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# THE HYDRO-ELECTRIC POWER STATION FOR THE GREENSIDE LEAD MINES, WESTMORLAND, c 1890

by D G Tucker

## Introduction

Within about ten years of the first-ever hydro-electric installation(1) at Cragside, Northumberland, in 1880, a rather remarkable hydro-electric plant was built on the slopes of the mountain Helvellyn in the English Lake District. It was remarkable not only for its remote and bleak situation but also for the fact that the electricity generated was used to provide power and locomotion in a lead mine. Around the same time the use of electricity in coal mines was developing, but in such applications it was thermally-generated.

The Greenside Silver-Lead Mining and Smelting Company had been operating on the mountainside to the west of Glenridding (at around grid reference NY 365 174) for over half a century and had made extensive use of water wheels and turbines(2) when it was decided in 1890 to generate electricity as a more convenient means of transmitting and utilising water power in the mines. The system was designed by A T Snell in conjunction with the mine manager, a Mr Borlase, and Snell claimed(3) that it was mainly the economies produced by the use of electricity that enabled the company to compete with foreign mines at a time when most British lead-silver mines were being forced to close. In fact, the Greenside mines survived as a going concern until 1962. The electricity was used for lighting, pumping, winding, and haulage in the mines, the last-mentioned use involving a small electric locomotive.

## The hydro-electric generating station

The generating station itself was close to the junction of the Glenridding Beck and the Red Tarn Beck, at grid reference NY 358 168. The initial equipment comprised a 100 h.p. Vortex reaction turbine made by Gilbert Gilkes and Co Ltd., of Kendal(4), driving a 4-pole compound dynamo made by the General Electric Power and Traction Company, (USA) who were responsible for the whole installation.

The building was made large enough to house another turbine and generator when required, and the head-water pipe was fitted with a Y-junction, one arm being blanked off, to permit the second turbine to be fitted with minimum disturbance. By 1908 at the latest(5), a 100-h.p. Pelton wheel had been fitted to the second branch and drove another similar dynamo. By 1921, the Vortex turbine was listed(6) as "spare (with faulty casing, otherwise complete)" and had been replaced in about 1911 by a 300-h.p. Pelton wheel driving a 220 kVA alternator designed and made by the British Westinghouse Electric and Manufacturing Co. at Manchester(7).

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## The electrical distribution and traction system

Reverting to the original system, the electricity was fed from the generating station by two bare copper conductors carried on insulators on poles for a distance of about three quarters of a mile to the mine entrance at one of the higher adit levels, at an elevation of 1850 ft. Inside the mine the conductors were in lead-covered insulated cables, fixed to insulators on the sides of the levels and on distance-pieces in the shafts. The main parts of the mine were lit by incandescent lamps working six in series across the 600 V supply. Three-quarters of a mile inside the mine, a 9-h.p. series motor was used to wind ore from the working levels to the adit; by 1908 this motor had been replaced by one of 50 h.p. One mile inside the mine, another 9-h.p. motor worked a pump forcing water up 360 ft. Midway between these motors was a dynamotor to reduce the voltage from the normal 600 V to 250 V for the electric locomotive, which worked in a lower level of the mine and hauled 12 wagons weighing 18 tons in total when loaded. The locomotive obtained its electric supply by means of four contact pulleys running on two phosphor-bronze conductors. It operated over a 1.5 mile route, taking about 20 mins. to complete the journey. It weighed 2.5 tons approximately and was apparently still working in 1921 after 30 years in service. A photograph of it is reproduced in Plate A. It is reputed to have given nearly 40 years service(8). Shaw(8) states that it was of 30 h.p., but the inventory (6) shows it as 14 h.p.

By about 1911, as has been mentioned, a 220 kVA a.c. supply was being provided by a new Pelton wheel and alternator. Transmission to the mine was at 2000 V, 3-phase, 50 Hz, using overhead line; within the mine, armoured cable continued the supply to a sub-station at Warsop. Crosscut where it was converted to 600 V d.c.(9). Evidently a considerable expansion of the electrical system had taken place, but full details are not known.

## Regulation and working of generating plant

By 1908 the Vortex turbine was supplying the winding motor and locomotive, and the Pelton wheel was supplying a 50 h.p. motor for driving an air-compressor and two 10-h.p. water pumps. The Pelton wheel thus normally had a constant load and needed no regulating; but an automatic magnetic cut-out was provided in case of failure of one or more of the motors. "The shaft of the Pelton wheel is fitted at its extremity with a small drum having a rope and weight attached, and held in place by a pawl gearing with a ratchet wheel on the end of the drum. Should one or both motors switch off at the same time, the cut-out drips out and falls on the pawl, which in turn relieves the ratchet wheel and through the weight attached to the drum, the shaft is wound into the supply valve, thus reducing the speed of the machine and bringing it to a standstill." (10)

The Vortex turbine, having a varying load, required constant regulating, but as no success was attained with several hydraulic governors which were tried, manual regulating was adopted using a 3-inch by-pass valve.

The station was staffed by two men, one being on duty at a time, the operating hours being 6 a.m. to 10 p.m. in two shifts.

It was claimed that the working cost of the installation was less than one farthing (about 0.1p) per h.p. hour.

## The water supply

The main sources of the water for the generating station were Red Tarn and Keppel Cove Tarn, both already considerably enlarged by damming some 20 to 30 years before electricity was generated. The arrangement of streams and artificial watercourses is shown in Fig. 1. The artificial watercourse which took the water of Keppel Cove Tarn at about the 1750 ft. contour is about 4 ft wide, and is partly cut in natural rock, partly lined with stone blocks, and is of varying depth as it cuts through rock faces; it was intended to carry about 1 ft depth of water. It was covered over with timber baulks and slats. Running roughly parallel to the 1750 ft contour it crosses Red Tarn Beck. It is not now easy to see what were the arrangements at this point. Presumably the water of the beck could be diverted into the watercourse, but the available maps are not clear[11], nor is Shaw's brief reference to the matter[12]. The watercourse continued to a point above the generating station where it terminated in a tank (N.B. Snell, ref. 3, says it terminated in a large reservoir, but there is no other evidence of this and it seems unlikely) from which a 15-inch iron pipe conveyed the water at a slope of about 1 in 3 to the turbines, the fall being about 400 ft. The pipe was in places supported on stone piers. The pipe and the generating station are shown in the contemporary photograph of Plate B.

## Present-day remains

There is now very little to be seen of this once-important installation. The watercourse still exists, and some of the timber covering also. A few feet of the 15-inch iron pipe still remains in the header tank. Some of the stone piers on which the pipe was supported still remain, as can be seen in the modern photograph of Plate C. Nothing of the station building remains, and hardly anything of the foundations, although the site can be recognized as shown in Plate D. It is a wild spot, and one feels for the poor lonely station attendant, especially when making his way to or from work on a winter's day at 6 a.m. or 10 p.m.! No doubt, however, he felt himself to be much better off than the miners.

## Later hydro-electric systems at Greenside Mines[13]

The reason for the almost total lack of remains of the generating station may well be the fact that in October 1927 the dam at Keppelcove Tarn broke after exceptional rains and released a flood which did considerable damage at Glenridding; in passing the generating station it may have destroyed it. At any rate, a new hydro-electric system was built in 1928, the station being at Rattlebeck Bridge (grid ref. NY 379 169); the water was taken from the Glenridding Beck at NY 363 173 and carried in a channel (largely of timber) at an elevation of about 1100 ft to the top of a pipe-line at NY 374 167, where it provided a head of about 400 ft to drive a 300 h.p. turbine.

There was also another hydro-electric system at the mine, built in 1924, using water from Top Dam, a large reservoir at grid ref. NY 357 181 and elevation about 1900 ft., to drive a 150 h.p. turbine near the main mine works (approx. grid ref. NY 634 174).

## Acknowledgement

Thanks are due to the staff of the Westmorland County Record Office, who were most helpful in turning out some of the records of the Greenside Company, amongst which were found the documents cited; and to Mr E N Foster who supplied information on the 1911 alternator.

## References


1. The Cragside installation was well documented and the date is reliable. An earlier use of water power for generating electricity at the Shaw Chemical Works in 1875 is claimed by E F Carter, "Hydro-electric Power", Muller, London 1960, but no authentication has so far been found.

2. Twelve turbines were installed; see M Davies-Shiel and J D Marshall, "Industrial Archaeology of the Lake Counties", David and Charles, Newton Abbot, 1969, pp.149-153.

3. A T Snell, "Note on the use of waste water power by electricity", The Elect. Engr., 12, 22 Sept. 1893, p 280.

4. See P N Wilson, "Early water turbines in the United Kingdom", Trans. Newcomen Soc., 31, 1957-9, pp. 219-241. Wilson states that this turbine was installed in 1893, but it must really have been well before that, for in The Elect., 10, 23 Sept. 1892, p.317 it is reported that the installations had then been completed, and Davies-Shiel and Marshall, loc. cit, state that even the electric haulage was operating by 1891.

5. E T Borlase, "The Greenside Lead Mines, Cumberland", The Eng. and Mining J., New York, 85, 8 Feb. 1908, pp.297-301. Note that the mines and generating station are actually just in Westmorland, but very near the Cumberland border.

6. Inventory of Machinery and Plant, Westmorland County Record Office.

7. Information contributed by Mr E N Foster of GEC Machines Ltd; he has presented to the author a set of prints of the specification and drawings of the alternator.

8. W T Shaw, "Mining in the Lake Counties", Dalesman, Clapham, Yorks. 1970, p.80.

9. ibid, p.89.

10. Borlase, loc.cit.

11. A post-1913 annotation of a 25 inch O.S. map shows the watercourse apparently passing under the beck, but this cannot be right. Fig. 1 is based on a plan of the Patterdale Hall Estate, undated, based on the 6 inch O.S. map; both maps in the Westmorland County Record Office.

12. Shaw, loc.cit., p.89.

13. ibid.


## Illustrations

Fig. 1 Map showing the location of the hydro-electric generating station (grid ref. NY 358 168) and of the watercourses and streams supplying it.

Plate A — The electric locomotive at the Greenside lead mines. (from The Eng. and Mining J., 85, 8 Feb. 1908).

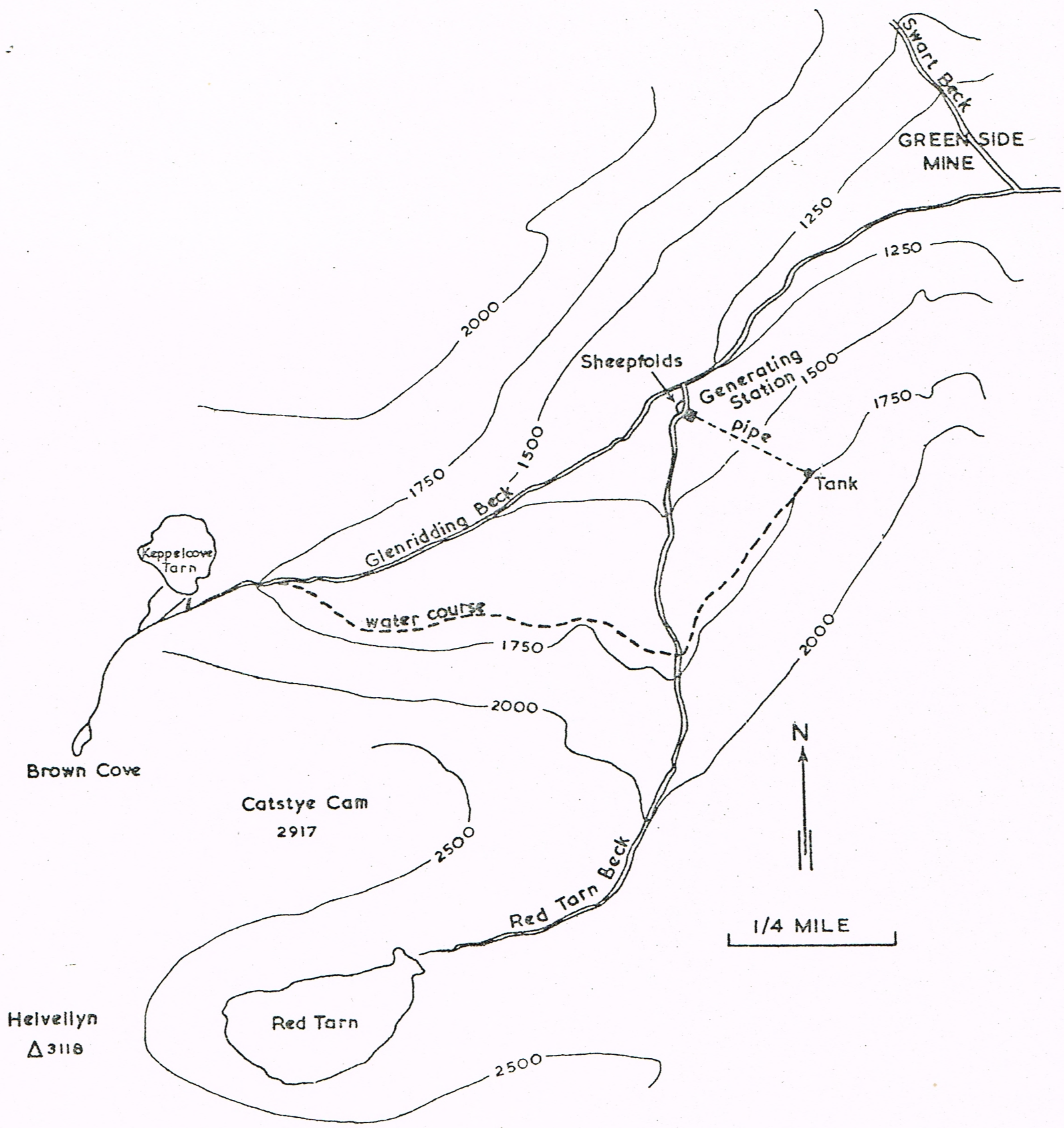
Plate B — The pipe-line from the header tank to the generating station supplying electricity to the Greenside lead mines. (from The Eng. and Mining J., 85, 8 Feb. 1908).

Plate C — Piers for supporting the pipe at the Greenside generating station, still in situ, April 1973.

(Photo by D G Tucker)

Plate D — Site of Greenside generating station, April 1973, in foreground (Sheepfolds in background, between the Red Tarn Beck and the Glenridding Beck, near their confluence)

(Photo by D G Tucker)



Swart Beck
GREEN SIDE
MINE
1250
1250
2000
Sheepfolds
Generating
Station
1500
1500
1750
1750
pipe
Tank
Glenridding Beck
Keppelcove
Tarn
water course
1750
2000
2000
N
Brown Cove
Catstye Cam
2917
2500
Red Tarn Beck
1/4 MILE
Red Tarn
Helvellyn
Δ3118
2500


Figure 1

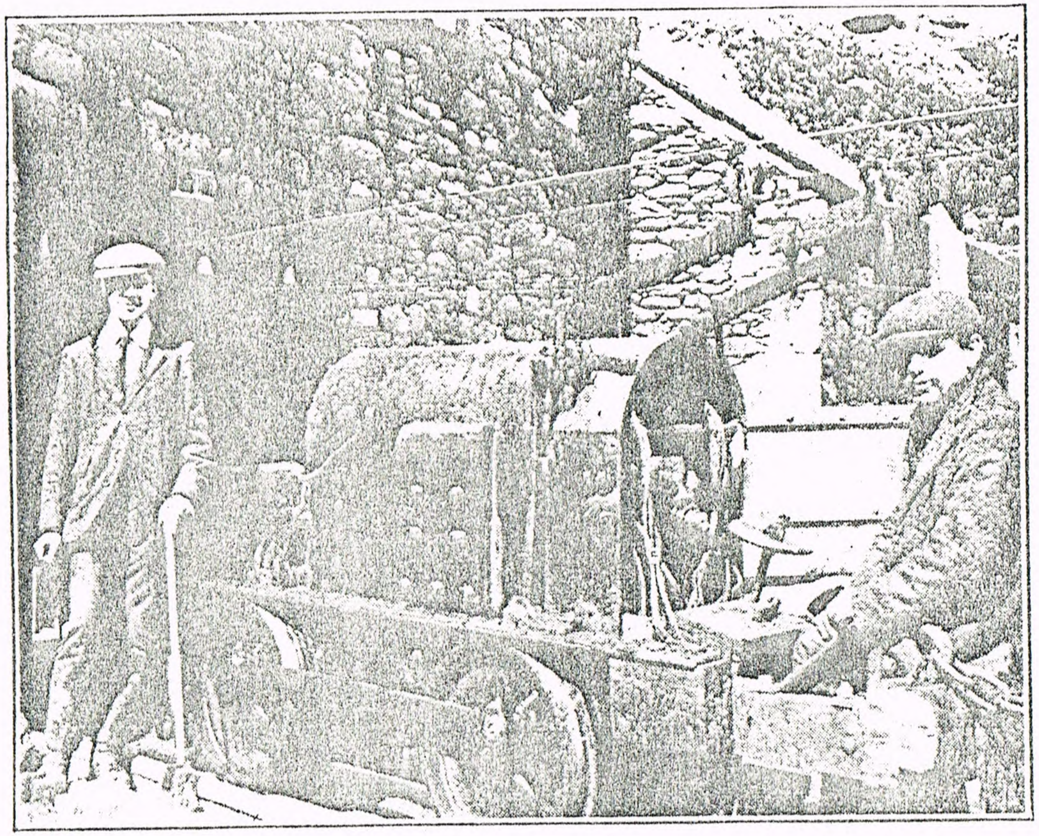


Plate A

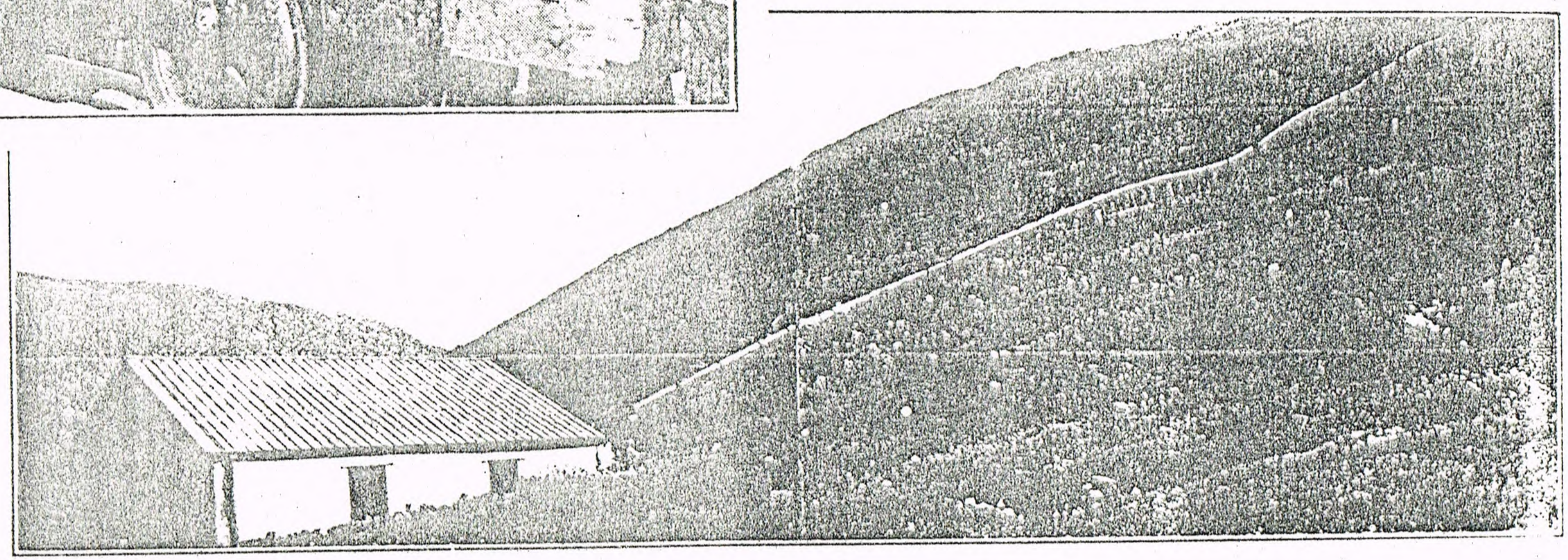


Plate B

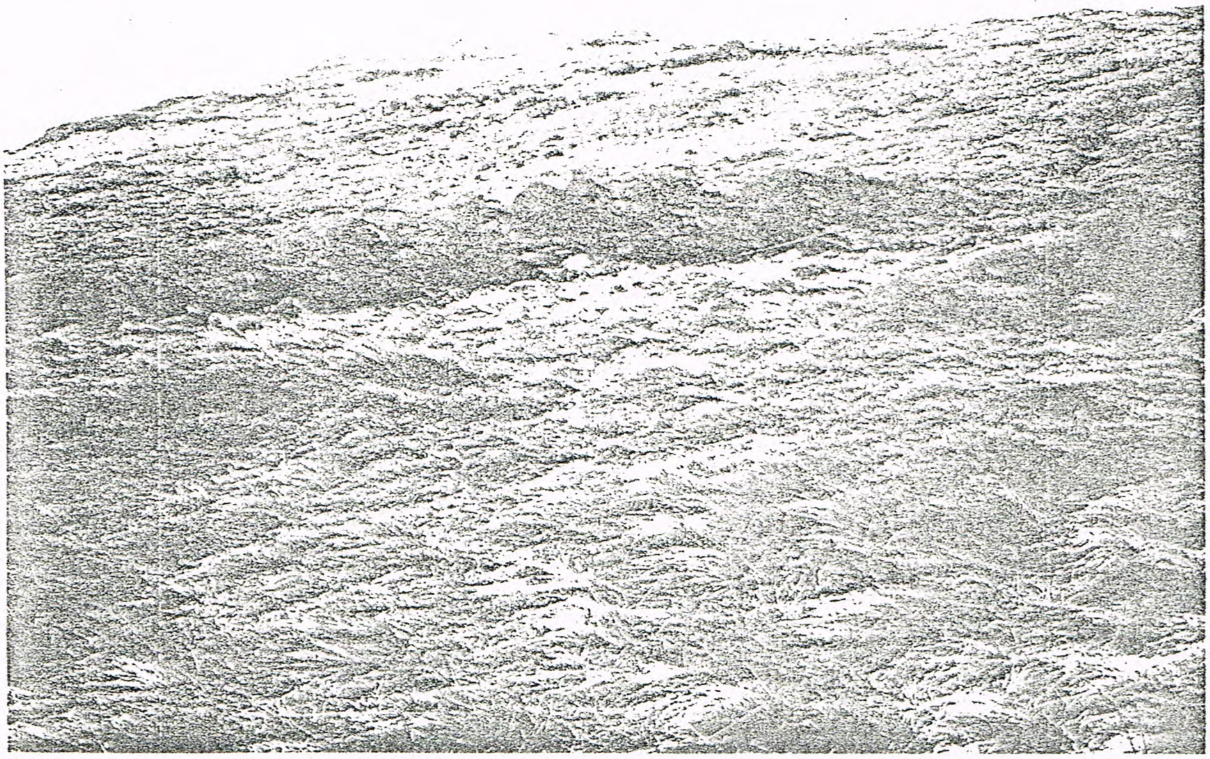


Plate C

Plate D