Water Power in Mining: **Papers presented at the National Association of Mining History Organisations' Conference at Aberystwyth, 5-8 July 2002.**
Mining History: **The Bulletin of the Peak District Mines Historical Society. Volume 15, No. 4/5, 2004.**

SMALL STREAMS OF WATER THE WATER RESOURCES ON GRASSINGTON MOOR

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Abstract: In the early 1820s John Taylor, as the Duke of Devonshire's Mineral Agent, considered using a steam engine to drain the Coalgrovebeck Mine on Grassington Out Moor. Instead, however, he built a large waterwheel and used it to drive pumps rods which ran to the shaft, some 280 metres away. In doing so, he established a system which, over time, drove pumps in four shafts before being converted to wind kibbles in seven shafts. Because of the distances involved, the mine was an early user of wire ropes for winding. The network of dams, leats and reservoirs was extended to include a number of mechanised dressing floors and five more pumping/winding wheels. Water-powered mechanisation was used at Grassington until the mines closed in May 1880.

Introduction

This paper examines the use, to great effect, of water power during the last 60 years of the 275-year recorded history of lead mining at Grassington. Equally importantly, it also seeks to look at the system in the context of the mines being served.

The mines are mostly on a gently sloping area of moorland and rough pasture between 1000 and 1400 feet above sea level (Gill 1993). The principal oreshoots were found in the Top and Bearing Grit, which were respectively 6 and 12 fathoms thick, and the top 10 fathoms, or so, of the Middle Limestone, which underlay them. These beds (and the veins) outcropped at the western side of the moor but dipped beneath an increasing cover of barren shale as they ran eastwards. Proximity of the limestone gave the shallower workings some relief from water but the absence of a convenient valley from which to drive an adit meant that mining at Grassington was compelled to be from shafts. For convenience, the area will be dealt with in two main parts: the Out Moor and Yarnbury, in the Old Pasture

It is first necessary to understand why water power had not been used at Grassington before. Until 1774 it was a private, customary liberty with miners working a number of meers, each 30 yards long, on the vein of their choice (Gill 1998). A typical mining landscape with runs of (fairly) shallow shafts developed (Gill 2000). Whilst good for proving and working the outcrops of veins, this system restricted miners to one vein and prevented them crosscutting to find new ones. In time, therefore, the mines were starved of the investment necessary for working them below the water table. Attempts to remedy this in 1774 by replacing the customary laws with fixed-term leases and greatly extending the quarter cord, or sideways limit of working, failed and the mines became moribund. In view of these constraints, therefore, large-scale undertakings, such as building dams and watercourses either for power or hushing, were impossible.

The Duke of Devonshire, as mineral owner, tried to encourage the miners by starting the Duke's Deep Level from Hebden Gill in 1796. This was horizontal and large enough (nine feet high by five feet wide) to be used as an underground canal which would drain the mine and convey all the stuff to the surface. This resolutely stupid idea meant that it took 20 years to reach the Yarnbury Veins and the level was only 4987 feet long by January 1818, when the Duke of Devonshire appointed John Taylor as his Mineral Agent with orders to sort matters out.

The Out Moor

Taylor's plans required a series of surface dams, with interconnecting leats. The first was at Priest Tarn, which was enlarged in 1821 by building three low earth dams across the col in which it lies. Priest Tarn formed the core of a system supplying water to small dressing floors on the western part of the Out Moor.

The Duke's Level was 2560 feet short of the Coalgrovebeck Mine on the Out Moor, so Taylor dismissed the idea of ever using boats in it and reduced its size to the normal "six feet above the rails". In 1755 the Coalgrovebeck Company had asked William Brown, a colliery viewer from Newcastle, to build a horse-whim for pumping their mine (William Brown's Letter Book, pp. 137-140). Using this, what became Coalgrovebeck Engine Shaft reached a depth of about 58 fathoms before its pumps were overwhelmed and abandoned. Taylor realised that, by fixing pumps in the Engine Shaft, he could drain the workings and sink it to the 72 fathom or adit level, thus gaining nearly 10 years. He also considered using a steam engine to drive the pumps but instead he built a large waterwheel and used it to drive pumps rods which ran to the shaft some 920 feet away. He later wrote that "I collected together some small streams of water into extensive reservoirs, erected a waterwheel of fifty feet in diameter, and in two or three years the mines were actively working, and some of them were profitable" (Taylor 1837). In doing so, he established a system which, over time, drove pumps in four shafts before being converted to wind kibbles in a total of seven shafts.

Little was done until February 1820, however, when the cast iron pumps were carried from the canal wharf at Skipton to the mine. A busy year then ensued in which the wheel house and pit (the Brake House) were built and water courses were dug. Like subsequent pits for large wheels it was lined with dry-stone walling backed with clay. In 1821 the Brake House wheel was built and the wheel house was thatched with ling from Barden Fell to protect it from the weather. A short tunnel, driven from the pit, took the waste water into a channel leading to Coalgrovebeck. The first of the three Blow Beck dams was also built and linked by the Duke's Low Watercourse to a reservoir in Sand Haw Gill and the Coalgrovebeck Mine.
Little now remains of the Brake House except the wheel pit, which is filling with debris and often flooded. The house was built from coarse, thin-bedded stone quarried nearby. When Arthur Raistrick measured the Brake House wheel axle in the

1950s he stated that it was 3 feet 6 inches across the flats and came down to 2 feet 6 inches. It had been mounted on a stone bearing-block, which was highly polished, and there was no obvious means of lubrication (Raistrick 1953-5).

From 1821 to 1823, work focussed on underground development, with refurbishment of four old shafts on the Coalgrovebeck Vein. These were Engine, Brunt's, Summers' and Taylor's. The first was fitted with pumps and the others were provided with horse whims for winding, and production rose almost immediately. Contracts were let in 1826 for building the other two dams and a by-pass channel, called the Deep Cut, to divert the great surges in flow which occur in Blow Beck at times of heavy rain or melting snow.

These new mines also needed lots of wood (larch and Scotch fir) for props and planks to support the workings. To supply them, a saw mill with a high-walled compound, was built in the summer of 1826 (Bolton MSS: Tutwork Book December 1819 to January 1847). The timber was cut on a saw driven by a ten-feet diameter by two-feet-wide waterwheel. The sawing and carpentry work was let on six-monthly contracts, of which the following for 27 May 1843 (Bolton MSS: Tutwork Setting Book February 1835 to February 1845). is typical:

All the carpentry and sawing work of the mines for the six month taken by James Wiseman at £6.50/month

The Coalgrovebeck oreshoot was richest in the gritstone, but it also entered the top of the limestone. The statistics between 1756 and 1763 are incomplete, but the Coalgrovebeck Company's output increased to about 1160 tons in 1757 and 1500 tons in 1760 (Gill and Burt 2003). Nevertheless, the large area of 19th century stoping between the 18th century stopes suggests that the ore was too disseminated in the vein for it to be dressed economically by hand. From the early 1770s until 1821, therefore, the mine rarely produced more than two or three tons per year. Taylor built the High Grinding Mill at Coalgrovebeck in the early 1820s and, like those at Yarnbury, it had a roller crusher driven by a waterwheel. That the ore was disseminated is supported by the addition of extra crushing capacity and equipment to treat the resulting slimes at the High Grinding Mill. These floors already had crushing rolls when waterwheel-powered stamps, plus stamp pits and slime pits, were built in 1830. Buddles were added in December 1832. The extra water needed to drive the stamps' wheel and work the buddles etc came from the Duke's High Water Course and Coalgrovebeck Dam which were built in 1833. From 1821 until 1836 production fluctuated widely, but still averaged 86 tons per year. Thereafter, the mine was worked by waste dressers, who produced very little ore.

In 1823 Taylor proposed to Fell, Alcock & Company, the lessees of Pit Moss Mine, that he could drain it at a moderate cost, adding that "you ought either to engage to do this without loss of time or you should consent to surrender your lease which is in fact void, little or nothing having been done to work the mine according to the covenants" (Bolton MSS: 30/08/1823. Letter from Joseph Mason, on behalf of John Taylor, to the Pit Moss Adventurers). They agreed, and pumps, driven by rods from the Brake House wheel, were fixed in the Pit Moss shaft the next year. This cost £548.25, but the expenditure was justified and, in 1836/37 when production fell, the pumps were moved to the company's Coalgrovehead Mine. The adit reached Coalgrovebeck Engine Shaft in May 1830, making its pumps redundant and giving free drainage to a depth of 72 fathoms. This should have opened a phase of expansion on the Out Moor, but the lead market entered a major price slump. Some new works were started but during the early 1830s the programme was one of consolidation rather than investment. Shafts were sunk into the limestone at Turf Pits, where workings cut a large self-draining cave, and were never part of the mechanisation scheme.

The Duke's agent, Stephen Eddy, drove the adit eastwards from Taylor's Shaft, and proprietors of mines on its route paid the cost of driving either the 72 or 58 fathom levels into their sets. Correspondence in 1835 shows that he was about to add a winding machine to the Brake House wheel in order to lift work in Taylor's Shaft (Bolton MSS: 05/06/1835. Agreement between Stephen Eddy and Friendship Co.).

In June 1838 Eddy began sinking Price's Shaft on Middle Vein at the boundary with the Hebden Liberty at Blow Beck. For some reason the Ordnance Survey called this trial Hulk Shaft. A shallow adit, or pump way, was driven to the shaft from the side of the Deep Cut and a waterwheel was also built to drive pumps in the shaft. The geology here changes and impoverishes the veins, however, which explains why little work was done at Price's. By September 1839, when it was abandoned, Price's Shaft was 15 fathoms deep.

In order to sustain Coalgrovebeck, pumps were fixed in Brunt's Shaft and the rods to the Engine Shaft, only a short distance to the east, were moved across to it. It was intended to make a deep trial to test the vein into the limestone beneath the bearing grits. By autumn 1845 the shaft was under the 72 fathom level, but the limestone was so hard that it took a year to get below 90 fathoms. Preparations were made to drive the 100 fathom level crosscut north in May 1847 but the vein proved to be poor and the trial was abandoned. The pumps must not have been removed until after the spring of 1856, however, when a note on the shaft section advises that the crosscut was driven another 16 fathoms north.

Fell, Alcock & Company's lease expired in 1841 and in 1848 Eddy refurbished Coalgrovehead Shaft and sank it to meet the adit level which was being driven along the Six and Three Meers Vein. Another deep trial took place at Coalgrovehead Shaft. For this a pumping and winding wheel was built in the summer of 1855 at the High Winding House, directly on the line of the old rods from the Brake House to the shaft. The wheel, supplied by P & H Barrett in 1857, was about 45 feet diameter by 6 feet wide and cost £223.60 (Bolton MSS: Merchants Ledger 1849 to 1862). The 109 fathom level was reached, but the vein was poor and it was abandoned in the spring of 1861 after a little work. Some stoping was done just below the adit and it was only in May 1879 that the rods were drawn out of Coalgrovehead Shaft. The winding rope was still in place in the early 1880s (Beamish Collection, photograph of Coalgrovehead Shaft during scrapping).

The Evolution From Pumping to Winding

After the adit reached Coalgrovebeck in 1830, it was steadily driven from mine to mine, as the 72 fathom level, making their pumps and the Brake House wheel redundant. As shown, the addition of a winding drum c1838 to serve Taylor's Shaft was an after-thought, but it showed the way in which existing plant could be adapted.

John Taylor read a paper 'On the use of wire rope in deep mines' to the British Association in 1838, but it excited little interest amongst metal mines, where shafts continued to be wound by heavy chains or hemp ropes (Taylor 1842). This was expensive and unreliable, and, probably because they needed to hoist greater weights faster, collieries were more likely to adopt wire-rope sooner than metal mines. Some wire-ropes were being tried in Cornwall by 1842 but it took a court case, brought by colliers in Durham, to prove the superiority of wire over hempen rope (Morrison 1983, p. 27; Galloway 1971, pp. 330-333).

As well as managing the Grassington Mines, Stephen Eddy ran the Duke of Devonshire's Burlington Slate Quarries and, from 1844, one of Newall's wire-ropes worked there, on an incline, for 14 years before being removed because it was felt to have done enough work. Wire-rope was reliable and, therefore, made long winding distances possible and in 1853 Eddy switched the Brake House waterwheel from pumping to winding and fitted wire-ropes leading to Old Moss and Sarah's Shafts. Each shaft had a single rope, which ran across the moor on sheaves fixed to posts, over the head frame pulley and down the shaft. Once the kibble was at the surface, its weight, even when empty, was enough to pull the rope back to the bottom. Sometimes a rope broke. In December 1864, for example, Henry Daykin wrote to James Ray Eddy that "I am sorry to inform you that we have had another break in the Moss line of wire rope. It was rather a fortunate break, as the full kibble was [at] about the roof of the plat when the rope broke so not much damage. Only four pulley stands and the rope that came down the shaft is a little worse" (Kinnaird Commission 1864, 7, pp. 434-436). That time, at least, the system was soon repaired. Eventually, this centralised winder served a total of seven shafts.[1]

The evidence of James Ray Eddy, Stephen's son and successor as manager, to the Kinnaird Commission in 1863 showed that the ropes used at Grassington had six strands of six wires, No.12 gauge. One in two opposite strands were wound around wire centres, although he preferred a hemp core. When new, the rope was 3 inches in circumference, weighed between 6 and 6½ lbs per fathom and, during nine years, had lifted about 10,000 tons, plus the weight of the kibble, which had reduced it to about 2¼ inches. New ropes were stronger, however, and had six strands of eight 13 gauge wires. They cost about £1.90 per cwt and weighed between 7¼ and 7½ lbs per fathom. A new 3½ inch rope would weigh 9½ lbs/fm. Henry Morton of Leeds supplied Cornwall with ropes, but Eddy had never tried them. Formerly, all Grassington ropes had come from R.S. Newall & Co., Dundee, but he had changed supplier and found an improvement. He had taken ropes from Garnock & Bibby, of Liverpool, and was trying one from Edge and Sons.

Wire-rope stretched less than hemp and, in the morning only, the men at the furthest shaft had two signals made to them to calibrate for it. From this it seems that a depth indicator, probably a marker on the rope, was used by the wheelman. The problem of signalling, when winding from remote shafts, was overcome by using a light signal wire connected to a knocker.

The new winding system's efficacy is conjecture, but the charges for winding at Taylor's Shaft stayed at 8s 6d per 100 kibbles when it was changed over from horse whim to the Brake House wheel. It is known, however, from contemporary mining practice, that winding speeds and kibble sizes were increased, the latter from about 5 cwts to between 10 and 20 cwts (Collins 1985, p. 74).

A great part of the ore raised at Old Moss came from the Middle Vein, which ran towards the boundary with Hebden. As the 60 and 44 fathom levels, on Middle Vein, were driven east from Old Moss a new shaft, Cottingham's, was needed. Work began in September 1855 when a hole was bored from the surface to drain and ventilate the shaft bottom during sinking (SCL Bag.C.414. New Rake Reckoning Book). The shaft proved that the Top and Main Grits got thinner and had increasing numbers of shale partings as they went eastwards. The Top Grit was 16 feet thinner than it was at Old Moss, but it carried an oreshoot above the 44 fathom level.

By 1857 Taylor's Shaft was abandoned and the workings from Cottingham's were developed enough to justify the former's ropes being extended to it from the Brake House winder. In preparation for this, the shaft top was raised about 12 feet and a poppet headgear erected in August 1857. On the west side of the shaft the rich stopes above the 40 fathom level in Middle Vein were worked from 1857 to 1864. The shaft was still served by a wire-rope in October 1870, when it was included in a contract for greasing the winding ropes. Tribute pitches were still let and, early in 1878, a crosscut was driven south from the Middle Vein at the 60 fathom level. By May 1879, however, Cottingham's was described as being in good repair, "with all the materials out, except in the 40 fathom levels and crosscuts to Eddy's Vein lately pitched." (Raistrick MSS: Statement of repairs of the different shafts and levels on the Grassington Mines May 1879, by Thomas Trevethan to J.R. Eddy).

The final work at Coalgrovebeck Mine began in the 1860s, when a crosscut was driven north, at the 58 fathom level, to explore a large wedge of virgin ground south of Hartington Vein. In preparation for the work, Coalgrovebeck Engine Shaft which had been idle since the 1840s, was repaired in the summer of 1861. Work at Sarah's was drawing to a close and so, in autumn 1862, its rope was transferred to the Engine Shaft where it hauled rock from the mine (Bolton MSS: H. Daykin to J.R. Eddy, 08/11/1862).

The crosscut began near the bottom of the Bearing Grit, a short distance west of the White Hillock and some 820 feet south-east of Coalgrovebeck Engine Shaft. Because the beds rose to the north, however, it must soon have entered the shale below the grit. In order to remove the development dirt from the two headings one of the winding ropes from the Brake House Wheel was fitted at the Coalgrovebeck Engine Shaft.

This new arrangement started work in mid-November 1862. When an Inspector for the Kinnaird Commission visited Grassington in January 1863, the crosscut was being driven by two shifts of two men, each working eight hours. Because both foreheads were blind and could not be ventilated from other workings, a water blast was being installed. This, and the waterwheel-driven fan at Beevers, are illustrative of the use water power for ventilation, a practice which was common in metalliferous mines. The forehead cut a back (i.e. a vein), with a little spar and "a spot of ore" in it, during Christmas week 1865, but it was not enough and the crosscut was abandoned after being driven for around 820 feet.

With the exception of Beever Mine, at Yarnbury, most of the production in the final years came from Eddy's and Slanter Veins at Old Moss. The last bargain was stopped in May 1880 and materials were salvaged from the mine.

Yarnbury

As well as work on the Out Moor, Taylor's agent, John Barratt, oversaw the sinking of new shafts (Barratt's, Bowdin's, Mason's, and Tonkin's) at Yarnbury in the 1820s. Because of its proximity to the limestone, there are no streams at Yarnbury and it was necessary to extend the Duke's Water Course from Coalgrovebeck for a distance of some two miles around the Folds Valley to a new wash dam. The base, sides and, in places, a cover for this watercourse were of local flagstone (Raistrick 1953-55). The new wash dam served the Low Grinding Mill, the waste water from which drove a stamp mill at Bowdin's then ran a short distance to the south-west of Beevers, near Eller Beck, to another dressing floor, which had its own crusher.These new shafts, which were drained by a branch of the Duke's Level, were linked to the Low Grinding Mill by a railway system. A network of properly drained roads was also built between the major shafts, dressing floors and the Cupola smelt mill. In 1831 Taylor wrote of Barratt's efforts:-

One of the best instances of arrangement of this sort connected by well constructed railroads, is to be seen at the mines belonging to the Duke of Devonshire at Grassington and which reflects much credit upon Captain Barratt, the resident agent, who has laid out the most systematic plan of ore dressing that I know of.

The amount of crushing capacity at Yarnbury suggests that here, like Coalgrovebeck, much of the ore was disseminated in the veins. The product of the crushers was first treated in hotching tubs, but, because there was so much of it, Barratt linked the tubs to a waterwheel both to handle the volume and keep down labour costs. Taylor (1831) wrote about this innovative use of brake sieves:-

This has been admirably accomplished by Captain Barratt, at Grassington, where several are worked by one small waterwheel, and the effect is excellent, and the expense of the process is so much reduced, that very poor work is now returning with profit, that would not have paid upon the old plan.

Two French mining students described one of the crushing mills at what was probably the Low Grinding Mill at Yarnbury around 1827. A twenty-five-feet diameter by three-feet-wide waterwheel drove two pairs of rolls and a battery of wet stamps. The mineral was passed through the upper, fluted rolls and then through the smooth ones, which were all 14 inches in diameter by 14 inches long and, the students were assured, could crush a ton of mineral in four or five minutes (Martell and Gill 1989).

Until 1853, the centralised floors served only the Duke's mines and the other companies had floors at their shafts. Afterwards, however, the various titles were consolidated as the Grassington Mines and run by the Duke. Transport costs were saved by rough dressing ore at the shaft top, which contributed to the accumulation of gangue minerals, such as barytes, fluorspar and calcite. During the 20th century, it became viable to recover these from dumps and so much archaeology was lost in doing so.

A spur was taken from the Duke's New Road to the Cockbur Engine Shaft, which was producing ore from Gray Vein, when a dressing floor was begun there early in 1826. It soon became necessary to pump the workings, however, because the oreshoot went below the adit. In the spring of 1827, therefore, the Engine Shaft was sunk deeper (the shaft was to be 8 ft 6 ins long and 5 ft 6 ins wide) and a waterwheel was built to drive the pumps. Water for the wheel was brought from the tail race of the Low Grinding Mill. Work there was short-lived, however, and Eddy sank Beevers Engine Shaft in August 1836. The rods from the Cockbur wheel were extended to it and to the nearby Union Shaft. Pumping from the Cockbur wheel was only an expedient, however, and the water course was extended from the Yarnbury stamps to serve a new wheel-house built at Beevers in the winter of 1837/8 (Bolton MSS: Tutwork Book December 1819 to January 1847). The shaft was then sunk to a depth of 10 fathoms below adit.

Beevers Mine proved to be one of the best locations because work continued without interruption until the mines closed in the spring of 1880. Nevertheless, it was nearing exhaustion by 1860 when Simpson's and Crosscut Veins and one other (probably Blue Level Vein) were developed at the 50 fathom level, which was 10 fathoms under the adit here. To work this, the Beevers' waterwheel and its pitwork were replaced in 1862 (Bolton MSS: H. Daykin to J.R. Eddy, 18/07/1862; Bolton MSS: Measurements for January 1862 to May 1880).[2]

As part of Eddy's systematic development programme, it was proposed to drive a long adit-level crosscut southwards into an almost virgin area of Bearing Grit. In 1865, therefore, a larger wheel and wheelhouse were built at Beevers and, in 1869, a new engine shaft was sunk at the edge of Grassington Mire (Gill 1976, 5). A drawing machine was added to the Beevers wheel and, in October 1870, work began on driving a crosscut towards the new shaft. A small waterwheel was also built underground, near the foot of the shaft on Simpson's Vein, and used to drive a fan which forced air through pipes to the forehead of the crosscut.

A reservoir, built near the Mire and served by a long new water course from Beevers, fed a new wheel, estimated to be about 40 feet in diameter by 3 feet wide. The pumps for the shaft were brought from the Duke's other mine at Cononley, near Skipton, which was then practically closed owing to exhaustion (Gill 1987). When the shaft reached the adit horizon at a depth of 28 fathoms, crosscuts were driven to north and south, but no workable vein was found and work stopped. The Beevers crosscut south was continued, however, and by early 1879 it had connected with the one north from the Mire (Raistrick MSS: Statement of repairs of the different shafts and levels on the Grassington Mines May 1879, by Thomas Trevethan to J.R. Eddy). The potential effect of this new trial on the neighbouring Hebden Moor Mining Company is interesting. Hitherto, all the Duke's waste water had run into Eller Beck, which flows into Hebden Beck, and was used by the Hebden Mines. The waste water from the new engine shaft wheel would, however, enter Hebden Beck below the company's lowest wheel, thus depriving it of much water. A law suit was in preparation when the Hebden Moor mines closed.

Because water was scarce at Yarnbury, where it was needed for dressing, the only shafts fitted with waterwheel-powered pumps were Cockbur, Beevers and the new engine shaft on the Mire. Furthermore, when mechanised winding was introduced in the 1850s, many of the early Yarnbury workings were nearly exhausted. All the major shafts, therefore, except New Engine and Beevers, were wound by horse whims, and when the upper part of the limestone strata were tried at Greenhaw Bottom Shaft on the New Rake, an 8 HP, high-pressure, mobile steam engine, costing £225, was used (Bolton MSS: Merchant's Ledger 1849 to 1862.).[3] This was the only time that steam was used at Grassington and the trial very quickly proved a disappointment. Little now remains at this shaft, which reached a depth of 51 fathoms, but it is known that an engine house was built in 1856 and that the pumps were drawn out in 1858 (Bolton MSS: Grassington Costs, September 1855 to July 1857).[4]

Conclusion

This paper has described a system of water power and management which, though it has left some obvious remains, has left few clues as to its true complexity. It is based on fieldwork, done by the author in the 1970s, and archival work done in the 1980s.

Before that, Arthur Raistrick's paper on *The mechanisation of the Grassington Moor Mines, Yorkshire*, saw the system as having two main parts (Raistrick 1953-55). The first, a series of watercourses, fed by Priests Tarn, was used for dressing ore, whilst the second, which was based on the Duke's Watercourses and the Blow Beck Dams, drove waterwheels for winding and pumping from shafts, as well as for crushing and dressing ore. As this paper has shown, that was accurate, but his proposed chronology of around 1780 for the first, and the early 19th century for the second was not.

What emerges, therefore, is a complex, multi-function system, which began in the early 1820s and developed from pumping to using wire-rope to wind over long distances in the 1840s. Moreover, many of the mechanised processes described by Martin Roe, for example, as being used from the late 1870s on the AD dressing floor in Gunnerside Gill, were in place at Grassington by the 1830s.

Notes

1. These were: Taylor's, Brunt, Coalgrovebeck Engine, Sarah's, Old Moss, Coalgrovehead and Cottingham's. Only three were worked at any one time.
2. Beevers wheelhouse was started in September 1865. New Engine Shaft was begun in July 1869.
3. Messrs Medwin & Hall, London, December 27th, 1855. By an 8 horsepower, high pressure portable steam engine on wheels, fly wheel, chimney & horse shafts, as per agreement = £225.00.
4. Sept. 1856 William Wright walling the engine house at Greenhaw Bottom.

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Bolton MSS: Bolton Abbey and/or Chatsworth House
Raistrick MSS: Arthur Raistrick's personal archive, now at the Institute of Industrial Archaeology Library, Ironbridge.
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