A photographic record of a water-powered wire-works at Thurgoland, Yorkshire

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ABSTRACT: Photographs of Thurgoland Upper Wire Mill, Yorkshire, taken between 1898 and 1913, are reproduced. The text provides a commentary, and outlines of the history of the mill, and of wire drawing using wortle plates.

Introduction

The photographs

In the journal *Engineering* for April 18 1913, Percy Longmuir and Joseph Kenworthy published 'Notes on early wire-drawing practice'. These were illustrated by photographs of the Upper Wire Mill, frequently referred to locally as 'Old Mill', at Thurgoland on the Yorkshire Don (SE 278005). The South Yorkshire Industrial History Society holds photographs of this mill, recently found to include those used by Longmuir and Kenworthy. The selection reproduced below complements the photographs which were published in 1913. The photographer is believed to have been Frank Downing, a local man, who started recording buildings in the district about 1898 (information from Maurice Williams, Thurgoland Historical Society).

Percy Longmuir (1873–1942) was a Sheffield metallurgist, a specialist in foundry practice. He was author of, *inter alia*, a contemporary metallurgical text-book (1905) and was manager of the Stocksbridge steelworks of Samuel Fox during the 1914–18 war (obituary in *The Sheffield Telegraph* 19 October 1942). Joseph Kenworthy (1852–1929) worked for Samuel Fox from 1865 to 1907, but is best known as a local historian, publishing a history of Stocksbridge in 33 instalments between 1914 and 1928. There survives, outside this series, what appears to be a marked proof for an article, shown by its content to have been written after 1915 and entitled 'Wire drawing: an ancient craft in Thurgoland and district'; it refers to these wire-works and is accompanied by prints of some of the same set of photographs (Sheffield Archives (subsequently SA) MD 3336/4). It is not known whether the article was ever published.

Methods of wire drawing

The making of copper-alloy wire by the use of a draw-plate is known from the Viking period (Armbruster 2006, 32–33). The process was recorded by Theophilus in the 12th century (Hawthorne and Smith 1979, 88) and there are references to wire drawers in Augsburg in the 1350s (Heine 1995, 50). In medieval England wire was required for wool-cards, used for raising the nap on cloth, and there are references to wire-drawing and wortle (draw) plate makers in the textile town of Coventry in the 1430s (Harris 1907–1913, 142, 160, 181–5). In 1540, Biringuccio (Smith and Gnudi 1990, 377–81) mentions the drawing of iron wire, and illustrates a process where the drawer sat on a swing seat,

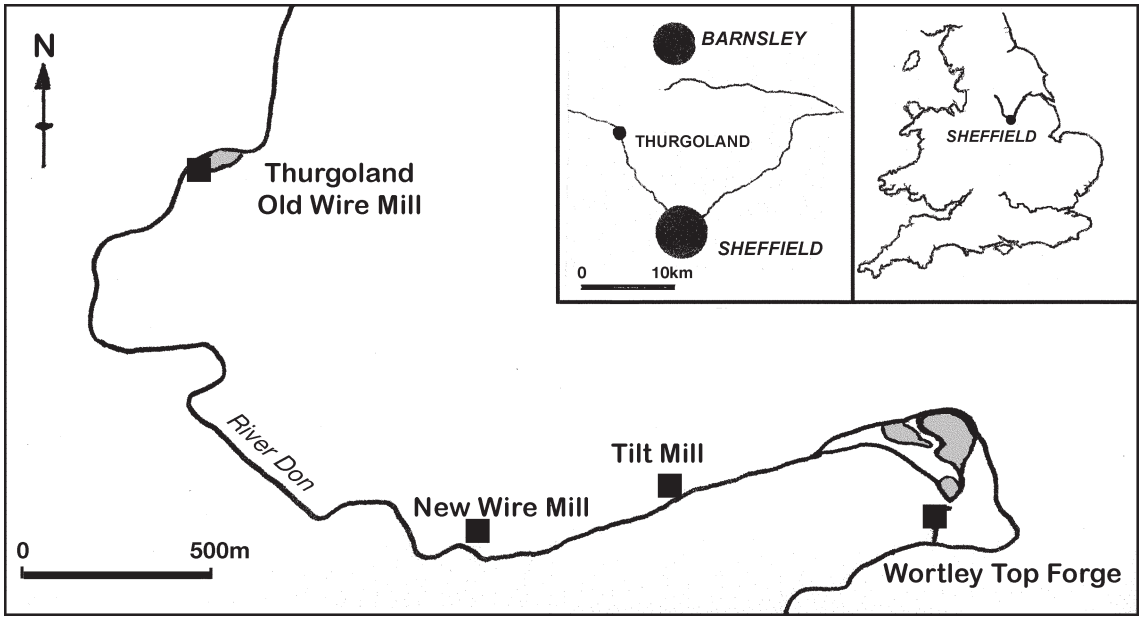

Figure 1: Location of Thurgoland and the wire mills.

his belt linked by a strap to the crank of a water-wheel shaft. He gripped the wire with tongs, pulled it through the draw-plate as he was pulled back by the crank, then swung forward with the motion of the crank, re-gripped the wire and was pulled again as the shaft and crank turned. An earlier German reference (*c* 1425) appears to relate to such a method (Heine 1995, 50). The draw-plate technique was essential for the production of long lengths of wire of uniform diameter, in contrast with forging, using swages, used for short lengths, and rolling, where strict uniformity of section was not essential.

In the 16th century the growing textile industry required wool-cards in quantity. The first-known water-powered wire-mill in Britain drawing ductile wrought ('osmond') iron was at Tintern, Monmouthshire, operated by the Mineral and Battery Company from 1556, and documented through to its closure in the middle of the 19th century (Paar and Tucker 1975, 11; Pickin 1982, 1–4; Rees 1968, 389ff). The industry became wide-spread, and the introduction of high-carbon crucible steel in the 18th century provided a material of a quality particularly suitable for the wire drawer, who required homogeneity for a strong and uniform product, particularly when supplied to the makers of needles.

From the 16th century onwards, wire was made at Barnsley (Longmuir and Kenworthy 1913). Angerstein gives a particularly full account of practices there, notably the use of horse-gins to draw the wire, seen on his tour of 1753–5 (Berg and Berg 2001, 214–216). Elsewhere in the region, a number of water-powered wire-mills came into use in the 18th and 19th centuries, particularly along the Yorkshire river Don and its Sheffield tributaries (Ball *et al* 2006).

Thurgoland Old Wire Mill

An example of a mill producing wire for needle-making was the Old Wire Mill at Thurgoland, a Wharncliffe estate property on the upper Don approximately 15 km NW of Sheffield (Fig 1). This was one of three wire mills in the parish, the others being Tilt Mill and New Wire Mill. Angerstein writes of one wire mill upstream from Wortley Forges, perhaps Old Wire Mill (Berg and Berg 2001, 208). The date of the original building of this mill is suggested as 1624, from a date-stone visible in the 19th century, but missing by 1913 (Longmuir and Kenworthy 1913, 542; Andrews 1950, 43).

A rating valuation of 1838 shows George Jubb as tenant (SA 3/RD 13/1), although a Wharncliffe estate valuation of *c* 1832 had shown the mill as empty, not valued (SA Wh.M 683). Jubb must have taken the mill soon after, for he appears there in the 1838 Sheffield Directory (White 1838, 251). He was in possession in 1850, when there is a description of Old Mill, a 'large building with water wheel in good repair, 9 feet fall, *c* 15 hp' (SA Wh.M 654), and 1852 (White 1852, 476). Longmuir and Kenworthy (1913) suggest that the mill which appears in the photographs, and of which elements still survive in residential use, dates from a comprehensive rebuilding of about 1850. This is clarified by a note in a Wharncliffe rental which shows that major work was carried out in 1858, for which the tenants, now John and George Jagger, appear to have borrowed money from the estate (SA Wh.M 657).

J. & G. JAGGER,
OLD WIRE MILLS,
THURGOLAND, NEAR SHEFFIELD,
MANUFACTURERS OF
CAST STEEL WIRE
FOR SEWING MACHINE NEEDLES,
AND FOR ALL KINDS OF NEEDLES,
FISH HOOKS & SPRINGS,
GIMLETS, AWL BLADES, &c.
240

Figure 2: Jaggers' advertisement in White's Sheffield Directory of 1868, 240.

In 1908 Kenworthy interviewed George Jagger, who recounted the experiences of his grandfather, also George, working at Old Mill (d 1884; copy of will in Barnsley Archives A1877/F). John and George Jagger (Fig 2) are recorded at Old Mill in a rating valuation for 1875 (SA 3/RD 13/1). Jaggers appear in Sheffield Directories for 1868 (White 1868, 404), 1883 (Kelly 1883, 419) and 1922 (Kelly 1922, 886). Frank Jagger was tenant when Old Mill, still water powered (Fig 3) ceased operation in 1926, when it was sold by the Earl of Wharncliffe (*Sheffield Star* 28 July 1960: interview with Frank Jagger). There is no evidence of subsequent use as a wire-mill: it is not listed in the 1927 and subsequent directories, and the building is said to have been derelict in 1990 (*Sheffield Telegraph* property guide 10 March 1995, 65), prior to residential conversion.

No water-powered wire-mills survive in Britain, either in use or protected, but in Germany a Westphalian example has been re-erected at the open-air museum at Hagen (freilichtmuseum-hagen@lwl.org) where many of the features recorded at Thurgoland have parallels (Fig 6).

Wire drawing at Thurgoland

Wire was drawn from lengths or coils of high-carbon steel rod, which was rolled to 8–10mm diameter and annealed. The Jaggers' advertisements show that they used cast (*ie* crucible) steel. The wire drawer drew out, cold, the end of a rod with his battering hammer (Fig 10), and filed it to a taper to fit through the bench-mounted steel draw plate, known as a wortle plate. Longmuir and Kenworthy (1913) cite wortle plates made from puddled steel about 1860, in the period when this short-lived process of steel making was used in Sheffield (Barraclough 1971).

When threaded through a hole in the wortle plate, the end of the rod was gripped in heavy-jawed dogs (Fig 10). These were attached to a chain-and-ratchet device, so that enough wire could be drawn to be attached to the power-driven drum (block), which was mounted on a heavy cast-iron framework driven by gearing from the water wheel (Figs 4, 5, 6). The first stage of drawing began. The speed of the take-up block was crucial and the wire was lubricated by being passed through a leather bag filled with soft soap. The coil of drawn wire was removed from the block, placed on the swift—a tapered

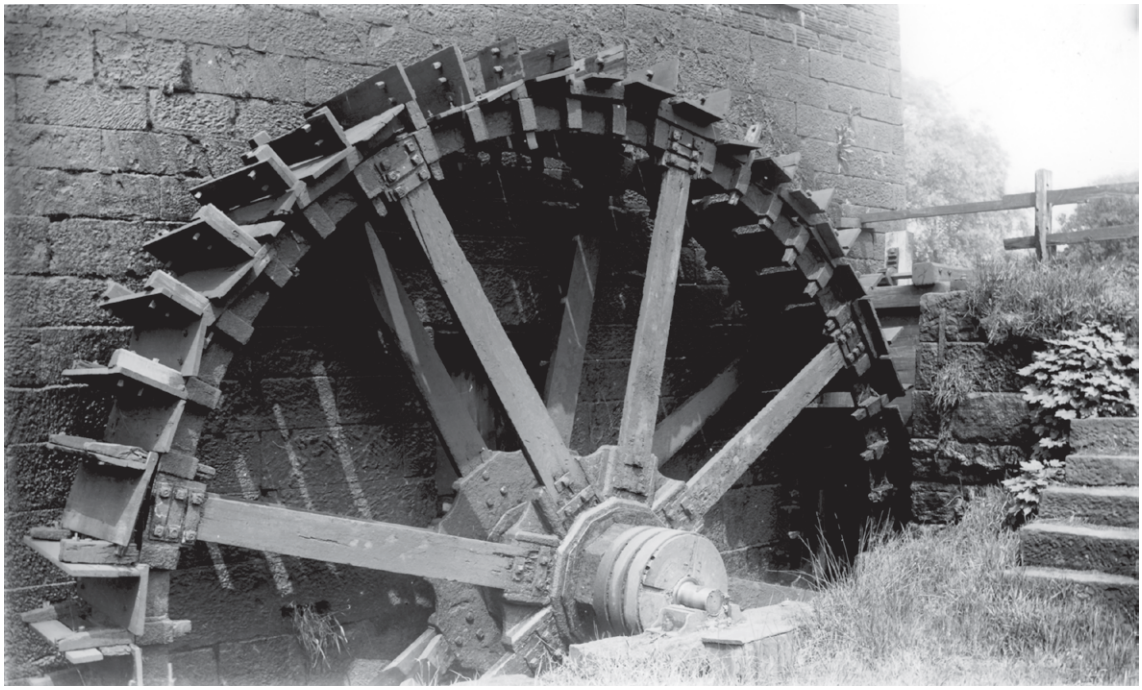

Figure 3: Exterior of Thurgoland Old Mill wire works, showing low-breast water wheel.

Figure 4: This interior view shows most of the equipment required for drawing steel wire by water power. The wire-drawing bench has three blocks (drums) with wire in position. An empty swift is on the floor near the far end of the bench. A wortle plate, of typical shape with drawn neck, rests on edge on the nearest end of the bench, and the ends of two more are just visible on the floor, partly out of the photograph, in the foreground. Another wortle plate is set up on the bench beyond the nearest drum. Clamps, in which wortle plates could be fixed, are fitted along the edge of the bench. The drive shaft from the water wheel is concealed within the bench, but an encased vertical drive shaft to benches on the floor above can be seen at the right hand of the image, near the end of the bench. Below this casing, close to the floor, and to the left of the two wortle plates, a clutch pedal is just visible, controlling the drive to the blocks.

Figure 5: The wire-drawing bench in Fig 4, from a different position at a different time, showing weighing scales and weights in the foreground, a barrel of soft soap near the left-hand end of the bench, and coils of wire.

rotating frame (Figs 4, 5, 6, 11), and drawn again on to a block, through a smaller hole in the wortle plate.

The wire was work-hardened by drawing, so it had to be annealed after a number of passes through the plate. Annealing took place in the back of a coal-fired furnace, in reducing conditions creating by closing the furnace doors (Fig 7). The coil of wire was then dipped

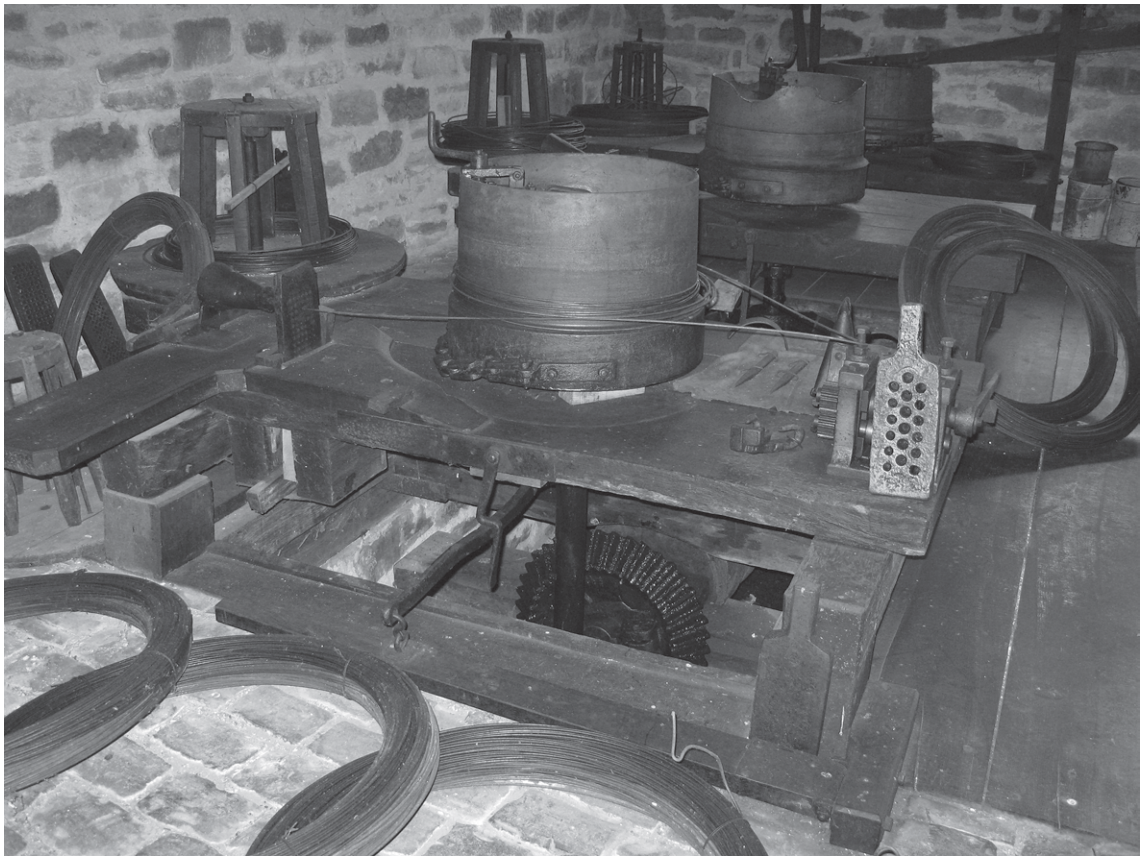

Figure 6: Interior of a reconstructed German wire mill at Hagen, Westphalia, showing wire being taken from a swift (to the left) through a draw plate and then taken up on a drum driven by the bevel gearing of the water-powered drive. A spare draw plate can be seen propped up at the right-hand front corner of the bench. Two further sets of wire-drawing equipment are visible in the background.

in an acid-bath to dissolve scale and was then scoured in a 'rumbler', a drum (Fig 8) containing, according to Longmuir and Kenworthy, blast-furnace slag, or some other available abrasive material such as beach pebbles, with which it was rotated at about 30 rpm for 12–24 hours. For finishing, it was common practice in wire works in the Sheffield area to use soft soap and pumice in the rumbler. At Thurgoland and elsewhere in the region, the rumbler was driven from a shaft geared to the water-wheel. This contrasts with mid-18th-century

Figure 7: Annealing furnaces. The closed doors can just be made out in the lower part of the shadows.

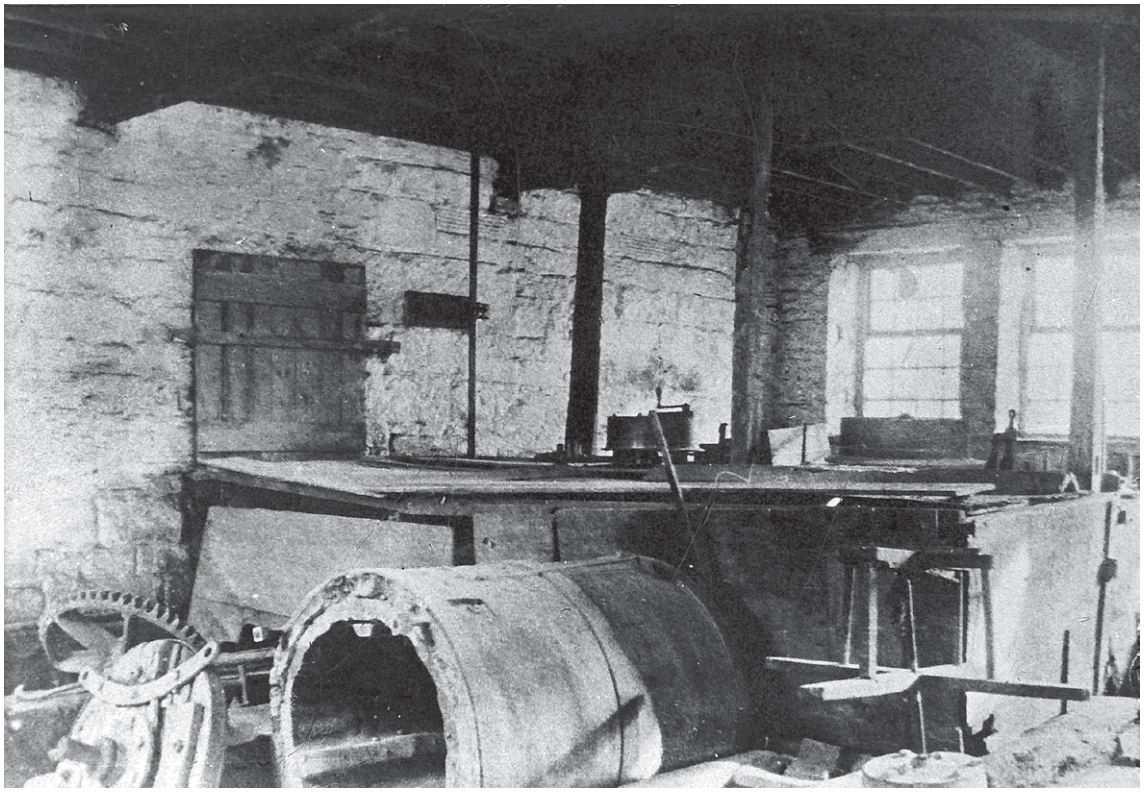

Figure 8 : This is the only photograph in the collection to show a rumbler, the horizontal barrel or drum in the foreground, in which wire was placed for de-scaling. This would rest on and be driven by rollers powered by the drive from the water wheel. An empty swift is prominent in the right foreground.

Figure 9: Reels of wire, coated with lime after annealing, drying outside the mill.

practice at Abercarn, South Wales, where Angerstein shows a scouring-drum incorporated in the hub of a water-wheel (Berg and Berg 2001, 156). In Kenworthy's 1908 interview with George Jagger, the latter described three rumblers in operation, up to 1907 (SA MD 3336/4). After scouring, the wire was dipped in lime to remove traces of acid. The coils of wire were dried, either near the annealing furnace or outside the mill (Fig 9). The process of drawing and annealing was repeated several times, the wire being reduced by about one gauge per

pass, until it reached the final diameter, which, for needle wire, could be accurate to within 0.08mm.

The accuracy of the holes punched through the wortle plate was crucial to precision in wire drawing, despite the absence of micrometers before *c* 1860 and their rarity until the beginning of the 20th century. The hardened-steel plate (Figs 4, 5, 6, 10), generally about 200mm by 100mm by 20mm thick, was forged under a power hammer by the wortle-plate pricker, who drew down the neck to allow it to be gripped with tongs. The pricker used a conical punch (Fig 10) to form blind holes in the hot plate. The depth of these depressions was usually 3–4mm less than the thickness of the plate. The wire drawer punched through the remaining steel, when cold, with parallel-sided punches (Fig 10), which he himself made (information from John Howden, wire drawer at William Smiths, Beulah Road, Sheffield, *c* 1980). The

Figure 10: Left to right: dog for gripping wire during the first stage of drawing; two wire-drawer's punches; wortle plate; wortle plate pricker's punch; battering hammer. Scale 100mm. (Hawley Tool Collection).

Figure 11: This is thought to be the first-floor wire-drawing shop at Thurgoland Old Mill. Blocks can be seen on the bench to the left, filled with wire, and empty swifts are prominent. The small bench on the right is probably for the hand-drawing of fine wire.

holes in the plate would wear with use, and had to be re-sized. They were partially closed by cold working, using a round-ended battering hammer about 700gm in weight (Fig 10). The plate was placed on an anvil and forged around the holes, reducing their diameter. The holes were then re-sized using the wire drawer's punches. There was a considerable range of sizes of plates, blocks and swifts, depending on the product, but the principles were the same, even for the finest of wire (Fig 11).

A problem faced by the wire drawer was the tendency for the product to form a set, a slight curve, when coiled. A simple way to straighten or 'kill' this was to pass the wire across a board into which was driven a line of nails (Figs 12 and 13). The wire was threaded zig-zag through this line of nails and drawn through, so that any set was removed. This was effective for small diameter wire, but for larger diameters rollers were used instead of nails. Longmuir and Kenworthy noted that this procedure could also be used for de-scaling wire.

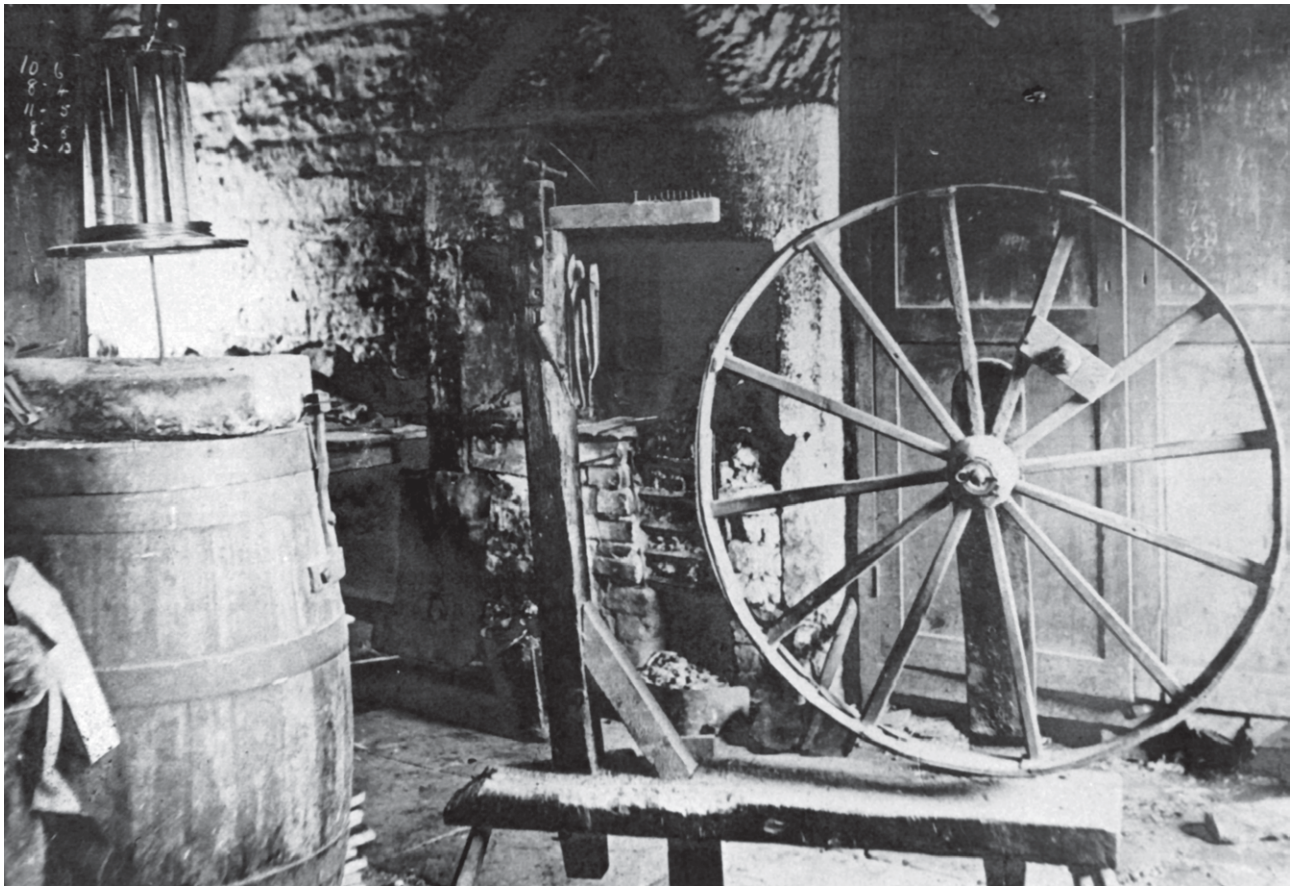

Figure 12: Device for straightening (killing) wire. On the right is a large-diameter hand-turned wheel on to which wire was wound. It was drawn off the swift on the left, between the nails driven into the upper surface of the short horizontal board fixed to the vertical post (centre of the image). It is just possible to make out the nails driven into this board.

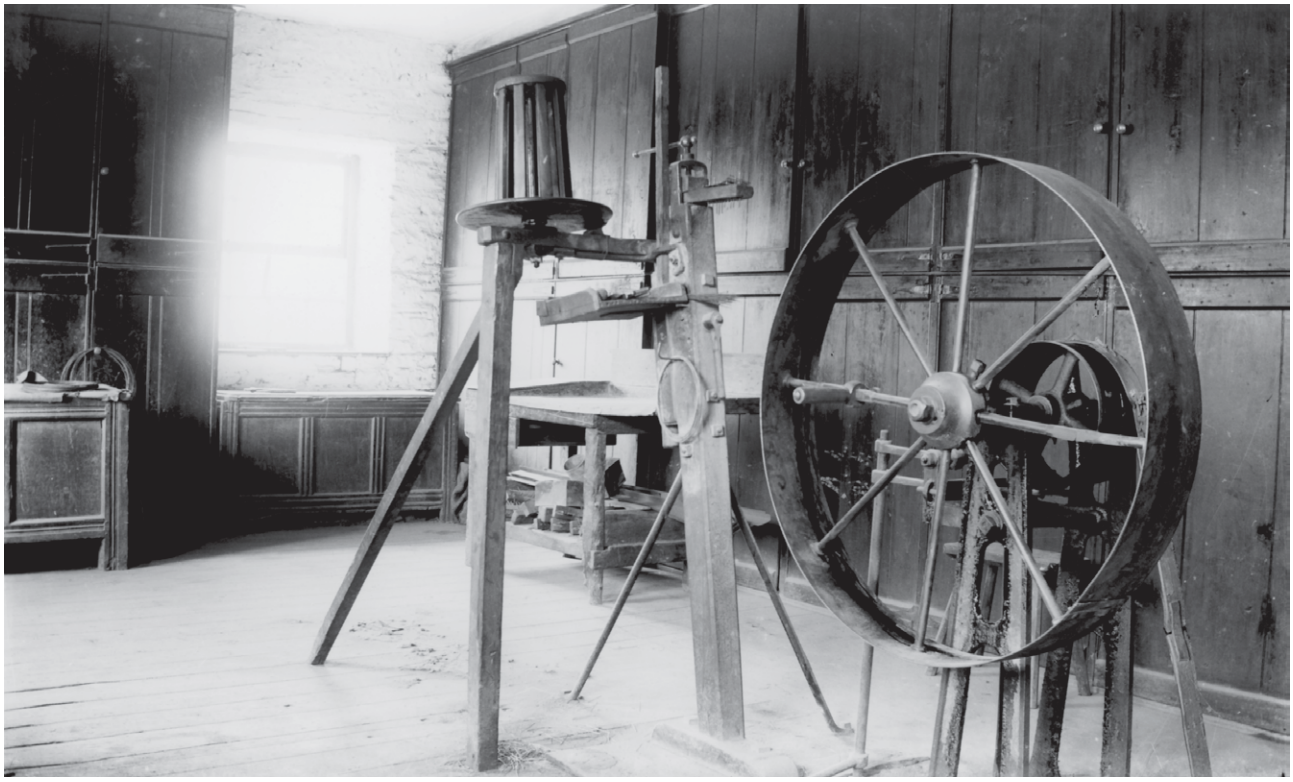

Figure 13: Another straightening device, whose take-up wheel is driven by a belt from the floor below.

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Ken Hawley is founder of the Hawley Tool Collection, about to be housed in Kelham Island Industrial Museum, Sheffield. He was custodian of Wortley Top Forge for 40 years.

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