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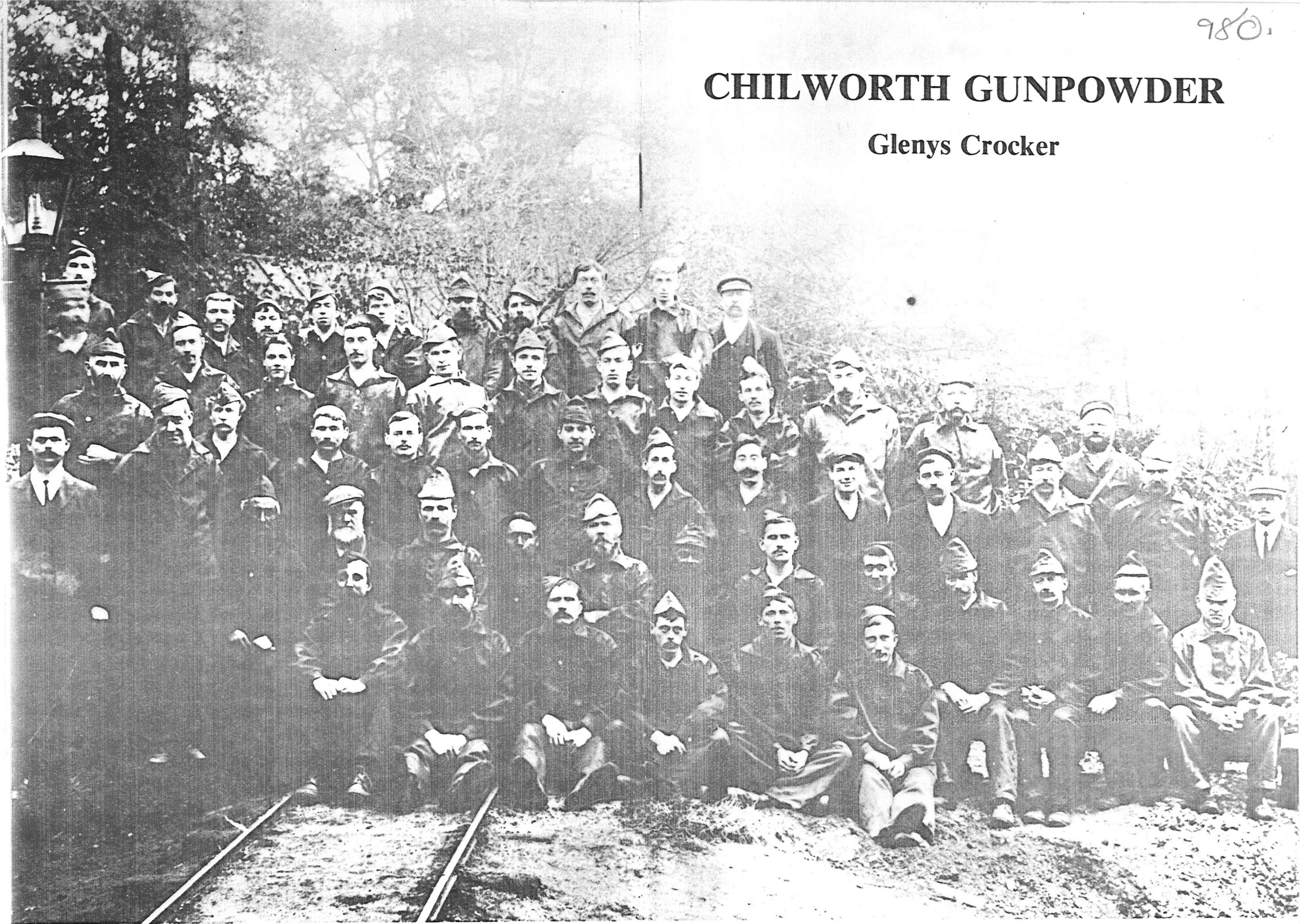


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CHILWORTH GUNPOWDER

Glenys Crocker



With compliments,
Glenys Crocker

CHILWORTH GUNPOWDER

Glenys Crocker

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Surrey Industrial History Group
1984

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Foreword

The early gunpowder industry was mainly confined to south-east England and until the middle of the seventeenth century was dominated by Surrey manufacturers. The Chilworth powder mills were not the first in the County but they were the longest running, being in operation for almost three hundred years. The remains of the factories have largely escaped redevelopment and thus constitute one of the most important archaeological sites in Surrey. Indeed, following representations by the Surrey Industrial History Group, a large part of the area they cover was scheduled as an Ancient Monument in 1982.

Members of SIHG, which is a group of the Surrey Archaeological Society, are engaged in a long-term project to record the physical remains, carry out documentary research and collect information from local people who remember the mills before they closed in 1920. This booklet provides a summary of their work so far. However, much research is still to be done and readers who have further information are encouraged to get in touch with the author c/o Castle Arch, Guildford.

I warmly commend this booklet to the widest possible audience. It is remarkably comprehensive, and is obviously more than a mere introduction to the subject. It presents a fair and up-to-date picture, and is very readable. Although the project is not yet completed, this account represents a considerable step forward in our knowledge of an important industry.

Eric S Wood, F.S.A., M.I.F.A.
President, Surrey Archaeological Society
May 1984

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Cover photo: Gunpowder workers at Chilworth c.1913 Courtesy: J. Puddick

CHILWORTH GUNPOWDER

Gunpowder was made at Chilworth, near Guildford in Surrey, from the early 17th century until after the First World War. The Chilworth manufacturers were appointed sole powder makers to the king in 1636 and in the following decade they supplied the Parliamentary side in the Civil War. Throughout most of the mills' history the methods of manufacture did not change greatly but in the 1880s Chilworth was at the forefront of developments in the production of a new type of gunpowder. Then in the 1890s explosives and propellants based on a completely different technology were introduced. There was major expansion during the First World War but demand for powder fell after the Armistice and the works closed in 1920. Substantial remains of the factories survive, though mainly in a decayed condition and though some of the ruins are inaccessible, much can be seen from footpaths. The location of the former works along a stretch of the Tillingbourne, a tributary of the River Wey, is shown in Figure 1.

THE EARLY GUNPOWDER INDUSTRY

Gunpowder consists of a mixture of saltpetre, charcoal and sulphur. Originally the ingredients were combined by pestle and mortar, at first by hand and later by water or animal power by means of a cam shaft. This raised the pestles and allowed them to fall under their own weight, as shown in Figure 2. The proportions of the ingredients varied but a standard recipe was 75 parts of saltpetre to 15 of charcoal and 10 of sulphur.¹ Charcoal was readily obtained by charring wood in circular stacks covered with turf. The favoured woods, obtained from local coppices, were alder, willow and "dogwood" which was the popular name for alder buckthorn, *Rhamnus frangula*.² Sulphur, formerly known as brimstone, was imported from Sicily. Saltpetre, the major ingredient, was at first more difficult to obtain.

In warm climates with a regular dry season, saltpetre is formed naturally by the bacterial oxidation of nitrogenous organic matter. In north-western Europe however it had to be made in artificial nitre beds which consisted of a mixture of earth, animal excrement, lime and ashes, watered with urine, exposed to the air and repeatedly turned until the saltpetre was ready to be extracted by solution. The method was not known in England until the reign of Elizabeth I and gunpowder, or saltpetre for its manufacture, had to be imported. Supplies were dependent upon the goodwill of foreign powers, so in 1561 the Government agreed to purchase instructions for making saltpetre from a German, Gerrard Honrick, for the sum of £300. To obtain the necessary material, saltpetre men were appointed who had the right to enter and dig in all dovehouses, barns, stables, stalls, outhouses, empty places in cellars, vaults and warehouses, an activity which caused some well-documented resentment.^{3,4}

The history of the English gunpowder industry proper begins with the agreement with Honrick in 1561, although gunpowder had been made from imported ingredients as early as the 14th century. Under Elizabeth I appointments to manufacture saltpetre and gunpowder were made by letters patent from the Crown. In

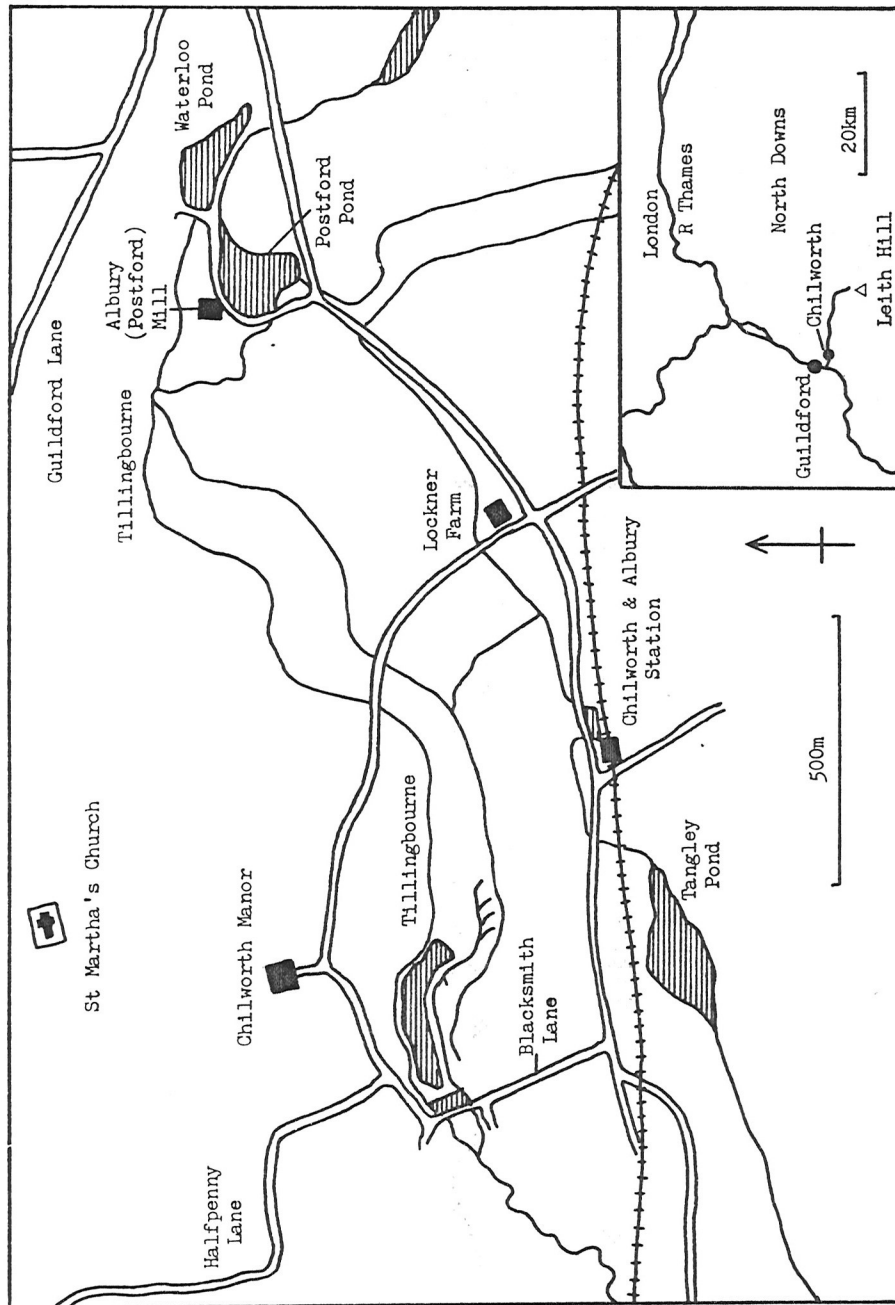


Figure 1 Location map. The works stretched from Postford Pond in the east to beyond Blacksmith Lane in the west

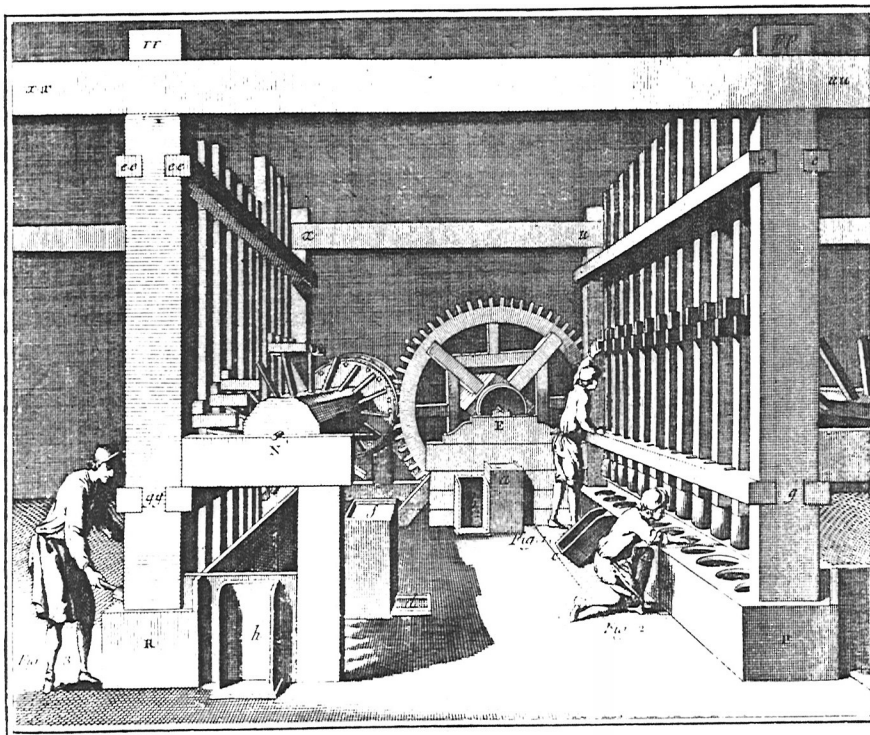


Figure 2 Gunpowder pestle mills from Diderot's *Encyclopédie*, 1762-1777
Courtesy: Science Museum, London

1620 the duty of contracting with manufacturers was deputed to Commissioners for Saltpetre and Gunpowder who from 1621 were the Lords of the Admiralty. Under Charles I the Crown was the only powder merchant and the industry was rigidly controlled as a monopoly. A sole powder maker to the king was appointed and efforts were made to suppress other manufacturers. The early industry was largely confined to south-east England, with important powder mills at Battle and Brede in Sussex, Faversham, Dartford, and Leigh near Tonbridge in Kent, Waltham Abbey in Essex and Hounslow in Middlesex. In Surrey, besides those at Chilworth, there were mills at East Molesey and Godstone and at sites on the Hogsmill and Wandle rivers. The Hogsmill sites were at Ewell and a place variously referred to as Tolworth, Malden, Long Ditton and Worcester Park. On the Wandle there were mills at Carshalton and Wimbledon. Surrey makers held most of the appointments under Elizabeth I and held the monopoly up to the eve of the Civil War.³

HISTORY OF THE CHILWORTH POWDER MILLS

The 17th century

It has been wrongly claimed that the Chilworth mills were started by the Evelyn

family in 1570.⁵ The story originated in statements made by John Aubrey in his *History of Surrey*, which was begun in 1673, and by John Evelyn, the diarist, in a letter to Aubrey which is prefaced to this work.⁶ Aubrey wrote that the Chilworth mills were the first in England and Evelyn claimed that his ancestors had been the first to bring the invention of gunpowder into England and had built powder mills near his brother George's house at Wotton, about 10km up the valley from Chilworth.

In fact, there is no evidence of powder making at Chilworth before 1625. The Evelyn family, with various partners, held a series of patents beginning in 1589. Their mills however are thought to have been first near Long Ditton and later at Godstone.⁷ There were indeed early powder mills near Wotton and also at Abinger, where Richard Hill, a partner of the Evelyns in their patent of 1589, probably operated.⁸ The Chilworth mills can be identified as those set up by the East India Company in 1625 "in the skirts of Windsor Forest", which then extended as far as Guildford, for it is known that Sir Edward Randyll, who owned the manor of Chilworth, leased powder mills to the Company at about that time.³

The East India Company later became important to the gunpowder industry because it brought supplies of natural saltpetre from India. Its Chilworth venture lasted only some ten years. The Company was licensed to make powder for its own use and set up three mills, all of which blew up within a few months. Two were repaired but there followed, on two occasions, breaches in the embankments of the mill-pond which flooded the local landowners' fields and hop gardens. This resulted in protracted disputes, and in the end the Company resigned its lease.⁸

The East India Company's powder-maker, Edward Collins, had been temporarily suspended by the Crown in the course of the litigation but in 1635, after the Company had left, he himself was awarded a contract. He died soon afterwards but his son George and Samuel Cordwell were appointed powder-makers to the king in 1636, in place of the Evelyns. George Collins soon disappears from the records but Cordwell held the monopoly until it was abolished by the Long Parliament in 1641. The king provided £2,000 for buildings and utensils, which were to be returned when the contract expired, and about 280 tons of powder were to be supplied annually. One hundred tons were lost in 1638 when Cordwell's stove caught fire.^{3,9}

Surrey makers continued to receive a large share of government contracts after the monopoly ended. During the Civil War of 1642-1652 Chilworth powder was employed in the cause of Parliament, which Cordwell supported. Samuel Cordwell died in 1648 and was succeeded by his brother Robert, who also died within a few years, probably in 1651. The owner of the mills at this time was Vincent Randyll, a son of Sir Edward who had leased the mills to the East India Company. In 1653-4 Vincent Randyll petitioned the Admiralty Committee to allow him to continue to supply the government, and the following year he was mentioned with George Duncombe and John Woodroff as one of the masters of the Chilworth works. In 1656 the works were run by Josias Dewy who may have been employed there previously, but this seems to have been temporary.³

After the restoration of the monarchy in 1660 Charles II recreated the office of sole powder-maker to the king. The patent for 21 years was given to Colonel Daniel O'Neale who delegated his authority to a number of makers, including Randyll and Dewy. The system changed again in 1664 when the king placed the Ordnance Office in control of the industry. The Ordnance bill books show that an eleven year contract was made with Vincent Randyll in 1671 but that the mills ceased to work in 1673, the year in which Vincent Randyll died and was succeeded to the manor by his son Morgan.³

There was a massive and ill-considered expansion of the works in the late 17th century. The story, from a broadsheet issued in about 1710 on *The Hard Case of Sir Polycarpus Wharton, baronet* was included by Aubrey in his History. Polycarpus was the son of Sir George Wharton who was treasurer and paymaster to the office of the Royal Ordnance until his death in 1681.¹⁰ He first supplied powder to the government in 1673 and was directed by the Ordnance to take a 21 year lease on the Chilworth mills in 1677. The mills were then so ruined that he had to spend £1,500 on making them serviceable. He also expanded the works so that their capacity was about 800 tons a year. Wharton's second contract, from 1687 to 1695, was for about 400 tons a year, out of a total requirement by the Ordnance of 650 tons. One of his tasks was to imitate a superior type of German powder, which he did successfully. However, to cut a long story short, the contracts were not properly honoured by the Ordnance. Sir Polycarpus was said to have suffered to the extent of £24,000 and was languishing in a debtor's prison when Aubrey publicised his plight.^{3,6}

Aubrey states that there were 16 or 18 powder mills at Chilworth and the extent of the works is shown on the 1693 edition of John Seller's map of Surrey, from which a sketch is shown in Figure 3. There are Upper, Middle and Lower Works and it is interesting to consider which of these represent Sir Polycarpus Wharton's expansion.

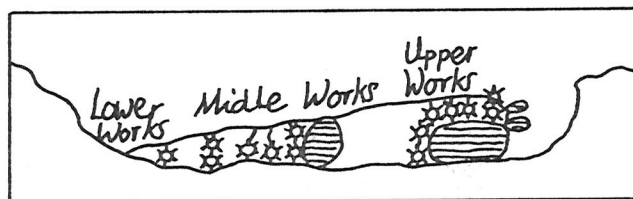


Figure 3 Sketch from John Seller's map of Surrey, c.1693

The Upper Works were relatively short-lived and no longer appear on maps of the 18th century, for instance John Senex's map of Surrey of 1729. A study of the watercourses suggests that the Lower Works were at an early mill site. This could have been the site of the corn mill recorded in the Domesday survey of 1086 and of the corn mill and fulling mill recorded in 1589.¹¹ There was also a

water-powered wire mill at Chilworth for a few years from 1602 to 1606.¹² It is likely that the powder mills started at this ancient site and expanded upstream. A comparison between the output of the mills in 1636 and 1790 suggests that there were about nine mills at the earlier date. The Lower and Middle Works would account for these. The Upper Works would bring the total to the 16 or 18 mills described by Aubrey and were probably the new mills built by Wharton. Aubrey referred separately to powder mills in the parish of Albury, but may have meant the Chilworth Upper Works which were on the parish boundary.⁶

Writing of Chilworth about a century later, Manning and Bray in their *History of Surrey* stated that "the powder mills were originally higher up the stream near to Albury; and till of late years were worked by pestles instead of stones."⁷ The word "stones" is a reference to incorporating mills with edge runners which are described later.

The 18th century

After the expansion in the late 17th century the mills went into decline. In 1704 the Lower Works were converted to paper mills and in 1720, when Morgan Randyll sold the manor, there were two mills only, called Chilworth Mills in St Martha. It seems likely that these were both paper mills and that the powder mills were not working. At the sale in 1720 the estate was bought by Richard Houlditch who was a director of the South Sea Company. When the notorious crash came, Houlditch's property was seized and sold towards indemnifying the victims and the Chilworth estate was purchased by Sarah, Duchess of Marlborough. She left it to her grandson John Spencer and it remained in the Spencer family until 1795.³

A survey of the estate carried out in 1728 shows the lay-out of the powder mills as illustrated in Figure 4.¹³ The buildings are basically the same as those described earlier by Aubrey:

"Here is a Nursery of Earth for the making of *Salt-Petre*. There is also here a Boyling-House, where the *Salt-Petre* is made, and shoots; a Corneing House, and separating and finishing Houses, all very well worth the seeing of the Ingenious. I had almost forgot the Brimstone Mill, and the Engine to search it."⁶

In 1728 saltpetre was evidently still made from collected manure, although much was now imported by the East India Company. Both natural and manufactured saltpetre had to be refined by dissolving it in hot water, boiling it down and allowing it to cool until the crystals were precipitated. All this was carried out at the western end of the site where there was also a stove for the final drying of the gunpowder. The service buildings were in the same area and consisted of a cooper's shop and a "workhouse" which was later described as a carpenter and millwright's shop. There were also two dwelling houses with gardens and an orchard. The buildings were surrounded by meadow and at the north end of the plot, beside the river, were two paper mills.

The remaining gunpowder buildings were ranged along the mill stream to the east, alongside the hop gardens which occupied the valley bottom. Here the other

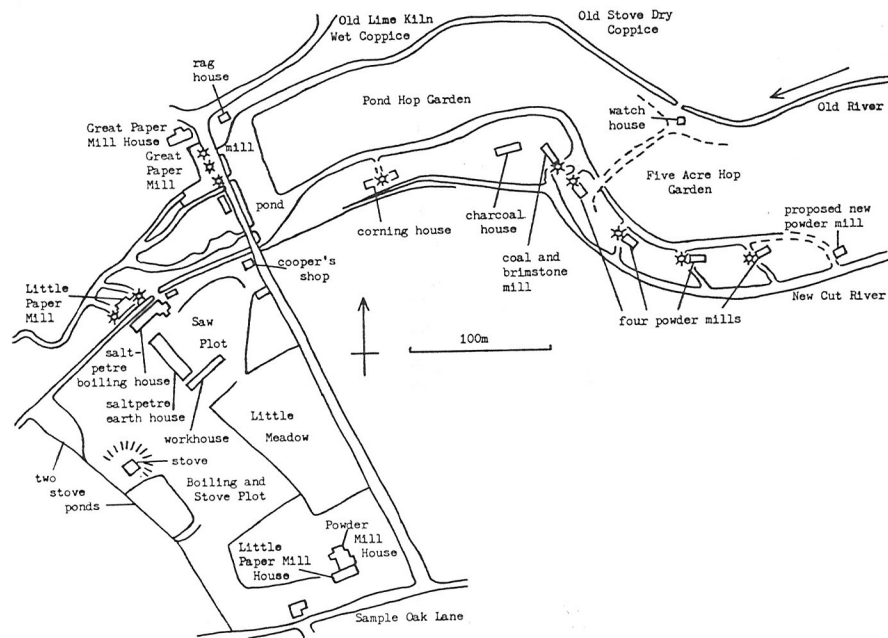


Figure 4 The mills in 1728 from the "General Survey of Chillworth St Martha"

raw materials were powdered in the coal (charcoal) and brimstone mill. The ingredients were then mixed, moistened to reduce the risk of explosion and incorporated in the four powder mills. These were probably still pestle mills at this period, as illustrated in Figure 2. The powder was then corned or granulated by being forced through sieves while it was still damp. This process had been introduced in the mid 16th century because gunpowder used in loose powder form did not explode consistently. After corning the grains were separated from the dust, glazed and sent to the stove to be dried.¹

In 1728, when the survey was made, the powder mills were on lease to Francis Grueber who was presumably one of the two men of the name who were managers of powder works at Faversham at the time.¹⁴ Grueber proposed to build a fifth mill as shown in Figure 4 but his plan does not appear to have been carried out. On Bowen's map of Surrey of 1753, sketched in Figure 5, there are still four powder mills and, although a new mill was built in 1790, there were only five in 1813. Manning and Bray gave the number as four in 1809 but their information was out-of-date.⁷

There are several records of explosions during the 18th century. A body was blown over the paper mill in 1755¹⁵, the tower of St Martha's Church was destroyed in about 1763¹¹ and three men were killed in 1778 when Isaac Dent was proprietor.¹⁶

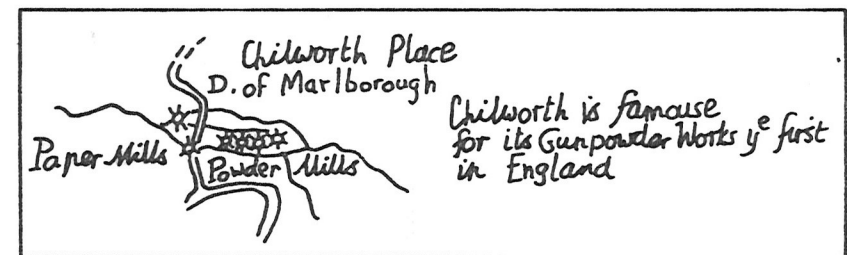


Figure 5 Sketch from Emanuel Bowen's map of Surrey, 1753 (note inaccurate information)

The most detailed information about the mills comes from a letter book of the next owner, William Tinkler, to whom Dent left the business when he died early in 1790.¹⁷ The book contains copies of the correspondence sent from Tinkler's London office from March 1790 to March 1791. Many of the letters are to the works' manager, Mr Harrison, about the day to day running of the mills and these make several references to a new mill which was being built. Other letters are to Tinkler's customers and, although their addresses are not given, it can be deduced that they include a major distributor in Scotland, a mining company; many smaller retailers and numerous individuals buying small quantities of powder for the shooting season. One order went to Ireland and there are several references to powder being sent to Africa.

By an Act of 1771, manufacturers had to provide a magazine remote from their mills, near the River Thames below Blackwall or in another convenient place to be licensed by the Justices.¹ The magazine for Chilworth was at Ripple Level on the east side of Barking Creek.¹⁸ A letter from Tinkler to Thomas Sibthorpe in 1793 shows that, at this time, powder went down the Wey and the Thames from Guildford rather than from Stonebridge wharf at Shalford which was nearer.¹⁹ Tinkler had been presented at a Session of the Peace at Guildford for carrying powder through the streets of the town, and was protesting that this was not unlawful, that it had been done for many years and that people created more danger with fireworks. However he said that he had directed it to be sent another way in future and this was probably via Stonebridge. The letter book shows that the waterman took powder from the magazine at Barking to coastal vessels bound for the east coast of Scotland and west Wales and to "the Inn" twelve miles up the river in London from which waggons took orders in all directions.¹⁷

Saltpetre, brimstone and empty barrels were sent from London by Jas Wilkins' barge and the quantities give an indication of the output of the works. This can be estimated roughly at 130 tons in the year, or less than half the amount in the Collins and Cordwell contract of 1636. The East India Company held a sale of saltpetre in March and September when they put up for sale a total of 26,000 bags. The Tinkler letters suggest that a bag weighed 140 lbs or 1¼ cwt and, on this basis, Chilworth took 6¼ per cent of the total. After the sale, the powder

makers met to agree on prices. There was concern about underselling, of which the Kendal makers were suspected, but it was found that the trouble came from some other, undisclosed, source. Powder making developed in the Lake counties in the 18th century to supply local quarries with blasting powder. The first mills there were established at Sedgwick, south of Kendal, in 1764.⁹ The Tinkler letters end abruptly on 17th March 1791 when prices ranged from 75 to 160 shillings a barrel, depending upon quality.¹⁷

The early 19th century

In 1796 the Earl Spencer sold the manor of Chilworth to Edmund Hill, a powder-maker of Hounslow, but William Tinkler continued to run the business. Hill had plans to expand the works and in 1801 applied for permission to build another powder mill. This was refused under the terms of the 1771 Act because the new mill would have been within half a mile of the parish church of St Martha.²⁰

The powder-makers also ran into conflict in 1805 with Messrs Crowder and Rowland at the paper mill, who had diverted a stream used by the powder works into the paper mill pond.²¹ Relations continued to be strained and Rowland instigated a prosecution of Tinkler, which was held in 1817, for erecting a danger building too close to the paper mill. A verdict of "not guilty" was reached and the judge pronounced it the most malicious prosecution he had known.³

Such disputes provide information about the works. A map which accompanied a draft water agreement of 1805 gives details of the saltpetre processing area.²¹ These correspond closely to the details on the 1728 map and, in addition, show the water channels and sluices which were used for soaking the saltpetre earth and were the subject of the dispute. The Tinkler letter book confirms that saltpetre was still being made in 1790, for on October 11th Tinkler instructed Harrison, his works' manager: "Let the Petre Earth be turned as soon as you can spare the men to do it."¹⁷ The letters give the impression however that the earth house was a minor source of supply compared with the East India Company's sale. The building was described in 1813, when the estate was being sold, as "a range of open Sheds, timber and pantiled."²²

The estate was sold in 1813 by the executors of John Fish who owned it from 1810 to 1812, after Edmund Hill.²³ The sale particulars and map show that at the west end of the site, in addition to the stove, earth house, boiling house and workshops noted previously, there was a cylinder house and a shed for refining brimstone.²² Coleman of the Royal Gunpowder Factory stated in 1801 that brimstone was refined by melting and skimming or, if it was very impure, by sublimation. The cylinder house would have been used for making charcoal by an improved method introduced in the late 18th century, using iron cylinders from which the by-products of combustion were extracted.¹ William Tinkler must have heard about this when he wrote to Harrison on August 9th, 1790: "I am informed that the Colliers for the Duke of Richmond has a new way of burning their Coal for Powder desire you will take some proper opportunity to

try to find it out."¹⁷ The estate map of 1813 shows that Tinkler leased dogwood coppices for charcoal near Postford Pond, in the present Colyers Hanger.²²

In the eastern part of the works in 1813 there were five powder mills, each with one water wheel about 24 feet in diameter and 3 feet wide and two pairs of stones, a brimstone house, composition house, corning house, dusting house, coal house, watch house etc. with a good stream of water.²² The five powder mills were incorporating mills of the type illustrated in Figure 6. Mills of this type replaced pestles and mortars which, because of the danger of over-heating, were made illegal by the 1771 Act, except at a group of mills in Sussex which made fine "Battle powder" for fowling. The mills would have been housed in wooden buildings with a boarded roof which would easily blow off in an explosion. They consisted of a pair of heavy edge runners which rolled around a circular bedstone. The charge, consisting of the powdered saltpetre, charcoal and sulphur which had been mixed in the composition house, was moistened and placed upon the bedstone. The Act allowed up to 40lb of powder to be incorporated at a time and the process took seven or eight hours.¹ Remains of mills of this type at Chilworth are shown in Figures 7 and 8. The bedstone in Figure 8 however is that of a later steam-powered incorporating mill which was driven from below, whereas the water-powered version in Figure 6 is geared from above.

The product of the incorporating mills was called mill-cake. It was pressed to remove excess moisture before being corned, dusted, glazed and dried in the stove. In the 1817 court case, reference was made to Tinkler's "gloom stove."³ This was a structure with shelves for the gunpowder into which projected the end of a cast iron fireplace which was heated from the outside.¹

At the sale in 1813, William Tinkler purchased the manor, for he appears as the owner in the land tax returns of 1815.²³ His son William succeeded him and owned the estate until 1845 but in 1819 the powder mills were leased to John Sharp.³

The mid 19th century

John Sharp was joined in partnership by his brother Thomas and then by John's son Samuel and the firm of J T & S Sharp continued until 1881.³

In 1822 William Cobbett visited Chilworth on one of his "rural rides". In a celebrated example of his prose, he denounced the perversion of the beautiful valley of Chilworth by "two of the most damnable inventions that ever sprang from the minds of man under the influence of the devil! namely, the making of *gunpowder* and of *bank-notes*!"²⁴ It may be appropriate here to mention that the local paper mills which made bank-note paper were the Upper and Lower mills at Postford. There is no evidence that bank-note paper was made at Chilworth paper mill and, despite local tradition, bank-notes were not printed there.²⁵

Records of the Wey Navigation show the quantities of gunpowder sent to London from 1827 onwards, and thus cover most of the period of the Sharps' tenure of the works. The amount for each year is shown in Figure 9. Except for the period

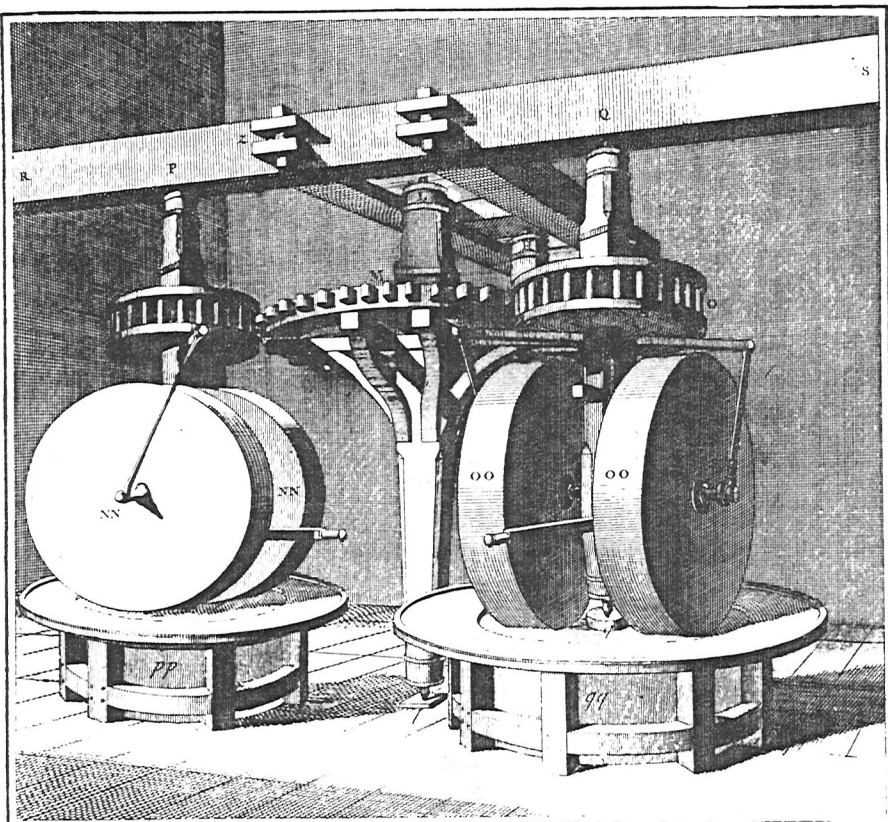


Figure 6 Roller incorporating mills from Diderot's *Encyclopédie*, 1762-1777
 Courtesy: Science Museum, London

from 1829 to 1845 when C & R Russell and then Hugh Russell ran the powder barges, cargoes were carried by the Sharps' own vessel, the "Hope", which was joined briefly by the "Faith" in 1856. On average, voyages were made once a month during the 1830s and early 1840s and from then on approximately fortnightly. Saltpetre and coal, and occasionally brimstone, were carried on the return journeys.^{26,27}

E W Brayley, writing in the 1840s, stated that the powder mills were currently out of employment,²⁸ but no significant gap in powder shipments during this period has been found. The increase in the 1850s coincides with the Crimean War. That in the early 1860s may be related to the introduction of steam-powered incorporating mills, some of which were working by 1865.²⁹ Steam-powered mills can be identified on the 25in Ordnance Survey map of 1870, which also shows how the works had expanded since 1813, as shown in Figure 10. Production



Figure 7 Edge runners of water-powered incorporating mill at Chilworth

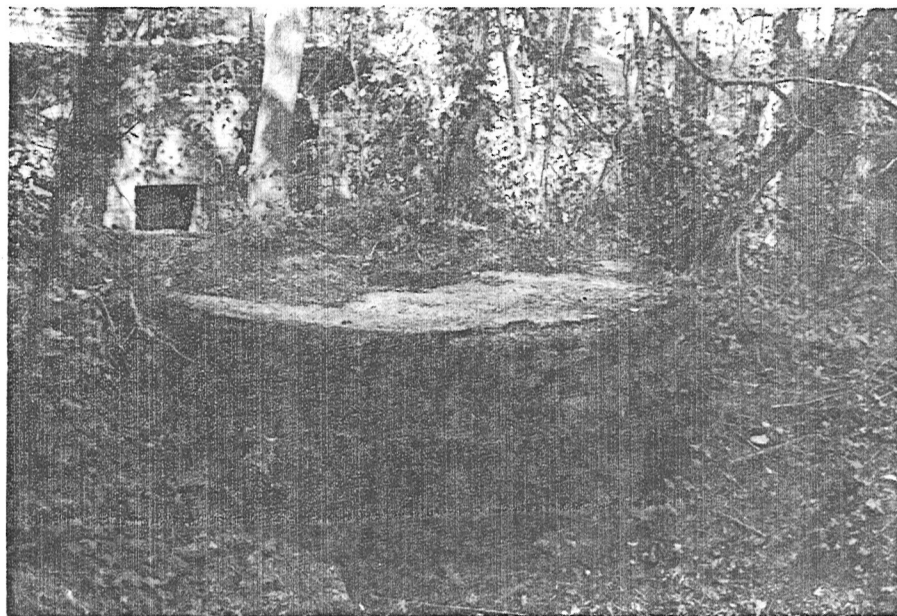


Figure 8 Bedstone of steam-powered incorporating mill at Chilworth. Steam engine bed in background

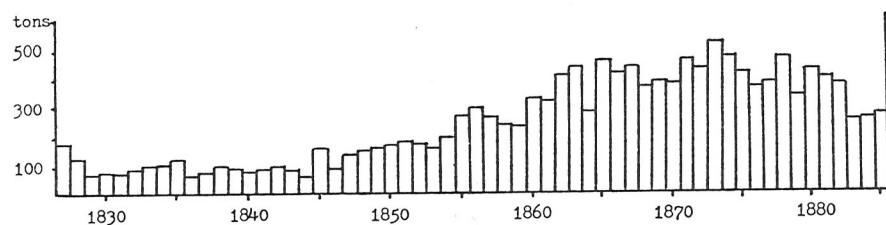


Figure 9 Tonnage of gunpowder carried on the Wey Navigation, 1827-1885

went down in 1864 because of an explosion in the press house which held up work for nearly three months.²⁹ Two men were killed in the explosion and there were two more fatalities in the same year when a powder barge blew up on the Godalming Navigation between Stonebridge and Guildford. In 1862 there had been a narrow escape at Guildford when a building caught fire not far from a powder barge which was illegally moored in the town.³⁰ Explosions at the works were not uncommon. Other notable accidents occurred in 1874,³¹ 1879³² and in 1883³² after J T & S Sharp had sold the business.

The Chilworth Estate meanwhile had become the property of the Duke of Northumberland. William Tinkler the younger had sold it in 1845 to Henry Drummond of Albury and it formed part of the marriage settlement of Drummond's daughter Louisa to Lord Lovaine, afterwards the 6th Duke, who appears as the owner on the 1847 tithe map.³³ It remained part of the Northumberland estates until 1922, after the powder works had closed down.³⁴

The gunpowder business was purchased from J T & S Sharp by C Marcus Westfield in 1881.³ The Navigation records show a decrease in powder traffic at this time, as indicated in Figure 9, although in 1882 Westfield asked the Duke's permission to build an enlarged magazine to accommodate a large order from the War Department.³⁵ The mills were still making black powder, but a new era was about to begin.

The Chilworth Gunpowder Company

As the design of guns improved in the 19th century, new propellants were needed. At first, development work was concentrated on black powder, by varying its composition to suit different classes of fire arms. An important invention was that of brown or "cocoa" powder which used brown charcoal made from straw and gave off less smoke than the black variety. To control the rate of burning it was made up into hexagonal prisms with holes down the middle and in that form was known as "brown prismatic powder". The invention was claimed by J. N. Heidemann and Max von Duttenhofer in Germany, though they were not alone in the field, and their product was made by Vereinigte Rheinisch-Westphälische Pulverfabriken. In 1883 the invention was taken up by the British authorities and arrangements were made for the superintendent of the Royal Gunpowder Factory at Waltham Abbey to be instructed in its manufacture. To make the product, the

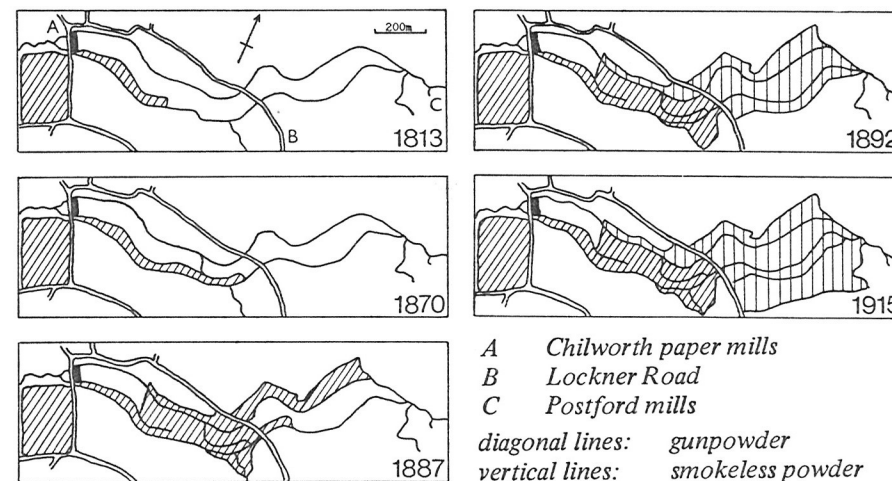


Figure 10 Development of the Chilworth powder works 1813-1915

Chilworth Gunpowder Company was formed in 1885 as a subsidiary of the German company. It was under German control but with Lord Sudeley as Chairman. Heidemann and Duttenhofer were on the board of directors and C. Marcus Westfield, whose interest in the works had been acquired by the Company, became joint managing director together with Edward Kraftmeier, a German settled in England who later became naturalised as Edward Kay.³⁶

Major work on new buildings was started in June 1885 and by 1887 Westfield was seeking permission to build new magazines on land to the east, to store the increased quantities of brown powder which were being made.³⁵ In December 1888 an agreement was made with the South Eastern Railway Company to build a tramway link to a siding at Chilworth and Albury station.³⁴ The area developed in the late 1880s is shown in Figure 10.^{37,38}

An account of the Company, illustrated by a view of the factory from a point near St Martha's Church, was published in Wyman's Commercial Encyclopaedia for 1888.³⁹ The book described the contemporary business scene by taking important examples of each industry covered, and Wymans had no difficulty in selecting Chilworth for their article on gunpowder. The factory's chief products were the various kinds of prismatic powder – black, "cocoa" or brown and "what is specially known as prismatic E.X.E." There was a large home and export trade in all the usual kinds of powder, including sporting and blasting powders. The Company's brochure for the Royal Naval Exhibition of 1891, which included an extract from the Wyman's article, described the prismatic powder as being suitable for all guns of 6in calibre and upwards. Dummy cartridges for 110 ton, 80 ton, 12 ton and 6in guns were shown.⁵

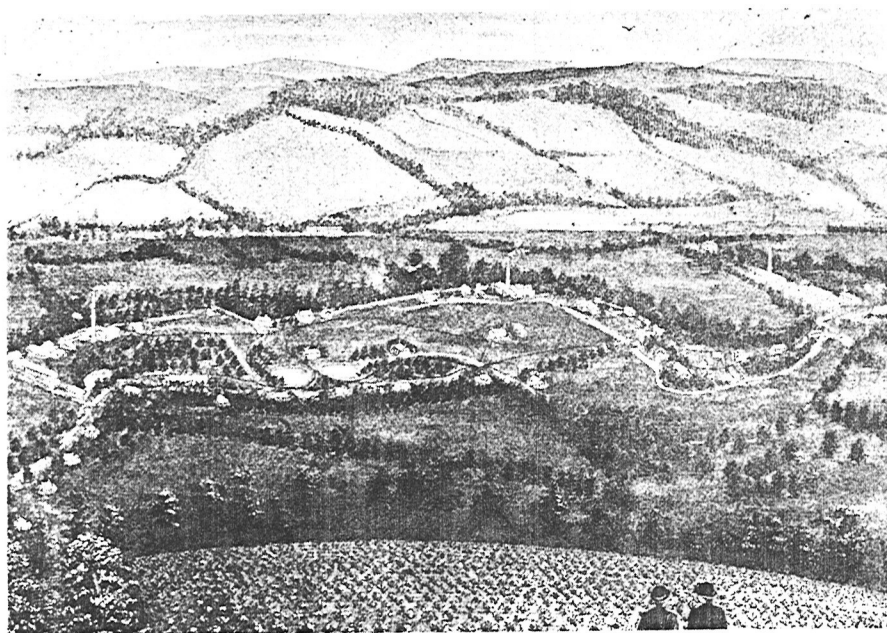


Figure 11 View of part of the factory from St Martha's hill, from Wyman's *Commercial Encyclopaedia* for 1888

Between 300 and 400 workers were employed in 1888, many of them army reserve men and old soldiers. A second factory at Fernilee near Buxton had been opened by the Company and there were magazines on the Thames, at Liverpool and in many other places. The drawing of the works, which is reproduced as Figure 11, shows three chimney shafts which were linked to boilers working twelve steam engines. There were also water wheels and turbines. The picture also shows tramways which, together with the mill stream along the southern edge of the site, provided transport between the various buildings. The extension of the tramway to the station had not yet been built. The buildings were widely spaced and surrounded by trees to minimise the damage from any explosion. Substantial remains of incorporating mills of this period survive, as shown in Figure 12.

Smokeless Powder

In order to explain the later phases of building at Chilworth it is necessary to refer to developments in the field of high explosives and propellants based on these. Unlike gunpowder, which was incorporated mechanically, the new explosives were made by chemical means. There were two parallel developments, based on the nitration of cellulose and of glycerine, both of which were first carried out in 1846. The development of nitrocellulose or guncotton suffered an early set-back because of several disastrous explosions in 1847. The problem was tackled by von

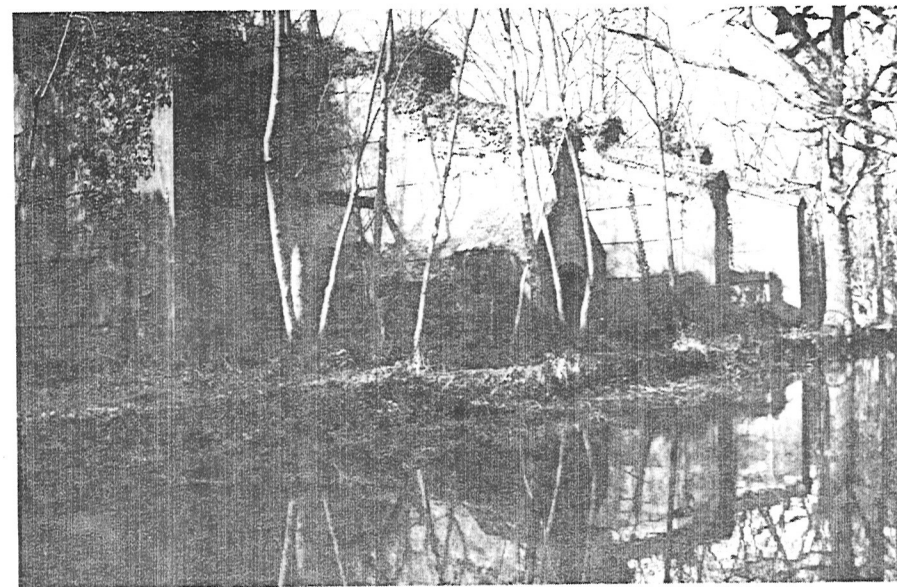


Figure 12 Brown powder incorporating mills of c.1885

Lenk in Austria and by Abel in Britain but it was not until 1872 that guncotton was approved by the British government and went into production at Waltham Abbey. Meanwhile, Nobel took up the problem of the detonation of nitroglycerine and produced dynamite in 1864 and blasting gelatine in 1875.

In the 1880s success was achieved in controlling the force of the new explosives for ballistic use. The new propellants were known as "smokeless powders". The first of these was a nitrocellulose propellant called "*Poudre B*" which was invented in France by Vieille in 1886. In the following year Nobel patented ballistite, a nitroglycerine-nitrocellulose mixture. The British Government set up an Explosives Committee in 1888 and in 1889 two of its members, Abel and Dewar, patented cordite. The product was so named because it was formed into long strings. Chemically it was closely related to ballistite and Nobel brought an unsuccessful legal action against its manufacturers for infringing his patent. Other synthetic explosives were developed from dyestuff intermediates, including lyddite (picric acid or trinitrophenol) and TNT (trinitro-toluene).^{40,41}

With the invention of smokeless powders the explosives and propellants industries, which had been developing separately, became technologically linked. The dynamite manufacturers and the powder makers therefore began to combine. Chilworth, as a subsidiary of the German company, came within the scope of a General Pooling Agreement made in 1889 between four German companies known as the "powder group" and a dynamite group consisting of the London-based Nobel Dynamite Trust and its subsidiaries in Germany, Britain and South America.

In 1901, Vickers acquired a 40 per cent interest in Chilworth as part of a trading agreement. In 1905 the Company was involved in setting up the Japanese Explosives Co Ltd of which it owned 20 per cent. Chilworth became wholly British in 1915 when the Nobel Dynamite Trust was split up and liquidated.³⁶

Some non-technical details of the Chilworth products are provided by the Company's Royal Naval Exhibition brochure of 1891. The exhibit included a range of smokeless powders alongside the assortment of other products already described. Shown as dummy replicas, they varied from fine sporting powder to cubes of three quarters of an inch surface and were recommended for magazine rifles and all guns up to the 9.2in breech-loader.⁵ The new Smokeless Powder factory was not built however until 1892.⁹ As shown in Figure 10 it was located east of the gunpowder works and the two factories continued to operate side by side.^{42,43}

The Company's entry in *The Rise and Progress of the British Explosives Industry* published in 1909 states that it was at Chilworth that cordite was first manufactured by a private company, clients having been supplied with cordite before the Government adopted it.⁹ The Government approved cordite in 1893 and the first contracts with private companies were awarded in 1894. Chilworth was allocated 2 per cent of the contracts in 1899-1900 and about 10 per cent in the years leading up to 1914.³⁶ The description of Chilworth in 1909 states that explosives were manufactured for home and foreign consumption. There were



Figure 13 Cottages converted c.1920 from the press house of the Admiralty cordite factory. Colyers Hanger in background

magazines and agents in all the principal Colonies and agents in all principal foreign countries. The mills were producing "all classes of propellant smokeless powders for military and sporting purposes, and Gunpowder ordinarily so-called." There were 143 buildings, steam engines totalling 1,500hp and water power of about 100hp, about five miles of tramway and three 10 ton weighbridges. There were about 300 male and 6 female workers, one head and one assistant chemist, two chief and assistant engineers and 20 manufacturing, commercial and administrative employees.⁹

The final stage in the development of the site was the building of a cordite works by the Admiralty in 1915, during the First World War. The new factory was however administered by the Company. It was on the south side of the mill stream, between Postford Mill and Lockner Road, as shown in Figure 10. The buildings included an acetone store, still house, jelly melting house, kneader house, paste-sieving house, recovery stove and recovery house, five stoves, three blending houses, several magazines and men's and women's mess rooms.⁴⁴ The ingredients of cordite – nitroglycerine, guncotton and mineral jelly – were kneaded together with acetone as a solvent. The paste was made into cord-like lengths by being forced through dies of the required diameter. Then some of the acetone was recovered before drying was completed and finally the cordite was blended.⁴⁰ Figure 13 shows the press house which after the First World War was converted into a row of cottages.

The great explosion and other memories

The accident at the black powder coming house on 12th February 1901, in which six men lost their lives, was the worst explosion on record at Chilworth. There were two explosions, the first in a tram outside the coming house setting off the second in the building itself. The iron rails of the tramway stopped five yards short of the building, paradoxically for safety reasons, and the powder was carried the rest of the way. The ground was frozen and it was thought that one of the men had slipped on his hob-nailed boots, making a spark which ignited the powder in the tram. No Home Office regulation had been contravened, but the Company decided to make some changes, in particular to provide more suitable foot-gear in future.³⁷ The card printed in memory of the victims is shown in Figure 14.

A few years earlier, in November 1895, there had been a narrow escape when Unwin's St Martha Printing Works, on the site of the old paper mill, was destroyed by fire. The Gunpowder Company fire brigade was first on the scene and set two of their engines to work on the fire while the third pumped water on to the factory magazine. Though it was not full to its capacity of 60 tons, the magazine contained a large quantity of powder and was down-wind from the inferno. Fire brigades shortly arrived from Guildford and Albury but it was clear that the printing works was doomed. A storeroom at the powder works containing packing cases caught fire and the north-east wind blew burning paper on to the magazine but, by much heroic effort, a terrible catastrophe was avoided.⁴⁵

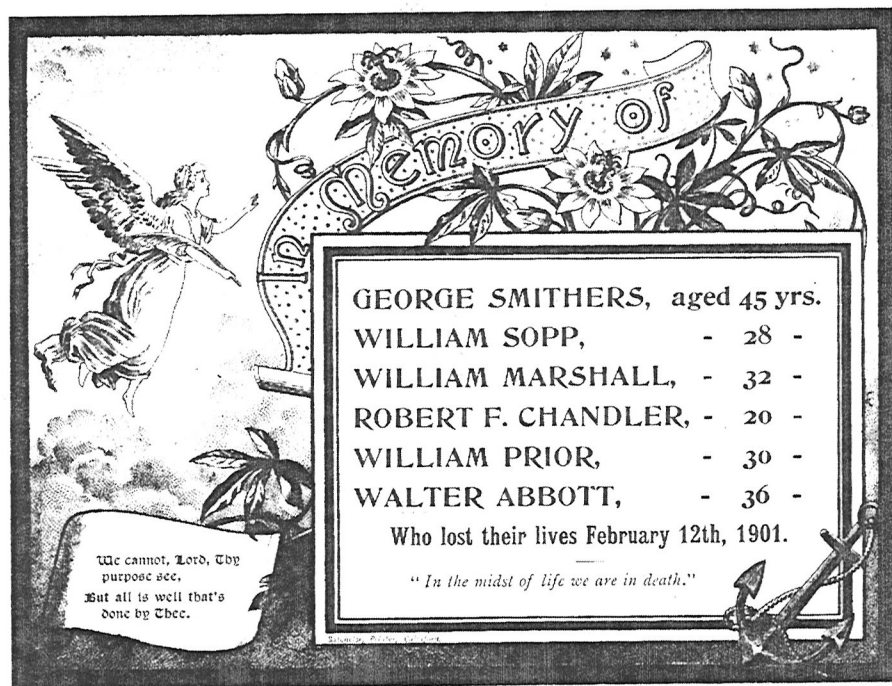


Figure 14 Memorial card for the victims of the 1901 explosion. Courtesy: J. Puddick

Local residents have provided information about their own and their parents' working lives at the mills, as well as photographs and other memorabilia. Two of the photographs showing men at work are reproduced in Figure 15 and on the cover. In the latter picture, the man beside the lamp-post on the left is Charlie Brownjohn of Merrow who in 1910 lost several fingers in a mangle-like machine. This may have been for making ballistite, which was rolled into thin sheets. Other surviving photographs show the works' cricket team which held fixtures on Saturday afternoons and bank holidays. Evidently some of the German personnel entered into the spirit of English village life for Captain Otto Bouvier, the works' manager, posed with the team in 1893 and one of the supervisors, H. Wirths, was among the players. Before the First World War there was an annual Saturday fete and a trip by train to the seaside. Other childhood memories are of home-made fireworks and the weekly dose of brimstone and treacle on Friday nights. There were some redundancies in 1897 owing to lack of orders.⁴⁶ There was a scheme whereby men paid into a fund to provide sick-pay, and this continued after a Workers Union was formed in 1913. Discontent had arisen about wages which were low because many ex-soldiers were employed who were already in receipt of a pension.³⁷

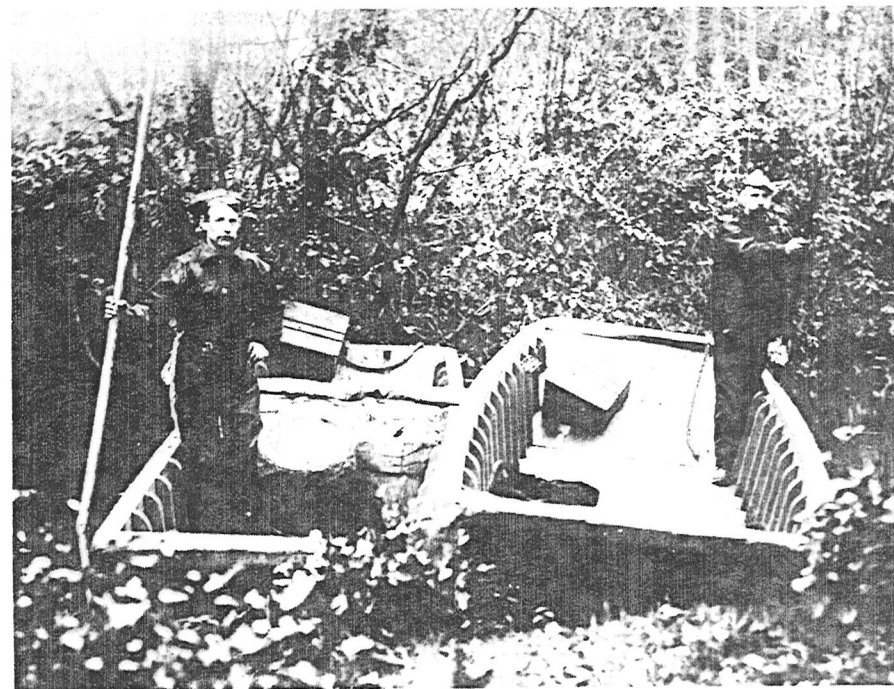


Figure 15 Punts on the mill stream in 1913. Courtesy: A. Hammond

The works operated around the clock with two shifts beginning at 6a.m. and 6p.m. Workers were searched before entering the site and wore special clothing with no buttons, pockets or trouser turn-ups. Many women worked at the cordite factory. They worked night shifts but not many of them entered the danger buildings. One of them remembers being paid 4d an hour. One of the men who worked there recalls that his father used to take the temperature in the stoves and clean the inside with acetone where beads of nitroglycerine were deposited. A wage of 30 shillings a week is recalled before the factory closed in 1920. Many workers at the cordite factory suffered badly from headaches. There were men's and women's mess rooms where workers prepared their meals. During air raids the women took shelter in the old flock mill at Postford and the men went to Lockner Holt. The worst scare was in 1915 when a Zeppelin dropped ten bombs between Guildford and Shalford.

Among the memorabilia is the letter which was sent to employees on 16th June 1920 announcing that the works was to close. This refers to the fall in demand for powder since the Armistice of 1918 and the growth of competition, particularly from Belgium and America. The workers received £5 for each year of

employment when the works closed. Some of the equipment was sold to an Argentine manufacturer and at least two men went to Argentina to help to set it up.^{37,46} The closure was part of a rationalisation of the explosives industry carried out by Explosives Trades Limited, into which the leading companies merged after the war. The new company became Nobel Industries Limited in 1920 and was itself merged into I.C.I. in 1926.³⁶

Local residents recall that, after the Duke of Northumberland sold the estate in 1922, an area east of Blacksmith Lane was purchased by a Mr Roach who built some timber houses there. Many of the industrial buildings were also used as dwellings and it is said that about twenty families lived on the site. Conditions deteriorated, the people were rehoused by the Council and many of the buildings were cleared. The central portion of the site is now owned by Guildford Borough Council and the western and eastern ends are privately owned, though served in part by public footpaths. The remains are being recorded and it is hoped that, while respecting the considerable natural history interests in the area, at least some features can be conserved. Documentary research is also still in progress and it is planned that a detailed research report will be published in due course. Meanwhile the author would be grateful for any further information about the site and the people who worked there.

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Abbreviations

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FIELD GUIDE TO THE CHILWORTH POWDER MILLS

All the approaches to the site are along narrow lanes and there are no conveniently located public car parks. Great care must therefore be taken when parking cars.

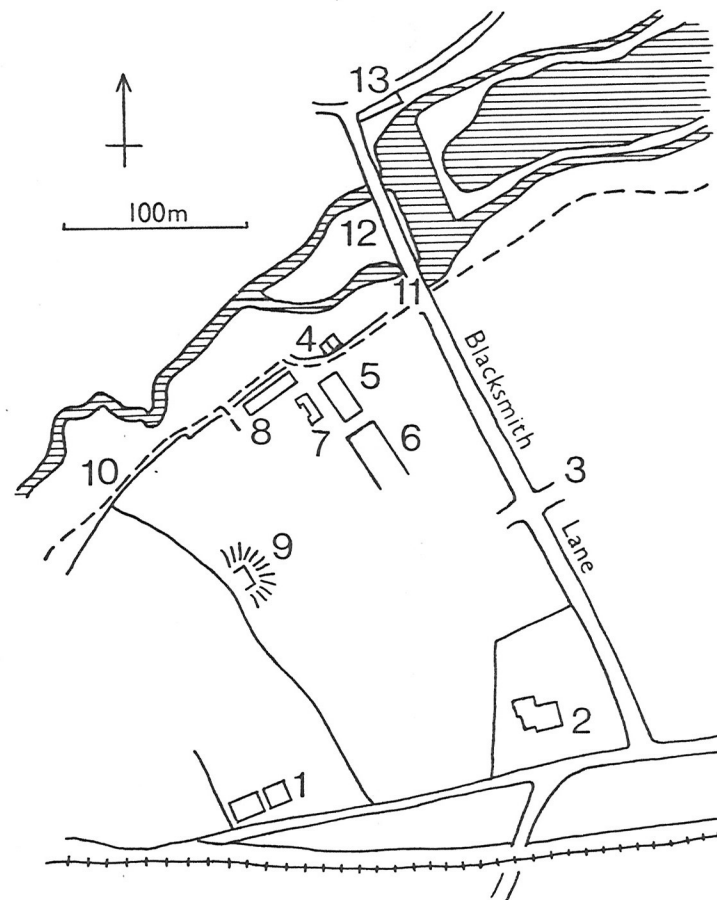
The western part of the site, where much of the processing of raw materials was carried out and where the original Lower powder works were situated, has been developed for residential and industrial use but some features are visible from roads and from a public footpath which leads to East Shalford. The central section, between Blacksmith Lane and Lockner Road, is owned by Guildford Borough Council. There is no public right of way but access to the main footpaths is permitted. Quite substantial remains can be seen of water and steam powered incorporating mills of the black powder and later prismatic powder factories. At the eastern end, between Lockner Road and Postford Pond, were situated the smokeless powder factory of the 1890s and the cordite works built by the Admiralty in 1915. The latter was largely demolished after the First World War. The land is privately owned but there is a public footpath through the Admiralty area from which several features can be seen. The walk is described in three sections, beginning at the western end. Footpaths are shown on the maps by dotted lines.

The remains on the ground have been identified from maps in the Northumberland Estate Office at Alnwick Castle, showing the gunpowder and smokeless powder works in about 1892 and the Admiralty works as proposed in 1915.

The western end

First walk to Magazine Cottages (1), two short terraces of three and four brick cottages built about 1890 for gunpowder workers. East of these, on the corner of Blacksmith Lane, stands the Old Manor House (2). This has the date 1609 over the porch but has been much altered. In 1728 it comprised two dwellings belonging to the powder mills and the little paper mill. It was called "Powder Mill House" on the 1847 tithe map and had acquired its present name by the 1880s. C. Marcus Westfield, who bought the powder works in 1881, asked the Duke of Northumberland for funds to restore it in 1882. Guildford directories show that Captain Otto Bouvier, the German manager of the Chilworth Gunpowder Company, lived here from 1887 to 1906.

Turn left along Blacksmith Lane. The works' cricket field was on the right where now there are houses. The 25in Ordnance Survey map of 1896 shows a tramway to the factory magazine and the charcoal house crossing the road near the present Halfpenny Close (3). Turn left along the footpath at (11). The Old Cottage and Rose Cottage (4) may have been converted from the drying house of the little paper mill which was behind them but of which no trace now remains. The present shed factory (5) is on the site of the saltpetre refining house and the building behind it (6) corresponds to the charcoal house. The Bungalow (7) was an office and laboratory and the long re-roofed building matches the workshop and stores (8).



The factory magazine (9) is a crescent-shaped mound on which mature trees are growing. It is in a private garden but can be seen from the footpath (10).

Return to Blacksmith Lane and note, on the left, the mill dam for the early Lower powder works, the paper mills which replaced them in 1704 and Unwin's Printing Works which burnt down in 1895. There was a leat to the little paper mill from the south end of the dam, where some old brickwork can be seen (11). Beside this is a former pumping station of the St Martha's Waterworks of the Hambledon Rural District Council which used a turbine to pump water to a reservoir on St Martha's Hill for distribution to local villages. On the bridge, facing the pump house, is the inscription "W T 1842", presumably referring to William Tinkler the younger who then owned Chilworth manor. The position of the water wheels can

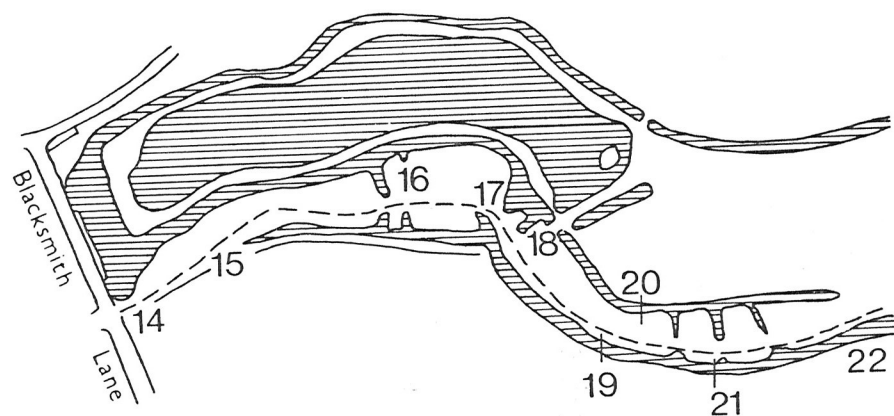
be seen over the wall (12). The cottages (13) are on the site of the paper mill rag house on the map of 1728 and of stables on the 1847 tithe map. The millstones nearby are not of local origin.

From the dam, view the mill pond, a small rectangular pond which is dammed at both its downstream and upstream ends and is fed by two streams. These are probably the water courses which the East India Company mismanaged in the early 17th century, to the annoyance of their landlords. The stream entering on the north side is the official Tillingbourne and the one on the south is the accumulated tail-water of a series of powder mills ranged along the valley. Both streams however are above the valley floor so they must be artificial. The water in the valley bottom is culverted under the mill pond and under the road. Until recently there was little water here, and in the past there were hop gardens, but the area has been excavated to form a large pond for fishing.

The central section : the gunpowder works

Enter the black powder works by the gate at the West Lodge of the factory which is now part of a cottage (14). The footpath crosses a series of mill races which flow down from the mill stream on the right to the tail water on the left. The mill stream peters out at its western end and first appears as a dry ditch along the fence.

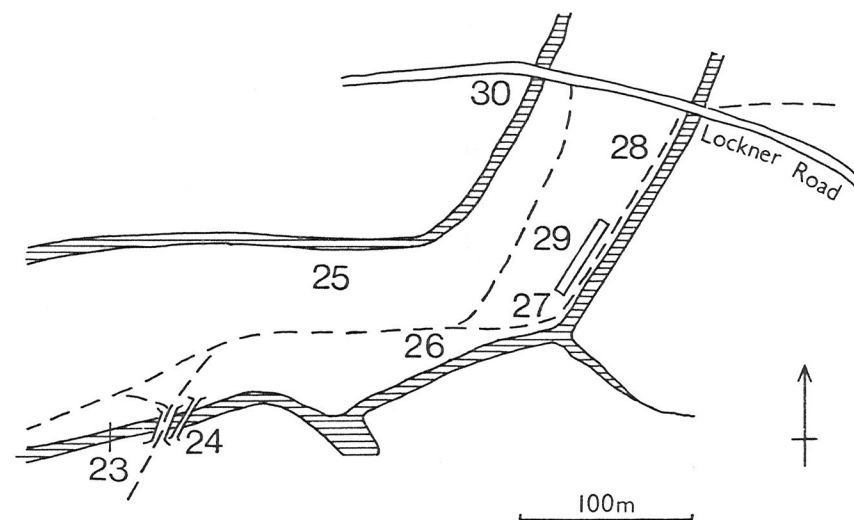
The footpath crosses scant remains of the dusting house (15). After crossing the first mill race note on the left the overgrown remains of the corning house which exploded in 1901 (16). The ruins before the next group of mill races are of the mixing house (17) and at (18) is a pair of edge runners from a water-powered incorporating mill. More edge runners can be seen on the left of the path as it continues and at (19) some of these have been rescued from burial and set up as a feature. Behind this row of stones are the remains of steam-powered mills (20) which include an engine bed, the bedstone of a bottom-driven incorporating mill,



brick piers of the building and an iron wheel-like object by the stream which is the inspection platform from the top of a tall chimney shaft.

Continue along the path, noting more edge runners lying on the ground and mill races which are now dry. A small iron post by the mill stream (21) is the only remnant of a swing bridge. The line of the tramway which it carried crosses the path diagonally. At (22) is the abutment of a bridge which is shown on a map of the Chilworth estate in 1728. Just beyond the remains of a wharf (23) a path branches right, crosses the mill stream and continues towards the village school on the main road to Dorking. Make a detour to the footbridge and note the swing-bridge alongside (24) which after 1888 carried an extension of the works tramway to a siding at the station. The fixed portion is made of wood and the moveable part is iron.

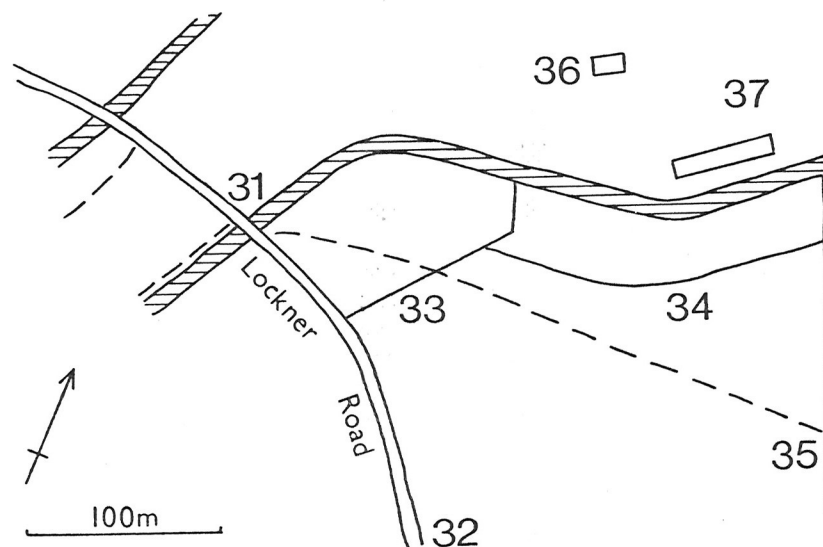
Return to the main footpath and continue straight ahead along the line of a tramway, noting some sleepers embedded in the path. The area ahead was developed largely by the Chilworth Gunpowder Company after 1885 for the manufacture of brown prismatic powder. An overgrown mound over on the left (25) corresponds to a prismatic press house on maps of the works. There are other overgrown ruins along the north side of the valley, including magazines and blending houses, but they are inaccessible. Just before the path forks, the remains of a building with a steam engine bed can be seen on the right (26). This is shown on an Ordnance Survey map of 1870 and marked as a corning house on later maps of the works.



Take the right fork through a protective earth and corrugated iron embankment and reach a row of six concrete incorporating mills of c.1885 (27). Note the line of the flimsy roof structure, the wooden battens in the walls to which match-boarding was fixed and the lever system at roof level whereby an explosion in one chamber triggered a drenching mechanism in all six. No edge runners survive, probably because the later ones were iron and would have been taken for scrap. Next are the remains of charcoal mills, a mixing house and a charge house (28).

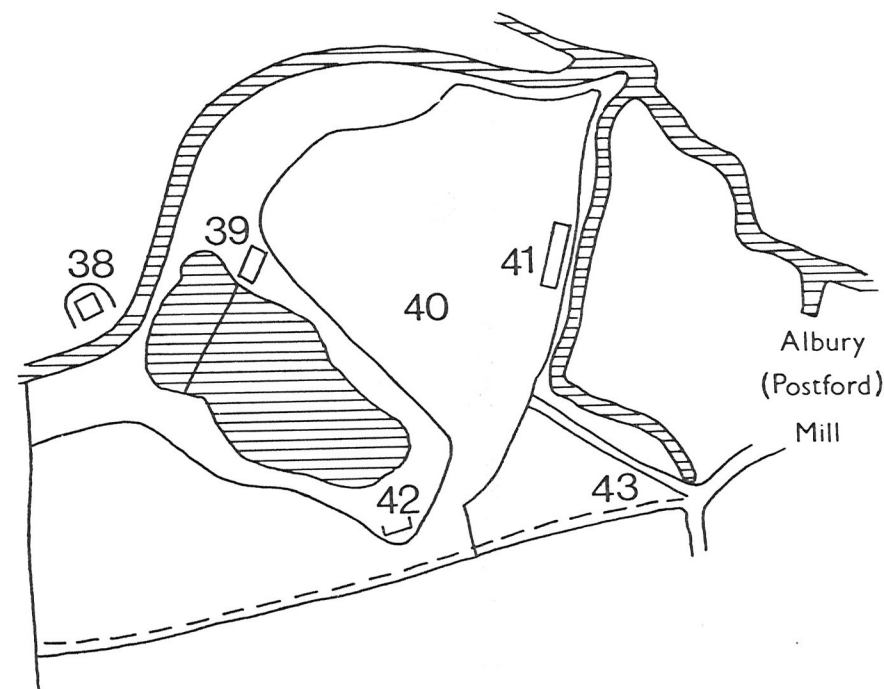
Return to where the paths diverged and take the left fork which goes behind the incorporating mills. In this area were the boiler houses for the steam engines and the associated chimney stack (29). The path approaches Lockner Road where, on the right, were laboratories and stores and the East Lodge. Over on the left near the road are the overgrown remains of a stove (30) of the 1890s smokeless powder factory whose main location was east of Lockner Road.

The eastern end : the smokeless powder works and the Admiralty cordite factory
On leaving the gunpowder works by the gate into Lockner Road, view the area of the smokeless powder works to the north-east. The house with five gables is named Longfrey. It was turned into a single dwelling in the 1920s from three small cottages and one of double size which were called Factory Cottages in the late 1880s. There was a barn on the site on the 1847 tithe map.



Follow the lane south-eastwards, passing a gate on the left and stone sets in the road which mark the path of a tramway (31) and passing the public footpath sign which is on the left. Note the foundations of the men's and women's mess rooms of the Admiralty cordite factory of 1915 (32). The women's mess room was removed to Peaslake where, as "the Hut", it served as the village dance hall and cinema before being converted into cottages.

Turn back down the lane and take the public footpath to Postford Pond, over a stile, diagonally across the first field and over a second stile. Foundations only remain of most of the Admiralty buildings because these were largely demolished after the First World War. There was a magazine to the right and rear of the second stile (33), blending houses to the left of the footpath (34) and another magazine just before the next stile (35). Over on the left, beyond the mill stream, are buildings of the 1890s smokeless powder works. The low white timber building with the corrugated iron roof (36) was a packing house and is now stables, the long red brick building (37) comprised press, kneading and accumulator houses and the brick buildings with the large protective embankment (38) was a stove for preliminary drying.



The remaining features which can be seen from the footpath belonged to the Admiralty works of 1915. The pond which comes into view was created recently. On its far side is the substantial ruin of a stove which was converted to a dwelling house after the works closed (39). To the right of this are some remains of the acetone recovery house (40) and further to the right is a row of cottages (41) converted from the former cordite press house by the Duke of Northumberland before he sold the estate in 1922. These are still occupied. Note the line of the former rounded roof in the end gable.

Close to the footpath on the left, just before the next stile, are the remains of a stove (42). Continue over the stile, follow the footpath alongside the fence and join the former Factory Road of the Admiralty cordite works (43) just before reaching Postford Pond and Botting's Albury Corn Mill and trout farm. Here and at Waterloo Pond, 200m to the east, there were powder mills in the late 17th century and paper mills from 1809 to 1865. On the hillside behind the mills there were dogwood (alder buckthorn) coppices which supplied charcoal for the powder works. The wood there is called Colyers Hanger, after the colliers or charcoal burners.

The Surrey Industrial History Group aims to study, record and where appropriate preserve the remains of the former industries of Surrey. The Group holds meetings, lectures, visits and social events and publishes a regular Newsletter. Further information may be obtained from the Membership Secretary, SIHG, c/o The Surrey Archaeological Society, Castle Arch, Guildford.

