On Her Majesty's Service

The Gunpowder Mills of Westmorland and Furness

BY

PAUL N. WILSON, O.B.E., D.S.C., M.A., D.L., M.I.C.E., M.I.Mech.E.,
Member of Council

(*Read at the Science Museum, London, 5 February* 1964)

The manufacture of gunpowder in south Westmorland started in the year 1764, and carried on until the last mill closed in 1937. Before 1750 gunpowder had been manufactured only in the south—and mainly in the south-east—of England. John Wakefield, of Kendal, displayed considerable courage when he built this, the first gunpowder mill in the north of England, but having established this new industry and made a success of it, he was soon followed by others. The location of the Westmorland and Furness gunpowder mills (for convenience I will refer to them as the "northern mills") is shown on the Map, and I give below brief particulars.

TABLE I

THE GUNPOWDER MILLS

Name of Gunpowder Mill	Year mill licensed or production started	Name(s) of principal owner(s)[1]	Remarks
Sedgwick (old)	1764	Wakefield	Closed *c.* 1850
Bassingill	1790	Wakefield	Extension of Sedgwick Mill
Lowwood	1799	Wilson & Barker	Bought by Wakefield in 1882
Elterwater	1824	Huddlestone	
Gateback	1850	Wakefield	Sedgwick moved to Gateback
Sedgwick (new)	1857	Swinglehurst	
Blackbeck	1860	Dickson	

From the above table it will be seen that the importance of the industry increased steadily, and it reached its greatest prosperity between about 1860 and the end of the 1914–18 war. Shortly before 1914 the local mills were producing about 50 per cent. of the gunpowder manufactured in the United Kingdom. No Paper on the manufacture of gunpowder has been presented to the Newcomen Society, and I must assume that most of our members are as ignorant upon this subject as I was two years ago. I therefore feel that I must devote some space to describing, as briefly as I can, the history and technology of gunpowder manufacture, although this means that I will be able to say rather less

[1] Several of the mills had changes of ownership. The names are those of the principal owners when the mills were operating as successful independent units.

about the northern mills. One aspect which interests me particularly is *why* this new industry started in Westmorland. I have been unable to find any written information upon this subject, but by weighing up the available evidence we can, I think, answer the economic questions with reasonable accuracy. First, however, we must consider when, how and why gunpowder was made.

The History of Gunpowder Manufacture

Roger Bacon (*c.* 1220–92) was the first man to describe gunpowder as we know it. He regarded it as a substance which burned with explosive rapidity, but did not appreciate the fact that, if enclosed in a tube, it could be made to eject a projectile at a high velocity.[1] In the thirteenth as in the twentieth century the men of war were quick to follow the men of science, and Bacon's explosive powder soon became as important as the atomic bomb became later. The uranium of the day was saltpetre (KNO_3) and this, mixed with sulphur and charcoal, produced a magic powder which was to give the European nations domination over the world for 600 years.

The first gunpowder was a loose, dry mixture of three ingredients, saltpetre, sulphur and charcoal. These were ground to a powder, and mixed by hand in wooden mortars. The resultant powder was known as "Serpentine," and was difficult to handle. Even when fresh it had to be packed into the gun barrels with great skill to ensure that there was an adequate charge of powder, and at the same time sufficient air space to allow rapid combustion. The art of the "Master Gunner" involved much more than the accurate sighting of his gun. When this powder was transported the ingredients tended to separate, the heavier saltpetre and sulphur settling to the bottom of the containers, and the lighter charcoal rising to the top. To overcome this trouble the powder was sometimes mixed almost on the field of battle.

Early in the fifteenth century the process of "Corning" was evolved. During the mixing or "incorporating," the powder was moistened with alcohol or urine.[2] This had the effect of converting the fine powder into a stable, hard "cake," which, after compression, could be broken down into grain sizes depending upon the use for which the power was required. This was the "Corning" process. Table 2 below shows in chart form the main processes of gunpowder manufacture. These varied only slightly from the sixteenth century, when the earliest British factories started work until 1937 when the last of the northern mills closed.

TABLE 2

The Processes of Gunpowder Manufacture

1.	(*a*) Saltpetre	(*b*) Sulphur	(*c*) Carbon
2.		Mixing	
3.		Incorporating	
4.		Pressing	
5.		Corning	
6.		Glazing or Reeling*	
7.		Drying	
8.		Moulding*	
9.		Packing	
10.		Transport	

* These processes were only carried out for certain types of powder.

[1] H. W. L. Hime, *Gunpowder and Ammunition, their Origin and Progress*, London, 1904. Hime places Bacon's description of gunpowder at about 1248. He examines carefully the claims that it was invented by the Arabs, the Hindus or the Chinese, or that it was a direct development of "Greek Fire," and dismisses all with, I would say, good reason. He is strongly of the opinion that the discovery of saltpetre as a separate compound was almost contemporary with the invention of gunpowder.

[2] *Encyclopedia Britannica*, Art. "Gunpowder," 1958, edn. "The urine of wine drinkers was held to make the 'strongest' powder."

In dealing with the basic ingredients and the processes of manufacture I must be brief. If I over-simplify, I can only apologise to those with a knowledge of the trade who would be happier if this subject were dealt with in greater detail.

1. (*a*) *Saltpetre* was first produced by a slow and somewhat unsavoury process which involved scraping rotten plaster from the walls of the cellars of old buildings, mixing it in heaps with earth and dung, and watering liberally with urine. In about two years the heap yielded a reasonable amount of saltpetre. Later it was imported from India, Italy and Chile. It was purified by dissolving in water, boiling, straining and evaporating the liquid to leave pure salt crystals. A new method of manufacture was first introduced at Gatebeck *c.* 1865; this will be mentioned later.

(*b*) *Sulphur* (Brimstone) was imported from Sicily and Italy; it was refined by slow heating and skimming off the dross from the surface.

(*c*) *Charcoal* was first made in the conventional way of charring "coppice wood" in open pits. Soft wood made the most suitable charcoal, and alder seems to have been preferred. "Pit Cole," as it was usually called, was satisfactory for iron smelting, but was the least pure of the three ingredients. By the end of the eighteenth century some improved method of manufacture was being sought.

It is a coincidence that this problem was solved by a Westmorland man. The Rev. Richard Watson, later to become Bishop of Llandaff, was born at Heversham in south Westmorland in 1737, and was educated at Heversham Grammar School within two miles of the village of Sedgwick. He was appointed Professor of Chemistry at Cambridge in 1764, and when asked by the Government to suggest some way of increasing the "strength" of gunpowder he put forward the idea that wood for charcoal should be distilled in iron cylinders, replacing the method of charcoal burning. His report was produced in 1786, and the first "cylinder charcoal" was made at Hythe in 1787.[1]

Long, horizontal iron cylinders or retorts, about 2 ft. in diameter, were supported between walls of brick. They were packed with coppice wood cut into short lengths, which were fired for about eight hours each day. The charcoal was removed after the retorts had been allowed to cool. Charcoal was the only basic ingredient which was produced near the mills. Although *by weight* it comprised only 10 per cent. of military or 15 per cent. of blasting powder, it required about 120 lb. of green, fresh wood to make 10 lb. of charcoal. Thus, allowing for waste during manufacture, it would take about 200 lb. of coppice wood to make 100 lb. of blasting powder.[2]

2. *Mixing.* The three basic ingredients were ground to a fine powder and mixed by stirring in tubs or rotating barrels containing brass "bullets," not unlike a modern "ball-mill."

3. *Incorporating* (also referred to as "Amalgamating"). Incorporating is the intimate mixing of the ingredients under pressure with water added. This is the process which requires the most massive machinery, and the greatest amount of motive power. At first the powder was incorporated in wooden mortars pounded by wooden pestles. Later wooden stamping mills were worked by water power, but this was a dangerous process, and stamp-mills were prohibited in England in 1772.[3] Plate XVI (*a*).)

The stamp-mill was replaced by the "edge" or "cylinder" mill. At first one, and later two, heavy rollers about 2 to 3 ft. wide and 5 to 7 ft. in diameter with their axes horizontal were rotated by a single

[1] Richard Watson, *Anecdotes of the life of Richard Watson, Bishop of Llandaff*, London, 1818, p. 240 *et sq.* Dickinson and Straker, "Charcoal and Pyroligeneous Acid making in Sussex," *Trans. Newc. Soc.*, vol. XVIII, 1937–8, pp. 61–68. This Paper includes an interesting illustration of "Charcoal cylinders at Faversham, 1798." Further sketches of eighteenth century powder-making plant and processes are reproduced in *The Rise and Progress of the British Explosives Industry*, VIIth Int. Congress of Applied Chemistry, London, 1909.

[2] Col. Wm. Anderson, *Manufacture of Gunpowder*, London, 1862, p. 55.

[3] Vittorio Zonca, *Novo Teatro*, Padua, 1621, p. 85 shows a seventeenth-century stamping mill. Belidor, *Architecture Hydraulique*, Paris, 1782, pt.1, bk. 2, pp. 348–59, ch. 3, 1st and 2nd plates.

vertical shaft so that they rolled around a plate or tray in which the charge of powder mixture was placed. The rollers were of stone, brass or cast-iron, and the material from which the incorporating mills were made were carefully chosen so that they could not accidentally strike a spark.[1] Stone rollers can still be seen at Elterwater and Lowwood. (Plate XVI (*b*).)

The output of a gunpowder factory depended almost entirely upon the number of incorporating mills which could be installed. The other processes, mixing, corning, pressing, etc. required relatively little power, and in the early days were often carried out by hand. The incorporating mill could only handle a charge of a given weight (limited by law after the passing of the Explosives Act of 1875), and the process took some time. The black blasting powder with which I am mainly concerned in this Paper was incorporated for about $1\frac{1}{4}$ to $1\frac{1}{2}$ hours, the average charge being 75 to 90 lb.[2] The output naturally varied with the state of trade, but the number of incorporating mills gives a useful indication as to the *maximum* capacity of any particular factory producing a given type of powder. The "ripe" charge was lifted from the mill with wooden shovels and taken to the press house. It was known as "mill-cake", and contained hard lumps which had to be broken down with wooden malls.

4. *Pressing.* The "mill-cake" was then compressed into thin slabs. The early "press boxes" were of wood, 2 to 3 ft. square internally, bound with iron (later copper) straps. The powder was packed into the box between copper plates about $\frac{3}{4}$ in. apart, and a wooden cover, fitting *inside* the box, was pressed down. At first this was done by hand with a powerful screw, but later conventional hydraulic presses were used.[3] In the local mills the hydraulic pumps were worked by waterwheels, turbines, or steam engines. Pressing reduced the powder to hard slabs, rather like slate, called "press cake."

5. *Corning* (Granulating). The "press cake" was broken into grains which varied in size depending upon the purpose for which the powder was to be used. We have a good description of a corning machine which was used at Elterwater Gunpowder Works in 1878 and which is probably typical of the early, simple mechanical equipment. This is given by H.M. Inspector of Explosives after he had investigated an explosion.

> "This machine in the corning-house, used for breaking the press cake into grains, was one of the old fashioned corning machines, consisting of a frame of wood suspended from the ceiling, and made to oscillate by means of a perpendicular crank [driven in this instance by a water wheel] passing [upwards] through the floor. In this machine a number of wooden sieves lined with copper and containing pieces of press cake and round blocks of *lignum vitae* placed upon the frame are shaken violently by the motion of the crank, and the blocks dashing about in the sieve soon reduce the press cake to fragments and dust which pass through the sieves to the floor."[4]

---

[1] Zonca, *op. cit.*, p. 82 shows a mill with a single stone roller. John Smeaton, *Catalogue of the Civil and Mechanical Engineering Designs, 1741–92*, Newc. Soc. Extra Pubn. No. 5, London, 1950, p. 31. Drawing 33v., title: "Water Mill, Waltham Abbey, Essex." Description: "For Mr. [Bouchier] Walton's double stack [edge runner] powder mills at Waltham Abbey." The two stones are 7 ft. in diameter and 1 ft. 9 in. wide.

[2] Information provided by Mr. Alfred Bush. Mr. Bush started his career at Gatebeck and later became Manager of the Sedgwick factory before moving to the I.C.I. factory at Ardeer in 1935, where he remained until his retirement in July 1958.

[3] Anderson, *op. cit.*, pp. 90–100 and plate 6. This shows a hand-operated press-box used at Ishapore in India during the early part of the nineteenth century. *I.C.I. Magazine*, vol. 4, no. 10, Oct. 1929. "A short history of the North of England Gunpowder Group," pp. 337–48. Illustration p. 348 shows a screw and nut used at Elterwater to operate a screw press. *The Rise and Progress of the British Explosives Industry*, *op. cit.* Fig. 13.

[4] *Reports of H.M. Inspector of Explosives, Elterwater*, 29 November 1878. After the passing of the Act of 1875 a report was issued after every fatal accident. Much useful information can be obtained from these reports to which further reference will be made in the Appendix. I quote in all cases the date of the accident, and use the abbreviation "H.M.I.Ex." An identical type of sieve, also worked by a waterwheel, can still (1963) be seen at work in Gawith Hoggarth's snuff mill, Helsington Laithes, near Kendal.

The pieces were then sorted into different-sized grains by further sieving. According to Marshall, Col. Congreve invented a corning machine in 1819.[1] This consisted of a series of toothed, gunmetal rolls, followed by plain rolls, which broke up the press cake and automatically sifted the different grain sizes and dust.

6. *Glazing and Reeling.* Nearly all ordinary blasting powder was glazed by placing it in rotating wooden drums, the polishing agent being black lead. Fine powders usually required further treatment to remove dust. It was put into a revolving hexagonal wooden frame fitted with a screen of fine meshed canvas (a "Reel") through which the dust escaped.

7. *Drying.* Water was added to the powder at the time of incorporating, and, in spite of the work put into it during the incorporating, pressing and corning processes, it still retained an appreciable amount of moisture. A sample of powder analysed in 1881 after pressing showed 1·01 per cent. of water and this was apparently regarded as quite normal.[2] Drying was first done with "gloom stoves." The drying chamber had a metal dome rising above its wooden floor, the dome being heated by a fire burning below. Major Ford, H.M.I.Ex., quotes this as a good example of the astonishing risks which were taken in the manufacture of gunpowder in the early days. He adds that by 1878 their use had been entirely discontinued, but he had seen one in a disused drying room in Cornwall. Later the powder was dried with hot air or water or steam coils. (Moulded cartridges were dried *after* moulding).

8. *Moulding.* The moulding of black powder into cylindrical cartridges was a development of the late nineteenth century. When blasting was first introduced into the collieries the pitmen used to provide their own powder, which they made up into paper cartridges in their homes. This was done at weekends or in the evenings, often by the light of a candle. Ultimately the authorities recognised that this was rather a hazardous home industry, and the moulded blasting cartridge was a welcome innovation. The powder was pressed into cylinders from $\frac{3}{4}$ in. to $1\frac{1}{2}$ in. diameter, with a central hole into which the fuse was fitted. These were produced by hydraulic presses of conventional design.

9. *Packing.* Gunpowder was traditionally packed in wooden barrels, holding 100 lb. Half and quarter barrels were also made. They had to be made of dry, well-seasoned wood, with strong oak staves to make them dust- and water-proof and strong enough to withstand rough handling. The cooperage was an important section of the gunpowder factory, and the availability of good local timber was an advantage. Blasting cartridges were packed in boxes.

10. *Transport.* Gunpowder was transported by the most convenient and economical method. Within the mills horses and carts were first used, and later tramways were laid down. The powder was moved in closed, horse-drawn vans. At Lowwood a derelict van can still be seen. After the passing of the 1875 Act canals, railways, etc., all had to be licensed to carry and store gunpowder.

The Economic Factors

In this section we need only consider the facts which must have influenced John Wakefield before he started his factory. He was the pioneer, and having made a success of his business it was only natural that others should follow. Until the end of the seventeenth century gunpowder was only used in England for military and sporting purposes and for fireworks. Wars were fought on the

[1] Arthur Marshall, *Explosives*, vol. 1, London, 1917, p. 82. This was presumably Sir William Congreve, Bt., 1772–1828. (According to Mr. M. Berrill, Congreve's patent was no. 3937 of 1815.)
[2] H.M.I.Ex., *Blackbeck*, 19 March 1881.

Continent and at sea, and all the naval bases were in the south. Saltpetre and sulphur came from the Mediterranean or from India, and in these circumstances there was no inducement to any intelligent business man to start manufacture in the far north.

Early in the seventeenth century gunpowder was first used for blasting in mines. It is generally accepted that Gaspar Weindle introduced this new method of mining in Hungary and that it had spread to Germany by 1627.[1] In 1665 Sir Robert Murray contributed a paper to the Royal Society on Blasting, but all evidence points to the fact that it was first used in England at the Ecton Copper Mines, Staffordshire, in 1670.[2] Metalliferous mining had been an important industry in Westmorland, Cumberland and Furness from the sixteenth century, and by the mid-eighteenth century copper, lead, iron and coal were being mined. Slate quarrying for the "building boom" which accompanied the Industrial Revolution was becoming established, and not far from Kendal, with reasonable pack horse communication, lay the lead mines of Alston Moor, north Yorkshire and Derbyshire. By 1750 a good market for blasting powder was developing in the north west.[3]

Of the southern gunpowder mills Waltham Abbey was one of the most important, and many of the facts relating to it probably applied to the others. From William Winter's interesting (and in many parts amusing) history of Waltham Abbey Mills there are a number of references to the efforts that were made to increase the use of water power. In 1739 the owner, Richard Walton, opposed the "New River Bill" because it might reduce his water power, and Winters quotes a local historian, Peter Muilman, writing in 1770 as follows:

> "Near the town on one of the rivers [the river Lea] are several curious gunpowder mills under a *new construction, worked by water*, the old ones having been worked by horses. They are reckoned the most complete in England . . ."[4]

We have seen from the illustrations in Zonca and Belidor that waterwheels were used to drive the incorporating mills, and here we have evidence that their use was being extended as far as possible. Adequate water power was becoming essential for powder mills if they were to maintain the maximum output. We also learn from Winters that difficulty was experienced in obtaining satisfactory supplies of charcoal, and Dickinson and Straker, in their article already referred to, state that charcoal from Fernhurst, Sussex, was sent to Waltham and Faversham, the former being 65 miles away and the latter even further.

Two other factors must be considered, namely, the type of powder required for the mining industry, and transport. The southern mills were built to make fine military powder which used roughly two-thirds of the proportion of charcoal required for coarse blasting powder, with a longer period of incorporation and different finishing processes. Their machinery was not suited to producing small quantities of blasting powder for mines 200 miles away in the north. We need say little about the difficulties of inland transport as the Industrial Revolution gathered momentum. It was fabulously costly, and the urge for local manufacture in the newly developing industrial areas of England was as great then as it is now in the many countries which are emerging from a largely agricultural economy. With these facts in mind we can visualise Wakefield and his partners sitting round a table, with pen

[1] Marshall, *op. cit.*, p. 33, quoting F. M. Feldhaus, *Zeitschrift fur das gesamte Schies- und Sprengstoffwesen*, p. 218.

[2] *Phil. Trans.*, 1665–66, pp. 82–85. I am indebted to Mr. F. Lebeter, Keeper of the Department of Transport and Mining, Science Museum, for this information. It is supported by Miss Nellie Kirkham of Newcastle, Staffs., who has also done research on this subject. It now seems to be generally agreed that Prince Rupert's German miners introduced blasting powder as a practical aid to mining.

[3] John Postlethwaite, *Mines and Mining in the English Lake District*, 3rd edn., Whitehaven, 1913. This excellent work gives much historical information about the mines, and contains a number of mine plans and sections.

[4] William Winters, *Centenary Memorial of the Royal Gunpowder Factory, Waltham Abbey*, 1887, pp. 19–20.

and paper, writing notes on the facts they must consider before embarking upon a costly and unusual enterprise. The notes might have read something like this:

1. Market	Mines and quarries. Plenty in the locality. Demand for minerals and slate increasing. More blasting powder bound to be used.
2. Product	Black blasting powder only.
3. Knowledge	Pay a powder maker to come up from the south.
4. Power	Buy or rent a local water mill where we can, as time goes on, install more waterwheels.
5. Raw materials	We must import saltpetre and sulphur. These will not cost us much more than they do in the south. There are hundreds of acres of coppice wood within 15 miles, and charcoal burning is a local industry.
6. Communications	Use port of Milnthorpe for coastal import and export. Pack horse roads lead from Kendal to our nearby markets.
7. Site	Near Kendal where we live, but must be well in the country as we are told that explosions cannot be avoided.
8. Capital and initiative	This is up to us.

Their questions answered, the three partners started their new venture.

The Wakefield Gunpowder Mills

I have been able to obtain no first-hand and little second-hand information about the original Sedgwick gunpowder mill. I think it best, therefore, after introducing the man who appears to have been the driving force behind the enterprise, to see how it achieved success, treating this section in the same order as the notes I have just set down. The subject matter under the different headings is interdependent, but because all trace of this mill has vanished it may be better to maintain continuity of thought on the economic line rather than to try and produce a chronological description as I will with the later mills.

John Wakefield, 1738–1811, was a Quaker, born of an Old Kendal family. He was brought up in his father's business of shearman dyer, a process of the woollen industry. His father was a delicate man, and the business was largely run by John and his mother.[1] He was 26 years old when the mill started, and we have no reason to believe that he knew much about gunpowder.

Market. This aspect I have dealt with. The northern mills made black blasting powder, and the only reference I have so far been able to find relating to markets is in a letter of July 1826 from John Wakefield II (son of the original John) to William Wager, agent for Mandale Mine in Derbyshire:

"On my return last week I found your letter and as requested I have forwarded the above [12 half barrels of powder] to put you on for awhile—our water is still very low and the rain we have, has yet had no effect on the springs."[2]

There must have been a great demand for gunpowder during the Napoleonic wars, but whether any of this came from Sedgwick I do not know.

Product. Some military powder may have been made, but all the northern mills stuck mainly to blasting powder.

[1] John Somervell, *Some Westmorland Wills*, Kendal, 1928, p. 93.
[2] Extract from a letter in the possession of Mr. Robert Thornhill of Great Longstone, Derbyshire.

Knowledge. We must assume that an experienced gunpowder maker was employed. In the case of Lowwood, which I will mention later, we know that there was correspondence between the manager (?) and a gunpowder maker at Faversham.

Power. The water power available on the river Kent at Sedgwick was much greater than that of the river Lea at Waltham Abbey. The catchment area was 75 square miles, and the average rainfall over 60 in. per annum. The fall was about 10 ft., and from a plan in the Archivist's Office of the Westmorland County Council we can see that this fall was to be developed on a pattern which became conventional. The headrace of the old mill was extended parallel to the river, and process houses were built between the headrace and the river. The machines were probably driven by a number of waterwheels working on a head of from 4 to 7 ft.

Soon it was found that more power was required, and Wakefield built a new set of incorporating mills at Bassingill, about half a mile lower down the river Kent. Here again the head was 10 ft., and when the Wakefields moved their main factory to Gatebeck in 1850 they still retained the Bassingill mill. The massive foundations and wheel pits at Bassingill are amongst the most striking remains of the northern mills (Plate XVII (*a*)). Originally there were two waterwheels, but I am told that one fell into disrepair and during the later years one large wheel drove six incorporating mills. Even with two excellent sites for water power we can see from the letter just quoted that summer drought could seriously reduce production and when, in 1845, an "Act for making and maintaining Reservoirs in the Parish of Kendal in the County of Westmorland" was promoted, the name of John Wakefield II is among the Commissioners who were responsible for the undertaking. Only one, the Kentmere Head reservoir (see Map) was built, but even this relatively small amount of controlled storage improved the continuity of water power for all the mills on the river.

Raw Materials. Saltpetre and sulphur probably came by sea to Milnthorpe, about which I will have more to say when dealing with communications. Iron had been smelted in Furness for at least 500 years, and charcoal burning was an important local industry. At first it would be bought from the local burners (see under "Lowwood," p. 57) but from the plan referred to above, Note 11, "Retort House for manufacturing charcoal and furnace" we see that the factory was making its own. Timber was also required for making barrels, powder drying and general purposes, and the availability of ample supplies was clearly of great importance.

Communications. From Roman times to the present day Kendal has been a focal point for roads. The main road to Scotland runs through it (nowadays "crawls" might be a better word), and it is the junction with the important (A.65) road to Yorkshire and the south-east. Northwestwards runs the road to the Lake District and there were pack horse tracks over the mountain passes to west Cumberland. Considering how remarkably bad inland communications were in the mid-eighteenth century Wakefield was well placed to send his powder to the Lake District and Furness mines and even further afield. Milnthorpe was at that time a small tidal port on the river Bela at the head of the Kent estuary. Ships up to 100 tons burthen came up with the tide, bringing coal from Whitehaven and other raw materials to Kendal and the surrounding district. It is about four miles by road to Sedgwick, and there can be little doubt that the port was used by the powder mills for both import and export.[1]

The Wakefields, father and son, were members of "Turnpike Trusts" formed to improve local roads and build new ones, and they also brought pressure to bear when plans were being made to construct the Kendal and Lancaster canal. According to Curwen, alternative proposals were put forward, one of which would have involved building mechanical lifts to avoid the Hincaster tunnel which was regarded as a difficult obstacle. If this plan had been accepted by the promoters the canal

[1] John F. Curwen, *History of Heversham with Milnthorpe*, Kendal, 1930, p. 74 *et seq.*

would have followed a line some distance from Sedgwick and, more important, on the opposite side of a ridge 250 ft. high. Curwen states:

> "The gunpowder influence appears to have been too strong against the [alternative] scheme, so that we find on the 7th of January, 1806, a report and survey for making a navigable canal . . . which virtually adopts the original Whitworth Survey."[1]

As will be seen from the Map, the canal, opened in 1819, ran within a few hundred yards of the Sedgwick mill, and must have solved nearly all the transport problems.

Site. The Sedgwick gunpowder factory was built on a flat strip of land on the east side of the river Kent well away from the few houses which comprised the hamlet. When it was built it probably complied with all the regulations and may have appeared to be ideal, but when compared with the later factories it is clear that the process houses and magazines were much too close together, and there was no room for expansion. One interesting record is a sketch entitled "Powder Mill, Sizergh," contained in a sketch-book of pencil drawings which are mostly of large houses in the north-west of England. The name of the artist is unknown, but it is dated 1802. It shows a few buildings, one of which may be the old corn mill, with the river sweeping round in front and the low hills rising in the background.[2] (Plate XVII (*b*).)

Capital and Initiative. I have referred to John Wakefield and his partners. These were Alderman Gurnall of Kendal and Edward Johnson of Old Hall. They entered into a "tontine" agreement, and as Wakefield survived the other two the business passed entirely into his hands. He was given credit for its success, and there is no reason to believe that he was not the driving force. The Wakefields prospered as a result of John's initiative.

After 80 years at Sedgwick the Wakefields decided to move their factory from rented land which was very restricted to land which they owned and which would make an excellent site for a gunpowder factory. They retained the incorporating mill at Bassingill but moved the remainder of the Sedgwick factory to Gatebeck in 1850.

Gatebeck

Gatebeck lies five miles SSE of Kendal, about a mile to the east of the busy A.65 road from Kendal to Yorkshire. The licence to manufacture gunpowder was granted at the Westmorland Quarter Sessions in October 1850. The country is pleasant undulating agricultural land, and the mills were built on either side of the Peasey Beck which forms the upper reaches of the River Bela. The beck runs down a shallow valley with enough flat ground for the construction of buildings. The site was developed in two stages, the first covering the area to the south of the road from Gatebeck to Kendal, and the second the area north of the road. The total was about 70 acres. The catchment area of the Peasey Beck at Gatebeck is smaller than that of the Kent at Sedgwick, and the average rainfall is lower. It was, however, possible to obtain a head of 50 ft. between the northern and southern boundaries of the property, and this head was developed in four stages. The tailrace from the water-wheels which drove the upper incorporating mills discharged into the beck just above the second weir, and this system was continued to the bottom end of the property.

Although Gatebeck factory was planned long after the steam engine had become the most important prime mover in England, we must appreciate the particular problems of the gunpowder mills. A considerable amount of power was required to drive the incorporating mills; elsewhere a little power

[1] John F. Curwen, "The Lancaster Canal," *Trans. Cumb. & Westd. Ant. & Arch. Soc.*, vol. XVII, n.s., 1916–17, pp. 26–47.

[2] I am indebted to Miss Clay of Ambleside for permission to reproduce this sketch.

was needed intermittently at a number of small process houses, workshops, etc. which had to be widely separated. There was no electric power transmission, and nobody wanted small steam engines and boilers scattered about the factory. The solution to the problem was to place the process houses along the side of the headraces and draw off water as required, using it as economically as possible. For those processes which only required hydraulic pressure the situation was rather different. As the demands on the water power became greater steam engines were installed to drive hydraulic pumps to feed the presses, and these could be located hundreds of yards from the engine houses.

At the source of the Peasey Beck was Killington reservoir, built in 1820 to feed the Kendal and Lancaster canal. The Lancaster Canal Navigation Act of 1819 laid down that this reservoir was not to interrupt the flow of water to the mills below, and that a minimum amount of compensation water was to be let out.[1] The compensation water would undoubtedly be greater than the normal minimum flow of the beck before the reservoir was built, and this would benefit the mill owners below in dry times. When we also bear in mind the fact that by 1850 the London & North Western Railway main line system was completed, and already the canal was being used very much less, there can be little doubt that although the Wakefields did not *control* Killington reservoir, it must have added appreciably to the value of their water power. In 1895 a supplementary source of power, which included a water supply to the factory and the villages of Gatebeck and Endmoor, was provided, by building a concrete dam on the Fall Beck about a mile from the factory. This delivered water at a head of over 300 ft. to the factory, and by feeding water under this pressure to the hydraulic pumps a considerable saving in power was achieved.[2] Later three Gilkes pelton wheels were installed, taking their water from this dam. Two provided power for the reeling mills and one for a gas plant fan.

Milnthorpe, on the L. & N.W.R., was the nearest railway station, and in 1874 the extensive tramway system of the factory was connected to sidings there by a horse-drawn tram. This followed the Peasey Beck to Crooklands where it crossed the A.65 road and the Kendal and Lancaster Canal. Thence it ran by the side of the Milnthorpe road to the station.[3]

There were 12 incorporating mills at Gatebeck and six at Bassingill. The weekly output of powder was about 30 tons.[4] The manufacture of charcoal in retorts was discontinued in 1860, but about 1865 a new process was evolved for the production of saltpetre from potassium chloride and sodium nitrate. This was first developed on a commercial scale at Gatebeck.[5] In addition to saltpetre manufacture there was a large sawmill and cooperage, much of the timber being bought locally. The total number employed, including women and boys, was about 140, of whom some 25 worked in the saltpetre manufacturing plant and 45 in the sawmill and cooperage. As a result the number employed per ton of powder produced was higher at Gatebeck than at the other factories.[6] Gatebeck supplied Lowwood with saltpetre, casks and cases.

[1] Lancaster Canal Navigation Act, 14 June 1819, Clause VIII ". . . the Gauge . . . at or near a certain Place called *Mutton Hall*, in the said Township of *Killington*, shall at all Times hereafter be kept fully supplied with Water by the said Company . . ."

[2] Letter from Mr. Bush to John Somervell, July 1934.

[3] Curwen, *Heversham and Milnthorpe, op. cit.*, p. 67.

[4] Information from Mr. Bush.

[5] *Imperial Chemical Industries Ltd., and its founding companies*, London, 1938, pp. 176–7. Mr. Bush gives the manufacturing formula as follows:

KCl	+	$NaNO_3$	=	KNO_3	+	NaCl
Potassium Chloride		Sodium Nitrate		Saltpetre		Common Salt

[6] These figures were given to me by Mr. Bush, and are confirmed by Mr. Fred Towell, now aged 86, a retired employee of Gatebeck. Census figures for 1901 show 149 Gunpowder Makers for the county of Westmorland. Those employed as coopers, drivers, labourers, etc. would not be included. Mr. Towell describes himself as an "odd job and maintenance man" who "never worked among the powder."

Mr. Bush tells me that the main markets for powder during his time were the coal mines of the north-east coast, quarries in the north of England and North Wales, the Crown Agents for the Colonies and West Africa. Mr. Towell, when in the British Army in India during the 1914–18 war saw a pile of familiar-looking barrels stacked on a jetty. It did his heart good when he went up and saw that they were marked: "W. H. Wakefield & Co., Gatebeck, England"! In 1882 Wakefields took control of the Lowwood factory, and from 1917 to 1920 all the Westmorland and Furness mills were absorbed into Explosives Trades Ltd. which finally merged with I.C.I. Ltd.[1] Gatebeck finally closed in 1937. Some of the workers moved to the I.C.I.—Nobel Division—explosives factory at Ardeer in Ayrshire. The sawmill and cooperage is now used as a contractor's depot, and the Low Mill is the Civil Defence training area of the Westmorland County Council. The coppice wood has come back into its own, and the site of a once thriving rural industry is now a bramble-infested jungle.

Lowwood (Furness)

Lowwood (not to be confused with the Low Wood Hotel between Windermere and Ambleside) is near the village of Haverthwaite; the gunpowder mills lie on the east side of the river Leven which flows from Windermere into Morecambe bay at Greenodd. A licence to manufacture gunpowder was granted in 1798 to Mr. King of Finsthwaite, Mr. Wilson of Rigmaden and Mr. Daye Barker.[2] A number of documents, dating from 1798 to 1846, relating to Lowwood, have been deposited with the Lancashire Records Office at Preston. These comprise Cash Books, Day Books, letters and sundry documents.[3] The first record in the Cash Book, 22 August 1798, is a credit of £10 10s. from "Maudes Wilson's Acct." This account appears to have included payments by the subscribers to the undertaking and, later, payments received from sales of powder. Similarly most disbursements were entered to "Charges on Trade."

Mr. J. Fayrer, living, at that time, at Harmony Hall, Milnthorpe, was evidently seeking advice from Mr. J. Stevens of Feversham (*sic*) about the manufacture of gunpowder. A few letters from Mr. Stevens, many parts of which are indecipherable due to damp, are amongst the records. It would be interesting to have these transcribed, but from my rather cursory examination I doubt if they would add much to the information already published about the contemporary methods of gunpowder manufacture. The earliest letter, dated 7 October 1799, gives Mr. Fayrer some advice about the amount of water to be added to the "green" powder in the incorporating mill: more should be added in dry weather than when the atmosphere is damp. No improvement in the final quality of the powder will result from too long a period of incorporating, and he must not worry if his saltpetre is not white. There are also a few notes on re-working dust from the corning mill. Later there is a badly mutilated sketch (undated) which shows, I think, refining vats for saltpetre, and another giving dimensions for "charcoal cylinders" which agree closely with those referred to in Dickinson and Straker's Paper.[4] Coming to the first "Cash Book," we find:

"Dec. 24th 1798. By charges on Trade to erect Mills £9 4 0"

Within a few months raw materials were evidently being purchased, but there is no direct record

[1] *I.C.I. Ltd.*, *op cit.*, p. 200. To attempt to describe the pattern of take-overs would be rather like reading Genesis X. Suffice it to say that until the latter part of the 1914–18 war W. H. Wakefield & Co. Ltd., owning the Lowwood Gunpowder Co. Ltd., formed one group, and the other mills, Sedgwick, Elterwater and Blackbeck, were independent.

[2] *I.C.I. Magazine*, *op. cit.*, p. 340.

[3] *Lowwood Documentw*, Lancs. Record Office, Ref. DDLo., deposited by Mr. D. A. While, Birkdault, Haverthwaite.

[4] *Lowwood Documents*, "Letters." Dickinson and Straker, *op. cit.*

of the buying of saltpetre. From time to time there is a small credit for the sale of saltpetre containers, together with an entry:

"Aug. 16th 1800. By Jn. Gibbons & Co. Charges on Trade for Freight, Cartage & Warehousing Sal. Petre a/c Pd. £73 18 0

"April 5th 1799. By Sulphur Acct. paid Downward £154 9 0"

From a local point of view the most interesting figures are the sudden and very considerable purchases of charcoal. From 19 April 1799 to 15 March 1800, 2,176 "sacks" of charcoal were purchased for a total sum of £775 14s., an average of 7s. 3d. per sack. The smallest single item is for six sacks, and the largest for 69. The suppliers appear to have been local, with names such as Newby, Barker, Robinson, Holmes, Baines, Clarke, Long, Dixon, etc., all of which are still common in the district.[1] For the next year or two charcoal purchases fell to a very low figure, and one must assume that either the company was building up a stock or that thereafter they bought coppice wood and made their own charcoal. A critical examination of the accounts over a much longer period would help to clear up these points.[2] For a description of Lowwood I can hardly do better than quote the official I.C.I. history:

"These works had been established in 1799 when six [incorporating] mills, with press, corning and other houses were erected, and the site could hardly have been more suitable. Originally, apart from the great advantage of cheap power from the volume of water flowing out of the lake [Windermere], the local coppice woods afforded a cheap supply of material for the making of charcoal on the spot. Charcoal burning had been a substantial industry for hundreds of years, the product being used for the considerable number of small iron furnaces in the neighbourhood.

"By 1860 another eight mills had been built, making a total of fourteen. Up to that time trade had been confined to blasting and 'African' powders, but it was then decided to enter the sporting gunpowder trade. The manufacture of these latter powders was undertaken and Government contracts were secured for military supplies.

"A great many alterations were made to accommodate the sporting and military trade, but a disastrous fire at the mixing house in 1862, and an explosion in the following year, proved a serious set-back. In the latter year the business was turned into a limited company under the name of the Lowwood Gunpowder Company Limited, with head offices at Liverpool. The new company never proved to be very prosperous, however, and it was sold in 1882 to W. H. Wakefield & Company."[3]

A stone weir was built across the river Leven which had a catchment area of 110 square miles with the balancing effect of Windermere, Esthwaite Water and large areas of woodland to even out the flow. Here again the site was long and narrow, and process houses could be placed at convenient intervals along the side of the headrace. A total fall of 22 ft. was available, with a potential of over 400 horse power.

[1] Nearly all this charcoal is described in the Accounts as "Savin." This was a local name for juniper, little of which now remains in the district. The following extract from a contemporary article in *The Gentleman's Magazine* dealing with this district is of interest:

"The most mountainous hills . . . being elevated too high for woodlands, are . . . become of little value, producing only ling, heath and savin; which last has been of late years much in demand when grown in sufficient substance to convert (after being peeled) into charcoal for gunpowder makers, who paid at one time 10s. a sack for its charcoal: now it is less in request and does not sell for more than 6s. to 7s. *per* sack." *Gent. Mag.*, vol. LXXII, 2nd part, 1803, p. 1202, "Statistical Account of Coltone."

[2] *Lowwood Documents*, "Cash Book 1798–."

[3] *I.C.I. Ltd., op. cit.*, p. 177.

The transport facilities were better than those of Wakefield's Sedgwick mills when Lowwood started production. There was a good road to Ulverston, six miles away, which was connected to the sea by the Ulverston canal in 1795. Powder could be taken by boat up Windermere to the mines and quarries of the central Lake District, or up Coniston Water to the copper mines at its head. When the Lakeside branch of the Furness Railway was built in 1869, Haverthwaite Station was only a few hundred yards away across the river, and was quickly connected to the internal tramway system of the factory. Early this century Lowwood produced about 20 tons per week, the main markets being the Scottish coal mines and quarries. There was also a good export trade to West Africa, and much of the powder was shipped in quite small barrels, 8 lb., 10 lb., 12 lb. and 20 lb. These were all made at Gatebeck. Reasons given for the use of these small containers was ease of manhandling over long distances, the reluctance of the Colonial Police to allow the Africans to have control of considerable weights of powder, and the inability of the Africans to purchase other than small quantities.[1]

In 1953 Mr. D. A. While, the owner of Lowwood, rebuilt the weir with an adequate fish-pass, extended the headrace, and installed two 150 kW hydro-electric sets which feed into the grid and generate some two million units of electricity per annum at a cost which is comparable to that of the most efficient steam power station. The remainder of the property is given over to a market garden and some densely-overgrown woodland.

Elterwater

Charming as are the sites of the other gunpowder mills, Elterwater must take pride of place for the beauty of its surroundings. The mills were situated just above the small lake and village of Elterwater in the heart of the Langdale valley, four miles west of Ambleside. In January 1823 Mr. David Huddleston retired from the "Kendal Bank" (this was Wakefield Crewdson's bank started by John Wakefield) and built himself a house at Elterwater.[2] According to information in the possession of I.C.I. he was also interested in the fulling industry and slate quarrying, and from his banking knowledge he must have known that there was money to be made in gunpowder. On 16 January 1824 he obtained a licence to erect gunpowder mills, and he started manufacture soon after.[3] The factory covered an area of about 20 acres and was roughly triangular in shape. Great Langdale Beck ran down the western boundary, and there was quite a large mill pond in the centre of the property (Plate XVIII). Water power was provided by the beck, with a total head of about 40 ft. The catchment area was small, only about 11 square miles, but this lay within an area of very high rainfall, and Huddleston built a dam at Stickle Tarn, under the shadow of the Langdale Pikes, which provided a reasonable amount of controlled storage. The waterways, many of which still remain, were intricate, and power was provided by a number of small waterwheels and turbines.

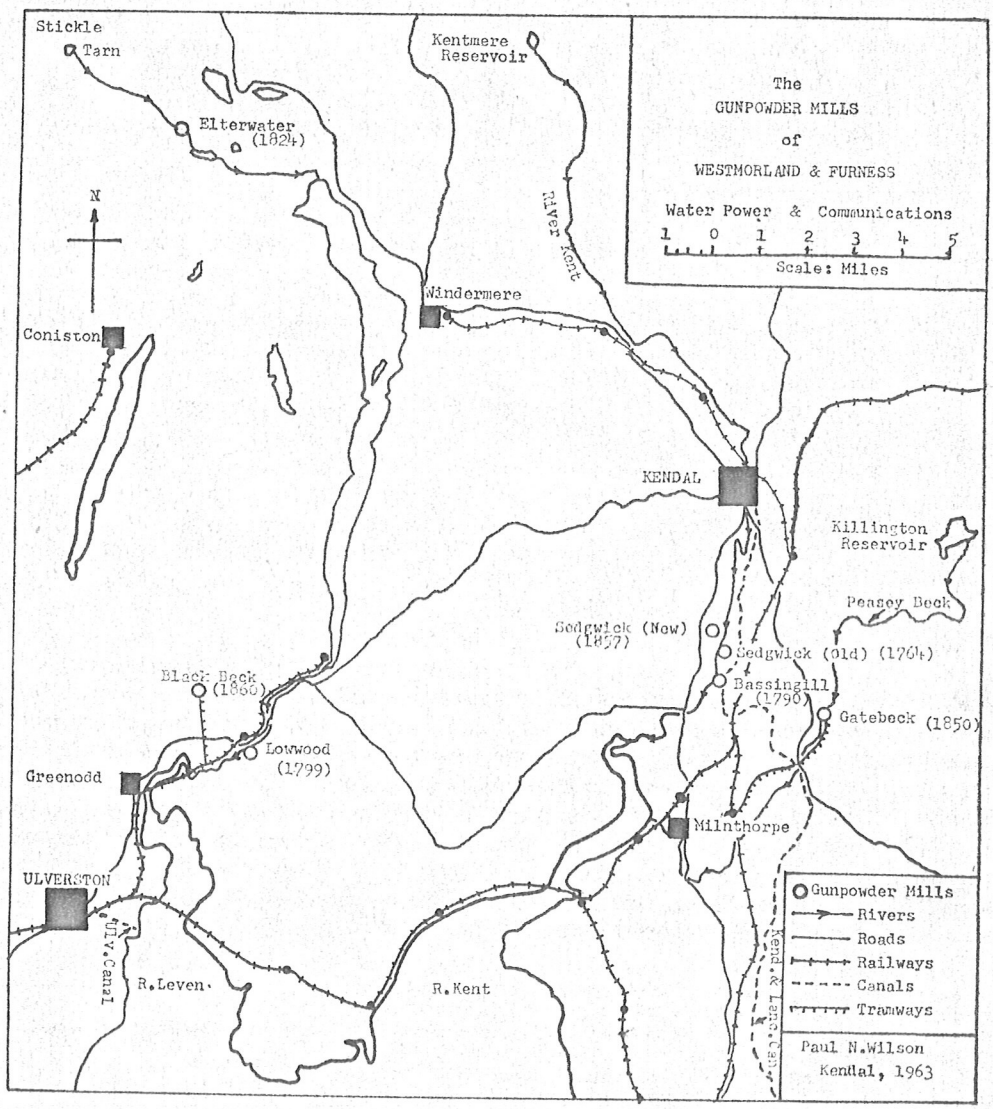
Powder was delivered to the local slate quarries of Langdale and Coniston copper mines by horse and cart. Even in its early days Elterwater gunpowder was exported to West Africa. It was taken by cart to the head of Windermere, thence by boat to Lakeside, then to Greenodd for shipment. When the Kendal & Windermere railway was completed in 1846 three or four cartloads of powder were taken to Windermere station every day.[4] Production was about 20 tons per week and an average of 50 workpeople were employed. The mills were closed in 1928 and were transformed by the owner, Mr. R. L. Hall, into one of the most beautiful holiday resorts in the Lake District. The trees originally planted to provide blast protection have now reached maturity; powder works buildings of

[1] Information from Mr. Bush.
[2] *Local Chronology*, a collection of local information mainly extracted from the Kendal newspapers. Thos. Atkinson, Kendal, 1865, p. 53.
[3] H.M.I.Ex., 29 November 1878. *I.C.I. Mag., op. cit.*, pp. 343–44.
[4] *I.C.I. Mag., op. cit.*, p. 347, and information from Mr. Bush.

local stone are furnished cottages and restaurants; caravans can be parked by running streams out of sight of their neighbours. The Elterwater Gunpowder Factory has been transformed into the Langdale Estate, and a more suitable change it would be hard to imagine.

The (New) Sedgwick Gunpowder Mills

On the west side of the river Kent, a few hundred yards above the weir which fed the original Sedgwick mills, there was a long reach of flat ground well above river level belonging to Mr. W. C. Strickland of Sizergh Castle. A company was formed to develop this site as a gunpowder factory,



and a licence to manufacture was obtained in January 1857.[1] The manufacture of black blasting powder started in 1858. The layout of the works was excellent. A "V"-shaped timber weir was built across the river, and a long headrace of dressed stone was constructed, designed to feed individual process houses, all of which were built close to the river bank. Their foundations can still be seen from the footpath which runs along the opposite side of the river. The incorporating mills were driven by a single waterwheel, 36 ft. in diameter and 6 ft. wide, working with a head of about 20 ft. An arched tailrace tunnel over 100 yards long took the discharge water back to the river. Five turbines, developing from 6 to 15 horse power each, were installed, in addition to some smaller waterwheels.

The new company got into financial difficulties, and in 1864 was taken over by a Manchester syndicate. Later Mr. Henry Swinglehurst of Hincaster (a village two miles from Sedgwick) bought out the other partners, and traded as "The Sedgwick Gunpowder Co." The employment and production were similar to Elterwater, namely about 50 employees and an output of 20 tons per week. The powder was taken by road to "Swinglehurst's siding," a stone building with loading platform at Hincaster Junction where the single (disused) line branches south from the main Carlisle-London line to join up with the old Furness Railway (see Map). The site is now owned by the National Trust and is completely overgrown.

Blackbeck

The licence to erect gunpowder mills at Blackbeck was granted in December 1860. The site is near the village of Bouth at the southern end of the Rusland valley, three miles from Newby Bridge at the foot of Windermere. The stream which runs through the mills is so small that most of the motive power was supplied by steam. The owners were F. C. Dickson & Co., and in 1881, 50 workpeople were employed.[2] The output was about 20 tons per week of black powder, most of which went to North Wales and the limestone quarries of the Peak District.[3] A tramway connected the factory to the Ulverston-Lakeside branch of the Furness railway. Unfortunately Blackbeck is mainly remembered for its record of fatal accidents. So far as I have been able to trace, no less than 27 workmen were killed there between 1867 and 1911. Even so, the reports of H.M.I.Ex. do not attribute any of these accidents to carelessness or bad management. The mills were closed in 1928, and the site now forms an attractive caravan park.

The End of the Northern Mills

By the time—shortly after the end of the 1914–18 war—the northern gunpowder mills had been taken over, it was only a matter of years before they were closed down. New explosives, particularly dynamite, were replacing gunpowder for blasting, and I.C.I. formulated a policy to concentrate all manufacture of the sort which had been carried on in Westmorland and Furness, at their factory at Ardeer. It was apparently regarded as uneconomic to continue working these small local industries, and no effort, apart from the direct transfer of labour to Scotland, was made to use the sites or provide alternative employment for the people who had worked there all their lives. The wheels of industrial efficiency continued, as they must, to turn, but their relentless motion left a legacy of unemployment with its sad consequences. Fortunately the outbreak of the second world war, disastrous as it was, brought jobs for all, and the subsequent prosperity of the area has blotted out the memory of the lean years. The houses in which the powder was worked or stored were destroyed. This is essential when a gunpowder factory is closed. The buildings must be burned to remove any trace of powder, and on the deserted and overgrown sites every year leaves less sign of stone walls, foundations, wheel

[1] John F. Curwen, *Records relating to the Barony of Kendale*, Kendal, 1926, vol. III, p. 236.
[2] H.M.I.Ex., Blackbeck, 19 March 1881.
[3] Information provided by Mr. Bush.

pits and water races. I regret particularly that there is no trace at all of Wakefield's original Sedgwick mill, and even those who have now built houses on the river bank where it stood have little idea of the industry which fluorished there 200 years ago.

Acknowledgments

Many people have helped me to collect the information necessary to prepare this Paper. My first thanks go to Mr. Alfred Bush who has gone to much trouble and has provided a great deal of the local background. Brigadier O. F. G. Hogg, C.B.E., F.S.A., gave me useful information on the history of gunpowder manufacture, and I am particularly grateful to the archivist's department of the Westmorland County Council for finding the map of the old Sedgwick Gunpowder Mill. Finally to my brother Professor E. M. Wilson, who laboured through my original text and pointed out many errors, and to all others who have taken an interest in this work I offer my sincere thanks.

APPENDIX

Fatal Accidents in the Northern Mills

I have deliberately made little reference to fatal accidents in this paper. Gunpowder manufacture was a dangerous business, but so are coal mining and erecting structural steelwork. The fact that the danger is ever present is in itself a safeguard, and every fatal accident called for an enquiry by a skilled government inspector who tried hard to find the reason and take steps to prevent a recurrence. At the same time an explosion in a gunpowder factory had much greater news value than a serious accident in a mill, and I feel that this paper would not be complete without some reference to this less pleasant side of the business. The Inspectors' Reports, available in any of the large reference libraries, make most interesting reading. They went to great pains to try to track down the cause of the accident, a difficult job when most of the evidence was scattered over the countryside. When no reasonable explanation could be found the inspectors did not hesitate to say so.

The Explosives Act of 1875 was far reaching in its regulations as to the minimum distance between buildings, the weight of charges which might be worked at one time, the number of men who might be present in any building and the amount of powder which might be stored. The co-operation between the inspectors and the managements appears to have been excellent, and recommendations were usually carried out. For example, when the press house at New Sedgwick blew up on 30 June 1875 and set off the corning house as well, the management were already in the process of building a new press house at such a distance that it would not have fired any other building. At Gatebeck on 21 July 1881, some press boxes with iron straps were still being used, and although this may not have been a partial cause of the accident, all the boxes with iron straps were replaced by boxes with bronze straps. Lightning was a danger which it was difficult to assess. The Act of 1875 laid down that an effective lightning conductor must be fitted to every house, but A. Desborough (H.M.I.Ex.), speaking on "The Administration of the Explosives Act" in 1910 said:

> "At the present time some outlying magazines have conductors attached to them for apparently the same reason that a horse-shoe is attached to the door."[1]

Fortunately south Westmorland and Furness seldom suffer from severe storms. According to the *Westmorland Gazette* the explosion at Bassingill on 15 June 1883 was due to lightning, and I have included in the list one non-fatal accident, namely New Sedgwick on 23 June 1906. A very bad storm drove up the Kent valley when the night shift were on, and the men obeyed orders, left the

[1] *Seventh International Congress of Applied Chemistry*, London, 1910, pages 7–17.

TABLE OF FATAL ACCIDENTS

LOCAL CHRONOLOGY, KENDAL, 1865 (Loc.Chron.)

Westmorland Gazette newspaper, published weekly in Kendal (W.G.)

Reports of H.M. Inspector of Explosives (H.M.I.Ex.)

Date of Accident	Factory	No. Killed	Process House	Remarks	Source of Information
16 July 1823	Lowwood	2	Corning		Loc. Chron., p. 55
24 Jan. 1840	Elterwater	5	Press Corning Glaze		W.G., 1 Feb. 1840
29 Jan. 1863	Lowwood	6	3 houses	Heard in Kendal 13 miles away	W.G., 7 Feb. 1863
7 Dec. 1867	Blackbeck	3	Press Corning Engine		W.G., 14 Dec. 1867
25 July 1868	Blackbeck	9	Press Corning		W.G., 1 Aug. 1868
28 Nov. 1868	Lowwood	5	Corning		W.G., 6 Dec. 1868
30 June 1875	New Sedgwick	4	Corning Press	New press house being built away from corning house	W.G., 3 July 1875
12 Oct. 1875	Bassingill	2	Incorporating		W.G., 16 Oct. 1875
29 Nov. 1878	Elterwater	3	Corning		H.M.I.Ex.
19 March 1881	Blackbeck	3	Press Corning	Originated in press and spread to corning	H.M.I.Ex.
21 July 1881	Gatebeck	2	Press		H.M.I.Ex.
12 April 1883	New Sedgwick	3	Cartridge filling		H.M.I.Ex.
15 June 1883	Bassingill	1	Incorporating	Lightning	W.G., 23 June 1883
6 Sept. 1887	Lowwood	2	Incorporating		W.G., 10 Sept. 1887
26 May 1900	Blackbeck	2	Press	Heard at Gatebeck 16 miles away	H.M.I.Ex.
27 Aug. 1900	Blackbeck	4	Corning		H.M.I.Ex.
23 Oct. 1901	Elterwater	1	Corning		H.M.I.Ex.
12 March 1903	Lowwood	2	Press		H.M.I.Ex.
30 March 1903	New Sedgwick	2	Glazing Corning	H.M.I. suggests that both accidents may have been caused by driving keys while machines were running	H.M.I.Ex.
30 April 1906	Blackbeck	2	Corning		H.M.I.Ex.
23 June 1906	New Sedgwick	Nil	Press and 4 incoporating	Factory struck by lightning	H.M.I.Ex.
15 July 1909	Blackbeck	2	Corning		H.M.I.Ex.
14 Dec. 1911	Blackbeck	2	Corning	Hot bearing on roller. Heard by Mr. Bush at Gatebeck	H.M.I.Ex.
18 Sept. 1916	Elterwater	4	Corning		W.G., 22 Sept. 1916

houses and took shelter. Thus, although the press house and four incorporating mills blew up, no one was hurt. The managers were as anxious as the inspectors to keep down accidents, and the use of protective clothing increased steadily. The men wore overalls with no pockets, boots without nails and protective overshoes.

From the attached table it will be seen that the fatalities with the unfortunate exception of those at Blackbeck, dropped rapidly after 1900; it soon became safer to work in a gunpowder factory than it now is to drive in a motor car to work. It is, perhaps, unfortunate that H.M.I.Ex. does not hold an enquiry after every fatal accident involving mechanically-propelled vehicles.

Discussion

Mr. J. Kenneth Major asked about the relationship between the holding of the water at Stickle tarn some four miles from the site and the usefulness of that water when released by a man every morning. As a point of interest he told the Meeting that the National Parks Authority, ably assisted by volunteers, had repaired the dam of the tarn which is now kept at its true water level. Mr. Major went on to say that his mother's daily woman, in her youth, used to pack cartridges at Elterwater: he asked Mr. Wilson if these would be cartridges used in blasting in shot holes, or normal shot cartridges like the 12-bore?

Mr. Wilson said that the partially-controlled water at Stickle tarn would not be as useful as properly stored piped water; it would run all the time whether the machines were working or not; probably half of it would run to waste. The cartridges would be those used for blasting, certainly not sporting ones.

Mr. Rex Wailes said that he visited Curtis & Harvey's at Faversham in 1918 and saw the corning mills, worked by water power and beam engines, and protected by large earthen banks. The whole area was planted with orchard trees, largely apple, cut when of a reasonable size and used for re-cogging mortice gears. He was there again in 1924, too late to see anything but the scrap-metal merchant breaking up and taking away a great deal of the machinery. In 1963 all that was left of such an historic place was one waterwheel, pit wheel, wallower, and two upright shafts and great spur wheels.

Last year Mr. Wailes had visited the Bonawel Furnace at Taynuilt and had seen there the furnace erected in 1752 by a Cumberland firm because they could not get enough wood for charcoal in Cumberland. They found it paid to send the ironstone to Scotland and ship the pig back to Cumberland. The buildings, all made of Cumberland stone and slate and built by Cumberland engineers, were still in fairly good repair and the whole complex was virtually complete.

Mr. Peter Davies quoted an obituary notice from the *Kentish Gazette* for 12 April 1814: "On Saturday the 9th inst. at his house, Tanner-street, Faversham, aged 72, Mr. John Stevens Minter, refiner of saltpetre at the Royal Powder Mills, at that place, who for 59 years served his country without a blemish. He was gunner of the garrison of Gibraltar during the late ever memorable siege. He received from nature a sound understanding. He was a faithful friend and a honest man." Mr. Davies suggested that the "John Stevens" mentioned in the Paper should in fact be John Stevens Minter.

Mr. Maurice Berrill mentioned the work by W. H. Simmons entitled *A Short History of the Royal Gunpowder Factory at Waltham Abbey* (1963) and said that it was apposite to have, within a few months of each other, the history of that mill in the south-east and Mr. Wilson's Paper on mills in the north-west. There were interesting comparisons, for instance, in the transport systems. In the south-east much use was made of the River Lea; many diverse channels were cut from it and used to transport material from one part of the works to another. There were a number of boatmen on the

staff. The map of the works in the north showed an extensive tramway system. Possibly the lie of the land made this necessary, or water was more turbulent than in the south-east. Mr. Berrill went on to say that in the past there had sometimes been confusion between William Congreve, father and son (though Mr. Wilson had made the correct deduction in his footnote). The father (Major, later Lt.-General William Congreve) was Controller of the Royal Laboratory at the time the Government took over Waltham Abbey in 1789. He was made a baronet in 1812 and died in 1814, when his son (also William) succeeded to the title, and also to his father's old job. It was the younger William who was responsible for "Congreve's Rocket." Mr. Berrill corrected the reference to the patent for the corning machine: it was No. 3937 of 1815. There was in the Public Record Office (Supply 4/762) *A Treatise on Gunpowder* by Frederick Drayson (1830), a folio volume of 79 pages with 37 detailed drawings of buildings, utensils, etc. The Joshua Gilpin diary might also be a contemporary source of information on the mills of the north-west.

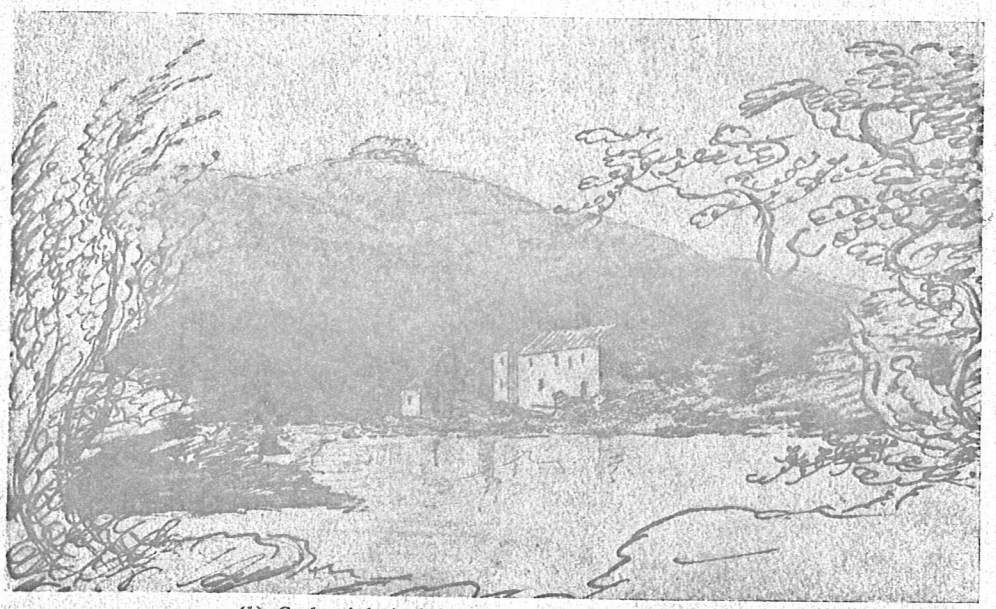
Mr. J. FOSTER PETRE told the story of a ship, named *Lottie Sleigh*, which blew up in the River Mersey in 1864; the explosion smashed all the windows in Liverpool and Birkenhead. She had loaded 11½ tons of gunpowder, consigned to West Africa. The explosion led to a lawsuit, the report of which might show the source of the powder—possibly Gatebeck.

Mr. D. S. SANDERS said he was familiar with the site of Hounslow mills where were the remains of edge runners and earthen banks. The mills were dismantled in 1926 and the machinery sold for scrap.

Mr. A. J. PERCIVAL (Hon. Secretary of the Faversham Society) said that his Society was hoping to preserve the mill site at Faversham as a link with an industry now non-existent in the town.

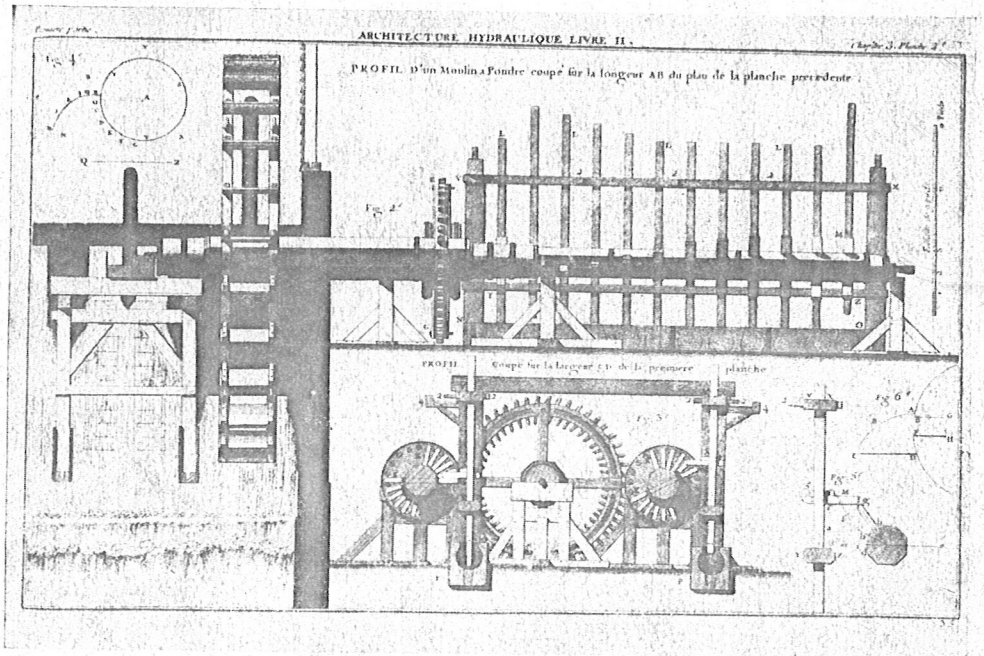
PLATE XVII

(*a*) Foundations of the Incorporating Mill at Bassingill, Westmorland, built 1790, photographed 1962

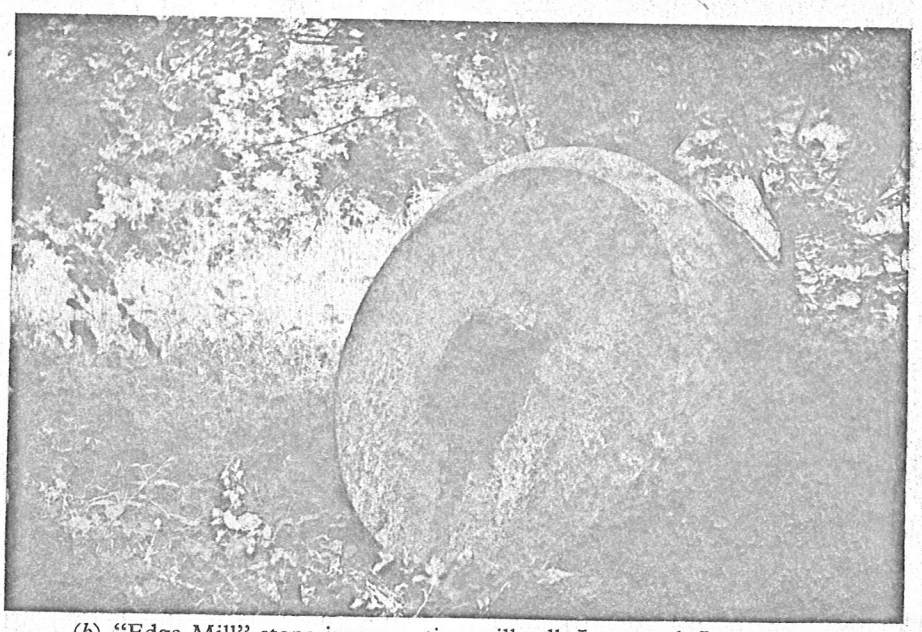


(*b*) Sedgwick (original) Gunpowder Mill, 1802
Reproduction from a pencil sketch by an unknown author

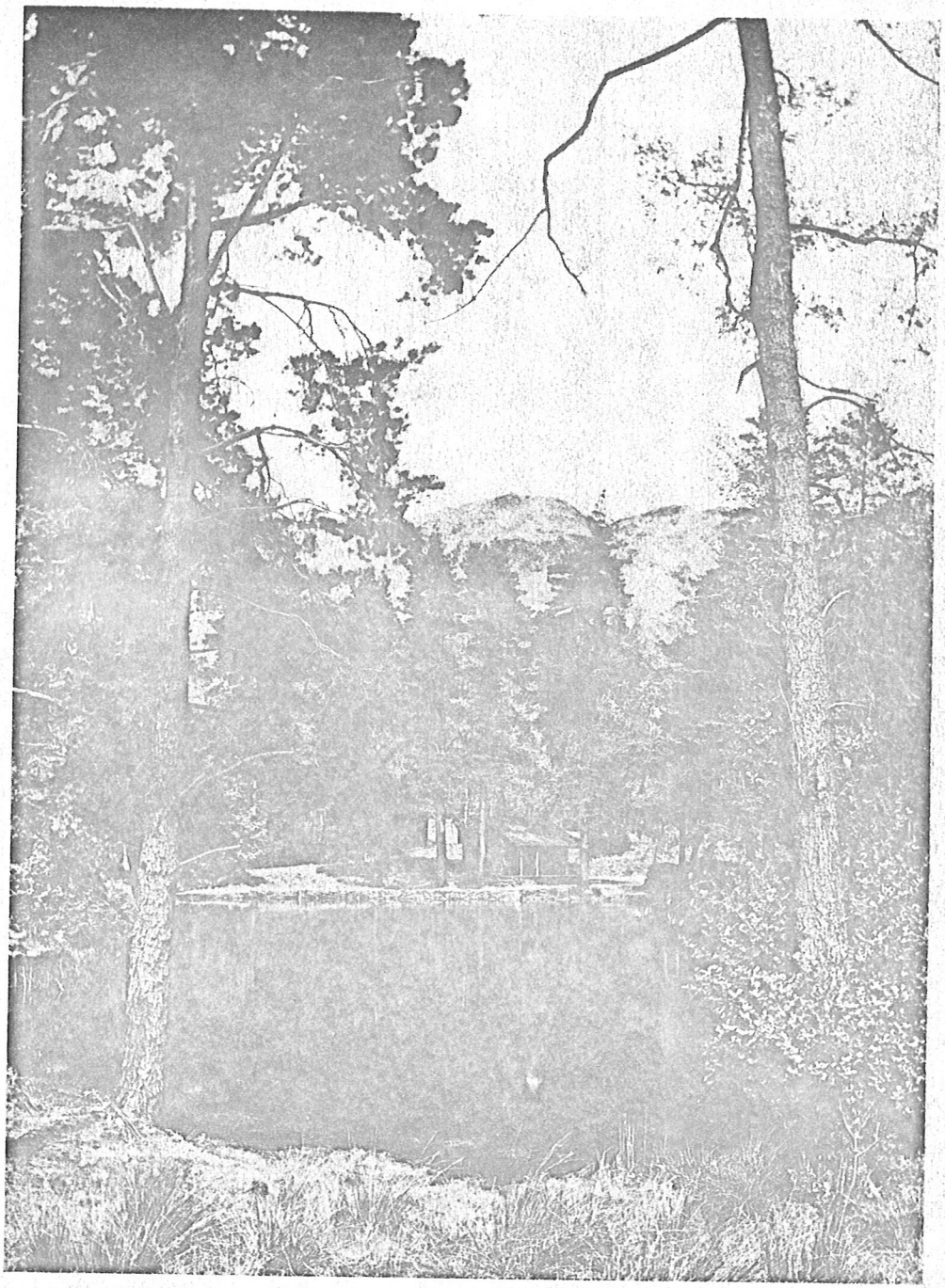
(By permission of Miss Clay, Ambleside)



(*a*) Waterwheel-driven gunpowder Stamp Mill
(Reproduced from *Architecture Hydraulique*, Belidor, Paris, 1782)



(*b*) "Edge Mill" stone incorporating mill roll, Lowwood, Lancs., 1962



The Mill Pond at Elterwater, showing a process house converted to a holiday bungalow

(*Photograph* Westmorland Gazette, *Kendal*)

Transactions of the Newcomen Society
1963/1964, Volume 36, 47–65, Plates XVI – XVIII

The Gunpowder Mills of Westmorland and Furness

BY

PAUL N. WILSON, O.B.E., D.S.C., M.A., D.L., M.I.C.E., M.I.Mech.E.,
Member of Council

(*Read at the Science Museum, London, 5 February* 1964)

The manufacture of gunpowder in south Westmorland started in the year 1764, and carried on until the last mill closed in 1937. Before 1750 gunpowder had been manufactured only in the south—and mainly in the south-east—of England. John Wakefield, of Kendal, displayed considerable courage when he built this, the first gunpowder mill in the north of England, but having established this new industry and made a success of it, he was soon followed by others. The location of the Westmorland and Furness gunpowder mills (for convenience I will refer to them as the "northern mills") is shown on the Map, and I give below brief particulars.

TABLE I
THE GUNPOWDER MILLS

Name of Gunpowder Mill	Year mill licensed or production started	Name(s) of principal owner(s)[1]	Remarks
Sedgwick (old)	1764	Wakefield	Closed *c.* 1850
Bassingill	1790	Wakefield	Extension of Sedgwick Mill
Lowwood	1799	Wilson & Barker	Bought by Wakefield in 1882
Elterwater	1824	Huddlestone	
Gateback	1850	Wakefield	Sedgwick moved to Gateback
Sedgwick (new)	1857	Swinglehurst	
Blackbeck	1860	Dickson	

From the above table it will be seen that the importance of the industry increased steadily, and it reached its greatest prosperity between about 1860 and the end of the 1914–18 war. Shortly before 1914 the local mills were producing about 50 per cent. of the gunpowder manufactured in the United Kingdom. No Paper on the manufacture of gunpowder has been presented to the Newcomen Society, and I must assume that most of our members are as ignorant upon this subject as I was two years ago. I therefore feel that I must devote some space to describing, as briefly as I can, the history and technology of gunpowder manufacture, although this means that I will be able to say rather less

[1] Several of the mills had changes of ownership. The names are those of the principal owners when the mills were operating as successful independent units.

about the northern mills. One aspect which interests me particularly is *why* this new industry started in Westmorland. I have been unable to find any written information upon this subject, but by weighing up the available evidence we can, I think, answer the economic questions with reasonable accuracy. First, however, we must consider when, how and why gunpowder was made.

The History of Gunpowder Manufacture

Roger Bacon (*c.* 1220–92) was the first man to describe gunpowder as we know it. He regarded it as a substance which burned with explosive rapidity, but did not appreciate the fact that, if enclosed in a tube, it could be made to eject a projectile at a high velocity.[1] In the thirteenth as in the twentieth century the men of war were quick to follow the men of science, and Bacon's explosive powder soon became as important as the atomic bomb became later. The uranium of the day was saltpetre (KNO_3) and this, mixed with sulphur and charcoal, produced a magic powder which was to give the European nations domination over the world for 600 years.

The first gunpowder was a loose, dry mixture of three ingredients, saltpetre, sulphur and charcoal. These were ground to a powder, and mixed by hand in wooden mortars. The resultant powder was known as "Serpentine," and was difficult to handle. Even when fresh it had to be packed into the gun barrels with great skill to ensure that there was an adequate charge of powder, and at the same time sufficient air space to allow rapid combustion. The art of the "Master Gunner" involved much more than the accurate sighting of his gun. When this powder was transported the ingredients tended to separate, the heavier saltpetre and sulphur settling to the bottom of the containers, and the lighter charcoal rising to the top. To overcome this trouble the powder was sometimes mixed almost on the field of battle.

Early in the fifteenth century the process of "Corning" was evolved. During the mixing or "incorporating," the powder was moistened with alcohol or urine.[2] This had the effect of converting the fine powder into a stable, hard "cake," which, after compression, could be broken down into grain sizes depending upon the use for which the power was required. This was the "Corning" process. Table 2 below shows in chart form the main processes of gunpowder manufacture. These varied only slightly from the sixteenth century, when the earliest British factories started work until 1937 when the last of the northern mills closed.

TABLE 2

The Processes of Gunpowder Manufacture

1.	(*a*) Saltpetre	(*b*) Sulphur	(*c*) Carbon
2.		Mixing	
3.		Incorporating	
4.		Pressing	
5.		Corning	
6.		Glazing or Reeling*	
7.		Drying	
8.		Moulding*	
9.		Packing	
10.		Transport	

* These processes were only carried out for certain types of powder.

[1] H. W. L. Hime, *Gunpowder and Ammunition, their Origin and Progress*, London, 1904. Hime places Bacon's description of gunpowder at about 1248. He examines carefully the claims that it was invented by the Arabs, the Hindus or the Chinese, or that it was a direct development of "Greek Fire," and dismisses all with, I would say, good reason. He is strongly of the opinion that the discovery of saltpetre as a separate compound was almost contemporary with the invention of gunpowder.

[2] *Encyclopedia Britannica*, Art. "Gunpowder," 1958, edn. "The urine of wine drinkers was held to make the 'strongest' powder."

In dealing with the basic ingredients and the processes of manufacture I must be brief. If I over-simplify, I can only apologise to those with a knowledge of the trade who would be happier if this subject were dealt with in greater detail.

1. (*a*) *Saltpetre* was first produced by a slow and somewhat unsavoury process which involved scraping rotten plaster from the walls of the cellars of old buildings, mixing it in heaps with earth and dung, and watering liberally with urine. In about two years the heap yielded a reasonable amount of saltpetre. Later it was imported from India, Italy and Chile. It was purified by dissolving in water, boiling, straining and evaporating the liquid to leave pure salt crystals. A new method of manufacture was first introduced at Gatebeck *c.* 1865; this will be mentioned later.

(*b*) *Sulphur* (Brimstone) was imported from Sicily and Italy; it was refined by slow heating and skimming off the dross from the surface.

(*c*) *Charcoal* was first made in the conventional way of charring "coppice wood" in open pits. Soft wood made the most suitable charcoal, and alder seems to have been preferred. "Pit Cole," as it was usually called, was satisfactory for iron smelting, but was the least pure of the three ingredients. By the end of the eighteenth century some improved method of manufacture was being sought.

It is a coincidence that this problem was solved by a Westmorland man. The Rev. Richard Watson, later to become Bishop of Llandaff, was born at Heversham in south Westmorland in 1737, and was educated at Heversham Grammar School within two miles of the village of Sedgwick. He was appointed Professor of Chemistry at Cambridge in 1764, and when asked by the Government to suggest some way of increasing the "strength" of gunpowder he put forward the idea that wood for charcoal should be distilled in iron cylinders, replacing the method of charcoal burning. His report was produced in 1786, and the first "cylinder charcoal" was made at Hythe in 1787.[1]

Long, horizontal iron cylinders or retorts, about 2 ft. in diameter, were supported between walls of brick. They were packed with coppice wood cut into short lengths, which were fired for about eight hours each day. The charcoal was removed after the retorts had been allowed to cool. Charcoal was the only basic ingredient which was produced near the mills. Although *by weight* it comprised only 10 per cent. of military or 15 per cent. of blasting powder, it required about 120 lb. of green, fresh wood to make 10 lb. of charcoal. Thus, allowing for waste during manufacture, it would take about 200 lb. of coppice wood to make 100 lb. of blasting powder.[2]

2. *Mixing*. The three basic ingredients were ground to a fine powder and mixed by stirring in tubs or rotating barrels containing brass "bullets," not unlike a modern "ball-mill."

3. *Incorporating* (also referred to as "Amalgamating"). Incorporating is the intimate mixing of the ingredients under pressure with water added. This is the process which requires the most massive machinery, and the greatest amount of motive power. At first the powder was incorporated in wooden mortars pounded by wooden pestles. Later wooden stamping mills were worked by water power, but this was a dangerous process, and stamp-mills were prohibited in England in 1772.[3] Plate XVI (*a*).)

The stamp-mill was replaced by the "edge" or "cylinder" mill. At first one, and later two, heavy rollers about 2 to 3 ft. wide and 5 to 7 ft. in diameter with their axes horizontal were rotated by a single

[1] Richard Watson, *Anecdotes of the life of Richard Watson, Bishop of Llandaff*, London, 1818, p. 240 *et sq.* Dickinson and Straker, "Charcoal and Pyroligeneous Acid making in Sussex," *Trans. Newc. Soc.*, vol. XVIII, 1937–8, pp. 61–68. This Paper includes an interesting illustration of "Charcoal cylinders at Faversham, 1798." Further sketches of eighteenth century powder-making plant and processes are reproduced in *The Rise and Progress of the British Explosives Industry*, VIIth Int. Congress of Applied Chemistry, London, 1909.

[2] Col. Wm. Anderson, *Manufacture of Gunpowder*, London, 1862, p. 55.

[3] Vittorio Zonca, *Novo Teatro*, Padua, 1621, p. 85 shows a seventeenth-century stamping mill. Belidor, *Architecture Hydraulique*, Paris, 1782, pt.1, bk. 2, pp. 348–59, ch. 3, 1st and 2nd plates.

vertical shaft so that they rolled around a plate or tray in which the charge of powder mixture was placed. The rollers were of stone, brass or cast-iron, and the material from which the incorporating mills were made were carefully chosen so that they could not accidentally strike a spark.[1] Stone rollers can still be seen at Elterwater and Lowwood. (Plate XVI (*b*).)

The output of a gunpowder factory depended almost entirely upon the number of incorporating mills which could be installed. The other processes, mixing, corning, pressing, etc. required relatively little power, and in the early days were often carried out by hand. The incorporating mill could only handle a charge of a given weight (limited by law after the passing of the Explosives Act of 1875), and the process took some time. The black blasting powder with which I am mainly concerned in this Paper was incorporated for about $1\frac{1}{4}$ to $1\frac{1}{2}$ hours, the average charge being 75 to 90 lb.[2] The output naturally varied with the state of trade, but the number of incorporating mills gives a useful indication as to the *maximum* capacity of any particular factory producing a given type of powder. The "ripe" charge was lifted from the mill with wooden shovels and taken to the press house. It was known as "mill-cake", and contained hard lumps which had to be broken down with wooden malls.

4. *Pressing*. The "mill-cake" was then compressed into thin slabs. The early "press boxes" were of wood, 2 to 3 ft. square internally, bound with iron (later copper) straps. The powder was packed into the box between copper plates about $\frac{3}{4}$ in. apart, and a wooden cover, fitting *inside* the box, was pressed down. At first this was done by hand with a powerful screw, but later conventional hydraulic presses were used.[3] In the local mills the hydraulic pumps were worked by waterwheels, turbines, or steam engines. Pressing reduced the powder to hard slabs, rather like slate, called "press cake."

5. *Corning* (Granulating). The "press cake" was broken into grains which varied in size depending upon the purpose for which the powder was to be used. We have a good description of a corning machine which was used at Elterwater Gunpowder Works in 1878 and which is probably typical of the early, simple mechanical equipment. This is given by H.M. Inspector of Explosives after he had investigated an explosion.

> "This machine in the corning-house, used for breaking the press cake into grains, was one of the old fashioned corning machines, consisting of a frame of wood suspended from the ceiling, and made to oscillate by means of a perpendicular crank [driven in this instance by a water wheel] passing [upwards] through the floor. In this machine a number of wooden sieves lined with copper and containing pieces of press cake and round blocks of *lignum vitae* placed upon the frame are shaken violently by the motion of the crank, and the blocks dashing about in the sieve soon reduce the press cake to fragments and dust which pass through the sieves to the floor."[4]

---

[1] Zonca, *op. cit.*, p. 82 shows a mill with a single stone roller. John Smeaton, *Catalogue of the Civil and Mechanical Engineering Designs, 1741–92*, Newc. Soc. Extra Pubn. No. 5, London, 1950, p. 31. Drawing 33v., title: "Water Mill, Waltham Abbey, Essex." Description: "For Mr. [Bouchier] Walton's double stack [edge runner] powder mills at Waltham Abbey." The two stones are 7 ft. in diameter and 1 ft. 9 in. wide.

[2] Information provided by Mr. Alfred Bush. Mr. Bush started his career at Gatebeck and later became Manager of the Sedgwick factory before moving to the I.C.I. factory at Ardeer in 1935, where he remained until his retirement in July 1958.

[3] Anderson, *op. cit.*, pp. 90–100 and plate 6. This shows a hand-operated press-box used at Ishapore in India during the early part of the nineteenth century. *I.C.I. Magazine*, vol. 4, no. 10, Oct. 1929. "A short history of the North of England Gunpowder Group," pp. 337–48. Illustration p. 348 shows a screw and nut used at Elterwater to operate a screw press. *The Rise and Progress of the British Explosives Industry*, *op. cit.* Fig. 13.

[4] *Reports of H.M. Inspector of Explosives, Elterwater*, 29 November 1878. After the passing of the Act of 1875 a report was issued after every fatal accident. Much useful information can be obtained from these reports to which further reference will be made in the Appendix. I quote in all cases the date of the accident, and use the abbreviation "H.M.I.Ex." An identical type of sieve, also worked by a waterwheel, can still (1963) be seen at work in Gawith Hoggarth's snuff mill, Helsington Laithes, near Kendal.

The pieces were then sorted into different-sized grains by further sieving. According to Marshall, Col. Congreve invented a corning machine in 1819.[1] This consisted of a series of toothed, gunmetal rolls, followed by plain rolls, which broke up the press cake and automatically sifted the different grain sizes and dust.

6. *Glazing and Reeling.* Nearly all ordinary blasting powder was glazed by placing it in rotating wooden drums, the polishing agent being black lead. Fine powders usually required further treatment to remove dust. It was put into a revolving hexagonal wooden frame fitted with a screen of fine meshed canvas (a "Reel") through which the dust escaped.

7. *Drying.* Water was added to the powder at the time of incorporating, and, in spite of the work put into it during the incorporating, pressing and corning processes, it still retained an appreciable amount of moisture. A sample of powder analysed in 1881 after pressing showed 1·01 per cent. of water and this was apparently regarded as quite normal.[2] Drying was first done with "gloom stoves." The drying chamber had a metal dome rising above its wooden floor, the dome being heated by a fire burning below. Major Ford, H.M.I.Ex., quotes this as a good example of the astonishing risks which were taken in the manufacture of gunpowder in the early days. He adds that by 1878 their use had been entirely discontinued, but he had seen one in a disused drying room in Cornwall. Later the powder was dried with hot air or water or steam coils. (Moulded cartridges were dried *after* moulding).

8. *Moulding.* The moulding of black powder into cylindrical cartridges was a development of the late nineteenth century. When blasting was first introduced into the collieries the pitmen used to provide their own powder, which they made up into paper cartridges in their homes. This was done at weekends or in the evenings, often by the light of a candle. Ultimately the authorities recognised that this was rather a hazardous home industry, and the moulded blasting cartridge was a welcome innovation. The powder was pressed into cylinders from $\frac{3}{4}$ in. to $1\frac{1}{2}$ in. diameter, with a central hole into which the fuse was fitted. These were produced by hydraulic presses of conventional design.

9. *Packing.* Gunpowder was traditionally packed in wooden barrels, holding 100 lb. Half and quarter barrels were also made. They had to be made of dry, well-seasoned wood, with strong oak staves to make them dust- and water-proof and strong enough to withstand rough handling. The cooperage was an important section of the gunpowder factory, and the availability of good local timber was an advantage. Blasting cartridges were packed in boxes.

10. *Transport.* Gunpowder was transported by the most convenient and economical method. Within the mills horses and carts were first used, and later tramways were laid down. The powder was moved in closed, horse-drawn vans. At Lowwood a derelict van can still be seen. After the passing of the 1875 Act canals, railways, etc., all had to be licensed to carry and store gunpowder.

The Economic Factors

In this section we need only consider the facts which must have influenced John Wakefield before he started his factory. He was the pioneer, and having made a success of his business it was only natural that others should follow. Until the end of the seventeenth century gunpowder was only used in England for military and sporting purposes and for fireworks. Wars were fought on the

[1] Arthur Marshall, *Explosives*, vol. 1, London, 1917, p. 82. This was presumably Sir William Congreve, Bt., 1772–1828. (According to Mr. M. Berrill, Congreve's patent was no. 3937 of 1815.)
[2] H.M.I.Ex., *Blackbeck*, 19 March 1881.

Continent and at sea, and all the naval bases were in the south. Saltpetre and sulphur came from the Mediterranean or from India, and in these circumstances there was no inducement to any intelligent business man to start manufacture in the far north.

Early in the seventeenth century gunpowder was first used for blasting in mines. It is generally accepted that Gaspar Weindle introduced this new method of mining in Hungary and that it had spread to Germany by 1627.[1] In 1665 Sir Robert Murray contributed a paper to the Royal Society on Blasting, but all evidence points to the fact that it was first used in England at the Ecton Copper Mines, Staffordshire, in 1670.[2] Metalliferous mining had been an important industry in Westmorland, Cumberland and Furness from the sixteenth century, and by the mid-eighteenth century copper, lead, iron and coal were being mined. Slate quarrying for the "building boom" which accompanied the Industrial Revolution was becoming established, and not far from Kendal, with reasonable pack horse communication, lay the lead mines of Alston Moor, north Yorkshire and Derbyshire. By 1750 a good market for blasting powder was developing in the north west.[3]

Of the southern gunpowder mills Waltham Abbey was one of the most important, and many of the facts relating to it probably applied to the others. From William Winter's interesting (and in many parts amusing) history of Waltham Abbey Mills there are a number of references to the efforts that were made to increase the use of water power. In 1739 the owner, Richard Walton, opposed the "New River Bill" because it might reduce his water power, and Winters quotes a local historian, Peter Muilman, writing in 1770 as follows:

> "Near the town on one of the rivers [the river Lea] are several curious gunpowder mills under a *new construction, worked by water*, the old ones having been worked by horses. They are reckoned the most complete in England . . ."[4]

We have seen from the illustrations in Zonca and Belidor that waterwheels were used to drive the incorporating mills, and here we have evidence that their use was being extended as far as possible. Adequate water power was becoming essential for powder mills if they were to maintain the maximum output. We also learn from Winters that difficulty was experienced in obtaining satisfactory supplies of charcoal, and Dickinson and Straker, in their article already referred to, state that charcoal from Fernhurst, Sussex, was sent to Waltham and Faversham, the former being 65 miles away and the latter even further.

Two other factors must be considered, namely, the type of powder required for the mining industry, and transport. The southern mills were built to make fine military powder which used roughly two-thirds of the proportion of charcoal required for coarse blasting powder, with a longer period of incorporation and different finishing processes. Their machinery was not suited to producing small quantities of blasting powder for mines 200 miles away in the north. We need say little about the difficulties of inland transport as the Industrial Revolution gathered momentum. It was fabulously costly, and the urge for local manufacture in the newly developing industrial areas of England was as great then as it is now in the many countries which are emerging from a largely agricultural economy. With these facts in mind we can visualise Wakefield and his partners sitting round a table, with pen

---

[1] Marshall, *op. cit.*, p. 33, quoting F. M. Feldhaus, *Zeitschrift fur das gesamte Schies- und Sprengstoffwesen*, p. 218.

[2] *Phil. Trans.*, 1665–66, pp. 82–85. I am indebted to Mr. F. Lebeter, Keeper of the Department of Transport and Mining, Science Museum, for this information. It is supported by Miss Nellie Kirkham of Newcastle, Staffs., who has also done research on this subject. It now seems to be generally agreed that Prince Rupert's German miners introduced blasting powder as a practical aid to mining.

[3] John Postlethwaite, *Mines and Mining in the English Lake District*, 3rd edn., Whitehaven, 1913. This excellent work gives much historical information about the mines, and contains a number of mine plans and sections.

[4] William Winters, *Centenary Memorial of the Royal Gunpowder Factory, Waltham Abbey*, 1887, pp. 19–20.

and paper, writing notes on the facts they must consider before embarking upon a costly and unusual enterprise. The notes might have read something like this:

1. Market	Mines and quarries. Plenty in the locality. Demand for minerals and slate increasing. More blasting powder bound to be used.
2. Product	Black blasting powder only.
3. Knowledge	Pay a powder maker to come up from the south.
4. Power	Buy or rent a local water mill where we can, as time goes on, install more waterwheels.
5. Raw materials	We must import saltpetre and sulphur. These will not cost us much more than they do in the south. There are hundreds of acres of coppice wood within 15 miles, and charcoal burning is a local industry.
6. Communications	Use port of Milnthorpe for coastal import and export. Pack horse roads lead from Kendal to our nearby markets.
7. Site	Near Kendal where we live, but must be well in the country as we are told that explosions cannot be avoided.
8. Capital and initiative	This is up to us.

Their questions answered, the three partners started their new venture.

The Wakefield Gunpowder Mills

I have been able to obtain no first-hand and little second-hand information about the original Sedgwick gunpowder mill. I think it best, therefore, after introducing the man who appears to have been the driving force behind the enterprise, to see how it achieved success, treating this section in the same order as the notes I have just set down. The subject matter under the different headings is interdependent, but because all trace of this mill has vanished it may be better to maintain continuity of thought on the economic line rather than to try and produce a chronological description as I will with the later mills.

John Wakefield, 1738–1811, was a Quaker, born of an Old Kendal family. He was brought up in his father's business of shearman dyer, a process of the woollen industry. His father was a delicate man, and the business was largely run by John and his mother.[1] He was 26 years old when the mill started, and we have no reason to believe that he knew much about gunpowder.

Market. This aspect I have dealt with. The northern mills made black blasting powder, and the only reference I have so far been able to find relating to markets is in a letter of July 1826 from John Wakefield II (son of the original John) to William Wager, agent for Mandale Mine in Derbyshire:

"On my return last week I found your letter and as requested I have forwarded the above [12 half barrels of powder] to put you on for awhile—our water is still very low and the rain we have, has yet had no effect on the springs."[2]

There must have been a great demand for gunpowder during the Napoleonic wars, but whether any of this came from Sedgwick I do not know.

Product. Some military powder may have been made, but all the northern mills stuck mainly to blasting powder.

[1] John Somervell, *Some Westmorland Wills*, Kendal, 1928, p. 93.
[2] Extract from a letter in the possession of Mr. Robert Thornhill of Great Longstone, Derbyshire.

Knowledge. We must assume that an experienced gunpowder maker was employed. In the case of Lowwood, which I will mention later, we know that there was correspondence between the manager (?) and a gunpowder maker at Faversham.

Power. The water power available on the river Kent at Sedgwick was much greater than that of the river Lea at Waltham Abbey. The catchment area was 75 square miles, and the average rainfall over 60 in. per annum. The fall was about 10 ft., and from a plan in the Archivist's Office of the Westmorland County Council we can see that this fall was to be developed on a pattern which became conventional. The headrace of the old mill was extended parallel to the river, and process houses were built between the headrace and the river. The machines were probably driven by a number of waterwheels working on a head of from 4 to 7 ft.

Soon it was found that more power was required, and Wakefield built a new set of incorporating mills at Bassingill, about half a mile lower down the river Kent. Here again the head was 10 ft., and when the Wakefields moved their main factory to Gatebeck in 1850 they still retained the Bassingill mill. The massive foundations and wheel pits at Bassingill are amongst the most striking remains of the northern mills (Plate XVII (*a*)). Originally there were two waterwheels, but I am told that one fell into disrepair and during the later years one large wheel drove six incorporating mills. Even with two excellent sites for water power we can see from the letter just quoted that summer drought could seriously reduce production and when, in 1845, an "Act for making and maintaining Reservoirs in the Parish of Kendal in the County of Westmorland" was promoted, the name of John Wakefield II is among the Commissioners who were responsible for the undertaking. Only one, the Kentmere Head reservoir (see Map) was built, but even this relatively small amount of controlled storage improved the continuity of water power for all the mills on the river.

Raw Materials. Saltpetre and sulphur probably came by sea to Milnthorpe, about which I will have more to say when dealing with communications. Iron had been smelted in Furness for at least 500 years, and charcoal burning was an important local industry. At first it would be bought from the local burners (see under "Lowwood," p. 57) but from the plan referred to above, Note 11, "Retort House for manufacturing charcoal and furnace" we see that the factory was making its own. Timber was also required for making barrels, powder drying and general purposes, and the availability of ample supplies was clearly of great importance.

Communications. From Roman times to the present day Kendal has been a focal point for roads. The main road to Scotland runs through it (nowadays "crawls" might be a better word), and it is the junction with the important (A.65) road to Yorkshire and the south-east. Northwestwards runs the road to the Lake District and there were pack horse tracks over the mountain passes to west Cumberland. Considering how remarkably bad inland communications were in the mid-eighteenth century Wakefield was well placed to send his powder to the Lake District and Furness mines and even further afield. Milnthorpe was at that time a small tidal port on the river Bela at the head of the Kent estuary. Ships up to 100 tons burthen came up with the tide, bringing coal from Whitehaven and other raw materials to Kendal and the surrounding district. It is about four miles by road to Sedgwick, and there can be little doubt that the port was used by the powder mills for both import and export.[1]

The Wakefields, father and son, were members of "Turnpike Trusts" formed to improve local roads and build new ones, and they also brought pressure to bear when plans were being made to construct the Kendal and Lancaster canal. According to Curwen, alternative proposals were put forward, one of which would have involved building mechanical lifts to avoid the Hincaster tunnel which was regarded as a difficult obstacle. If this plan had been accepted by the promoters the canal

[1] John F. Curwen, *History of Heversham with Milnthorpe*, Kendal, 1930, p. 74 *et seq.*

would have followed a line some distance from Sedgwick and, more important, on the opposite side of a ridge 250 ft. high. Curwen states:

> "The gunpowder influence appears to have been too strong against the [alternative] scheme, so that we find on the 7th of January, 1806, a report and survey for making a navigable canal . . . which virtually adopts the original Whitworth Survey."[1]

As will be seen from the Map, the canal, opened in 1819, ran within a few hundred yards of the Sedgwick mill, and must have solved nearly all the transport problems.

Site. The Sedgwick gunpowder factory was built on a flat strip of land on the east side of the river Kent well away from the few houses which comprised the hamlet. When it was built it probably complied with all the regulations and may have appeared to be ideal, but when compared with the later factories it is clear that the process houses and magazines were much too close together, and there was no room for expansion. One interesting record is a sketch entitled "Powder Mill, Sizergh," contained in a sketch-book of pencil drawings which are mostly of large houses in the north-west of England. The name of the artist is unknown, but it is dated 1802. It shows a few buildings, one of which may be the old corn mill, with the river sweeping round in front and the low hills rising in the background.[2] (Plate XVII (*b*).)

Capital and Initiative. I have referred to John Wakefield and his partners. These were Alderman Gurnall of Kendal and Edward Johnson of Old Hall. They entered into a "tontine" agreement, and as Wakefield survived the other two the business passed entirely into his hands. He was given credit for its success, and there is no reason to believe that he was not the driving force. The Wakefields prospered as a result of John's initiative.

After 80 years at Sedgwick the Wakefields decided to move their factory from rented land which was very restricted to land which they owned and which would make an excellent site for a gunpowder factory. They retained the incorporating mill at Bassingill but moved the remainder of the Sedgwick factory to Gatebeck in 1850.

Gatebeck

Gatebeck lies five miles SSE of Kendal, about a mile to the east of the busy A.65 road from Kendal to Yorkshire. The licence to manufacture gunpowder was granted at the Westmorland Quarter Sessions in October 1850. The country is pleasant undulating agricultural land, and the mills were built on either side of the Peasey Beck which forms the upper reaches of the River Bela. The beck runs down a shallow valley with enough flat ground for the construction of buildings. The site was developed in two stages, the first covering the area to the south of the road from Gatebeck to Kendal, and the second the area north of the road. The total was about 70 acres. The catchment area of the Peasey Beck at Gatebeck is smaller than that of the Kent at Sedgwick, and the average rainfall is lower. It was, however, possible to obtain a head of 50 ft. between the northern and southern boundaries of the property, and this head was developed in four stages. The tailrace from the water-wheels which drove the upper incorporating mills discharged into the beck just above the second weir, and this system was continued to the bottom end of the property.

Although Gatebeck factory was planned long after the steam engine had become the most important prime mover in England, we must appreciate the particular problems of the gunpowder mills. A considerable amount of power was required to drive the incorporating mills; elsewhere a little power

[1] John F. Curwen, "The Lancaster Canal," *Trans. Cumb. & Westd. Ant. & Arch. Soc.*, vol. XVII, n.s., 1916–17, pp. 26–47.

[2] I am indebted to Miss Clay of Ambleside for permission to reproduce this sketch.

was needed intermittently at a number of small process houses, workshops, etc. which had to be widely separated. There was no electric power transmission, and nobody wanted small steam engines and boilers scattered about the factory. The solution to the problem was to place the process houses along the side of the headraces and draw off water as required, using it as economically as possible. For those processes which only required hydraulic pressure the situation was rather different. As the demands on the water power became greater steam engines were installed to drive hydraulic pumps to feed the presses, and these could be located hundreds of yards from the engine houses.

At the source of the Peasey Beck was Killington reservoir, built in 1820 to feed the Kendal and Lancaster canal. The Lancaster Canal Navigation Act of 1819 laid down that this reservoir was not to interrupt the flow of water to the mills below, and that a minimum amount of compensation water was to be let out.[1] The compensation water would undoubtedly be greater than the normal minimum flow of the beck before the reservoir was built, and this would benefit the mill owners below in dry times. When we also bear in mind the fact that by 1850 the London & North Western Railway main line system was completed, and already the canal was being used very much less, there can be little doubt that although the Wakefields did not *control* Killington reservoir, it must have added appreciably to the value of their water power. In 1895 a supplementary source of power, which included a water supply to the factory and the villages of Gatebeck and Endmoor, was provided, by building a concrete dam on the Fall Beck about a mile from the factory. This delivered water at a head of over 300 ft. to the factory, and by feeding water under this pressure to the hydraulic pumps a considerable saving in power was achieved.[2] Later three Gilkes pelton wheels were installed, taking their water from this dam. Two provided power for the reeling mills and one for a gas plant fan.

Milnthorpe, on the L. & N.W.R., was the nearest railway station, and in 1874 the extensive tramway system of the factory was connected to sidings there by a horse-drawn tram. This followed the Peasey Beck to Crooklands where it crossed the A.65 road and the Kendal and Lancaster Canal. Thence it ran by the side of the Milnthorpe road to the station.[3]

There were 12 incorporating mills at Gatebeck and six at Bassingill. The weekly output of powder was about 30 tons.[4] The manufacture of charcoal in retorts was discontinued in 1860, but about 1865 a new process was evolved for the production of saltpetre from potassium chloride and sodium nitrate. This was first developed on a commercial scale at Gatebeck.[5] In addition to saltpetre manufacture there was a large sawmill and cooperage, much of the timber being bought locally. The total number employed, including women and boys, was about 140, of whom some 25 worked in the saltpetre manufacturing plant and 45 in the sawmill and cooperage. As a result the number employed per ton of powder produced was higher at Gatebeck than at the other factories.[6] Gatebeck supplied Lowwood with saltpetre, casks and cases.

---

[1] Lancaster Canal Navigation Act, 14 June 1819, Clause VIII ". . . the Gauge . . . at or near a certain Place called *Mutton Hall*, in the said Township of *Killington*, shall at all Times hereafter be kept fully supplied with Water by the said Company . . ."

[2] Letter from Mr. Bush to John Somervell, July 1934.

[3] Curwen, *Heversham and Milnthorpe, op. cit.*, p. 67.

[4] Information from Mr. Bush.

[5] *Imperial Chemical Industries Ltd., and its founding companies*, London, 1938, pp. 176–7. Mr. Bush gives the manufacturing formula as follows:

KCl	+	$NaNO_3$	=	KNO_3	+	NaCl
Potassium Chloride		Sodium Nitrate		Saltpetre		Common Salt

[6] These figures were given to me by Mr. Bush, and are confirmed by Mr. Fred Towell, now aged 86, a retired employee of Gatebeck. Census figures for 1901 show 149 Gunpowder Makers for the county of Westmorland. Those employed as coopers, drivers, labourers, etc. would not be included. Mr. Towell describes himself as an "odd job and maintenance man" who "never worked among the powder."

Mr. Bush tells me that the main markets for powder during his time were the coal mines of the north-east coast, quarries in the north of England and North Wales, the Crown Agents for the Colonies and West Africa. Mr. Towell, when in the British Army in India during the 1914–18 war saw a pile of familiar-looking barrels stacked on a jetty. It did his heart good when he went up and saw that they were marked: "W. H. Wakefield & Co., Gatebeck, England"! In 1882 Wakefields took control of the Lowwood factory, and from 1917 to 1920 all the Westmorland and Furness mills were absorbed into Explosives Trades Ltd. which finally merged with I.C.I. Ltd.[1] Gatebeck finally closed in 1937. Some of the workers moved to the I.C.I.—Nobel Division—explosives factory at Ardeer in Ayrshire. The sawmill and cooperage is now used as a contractor's depot, and the Low Mill is the Civil Defence training area of the Westmorland County Council. The coppice wood has come back into its own, and the site of a once thriving rural industry is now a bramble-infested jungle.

Lowwood (Furness)

Lowwood (not to be confused with the Low Wood Hotel between Windermere and Ambleside) is near the village of Haverthwaite; the gunpowder mills lie on the east side of the river Leven which flows from Windermere into Morecambe bay at Greenodd. A licence to manufacture gunpowder was granted in 1798 to Mr. King of Finsthwaite, Mr. Wilson of Rigmaden and Mr. Daye Barker.[2] A number of documents, dating from 1798 to 1846, relating to Lowwood, have been deposited with the Lancashire Records Office at Preston. These comprise Cash Books, Day Books, letters and sundry documents.[3] The first record in the Cash Book, 22 August 1798, is a credit of £10 10s. from "Maudes Wilson's Acct." This account appears to have included payments by the subscribers to the undertaking and, later, payments received from sales of powder. Similarly most disbursements were entered to "Charges on Trade."

Mr. J. Fayrer, living, at that time, at Harmony Hall, Milnthorpe, was evidently seeking advice from Mr. J. Stevens of Feversham (*sic*) about the manufacture of gunpowder. A few letters from Mr. Stevens, many parts of which are indecipherable due to damp, are amongst the records. It would be interesting to have these transcribed, but from my rather cursory examination I doubt if they would add much to the information already published about the contemporary methods of gunpowder manufacture. The earliest letter, dated 7 October 1799, gives Mr. Fayrer some advice about the amount of water to be added to the "green" powder in the incorporating mill: more should be added in dry weather than when the atmosphere is damp. No improvement in the final quality of the powder will result from too long a period of incorporating, and he must not worry if his saltpetre is not white. There are also a few notes on re-working dust from the corning mill. Later there is a badly mutilated sketch (undated) which shows, I think, refining vats for saltpetre, and another giving dimensions for "charcoal cylinders" which agree closely with those referred to in Dickinson and Straker's Paper.[4] Coming to the first "Cash Book," we find:

"Dec. 24th 1798. By charges on Trade to erect Mills £9 4 0"

Within a few months raw materials were evidently being purchased, but there is no direct record

[1] *I.C.I. Ltd., op cit.*, p. 200. To attempt to describe the pattern of take-overs would be rather like reading Genesis X. Suffice it to say that until the latter part of the 1914–18 war W. H. Wakefield & Co. Ltd., owning the Lowwood Gunpowder Co. Ltd., formed one group, and the other mills, Sedgwick, Elterwater and Blackbeck, were independent.

[2] *I.C.I. Magazine, op. cit.*, p. 340.

[3] *Lowwood Documentw*, Lancs. Record Office, Ref. DDLo., deposited by Mr. D. A. While, Birkdault, Haverthwaite.

[4] *Lowwood Documents*, "Letters." Dickinson and Straker, *op. cit.*

of the buying of saltpetre. From time to time there is a small credit for the sale of saltpetre containers, together with an entry:

"Aug. 16th 1800. By Jn. Gibbons & Co. Charges on Trade for Freight, Cartage & Warehousing Sal. Petre a/c Pd. £73 18 0

"April 5th 1799. By Sulphur Acct. paid Downward £154 9 0"

From a local point of view the most interesting figures are the sudden and very considerable purchases of charcoal. From 19 April 1799 to 15 March 1800, 2,176 "sacks" of charcoal were purchased for a total sum of £775 14s., an average of 7s. 3d. per sack. The smallest single item is for six sacks, and the largest for 69. The suppliers appear to have been local, with names such as Newby, Barker, Robinson, Holmes, Baines, Clarke, Long, Dixon, etc., all of which are still common in the district.[1] For the next year or two charcoal purchases fell to a very low figure, and one must assume that either the company was building up a stock or that thereafter they bought coppice wood and made their own charcoal. A critical examination of the accounts over a much longer period would help to clear up these points.[2] For a description of Lowwood I can hardly do better than quote the official I.C.I. history:

"These works had been established in 1799 when six [incorporating] mills, with press, corning and other houses were erected, and the site could hardly have been more suitable. Originally, apart from the great advantage of cheap power from the volume of water flowing out of the lake [Windermere], the local coppice woods afforded a cheap supply of material for the making of charcoal on the spot. Charcoal burning had been a substantial industry for hundreds of years, the product being used for the considerable number of small iron furnaces in the neighbourhood.

"By 1860 another eight mills had been built, making a total of fourteen. Up to that time trade had been confined to blasting and 'African' powders, but it was then decided to enter the sporting gunpowder trade. The manufacture of these latter powders was undertaken and Government contracts were secured for military supplies.

"A great many alterations were made to accommodate the sporting and military trade, but a disastrous fire at the mixing house in 1862, and an explosion in the following year, proved a serious set-back. In the latter year the business was turned into a limited company under the name of the Lowwood Gunpowder Company Limited, with head offices at Liverpool. The new company never proved to be very prosperous, however, and it was sold in 1882 to W. H. Wakefield & Company."[3]

A stone weir was built across the river Leven which had a catchment area of 110 square miles with the balancing effect of Windermere, Esthwaite Water and large areas of woodland to even out the flow. Here again the site was long and narrow, and process houses could be placed at convenient intervals along the side of the headrace. A total fall of 22 ft. was available, with a potential of over 400 horse power.

[1] Nearly all this charcoal is described in the Accounts as "Savin." This was a local name for juniper, little of which now remains in the district. The following extract from a contemporary article in *The Gentleman's Magazine* dealing with this district is of interest:

"The most mountainous hills . . . being elevated too high for woodlands, are . . . become of little value, producing only ling, heath and savin; which last has been of late years much in demand when grown in sufficient substance to convert (after being peeled) into charcoal for gunpowder makers, who paid at one time 10s. a sack for its charcoal: now it is less in request and does not sell for more than 6s. to 7s. *per* sack."
Gent. Mag., vol. LXXII, 2nd part, 1803, p. 1202, "Statistical Account of Coltone."

[2] *Lowwood Documents*, "Cash Book 1798–."

[3] *I.C.I. Ltd., op. cit.*, p. 177.

The transport facilities were better than those of Wakefield's Sedgwick mills when Lowwood started production. There was a good road to Ulverston, six miles away, which was connected to the sea by the Ulverston canal in 1795. Powder could be taken by boat up Windermere to the mines and quarries of the central Lake District, or up Coniston Water to the copper mines at its head. When the Lakeside branch of the Furness Railway was built in 1869, Haverthwaite Station was only a few hundred yards away across the river, and was quickly connected to the internal tramway system of the factory. Early this century Lowwood produced about 20 tons per week, the main markets being the Scottish coal mines and quarries. There was also a good export trade to West Africa, and much of the powder was shipped in quite small barrels, 8 lb., 10 lb., 12 lb. and 20 lb. These were all made at Gatebeck. Reasons given for the use of these small containers was ease of manhandling over long distances, the reluctance of the Colonial Police to allow the Africans to have control of considerable weights of powder, and the inability of the Africans to purchase other than small quantities.[1]

In 1953 Mr. D. A. While, the owner of Lowwood, rebuilt the weir with an adequate fish-pass, extended the headrace, and installed two 150 kW hydro-electric sets which feed into the grid and generate some two million units of electricity per annum at a cost which is comparable to that of the most efficient steam power station. The remainder of the property is given over to a market garden and some densely-overgrown woodland.

Elterwater

Charming as are the sites of the other gunpowder mills, Elterwater must take pride of place for the beauty of its surroundings. The mills were situated just above the small lake and village of Elterwater in the heart of the Langdale valley, four miles west of Ambleside. In January 1823 Mr. David Huddleston retired from the "Kendal Bank" (this was Wakefield Crewdson's bank started by John Wakefield) and built himself a house at Elterwater.[2] According to information in the possession of I.C.I. he was also interested in the fulling industry and slate quarrying, and from his banking knowledge he must have known that there was money to be made in gunpowder. On 16 January 1824 he obtained a licence to erect gunpowder mills, and he started manufacture soon after.[3] The factory covered an area of about 20 acres and was roughly triangular in shape. Great Langdale Beck ran down the western boundary, and there was quite a large mill pond in the centre of the property (Plate XVIII). Water power was provided by the beck, with a total head of about 40 ft. The catchment area was small, only about 11 square miles, but this lay within an area of very high rainfall, and Huddleston built a dam at Stickle Tarn, under the shadow of the Langdale Pikes, which provided a reasonable amount of controlled storage. The waterways, many of which still remain, were intricate, and power was provided by a number of small waterwheels and turbines.

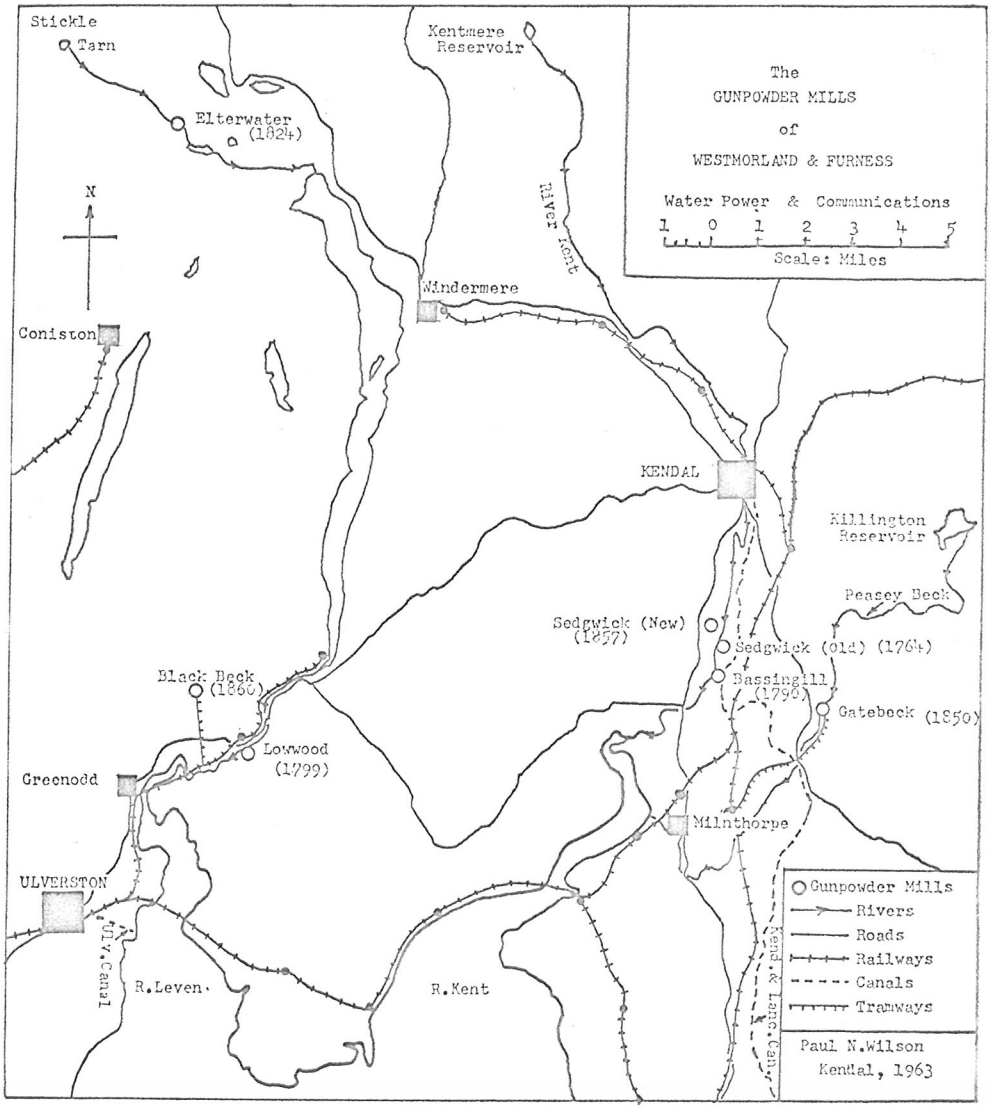
Powder was delivered to the local slate quarries of Langdale and Coniston copper mines by horse and cart. Even in its early days Elterwater gunpowder was exported to West Africa. It was taken by cart to the head of Windermere, thence by boat to Lakeside, then to Greenodd for shipment. When the Kendal & Windermere railway was completed in 1846 three or four cartloads of powder were taken to Windermere station every day.[4] Production was about 20 tons per week and an average of 50 workpeople were employed. The mills were closed in 1928 and were transformed by the owner, Mr. R. L. Hall, into one of the most beautiful holiday resorts in the Lake District. The trees originally planted to provide blast protection have now reached maturity; powder works buildings of

[1] Information from Mr. Bush.
[2] *Local Chronology*, a collection of local information mainly extracted from the Kendal newspapers. Thos. Atkinson, Kendal, 1865, p. 53.
[3] H.M.I.Ex., 29 November 1878. *I.C.I. Mag., op. cit.*, pp. 343–44.
[4] *I.C.I. Mag., op. cit.*, p. 347, and information from Mr. Bush.

local stone are furnished cottages and restaurants; caravans can be parked by running streams out of sight of their neighbours. The Elterwater Gunpowder Factory has been transformed into the Langdale Estate, and a more suitable change it would be hard to imagine.

The (New) Sedgwick Gunpowder Mills

On the west side of the river Kent, a few hundred yards above the weir which fed the original Sedgwick mills, there was a long reach of flat ground well above river level belonging to Mr. W. C. Strickland of Sizergh Castle. A company was formed to develop this site as a gunpowder factory,



and a licence to manufacture was obtained in January 1857.[1] The manufacture of black blasting powder started in 1858. The layout of the works was excellent. A "V"-shaped timber weir was built across the river, and a long headrace of dressed stone was constructed, designed to feed individual process houses, all of which were built close to the river bank. Their foundations can still be seen from the footpath which runs along the opposite side of the river. The incorporating mills were driven by a single waterwheel, 36 ft. in diameter and 6 ft. wide, working with a head of about 20 ft. An arched tailrace tunnel over 100 yards long took the discharge water back to the river. Five turbines, developing from 6 to 15 horse power each, were installed, in addition to some smaller waterwheels.

The new company got into financial difficulties, and in 1864 was taken over by a Manchester syndicate. Later Mr. Henry Swinglehurst of Hincaster (a village two miles from Sedgwick) bought out the other partners, and traded as "The Sedgwick Gunpowder Co." The employment and production were similar to Elterwater, namely about 50 employees and an output of 20 tons per week. The powder was taken by road to "Swinglehurst's siding," a stone building with loading platform at Hincaster Junction where the single (disused) line branches south from the main Carlisle-London line to join up with the old Furness Railway (see Map). The site is now owned by the National Trust and is completely overgrown.

Blackbeck

The licence to erect gunpowder mills at Blackbeck was granted in December 1860. The site is near the village of Bouth at the southern end of the Rusland valley, three miles from Newby Bridge at the foot of Windermere. The stream which runs through the mills is so small that most of the motive power was supplied by steam. The owners were F. C. Dickson & Co., and in 1881, 50 workpeople were employed.[2] The output was about 20 tons per week of black powder, most of which went to North Wales and the limestone quarries of the Peak District.[3] A tramway connected the factory to the Ulverston-Lakeside branch of the Furness railway. Unfortunately Blackbeck is mainly remembered for its record of fatal accidents. So far as I have been able to trace, no less than 27 workmen were killed there between 1867 and 1911. Even so, the reports of H.M.I.Ex. do not attribute any of these accidents to carelessness or bad management. The mills were closed in 1928, and the site now forms an attractive caravan park.

The End of the Northern Mills

By the time—shortly after the end of the 1914–18 war—the northern gunpowder mills had been taken over, it was only a matter of years before they were closed down. New explosives, particularly dynamite, were replacing gunpowder for blasting, and I.C.I. formulated a policy to concentrate all manufacture of the sort which had been carried on in Westmorland and Furness, at their factory at Ardeer. It was apparently regarded as uneconomic to continue working these small local industries, and no effort, apart from the direct transfer of labour to Scotland, was made to use the sites or provide alternative employment for the people who had worked there all their lives. The wheels of industrial efficiency continued, as they must, to turn, but their relentless motion left a legacy of unemployment with its sad consequences. Fortunately the outbreak of the second world war, disastrous as it was, brought jobs for all, and the subsequent prosperity of the area has blotted out the memory of the lean years. The houses in which the powder was worked or stored were destroyed. This is essential when a gunpowder factory is closed. The buildings must be burned to remove any trace of powder, and on the deserted and overgrown sites every year leaves less sign of stone walls, foundations, wheel

[1] John F. Curwen, *Records relating to the Barony of Kendale*, Kendal, 1926, vol. III, p. 236.
[2] H.M.I.Ex., Blackbeck, 19 March 1881.
[3] Information provided by Mr. Bush.

pits and water races. I regret particularly that there is no trace at all of Wakefield's original Sedgwick mill, and even those who have now built houses on the river bank where it stood have little idea of the industry which fluorished there 200 years ago.

Acknowledgments

Many people have helped me to collect the information necessary to prepare this Paper. My first thanks go to Mr. Alfred Bush who has gone to much trouble and has provided a great deal of the local background. Brigadier O. F. G. Hogg, C.B.E., F.S.A., gave me useful information on the history of gunpowder manufacture, and I am particularly grateful to the archivist's department of the Westmorland County Council for finding the map of the old Sedgwick Gunpowder Mill. Finally to my brother Professor E. M. Wilson, who laboured through my original text and pointed out many errors, and to all others who have taken an interest in this work I offer my sincere thanks.

APPENDIX

Fatal Accidents in the Northern Mills

I have deliberately made little reference to fatal accidents in this paper. Gunpowder manufacture was a dangerous business, but so are coal mining and erecting structural steelwork. The fact that the danger is ever present is in itself a safeguard, and every fatal accident called for an enquiry by a skilled government inspector who tried hard to find the reason and take steps to prevent a recurrence. At the same time an explosion in a gunpowder factory had much greater news value than a serious accident in a mill, and I feel that this paper would not be complete without some reference to this less pleasant side of the business. The Inspectors' Reports, available in any of the large reference libraries, make most interesting reading. They went to great pains to try to track down the cause of the accident, a difficult job when most of the evidence was scattered over the countryside. When no reasonable explanation could be found the inspectors did not hesitate to say so.

The Explosives Act of 1875 was far reaching in its regulations as to the minimum distance between buildings, the weight of charges which might be worked at one time, the number of men who might be present in any building and the amount of powder which might be stored. The co-operation between the inspectors and the managements appears to have been excellent, and recommendations were usually carried out. For example, when the press house at New Sedgwick blew up on 30 June 1875 and set off the corning house as well, the management were already in the process of building a new press house at such a distance that it would not have fired any other building. At Gatebeck on 21 July 1881, some press boxes with iron straps were still being used, and although this may not have been a partial cause of the accident, all the boxes with iron straps were replaced by boxes with bronze straps. Lightning was a danger which it was difficult to assess. The Act of 1875 laid down that an effective lightning conductor must be fitted to every house, but A. Desborough (H.M.I.Ex.), speaking on "The Administration of the Explosives Act" in 1910 said:

> "At the present time some outlying magazines have conductors attached to them for apparently the same reason that a horse-shoe is attached to the door."[1]

Fortunately south Westmorland and Furness seldom suffer from severe storms. According to the *Westmorland Gazette* the explosion at Bassingill on 15 June 1883 was due to lightning, and I have included in the list one non-fatal accident, namely New Sedgwick on 23 June 1906. A very bad storm drove up the Kent valley when the night shift were on, and the men obeyed orders, left the

[1] *Seventh International Congress of Applied Chemistry*, London, 1910, pages 7–17.

TABLE OF FATAL ACCIDENTS

LOCAL CHRONOLOGY, KENDAL, 1865 (Loc.Chron.)

Westmorland Gazette newspaper, published weekly in Kendal (W.G.)

Reports of H.M. Inspector of Explosives (H.M.I.Ex.)

Date of Accident	Factory	No. Killed	Process House	Remarks	Source of Information
16 July 1823	Lowwood	2	Corning		Loc. Chron., p. 55
24 Jan. 1840	Elterwater	5	Press Corning Glaze		W.G., 1 Feb. 1840
29 Jan. 1863	Lowwood	6	3 houses	Heard in Kendal 13 miles away	W.G., 7 Feb. 1863
7 Dec. 1867	Blackbeck	3	Press Corning Engine		W.G., 14 Dec. 1867
25 July 1868	Blackbeck	9	Press Corning		W.G., 1 Aug. 1868
28 Nov. 1868	Lowwood	5	Corning		W.G., 6 Dec. 1868
30 June 1875	New Sedgwick	4	Corning Press	New press house being built away from corning house	W.G., 3 July 1875
12 Oct. 1875	Bassingill	2	Incorporating		W.G., 16 Oct. 1875
29 Nov. 1878	Elterwater	3	Corning		H.M.I.Ex.
19 March 1881	Blackbeck	3	Press Corning	Originated in press and spread to corning	H.M.I.Ex.
21 July 1881	Gatebeck	2	Press		H.M.I.Ex.
12 April 1883	New Sedgwick	3	Cartridge filling		H.M.I.Ex.
15 June 1883	Bassingill	1	Incorporating	Lightning	W.G., 23 June 1883
6 Sept. 1887	Lowwood	2	Incorporating		W.G., 10 Sept. 1887
26 May 1900	Blackbeck	2	Press	Heard at Gatebeck 16 miles away	H.M.I.Ex.
27 Aug. 1900	Blackbeck	4	Corning		H.M.I.Ex.
23 Oct. 1901	Elterwater	1	Corning		H.M.I.Ex.
12 March 1903	Lowwood	2	Press		H.M.I.Ex.
30 March 1903	New Sedgwick	2	Glazing Corning	H.M.I. suggests that both accidents may have been caused by driving keys while machines were running	H.M.I.Ex.
30 April 1906	Blackbeck	2	Corning		H.M.I.Ex.
23 June 1906	New Sedgwick	Nil	Press and 4 incoporating	Factory struck by lightning	H.M.I.Ex.
15 July 1909	Blackbeck	2	Corning		H.M.I.Ex.
14 Dec. 1911	Blackbeck	2	Corning	Hot bearing on roller. Heard by Mr. Bush at Gatebeck	H.M.I.Ex.
18 Sept. 1916	Elterwater	4	Corning		W.G., 22 Sept. 1916

houses and took shelter. Thus, although the press house and four incorporating mills blew up, no one was hurt. The managers were as anxious as the inspectors to keep down accidents, and the use of protective clothing increased steadily. The men wore overalls with no pockets, boots without nails and protective overshoes.

From the attached table it will be seen that the fatalities with the unfortunate exception of those at Blackbeck, dropped rapidly after 1900; it soon became safer to work in a gunpowder factory than it now is to drive in a motor car to work. It is, perhaps, unfortunate that H.M.I.Ex. does not hold an enquiry after every fatal accident involving mechanically-propelled vehicles.

Discussion

Mr. J. Kenneth Major asked about the relationship between the holding of the water at Stickle tarn some four miles from the site and the usefulness of that water when released by a man every morning. As a point of interest he told the Meeting that the National Parks Authority, ably assisted by volunteers, had repaired the dam of the tarn which is now kept at its true water level. Mr. Major went on to say that his mother's daily woman, in her youth, used to pack cartridges at Elterwater: he asked Mr. Wilson if these would be cartridges used in blasting in shot holes, or normal shot cartridges like the 12-bore?

Mr. Wilson said that the partially-controlled water at Stickle tarn would not be as useful as properly stored piped water; it would run all the time whether the machines were working or not; probably half of it would run to waste. The cartridges would be those used for blasting, certainly not sporting ones.

Mr. Rex Wailes said that he visited Curtis & Harvey's at Faversham in 1918 and saw the corning mills, worked by water power and beam engines, and protected by large earthen banks. The whole area was planted with orchard trees, largely apple, cut when of a reasonable size and used for re-cogging mortice gears. He was there again in 1924, too late to see anything but the scrap-metal merchant breaking up and taking away a great deal of the machinery. In 1963 all that was left of such an historic place was one waterwheel, pit wheel, wallower, and two upright shafts and great spur wheels.

Last year Mr. Wailes had visited the Bonawel Furnace at Taynuilt and had seen there the furnace erected in 1752 by a Cumberland firm because they could not get enough wood for charcoal in Cumberland. They found it paid to send the ironstone to Scotland and ship the pig back to Cumberland. The buildings, all made of Cumberland stone and slate and built by Cumberland engineers, were still in fairly good repair and the whole complex was virtually complete.

Mr. Peter Davies quoted an obituary notice from the *Kentish Gazette* for 12 April 1814: "On Saturday the 9th inst. at his house, Tanner-street, Faversham, aged 72, Mr. John Stevens Minter, refiner of saltpetre at the Royal Powder Mills, at that place, who for 59 years served his country without a blemish. He was gunner of the garrison of Gibraltar during the late ever memorable siege. He received from nature a sound understanding. He was a faithful friend and a honest man." Mr. Davies suggested that the "John Stevens" mentioned in the Paper should in fact be John Stevens Minter.

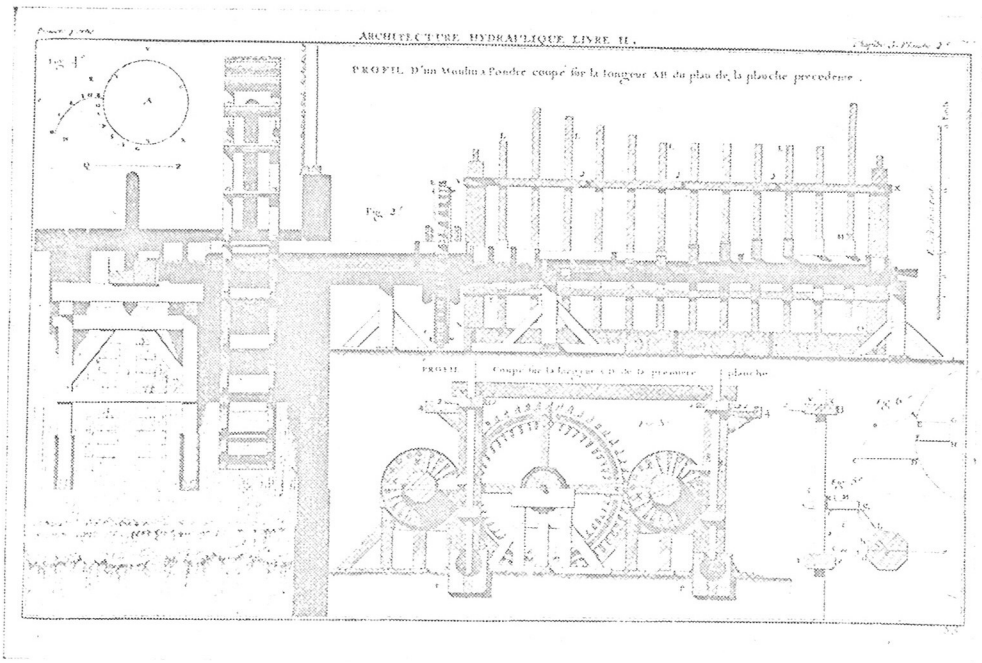
Mr. Maurice Berrill mentioned the work by W. H. Simmons entitled *A Short History of the Royal Gunpowder Factory at Waltham Abbey* (1963) and said that it was apposite to have, within a few months of each other, the history of that mill in the south-east and Mr. Wilson's Paper on mills in the north-west. There were interesting comparisons, for instance, in the transport systems. In the south-east much use was made of the River Lea; many diverse channels were cut from it and used to transport material from one part of the works to another. There were a number of boatmen on the

staff. The map of the works in the north showed an extensive tramway system. Possibly the lie of the land made this necessary, or water was more turbulent than in the south-east. Mr. Berrill went on to say that in the past there had sometimes been confusion between William Congreve, father and son (though Mr. Wilson had made the correct deduction in his footnote). The father (Major, later Lt.-General William Congreve) was Controller of the Royal Laboratory at the time the Government took over Waltham Abbey in 1789. He was made a baronet in 1812 and died in 1814, when his son (also William) succeeded to the title, and also to his father's old job. It was the younger William who was responsible for "Congreve's Rocket." Mr. Berrill corrected the reference to the patent for the corning machine: it was No. 3937 of 1815. There was in the Public Record Office (Supply 4/762) *A Treatise on Gunpowder* by Frederick Drayson (1830), a folio volume of 79 pages with 37 detailed drawings of buildings, utensils, etc. The Joshua Gilpin diary might also be a contemporary source of information on the mills of the north-west.

Mr. J. FOSTER PETRE told the story of a ship, named *Lottie Sleigh*, which blew up in the River Mersey in 1864; the explosion smashed all the windows in Liverpool and Birkenhead. She had loaded 11½ tons of gunpowder, consigned to West Africa. The explosion led to a lawsuit, the report of which might show the source of the powder—possibly Gatebeck.

Mr. D. S. SANDERS said he was familiar with the site of Hounslow mills where were the remains of edge runners and earthen banks. The mills were dismantled in 1926 and the machinery sold for scrap.

Mr. A. J. PERCIVAL (Hon. Secretary of the Faversham Society) said that his Society was hoping to preserve the mill site at Faversham as a link with an industry now non-existent in the town.



(*a*) Waterwheel-driven gunpowder Stamp Mill
(Reproduced from *Architecture Hydraulique*, Belidor, Paris, 1782)

(*b*) "Edge Mill" stone incorporating mill roll, Lowwood, Lancs., 1962

(*a*) Foundations of the Incorporating Mill at Bassingill, Westmorland, built 1790, photographed 1962

(*b*) Sedgwick (original) Gunpowder Mill, 1802
Reproduction from a pencil sketch by an unknown author

(*By permission of Miss Clay, Ambleside*)

The Mill Pond at Elterwater, showing a process house converted to a holiday bungalow

(*Photograph* Westmorland Gazette, *Kendal*)