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THE EARLY HISTORY OF GUNPOWDER MANUFACTURE AT CHILWORTH

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Chilworth Village lies in the valley of the Tillingbourne, one of the most beautiful parts of Surrey. William Cobbett,¹ writing in 1822, says: "This valley, which seems to have been created by a bountiful providence, as one of the choicest retreats of man; which seems formed for a scene of innocence and happiness, has been, by ungrateful man, so perverted as to make it instrumental in effecting two of the most damnable of purposes; in carrying into execution two of the most damnable inventions that ever sprang from the minds of men under the influence of the devil! namely, the making of *gunpowder* and of *banknotes*! Here in this tranquil spot, where the nightingales are to be heard earlier and later in the year than in any other part of England; where the first bursting of the buds is seen in spring, where no rigour of seasons can ever be felt; where everything seems formed for precluding the very thought of wickedness; here has the devil fixed on as one of the seats of his grand manufactory." I have no doubt that Cobbett saw the reason for the siting of these two industries at Chilworth — the Tillingbourne river. This little stream, which rises at Leith Hill, has for many centuries supported industries dependent upon the good water power which it supplies.

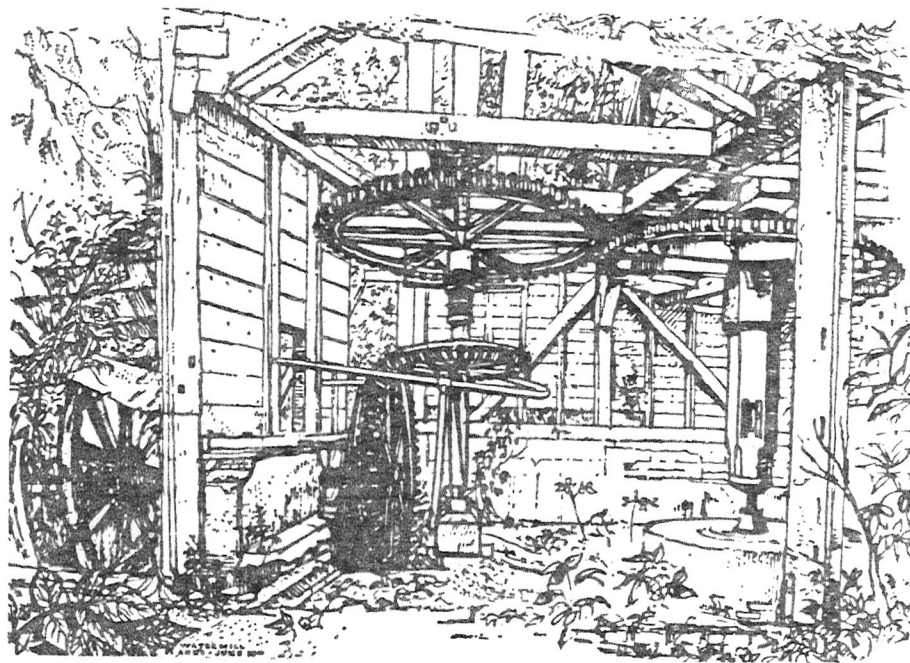
Before starting on the actual history of the Chilworth Gunpowder Mills it may be of benefit to know a little about gunpowder itself. Very few substances have had a greater effect on civilisation. Its employment altered the whole art of war and its influence gradually affected the whole fabric of society, perhaps in its infant years with comparable effects to the nuclear age we have just entered. The basic ingredients of gunpowder are charcoal, sulphur and saltpetre. Charcoal is the chief combustible in the powder. It must burn freely, having as little ash as possible; it must be fireable and grind into a non-gritty powder. The main woods used for charcoal were dogwood, willow and alder; dogwood being mainly used for smallarms powders, which burn more freely than those made from alder and willow. The manufacture of charcoal was a lengthy process. The wood, after cutting, was stripped of bark and allowed to season for two to three years. It was then picked to uniform sizes and charred in cylindrical iron cases or 'slips', provided with openings for the escape of gases and inserted into slightly larger cylinders set in a furnace. The heat rate governed the amount of charcoal produced, the less heat the more charcoal. As a rule, the time of charring was five to seven hours, when the slips were removed from the furnaces and placed into larger iron vessels, where they were kept comparatively air-tight until cold. The charcoal was then sorted and kept for some time before grinding. After grinding it was sieved on a rotating fine-mesh cylinder and then stored in a closed iron vessel.

Sulphur is mined in Sicily and was purified by distillation and then remelting into moulds. It was then ground into powder like the charcoal. Saltpetre is Potassium Nitrate and the chief source was the droppings of doves and pigeons. It is sometimes found in the soil when it is known as nitre. It is much more soluble in hot water than cold and was purified by dissolving to saturation in boiling water and cooling to about 30°C when almost pure nitre crystallizes out. The nitre provides the oxygen for the combustion of the charcoal and sulphur for the explosion to occur, and produces most of the gases.

The invention of gunpowder was impossible until this process of purification of saltpetre was discovered. It has been attributed to a German monk, Berthold Schwartz and also to Roger Bacon, who wrote about gunpowder in 1242, but it is now known to have originated in China and probably reached Europe through the Muslim world.² In 1345 Edward III was purchasing the ingredients for making powder and shipping cannon to France. In 1346, he ordered all available saltpetre to be brought to him. Prior to the reign of Elizabeth I, gunpowder had been made up in England from imported materials and large quantities of foreign powder purchased. It was the practice to store this gunpowder in English-owned stores abroad, chiefly in Antwerp, where it stayed until required, but since the consent of the sovereign, in whose dominions the store was situated, was required for its removal, Elizabeth decided that gunpowder should be made at home. At this time there were a large number of foreign refugees in the kingdom and it was to these people that Englishmen looked for many industrial secrets. The services of a German captain, Gerrard Honrick, who claimed a perfect knowledge in the art of making saltpetre 'in the best fashion and much in use beyond the sea', were requisitioned and on 13th March 1561 an agreement was made between the Queen on one part and Honrick on the other, by which for a sum of £300 Honrick agreed to instruct the subject of the Queen in the art of making saltpetre.³ From that date the history of English gunpowder manufacture begins. The sources of saltpetre were the efflorescence on damp walls and the nitrogenous earth in stables, pig-styes and principally dovecotes, 'the chiefest nurses of saltpetre in the kingdom'. The pigeons were not to be unnecessarily disturbed and the saltpetre contractors were to confine their operations to a half hour in the day and were to compensate the owners for loss of pigeons or eggs or for structural damage. Later in 1625, Charles I allowed the men to work for two hours a day at the convenience of the owner and no more. The kingdom was divided up into districts for saltpetre making, each with a number of men and a quota required. In June 1637, the rector of Knoyle in Wiltshire, Dr. Christopher Wren, the father of the architect, gave to the commissioner a bill for damages done by digging for saltpetre in the pigeon house of the rectory. There had been two diggings, one about eight years before, the other in March 1637. On the first occasion the pigeon-house, which was built of massive stone walls twenty feet high, was so shaken that the rector had to buttress up one side. On the second occasion the foundation was so undermined that the north wall fell in. The saltpetre men refused to make any compensation.⁴ It is not surprising that such drastic measures caused complaint and another cause of discontent was the gunpowder makers 'taking

of carriages' for conveyance of saltpetre and gunpowder and although this was to be paid for at the fixed rate of 4d. a mile, there were disagreements over distance. It is little wonder that the supply of saltpetre showed an increasing tendency to become inadequate. The incorporation of the East India Company and the establishment of trade with India made possible the import of large quantities without political complications and by October 1629 the Company was allowed to export fifty tons of saltpetre, as the King's stores and Mr. Evelyn's were sufficiently supplied.

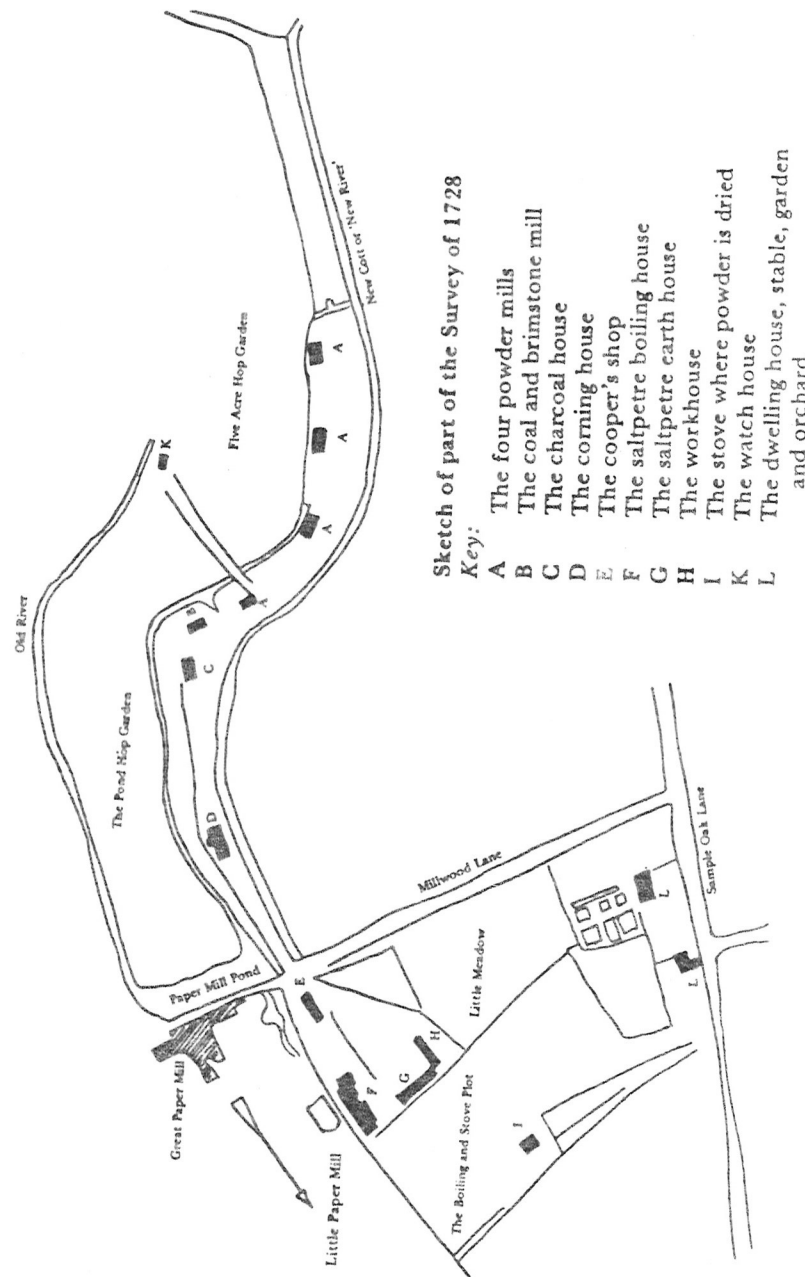
Since the sixteenth century, the making of gunpowder was as follows. The materials were weighed out separately, mixed by passing through a sieve and then uniformly moistened with water whilst on the bed of an incorporating mill. This consisted of two heavy stone or concrete wheels, which were covered with copper and mounted so as to roll around a circular bed. The incorporation needed about four hours. The action of the rollers on the powder paste was a double one, not only crushing but mixing. The paste was deflected, so that it came under one roller then the next, by scrapers, which followed each wheel, set at an angle to the bed.



Remains of Incorporating Mill before restoration at the Faversham Gunpowder Works, (by kind permission of A. Percival, Esq., F.S.A., Hon. Sec. of the Faversham Society).

Although the charge at this stage was still wet it was possible for it to be fired either by the heat developed by the friction of the rollers or by sparks from foreign bodies such as stones or grit. Therefore each mill was provided with a drenching apparatus, so that, if one mill fired, it and its neighbours were drowned by water from a tank immediately above the mill. The product from this stage was called 'Mill Cake'. After the mixing stage the powder was still damp. It could then be granulated or 'corned' by rubbing through a sieve while damp or it could be pressed while drying. These processes were important in regard to the rate of burning and the purpose of the powder. The less dense it was the more rapidly it burned and the more stress it put on the gun.

The earliest reference to a gunpowder mill in Surrey occurs in February 1535, when Henry Reve erected a mill in Rotherhithe.⁵ The year of the Armada, 1588 demonstrated the need for a good supply of gunpowder and on 28th January, 1589 George Evelyn, Richard Hills (or Hill) and John Evelyn, son of George were licensed by Royal Letters Patent to dig and get saltpetre within the realms of England and Ireland, except in London and within two miles radius of the walls, and in the five most northern English counties, and to convert the same into gunpowder for provision of the Queen's stores. The license was to run for eleven years, and the Justices of the Peace and Mayors were ordered to assist them.⁶ Although John Evelyn, in a letter published in Aubrey,⁷ referred to lost powder mills near Wotton, it would appear that the Evelyn's mills were at Long Ditton on the Hogsmill. However, their partner, Richard Hill is described as a gentleman of Shere and may have had mills on the Tillingbourne. These men never worked together as a firm, but appear to have shared the work between them. Of the saltpetre brought into the Tower between 28th February and 25th September, 1589, 45,583 lb. were supplied to the Evelyns and 19,754 lb. to Hill. With various renewals, the Royal Warrant was continued by the Evelyns until 31st October, 1636, the conditions being given in the Victoria County History,⁸ and they built the Godstone Mills. Meanwhile in 1625, the East India Company appear to have set up mills 'on the skirts of Windsor Forest' which at that time reached into Surrey. From a statement of Vincent Randyll in 1654, it would appear that they were at Chilworth, leased from his father, Sir Edward Randyll. The Company may have intended only to supply its own service, but in 1627 Evelyn complained of competition and in 1631 he complained that in spite of prohibition the Company's workman, Collins was making thirty barrels of gunpowder weekly.⁹ But in November 1635, Edward Collins of Chilworth contracted with the Commissioners for Saltpetre and Gunpowder to convert the 100 lasts of saltpetre which the King had arranged for the East India Company to import. He died before the contract was completed and arrangements were made to pay his widow. On 1st November 1636, the appointment of powder-maker to the King was given to Samuel Cordwell and George Collins, tenants of the Chilworth Mills and they became the only authorised makers in the kingdom. A sum of £2,000 was impressed from the Crown for building mills, storehouses and workhouses, and for providing utensils, but all of these on the expiry of the contract were to be delivered to the King, who was also to pay the rent for the



Sketch of part of the Survey of 1728

Key:

- A The four powder mills
- B The coal and brimstone mill
- C The charcoal house
- D The corning house
- E The cooper's shop
- F The saltpetre boiling house
- G The saltpetre earth house
- H The workhouse
- I The stove where powder is dried
- K The watch house
- L The dwelling house, stable, garden and orchard

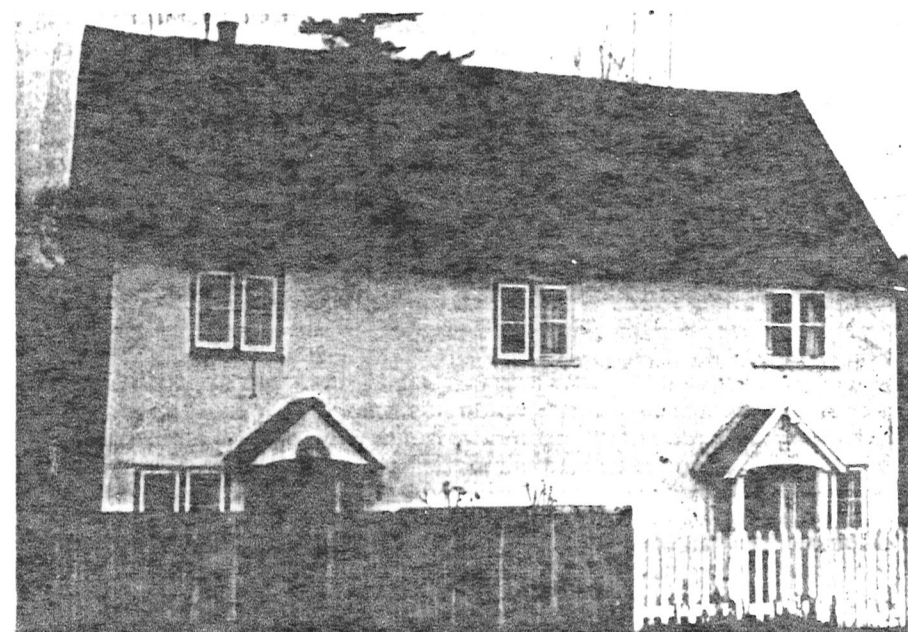
waters and lands, hired for the work, for the residue of the term of the lease, should he employ any other maker for the service. They were to supply 240 lasts a year, (a last being 24 cwt.). On the 25th September 1636, a few days before this contract came into operation, an order sent by Council to the mayors, sheriffs, justices and other local officers, directing them that as there was occasion of carriage of powder from His Majesty's powder mills at Chilworth to Hamhaw and thence to London, they were to assist Cordwell in taking up at the King's prices such carts, hoys and barges as should be necessary for the purpose.¹⁰ About this time the King's saltpetre house was moved to Kingston. Cordwell seems to have become sole manager of the works and succeeded in carrying out the contract, supplying 240 lasts in the first and third years, but only 200 in the other years when he petitioned for all the saltpetre the East India Company could bring. A fire at his works in 1638 lost him his store and 2,000 cwt. of powder. In February 1639 he found himself obliged to ask the Council to release the £2,000 to him to rebuild his works and offered in return to disclaim all his interest in the buildings used by him in his industry. The gunpowder industry was destined to be changed in 1641, for the Act 16 Charles I. c. 21, "for the free bringing in of gunpowder and saltpetre from foreign parts and for the free making of gunpowder in this realm", brought to an end the Crown monopoly, but the mills at Chilworth continued to function. They were important to Parliament in the Civil War. Samuel Cordwell died in 1648 and was succeeded by his brother Robert and then by a succession of makers within the next few years¹¹ and it is likely that the mills were allowed to run down.

Aubrey visited Chilworth sometime before 1692. He says:¹² "Was the Seat of ... Randyll, Esq; Master of the Gun-powder Works, for which in this little Romancy Vale are sixteen Powder Mills erected: It now belongs to Morgan Randyll, Esq; one of the Representatives in Parliament for the Town of Guildford ... In this little pleasant Valley, the Springs serve not only to water the Grounds, but for the driving of 18 Powder Mills, 5 whereof were blown up in a little more than half a Years Time. 'Tis a little Commonwealth of Powdermakers, who are as black as Negroes. 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". Aubrey's book was published by Rawlinson in 1719. He continues: "The Powder-Mills of this Place were the first in England; and before they were erected, all our Gun-powder was imported at a great Expence from foreign Parts: [as has been seen above, this is not true] Since which time, the Place itself being so proper for such dangerous and useful Undertakings, the Mills have been farm'd out to several Hands, amongst the rest of the Gentlemen, Sir Polycarpus Wharton, Bart. ... was for some Years Tenant."

When Sir Polycarpus Wharton took out a lease on the mills for a term of 21 years, they were in such a bad state that he had to pay out £1,500 to make them servicable. This came out of his own pocket. The rent, growing charges, repairs and incidental charges amounted to £1,000 a year but this was paid by the Ordnance under the terms of his contract. This was dated 1st January 1677, and ran until 1898, when Sir



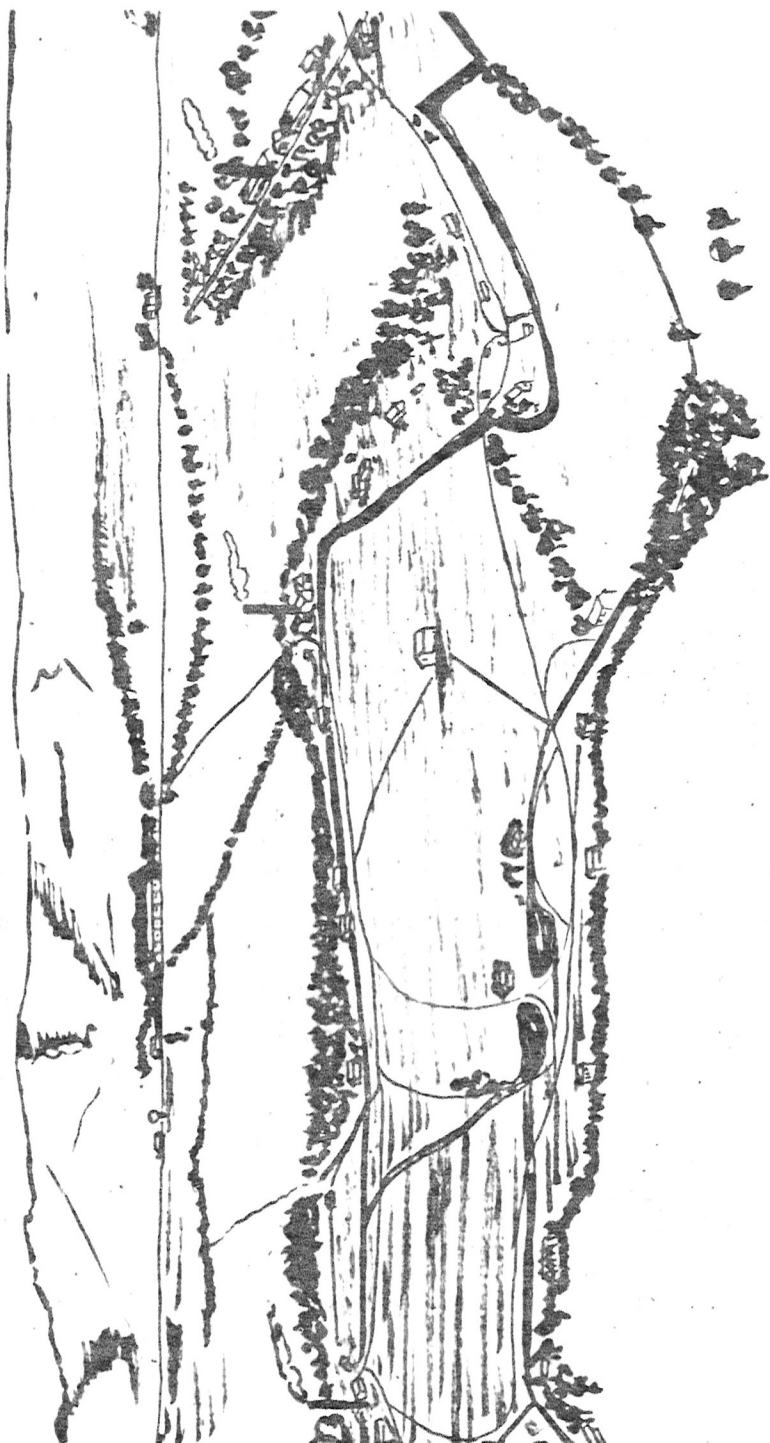
Roller millstone for an incorporating mill now half buried on the Chilworth site.



Pair of Cottages, now privately owned but once included in the grounds of the gunpowder works. They are believed to date from the early seventeenth century.

Polycarpus lost his fortune over this venture and ended up in debtors prison.¹³ After this the mills do not appear to be occupied until July 1728, when a survey was carried out for Francis Grueber. Morgan Randyll had sold the estate to Richard Houlditch, who lost his fortune in the South Sea Bubble, and the estate was bought by Sarah, Duchess of Marlborough. Mr. Grueber, proposed to build a new powder mill in the five acre bank meadow, 150 feet eastwards from the furthest mill in meadow. 'The ditch that must be dug for supplying the mill with water and carrying it under the stream must be nine feet broad and 260 ft. in length and will spoil five perches of the meadow, valued at 3 shillings a year. The other part of the ditch, with a road or way continued to the mill, the damage valued at 3 shillings a year. The whole damage of building this new powder mill will amount to six shillings yearly.' Apparently Grueber was responsible for the ditch on the southern side of the factory site. The manor was sold to Edmund Hill in 1796, then to William Tinkler before 1817, and in 1845 to Henry Drummond of Albury from whom it passed to the Dukes of Northumberland. Tinkler worked the mills himself until 4th March 1819, when they were leased to John Sharp and the business was carried on in the name of J. T. & S. Sharp until 1881 when it was sold to C. M. Westfield, trading as Westfield Brothers until 1885, when The Chilworth Gunpowder Company was formed with C. Marcus Westfield and Edward Kraftmeier as managing directors.¹⁴

There had recently been many developments in heavy guns and these gave rise to changes in gunpowder, particularly for heavy guns a slower-burning form with less sulphur and a lighter coloured charcoal, known as brown or cocoa powder. It was often supplied formed into hexagonal prisms with a central hole, when it was called prismatic powder. Another recent invention was smokeless powder, based on nitrocellulose, and this was the forerunner of Cordite. The Chilworth Gunpowder Company never advertised directly, but they did attend, as exhibit 5149, The Royal Naval Exhibition of 1891 at Camperdown Gallery. The following information is taken from the leaflet prepared for the exhibition. The Company claimed that they stood partly on the site of a works established in 1570. "The factory is of course very different now from what it was when purchased by the Company in 1885. Modern requirements have demanded many changes, and the place has been changed and enlarged and improved from time to time, until now many times the size it was six years ago." In their exhibit the Company showed not only a full assortment of sporting and blasting powders, but, more particularly, they had samples of the chief varieties of Military Powder. The harmless looking prisms of black, brown and E.X.E. powders were in appearance more like hexagonal nuts for machinery than gunpowder. All the exhibits were of course dummies but they nevertheless were a source of considerable interest. This form of powder was for use in all guns from 6-inch calibre upwards. The Company also had on show samples of the cases and cylinders which were used on land and sea for the storing and transporting of the powder. The prismatic powder case patented by Ritter, was the most modern of its kind being strong and yet perfectly airtight. The exhibit which had perhaps the greatest interest was the collection of various size dummies of Smokeless Powder. The sizes varied from that of fine Sporting powder to that of cubes three-quarters of



A Birds-eye View of the Chilworth Factory, 1891.
(from the exhibition leaflet).

an inch surface. This powder gave the most satisfactory results, not only in magazine rifles but in all guns up to 9.2 inch breech loaders firing a projectile of 3801 lbs.

The handout goes on to quote an extract from Wyman's *Commercial Encyclopedia* for 1888, which gave some idea of the work of the Company. "About twenty years ago nearly all the processes of the manufacture were carried out by rough and ready rules, passed by word of mouth from one manager or foreman to another; no instruments were used nor calculations made to determine the velocity or the projectile or the pressure exerted in the gun; nor was there much thought given to fit the powder for any special purpose; indeed, the only distinction drawn was between the powder for cannon and that for smallarms. All this has now changed, and as the subject is at once new and very interesting it behoves us in dealing with it to look for the most successful factory to describe. The task of making the selection is not a difficult one; we have in Chilworth Factory, at once the oldest, and yet the newest in England. It is the newest, or rather the most modern because since 1884 it has been almost rebuilt, and is now provided with all the latest and most efficient machinery, combining the two great desiderata of rapid and regular turn-out, with the utmost amount of safety for the workpeople. The extensive works have been increased and improved until they are now most certainly one of the leading gunpowder mills in the world; they stretch for nearly two miles along the valley, bounded on the north by the hill of St. Martha; south and east by spurs of the Surrey Hills. They are situated about four miles distant from Guildford. There was a drawing of the factory given with this handout giving a view from St. Martha's Hill, but as the Company were ready to admit "fails to do it justice, as, in the manufacture of gunpowder every operation must be carried out in a separate building, each being of considerable size and distance from any others. It was therefore impossible, in a small view to give an adequate idea of the size of the factory. Most of what look like small dots on the picture are large, substantial, and even handsome buildings of brick and cement; the three shafts are each close to 150 feet high. These shafts are attached to furnaces and boilers working twelve steam engines, several of which develop up to 100 horse power, which, with water-wheels and turbines, give the necessary power. The whole factory lies in a well timbered valley and is almost entirely hidden; passengers on the nearby railway have little idea that they are within a short distance of a busy factory employing between 300 and 400 men, and one which is, after the Royal Powder Factory at Waltham Abbey, the chief source of the powder supply for the British Colonial Governments."

The Chilworth Gunpowder Company grew so rapidly that they bought another factory near Buxton, they also owned magazines at Liverpool, on the Thames and in many other places, and work was carried on day and night.

The *Standard* of 23rd May 1888, under the heading "Our Powder Supply" drew attention to the importance of the Chilworth Mills and ended their article by saying, "At this factory, not only can the most improved kinds of gunpowder be procured, but also in quantities as large as are likely to be required for the Government service, even if the extensive programme, for making England secure, which has so long in contemplation is carried out".

So complicated had the manufacture of gunpowder become, by reason of the accuracy and uniformity required by the modern guns, that it was necessary to test each operation from the very receipt of the raw materials. For this purpose many branches of chemistry, electricity and optics, including the chronograph, densimeter, microscope, polariscope, etc., were constantly in use. No practicable improvement or suggestion was left untried to ensure that in each phase of its manufacture the powder was of the best possible quality. It was stated that the Company's lists contained no fewer than seventy-two brands of powder, some of which were tested in at least thirteen different stages of their manufacture.

"It was therefore, with the confidence born of success, that the Company supplied powders which acted as surely in the mammoth 110 ton guns as in the beautiful match rifle or powerful Express. They were as successful with ammunition for the delicate sporting guns of Greener, Purdy etc., as when they were required to supply the explosives for Armstrong, Nordenfelt, Hotchkiss and Maxim. The quartz rocks of Australia, the trapp and basalt of India, the slates of Wales and the coal of England, all in their turn yielded to the Chilworth Blasting Powder."

- 1 W. Cobbett, *Rural Rides*. Everyman Edition I. 150
- 2 A. R. Hall. 'A Note on Military Pyrotechnics'. *History of Technology*. II. 374
- 3 V. C. H. Surrey. II. 307.
- 4 *Ibid.* 308.
- 5 *Ibid.* 310.
- 6 *Ibid.* 312.
- 7 Aubrey. I. Introduction.
- 8 V. C. H. Surrey. II..312-318.
- 9 *Ibid.* 318.
- 10 *Ibid.* 319-20.
- 11 *Ibid.* 322-3.
- 12 Aubrey. IV. 56.
- 13 His case is given in Aubrey. IV. 58-65.
- 14 V. C. H. Surrey. II. 328

[cont. p 131.]