ART. XIII.—*The collieries of J. C. Curwen.* By OLIVER WOOD, Ph.D.

Read at Hexham, July 15th, 1971.

A HANDFUL of landowners was responsible for the rise of the coal industry in Cumberland and of the ports of Whitehaven, Workington, Maryport and Harrington to ship their coal to Ireland. Owning the minerals and with influence to obtain Acts of Parliament favourable to their plans, these landowners — the Lowthers, Curwens, Senhouses and Christians — had the capital necessary to finance operations. Wealth was needed to bore for coal, sink shafts, drive levels, install machinery, hire workmen and bear losses caused by flooding or explosion. Waggon-ways and staithes added to costs and often expensive harbour works had to be constructed before coal could be exported.

Here we are primarily concerned with the contribution to mining development made by one of these landowners, John Christian Curwen (1756-1828) who, by his marriage in 1782 to his cousin Isabella Curwen, added to his patrimony by acquiring control of the Curwen estates and thereby increased significantly his capacity for further colliery expansion. His work at first, however, was the continuation and extension of the efforts of his father, John Christian (1719-67).

John Christian senior succeeded his brother Ewan in the manor of Ewanrigg in 1752 and worked a number of small pits there.* But his most successful work was the sinking of mines in the Broughton area. The Broughton pits, which lay between Maryport and the

* Gin, Harry, Water, Thompson Pits and Union Pits nos. 3 and 4 were working 1762/3. In 1763 Thompson Pit and Union Pits nos. 3 and 4 employed a total of 16 haggers (hewers), 12 trailers, 2 bankers, 2 pickers and 2 winders.

Derwent and some two miles from the sea, were denied access to Maryport harbour by the Senhouse and Christian lands. It was impossible to export Broughton coal without the consent of these landowners, for it would be too expensive to cart coal by a route which would avoid their territory.[1] In 1755 an understanding was reached by the landowners when the collieries in Great and Little Broughton were leased by Lord Egremont, lord of the manor, to John Christian, Humphrey Senhouse, John Gale, Thomas Hartley, Edmund Gibson and James Postlethwaite for 21 years at a yearly rent of £200 and 10s. royalty per Ten* of coals raised above 400 Tens per annum.[2] John Christian was to have a quarter share in the colliery company and his five partners were each to have an equal share in the remainder. Before this lease was signed, Christian and Senhouse had agreed to provide the necessary wayleaves to the harbour at Maryport. Christian had also promised to allow the partners to use the levels or drains in his existing collieries and to extend them to Great and Little Broughton to drain the mines there. For this he was to receive £150. In addition Christian undertook to pay half of the cost of a waggon-way through his grounds from Broughton pits and was to receive a yearly wayleave rent of £78. 15s. Similarly Senhouse would pay one quarter of the cost of a waggon-way through his lands and would receive an

* Not per "tun" as stated by E. Hughes, *North Country Life in the Eighteenth Century*, II 138 and 146. John Barnes in his "View Book 1717-78" when dealing with this lease defines a "Ten" in these terms: "A Ten to contain 22 waggons, each Waggon 19 Bowles, each Bowle 4½ Bushels Winchester measure, and each Bushel 8 gallons Winchester measure." From the account he gave of the tentale rent owing to Lord Egremont, it is clear that the lease called for 10s. per Ten, not per tun. W. Tiffen, in a letter to C. Udale (8 February 1794), said: "In a note of Mr Addison a Ten is said to contain 22 waggons, each waggon containing 19 bowls of 36 Gallons each (Dry Measure). By the lease of 1781 from Lord Egremont to Mr Curwen I perceive a Waggon is considered as equall to three Tons — if so & if Mr Addison's note is correct the Ten is 66 Tons." (Curwen MSS. 3/68.) From this it appears that the statement that a "Ten" "may, I believe, invariably be taken to mean 10 Newcastle chaldrons" (J. U. Nef, *The Rise of the British Coal Industry*, II 377) is incorrect.

annual wayleave rent of £10. William Williamson contracted to build the waggon-way from Broughton to the harbour for £900,[3] and Richard Laws was appointed overseer of Broughton Colliery at a salary of £50 per annum.[4]

In less than a year the colliery was producing coal and by 1777 it had yielded 612,082 tons of coal. The annual output was:[5]

Year.	Tons	Year.	Tons.
1756	7,175	1767	32,562
1757	5,149	1768	38,019
1758	9,399	1769	45,665
1759	9,354	1770	38,155
1760	8,981	1771	39,074
1761	10,891	1772	37,462
1762	19,756	1773	38,212½
1763	37,269	1774	36,361½
1764	23,439	1775	36,604½
1765	30,214	1776	38,200
1766	30,079	1777	40,060½

By an agreement[6] of 19 September 1763, John Christian took over the lease of the colliery from the other partners, agreeing to pay them 9d. for every ton of coal shipped and 1½d. for every ton sold locally. As Professor Hughes has pointed out,* it is difficult to understand why Christian's partners should withdraw from an apparently successful concern. He suggests that lack of ready cash was the probable cause of Senhouse's withdrawal. Four of the partners (Gale, Hartley, Gibson and Postlethwaite) were also partners in the Maryport Ironworks. It seems that they were having difficulties with their furnace at this time and therefore felt it necessary to reduce their financial commitments.

The new arrangement benefited Christian's partners considerably, for in the first five years, Michaelmas 1763—Michaelmas 1768, they received £6,344. 18s.

* Hughes, *op. cit.*, 141.

4½d. as tentale rent for coals shipped from Broughton Colliery.[7] But John Christian did not live long to enjoy the growing success of his colliery. He died in 1767, and since his son and heir John was a boy of twelve, the management of the estate, including the coal mines, fell to Charles Udale who had served the family faithfully since 1755.

It was during the minority of the heir that a dispute arose over the amount of tentale rent payable to Lord Egremont. As stated above, he was entitled to 10s. per Ten for every Ten of coals above 400 Tens per annum, according to the Newcastle measure. If he was to obtain all he was entitled to an accurate account of the output of Broughton Colliery, measured in the Newcastle manner, would be necessary. By 1773 he had received nothing since the beginning of the lease and this was clearly the fault of his agent who had

Year.	Total Quantity Wrought in			Surplus Quantity Wrought in			Surplus Quantity at 10s.		
	Tens.	W.	Bo.	Tens.	W.	Bo.	£	s.	d.
1756	147	13	12	No Surplus					
1757	105	20	11	do.					
1758	193	8	5	do.					
1759	192	9	17	do.					
1760	184	17	1	do.					
1761	224	1	11	do.					
1762	406	10	3	6	10	3	3	4	7½
1763	766	17	2	366	17	2	183	7	9¼
1764	482	5	4	82	5	4	41	2	4¼
1765	621	13	15	221	13	15	110	16	3
1766	618	18	13	218	18	13	109	8	5¾
1767	669	20	11	269	20	11	134	19	4¼
1768	782	4	11	382	4	11	191	2	0¾
1769	939	11	8	539	11	8	269	15	2¼
1770	785	—	3	385	—	3	192	10	0¾
1771	803	20	2	403	20	2	201	19	1½
1772	770	16	9	370	16	9	185	7	5¾
1773	802	20	17	402	20	17	201	9	5½
Total	9498	10	3	3650	5	3	1825	2	2½

failed in his duty to ensure the prompt payment of royalties. In that year Messrs Walton and Barnes were called in to inspect the records of the colliery and to re-measure the corves in use there. This they did and John Barnes has left to us his "Account[8] of all Coals raised from Broughton Colliery and the the Tentale Rent exceeding the certain annual Quantity made out from Mr Udale's Account and Mr Barnes's Admeasurement of the Corves 8 September 1773 by the Newcastle Measure". In addition to the figures given above, Barnes gives the output in tons (already provided), in corves (1 ton = 12 corves), in gallons (1 corf = $25^8/_{10}$ gallons), and in Boules, each containing 36 gallons.

Thus by 1773, according to Barnes's calculations, Lord Egremont was owed £1,825. 2s. 2½d. as tentale rent for coals. From the same source further information is available for the years 1774-77:

Year.	Total Quantity Wrought in			Surplus Quantity Wrought in			Surplus Quantity at 10s.		
	Tens.	W.	Bo.	Tens.	W.	Bo.	£	s.	d.
1774	764	1	4	364	1	4	788	16	10½
1775	769	3	10	369	3	10			
1776	802	15	2	402	15	2			
1777	841	17	3	441	17	3			
Total for 1756-77:	12676	3	3	5227	20	3	2613	19	1

Coal had been raised from seven pits at Broughton between 1755 and 1763 and from eighteen more pits sunk by John Christian after he had taken over the lease from his partners.[9] When he died in 1767 he left personal estate valued at £8,404 gross.[10] Charles Udale was responsible for the management of the collieries after that date and his success can be measured by the net income derived from the collieries:[11]

Year ending Sept.	Net Income £	s.	d.
1768	1,738	14	5¼
1769	2,131	17	8
1770	1,842	17	1½
1771	1,522	9	6
1772	1,452	1	5½
1773	1,856	12	5¾
1774	1,117	16	0¼
1775	1,375	13	2½
1776	2,614	8	11¼

Young John Christian, therefore, found on attaining his majority that he had inherited a prosperous undertaking, and although from now on the decisions were his he continued to rely heavily upon the advice and experience of Udale. His first major move was to break away completely from his father's former partners in the Broughton Colliery and to negotiate a new lease with Lord Egremont, for by the agreement of 1763 these partners had become merely sleeping partners and had been more than amply rewarded. The 1755 lease* was due for renewal in 1781 and Lord Egremont was prepared to renew provided his higher terms were accepted. By a lease of 1 June 1781, John Christian became sole lessee of the collieries at Great and Little Broughton for 21 years on payment of a yearly rent of £400 and 3d. for every ton of coals for land sale above 12,800 tons and 7½d. per ton for coal shipped above the said 12,800 tons.[12]

In the same year Christian also leased from Lord Egremont the coal in the manor of Birkby for 21 years at a total yearly rent of £100.[13] Pits were sunk on the north bank of the River Ellen to a 30-in. seam at a depth of 10 fathoms and were drained by a level from the Ellen.[14] But output from this colliery was always small; in 1796, for example, Birkby produced 6,430 tons of coal.[15]

* The 1755 lease for 21 years had been extended for a further five years in 1760.

But there can be no doubt that John Christian's most successful venture was his marriage in 1782 to his beautiful young cousin Isabella Curwen, heiress to the Curwen estates. On his death in 1778 her father, Henry Curwen had left personal estate valued at £15,000 and real estate valued at £2,000 a year. To this were added collieries at Moorbanks, New Lands, Harrington and Chapel Bank.[16] Controlling the combined resources of both families, the way was open for Christian to play a much bigger part in the mining development of his native county. In 1790 he adopted the Curwen name and it is as John Christian Curwen that he is known to history.

A guide to the success of Broughton Colliery is the increasing amount of money paid to Lord Egremont who, unlike the Lowthers, Curwens and Senhouses, did not work his own coal, but was content to act as a rent-receiver. Between 1756 and 1777 the colliery earned for him £7,013. 19s. 1d. on an output of 612,082 tons; this sum including both the fixed annual rent of £200 and tentale rent on coals. From the Broughton Colliery his rents in later years were:[17]

Year.	£	s.	d.	Coal Shipped (Waggons)	Country Sale (Tons).
1789	854	4	3½		
1790	738	6	6¼		
1791	786	12	8		
1792	946	5	2¾		
1793	842	18	1½		
1794	1,098	0	0		
1795	1,295	8	3	12,568	9,373
1796	1,289	6	11	12,482	9,532
1797	1,379	16	6	13,716	7,516
1798	1,263	13	10	12,579	6,753
1799	1,357	11	9¼	13,171	9,824
1800	1,355	8	6	13,140	9,884
1801	1,490	11	7	14,254	12,341
1802	1,265	8	2	10,086	10,481
1803	1,600	19	2	11,003	5,412
1804	1,641	14	2	10,902	6,693

By a lease of 13 May 1802, J. C. Curwen again renewed the lease of this colliery for a further 21 years and again the terms of the lease were raised. He was to pay a dead rent of £1,000 per annum and 2s. 6d. for every waggon of coal beyond 8,000 waggons, each waggon containing three Cumberland tons.[18]

It seems that Broughton Colliery was taken over by John Christian (son of J. C. Curwen by his first marriage), but he was unable to carry on successfully, and from 1811 to 1822 "Mr Curwen re-occupied the colliery for Mr Christian's benefit".[19] From the five pits being worked there the following amounts of coal were sold:

Year.	Waggons.	Bushels.	Year.	Waggons.	Bushels.
1811	15,138	7	1817	7,663	11
1812	13,458	5	1818	8,302	0
1813	9,969	13½	1819	8,768	18
1814	10,746	2½	1820	7,364	12
1815	10,913	22½	1822	7,992	22
1816	10,411	5½	1822	6,891	19

On the expiration of the lease in 1823 the colliery passed to John and Thomas Walker who had to pay 1s. 7d. per waggon for wayleave from Broughton Moor to Maryport harbour and also 100 guineas per annum for water passing from the colliery through the Ewanrigg level.[20]

Both Henry Curwen and J. C. Curwen did much to develop the Moorbanks Colliery at Workington. From "An A/ct of all the Coals raised from Moorbanks Colliery, Workington, from 5 October 1771, in the customary tons, taken from the Fawcett papers and the subsequent A/ct"[21] we learn that the colliery between 1771 and 1801 produced a total of 859,260 tons of coal from seventeen working pits.

But the movement of coal from Moorbanks to Workington harbour made it necessary to construct a waggon-way through the Banklands estate where

another colliery was already in existence. Accordingly Henry Curwen agreed (27 July 1771) to pay George Wharton, William Mence and William Miles 40s. for every acre that his waggon-way through Banklands would take up.[22] On the same day it was also agreed that the Banklands Colliery Co. would be allowed to make a branch waggon-way from their colliery to link up with the projected waggon-way from Moorbanks to Workington quay. They would be allowed to use the waggon-way from Banklands to the quay and the three additional coal hurries that would be erected. For this they agreed to pay £300 towards the cost of constructing the waggon-way and hurries, an annual rent of £100 and half the cost of repairing the hurries and the waggon-way from Banklands.[23]

The Banklands Colliery Co. fell into difficulties and the estate was purchased by Anthony Bacon* for £4,400. He continued to work coal there, but, he complained, "I am limitted to ship no more than Thirty Waggons a day, and am to pay one Shilling a Waggon for the use of your Fire Engine and way leave, by which I shall pay you about five hundred pounds per ann. when I am able to raise sufficient to ship my Morsel."[24] His complaint had some effect, for the terms of the agreement he had made with the executors of Henry Curwen's estate were modified. By a new agreement with John Christian (25 February 1783) he continued to use the waggon-way from Moorbanks to the harbour and to have the benefit of Christian's pumping-engine to drain Banklands

* This famous ironmaster was engaged in the tobacco trade at Whitehaven before he amassed a fortune at his ironworks in South Wales. On his death Banklands Colliery was worked for the benefit of his five illegitimate children (Anthony, Thomas, Robert, William and Elizabeth) by Mary Bushby. These children he acknowledged as his own in his will. The colliery was managed by William Walker under the direction of Thomas Harrison of Whitehaven, a trustee of the estate. Detailed accounts of working costs at Banklands Colliery for the years 1786-96 are available in the Record Office, The Castle, Carlisle.

Colliery. For this he had to pay an annual rent of £100 and 6d. per waggon of coal raised, but he was still restricted to 30 waggons of coal per day.[25]

J. C. Curwen also exploited the coal seams at Banklands. Engine and Crosthwaite pits were producing coal there in 1787, and in the same year Hope pit began production. These were followed by Henry pit (1789), John and Elizabeth pits (1790) and Bowness pit (1799).* In 1800 these seven pits produced 31,689 tons of coal.[26]

According to R. W. Moore all coal from Workington Colliery until 1794 came from the Banklands or eastern division, but in that year John Christian Curwen, advised by John Grieve, an Edinburgh engineer, began the Chapel Bank or western division of the colliery when he completed the sinking of Lady Pit on the shore to the Main Band at 84 fathoms.† But the Curwen records show that mining activity was going on at Chapel Bank before this date. In 1771 the Chapel Bank estate belonged to the Rev. Robert Gibson but the underlying coal to the Curwen family. By an agreement of 1 August 1771, Henry Curwen leased the right to work coal under the Chapel Bank estate to John Hodgson, Edward Stanley, John Falcon and John Stead for eleven years. After the first eighteen months the lessees were to pay Curwen £300 for the use of the waggon-way and hurries, and 6d. for every ton of coal raised throughout the whole period of the lease.[27] This venture was short-lived. The agreement bears this endorsement, "Be it remembered that (9 January 1773) the above unfortunate lessees gave up their Rights and Lease of the said colliery to Henry Curwen, Esquire. He at the same time generously forgave them all Rents and payments due unto himself and took the colliery into his own possession again

* Church Pit was also producing coal 1793-5.
† *VCH Cumberland* II, 366.

together with all the materials &c." Curwen bought the Chapel Bank estate from Mr Gibson in 1775 for £2,000[28] and worked the colliery there between 1773 and 1778 in partnership with William Hodgson and others. He was more fortunate than his predecessors for his half-share of the profits amounted to:[29]

Year.	£	s.	d.
1773	180	10	6
1774	185	16	6
1775	253	0	3½
1776	120	1	0
1777	290	4	6

As the Banklands pits declined, Curwen devoted much energy and capital to winning coal at Chapel Bank. After Lady Pit went into production the sinking of Union Pit was begun in 1795 and completed in 1798.[30] These two pits in their early years yielded the following quantities of coal:[31]

Year.	Lady Pit (Tons).	Union Pit (Tons).
1795	6,197	
1796	19,725	
1797	22,253	
1798	19,120	3,107
1799	17,379	6,970
1800	21,062	11,091
1801	17,863	10,027
1802	18,756	14,670

Further exploratory work was undertaken when the sinking of Isabella Pit was begun in 1807, and by 1814 it had reached the Moorbanks Seam at 90 fathoms. Sinking was resumed in 1816 in an effort to reach the main Band, but at a depth of 128 fathoms a fault was encountered, and not until 1822 was the Main Band found after driving a stone-drift through the "nip".[32] This pit proved most expensive; by the end of 1817 £62,100 had been spent on it.[33]

By 1816 Curwen had reduced the number of his

pits at Workington to four — Lady, Union, Isabella and Church (the last of the Banklands pits) — but he did try to sink more at Chapel Bank. Drainage, however, was a major difficulty; the sinking of four pits had to be abandoned owing to a large feeder of salt water, the pumps being quite ineffective to remove it.[34] Between 1818 and 1820 £2,855 was spent on sinking the new Buddle Pit,[35] but to no avail, and not until 1837 did this pit draw coal. At this time pumps were kept going most of the day at the four working pits, and since Church Pit was approaching exhaustion pillar robbing was being undertaken there to remove the maximum amount of coal before it was abandoned. In March 1821 Church Pit was drowned out by a fall of roof bringing down a feeder of water,[36] and in the following year Union Pit ceased because the drainage problem proved insoluble.

A colliery had been developed at Harrington by Henry Curwen. The coal was sent in waggons along wooden railways to the harbour at Harrington which he had constructed in 1760 to facilitate the export trade.[37] His work was continued by John Christian when he took over the Curwen estates and he was responsible for the sinking of a number of new pits, at least eight being sunk between 1783 and 1796. From this colliery the following quantities of coal were sold:[38]

Year.	Shipped. (Waggons).	Country Sale. (Tons).	Profit on Coal Sold. £	s.	d.
1783	12,516½	4,294			
1785	14,389	5,494	2,827	9	9
1786	12,866	3,954½	2,904	12	3

In 1804 the colliery consisted of five pits (Udale, Tarn, Jane, Bella and Henry Pits) which yielded 41,420 tons of coal, providing employment for 70 hewers.[39] Hodgson Pit was sunk in the same year. Coal shipments continued:[40]

Year.	Shipped. (Waggons).
1804	20,510
1805	17,375
1806	19,571
1807	18,323
1808	24,252
1809	16,219

By 1812 the number of working pits at Harrington Colliery had been reduced to three — Hodgson, John and Henry Pits.[41] In 1814 the colliery shipped 15,391 waggons of coal.[42] An attempt was made in 1825 to win coal from the seashore by the sinking of Micklam or Lowca Pit to a depth of 90 fathoms, but the attempt was unsuccessful owing to the volume of the sea water which penetrated into the workings.[43]

There were few changes in mining methods in the Cumberland coalfield until the close of the 18th century. Shallow mines were worked by means of drifts, the miners entering the pits through bear-mouths or day-holes, i.e. openings in the side of a hill, and descending to the bottom of the pit along sloping roads cut through the rock.[44] This method of reaching the coal face persisted for a long time in the deep mines; there were three bearmouths at How-gill and four at Whingill in 1816.[45] Until the 19th century the bord and pillar system was exclusively employed and the coal was removed by picks and wedges. When pits were shallow the coal pillars left were small, sometimes only four or five yards square, others were fifteen yards long by two yards wide.[46] But as the pits became deeper the pillars increased in size;* at Broughton Moor in 1812 the pillars were seven yards wide by twenty-two yards long, the bords or working places being five yards wide.[47]

* By 1800, pillars in the deep mines at Whitehaven were 18-20 yards square, only about one-third of the coal being extracted, the other two-thirds being left to support the roof. (J. Dixon, "An Account of the Coal Mines near Whitehaven", p. 101.)

Women had carried coal out of the pits on their backs in the 17th century,[48] but early in the next century the work was being done by trailers who pushed or dragged corves on sledges mounted on ashen runners.[49] These corves were carried along a corfway consisting of two parallel lines of wooden rails, the wooden rails remaining in use until the end of the 18th century when cast-iron rails were introduced. Professor Hughes has shown that there is clear evidence that iron rails were being used at Workington by 1800.[50] After the adoption of tram plates the corves were placed on low trams fitted with small plain wheels which were "trailed" from the workings to sidings in the main roads. At the sidings hand cranes were used to lift the full corves from the small trams on to larger trams, mounted on flanged wheels, which were then drawn by horses to the shaft bottom.[51]

Drainage had presented few problems in the early days since coal was worked to the rise, the water flowing naturally from the workings. But as pits were sunk, levels or watercourses had to be driven to drain the mines. Where gravitation drainage was impossible horse gins were employed to draw water. Horse gins, however, proved inadequate to drain deep mines, and for these more powerful machinery was necessary. This led to the use of steam pumping engines or "fire engines", the first of these employed in Cumberland being a Newcomen atmospheric engine erected at Stone Pit, Whitehaven, by James Lowther.* The Lowther example was followed by the Curwens of Workington whose pits, until the adoption of the steam engine, had been small and shallow. At Isabella Pit, Workington, a pumping engine of 160 h.p. worked six sets of pumps down to a depth of 130 fathoms.†

* According to the *VCH Cumberland* II, 354, Mr Lowther hired this engine by an agreement of 10 November 1715 for £182 per annum. R. L. Galloway states in his *Annals of Coal Mining*, I 345, that this engine was erected in 1718.

† Materials for this pump were moved to Workington by Messrs Fenton & Murray of Leeds. They arrived in 1811 and the engine was set to work in August 1813. (Curwen MSS. 3/43.)

The application of steam to the winding of coal came much later than steam pumping. Coal had been drawn out of the pits first by coal-bearers and then by jack-rolls, i.e. winches worked by manual labour. By 1700 these had been replaced by horse gins. Increasing pit depth necessitated the employment of horse gins underground, the coal being raised by successive stages or stories from one seam to another. The high cost of hiring and keeping horses made an alternative method of winding coal desirable. In 1787 the first recorded departure from winding coal by horse gins in Cumberland was made at George Pit, Whitehaven, where on the same shaft as the rope rolls a water-wheel driven by water pumped by the "fire engine" was erected.[52]

The first direct application of the steam engine to winding coal in Cumberland was made, as the Curwen records show, at the Hope Pit, Workington. J. C. Curwen in the 1780s became increasingly aware that in winning coal at greater depths the old methods of winding were inadequate and that mechanisation was essential. Accordingly he turned for help to the famous firm of Boulton & Watt in Birmingham. By an agreement of 1 July 1788, between John Christian (as he then was) and Messrs Boulton & Watt, the latter undertook to provide at Workington Colliery "a Steam Engine of the said James Watt's invention as aforesaid and of dimensions following, that is to say the Cylinder of the said Engine to be fourteen inches in diameter and four foot long in the stroke and the piston thereof to be acted upon by the force of Steam both in its ascent and descent with a rotative motion of his, the said James Watt's invention applied thereto for the purpose of drawing coals and water from the said Colliery."[53] This was a 6-h.p. engine which cost £607. 5s. — £251. 13s. 7d. for materials supplied by Boulton & Watt and £355. 11s. 5d. for workmen's wages August

1788-July[54] 1789. In addition, Christian had to pay an annual premium of £30 for the use of the engine since the firm charged £5 per horse-power.* This engine was "calculated to wind Coals at the rate of 4½ feet per second"[55] and its success led Christian to order more engines from Birmingham. Thus we find Charles Udale writing to Messrs Boulton & Watt (6 June 1789), "Mr Christian is desirous to be furnished with directions for Erecting another of your patent Engines as soon as can be convenient ——— The Engine should be adapted so as to draw water by pumps as also to wind Coals, it should therefore have power to take out the water in a few hours of the 24, that the rest of the time may be apply[d] to the winding of Coals and other matter that may be necessary to take up."[56] Nine days later he wrote to the firm, "The present Engine which we work, we always understood to be equal to the winding of Coals of the weight we now draw by it, from the depth of 110 fathoms with a velocity equal to the passing thro' a space of 4½ feet in a Second of time. In the Engine we now want we do not wish for any increase in the velocity or to load it with more than the usual weight ——— But the power we wish for in an Engine is to be amply provided for the draining of that part of the Colliery which we are about to open, & extend, And at the same time to avail ourselves of any spare time such Engine might have (if practicable) by applying it to the winding of Coals but the drawing of water is the principal object. ——— If a rotative motion for the drawg of Coals in Baskets of about 7 cwt. each thro' a space of about 4½ ft. in a 2[d] of time cannot with propriety be applied to such an Engine or such other Engine as

* A paper entitled "Memorandums of Mr Curwen's Engines for Mr Lawson", dated 13 October 1798, says this engine was "put together" at Hope Pit by James Murdock in 1788. (Boulton & Watt MSS.) But from the accounts of money paid out in wages when erecting this engine it would seem that it did not begin working until 1789.

you may recommend for the above purpose, we must for the present drop the Idea & draw our sinking stuff and the Coals when we come at by Horses in the usual way unless we should wish to have another small Engine Erected there for that purpose."[57]

Messrs Boulton & Watt recommended a 16-h.p. engine for which they said "our annual premium (£5 a horse) would be £80 a year".[58] This suggestion was adopted and a 16-h.p. engine was erected at Elizabeth Pit in 1789 at a total cost of £1,300. 8s. 3½d., the materials supplied by Boulton & Watt costing £462. 9s. 1d.[59] This engine and its predecessor gave satisfaction as Charles Udale reported, "I now enclose you Mr Curwen's draft on Mr Joseph Christian London, for Four Hundred & Sixty two pounds nine shillings, which is the amount of your charge received here, some time ago, for the materials of the latter Engine ——— This Engine performs the work we have at present for it very well, and goes with the pumps now 70 fathom, at the rate of 24 or 25 Strokes per minute when necessary — As to its Work in drawing Coals, it has very ample power — The little Engine also continues in very good order, and does much business.

"We are much amused here with an acct of A. Heslop's improvements made in those kind of Engines, whose powers are said to be equal to more than 10 pounds per inch effective in a single Engine, and that he has not only obtained a patent for his invention, but has received large orders for the Erection of such Engines."[60]

Additional Boulton & Watt engines were bought later. A winding engine was installed at Lady Pit in 1793, apparently the one referred to by Udale in his letter (8 December 1793) to the firm, "the last Engine sent here from Birmingham for Mr Curwen is compleated and has been drawing water &c in Bucketts

since the 26 October last. The Engine goes very well & is not exceeded by any of yours yet erected here".[61] This was followed by a pumping engine which worked a $9\frac{3}{4}$-in. pump.* There is evidence to suggest, although it is not wholly conclusive, that a fifth Boulton & Watt engine was erected at Workington. A letter from Udale, 11 September 1798, endorsed "Order for a Winding Engine No. 5" orders a winding engine for "the new pit". This pit, presumably, was Union Pit. Detailed drawings of an "Engine for J. C. Curwen No. 5", dated 13 June 1799, exist among the Boulton & Watt records. An item among the Curwen MSS. shows that the Union Pit engine cost £630.

Udale had referred in pejorative terms to Heslop's engine, a view shared by the firm of Boulton & Watt.† Nevertheless three Heslop engines were erected at Whitehaven, the first of these (made at the Seaton Ironworks) at Davy Pit in 1791.[62] At least two Heslop engines were bought by J. C. Curwen, one at John Pit and one at Harrington for which he paid annual premiums of £27 and £45 respectively.[63] The Heslop engine, patented in 1790, was provided with two cylinders, one at each end of the beam, named respectively, the hot and cold cylinders, the former resembling the cylinder of an ordinary Newcomen engine, while the latter was used as a separate condenser. This engine was undoubtedly an infringement of Watt's patent rights, but he does not appear to have interfered with it.[64]

Winding engines, by displacing horses, reduced costs considerably, for until the adoption of steam engines horses in the mines were both numerous and

* This engine seems to have been erected in 1795. It was working at Lady Pit, Chapel Bank in 1798. (Boulton & Watt MSS.).

† James Watt junior to J. C. Curwen, 2 November 1798: "We may have acted wrong in not noticing Heslop, but if so it has proceeded from an error in Judgement & in supposing his Engine too contemptible. Had we thought it necessary to notice his Engine, we certainly should not have commenced with those he has erected for you." (Boulton & Watt MSS.)

expensive. Hutchinson[65] estimated that an engine capable of drawing coal from 90 fathoms could be erected for £600 and that, in lieu of an engine, the purchase price of horses necessary to draw the coal would amount to more than half this figure. In addition, the horses would have to be fed and wages paid to their drivers, a heavy item in production costs; at Workington the feed of each colliery horse in 1814 was estimated to cost 30s. per week.[66]

Engines made possible mining at much greater depths but at the same time introduced another problem, that of providing ropes safe enough and strong enough to lift coal from these depths. John Bateman, manager of the Whitehaven Collieries, was experimenting in 1803 with the flat ropes invented by John Curr of Sheffield, but at first he did not find them satisfactory, nor did he like the high price charged for them, a flat rope of 130 fathoms costing £67. 4s., compared with £20 for an ordinary rope.[67] Again Workington followed the example of Whitehaven as the following letter from William Swinburn, Curwen's agent, to John Curr, dated 7 October 1812, shows:

We are induced to make one fur. trial of your ropes — you may therefore if you please send us 4 Ropes of 234 yards long each & 2 of 200 yards long each, by the usual conveyance *as soon as you can.*

What we have to complain of in the former Ropes are first the *Sticking together* which very frequently opens in many parts — and next the quallity. Which in the late ropes we have had are very little if any superior to the common round; as you will see by the quantity drawn at a pit 180 yards deep, the Basket & Coals weighing 8 cwt. 1 qr. I think if I do not mistake our manager.

The two ropes I am now about to state the quantities upon went about 6 months each drawing one 2625 Score of such Baskets, & the other 2601. If we are so unfortunate as to get any more from you of this inferior quallity we must change our Pit ropes for the round as any thing you State to return is nothing near adequate to the loss.[68]

Apparently the new ropes were more satisfactory since four more flat ropes were ordered (14 January 1814) — two ropes, each about 230 yards long and two about 200 yards long each. In the following year* four more ropes of the same dimensions were ordered from the same source. However, from 1816 onwards the colliery was supplied with flat ropes by the Sunderland firm of Ronald Webster & Co.[69]

It is unfortunate that complete statistics of coal output at Workington Colliery do not exist, but from the information that is available it is clear that there was a distinct improvement, which continued for many years, after J. C. Curwen took over. In 1771 the colliery produced 1,701 tons of coal, 10,742 tons in 1772, 12,949 tons in 1773, and 23,600 tons in 1774. Annual output at Workington Colliery 1787-1802 was as follows:[70]

Year.	Output. Tons.	Year.	Output. Tons.
1787	52,890	1795	54,555
1788	55,166	1796	50,064
1789	50,070	1797	52,664
1790	51,355	1798	52,952
1791	55,354	1799	49,193
1792	46,550	1800	63,844
1793	53,203	1801	57,996
1794	51,775	1802	65,309

Increased production, however, could not continue indefinitely and it appears from the decline in shipments (see below) that output began to diminish about the year 1807. To correct this, Curwen turned to Newcastle mining engineers for guidance in the working of his pits. John Buddle, probably the leading mining engineer of the time, was appointed in 1814 to advise on the management of the Curwen collieries.

* Swinburn to Curr, 30 January 1815 — Curwen MSS.

His many reports, covering the period 1814-37, give a detailed description of their working and of the defects from which they suffered. He found that the Workington Colliery was not being efficiently administered, and the daily output of 165 tons from four pits (August 1816) he regarded as much too small. He recommended:

(1) The suspension of work at Lady Pit, since it was the most expensive, and more work to be done at Union and Church Pits.

(2) A reduction in the size of pillars at the Union Pit to 18 yards long by 8 yards broad which would increase output by 12% and still leave sufficiently strong pillars at a depth of 30 fathoms.

(3) The sinking of Isabella Pit to the Main Band — estimated to take 30 weeks and to cost £1,370.

(4) Church Pit should be allowed to drown up when the coal is exhausted in order to reduce pumping costs and to liberate the engine for use elsewhere.

(5) After exhausting the Main Band at Union Pit the shaft there should be sunk deeper to win coal in the Four Foot seam.

(6) Ventilation at Moorbanks should be greatly improved and at Union Pit a small furnace placed at the bottom of the pit should replace the lamp then in use.[71]

His later reports criticised the poor condition of the rolley-way, the steepness of the descent into the stear, which distressed the horses drawing out full baskets, and the filthy condition of the stables. Some of his suggestions were acted upon. Union Pit was ventilated by a furnace instead of a lamp, the stables were cleaned up, and by 1821 pillars had been reduced in size, 45.8% of the coal being taken out of Union Pit.[72]

Little progress in the conduct of the colliery was made in the next ten years and the reports of Matthias Dunn[73] show how far methods employed at Workington lagged behind the best mining practice. Thus, after a long period of increasing output, Curwen in the last years of his life was faced inevitably with some of

the insoluble problems inseparable from what is essentially a robber industry — the exhaustion of seams, increased depths, increased distances from the shaft to the working face and the obsolescence of pit equipment. Unfortunately for him this was a time when his heavy debts made it impossible to finance necessary improvements in his collieries.

An adequate supply of labour to cope with the growing demand for coal in the 18th century was not available in thinly populated Cumberland, and colliery managers made strenuous efforts to recruit workers from other areas. Ireland, Scotland and the Newcastle district proved a fruitful source of manpower.* John Bateman, manager of Whitehaven Colliery, reported in 1804, "A great number of Irishmen from the County of Down have very lately come into Cumberland — we have got several to work. Some offer well and others were very indolent and went to country work, several Scotchmen have come over since Whitsuntide as wages there are very much come down the last term. We had rather have one Scotchman than five Irishmen, if we can keep the Scotchmen a few weeks they are sure to turn out well."[74] At Workington a contemporary wrote, "Mr Curwen employs a great number of Irish, much to the dissatisfaction of his English workmen, who protest against them generally as foreigners and papists, and are particularly irritated against them for sneakingly submitting to receive such wages as they can procure."[75] These feelings precipitated a serious riot by the Workington miners in 1814 which had to be put down by troops.

* Cf.: A. Redford, *Labour Migration in England 1800-50*, 49: "In general, the evidence for any strong influx of labour into coal mining is not plentiful. A large part of the supply of new labour required by the expansion of the industry probably came from the natural increase of a notoriously prolific section of the population." In 1802, of the 453 employees at Howgill Colliery 149 were immigrants — 44 were Irish, 41 were Scotsmen and 21 came from Northumberland and Durham. (Howgill Colliery payroll, 1802.) Between October 1810 and May 1811 43 workpeople left Whingill Colliery, all of them immigrants. Of these, 19 were Irish, 19 came from Newcastle and 2 were Scots. (Curwen MSS.)

During the Napoleonic War, shortage of labour in the mines became an acute problem for colliery proprietors in Cumberland. To attract miners, advertisements were inserted in Newcastle, Scottish and Manchester newspapers as well as local publications. Competition among employers to obtain miners forced up wages and stimulated a rapid turnover of labour. The mobility of labour is shown by the number of absentees from Workington Colliery noted by the viewer, Edmond Bowness:

23 July 1806—30 May 1807 .	60
30 May 1807—30 March 1808 .	49
30 March 1808—6 July 1808 .	32
6 July 1808—31 August 1808 .	25

Between 1809 and 1812 the colliery lost in successive years 147, 108, 81 and 50 employees, but gained in the same period 154, 102, 119 and 111 employees.[76]

Matters were made worse when the Cumberland coal-owners poached miners from each other. Curwen was no exception. John Bateman informed his master, Viscount Lowther, "I afterwards found Mr Curwen's people had been trying to get hold of some of your good men. I think it would be an agreable and beneficial thing both for your Lordship & Mr Curwen if you would draw a line not to employ each other's men but under certain restrictions — their running from Colliery to Colliery makes them very unmanageable."[77] Bateman, however, was very willing to hire men belonging to the Curwen collieries. A letter of his refers to a visit from Mr Swinburn, Curwen's agent, "about some of their men we got last week, & wanted me to promise not to take any more, & they would engage not to take any of your Lordship's men, but I found they were full of men & Shipping a Thousand Waggons a week which is more than we are Shipping here & we used to Ship more than all the

Northern ports together. I told him if he would allow us to fill up our Number wanted, then we would comply with his request, this he objected to; then I asked him if they would give up all the Colliers that formerly belonged to these collieries; this he also objected to; then I told him we must remain at liberty to take all that offered untill we have enough & then we would treat with them. Upon which he desired we would make out a List of all those we claimed & he would name it to Mr Curwen. Here the Business stopped.

"I think it would be very wrong to stop taking their men untill we have enough, in fact we might be some years in getting to the extent we aim at, as they are better situated for getting the Newcastle Colliers than we are, they call there first, as their Colliery is in their way to this Place."[78] Naturally Curwen's men continued to try to tempt miners away from Whitehaven and in 1803 they were offering "the Haggers 4/6 per day certain, if they could not make that sum at their price of Hagging Mr Curwen would make it up to them, the women fillers of Coals he offered 12s per score (*above double our price*) ——— they would give in Hand on their arrival at Workington from one to five guineas for each Hagger. What Mr Curwen can mean by such conduct I cannot guess. He knows I dare say that all your Lordship's People are hired Servants, & that he cannot legally keep one of them."[79]

Such a state of affairs could not continue indefinitely. Reason prevailed when on 11 June 1803 an agreement was made by the rival employers not to employ each other's men for the next seven years although each would retain workmen acquired prior to this date.[80] Agreements of this kind did much to reduce the pressure on harassed collier managers; after the agreement with Mr Curwen, Bateman could write, "Our Haggers' Conduct is very much altered for the

better since they find they cannot when loose go to Workington, they follow their work better & are far more moderate in their expectations about the Prices of their Works."[81]

Working conditions in the Cumberland coalfield in the early 19th century were harsh. To one horrified writer who visited the mines there the workers seemed little better than slaves, prematurely aged, diseased, wretched and almost sub-human, "The people in the mines are looked upon as mere machinery, of no worth or importance beyond their horse power. The strength of a man is required in excavating the workings, women can drive the horses, and children can open the doors; and a child or woman is sacrificed, where a man is not required, as a matter of economy, that makes not the smallest account of human life in its calculations."[82]

The worst feature was the employment underground of women and children. In Cumberland the proportion of female workers to male workers remained high; out of 453 employees at Howgill Colliery in 1802 at least 124 were females.[83] Women and girls were employed in filling and hooking baskets, tending to the roads and driving the underground horses. From the age of five, children were employed as trappers and to carry lights for the men, for as long as 13 hours per day. An indenture of 25 June 1804, preserved among the Curwen records, shows James Wilkinson, a boy of seven, being bound apprentice for fourteen years as a coal-hewer and engine-man, "And whereas the said Apprentice by reason of his Tender Age will not be fit to be employed in the business of Coal Hewer and Engine Hand for some years it is agreed, that in the meantime, and until the said Apprentice is of fit Age and Strength to be employed in the aforesaid business; He is to be employed in attending Trap doors, Cleaning of Roads, Drawing of Horses under ground, or any

other offices, in any of the Coal Works of his said Master, and the said Apprentice shall and will find and provide for himself, Meat, drink, Washing and Lodging and also all proper and necessary Wearing Apparel during the said Term of fourteen years.'' The boy's weekly wage for the first four years was to be 5s., then 6s. for the next four years; then 7s. for three years and 8s. for the last three years. Long hours, loneliness, darkness and discomfort took their toll of these children and as early as 1814 Ayton was calling for government intervention to prevent parents from exposing their children to the hardships of the mines.[84]

Mine workers in Cumberland in the early 18th century were paid on time-basis; thus at Whitehaven in 1709, haggers were paid 10d. per day, trailers, bankmen and winders 8d. and corvers 1s.[85] But about 1730, piece rates replaced time rates, a change which makes it difficult to determine the precise earnings of the hewers; and piece rates varied not only from one pit to another, but also in different seams in the same pit, higher rates being paid to those working in the more difficult seams. At Broughton in 1760, hagging cost 5d. per ton at the Hopewell Pit; two years later it cost 6d. per ton at Hopewell Pit and 7d. per ton at the Well, Success and Delight Pits in the same colliery.[86] As mining developed the shortage of men made pay increases necessary to attract them to the mines. Thus at Harrington in 1783, hewers were being paid 12d.-14d. per ton.[87] At the Workington Colliery in 1796 the wages of hewers (who also trailed their coal) varied from 13d. to 22d. per ton. The daily wages of the other employees were:[88]

Waggon drivers	12d.	Lamp keeper	18d.
Banksmen	22d - 24d.	Screenworker	21d.
Enginemen	24d - 30d.	Hooker	20d.
Overmen	24d - 32d.	Coal picker	5d - 8d.
Firemen	17d - 22d.	Doorkeeper	4d - 6d.

A six-day working week was then in operation and wages were paid fortnightly.

Wages continued to rise sharply during the war since the scarcity of manpower and the consequent loss of profit* made it impossible for employers to resist repeated demands for higher pay. By 1810, miners at Broughton Moor were being paid 2s. 9d. per ton for hagging and trailing, bankers received 21s. per week and bank pickers 12s. per week.[89] At Harrington in 1812, haggers were paid 1s. 9d. to 2s. 2d. per ton, hookers 2s. 2d. to 3s. per day, engine men 2s. 6d. to 3s. per day, firemen 1s. 9d. per day and trappers 8d. per day.[90] In 1814, wages at Workington were:[91]

Hagging & putting the Main Coal	2s. 6d. per waggon
Driving rollies	2s. per day
Hookers and on-setters	3s. ,, ,,
Overmen	3s. 6d. per day
Shift work 2s. 6d. to 3s. to 3s. 6d. per shift of 8 hours	
Enginemen	3s. 2d. per day
Plugmen at Main Engine	3s. 6d. ,, ,,
Firemen, Waggon men and fillers	2s. 6d. ,, ,,
Bankmen	3s. ,, ,,

The miners had to find their own candles, pay for their coal (which cost them about 1s. 6d. per week) and pay their own house rent which varied from £2. 10s. to £5 per annum. This was not the case at Whitehaven where the Lowthers provided their workmen with rent-free cottages and with fuel for which they had to pay only the cartage cost to their homes.

During the war Curwen established a warehouse where his workpeople could buy cheap meal and flour. This scheme was discussed by his senior officials at their regular meetings in 1801.[92] To the question put forward for discussion, "Is Mr Curwen's carrying on a Warehouse for supplying the Colliers and others with Meal and flour at reduced prices, found to be

* "The profit upon each Hagger until we have enough at 2 Waggons per day is 14s. or £4. 4s. per week." (Bateman to Viscount Lowther, 12 December 1802.)

generally beneficial to that Class of People?" The answer given was, "Under the present mode of Conducting such Warehouse it is not thought to be generally beneficial to the people." A week later (27 June 1801) the question was put, "Should Mr Curwen think proper shortly to discontinue his present warehouse (on giving Credit to such of the workmen as stood in need of it, for the amount of one 4th nights provisions, to be afterwards paid by small installments each pay day) would any inconvenience or hardship arrise by such discontinuance or would it be productive of any disturbance?" The reply was, "Under the mode proposed by the question it does not appear that any inconvenience or disturbance would arrise." Nevertheless the warehouse continued, but after the war it gave rise to much dispute because, it was alleged, it was part of a system of truck payments.

Truck payments were never widespread in Cumberland. There is no evidence to show that the Lowthers indulged in this practice. But a petition to Curwen, dated 15 May 1822, and signed by about a hundred tradesmen, attributed their diminished business to "the mode adopted of paying the workmen you employ in various articles of general consumption instead of money . . . we therefore trust, that upon this representation you will give instructions forthwith to your agents to pay the workmen in money only." It may be that the Workington miners had some reason for calling the pay-office the "Juggling Room", although one local newspaper claimed that the system enabled the employees to obtain meat, flour and other goods at low prices in bad times. It was asserted that a counter-petition, signed by 800 people, calling for the retention of the truck system was obtained by the threat of dismissing all those who would not sign.*[93]

* Hughes, *op. cit.*, 183-184 and 370, does not appear to find any element of "truck" in this system of Curwen's. The 1822 episode he attributes to a malicious party political manœuvre to discredit Curwen during a heated controversy with Lowther over improvements to Workington harbour.

Apparently truck payments were then abandoned. The Report of the Committee on the Payment of Wages (1842) contains no evidence on the existence of truck in Cumberland.

At Workington, as at other coastal collieries in Cumberland, mining developed primarily to provide fuel for the ever-growing market in Ireland; comparatively little was needed to satisfy home demand. But control of the coal trade lay with the masters of vessels sailing out of the Cumberland ports and not with the colliery proprietors. The master bought the coal, shipped it, sold it and, after paying all expenses, shared out trading profits among the owners of the vessel. At the close of the 18th century the trade in coal was not very profitable, and Hutchinson commented,[94] "The profits to the shipping are very uncertain, no capital of such extent makes so poor a return; it barely affords a living profit to the industrious and the careful. The shares are divided into small parts, and are generally taken to oblige some individual, rather than with the view of much advantage."

Colliery owners held shares in vessels, but were never able to dominate the fleets of colliers as is shown by their disputes with ships' captains over coal prices, harbour facilities and port dues. Curwen by 1804 had bought shares in a hundred vessels, not all of them engaged in the coal trade, but his profits from shipping were a very small proportion of his total income; in 1798 they amounted to £303. 1§s. 6d.[95]

It was the coal-owners who fixed the price of their coal at the ports, and price increases often led to friction with the masters of vessels whose profits were often meagre enough because of their lack of organisation and business skills. For the last twenty years of the 18th century the price of coal, apart from minor fluctuations, had remained steady at 10s. 6d. per

waggon. After 1801 came a series of price increases, usually initiated at Whitehaven and followed at the other Cumbrian ports. At Whitehaven from 10s. 6d. per waggon in 1801 the price went up to 13s.-14s. in 1802, 15s. in January 1803, and 17s. in December 1803.[96] A letter to Curwen from John Grieve (1 February 1804) suggested a further increase:

> I have now to suggest a remedy for the present outstand between the Shipmasters and their sailors . . . A sailor has £5 — 5 a trip to Dublin and he asks another guinea while the risk continues of his being impressed at Dublin. The Shipmasters refuse to give the additional guinea alledging, if they once give it, they must always give it, even after the risk of impressing in Ireland is at an end.
>
> Now without interfering with the promise that the Shipmasters may have made to one another not to pay their sailors more than £5 — 5 a Trip Lord Lowther and you by laying an additional 1/- on the price of the waggon of coals could pay that risk-guinea to each Sailor without any loss to yourselves — and with much benefit to the Trade in these parts where the present outstand has been so detrimental, as to distant coal Ports it has been profitable.
>
> Whitehaven coals and yours are shipped free on board at 17/- per waggon or 8/6 a Ton or 24 Cwt. The same Ton is shipped free on board at Ayr, Irvine and Saltcoats for 13/-.
>
> At Liverpool the Tons is shipped for 17/-.
>
> . . . from the disparity between your price and the Scots price, it seems plain that your price would bear a rise.[97]

This advice was not followed immediately, but when John Bateman attempted to raise the price at Whitehaven to 18s. per waggon in December 1805 he aroused a storm of opposition. For three months the infuriated shipmasters refused to take on coal at the new price and Bateman had to give way. Not only did the price remain at 17s. but also the waggon was now to contain 26 instead of 24 Cumberland bushels, with the result that Lord Lowther received 15s. 7d. for the same amount of coal that had formerly brought 17s.[98] However in 1812 the price was raised and again it provoked anger as William Swinburn reported in a letter to W. Renwick of Ayr Colliery (9 March 1812):[99]

"Sir,

I take the liberty of recommending to your attention Mr. Wm. Lonsdale who I send over in behalf & on the acct. of J. C. Curwen, Esq. to learn a little of the nature of your Coal works, Harbour & that of the neighbouring Collieries. In the attempt by Mr. Curwen and my Ld. Lonsdale to advance the sea sale prices here from 17 shillings to 18/6 per Waggon they have met with opposition & our Shipmasters continue to hold out against it.* They set forth as a plea the great advantages held out to them at the Scotch Collieries, particularly Ayr & Truin. Mr. Lonsdale will give you every information respecting our collieries & ports. And we would be very glad to know the fact as to the quantities, quallity, weight &c of your Coals. I think the export Collieries ought to be nearly upon a par taking every Circumstance into Consideration." This time the coal-owners were successful and the new price of 18s. 6d. per waggon remained in force for the remainder of the war period. After the war the price was lowered to 16s. per waggon but the shipmasters gained little from this. Swinburn informed John Buddle (17 May 1817), "The coal trade had never since I knew it a worse aspect — the shipments have indeed not been so bad lately as the profits to the ship owners . . . The principal cause seems to me to be from the poverty & distress of the Irish — compelling them to use only (perhaps) half the quantity of what they formerly consumed & the same quantity being exported from this coast causes such an overplus in the market as to leave no profits to the carriers."[100]

From the records available[101] the following are the shipments of coal from the Curwen collieries and from Workington:

Year.	Workington Colliery.	Harrington Colliery.	Workington†
1774			46,426 Tons
1775			58,848 ,,
1776			60,380 ,,
1777			64,320 ,,
1778			75,193 ,,
1779			66,405 ,,

* On the same topic Swinburn wrote to Thomas Harriston, a Dublin coal merchant (4 March 1812): "They (i.e. Lonsdale and Curwen) have met with a serious opposition from the ship owners & masters which will of necessity cause a very considerable delay in the shipment of Coals from these Ports, Whitehaven, Workington, Harrington, Maryport. This will I doubt not have a considerable effect in advancing the price in the Markets in Ireland." (Curwen MSS. 3/43.)

† 1774-86, year ending February; 1791-95, year ending April; 1796-1816, year ending May.

Year.	Workington Colliery.	Harrington Colliery.	Workington*
1780			65,403 Tons
1781			64,663 ,,
1782			62,835 ,,
1783			72,079 ,,
1784			72,799 ,,
1785		14,389 Waggons	79,368 ,,
1786		12,866 ,,	80,769 ,,
1787	63,618 Tons		
1788	60,930 ,,		
1789	57,909 ,,		
1790	65,148 ,,		
1791	72,912 ,,		43,117 Waggons
1792	59,313 ,,		45,743 ,,
1793	69,012 ,,		37,584 ,,
1794	66,585 ,,		43,041 ,,
1795	69,033 ,,		44,867 ,,
1796	61,608 ,,		44,140 ,,
1797	63,885 ,,		45,169 ,,
1798	69,204 ,,		47,250 ,,
1799	23,577 Waggons		48,543 ,,
1800	32,481¾ ,,		45,009 ,,
1801	30,823 ,,		47,970 ,,
1802	34,980 ,,		42,778 ,,
1803			46,733 ,
1804	39,301 ,,	20,510 ,,	41,269 ,,
1805	37,178 ,,	17,375 ,,	47,272 ,,
1806	39,022 ,,	19,571 ,,	45,797 ,,
1807	33,941 ,,	18,323 ,,	41,011 ,,
1808	35,098 ,,	24,252 ,,	38,726 ,,
1809	25,196 ,,	16,219 ,,	32,322 ,,
1810			26,563 ,,
1811			25,742 ,,
1812			29,279 ,,
1813			29,659 ,,
1814		15,391 ,,	25,112 ,,
1815			23,378 ,,
1816			26,695 ,,
1817			
1818	30,515 ,,		
1819	32,794 ,,		
1820	28,900 ,,		
1821	30,770 ,,		

* 1774-86, year ending February; 1791-95, year ending April; 1796-1816, year ending May.

Working costs increased as the mining industry developed; deeper pits, longer distances from the face to the shaft, the provision of steam engines and rising wages accounted for the increase. In 1709 the average cost of getting coal at Whitehaven scarcely exceeded 1s. per ton,[102] but by 1800 the cost of working Howgill coal had risen to 2s. 5½d. per ton.[103] Costs varied from one colliery to another, the large and well-equipped collieries with their thick seams producing coal at lower costs than their rivals. At Harrington in 1783 working costs were 2s. 1¾d. per ton, the shipping price 3s. 6d. per ton, leaving a profit of 1s. 4¼d. per ton.[104] At the small inland colliery at Bolton in 1773 it cost 3s. 10½d. to raise a ton of coal, which left a profit of only 1½d. per ton.[105]

In 1810 Broughton Moor coal was obtained at a cost of 10s. 9d. per waggon and sold inland for 14s., earning a profit of 3s. 3d. per waggon. But the same coal, shipped at Maryport for 16s. 8d. per waggon, showed a profit of only 1s. 8d. because cartage costs were so high. To move a waggon of coal from Broughton to a staith near Maryport cost 1s. 3d., cartage from there to the ships cost a further 2s. and the upkeep of the waggon-way amounted to 1s. per waggon.[106]

Buddle in 1817 calculated the cost of working and delivering a 42-cwt. waggon of coal to the ships from the individual pits of the Workington Colliery, and the results of his calculations were:

	Union		Lady		Isabella		Church	
	s.	d.	s.	d.	s.	d.	s.	d.
Working and delivering to ships.	10	3	12	7	9	6	7	9¼
Difference between Pit & Shipping ton, one-sixth.	1	8½	2	1	1	7	1	3½
Engine Coal & Machine.	1	0½		2	1	4¼		3¼
	13	0	14	10	12	5¼	9	4

At that time a waggon of coal for shipment was sold for 16s.

The Curwen collieries were much less profitable than those of the Lowthers. His net income for tax purposes for 1798 was £10,141. 2s. 1d., of which £6,875. 15s. 5d. came from coal mines worked by him.[107] His profits fluctuated considerably, as can be seen from the following table showing the profits and losses between 1806 and 1813 at Moorbanks, Chapel Bank, Harrington and Broughton Collieries, and from the sale of ironstone.[108] Losses are underlined.

	Moorbanks Colliery.	Chapel Bank Colliery.	Harrington Colliery	Broughton Colliery	Ironstone	Total Profit.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1806	3,952 14 8	9,627 13 2½	6,466 14 3	640 13 7¾	201 0 4	20,888 16 1¼
1807	649 3 11½	5,912 14 9½	6,078 18 1¾	314 2 8	72 17 11	13,027 17 5¾
1808	618 12 8½	1,716 2 7	6,782 17 3½	845 4 9¼	247 15 10	8,973 7 9¼
1809	347 14 2½	40 18 1½	3,452 17 4½	824 4 3	12 9 7	3,982 15 1½
1810	835 12 7½	2,217 10 11	4,531 7 5	907 8 0	410 15 9	2,796 7 7½
1811	2,794 1 4	3,218 14 6	5,517 17 0		102 8 0	11,633 0 10
1812	1,499 9 3	308 18 2*	4,496 14 1	1,500	43 15 0	6,871 11 2
1813	2,791 18 8	4,254 17 10	4,719 0 11½	1,000	56 15 2½	4,312 17 0

But these figures do not include the costs involved in sinking the new Isabella Pit and the amount of profits should be amended as follows:

Year.	Cost of Isabella Pit.	Total Profit.	Total Loss.
	£ s. d.	£ s. d.	£ s. d.
1807	265 8 4	12,762 9 1¾	
1808	5774 6 9	3,199 1 0¼	
1809	5841 2 11		1,858 7 9½
1810	4837 8 10½		2,041 1 3

Unfortunately for Curwen matters were made worse by an explosion at Isabella Pit in November 1810 which caused a loss estimated at £3,000.

The situation at Workington showed little improvement after the war:

* In addition to the losses in 1812 at Chapel Bank and from the sale of ironstone Schoose Colliery incurred a loss of £271. 19s., which has been taken into account when calculating the total profit for the year.

Year.	Colliery.	Profit. £		Loss. £
1818	Moorbanks	1,966	Chapel Bank	1,573
1819	Moorbanks	1,058		
	Chapel Bank	2,467		
1820	Moorbanks	488		
	Chapel Bank	1,666		
1821	Chapel Bank	1,803		

The average annual profit at Workington between 1818 and 1820 was therefore £2,024. But the above figures disregard the sum of £2,855. 15s. 11d. expended on the new Buddle Pit, which, if included in the working charges, would reduce the average annual profit to £1,072.[109] There is no information available about profits and losses at Harrington and Broughton Collieries at this time.

It is clear, therefore, that coal mining was not always productive of unreasonably high profits, and the return to capital was sometimes slight. Exploratory work, at times to no purpose, could be extremely expensive and an accident could wipe out the work of many years and invested capital amounting to many thousands of pounds. It was a business that involved much risk and, to quote Buddle, "Perhaps no stronger Proof of the great Risk can be adduced than that it is a property which cannot be insured, either against Fire, Water, or any other Accident. We have never been able to effect an Insurance on a Coal Work." In addition it was impossible to borrow money on collieries without collateral security almost equal in amount to the money borrowed.[110]

Increasing costs and declining profits compelled Curwen to borrow money on a large scale from a wide variety of individuals. It is reasonable to suppose that the expenditure involved in sinking Isabella Pit was a major cause of his indebtedness. His financial position in his last years may be summarised in this way:[111]

Year.	Money Owed to J. C. Curwen. £	Money Owed by J. C. Curwen. £
1818	14,649 13 9½	118,042 4 7
1819	16,003 17 10	120,522 4 1½
1820	15,749 19 5	120,567 15 7½
1821	21,020 15 8	124,302 7 6
1822	20,836 14 6½	124,710 7 10
1823	16,007 15 10½	124,111 3 1½
1824	14,827 9 1½	124,796 17 2½
1825	15,202 12 3½	126,818 16 11½
1826	17,304 17 9½	126,763 13 7½
1827	16,996 12 5½	122,606 18 1
1828	16,579 12 8	118,334 9 0

Thus the combined resources of the Christian and Curwen estates had proved inadequate to finance the collieries, but the injection of borrowed capital could not stop the rot. The high hopes and prosperity of Curwen's early years gave way to falling output, smaller profits and a large debt burden and the collieries themselves were badly in need of a thorough overhaul.

Acknowledgement.

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Location of Primary Sources.

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Leconfield MSS.	Cockermouth Castle. Accessible to searchers through the Record Office, Carlisle.
Boulton & Watt MSS. John Buddle MSS. Watson Collection.	Birmingham Reference Library.
T. E. Forster Collection.	This large collection includes the view books of John Barnes and Matthias Dunn.

The Buddle, Watson and Forster collections are deposited in the North of England Institute of Mining & Mechanical Engineers, Neville Hall, Newcastle upon Tyne. There is an index, by collieries, to the MSS. here, and material may often be traced most readily by first referring to it.