ART. XIV.—*Water-power and the Industrial Revolution.* By D. G. WATTS, M.A., B.Litt.

Read at Carlisle, September 1st, 1966.

IN examining the early industrial history of the North-West, we are fortunate in being able to draw on John Somervell's pioneer survey of the *Water-Power Mills of South Westmorland.*[1] It is one of the few accounts at present in print which attempt a systematic description of all the mills on a particular river system, and not merely those which were prominent or picturesque. Somervell's study was limited to the River Kent and its tributaries (to be called Kentdale in this paper); it did not attempt to deal with the streams flowing into Windermere, or with Lonsdale, both areas with an interesting history of water-milling.[2] But even for the limited area of Kentdale, an analysis of Somervell's work provides evidence of a use of water-power remarkable both in magnitude and in variety of application.

TABLE 1.—*Water-mills in Kentdale.*[3]

	To 1250	1250-1350	1350-1450	1450-1550	1550-1650	1650-1750	1750-1850	1850 on
Corn	11	28	16	19	19	18	36	26
Industrial	—	7	12	6	10	16	54	53
Total	11	35	28	25	29	34	90	79

[1] John Somervell, *Water-Power Mills of South Westmorland*; for the purposes of this paper I have confined myself to Somervell's published material, and have not incorporated additional evidence, e.g. Witherslack Mill.

[2] For the Windermere district, see M. L. Armitt, "Fullers and Freeholders of Grasmere", CW2 viii 136 *sq.*; and M. L. Armitt, *Rydal,* ch. v. For Kirkby Lonsdale, see A. Pearson, *Annals of Kirkby Lonsdale,* 66.

[3] A precise count of water-mills is difficult, if not impossible. The sources are frequently insufficiently precise, e.g. on the water-mills of Crosthwaite, Somervell, *op. cit.,* 113 *sq.* A particular problem is whether two pairs of stones in one building are two mills (they are often described as such in medieval documents); another, whether two mills should be counted if one wheel is used to power more than one industrial process. The totals therefore depend to some extent on personal judgement. Another difficulty is evidence of continuity in the use of a mill. The rule normally followed in compiling the table has been that where, after a gap in the evidence of a century, a mill has reappeared on the same site and/or with the same name, continuity has been assumed; where the gap is two centuries or more, discontinuity.

The fluctuations in the numbers of mills are to some extent due to the variable quality of the evidence. There were probably more than eleven mills before 1250, but we lack the early sources, particularly the Domesday Book entries, which would tell us about them. Similarly, in the later Middle Ages, the decline in the number of mills may be as much the outcome of inadequate sources for that period as of the economic depression which followed the Black Death. On the other hand, the sharp rise after 1750 is partly the result of the much improved sources, such as maps, directories, and local histories, for the early 19th century. While bearing this element of caution in mind, I believe the figures indicate a number of interesting features over the whole period. This paper will however be concerned only with the features of the last three centuries.

The long history of industrial milling in Westmorland began with the fulling of cloth in the 13th century, when the spread of the woollen industry to the north and west of England was part of what has been called "an Industrial Revolution of the 13th century".[4] In Kentdale, water-mills did not decline with the depression in the woollen industry in the mid-17th century, but began to be harnessed to other industrial uses.[5] Then, after 1750, the numbers of mills increased so rapidly that I think we are justified in speaking of an Industrial Revolution in Kentdale during the late 18th and early 19th centuries.[6] The particular industries served are shown below.

[4] E. Carus-Wilson, "An Industrial Revolution of the Thirteenth Century", *Essays in Economic History*, i (1954) 41 *sq.*

[5] In contrast to the mills in Grasmere: see "Fullers and Freeholders", *op. cit.* For decline, *circa* 1641, see C. M. L. Bouch and G. P. Jones, *The Lake Counties*, 136; for revival, *circa* 1671, see Sir Daniel Fleming in *Fleming-Senhouse Papers*, 7 — "the people seem to be shaped out for trade", and in 1721 — "this ancient and industrious town owes much of its flourishing condition to manufacture", *Local Chronology*, 123.

[6] For a general account of the industries of the district, see Bouch and Jones, *op. cit.*, chs. v and x.

TABLE 2.—*Industrial water-milling in Kentdale after 1750.*[7]

	1750-1850	1850 on
Corn	36	26
Bobbin	16	15
Woollen	14	10
Linen, cotton	5	3
Metals	5	3
Others	14	22

"Others" included 1750-1850: paper, saw, snuff, dyewood grinding, silk, marble, gunpowder; 1850 onwards: saw, paper, snuff, dyewood, carpets, comb, rope, gunpowder, bone.

This revolution in industrial water-milling took place in spite of the development and spread of the steam-engine during the same period. The effective competition from water as a source of power is demonstrated by the slow introduction of steam-power into this district. The first steam-engine in Westmorland — of only 2½ h.p. — seems to have been that erected in Finkle Street, Kendal, in 1823.[8] But there were probably no more than three or four engines in the district before the 1850's, when steam-engines were first installed in the woollen mills.[9] Water-milling was of continuing importance in the early 20th century in spite of competition from steam, gas, electricity, and petrol, and the history of water-power in the district is still not over today.

This was, then, an industrial revolution without steam; it was also, of course, an industrial revolution without

[7] Where the usage of the mill changed during each period, the first usage has been counted.

[8] The date 13 December 1823 is that given in *Local Chron., op. cit.*, 56; the dates 1823 and 1826 are mentioned in *Westmorland Note-Book* i (1889) 284-285; Bouch and Jones, *op. cit.*, 346, gives the date 1826. Compare steam-engines in Cumberland from 1780 in E. Hughes, *North-Country Life in the Eighteenth Century*, ii 31-32, and at Cark near Cartmel from 1786 in W. H. Chaloner, "The Stockdale Family . . .", CW2 lxiv 365 *sq.*

[9] The first installation at Castle Mills is dated 1850 by Somervell, *op. cit.*, and 1855 by C. Nicholson, *The Annals of Kendal* (1st edn. 1832; 2nd edn. 1861), 243. The early engines are discussed in *Westmorland Note-Book, op. cit.*; engines were installed at Burneside paper mill *circa* 1850, and at Meal Bank woollen mill in 1854 — Nicholson, *op. cit.*, 244, 248; other engines installed at water-mills were at Docwray Hall, Crooklands, Holme, and Crook — Somervell, 57, 81, 100, 122.

the railway, which reached Kendal only in 1846, and in the absence of these two innovations, without the extensive use of coal. Improved transport did contribute to local developments. The main roads were turnpiked after 1752, and the Lancaster Canal reached Kendal in 1819.[10] But the local industrialization was also based on more general factors. It was stimulated, first, by the early industrial development of Cumberland and Furness to the north and west, and by the prosperity of Whitehaven and other ports; and then by the growth, to the south, of the Lancashire cotton industry, with its demand for bobbins, and of the Lancashire ports.[11] It saw the revival of the ancient woollen industry after its 17th-century decline; and it continued to utilize the native resources of the district, wool, wood, and water. Nicholson, writing in 1861, clearly recognized the end of this era: "Before the almost general introduction of steam-engines, and the combination of machinery, the plentiful supply of water might afford some advantages to the manufacturers of Kendal, over those of many other places; but after that the local situation of the town — so far removed from the first essential of modern manufactures — coal; . . . must be confessed to have been greatly detrimental to its prosperity."[12]

It may be argued that these features of local economic history, though interesting, are not significant, because we have been describing only poor, little, underpopulated Westmorland; and that the doubling or trebling of the water-mills of Kentdale was merely a minor side-effect of the Industrial Revolution in Britain as a whole. To put the Westmorland figures in perspective we should compare them with those for some more representative industrial centre.

[10] For transport see Bouch and Jones, *op. cit.*, 273, 279, and *Records of Kendale* iii 1 *sq.* and 101-102.

[11] For a Whitehaven merchant with a Kendal agent, *circa* 1740, see Hughes, *op. cit.*, 31-32; for exports through Liverpool in 1770, see N. & B. i 619.

[12] Nicholson, *Annals, op. cit.*, 242.

Such figures are available for Birmingham. Birmingham was, in 1801, the sixth city in the kingdom.[13] It had early turnpikes (from 1727), canals (from 1768), and railways (from 1837). After 1775, Watt's engines were developed at Matthew Boulton's Soho works there. De Tocqueville was to describe the town as "an immense workshop, a huge forge, a vast shop".[14]

In the early 19th century there were some 45 water-mills in the area of the present city of Birmingham; 29 of these were industrial mills.[15] So that there were in Kentdale twice as many water-mills as in Birmingham and its neighbourhood (90 to 45), among them nearly twice as many industrial mills (54 to 29). Not only were far greater resources of water-power available in Westmorland, but those resources were being actively utilized.

It may be supposed that with the installation of improved steam-engines, the situation was rapidly reversed, and the industrial supremacy of Birmingham demonstrated. But this was not the case. By 1800, about 20 steam-engines, with a total output of 270 h.p., had been installed in Birmingham; if there are added to this the 45 water-mills, with an average output of 5 h.p., or 225 h.p., the total power resources of the area were 495 h.p.[16] The 90 mills of Kentdale would have produced 450 h.p. At that date, then, Birmingham had only just overhauled Kentdale in total power resources. But we are not, of course, dealing with comparable areas; there were about 17,000 people in Kentdale in 1801, and 90,000 in Birmingham.[17] If population is shown as a ratio of power resources, the results are striking. In Kentdale, there was a water-mill for every 190 people; an industrial water-mill for every 315 people; one unit of horse-power for

[13] *Census*, 1801; in descending order of population — London, Manchester, Edinburgh, Liverpool, Glasgow, Birmingham.
[14] *VCH Warwick* vii 26 *sq.*, 122, 223.
[15] *Ibid.*, 253 *sq.*; windmills were of negligible importance in both areas.
[16] *Ibid.*, 122; *A History of Technology*, ed. C. Singer, *et al.*, iv 155, 166.
[17] *Census*, 1801; Birmingham — area of modern city; precise figures are impossible because of changes in local government areas.

every 38 people; and one unit of industrial horse-power for every 63 people. The comparable figures for Birmingham were: water-mills 1 for 2,000; industrial mills and steam-engines 1 for 1,380; total horse-power 1 for 182; industrial horse-power 1 for 216. Looked at in this way, it is Kentdale, for all its hill-farms and bleak fells, which appears as the highly industrialized community, and Birmingham as only partially industrialized. Nor was the disparity rapidly made good during the 19th century. By 1820, there were 60 steam-engines in Birmingham, with an average output of 15 h.p.; with the addition of the continuing water-mills, there was one unit of h.p. for each 105 people (the population was then about 120,000). By 1835, there were 169 steam-engines, and the h.p. ratio, if compared with the 1841 population (about 200,000) was 1 for 68. In Kentdale, by the same date, with rising population (about 26,000), and almost static power resources, the h.p. ratio had deteriorated — to 1 for 58.[18] It was not, therefore, until the mid-19th century that the power resources available to each citizen of Birmingham decisively overhauled those available to the inhabitants of Kentdale.

It is, of course, not the purpose of this paper to claim that Kentdale was a more important industrial district than Birmingham during the Industrial Revolution. Birmingham and district was five times more populous than Kentdale in 1801, and eight times in 1841. Many of the most famous industries of Birmingham were workshop industries which used no power. Nor has it been a purpose to suggest that Kentdale was noteworthy for anything more than Somervell's careful work. An equally exhaustive account of the water-powered industries of Cumberland and Furness would be even more illuminating. But the comparison of Kentdale and Birmingham does, I believe, serve to make clearer what the "Industrial Revolution" was, and what it was not.

[18] *Ibid.*, 1841; *VCH Warwick, op. cit.*, 122.

Water-power made an important contribution, not only to "pre-industrial" society, but to the Industrial Revolution itself. The growth of industry in the north and west of Britain was not merely, or even mainly, the result of the exploitation of coal there; it was an acceleration of the process begun in the 13th century, of harnessing the water-power resources of wet, hilly districts. That the water-milling areas around the Pennines also turned out to be on or near coalfields was a fortunate coincidence. The Industrial Revolution was not a power revolution; in Kentdale, an industrial revolution took place on the basis of the ancient source of power; in Birmingham, such a revolution took place with sources of power which continued to be inadequate in the early 19th century. In 1830, even the cotton industry obtained 25% of its power from water; in 1835, there were in Lancashire and the West Riding 866 water-wheels, as well as 1,369 steam-engines; and in 1850, the woollen industry still obtained a third of its power from water.[19] It was clearly industrial growth which produced the steam-engine and the railway, not the steam-engine and the railway which made possible industrial growth. Not until after 1830 in the second (or was it third or fourth?) stage of industrialization, did the steam-powered factory and the coal-fired locomotive become the distinctive features of industry. Until then, small towns and industrial villages along the valleys, hidden amongst the woods and the hills, served by coastal shipping and horse-transport, remained viable and significant features of the economic system.[20]

[19] *Hist. Tech.* iv, *op. cit.*; *The Cambridge Economic History of Europe* vi, ed. H. J. Habakkuk and M. Postan, pt. 1, 328.

[20] N. & B. i 66 — "goods brought into and carried out of this town weekly, by the pack-horse carriers, before the turnpike roads were made, when waggons came in use"; for coaches see J. F. Curwen, *Kirkbie-Kendall*, 276 *sq.* and *passim*. For coastal shipping see J. D. Marshall, *Furness and the Industrial Revolution*, 85 *sq.*