wheel had been "lame" for three weeks, (*i.e.* not at work,) and he had been working at another place without a fannie, and felt so bad at his chest that he was glad to get back to his own "trow" again. He never felt bad there.[39] At the Soho Wheel, and at the Union Wheel also, and I may add, at many other wheels, I have seen the fan at work with the happiest effects, and in the next room I have seen a set of reckless fools destroying themselves because they would not use it. Many years ago, the late Mr. Trickett, at the Union Wheel, showed me how the different processes could be gone through without injury to the grinder from the dust, and at the Soho Wheel, I saw that shaping razors and even racing a stone, by adding a properly contrived box could be rendered perfectly innocuous by the use of the fan; almost all the dust being driven off by the

[39] The Messrs. Rodgers provide the fans free of charge, and will not permit dry grinders to work without them.

fan, up a shaft on the outside of the building. The particles of dust and steel not carried away by the fan, in "racing" a stone, may be prevented from entering the air passages by tying, as all intelligent grinders do, when performing this work, a light handkerchief over their nose and mouth. That these fans, or [p.21] "Fannies," answer perfectly well, I have convinced myself by repeated experiments, and by the testimony of every dry-grinder who uses them.

To prevent the Grinders, disease I am therefore of opinion, 1st. That the hours of labour should be reduced, 2nd. That wet and dry grinders should on no pretence be allowed to work in the same room. 3rd. That the owners of wheels should be compelled to provide a fan for all dry grinders. 4th. That all wheels should be placed under proper inspection - properly[40] ventilated and kept clean - the rooms built of a sufficient height with enough space for each man, and every wheel properly provided with conveniences, the want of which at present - or the substitutes for which, at many wheels are a disgrace to the civilization of the 19th Century, and in a sanitary point of view a great evil. No floor should be of mud. Where wet grinding is carried on the floor should be flagged with a sufficient incline to let the water run off.

LASTLY.–CHILDREN SHOULD BE PREVENTED FROM ENTERING THE WHEELS AT AN EARLY AGE.

[40] Ventilation of the Wheels. - The hulls cannot be constructed with windows before and behind the grinder as has been suggested. The light at his back would interfere with his work. Ventilation, however, could be provided by gratings at the back of the hull. The fan also, when at work, powerfully assists ventilation- Too commonly the grinders regard the hull as "only a place to work in," and take every care that it shall remain, as its name implies, a stye.

Appendix 4.9

Report on the proposed new grinding wheels between John Street and Thomas Street

Source: SCL (Local Studies) Fairbank Collection CP-2-(132)

During the boom period of the early 1830s, grinding wheel places for Sheffield's cutlery and edge tool trades were in constant demand, leading to the construction of many speculative 'public' and 'semi-public' wheels primarily as a high return investment. It was in this context that Josiah Fairbank proposed the construction of a large new public wheel on the southern fringe of Sheffield. The surviving documentation includes a promotional text written by Fairbank and targeting potential investors, outlining the benefits of the scheme and providing a breakdown of the anticipated costs and returns. Also attached is a sketch of the proposed engine chimney with notes regarding its construction; the same sheet includes what appears to be a thumbnail sketch of the elevation, with pediment, pilasters, central chimney and windows over two floors.

[p.1]

It is proposed to erect by Subscription a large & very commodious Building 180 feet 16 inches long and 47 feet wide for Grinding Cutlery Wares & to contain 60 Heavy Troughs & 60 Light Troughs to be worked by 2 Steam Engines of 30 Horse Power each in the center [sic] of the Building as described in the Elevation & Plan thereof with 3 Boilers, the situation chosen for the purpose is exceedingly eligible, the yard room ample & very airy, & the supply of water abundant & of the best quality.

There are no other Grinding Wheels worked by Steam on that side of the Town & from the large number of manufacturers & Merchants in that quarter it is presumed all the Troughs would very soon meet with tenants at a fair & reasonable price, these circumstances hold out much encouragement to Persons desirous of taking Shares particularly Merchants, Manufacturers & Grinders, the latter of whom are well acquainted with the Superior advantages arising from a constant moving Power over a precarious one depending on contingencies not under their control.

It is thought advisable to have two Engines as well as three Boilers in order to prevent in a great degree any Risk of loss whilst one might be out of order & undergoing repair so that a great part of the Machinery may be worked by one & for the same reason three Boilers are considered better than two, the work is proposed to be done in a very Superior manner & the Engines to be of the best construction & what are called Foundation framed Engines. It is proposed to make a Reservoir to contain 42304 cubic feet or 1566.80 cubic yards of Water;

the ground being so abundantly supplied with water it will soon be filled & by proper management may be so contrived as to keep the cold water separate from the warm & to work it over again & again if necessary.

[p.2]

Our estimate of the total cost of the Buildings, Fence Walls, Reservoir, & Soughs amounts to £3506-12-2

Do. of two Steam Engines with the Machinery and Boilers £3109-0-0

Total including a large Sum for contingencies £6615-12-2

And the annual expenditure wear & tear, Coals for the Engines Machinery Ground Rent wages of two Engine Men and 5 P. Cent on the gross rental for contingencies we estimate at £839-2-5

Income:

60 Large Troughs at	£15-15-0 P Trough	£945-0-0
60 Smaller do.	£8-8-0	£504-0-0
Gross Rental		£1449-0-0
Annual Rental		£1449-0-0
Annual Expences [sic] as above	£839-2-5	
Clear annual profit		£609-17-7

The number of Shares required to raise the Sum of £6615-12-2 at £25 P. Share will be 265

And the clear Income arising from each share £2-6-0 per annum, which is after the rate of £9-4-0 P. Cent on the whole expenditure after deducting all expences and allowing from depreciation of Machinery & Buildings rent of Land & other contingencies–

J Fairbank & Son

Civil Engineers & Land Surveyors

May 24 1832

Notes accompanying sketch of chimney & boilers.

For 2 Engines & 40 yds. Chimney

Bottom of Flue inside should be 3/6 ea. divided with two parts by 7 feet & the other Walls 3 Bricks thick

Circular Wall to be 2 Bricks thick for 10 yds. 1"6 thick the rest 10 yds. & the remainder 10 In. thick

Pedestal shd. be at least 3 Bricks thick

No occasion for division in flues as the flues all go in the way

Ought to be 26 courses of Ashler [sic] Stone to be at least 2 feet thick each & 3 feet broad leaving inside hollow or rubble stone

Ashler 16s P. [Cwt?] & setting

Estimate (Chears)

40 yds at 32s P. yd. running

reckon 650 Bricks for 10 In. wall

	975 say 1000	15
	1300	2 Bricks
	1950	3 Do.
1 Ch. Lime		1"0"0
3 Loads good sharp sand		0"10"6
		1"10"6 will be sufficient

for 4½ thousand of Bricks & the labour of men

ties includg. in the buildg.

Bricks say 30*s*. P. Thous.

Appendix 4.10

Dialect description of Rodger's Sycamore Street grinding wheel

Source: Abel Bywater (1839) *The Sheffield Dialect.*

The account first appeared in 1836, in the privately published 'Wheelswarf Chronicle', later collected together in a short book.[41] *As well as its interest as a contemporary example of the regional dialect, the subject matter can be linked to a specific example of a grinding wheel–Rodgers' Sycamore Street works.*[42]

Few comparable descriptions of a grinding hull from the grinder's perspective are known, and Bywater's short example is more notable for its social commentary than for its technical detail. There is a distinct sense of camaraderie between the grinders–despite their frequent moves from wheel to wheel or time off sick–and a contrary ambivalence to the wealthy visitors who toured Rodgers' premises daily.

Confirmation of the account's accuracy can be found in the contemporaneous Fairbank rate survey which describes the main wheel as housing 30 troughs; a the smaller extension to one side was added soon after. Other elements found in the description–the steps leading to the garret with a clock above–may be seen in a view of the yard published as a trade advertisement (c.1840s).

The discrepancy between the engine power stated by the grinder (16 hp) and that recorded by the Fairbanks (14 hp) is due to the various methods used at the time to calculate this figure. Sixteen horsepower was no doubt the manufacturer's stated power, while Josiah Fairbank often calculated the value from first principles, based on steam pressure, cylinder size and length and number of strokes; on other occasions, the number was based on the verbal estimate of the engine tenter.

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[41] Bywater (1839) p. iv.

[42] The connection was made by the author, based on a comprehensive study of Sheffield's steam-powered sites; although nothing in Bywater's publication definitively suggests that the passage represents a real example, the book's context reinforces the relationship with Rodgers' wheel, with a reference to one of the grinders making a two-foot long display razor for Rodgers' famous showroom [p. 10].

[p. 149]

"Uppa ahr hull arston."

JACK–O say, Bil, o've getn a letter throo Jonna Flatstick we a description a their wheel. It's a grand place, o'l ashure the; mun e read it the?

BIL–Hah, lad, let's have it.

JACK (*reading*)–OUD FRIEND JACK,–O do'nt kno wot day at munth is–Thursday, o reckon. O thowt o'd just send the two or three loines to tell the bit a wot ta art. It's abaht six munths sin o left yore wheel, an we'n near seen won anuther sin; bur o can tell the won thing, if o'd two as good legs an feet as thah has, o'd a seen thee long sin. Thah's no thowt for abboda, or else thah'd a call'd at ahr place long afoor nah. We'n a proime wheel, o'l ashure the, we a grand polished steeam engine, sixteen horse pahwer, made be Peel an Williams, Manchester. At top at yard there's ahr wheel, an it [p. 150] center at yard there's a lot a steps wot leads intot chamber an garret; o'ert steps we'n a clock. Here's three heavy trows it bottom room wot they groind table knoives in, and seven leet ans wot they groind razors an penknoives in; it chamber aboon there's a room we ten trows a penknoife groinders, fitted up we dust masheens to ivvera trow; an it garret there's ten trows, all razor groinders, we ivvera thing compleat for't wark; an thah kno's there's mooar variety e ahr trade nor't tuther, an soon we'nt mooast visitors. Thah'l happen not believe it, but we'n lords, an dukes, an dutchesses, an gentlemen an ladies a all sooarts ivvera week cums to see us, an they awlis seem t'best pleeas'd it garret, when they seen sum rahndin backs, sum ore houdin, sum glazin, sum buffin, sum groindin, sum lappin, sum jimpin, an sum polishin; an we all work away, an cares for nobbada. Prethe call oud lad, and see all the oud wheel-fellows; they'l be pleased to see the, especially oud Charley. If ta dus'nt, o wish t'next toime thah feighs the trow, thah ma breik all the gallos buttons off.

JONNA FLATSTICK.

Appendix 4.11

Steam engines in Sheffield not associated with grinding wheels

Abstracted from Fairbank Poor Law Rate Valuations 1834-38 (SCA CA VS series).

Darwin & Co., Workhouse Croft	Foundry / boring mill
Wm. Bradshaw, Townhead Street	Cutlers' shop
Waterhouse & Co., Portobello	Plated manufactory
Marshall, Martin, Scotland Street	Purl cutters / nail shops
Gibson, Geo., Watery Street	Screw manufactory
Dixon, James & Son, Cornish Place	Metal turning, boil shop, etc.
Warburton, Turton & Co., Penistone Road	Brewery
Turton, Thomas, Russell Street	File cutting
Charles & Travis, Kelham Island	Rolling mill
Davy Bros., Steam Street	Millwright, brassfounders
Roebuck, Wm., Love Street	Cutlers, casting
Nanson, Edw. & Co., Bridge Street	Brewery, cooperage
Vickers Naylor Hutchinson & Co., Millsands	Rolling mill, etc.
Laycock, Saml. & Son., Millsands	Weaving
Shirley, Thos. & Co., Shude Hill	Corn mill
Lockwood, Benj., Forge Lane	Corn mill
Parker, Wm., Forge Lane	Rolling mill
Rawson & Co., Pond Street	Brewery
Wigfall, Joshua, Pond Mill	Corn mill
Rawson Barker & Co., White Lead Works	Lead mill
Laycock, J & T, Arundel Street	Weaving
Shaw & Fisher, Eyre Lane	Rolling
Creswick, J T & N, Paternoster Row	Stamp and die, casting
Roberts & Smith, Eyre Street	Plating
Rodgers & Sons, Norfolk Street	Cutlers' shops

Younge, Saml., Row Lees	Rolling mill
Walker Kitchen & Co., Burgess Street	Rolling mill
Roberts Mettam & Co., Balm Green	Boiling shops, etc.
Dickenson, B & G, Orchard Street	Workshops
Fowler, Jos., New Market	Foundry
Smith, Jos., Blast Lane	Sawmill, corn mill
Wilson & Co., Norwich Street	Foundry

Appendix 5.1

Spear & Jackson at Savile Works

Source: Brightside valuations 1824 SCA CA VB 1, Township of Brightside Bierlow Valuation Book (rate of 5d in £).

from p. 92 'Additions since August 1824', *includes p. 97*

Stuart, James	Stuart & Parkin	Savile St.	Grinding Wheel }	
			Engine House }	
			Shed over boiler }	9,15,0
			Boiler seating }	
			Engine chimney }	
			Workshop raised 1 storey	1,17,6
			Allow for–Gin race–Taken away	
			A shed– "	
			Old warehouse "	
			Carter's house–Empty	

p. 104

Stewart & Co.	Stewart & Co.	House as before	-,7,10
		Shop	-,6,-
		Ware & Countg. House	5,5,-
		Smith & Fender Shop	6,-,-
		Metal Warehouse	-,15,-
		Grinding Wheel	5,15,-
		Engine House	2,-,-
		Boiler Ho. & Chimney	1,10,-
		2 Sheds	1,10,-
		3 Stall Stable & Gig House	2,-,-
		Foundry	5,12,6
		Near Yard	5,-,-
		Garden & Yard	2,10,-

rate 1,1,5 former rate to be abandoned fol. 4

[In 1832 Richard Stuart's house is still in Savile Street, see CA VB 2 no. 51.]

Appendix 5.2

Description of the Etna Works (1890)

Source: *Proceedings of the Institution of Mechanical Engineers* (July 1890) 'Sheffield meeting', pp. 295-469; pls. 118-136. p.463 (SCL Local Pamphlets vol. 52, no. 7).

AETNA EDGE-TOOL WORKS These extensive works, belonging to Messrs. Spear and Jackson, are situated in Savile Street East, and have been established over a century for the manufacture of saws, files, and tools of almost all kinds. They are furnished with all modern facilities for the perfection and manufacture of these various productions, all of which are made and manipulated on the premises from the crude material up to the finished article. The firm make their own steel by the cementation and crucible process, rolling it into bars, rods, and sheets as required. One of the chief branches of the work here carried on is saw making. Rolled sheets of steel are taken from the mill and pared to shape in shearing presses. The blanks then have the teeth punched out in other presses; after which they are hardened, hammered, and straightened ready for grinding. The grinding is done between two stones placed one above the other, whereby both sided of the saw are ground simultaneously. The axes of the two stones are not exactly parallel, so that the grinding surfaces are also at a slight angle. By this means the back of the saw is made somewhat thinner than the toothed edge, thereby enabling the saw to clear itself in the cut. The surfaces are finished by means of wooden rollers covered with leather, on which emery powder is fed by hand. The saw is then sharpened and set by hand, and lastly fitted with handles. In the department for making garden and field tools, steel shovels forged solid are a special article of manufacture. These are first hammered out of a solid block by a machine hammer, after which they are pared to shape by a shearing press. The piece, which is still flat, is then heated and dished to the required shape under a drop hammer. The strap, which is forged out solid with the rest, is then riveted upon the wooden handle, and rounded to fit it by means of half rolls; after which the implement is completed by finishing portions of it on a leather band with emery. Digging and hay forks are forge solid, and the straps for attachment to the wooden handle are welded on. In the wood department, where shafts and handles are prepared for the different tools, the wood is steamed and bent into the various curved shapes required by means of a machine with dies, into which the wood is pressed by a cam action. The steelmaking department comprises the usual crucibles and other appliances; and the sheet mill contains rolls to produce steel sheets up to five feet square. There is a large hammer forge, and a steam press for shaping plough boards and articles of a similar kind. A large file-making department produces files of all kinds for engineers, saw-mills, &c. Reaper and mower and hay and sugar-cane knives, scythes, axes, chisels, plane irons, picks and mattocks, hatchets, hoes,

tools for paper mills and tanneries, mining tools, and many kinds of engineers' tools are also made.

Appendix 5.3

Description of the Bessemer process at the Atlas Works

Source: Percy (1864) vol. 2, pp. 823-824.

At the Atlas Works, the process is conducted in the following manner. The charge of pig-iron (that smelted from Whitehaven hæmatite being the most suitable), weighing about 3 tons, is melted in an air-furnace, the bed of which is above the level of the converting vessel; the latter is then turned to a horizontal position, with its open mouth upwards. The air furnace is tapped, and the charge of molten pig is run through a trough lined with sand into the converter, filling it nearly up to the level of the twyers; the blast is turned on, and the converter is swung slowly back to the vertical position. A pressure of blast of 15 lbs. to the square inch is employed, with a converting vessel of 42 inches internal diameter, having 49 holes, each ½ an inch in diameter, the charge varying from 3 to 4 tons. The blowing engines are driven by a pair of horizontal steam engines, with pistons 16 inches in diameter and 24-inch stroke, working with steam of 40 lbs. pressure.

The blowing is continued from 12 to 20 minutes, according to the quality of the pig-iron operated upon; when the proper stage of decarburization has been reached, the converter is turned back to the horizontal position, the blast is shut off, and from a small furnace a specific quantity of molten spiegeleisen, usually from 5 to 10%, is run in; the blowing is then resumed for a period of five minutes, in order to effect the incorporation of the spiegeleisen with the original charge; the converter is then lowered again, and its entire contents are run into a ladle, from which the ingot moulds are filled.

The ladle is lifted by hydraulic power, derived from the same pair of pumps which give motion to the tilting apparatus of the converter. A vertical ram is placed below the level of the casting-pit, carrying on its upper end a strong radial arm, which embraces the ladle; this arm revolves freely from the top of the ram, and permits the ladle to be brought into position over the mouth of each of the moulds in succession.

The ladle is made of wrought-iron, measuring 42 inches in diameter and 4 feet in depth; it is lined with sand, and is provided with an iron plug, also coated with sand, the lower end of which is fitted into a socket at the bottom of the ladle. When the plug is raised, the molten steel flows out in a stream of about 1 inch in diameter into the mould. When the ingots have cooled they are ready for hammering.

The loss of weight during the conversion amounts to about 15% of the original weight of the pig-iron employed, in addition to which the charge loses about 7½% of its weight in the preliminary fusion in the air furnace. The converting vessels will blow about 250 tons of metal without relining; the twyers have to be renewed after about 10 tons of steel have been made.

Mr. Ellis[43] observes, "statements have been made which have led the public to believe that steel by this process can be made at very low prices; but our experience has proved that it is necessary to use a much more expensive class of pig than was ever contemplated by Mr. Bessemer, and that ingots cannot be produced at less than 10*l.* per ton." (September 11th, 1863.)

[43] This was 'Mr. John D. Ellis, of the firm of Messrs. John Brown and Company', who also supplied the drawings of the Bessemer equipment at the works illustrated in Percy (1864) p. 821, figs. 212, 213.

Appendix 5.4

The development of armour plate

Source: *Encyclopaedia Britannica* (1911) New York, vol. 2 pp. 578-582.

ARMOUR PLATES

The earliest recorded proposal to employ armour for ships of war appears to have been made in England by Sir William Congreve in 1805. In *The Times* of the 20th of February of that year reference is made to Congreve's designs for an armoured floating mortar battery which the inventor considered would be proof against artillery fire.

[...]

The necessity for armouring ships as a protection against shell fire was again pointed out by General Paixhans in 1841, and in 1845 Dupuy de LÔme had prepared the designs of an armoured frigate for the French government. During the period between 1827 and 1854, experiments in connexion with the proposed application of armour to both ships and forts were carried out in England, the United States and France, but the question did not get beyond the experimental stage until the latter year, when armoured floating batteries were laid down in all three countries, probably as the immediate outcome of the destruction of the Turkish fleet by shell fire at Sinope on the 30th of November 1853.

Three of the French floating batteries were in action at the bombardment of Kinburn in 1855, where they achieved a conspicuous success, silencing the Russian forts after a four hours' engagement, during which they themselves, although frequently struck, were practically uninjured, their loss in personnel being but trifling. To quote Very: "This comparatively insignificant action, which had little if any effect upon the course of the Crimean War, changed the whole condition of armour for naval use from one of speculation to one of actual and constant necessity."

[...]

[p. 579] Chilled iron was never employed for naval purposes, and warship armour continued to be made exclusively of wrought iron until 1876 when steel was introduced by Schneider. In an important trial at Spezzia in that year the superiority in resisting power of steel to wrought iron was conclusively proved, but, on the other hand, steel showed a great tendency to through-cracking, a defect which led Messrs Cammell of Sheffield in 1877 to introduce compound armour consisting of a steel surface in intimate union with a wrought-iron foundation plate. In Cammell plates, which were made by the Wilson process, the steel face was formed by running molten steel on to a white-hot foundation plate of iron, while in the compound plates, made by Messrs John Brown & Co. according to the patent of J. D. Ellis, a

thin steel surface plate was cemented on to the wrought-iron foundation by running in molten steel between. Compound armour possessed the advantages of a harder face than was then possible in a homogeneous steel plate, while, on the other hand, the back was softer and less liable to crack. Its weak point was the liability of the surface plate to crack through under fire and become detached from its iron backing. The manufacture of steel, however, continued to improve, so that in 1890 we find steel plates being made which were comparatively free from liability to through-cracking, while their power to resist perforation was somewhat greater than that of the best compound. The difference, however, was at no time very marked, and between 1880 and 1890 the resistance to perforation of either steel or compound as compared with wrought iron may be taken as about 1.3 to 1.

Compound armour required to be well backed to bring out its best qualities, and there is a case on record in 1883 when a 12-in. Cammell plate weighing 10 1/2 tons, backed by granite, stopped a 16-in. Palliser shot with a striking energy of nearly 30,000 foot tons and a calculated perforation of 25 inches of wrought iron. As steel improved, efforts were made to impart an even greater hardness to the actual surface or skin of compound armour, and, with this object in view, Captain T. J. Tressider, C.M.G., patented in 1887 a method of chilling the heated surface of a plate by means of jets of water under pressure. By this method it was found possible to obtain a degree of hardness which was prevented in ordinary plunging by the formation of a layer of steam between the water and the heated surface of the plate. Compound plates face-hardened on this system gave excellent results, and forged-steel armour-piercing projectiles were in some cases broken up on their surfaces as if they had been merely chilled iron. Attempts were also made to increase the toughness of the back by the substitution of mild nickel steel for wrought iron. The inherent defect of compound armour, however – its want of homogeneity, – remained, and in the year 1891 H. A. Harvey of Newark, N.J., introduced a process whereby an all steel plate could be face-hardened in such a way that the advantages of the compound principle were obtained in a homogeneous plate. The process in question consisted in carburizing or cementing the surface of a steel plate by keeping it for a fortnight or so at a high temperature in contact with finely divided charcoal, so that the heated surface absorbed a certain amount of carbon, which penetrated to a considerable depth, thus causing a difference in chemical composition between the front and the back of the plate. After it had been left a sufficient time in the cementation furnace, the plate was withdrawn and allowed to cool slowly until it reached a dull red heat, when it was suddenly chilled by the application of water, but by a less perfect method than that employed by Tresidder. Steel plates treated by the Harvey and Tresidder processes, which shortly became combined, possessed about twice the resisting power of wrought iron. The figure of merit, or resistance to penetration as compared with wrought iron varied with the thickness of the plate, being rather more than 2 with plates from 6 to 8 in. thick and rather less for the thicker plates. In 1889 Schneider introduced the use of nickel in steel for armour plates, and in 1891 or 1892 the St Chamond works employed a nickel steel to which was added a small percentage of chromium.

All modern armour contains nickel in percentages varying from 3 to 5, and from 1.0 to 2.0% of chromium is also employed as a general rule. Nickel in the above quantities adds greatly to the toughness as well as to the hardness of steel, while chromium enables it to absorb carbon to a greater depth during cementation, and increases its susceptibility to tempering, besides conducing to a tough fibrous condition in the body of a plate.

[goes on to describe the Krupp process, widely used. States that non-cemented plates were usual in England until about 1902, and also in curved plates. Krupp process to do with heat treatment.]

[...]

[p. 581] With regard to manufacture, a brief account of the Krupp process as applied in one of the great English armour plate works (omitting confidential details of temperature, &c.) will illustrate the great complexity of treatment which the modern armour plate has to undergo before its remarkable qualities of combined hardness and toughness can be developed. The composition of the steel probably differs slightly with the manufacturer, and also with the thickness of the armour, but it will usually contain from 3 to 4% of nickel, from 1.0 to 2.0% of chromium and about 0.25 to 0.35% of carbon, together with from 0.3 to 0.7% of manganese. After being cast, the ingot is first heated to a uniform degree of temperature throughout its mass and then generally forged under the hydraulic forging press. It is then reheated and passed through the rolls. After rolling, the plate is allowed to cool, and is then subjected to a thermal treatment preparatory to surfacing and cutting. Its surface is then freed from scale and planed. After planing, the plate is passed into the cementation furnace, where its face remains for some weeks in contact with specially prepared carbon, the temperature being gradually raised to that required for cementation and as gradually lowered after that is effected. After cementation the plate is heated to a certain temperature and is then plunged into an oil bath in order to toughen it. After withdrawal from the oil bath, the plate is cooled, reheated to a lower temperature, quenched again in water, reheated and passed to the bending press, where it is bent to shape while hot, proper allowance being made for the slight change of curve which takes place on the final chilling. After bending it is again heated and then allowed to get cold, when the final machining, drilling and cutting are carried out. The plate is now placed in a furnace and differentially heated so that the face is raised to a higher temperature than the back. After being thus heated for a certain period the plate is withdrawn, and both back and face are douched simultaneously with jets of cold water under pressure, the result being that the face is left glass-hard while the back is in the toughest condition possible for such hard steel.

[...]

[p. 582] The bullet-proof steel made by Messrs Cammell, Laird & Co. in Great Britain may be taken as typical of that produced by the best modern manufacturers. It is proof against the 215-grain Lee-Enfield bullet of 0.303 in. calibre striking directly, as under:

Range.	Thickness of Plate.	Striking Velocity.
10 yards	0.187 inch	2050 f.s.
100 "	0.167 "	1865 "
560 "	0.080 "	1080 "

The weight of the 0.08-in. plating is only 3.2 lb per sq. ft. The material is stated to be readily adaptable to the ordinary operation of bending, machining, drilling, &c., and is thus very suitable for the purposes indicated above.

Appendix 6.1: Selected quotations relating to Sheffield

Five rivers, like the fingers of a hand,
Flung from black mountains, mingle, and are one,
Where sweetest vallies quit the wild and grand
And eldest forests, o'er the sylvan Don
Bid their immortal brother journey on,
A stately pilgrim, watched by all the hills.

Ebenezer Elliott (1779-1849)

[Arranged chronologically].

Zedler (1743) vol. 37, col. 803:

Sheffield oder Sheafield eine Stadt in der westlichen Gegend der Engelländischen Provinz Yorkshire, an dem Flusse Dun, nahe bey den Grenzen von der Byshire, war vor Zeiten wegen ihres Handels mit allerley Eisen-Waaren, insonderheit mit Messern und Klingen, berühmt. Man siehet allhier noch einige Uberbleibsel von einem alten Schlosse, deren 5 an diesem Flusse gestanden, und zwar ein jegliches von dem andern 10 Meilen.

Young (1770) vol. 1, pp. 134-135.

I would advise you, in case you take this place in your way to the more northerly parts, to view all the mills in town; among others, do not forget the tilting-mill, which is a blacksmith's immense hammer in constant motion on an anvil, worked by water-wheels, and by the same power the bellows of a forge adjoining kept regularly blown: The force of this mechanism is prodigious; so great, that you cannot lay your hand upon a gate at three perch distance, without feeling a strong trembling, which is communicated to all the earth around.

François de La Rochefoucauld [from Scarfe (1995) p. 52].

The town occupies a curious site, on the top and sides of a little hill which stands in the middle of a wide valley, so that although the town is quite large, it is impossible to see it properly. There is no view-point that could give you an overall view. There is an unevenness about the buildings which is disagreeable. The houses are mostly low and built with no great elegance, generally covered with large stones about an inch thick. Some houses are brick, some stone, and

there is a fair number of pretty ones; but they are lost in such a multitude of shapeless huts and outlandish factory-buildings that Sheffield could never pass as a fine town. For some years now the town has been growing enormously. A whole district has been built in a very little time, and this is the finest part. Lord Surrey owns a great part of the land in this quarter, and he is the principal agent in its embellishment.

Skirne (1795) p. vi.

Passing the village of Hope, in the midst of its rich valley, we mounted a dreary range of moors, from whence we descended to Sheffield, a dirty, unpleasant town, but rich in its manufactures.

Mavor (1798) vol. 3, p. 109 [from: 'Tour through different Parts of England, Scotland, and Wales, by Richard Joseph Sullivan, Esq. Performed in 1778'].

Proceeding, we visited Sheffield in Yorkshire; but this was so thoroughly dirty, and mean in appearance, that after viewing its manufactories, which, by the way, are inferior to those of Birmingham, we advanced to Doncaster.

Mavor (1800) vol. 5, p. 234 [from: 'Journal of a three weeks tour, in 1797, through Derbyshire to the Lakes. By a gentleman of the University of Oxford'].

Its streets are ill paved, its inns dear and dirty, its neighbourhood adorned *with men hanging in chains; and, as a* toute ensemble, *it is the most smokey, ugly town I ever travelled through, or rested in.*

Garlick and MacIntyre (eds.) (1978) vol. 5, p. 1595.

*Tuesday August 25th [1801] ...*Sheffield, *at a distance appears to be agreeably situated on a gently rising Hill, surrounded & overlooked by higher Hills, and promises very different from what it proves to be on entering it, where the effects of smoke & sutty Manufactories are everywhere visible.–Like* Birmingham *indeed something of this is at a distance indicated for Smoke rushes up in Clouds in various parts...Having several things to do we resolved to remain at* Sheffield *all night, but not for the sake of any amusement which we found.*

Hunter (1819) pp. 125-126.

> *The town had the good fortune to find in the earl of Surrey (the late duke of Norfolk), who in 1777 became owner of the vast interest which his family enjoyed at Sheffield, a nobleman who was disposed to encourage its growth and prosperity.*
>
> *Vincent Eyre, esquire, the principal agent for the earl of Surrey in the management of his Yorkshire estates...caused regular plans to be drawn of that part of the estate [Alsop fields], to which adherence was required in the building-leases which from time to time the earl was induced to grant. To these streets, now among the best parts of the town, Mr. Eyre gave names for the most part of them taken from the family-names and titles of the noble proprietor of the soil.*

Holland (1824) p. 112.

> *Sheffield cannot boast of much display in public buildings; the establishment of conveniences for religion, charity, business, and amusement, is the certain consequence of the success of commercial enterprise and industry, and although Sheffield like other towns which have risen to importance, has its full share of such conveniences, there has hitherto been rather a deficiency of that public spirit which is necessary to give an appearance of splendour and ornament to its public edifices.*

Holland (1837) vol. 2, pp. 281-282.

> *...the steam-engine, forge, and other chimneys of Sheffield do indeed evolve collectively a prodigious quantity of smoke–and where is the objection to this, either pictorially or profitably?*

Haywood and Lee (1848) pp. 119-120.

> *The most regularly built part of the town, and least occupied by confined courts, is that bounded on the west by Norfolk-street, Union-street, and Porter-street, and on the east by Arundel-street. With the exception of the suburbs, we have no hesitation in saying, that this is the most healthy part of the town. It is not so well drained, artificially, as some parts of the town; the pavements are not better, or the inclination of the surface greater; but there is a greater quantity of free air in circulation, and the buildings are not generally so closely packed together.*
>
> *Probably few towns of equal size and importance have such narrow streets as Sheffield. Excepting South-street, Broad-lane, Shales-moor, the Old Haymarket,*

and the Wicker, we are not aware of any street more than 40 feet wide. That seems to have been considered by those who have laid out the streets within the last fifty years as the maximum width under any circumstances.

...the streets [of Sheffield] are broken up into zigzags and fragments, and exhibit all possible evidences of narrow and contracted notions. We recommend that in future no road be set out until the level has been fixed in a satisfactory manner; that 30 feet shall be the minimum width of every lane, and that new streets shall not in any case be less than 45 feet; or, if a first-class street, from 60 to 75 feet in width. The plan and section of every new road, intended to be set out by any private individual, ought to be subject to the approval of the Corporation, or their officer; otherwise the evil will still be perpetrated; and when the road becomes a public highway, with buildings erected upon it, no effectual remedy can be applied. This has been the case very frequently in the town, instances of which will occur to the memories of most of the council.

Smith (1865) p. 23.

The town of Sheffield has had to bear the triple reproach of crooked streets, small houses, and a smoky atmosphere, the truth of which the inhabitants need not be ashamed to acknowledge. For our part, we see no beauty in a city laid out in the plan of a chess-board: and where are the dwellings of the labouring classes so clean, healthful and entire as ours? We don't know of a single instance of a family living in a cellar or even a garret in a population of nearly 200,000 persons. Smoke there is over the town–but how seldom fever in it! and notwithstanding this unwelcome obscuring of the sky overhead, a visitor may at almost any hour verify the assertion formerly current that from some point in every street the country may be seen! Hence, a series of street views of a most diversified character constantly present themselves, and might be delineated with pen or pencil.

Reade (1870), a description of 'Hillsborough' (a thinly-veiled allusion to Sheffield) from the novel *Put Yourself in His Place*.

Hillsborough and its outlying suburbs make bricks by the million, spin and weave both wool and cotton, forge in steel from the finest needle up to a ship's armor, and so add considerably to the kingdom's wealth.

But industry so vast, working by steam on a limited space, has been fatal to beauty: Hillsborough, though built on one of the loveliest sites in England, is perhaps the most hideous town in creation. All ups and down and back slums. Not one of its wriggling, broken-backed streets has handsome shops in an

unbroken row. Houses seem to have battled in the air, and stuck wherever they tumbled down dead out of the melee. But worst of all, the city is pockmarked with public-houses, and bristles with high round chimneys. These are not confined to a locality, but stuck all over the place like cloves in an orange. They defy the law, and belch forth massy volumes of black smoke, that hang like acres of crape over the place, and veil the sun and the blue sky even in the brightest day. But in a fog–why, the air of Hillsborough looks a thing to plow, if you want a dirty job.

Harper's New Monthly Magazine (1884) vol. LXIX no. 409.

One beauty of Sheffield is that you can see very little of it at a time. The greatest altitude and the clearest day combined do not considerably affect this circumstance. No matter which point of view is selected, the foreground is dim, yellow, and confined; the distance is spectral, muffled, and deplorably gloomy. Down below us, from every height, is a nest of dark, unornamental houses; a complication of narrow, winding streets; the lofty spire or dome of a church; the urgent traffic of pedestrians and vehicles. Beyond, in every direction, is a screen of torpid smoke which obscures the sky, and tones the warm radiance behind it to a mellow and sometimes golden twilight.

The Builder (1897) October 9, vol. 78, no. 2853, p. 280.

From the eastern hill, behind the Midland Railway station, bird's eye views of practically the whole town may be obtained, and one notes how the tall chimneys congregate in the valleys, particularly in the north-east. There is not, however, much of architectural interest in the district.

J S Fletcher *A Picturesque History of Yorkshire* (1899).

Under smoke and rain, Sheffield is suggestive of nothing so much as of the popular conception of the infernal regions. From the chimneys, great volumes of smoke pour their listless way towards a forbidding sky; out of the furnaces shoot forth great tongues of flame which relieve the sombreness of the scene and illuminate it at the same time; in the streets there is a substratum of dust and mud; in the atmosphere a choking something that appears to take a firm grip of one's throat. The aspect of the northern fringe of Sheffield on such a day is terrifying, the black heaps of refuse, the rows of cheerless-looking houses, the thousand and one signs of grinding industrial life, the inky waters of river and canal, the general darkness and dirt of the whole scene serves but to create feelings of repugnance and even horror.

Gazetteer of Sheffield's steam-powered grinding wheels

This gazetteer is intended to complement the more detailed case studies of grinding wheels in chapter four, and to present for the interested researcher some of the source material uncovered during the search for these elusive buildings.

The period up to 1850 is covered (after which time steam engines became too numerous to be reasonably researched in depth), and the first forty years of steam wheel development is presented in chronological order.

Each entry comprises the name used to identify the wheel and its numerical reference on the accompanying key, followed by an OS grid location (centred where possible on the wheel itself), dates of construction and demolition/closure, other uses at the site, physical dimensions where known, and further details relating to the steam engine, boilers and water source.

Sources that led to the identification of the site are presented on the lower half of every page, including references to visual and documentary artefacts, sometimes including salient excerpts. Finally, the present state of the site is described.

Within the scope of this study, to which the gazetteer is merely an appendix, it is not possible to research or present findings in the depth that makes Crossley's *Water power* (1989) such an indispensable resource. However, in the absence of any comparable database or publication relating to the state of early steam-power in Sheffield, it is hoped that the author's modest efforts will be of use to future students of the field.

Note that the plans used to identify each steam wheel are not presented to a uniform scale or orientations (due to the great difference in size and geometry between sites) and are intended only for identification purposes, preferably in conjunction with the main key and OS grid locations.. All are taken from the 1850 six inch to the mile OS sheets, excepting the plan of Cleakham Wheel (demolished by this date).

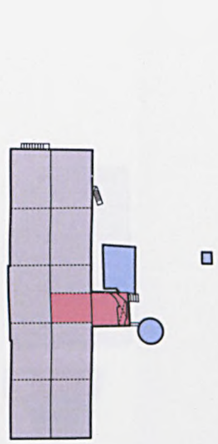
Key to chapter 4: steam-powered grinding wheels in Sheffield up to 1850. Scale 1:15,000.

Steam-powered grinding wheel plan types (scale 1:1000)

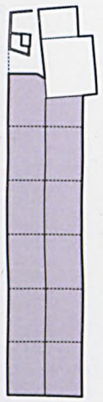
grinding wheel

engine house

boiler and stack



1786-1820 1



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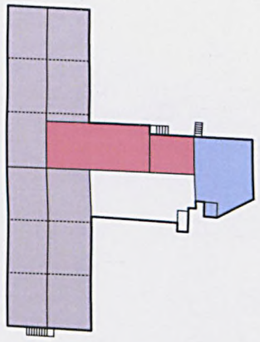

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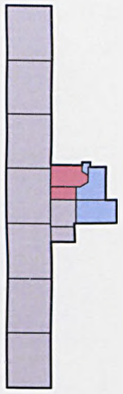

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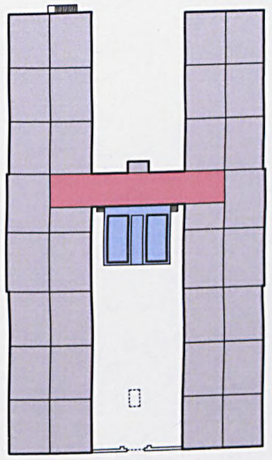

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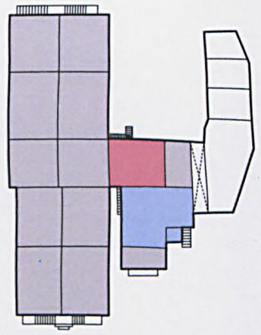

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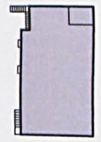

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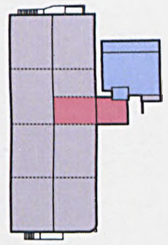

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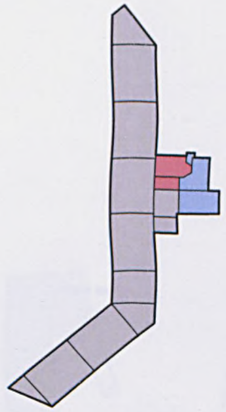

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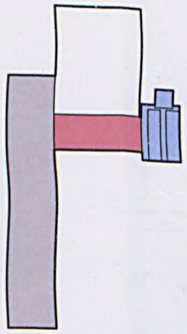

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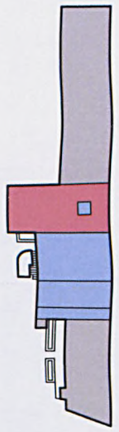

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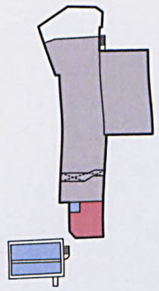

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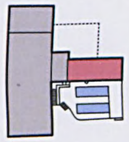

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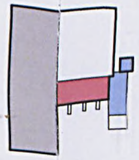

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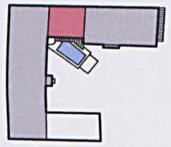

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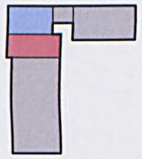
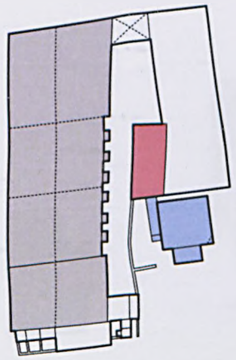


20

1821-1830



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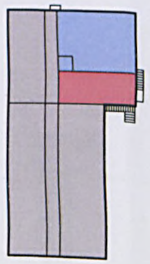

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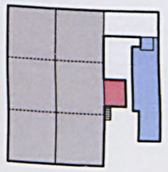

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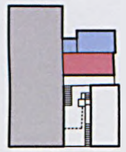

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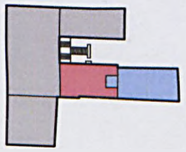

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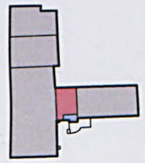

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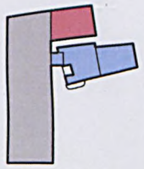

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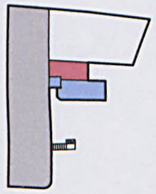

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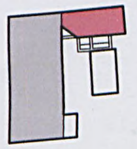


36

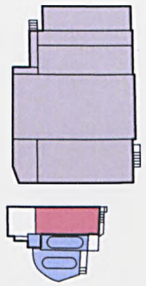
1831-1840

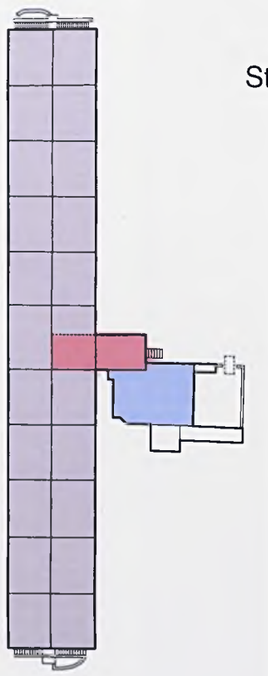
Steam-powered grinding wheel plan types (scale 1:1000)

grinding wheel

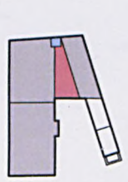
engine house

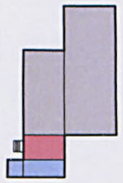
boiler and stack

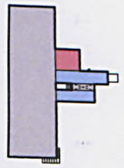


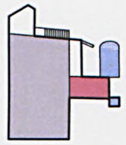


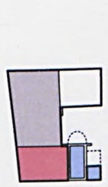
1786-1820 10 11

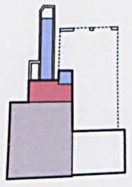




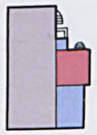


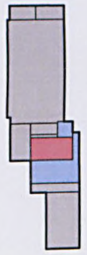


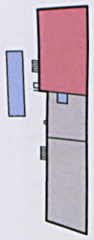


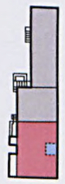


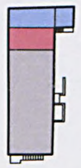
1821-1830 21 22 23 24 25 26 27

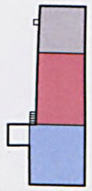


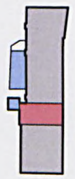


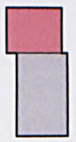


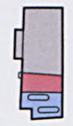












1831-1840 37 38 39 40 41 42 43 44 45 46 47 48

1 Park Grinding Wheel

Location: Sheaf Street
OS grid (x,y): 435949,387408

Owner/occupier: Proctor & Beilby (later Smith, Woodcock & Co.; Eadon & Co.)

Date built: 1786

Date demolished/closed: not known

Wheel type: public

Associated works: glass grinding / optical instrument manufacture

Storeys: 2?

Length (m): 46.15
Width (m): 12.66
Ground floor area (m²): 584.26
Total floor area (m²): 1169?

Troughs: 100

Engine power (h.p.): 35 [say 43]
Engine maker: B&W
Boilers: haystack (1), later wagon

Water source: River Sheaf

Sources:
NB3 (c. 1786-1793) p. 15:
Proprietors of the Steam Engine

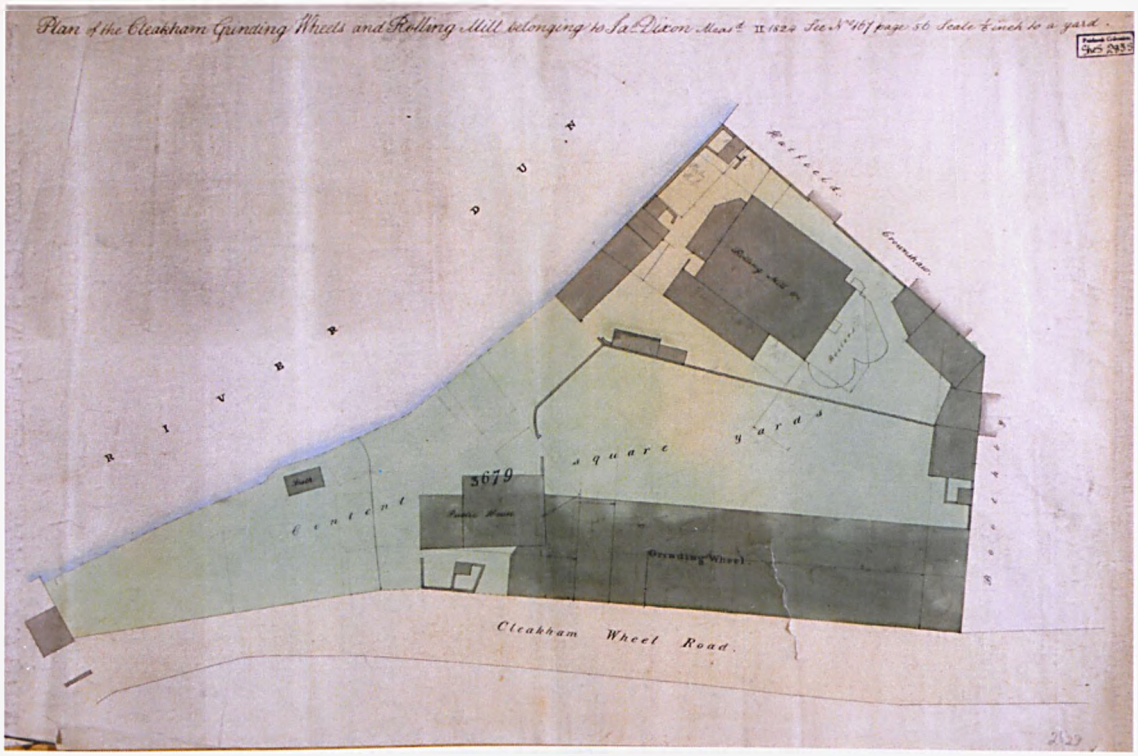
Water powered troughs in same book are generally £5--therefore steam power commands a slight premium. Also includes steam engines at cotton mill.

CP-25-(32) (watermark 1828) 'Woodcock--Park Steam Wheel, Boulton & Watt, called 35 Horse Power, cylinder 32 in., stroke 7 ft., 17 dbl./min., say 10lbs./sq. in. (say 43 hp)'.

NB34 (1833?) pp. 18-19 Woodcock's engine required 67.23 cu. ft. of water per minute.
Robson (1839) p. 784: 'Eadon, W H & Co., Park Steam Grinding Wheel, Sheaf St., Broad St., Park'.

Visual sources: Plan: ACM SheS 1897 [1792]
Extant: nothing.

2 Cleakham Grinding Wheel



Location: Green Lane
OS grid (x,y): 434820,388274

Owner/occupier: Ward, Ellis, Ellis

Date built: 1790

Date demolished/closed: not known

Wheel type: public

Associated works: steam tilt

Storeys: 2?

Length (m): 51.34
Width (m): 11.75
Ground floor area (m²): 603
Total floor area (m²): 1206?

Troughs: not known

Engine power (h.p.): not known
Engine maker: not known
Boilers: not known

Water source: River Don

Sources:
RB41 (1794) p. 273 'Josh. Ward & Co., Steam Wheel £2 16s. 6d.; Tilt £2 4s. 6d.; do. for a Stable 9d.'

Visual sources: Plan: SheS 283S.

Extant: nothing (unless foundations etc. preserved under Cornish Place).

3 Pond Forge Mills

Location: Forge Lane
OS grid (x,y): 435909,387401

Owner/occupier: Fox & others

Date built: 1793

Date demolished/closed: not known

Wheel type: public / forge

Associated works: forge, glass grinding

Storeys: 2

Length (m): 22.86, 51.76, 18.43
Width (m): 6.86
Ground floor area (m²): 638
Total floor area (m²): 1277

Troughs: not known

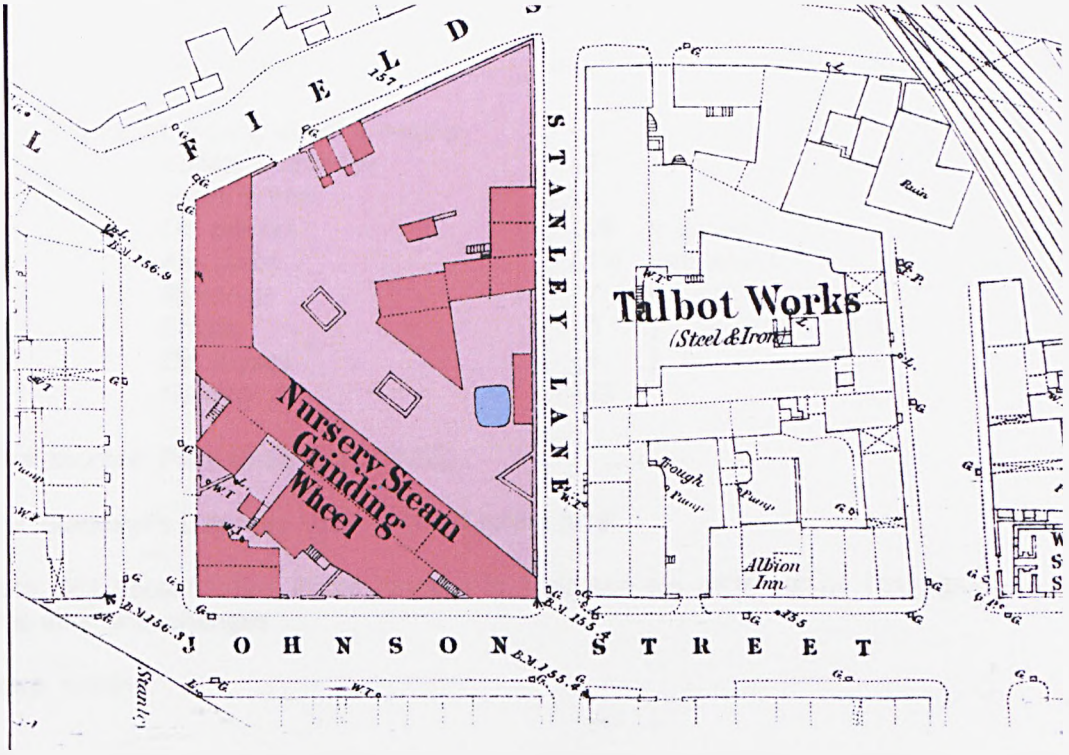
Engine power (h.p.): 80 [say 83]
Engine maker: B&W
Boilers: not known

Water source: River Sheaf

Sources:
RB41 (1794) p. 3 'Messrs. Frith & Co.: Forges, Mill & Land £3 4s. 3d.; do. for Houses 7s. 6d.; do. New Steam Wheel & Mill £4 15s. 5¾d.' [etc.]
MB399 p. 34, engine 80 h.p., stack 30 yds., owned by Pond Forge Co. Water power on same site, with 18ft. head & fall.
CP-25-(32) (watermark 1828) 'Pond Forge Steam Engine, Boulton & Watt's, called 80 hp, 44 in. cylinder, 8 ft. stroke, 15 dbl./min., 10 lbs./sq. ft. (say 83 hp)'.
NB34 (1833?) pp. 18-19 noted that the water power equated to 18½ hp, with a relative cost of 15s. per hp steam and 60s. water, and that the works required 1353.57 cu. ft. of water every minute (mostly for the water wheel) compared to Woodcock [Old Park] which required 67.23 and Frith [Bees' Wax] 23.49.
Visual sources: View: Pollard pl. 17 [c. 1880]. View: (possible) "Sheffield Electicity - Efficiency, Progress, Service 1886-1948" (1948) Sheaf St. generator 1886, boiler house 1900 (in Hawley Coll., FH, no cat.).

Extant: nothing.

4 Nursery Steam Grinding



Location: Johnson Street
OS grid (x,y): 435723,388096

Owner/occupier: John Leather (later Alfred Chadburn)

Date built: c.1801? / modified c.1822

Date demolished/closed: not known

Wheel type: semi-public

Associated works: optical instrument

Storeys: 2

Length (m): 19.24, 43.41, 4.29
Width (m): 6.82, 7.00, 4.03
Ground floor area (m²): 452.38
Total floor area (m²): 905

Troughs: not known

Engine power (h.p.): 28* (NB30)
Engine maker: not known
Boilers: not known

Water source: River Don (Wicker Wheel)

Sources:
(also note 1822 Baine's Directory: 'Leather John, grinding wheel, Nursery')

NB30 (1830) p. 26, 'Steam Engines. Chadburn & Co. pay to the Wicker Wheel Co. for water for their Engine £5 p. Ann. query How many Horse Power. Ans: 28 Horse Power as the Engine Man says'.

Jno Andrews £1,9,6 Spital Hill RB62 from 1801...
RB64 Mich Hesting[?] Saml Petty 4,6
Do. Engine
RB66 (5th Dec. 1820) p. 9 Nursery Street 'John Leather 4/6 do. Engine 18/4} 1/2/10'.

CA VB4 Henry Sanderson, Brightside valuations (1838) p. 35: 'Alfred Chadburn, Johnson St., Grinding Wheel, Workshops & Engine House' g.e.r £120 [546 on map, 810 in rate book].

CA VB2 Sanderson's Survey, Brightside Bierlow valuation 1832.
no. 116 Chadburn's Assignees [own.] John Sorby & others [occ.]

no. on plans	description	quantity A R P		total annual value
546 a, b & a2	Grinding wheel & engine	-,-,20	}	
c	Boilers & chimney	-,-,2	}	29,4,-
c2	Yards in front	-,-,8	}	
e	Do. behind	-,-,29	included	
f	Ash place	-,-,1½	with wheel	
g	Reservoir	-,-,7	&c.	
h	Shops	-,-,3	}	6,8,-
i & j	Do. & yard	-,-,4	}	
k	Garden	-,-,12		-,4,-

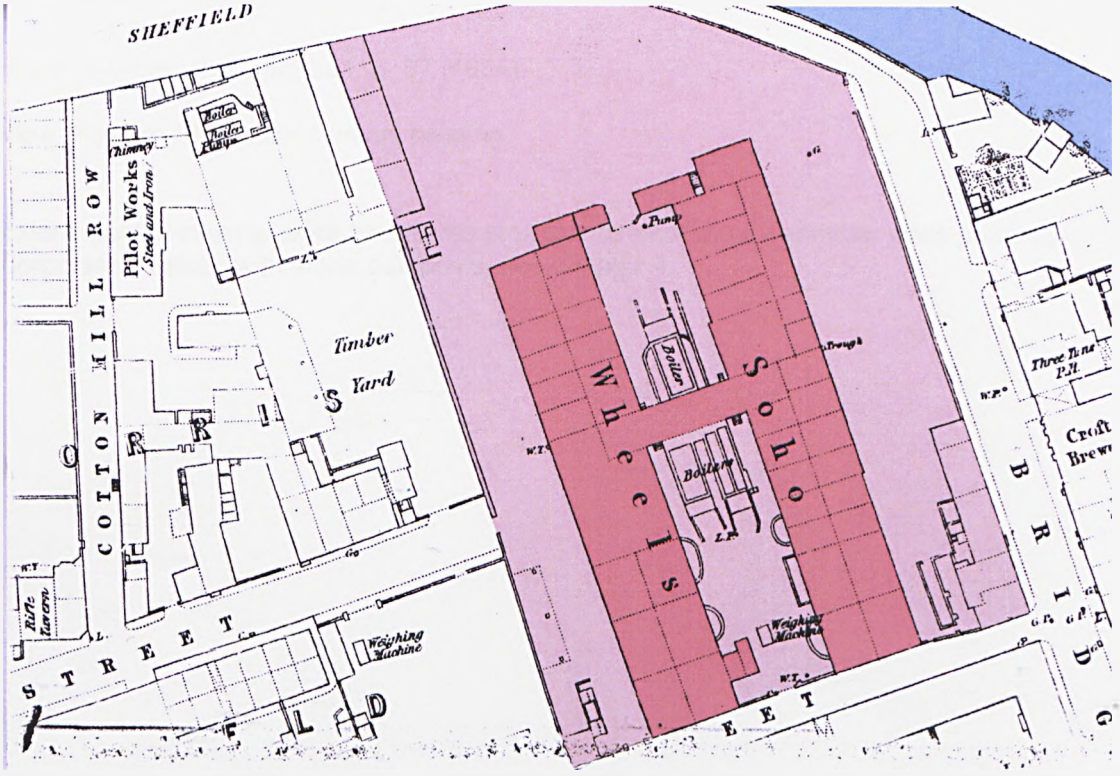
Visual sources: Plan: SheS 630L [1822];

View: Blackwell's Directory 1828, gatefold facing p.18;

Photo: SCL Local Studies, Photo Johnson St. Main Acc. No. 0635-192 (c. 1937) shows the same view, with changes.

Extant: nothing.

5 Soho Wheel



Location: Bridge Street
OS grid (x,y): 435450,387992

Owner/occupier: Simpson, Nowill & Co.

Date built: 1802-05

Date demolished/closed: not known

Wheel type: public

Associated works: none

Storeys: 1-2

Length (m): 70.41, 70.41
Width (m): 13.17, 13.17
Ground floor area (m²): 1855
Total floor area (m²): 2352

Troughs: 169L15H2Scale(264 in c. 1830)

Engine power (h.p.): 30 + 30
Engine maker: not known
Boilers: wagon (3)

Water source: unknown (later Town Mill)

Sources:
NB31 (1834) p. 10 'From information recd. from ---- Simpson, Agent for the Soho Grinding Wheels in Colson Crofts, it appears that No. 1 Engine works 85 Light troughs at 8 gus., 6 Heavy do. at 17 gus., 2 Scale stones in all £36; No. 2 Engine works 84 Light troughs, 9 Heavy do., and there are 5 rooms without Troughs which let for 12 Gus. each on the average', giving a total rental of £1786, 7, 0.

See also NB25 (c.1829-30) p. 106 'Colson Crofts Grinding Wheels. I am informed by a grinder there that there are 264 Troughs at these Works of different sorts. There are 32 Hulls on the Ground floor, each containing 6 troughs = 192, and 12 Hulls on the Chambers ea. 6 do. = 72, make 264 Troughs. There are two Steam Engines of 30 HP ea. and they reckon 16 Hulls to one Engine--but as there are various descriptions of Troughs here one cannot say how many Troughs of a given sort an Engine of this kind can turn--He says they pay as a rent 8 Gus. per Troughs for Penknife grinding & 17 Gus. per Trough for Tableknife grinding, & they have every they found them except the stones & straps, even Coals to warm the rooms'.

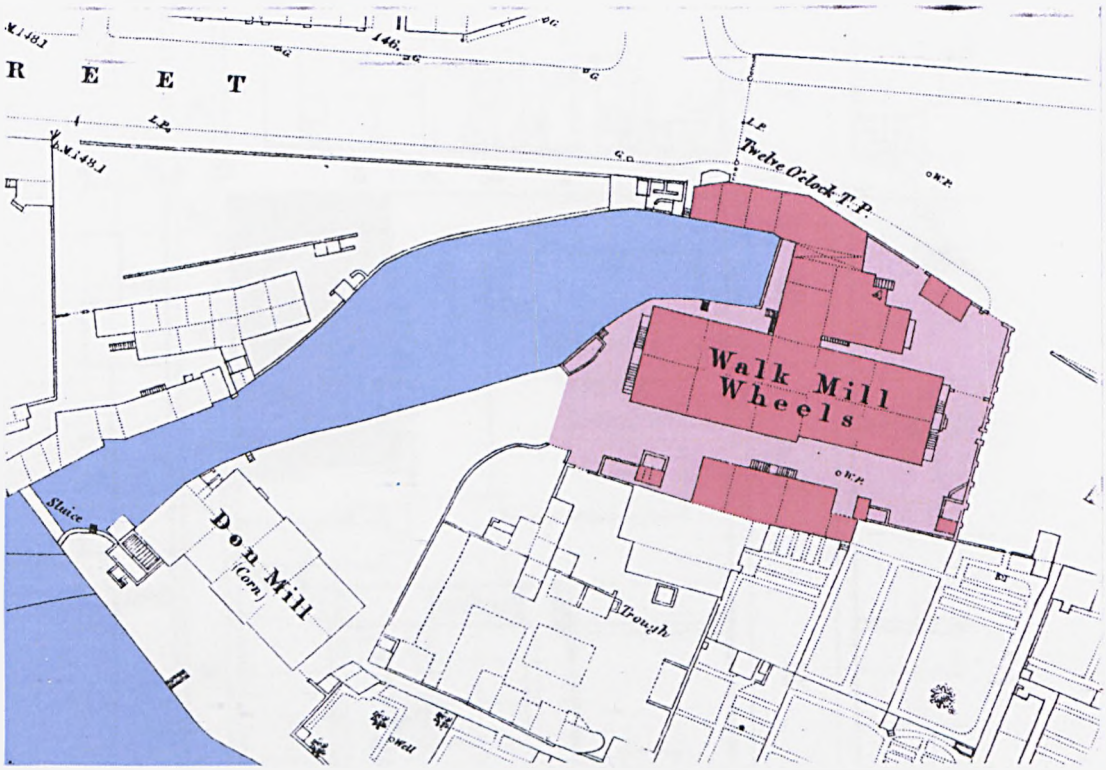
CP-25-(32) (watermark 1828) 'Darwin & Sons, Soho Steam Engine, 30 hp Murrays, Stroke 6 ft., 19 dbl./min., 16 lbs./sq. in. (say 34 hp)'.

Visual sources: Plan: MB 391, p. 37 (1834).

View: Kelham Island, anonymous painting.

Extant: part of external walls and eaves structure to west wing; perimeter walls postdating Corporation Street, with stone gateposts; see chapter 4.

6 Walk Mill Wheels



Location: Saville Street
OS grid (x,y): 436300,388204

Owner/occupier: Brownell & Co.

Date built: before 1808

Date demolished/closed: not known

Wheel type: public

Associated works: Corn mill, fulling mill

Storeys: 2?

Length (m): ?
Width (m): ?
Ground floor area (m²): ?
Total floor area (m²): ?

Troughs: 1830upper35H 4Llower42H 14L

Engine power (h.p.): 31.64 (CP-25-48)
Engine maker: not known
Boilers: not known

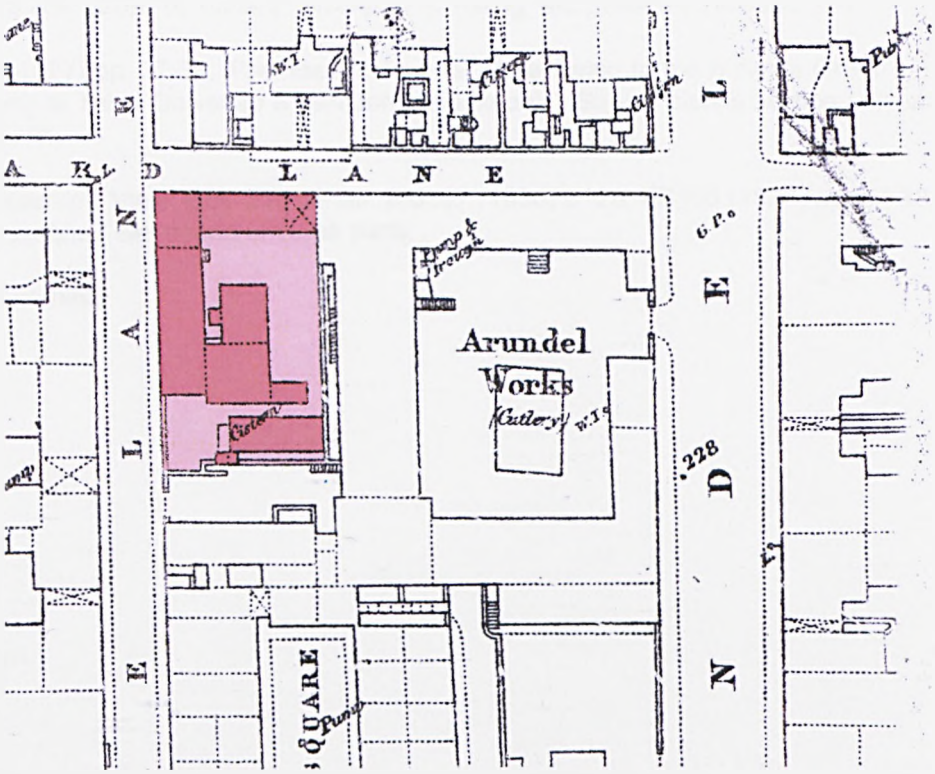
Water source: River don / reservoir

Sources:
Hunter (1819) p. 237: 'A small and ancient fulling-mill is still called the Walk-mill. This was a general name for mills of this description, and persons engaged in the making of cloth were anciently called Walkers. Hence that name is so common in the west riding of Yorkshire'.

NB30 (1830) p. 82 'Estimate of the Value of the Property at Walk Mill belonging to Elizth. Wilkinson & Marianne Brownell. 4mo. 1 1830'. Records that the 'Upper Wheel' has 35 large troughs at £9 9s. 0d. per annum, 4 light troughs at £6 0s. 0d. per annum; 'Lower Wheel' has 42 large and 14 light troughs at the same rates respectively. Also a glass-grinder's room and fulling mill. [no mention is made of steam engines].

CA VB4 Henry Sanderson, Brightside valuations (1838) p. 17: 'Messrs. Brownell & Co., Walk Mills, Old Grinding Wheel, Weir, Dams & Goits, New Grinding Wheel & Engine House, Bone & Emery Mills, Oil Mill & Stable', g.e.r £456.
Visual sources: none known.
Extant: nothing.

7 Shaw & Fisher



Location: Eyre Lane
OS grid (x,y): 435531,386987

Owner/occupier: Dewsnap (later Shaw & Fisher)

Date built: before 1812

Date demolished/closed: not known

Wheel type: public

Associated works: Silver rolling, buffing

Storeys: 2?

Length (m): ?
Width (m): ?
Ground floor area (m²): ?
Total floor area (m²): ?

Troughs: not known

Engine power (h.p.): not known
Engine maker: not known
Boilers: single, circular

Water source: not known

Sources:
Before the Police Act was introduced, with similar powers, Dewsnap was one of the first steam engine owners to be brought to trial for smoke nuisance: FB114 p. 77 (5 March 1812) 'Measures taken of Jno. Dewsnap's Steam Engine Works in Arundel Street also of Several of the Premises near on acct. of a Trial at York an Action for a nuisance meas. 3mo. 5 1812'. Local Register (1830) p. 130, recorded for 16 Oct. 1812 'Steam Engines;- true bills for nuisances found by the grand jury at the sessions, against the owners of two steam engines in Arundel-street and Pond-street, for not consuming the smoke', (I think the other was Darwin's wheel, later to be Marsh's Pond Works).

SheS 42S (1820), AB12 p. 48 (also see SheS43S, SheS44S) 'Ground belonging to Green & Dewsnap with a note, unsigned, referring to a boundary dispute between J. Dewsnap and J. Middleton, 1820'.

FB198 (1829) pp. 4-7 'Dilapidations in the premises occupied by Armitage & Standish in Eyre Lane, taken on account of Thomas Dewsnap'.

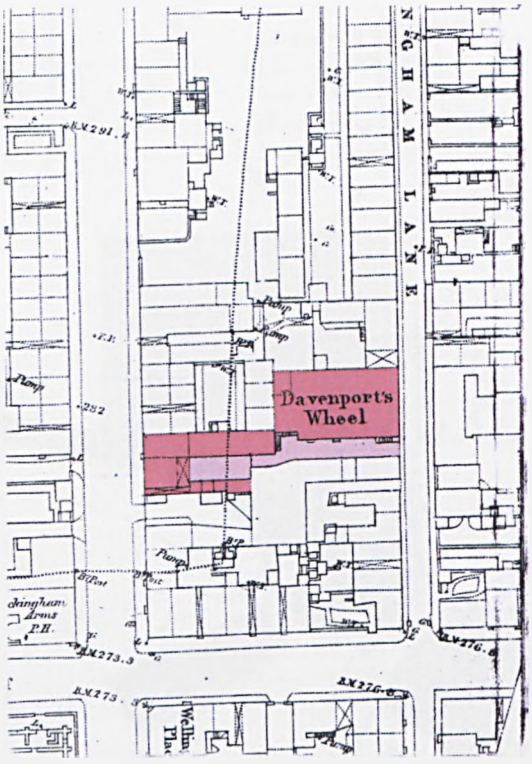
Later occupied by Shaw & Fisher, MB399 (1836) p. 30, owned by Dewsnap, engine 6 h.p., stack 15 yds. (used by buffers, silversmiths, rolling, etc.) See also MB398 p. 4.

FB183 (1827) pp. 37-38, 'Premises in Arundel Street being formerly Amos Green's, part now belonging to Thos. Dewsnap & part John Middleton's'. Survey plan & section / elevations of some parts.

Visual sources: View: EBu 218 SPlan: MB397 (1836) p. 20; FB183 (1827) pp. 37-38, survey plan & section / elevations of some parts.

Extant: nothing.

8 Rockingham Steam Engine



Location: Rockingham Lane
OS grid (x,y): 435063,387029

Owner/occupier: Davenport, Jno.

Date built: before 1834

Date demolished/closed: not known

Wheel type: public / cutlery

Associated works: none known

Storeys: 3

Length (m): 16.73
Width (m): 11.44
Ground floor area (m²): 191.39
Total floor area (m²): 574

Troughs: not known

Engine power (h.p.): 16* in 1832 (NB29)
Engine maker: not known
Boilers: not known

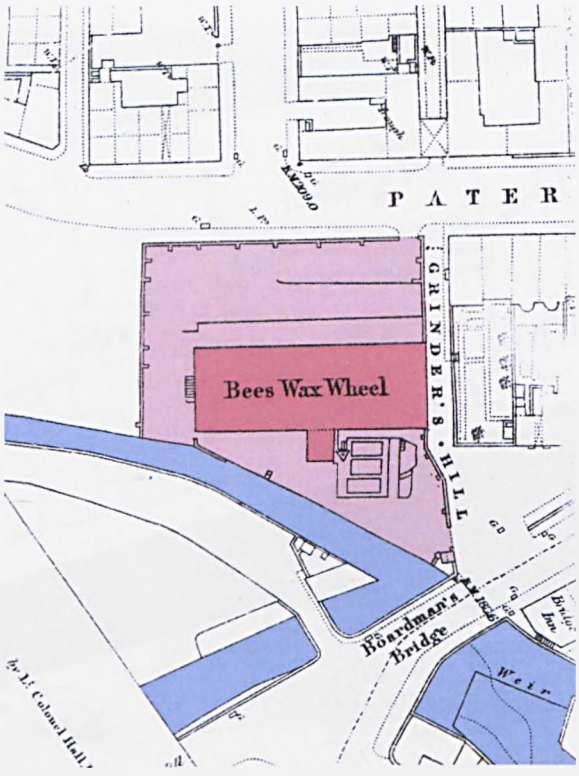
Water source: reservoir

Sources:
MB401 p. 13, reservoirs 600x745, 520x3550 [metric yards]. NB29 p. 123 (16 July 1835) 'Devenport's [sic] Engine in Rockingham Street, 16 Horse Power'. Fairbank recorded that Davenport 'says the expence or loss of water for this engine working 11 hours per day & 6 days per week is 60,000 Gallons per week' calculated as 9.46 gallons per minute per h.p. He considered this to be 'a much larger quantity than is sometimes calculated ... Christy says 5 and others 7 Galls. p. minute p. HP, but Davonport [sic] says he has made very accurate caluculations, he draws all his water from a Well & has but a small Reservoir'.

Visual sources: View: Yorkshire Directory 1834, p. 1045

Extant: nothing.

9 Bees Wax Wheel



Location: Brown Street
OS grid (x,y): 435652,386826

Owner/occupier: Peter Frith & Co.

Date built: c.1816

Date demolished/closed: post-1900

Wheel type: public

Associated works: none

Storeys: 2 + garret

Length (m): 33.38, 4.80, 8.87
Width (m): 13.26, 3.93, 5.94
Ground floor area (m²): 514
Total floor area (m²): 1285

Troughs: over 60

Engine power (h.p.): 30 [24 say 29]
Engine maker: Thompson
Boilers: 3

Water source: Porter Brook (direct)

Sources:
MB399 p. 18, engine 30 h.p., 2½ storey grinding wheel (i.e. garret space).

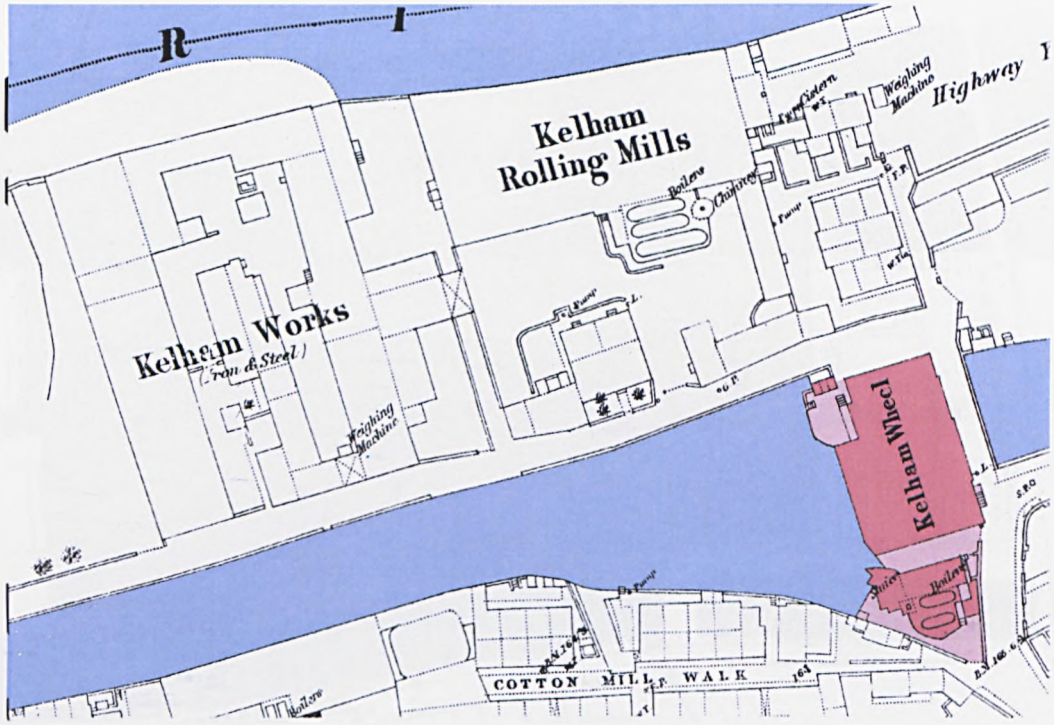
CP-25-(32) (watermark 1828) 'Frith, Grinding Wheels near Boardman's Bridge, Engine 24 hp by Thompson, Cylinder diam. 28 in., Stroke 5 ft., 21 dbl./min., 10lb. pressure (say 29 hp)'.

NB34 (1833?) pp. 18-19 Frith's engine required 23.49 cu. ft. of water per minute.

Visual sources: Plan: SheS 202 [surveyed 1816].
Plan: Sale Plan 27 April 1875View: Tatton vol. 1, p. 94 (95).
View: Hawley CAT2134a, frontispiece, Spafford & co. ltd., Imperial Works (crude red/black woodcut, 1920-30s).

Extant: nothing.

10 Kelham Wheel



Location: Kelham Island
OS grid (x,y): 435260,388127

Owner/occupier: Dunn, Thos.

Date built: not known (early water-powered site)

Date demolished/closed: not known

Wheel type: public

Associated works: none

Storeys: 2-4

Length (m): Various
Width (m): Various
Ground floor area (m²): 480
Total floor area (m²): 1408

Troughs: not known
Engine power (h.p.): 30 [20 in Cross.*]

Engine maker: B&W
Boilers: two, waggon?

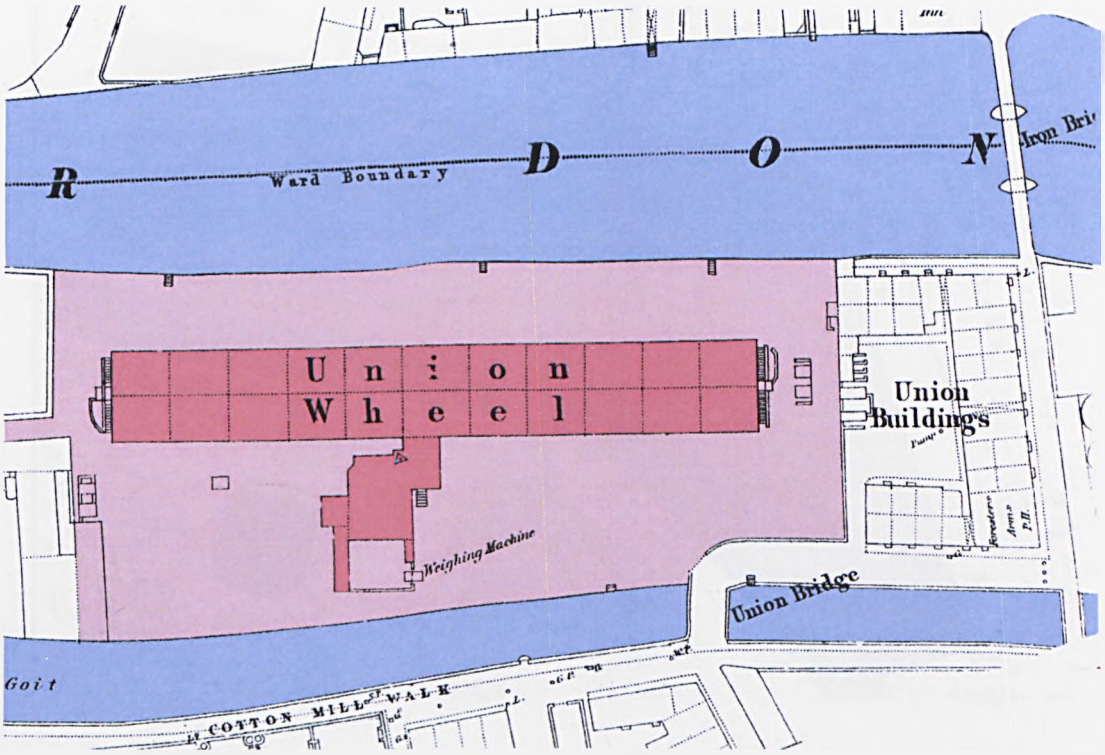
Water source: River Don (Town Mill)

Sources:
Robson (1839) p. 784: 'Dunn, Thomas, Kelham Grinding Wheel, 25 Kelham Street'.

Visual sources: Plan: MB394, p. 11.

Extant: engine seating to side of wheel foundations

11 Union Grinding Wheel



Location: Bridge Street
OS grid (x,y): 435387,388132

Owner/occupier: Beckett, Jos. & Co.

Date built: 1818-20

Date demolished/closed: 1954

Wheel type: public

Associated works: none

Storeys: 2

Length (m): 100.58
Width (m): 13.72
Ground floor area (m²): 1380
Total floor area (m²): 2760

Troughs: 231 light, 11 heavy, 1scale

Engine power (h.p.): 60 (40 in 1818?)
Engine maker: not known
Boilers: wagon (3)

Water source: River Don (Town Mill)

Sources:
Robson (1839) p. 784: 'Union Steam Grinding Mills, Union Buildings'.

NB31 (1834) p. 11 'Union Grinding Wheels, account given by Beckett & Co. 8mo. 2 1834', specifies 22 ground floor hulls (113 light, 11 heavy, 1 scale), 25 chamber floor hulls (118 light--including glass-cutting and buffing room), '1 engine of 60 horse power'. Light troughs 8 guineas, heavy 17, scale 36; 'Gross rental when all are let £2248, 7, 0. Out of which sum the wear and tear of the engine and other machinery belonging to the concern and the coals used with interest upon the capital sunk thereon must be deducted'.

Visual sources: Plan: MB 391, p. 37 (1834); (partial) MB 395, p. 31 (1836)
View: Kelham Island, anonymous painting

Extant: part of built-up riverbank with steps made of grindstones; perimeter wall to Bridge Street / Alma Street

12 Sheaf Works

Location: Maltravers Street
OS grid (x,y): 436205,387895

Owner/occupier: Greaves & Co.

Date built: 1823-26

Date demolished/closed: 20th century

Wheel type: private

Associated works: cutlery, edge tools

Storeys: 4?

Length (m): 40.76
Width (m): 7.68
Ground floor area (m²): 313
Total floor area (m²): 1252?

Troughs: not known

Engine power (h.p.): not known
Engine maker: not known
Boilers: wagon (2, later 3)

Water source: canal or reservoir

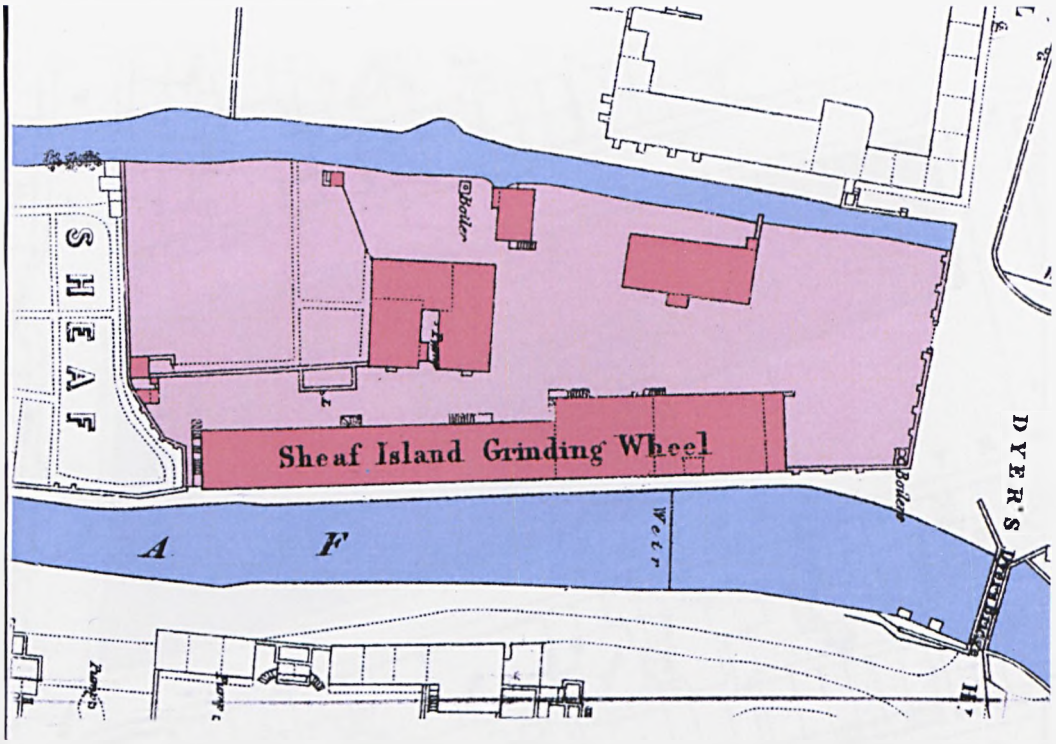
Sources:
Visual sources: Plan: ACM Misc. Maps 52 [earliest plan].

View: Hawley CAT1030, frontispiece, Greaves, William & sons (Parkin & Bacon del. et sculp.)

View: Hawley CAT 2419-2421View: Illustrated Guide to Sheffield 1879, p. 224.

Extant: part of engine house

13 Sheaf Island Grinding Wheel



Location: Forge Lane
OS grid (x,y): 435897,387225

Owner/occupier: Rhodes, John / Parker, Shore & Co.

Date built: not known

Date demolished/closed: not known

Wheel type: public (later private cutlery)

Associated works: none

Storeys: 1, 2, 3

Length (m): 11.61, 11.61, 42.25
Width (m): 3.79, 6.02, 7.16
Ground floor area (m²): 44.00, 69.89, 302.51
Total floor area (m²): 1091

Troughs: not known

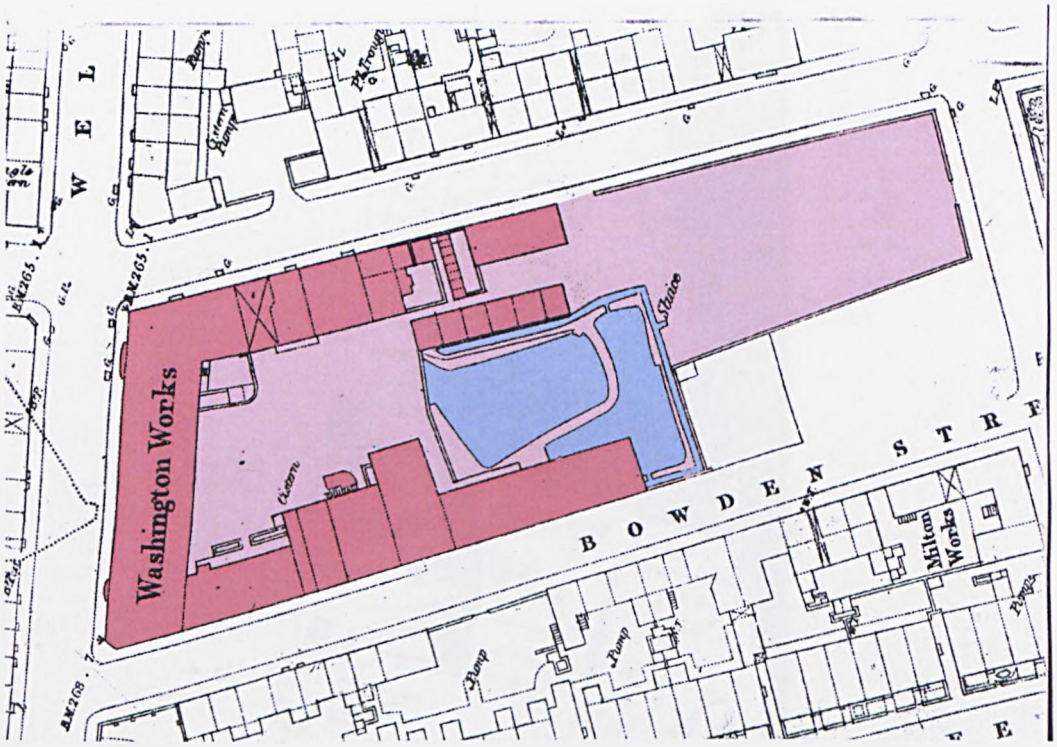
Engine power (h.p.): 30
Engine maker: not known
Boilers: not known
Water source: River Sheaf

Sources:
MB399 p. 2; engine 30 h.p., stack 25 yds. [Samuel Darwin had occupied a 2 storey hardening shop on the site, demolished around 1836].

Visual sources: View: General Directory of Sheffield1856, p. 35 ads., Jackson, William & co., Sheaf Island Works.

Extant: nothing.

14 Washington Place



Location: Wellington Street
OS grid (x,y): 434873,386885

Owner/occupier: Oakes, Joseph (later George Wostenholm)

Date built: 1830s

Date demolished/closed: 1980s

Wheel type: public (later private cutlery)

Associated works: not known

Sources: see chapter 4.

Storeys: 4, 4, 2, 2

Length (m): 27.38, c. 16.20, 13.66, 7.26
Width (m): 7.87, 7.07, 11.70, c. 11.10
Ground floor area (m²): 570.42
Total floor area (m²): 1801

Troughs: not known

Engine power (h.p.): not known
Engine maker: not known
Boilers: not known

Water source: reservoir

15 Sheldon Row

Location: Sheldon Yard
OS grid (x,y): 435936,387965

Owner/occupier: Smith, Edward

Date built: not known

Date demolished/closed: not known

Wheel type: semi-public / private cutlery

Associated works: not known

Storeys: not known

Length (m): ?
Width (m): ?
Ground floor area (m²): ?
Total floor area (m²): ?

Troughs: not known

Engine power (h.p.): not known
Engine maker: not known
Boilers: not known

Water source: River Don (Wicker Wheel)

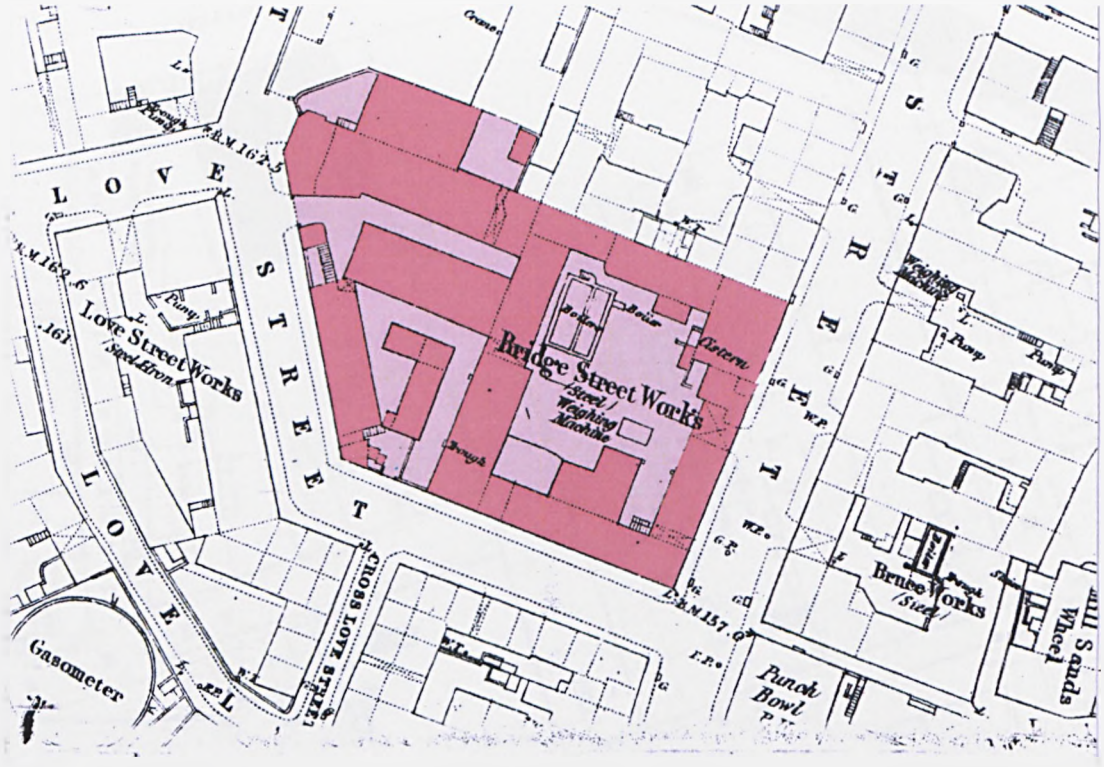
Sources:
CA VB1 Brightside valuations (1824) p. 109, lists: 'Smith E & W, Wicker, New Grindg Wheel £24; Wareho. & Workshops £3 17s. 6d.; Table Blade Shops £3 2s. 6d.'

CA VB2 Sanderson's Survey, Brightside valuations (1832) no. 55 Smith Edwd. Sheldon Row, Grinding Wheel 10 perches, Grinding Wheel (separate) 2 perches, Superintendent's House &c. 4 perches, House 2 perches, House 2 perches, [etc.]

CA VB4 Henry Sanderson, Brightside valuations (1838) p. 19: 'Edward Smith, Sheldon Row, Grinding Wheels & Workshops and Engine House, £150' [no. 520 on map, no. 433 in rate book].

Extant: nothing.

16 Whitham's Works



Location: Bridge Street
OS grid (x,y): 435465,387876

Owner/occupier: Whitham's trustees

Date built: 1810s

Date demolished/closed: 20th century

Wheel type: semi-public

Associated works: spindles, edge tools

Storeys: 2

Length (m): 28.20, 14.78
Width (m): 6.93, 6.59
Ground floor area (m²): 292.83
Total floor area (m²): 586

Troughs: not known

Engine power (h.p.): not known
Engine maker: not known
Boilers: two, waggon?

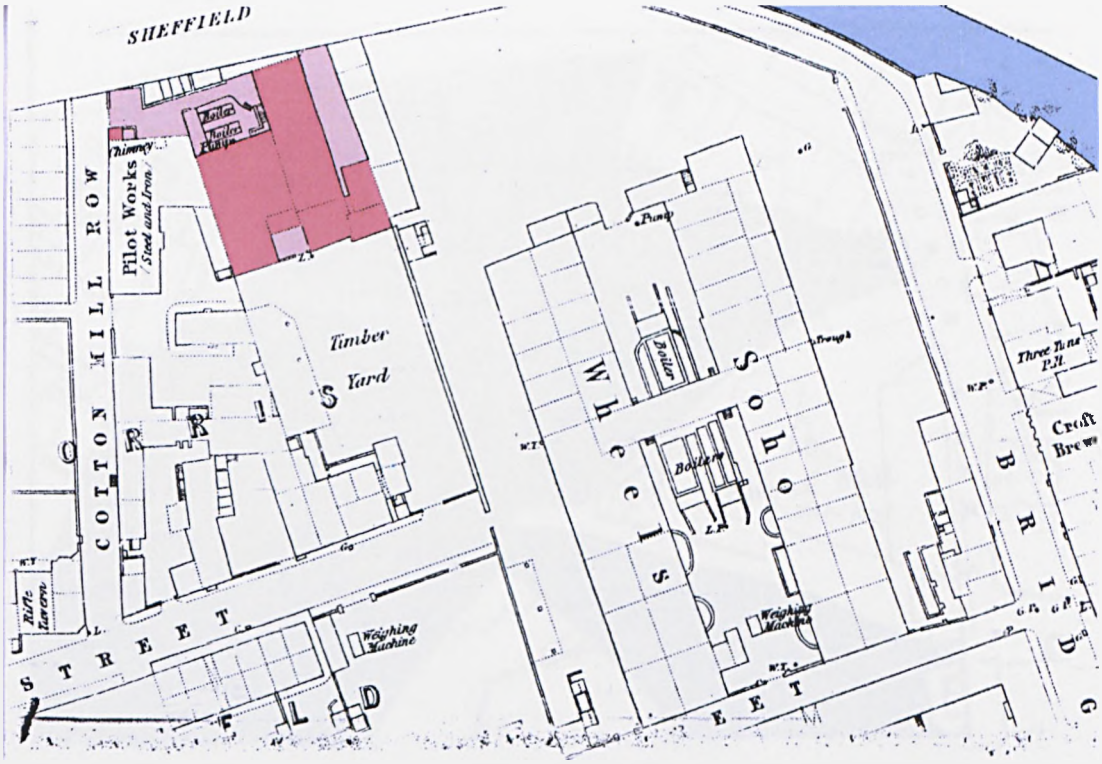
Water source: not known

Sources:
Visual sources: Plan: EBu 221S [watermark 1829].

View: Melville's Directory.

Extant: grinding wheel building from later phase of site, now occupied as signboard maker's workshops.

17 Reform Wheel



Location: Steam Street
OS grid (x,y): 435403,388043

Owner/occupier: Walker, Wm. & Co.

Date built: not known

Date demolished/closed: not known

Wheel type: public

Associated works: not known

Storeys: 2

Length (m): 17.10, 2.56
Width (m): 7.13, 4.84
Ground floor area (m²): 122, 12
Total floor area (m²): 268

Troughs: not known

Engine power (h.p.): 20
Engine maker: not known
Boilers: (2)

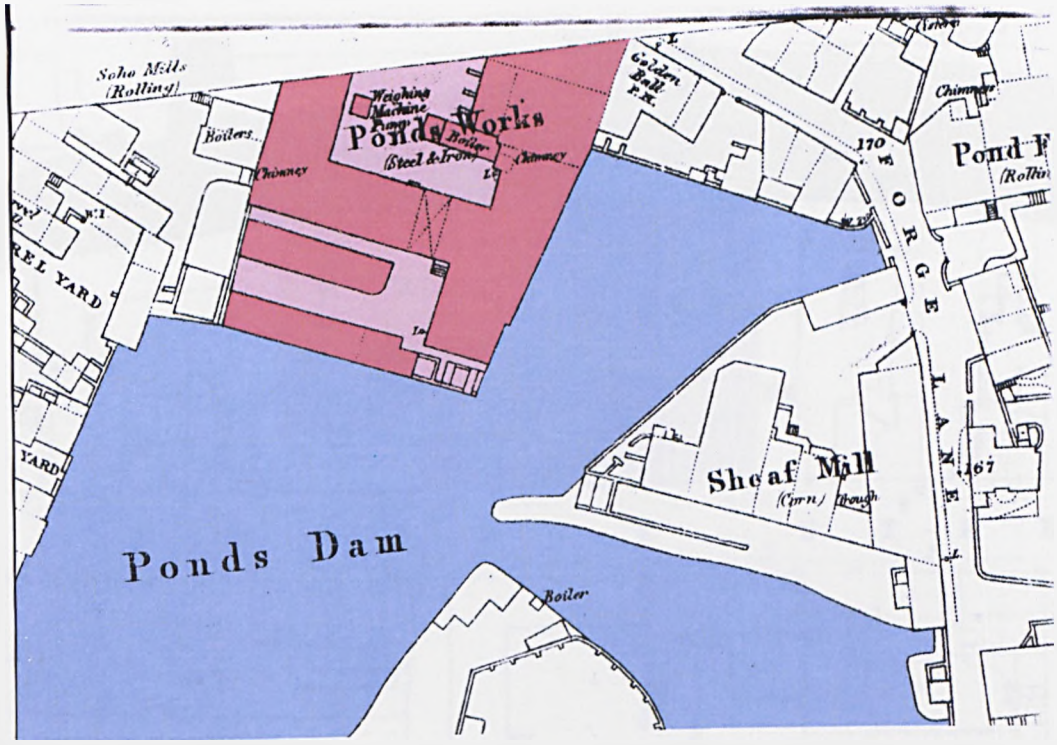
Water source: not known

Sources:
Robson (1839) p. 784: 'Ashforth, William, 31 Norris Fields', probably the same wheel.

Visual sources: Plan: MB 395, p. 33 (1836); SCA Sale Plan J.C. 1828 (1854) land left over by the intended creation of Corporation Street and Alma Street, auctioned Tuesday 12th December 1854.

Extant: nothing.

18 Ponds Works



Location: Forge Lane
OS grid (x,y): 435838,387421

Owner/occupier: Darwin & Co. (later Marsh & Shepherd)

Date built: before 1812

Date demolished/closed: 20th century

Wheel type: private

Associated works: steel, cutlery, edge tools

Storeys: 4

Length (m): 23.73
Width (m): 7.52
Ground floor area (m²): 178
Total floor area (m²): 714

Troughs: not known

Engine power (h.p.): 16
Engine maker: not known
Boilers: 1, waggon?

Water source: Ponds Dam

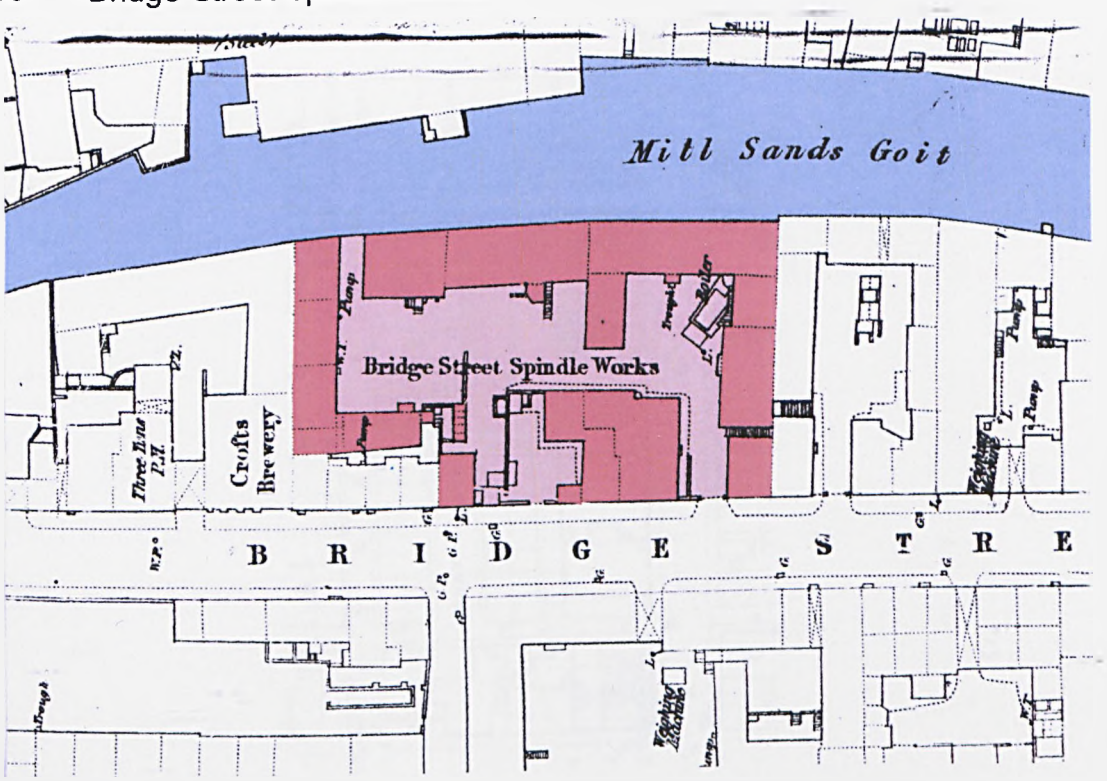
Sources:
MB399 p. 22, engine 16 h.p., stack 25 yds., owned by Richard Jessop. 14 hole melting furnace and rolling mill. 4 storey wheel.

Visual sources: View: Pollard pl. 9 [c. 1838]; pl. 10 [c.1846]

View: Hawley CAT1424, Marshes & Shepherd, Ponds Works, 1847.

Extant: nothing.

19 Bridge Street Spindle Works



Location: Bridge Street
OS grid (x,y): 435543,387929

Owner/occupier: Whitham

Date built: not known

Date demolished/closed: not known

Wheel type: private

Associated works: spindles

Storeys: not known

Length (m): ?
Width (m): ?
Ground floor area (m²): ?
Total floor area (m²): ?

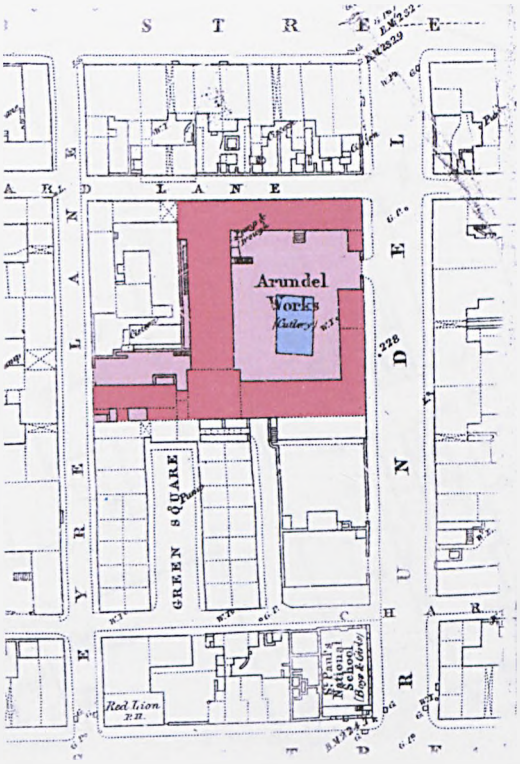
Troughs: not known

Engine power (h.p.): not known
Engine maker: not known
Boilers: single, waggon?

Water source: Town Mill goit

Sources: see chapter 4.

20 Arundel Works



Location: Arundel Street
OS grid (x,y): 435537,386960

Owner/occupier: Dewsnap, Jno. & Son

Date built: 1820s

Date demolished/closed: 20th century

Wheel type: semi-public

Associated works: cutlery

Storeys: 3

Length (m): 19.20, 17.19
Width (m): 3.70, 3.66
Ground floor area (m²): 134
Total floor area (m²): 402

Troughs: not known

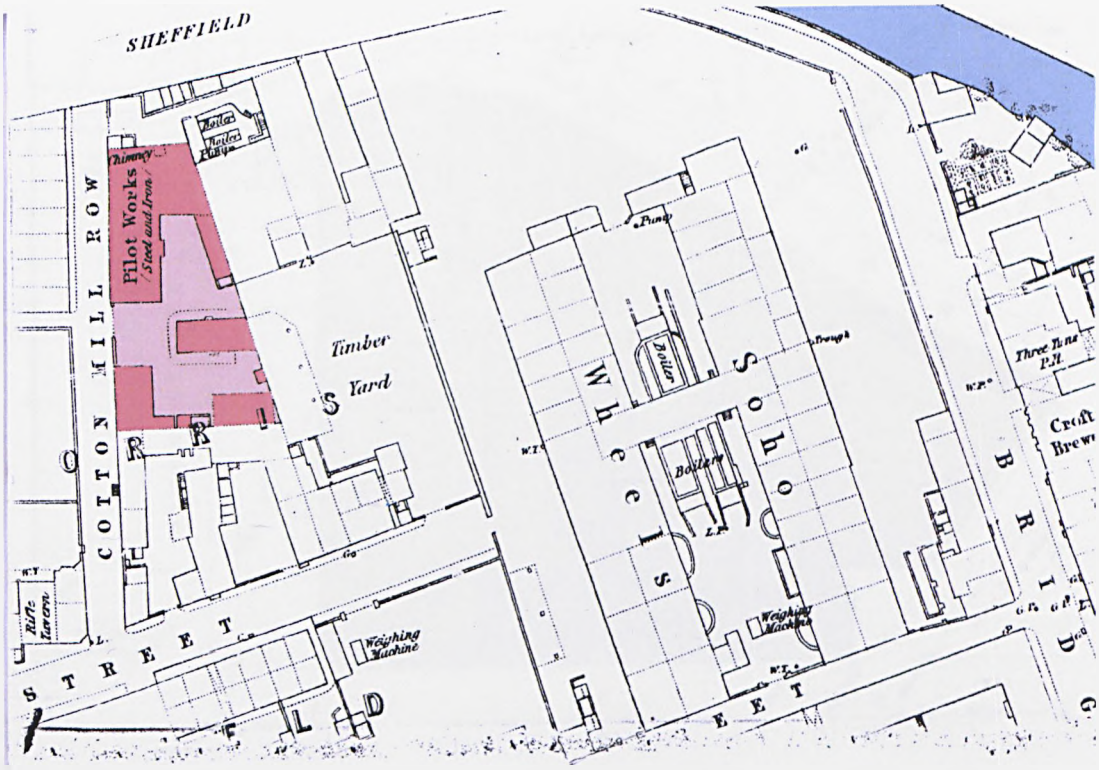
Engine power (h.p.): 18
Engine maker: not known
Boilers: not known

Water source: reservoir

Sources: see no. 7, Shaw & Fisher

Extant: nothing.

21 Pilot Works



Location: Cotton Street
OS grid (x,y): 435382,388038

Owner/occupier: Marsden, Thos.

Date built: 1820s

Date demolished/closed: not known

Wheel type: semi-public

Associated works: steel, cutlery

Storeys: 2, 3

Length (m): 9.51, 10.33
Width (m): 6.08, 7.32
Ground floor area (m²): 57.82, 75.62
Total floor area (m²): 342

Troughs: not known

Engine power (h.p.): 6
Engine maker: not known
Boilers: not known

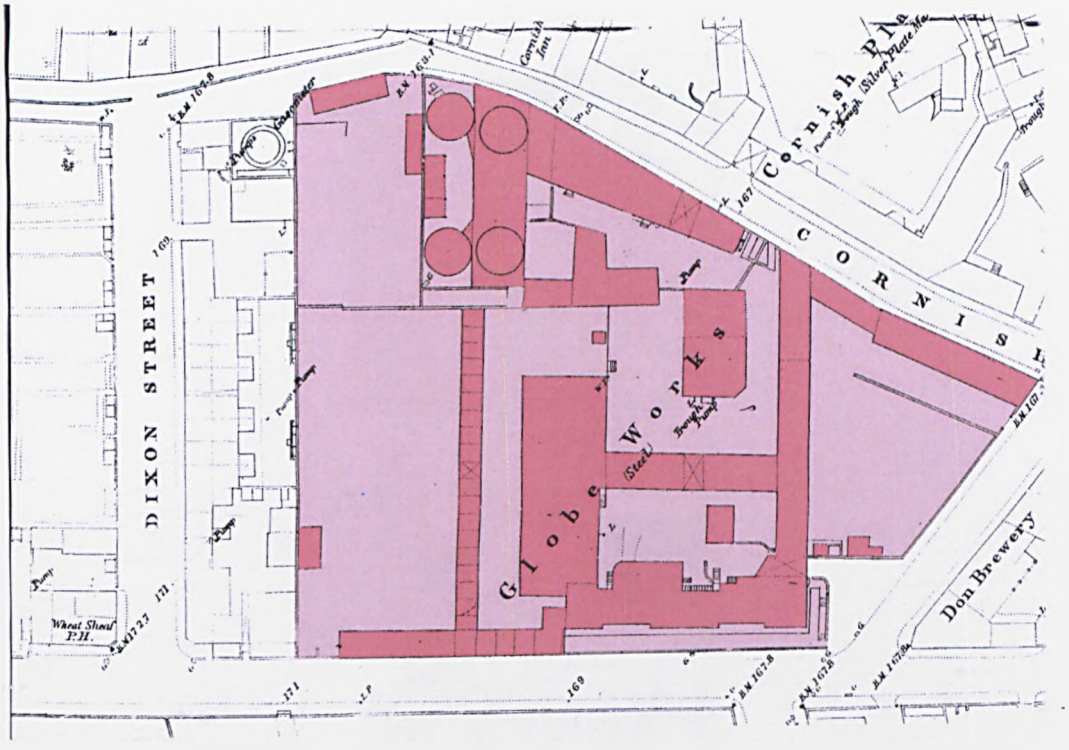
Water source: not known

Sources:
Visual sources: Plan: MB 395, p. 32 (1836).

View: Industries of Sheffield (1905) n.p. [78].

Extant: part of wall to Cotton Mill Row.

22 Globe Works



Location: Penistone Road
OS grid (x,y): 434820,388274

Owner/occupier: Ibbotson Bros.

Date built: 1825

Date demolished/closed: 20th century

Wheel type: private

Associated works: cutlery, edge tools, scythes

Storeys: 3

Length (m): 13.90, 37.72
Width (m): 7.00, 8.41
Ground floor area (m²): 97, 317
Total floor area (m²): 1242

Troughs: not known

Engine power (h.p.): 20 (30 in 1846 Fv)
Engine maker: not known
Boilers: not known

Water source: River Don

Sources:
Visual sources: Plan: MB 393, pp. 67-70 (1835); Pawson & Brailsford (1862).

Extant: most of grinding wheel building.

23 Roscoe Place

Location: Shalesmoor
OS grid (x,y): 434803,388055

Owner/occupier: Stuart & Smith

Date built: 1830s

Date demolished/closed: not known

Wheel type: private

Associated works: iron foundry

Storeys: 3

Length (m): ?
Width (m): ?
Ground floor area (m²): ?
Total floor area (m²): ?

Troughs: not known

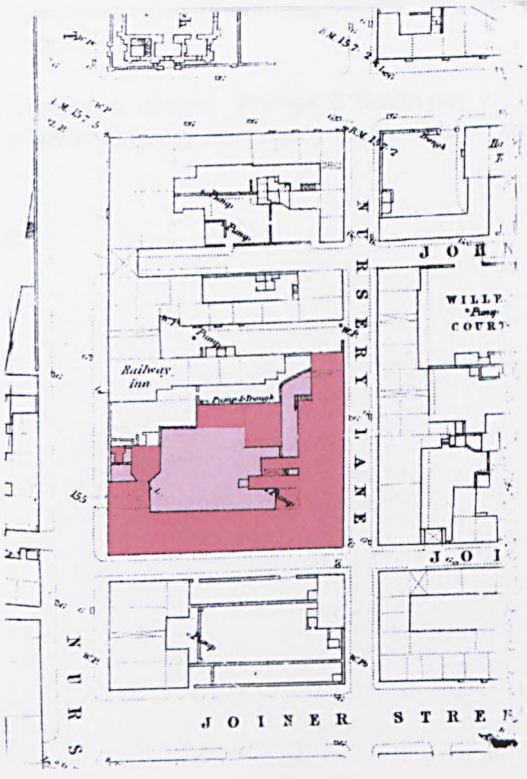
Engine power (h.p.): not known
Engine maker: not known
Boilers: not known

Water source: reservoir

Sources:
see SheS1332L (1807, 1816).
SheS1333L (1828).
SheS1334S (1836).
SheS1335S (1836-46).
SheS1337S (1845).

Extant: nothing.

24 Nursery Lane



Location: Nursery Street
OS grid (x,y): 435688,387979

Owner/occupier: Younge & Smith

Date built: 1830s

Date demolished/closed: not known

Wheel type: private

Associated works: saws, etc.

Storeys: 2?

Length (m): ?
Width (m): ?
Ground floor area (m²): ?
Total floor area (m²): ?

Troughs: not known

Engine power (h.p.): 10* (NB30)
Engine maker: not known
Boilers: not known

Water source: not known (River Don?)

Sources:
CA VB2 Sanderson's Survey, Brightside valuation (1832).

no. 110 Messrs. Younge & Smith, Nursery St., Thomas Smith [own.] Younge & Smith [occ.]

no. on plans	description	quantity A R P	total annual value
541o	Stable & Chamber	-,-,1½ }	
pp2	Grinding wheel	-,-,8 }	
o2	Yard	-,-,2 }	
q	Engine House &c.	-,-,1½ }	£38 0s 0d
r	Saw Shed &c.	-,-,3 }	
s	Large Yard	-,-,10½ }	
t	Smith's Shop	-,-,1 }	
u	Workshops &c.	-,-,9 }	

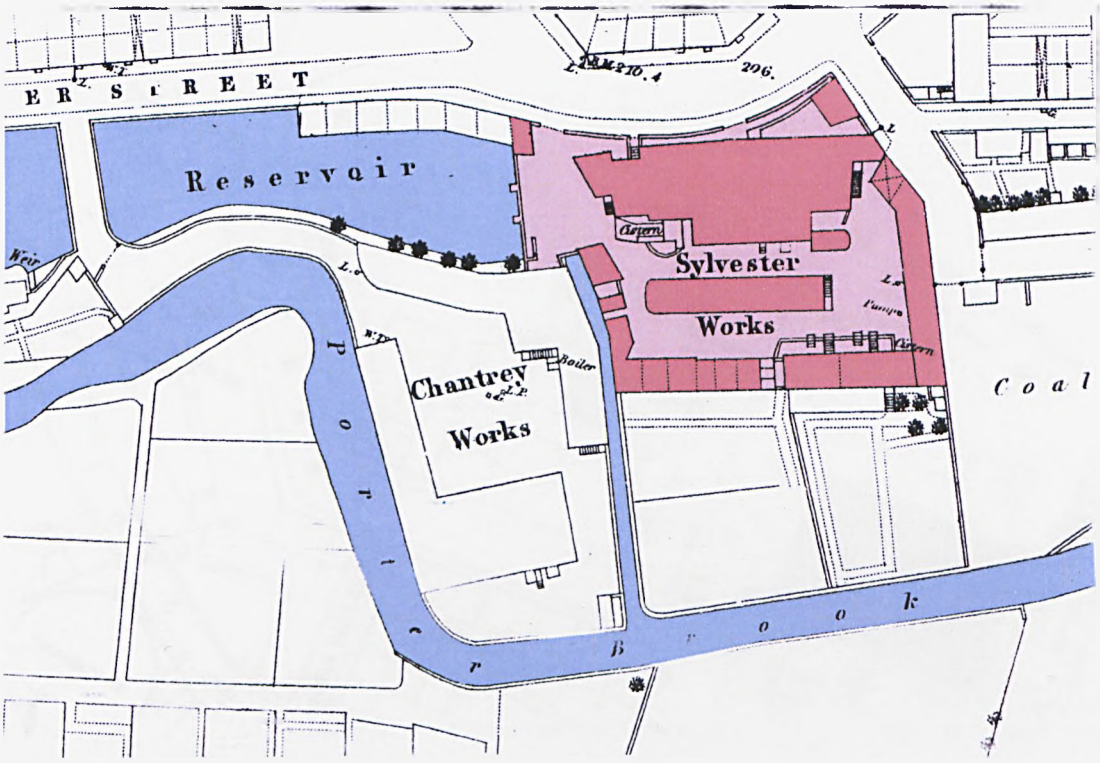
CA VB4 Henry Sanderson, Brightside valuations (1838) p. 31: 'Messrs. Younge & Smith, Nursery St., Workshops, Counting House, Grinding Wheel, Engine House &c.' g.e.r. £116 [541 on map, 717 in rate book].

NB30 (1830) p. 26 [see Chadburn, above] 'Younge & Smith pay for their do. [Engine] £3 [to the Wicker Wheel Co. per annum] query how many Horse Power. Ans: 10 Horse Power as the Engineman says'.

Visual sources: not known

Extant: nothing.

25 Sylvester Works



Location: Sylvester Street
OS grid (x,y): 435293,386500

Owner/occupier: Ellin, Thos. & Co.

Date built: not known

Date demolished/closed: not known

Wheel type: semi-public

Associated works: cutlery

Storeys: 2, 2, 2, 3

Length (m): 16.32, 5.30, 5.85, 3.84
Width (m): 9.51, 3.84, 3.63, 4.21
Ground floor area (m²): 155.20, 20.35, 21.24, 16.17
Total floor area (m²): 442

Troughs: not known

Engine power (h.p.): 10 [say 11.5]
Engine maker: B&W
Boilers: not known
Water source: reservoir (Porter Brook)

Sources:
MB400 p. 7, engine 10 h.p., stack 24 yds., site still includes water power with head & fall.

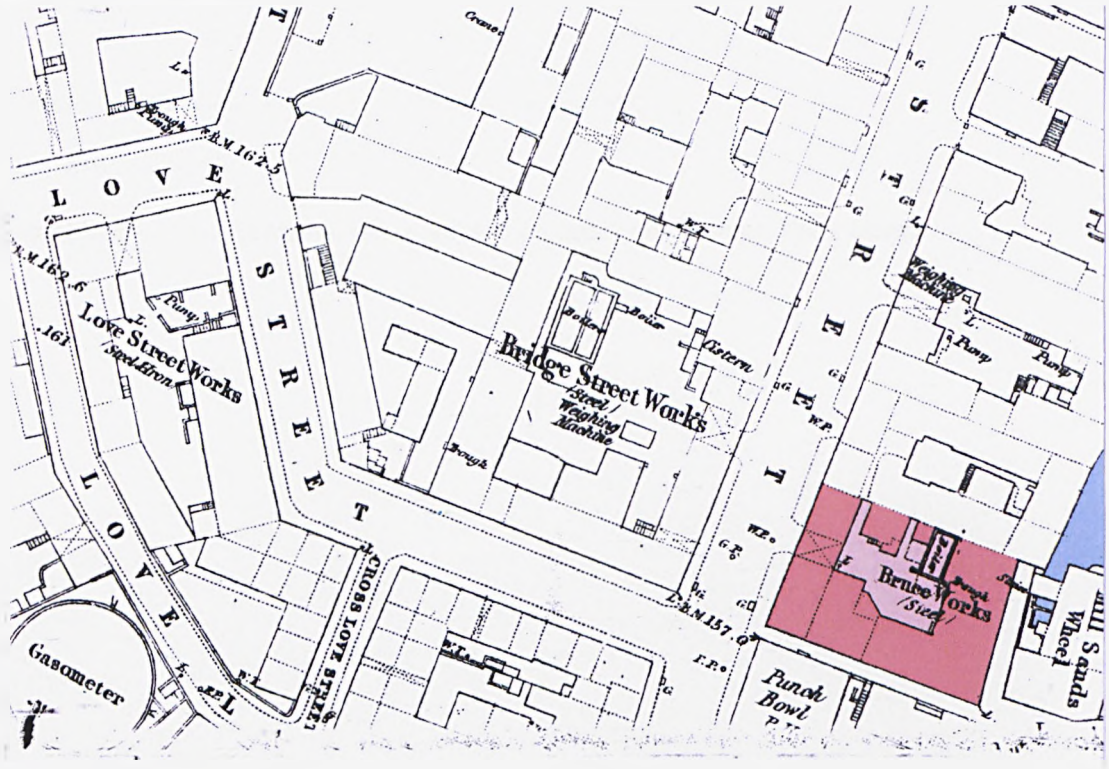
CP-25-(32) (watermark 1828) 'Ellin & Co., 10 horse by Boulton & Watt, Cylinder 18in, Stroke 4 ft., 25 dbl./min., 10 lbs./sq. ft. (say 11½ hp)'.

Visual sources: View: "The Industries of Sheffield" p. 48, SCL Archives n.d.

View: (possible) Hawley C104 (Lockwood Bros. / John Sorby & Sons, 1 Sylvester St.)

Extant: part of grinding wheels / workshops to side lane; partly demolished / converted in 2001.

26 Bruce Works



Location: Bridge Street
OS grid (x,y): 435539,387859

Owner/occupier: Gallimore

Date built: 1830s

Date demolished/closed: not known

Wheel type: private

Associated works: engineering

Storeys: 3

Length (m): 13.26
Width (m): 7.13
Ground floor area (m²): 95
Total floor area (m²): 283

Troughs: not known

Engine power (h.p.): 10 (later 20.5)
Engine maker: not known
Boilers: single, waggon?

Water source: Town Mill goit (or well?)

Sources:
NB30 (1830) p. 26 'Mem: To fix what Jno. Gallimore in the Mill Sands ought to pay for his Engine say of 20 Horse Power upon the same principle [as Chadburn & Co., Nursery Wheel]. Also what he should pay for the land he has taken from the River'.

p. 66 'Calculation of Water rent for steam engines charged by the Wicker Wheel Co.

Chadburn & Wright	28 hp	£5
Younge & Smith	10 hp	£3
	38	£8

Upon the above principle, Gallimore's Engine which is of 20 Horse Power should pay £4 4s. 0d. per An. Should pay 20s. per yard for the 24 yards of land taken from the river'.

NB30 (1830) p. 68 'Copy of note left at the office of J. F. & Son, 3mo. 11 1830. J. Marshall called to say that he does not consider that he has the least right to pay for water to the Inginge [sic] of Mr. Gallimore's as he draws it from a Well below the Engine in his own Premises the same as Jno. Revill [of the sugar house] does and returns all into the river

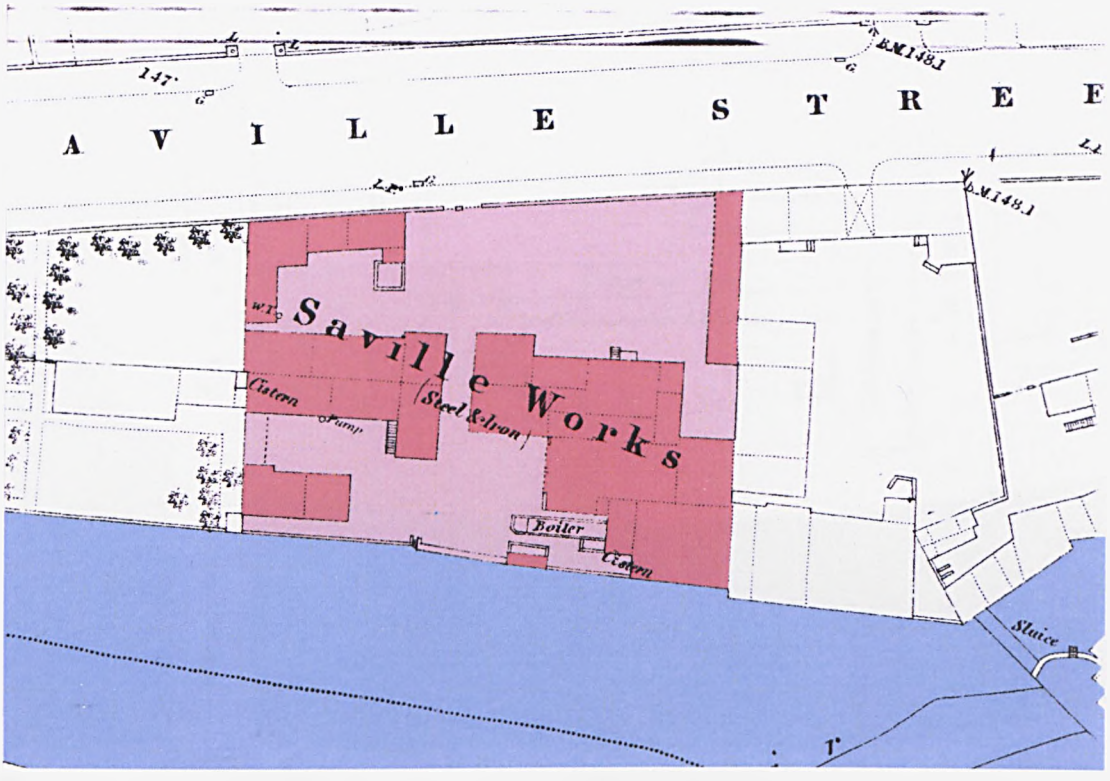
warm having had those places on lease from the Duke with the right of Water for what was wanted on them. Why don't they charge for the great many Barrels lead with the Town which never goes back into the Tilt Dam. Gave the original to Jno. Brown at Parker & Brown'.

Visual sources: View: E Bu 117 S [Vickers vs. Gallimore].

Plan: MB 394, p.19.

Extant: sub-surface remains, recorded and probably now entirely demolished.

27 Saville Works



Location: Saville Street
OS grid (x,y): 436177,388140

Owner/occupier: Stuart, Smith & Co. (later Spear & Jackson)

Date built: pre-1832

Date demolished/closed: not known

Wheel type: private

Associated works: foundry, sawmills (later edge tools)

Storeys: 2

Length (m): ?
Width (m): ?
Ground floor area (m²): ?
Total floor area (m²): ?

Troughs: not known

Engine power (h.p.): not known
Engine maker: not known
Boilers: 1, wagon

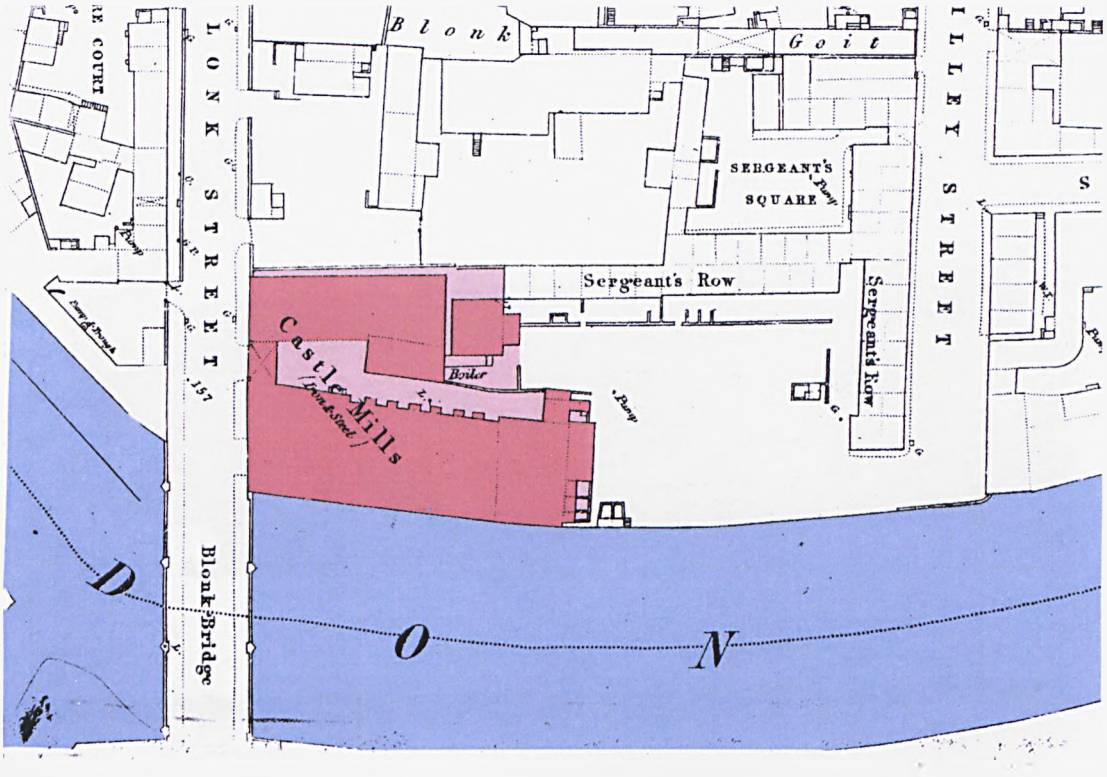
Water source: River Don

Sources:
CA VB2 Sanderson's Survey, Brightside valuation (1832).
no. 51 Stuart, Smith & Co., Saville St., Richard Stuart [own.] Stuart, Smith & Co. [occ.]: Saville Works, Grinding Wheel & Engine Ho., 8 perches; Foundry, 4 perches; ... Richd. Stuart, House, Saville Street, 4 perches'.

CA VB4 Henry Sanderson, Brightside valuations (1838) p. 17: 'Spear, Jackson & Co., Saville St., Steel Furnaces, Warehouses, Workshops, Furnaces, Shed & Yards', g.e.r £121 10s. [400 in rate book].

Extant: part of works, later sawmills; possibly unrelated to grinding wheels.

28 Castle Mills (Tower Wheel)



Location: Blonk Street
OS grid (x,y): 435861,387797

Owner/occupier: Marshall Bros. (later Osborn)

Date built: early 1830s

Date demolished/closed: early 20th century

Wheel type: public

Associated works: saw mills?

Sources: see chapter 4.

Storeys: 4

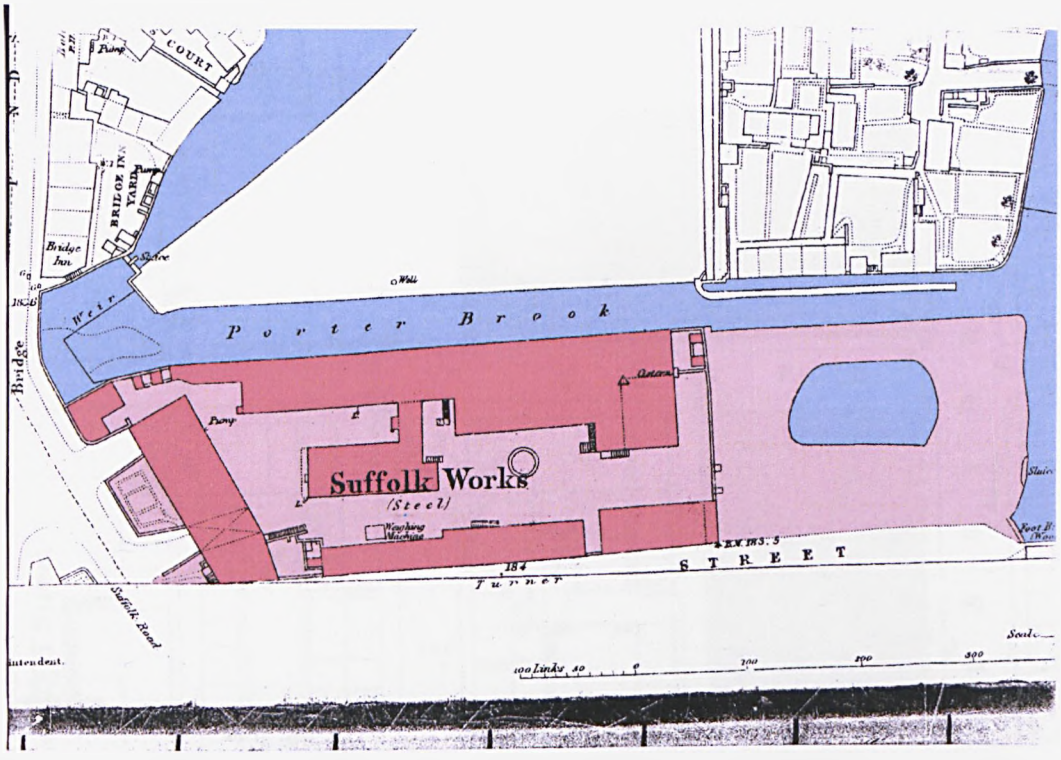
Length (m): ?
Width (m): ?
Ground floor area (m²): ?
Total floor area (m²): ?

Troughs: not known

Engine power (h.p.): not known
Engine maker: not known
Boilers: not known

Water source: River Don

29 Suffolk Works



Location: Suffolk Road
OS grid (x,y): 435777,386802

Owner/occupier: Turner & Johnson

Date built: 1830s

Date demolished/closed: not known

Wheel type: private

Associated works: steel, cutlery

Storeys: 3.5

Length (m): 24.32, 14.08
Width (m): 13.21, 5.85
Ground floor area (m²): 404
Total floor area (m²): 1413

Troughs: not known

Engine power (h.p.): 40
Engine maker: PW
Boilers: not known

Water source: reservoir (Porter Brook)

Sources:
MB399 p. 5, engine 40 h.p., 3½ storey wheel (i.e. garret space--see dormers in images). Additional buildings MB399 p. 35.

Flockton valuations, Book 2, p. 15, includes reservoir 'very large & costly'.

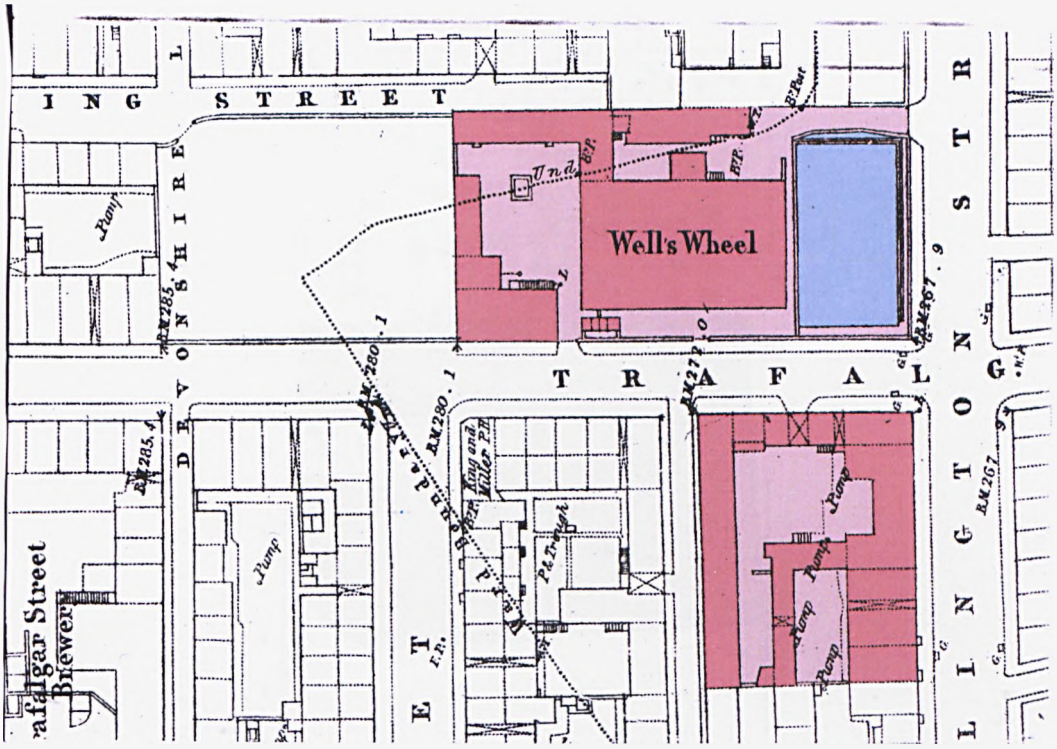
Visual sources: View: General Directory of Sheffield 1856, 18A ads.

View: Illustrated Guide to Sheffield 1879, p. 265.

View: Whites 1876, ads. p. 38.

Extant: nothing.

30 Wells' Wheel



Location: Trafalgar Street
OS grid (x,y): 434974,386989

Owner/occupier: Wells, S & H

Date built: 1833

Date demolished/closed: not known

Wheel type: semi-public

Associated works: cutlery

Storeys: 4

Length (m): 24.59
Width (m): 15.28
Ground floor area (m²): 375.74
Total floor area (m²): 1503

Troughs: not known

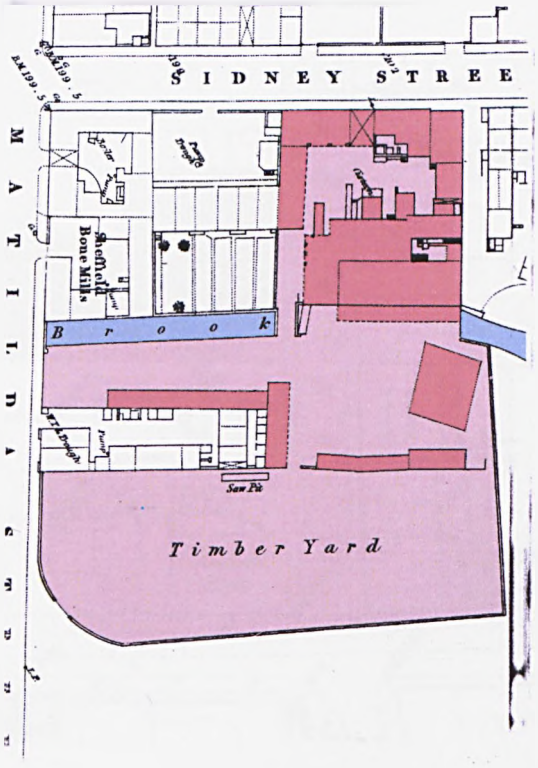
Engine power (h.p.): 25 (Fv)
Engine maker: not known
Boilers: not known

Water source: reservoir

Sources:
Visual sources: View: Hawley CAT2123a (frontispiece, c.1911).

Extant: part of south wall to full height of building, attached to later 'Kangaroo Works'. Includes iron ties, beams for jack-arch vaults, window openings. Space of yard where wheel stood, now occupied as car park.

31 Sidney Street



Location: Sidney Street
OS grid (x,y): 435515,386691

Owner/occupier: Smith, J.

Date built: 1837

Date demolished/closed: not known

Wheel type: semi-public

Associated works: sawmills, wood turning

Storeys: 4

Length (m): 22.40
Width (m): 7.96
Ground floor area (m²): 178
Total floor area (m²): 713

Troughs: not known

Engine power (h.p.): 14 (16 Fv)
Engine maker: not known
Boilers: single, waggon

Water source: reservoir (Porter Brook)

Sources:
FB240 (1836) p. 15 (also see SheS447S) 'Lots of William Ashmore and Joseph Smith'.

NB27 (n.d.) n.p. survey of the grinding wheel and house, showing boiler, engine and stack positions. Also lists the various equipment powered by steam (grinding, buffing, ivory and wood cutting with circular saws, bone button making, wood turning).

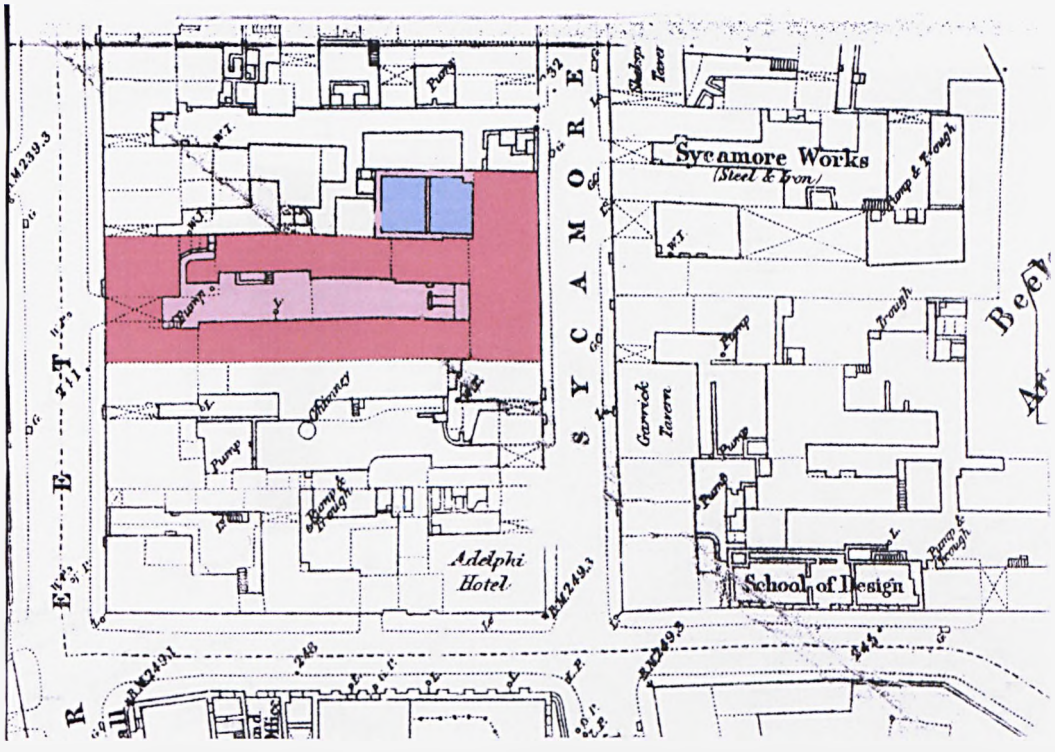
Visual sources: View: P&B Illustrated Guide 1879, p. 81.

Plan: MB 394, p. 45 (1837).

View: (possible) Hawley C270.

Extant: nothing.

32 Rodgers Sycamore Street



Location: Sycamore Street
OS grid (x,y): 435592,387275

Owner/occupier: Rodgers & Son

Date built: c.1834

Date demolished/closed: 20th century

Wheel type: private

Associated works: cutlery

Storeys: 3, 2

Length (m): 17.46, 6.10
Width (m): 15.09, 8.69
Ground floor area (m²): 263.47, 53.01
Total floor area (m²): 896

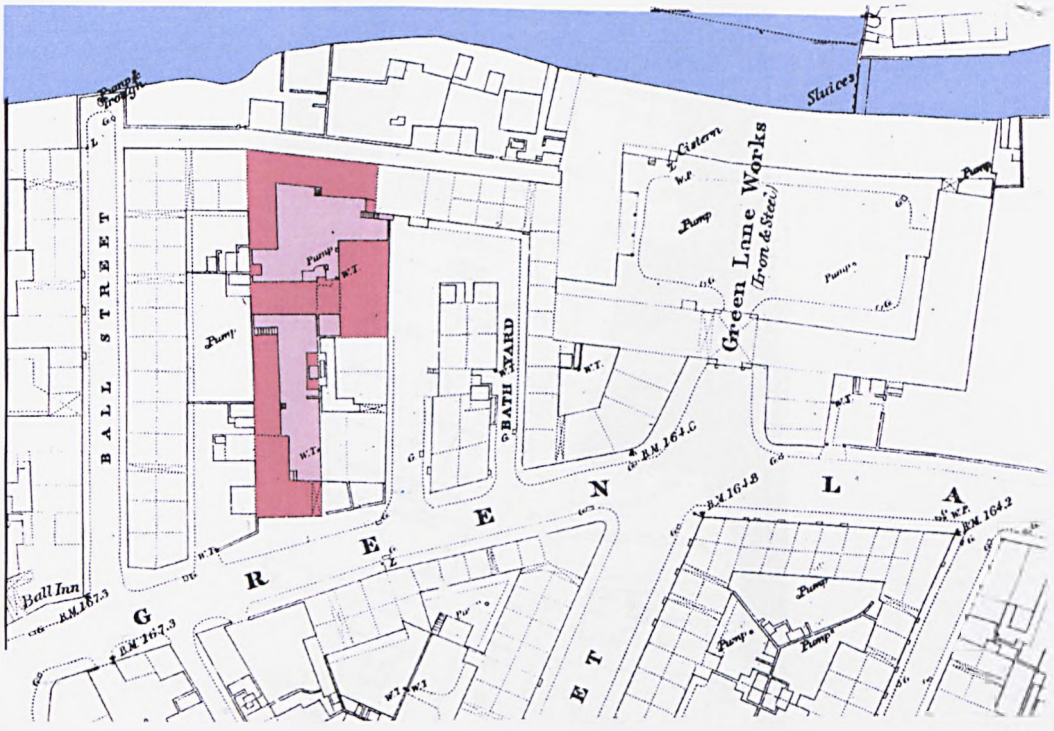
Troughs: 30 (3H, 7L, 10 pen, 10 razor)

Engine power (h.p.): 14-16
Engine maker: Peel Williams
Boilers: not known

Water source: reservoir

Sources: see chapter 4.

33 Milner, Green Lane



Location: Green Lane
OS grid (x,y): 434971,388232

Owner/occupier: Milner, John

Date built: not known

Date demolished/closed: not known

Wheel type: private

Associated works: cutlery?

Storeys: 3, 4

Length (m): 8.69, 6.13
Width (m): 7.08, 7.04
Ground floor area (m²): 61.52, 43.16
Total floor area (m²): 357

Troughs: not known

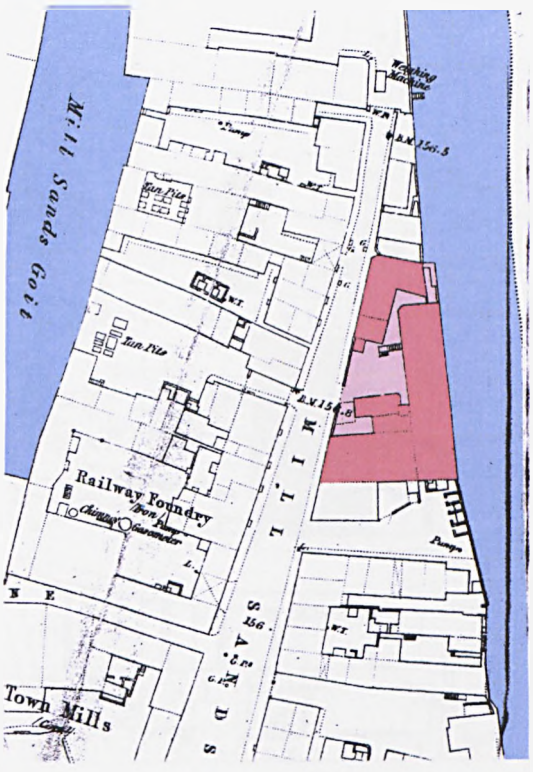
Engine power (h.p.): 6
Engine maker: not known
Boilers: not known

Water source: River Don

Sources:
Visual sources: Plan: MB 395, p. 23 (1836).

Extant: nothing.

35 Millsand Mills



Location: Millsands
OS grid (x,y): 435618,387909

Owner/occupier: Frost, Samuel

Date built: not known

Date demolished/closed: not known

Wheel type: private

Associated works: cutlery?

Storeys: 2?

Length (m): ?
Width (m): ?
Ground floor area (m²): ?
Total floor area (m²): ?

Troughs: not known

Engine power (h.p.): not known
Engine maker: not known
Boilers: not known

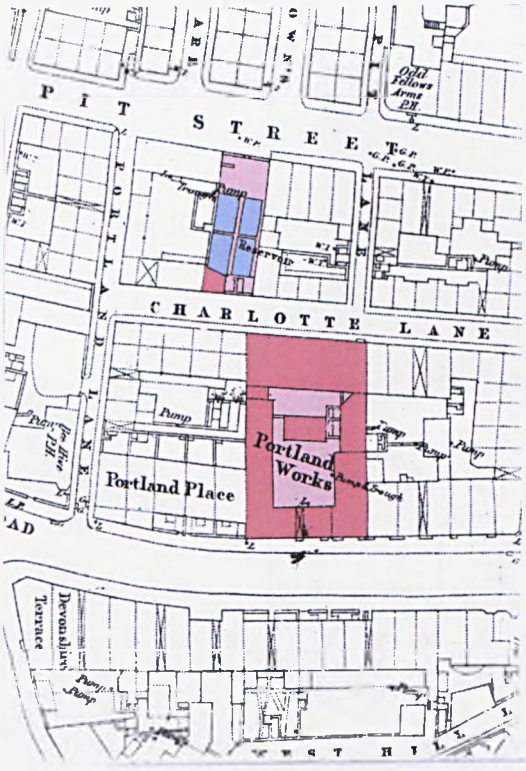
Water source: River Don

Sources:
Robson (1839) p. 784: 'Walker, S., Mill Sand Mills, Mill La., & 59 Bridge St.', probably the same wheel.

Visual sources: View: (possible) Hawley CAT 1270, Kenyon & Co., Millsands Works.

Extant: nothing.
Built on the site of John Marshall's workshops, yard and houses, see SheS 1495L (1781).

36 Portland Works



Location: Glossop Road
OS grid (x,y): 434719,387190

Owner/occupier: Smith & Sons

Date built: c.1836

Date demolished/closed: not known

Wheel type: private

Associated works: saw-making

Storeys: 3?

Length (m): 20.17
Width (m): 8.60
Ground floor area (m²): 173.46
Total floor area (m²): 520?

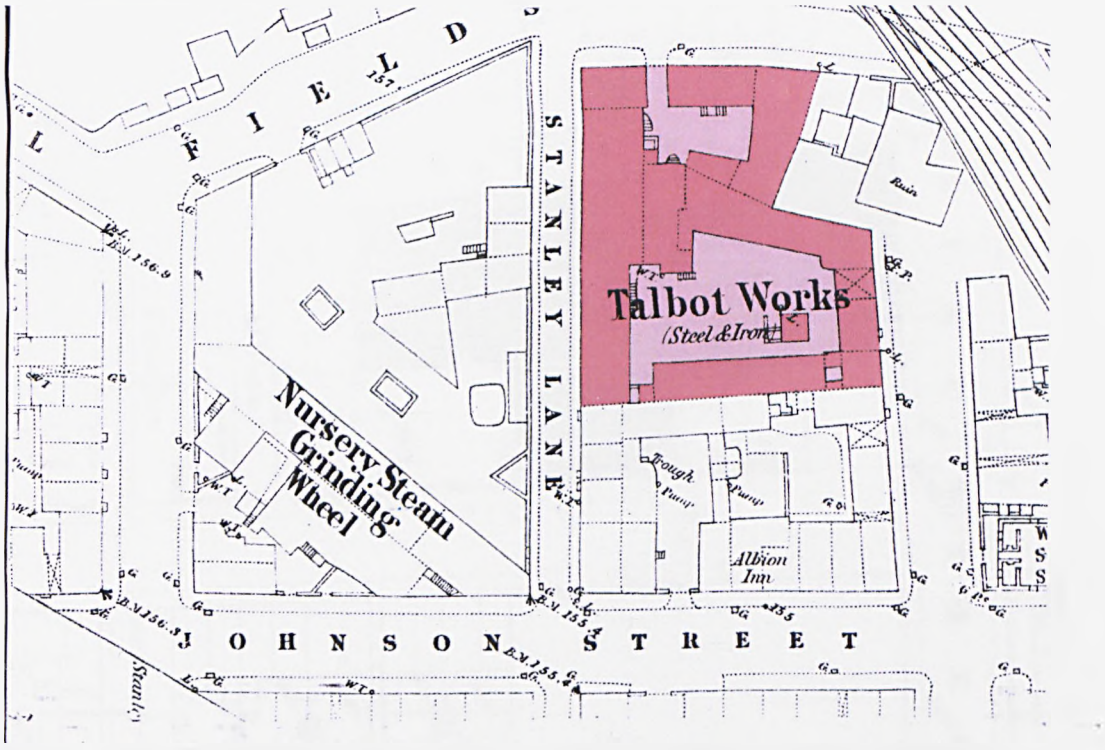
Troughs: not known

Engine power (h.p.): not known
Engine maker: not known
Boilers: not known

Water source: reservoir

Sources: Fairbank valuations, see chapter 4.

37 Talbot Works



Location: Spital Fields
OS grid (x,y): 435729,388133

Owner/occupier: Hunter, Michael

Date built: not known

Date demolished/closed: not known

Wheel type: private

Associated works: cutlery, steel

Storeys: 3

Length (m): 19.27
Width (m): 7.53
Ground floor area (m²): 145.11
Total floor area (m²): 435

Troughs: 24H, 3L, 21 bands, 2 saws

Engine power (h.p.): 21* (Fv)
Engine maker: not known
Boilers: not known

Water source: well

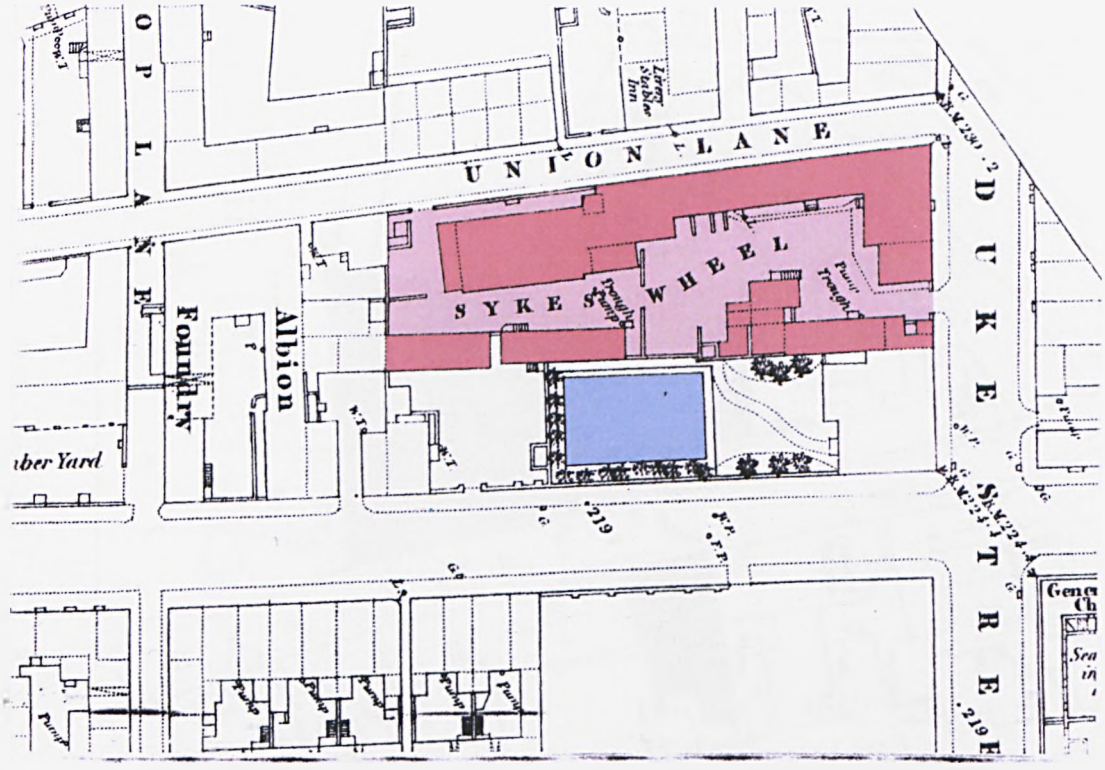
Sources:
CA VB4 Henry Sanderson, Brightside valuations (1838) p. 36: 'Michael Hunter, Spital Fields, Workshops, Warehouse, Grinding Wheel, Counting House &c'. g.e.r. £99 [545 on map, 834 in rate book].

SYCRO 141/B Flockton valuations (c.1843-45) p. 131: '[Railway, Sheffield-Chesterfield to Meersbrook] no. 89 Michael Hunter: Grinding Wheel, 3 stories, 63.0x25.0, £500; Workshops, 3 stories, 55x18.9, £350; Engine House &c. £100; Steam Engine 21hp, Boilers & Mach. £1000; 24 Heavy Troughs, 3 Light Troughs, 21 Bands & 2 Circ. Saws; Damage to remaining bdgs.'; also p. 255 (30 May 1856) including 'Grinding wheel with one floor arched in brick, 3 stories... brick & wood frames for 30 Troughs; two wells for water supply'.

Visual sources: interior of steam hammer shop (P&B ill. guide).

Extant: nothing.

38 Sykes' Wheel



Location: Duke Street
OS grid (x,y): 435251,386711

Owner/occupier: Sykes, Jno.

Date built: not known

Date demolished/closed: not known

Wheel type: semi-public

Associated works: cutlery?

Storeys: 3

Length (m): 14.63
Width (m): 7.77
Ground floor area (m²): 114
Total floor area (m²): 341

Troughs: not known

Engine power (h.p.): 16
Engine maker: not known
Boilers: not known

Water source: reservoir

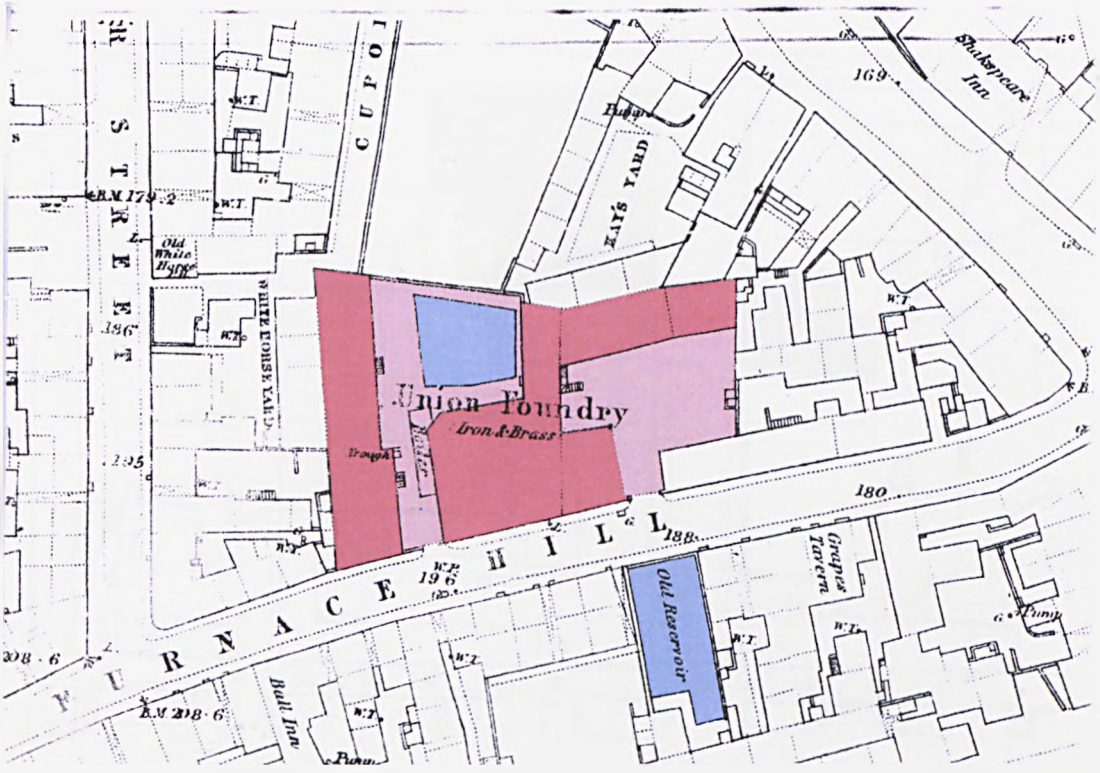
Sources:
NB30 (1830) p. 72, plan with 'Sykes' Freehold' and 'Newton's Freehold, let to Mr. Sykes at £11 5s. 0d. p. year rent from Michs. 1804 for 99 years'. [either side of Eyre St. along Duke St.]

Visual sources: Plan: FB237 (9 Oct.1837) p. 78: 'Mr. Sykes' Premises in Eyre Street'; [bb2:60].

Plan: (partial) MB 394, p. 49 (1837).

Extant: nothing.

39 Union Foundry



Location: Bridge Street
OS grid (x,y): 435170.387855

Owner/occupier: Hudson & Clarke

Date built: before 1834

Date demolished/closed: not known

Wheel type: private

Associated works: iron foundry

Storeys: 3

Length (m): ?
Width (m): ?
Ground floor area (m²): ?
Total floor area (m²): ?

Troughs: not known

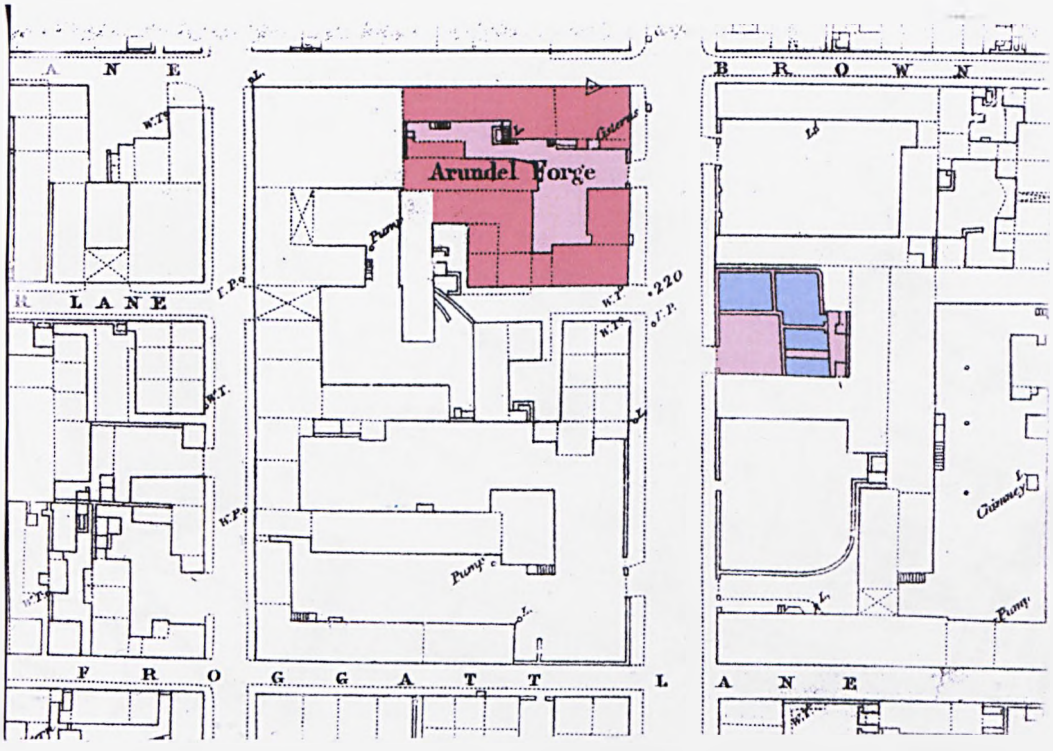
Engine power (h.p.): not known
Engine maker: not known
Boilers: not known

Water source: reservoir

Sources:
Visual sources: MB393 (1835) pp. 34-35, includes a plan of the foundry dated May 4; MB 394, p.55.

Extant: grinding wheel / part of stack.

40 Arundel Forge



Location: Arundel Street
OS grid (x,y): 435497,386873

Owner/occupier: Raworth, J B (later W & S Butcher)

Date built: not known

Date demolished/closed: not known

Wheel type: semi-public (later private)

Associated works: edge tools?

Storeys: 3

Length (m): 6.26
Width (m): 5.30
Ground floor area (m²): 33
Total floor area (m²): 100

Troughs: not known

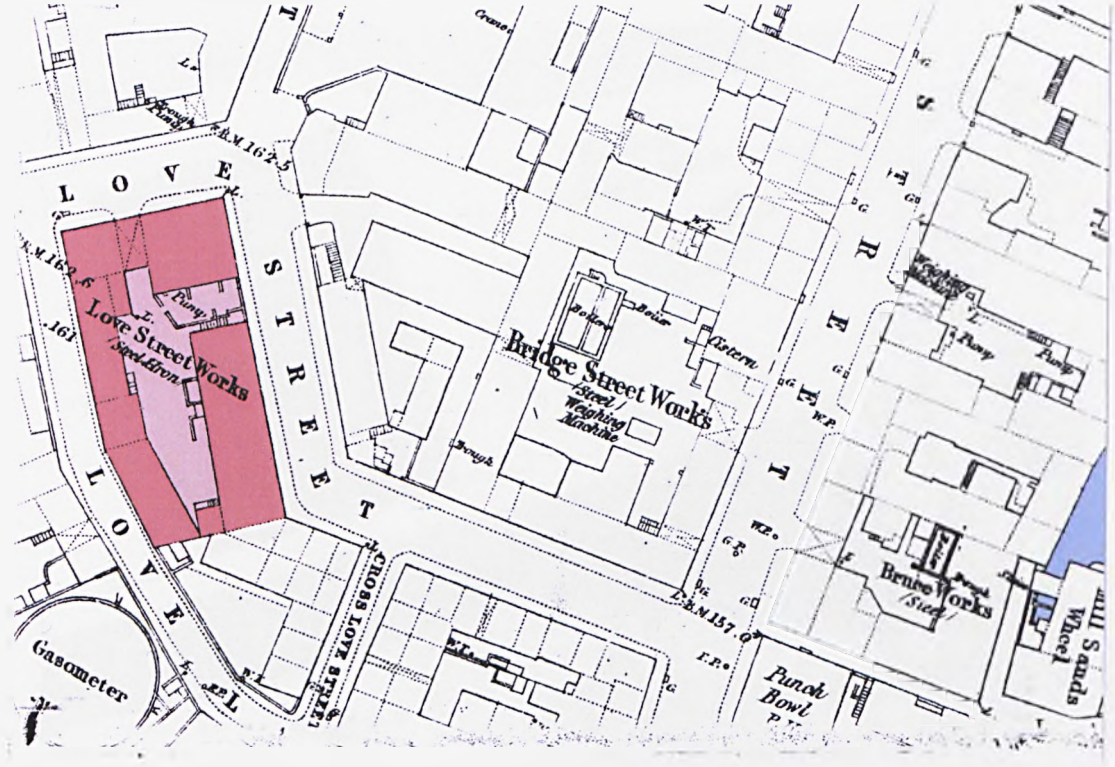
Engine power (h.p.): 8
Engine maker: not known
Boilers: not known

Water source: reservoir

Sources:
Visual sources: Plan: MB 398, p. 4 (1836).

Extant: original grinding wheel building integrated in later Butcher's Wheel complex, with three storey elevation to lane. See chapter 4.

41 Love Street Works



Location: Love Street
OS grid (x,y): 435453,387840

Owner/occupier: Radcliff, Geo.

Date built: not known

Date demolished/closed: not known

Wheel type: private

Associated works: steel, cutlery?

Storeys: 3

Length (m): 17.74
Width (m): 7.32
Ground floor area (m²): 130
Total floor area (m²): 390

Troughs: not known

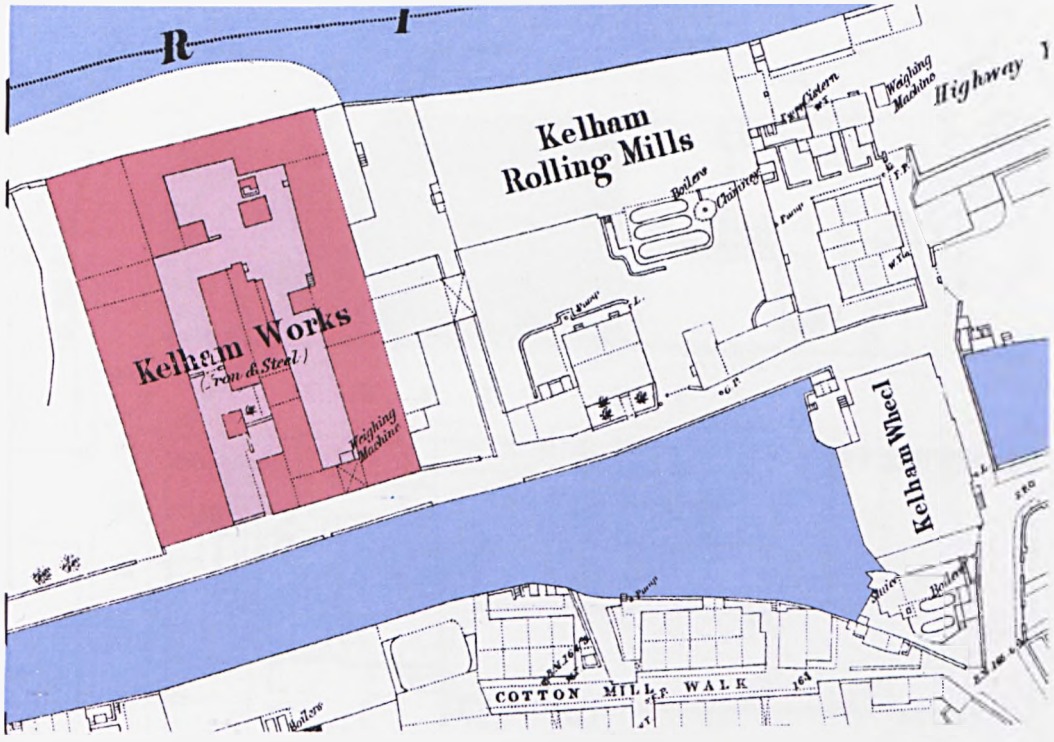
Engine power (h.p.): 10
Engine maker: not known
Boilers: not known

Water source: not known

Sources:
Visual sources: Plan: MB 393, p. 74 (1835).

Extant: nothing.

42 Kelham Works



Location: Kelham Island
OS grid (x,y): 435218,388208

Owner/occupier: Crowley & Pearson

Date built: not known

Date demolished/closed: not known

Wheel type: private

Associated works: iron & steel foundry

Storeys: 2

Length (m): 19.02
Width (m): 6.95
Ground floor area (m²): 132
Total floor area (m²): 264

Troughs: not known

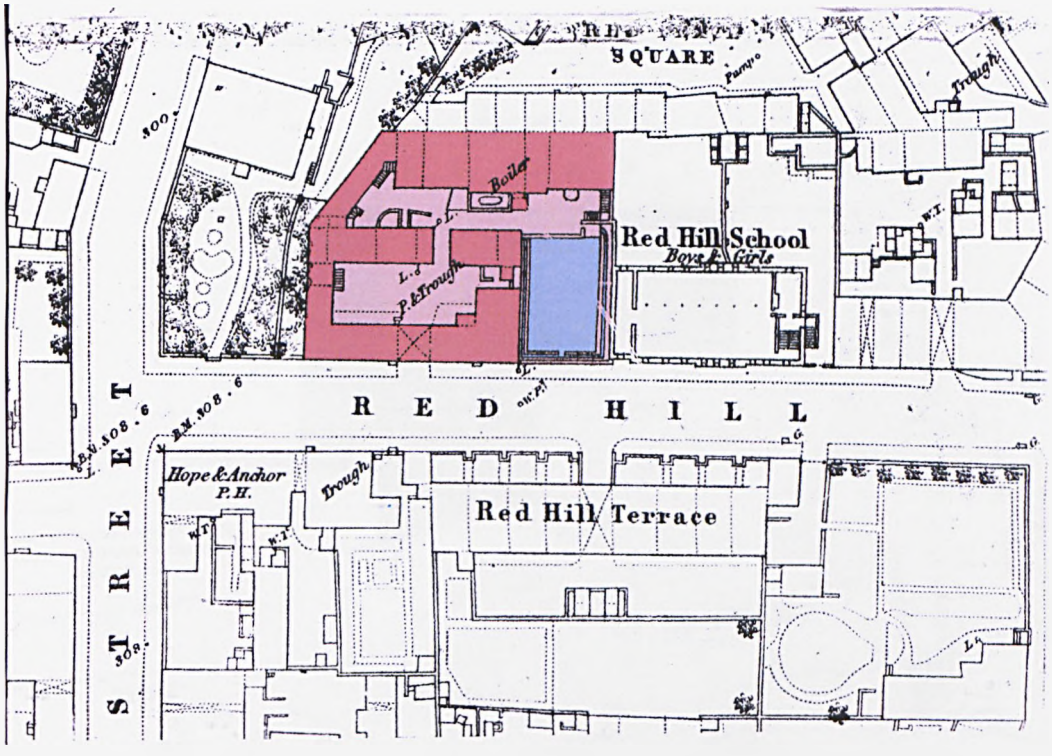
Engine power (h.p.): 9
Engine maker: not known
Boilers: not known

Water source: River Don

Sources:
Visual sources: Plan: MB394, p. 12, p. 22.

Extant: possibly some fabric survives as part of Kelham Island Industrial Museum.

43 Red Hill Works



Location: Red Hill
OS grid (x,y): 434765,387542

Owner/occupier: Horrabin, W & S

Date built: not known

Date demolished/closed: not known

Wheel type: private

Associated works: cutlery

Storeys: 3

Length (m): 15.36, 7.86
Width (m): 5.82, 6.63
Ground floor area (m²): 141.51
Total floor area (m²): 425

Troughs: not known

Engine power (h.p.): 10 (proposed)
Engine maker: not known
Boilers: (1)

Water source: reservoir

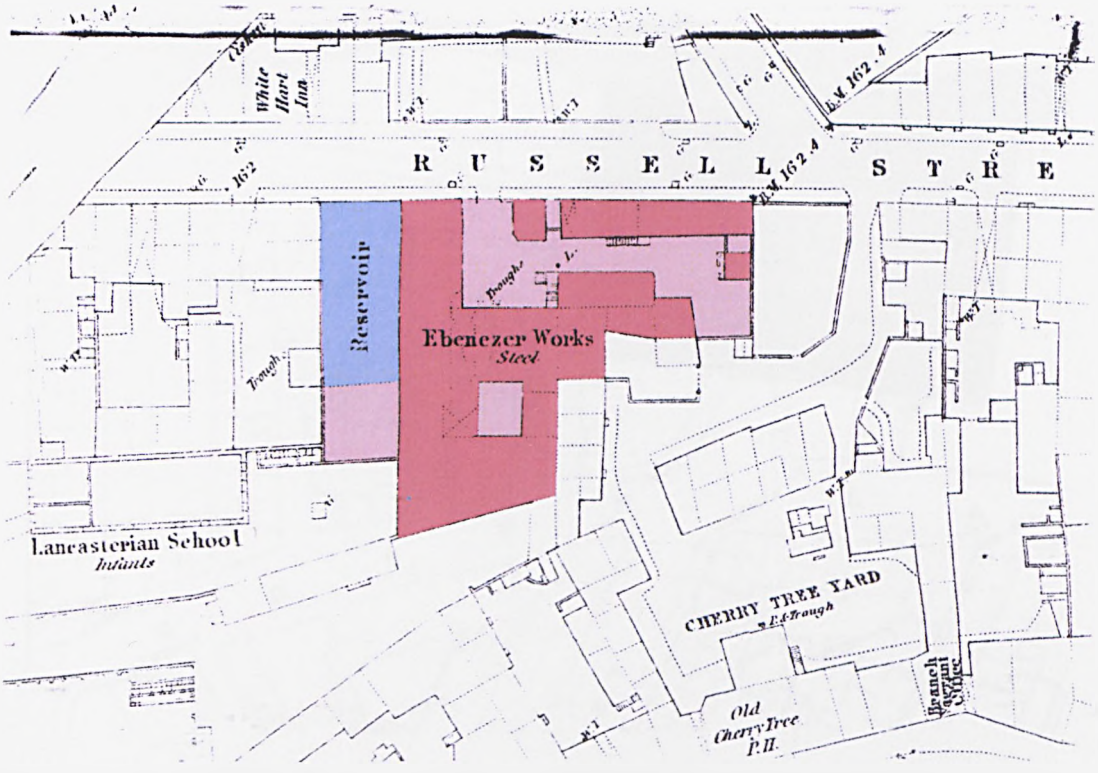
Sources:
Site prior to erection of grinding wheel surveyed in NB31 pp. 26-27 (6 Aug. 1834) 'Horrabin's Warehouses &c.'; shows 'vacant ground 364 yd.' adjoining with a pencil outline of the proposed reservoir, and the notes 'for reservoir' and '10H Engine will be fixed'.

Visual sources: Plan: FB 237 (1837) p. 80: 'Horrabin's Red Hill';

Plan: Sale Plan 26 Feb. 1878;

Plan: NB31 pp. 26-27 (1834).

44 Ebenezer Works



Location: Russell Street
OS grid (x,y): 435190,388022

Owner/occupier: Drabble & Sanderson

Date built: not known

Date demolished/closed: not known

Wheel type: private

Associated works: saws, steel

Storeys: 3

Length (m): 12.44
Width (m): 6.77
Ground floor area (m²): 84
Total floor area (m²): 253

Troughs: 22 (16 L, 5 saw, 1 file)

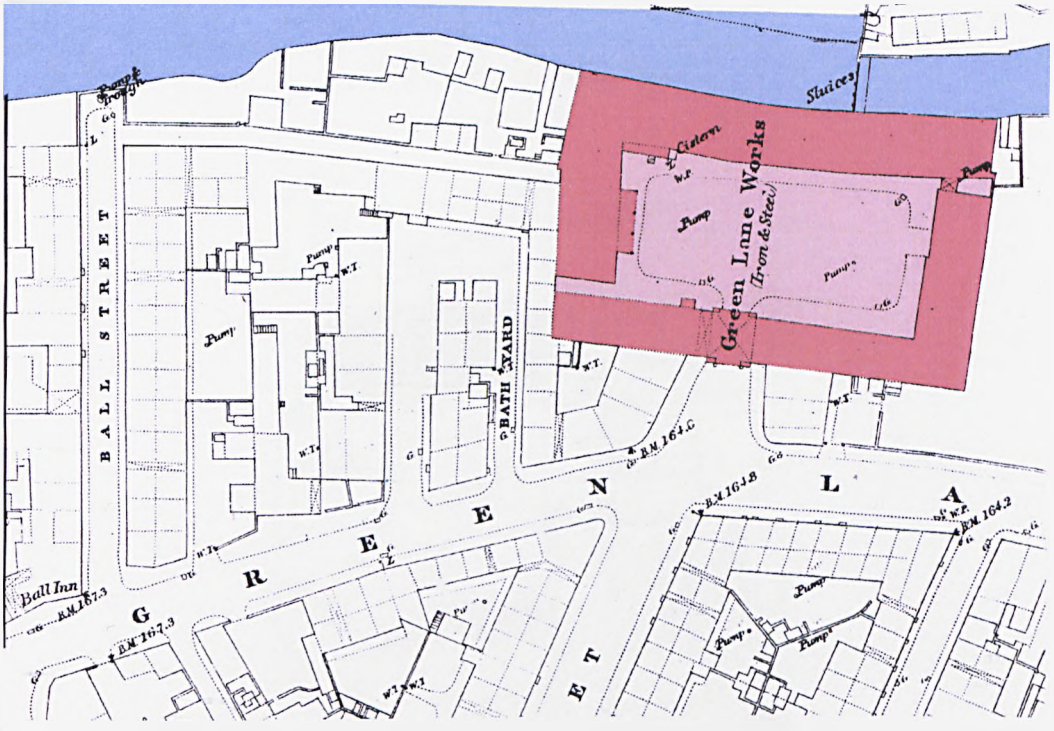
Engine power (h.p.): 10
Engine maker: not known
Boilers: not known

Water source: reservoir

Sources:
Visual sources: Plan: MB395, p. 19 (1836).

Extant: nothing

45 Green Lane Works



Location: Green Lane
OS grid (x,y): 435040,388226

Owner/occupier: Nicholson & Hoole

Date built: not known

Date demolished/closed: not known

Wheel type: private

Associated works: iron foundry, stove grates

Storeys: 3

Length (m): 13.13
Width (m): 8.09
Ground floor area (m²): 106
Total floor area (m²): 319

Troughs: not known

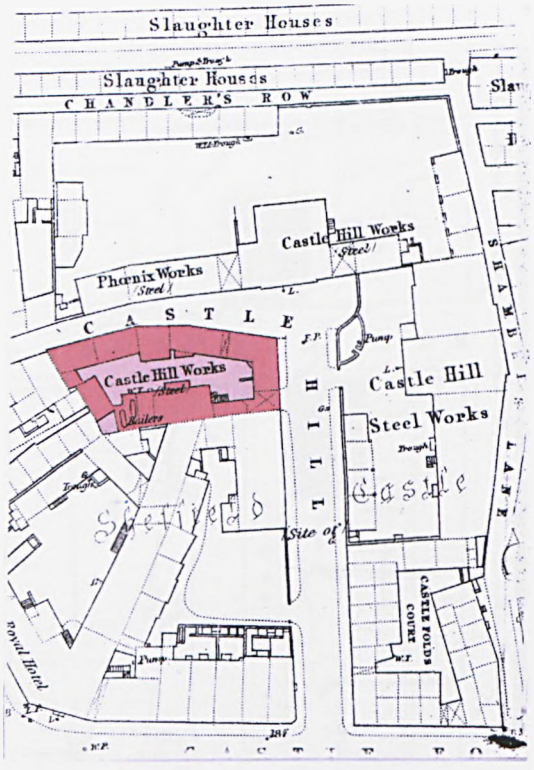
Engine power (h.p.): 10
Engine maker: not known
Boilers: not known

Water source: River Don

Sources:
Visual sources: Plan: MB 394, p. 23; photographs in Cox (1978) passim.

Extant: part of later rear range of grinding wheel / workshops to river, with internal engine house.

46 Castle Hill Works



Location: Castle Hill
OS grid (x,y): 435762,387683

Owner/occupier: Steer, Geo. & Wm.

Date built: not known

Date demolished/closed: not known

Wheel type: private

Associated works: steel, cutlery?

Storeys: 2?

Length (m): ?
Width (m): ?
Ground floor area (m²): ?
Total floor area (m²): ?

Troughs: not known

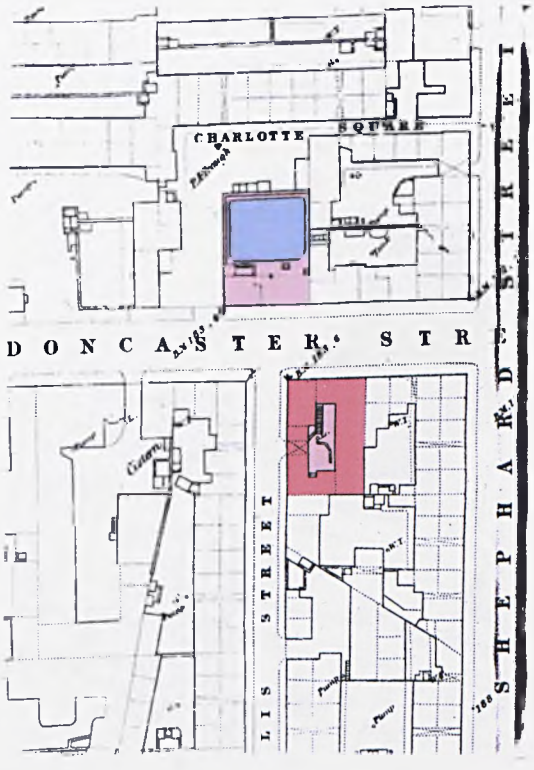
Engine power (h.p.): not known
Engine maker: not known
Boilers: not known

Water source: well?

Sources:
Visual sources: none known.

Extant: nothing.

47 Ryalls Doncaster Street



Location: Doncaster Street
OS grid (x,y): 434882,387929

Owner/occupier: Ryalls, Matt.

Date built: not known

Date demolished/closed: not known

Wheel type: private

Associated works: cutlery?

Storeys: 3

Length (m): 19.93
Width (m): 4.57
Ground floor area (m²): 91
Total floor area (m²): 273

Troughs: not known

Engine power (h.p.): 8
Engine maker: not known
Boilers: not known

Water source: reservoir

Sources:
Visual sources: Plan: MB 393, p. 17 (1835).

Extant: nothing.

48 Phoenix Foundry

Location: Furnace Hill
OS grid (x,y): 435076,387799

Owner/occupier: Longden, Henry & Sons

Date built: not known

Date demolished/closed: not known

Wheel type: private

Associated works: iron foundry

Storeys: 2

Length (m): 5.58
Width (m): 4.30
Ground floor area (m²): 24
Total floor area (m²): 48

Troughs: not known

Engine power (h.p.): 10 [as Fv]
Engine maker: PW?[Flav.]
Boilers: not known

Water source: reservoir

Sources:
Visual sources: Plan: MB 393, pp. 26-27 (1835);

Copper currency token.

Extant: nothing.