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THE PROPELLANT EXPLOSIVES AND ROCKET MOTOR ESTABLISHMENT
AT WALTHAM ABBEY

I T S H I S T O R I C A L B A C K G R O U N D

Contributed by Malcolm McLaren, Management Services

PART I

THE EARLY YEARS OF PRIVATE OWNERSHIP

The present Establishment at Waltham Abbey occupies the site with the longest continuous association with explosives. Just after World War II the Research Establishment took over from the Royal Gunpowder Factory which had provided a manufacturing capability since 1787 and which, in its turn, was the successor to the earlier privately-owned Powder Mills. No history of this Establishment is therefore complete without reference to the history of gunpowder itself.

Gunpowder is an emotive word which conjures up a whole range of impressions, from dastardly plots to festive celebrations, but for five centuries it remained the undisputed explosive and propellant and, as such, it served to change world history. At a more parochial level it is responsible for PERME Waltham Abbey being where it is today.

It is now accepted from the writings of Taoist alchemists, as early as the 9th century, that the Chinese were the first to develop incendiary mixtures of saltpetre, sulphur and charcoal and later, in 1044, to give detailed compositions of these mixtures. The availability of saltpetre and an awareness of its properties were key factors in this development. Knowledge of gunpowder then spread westwards to Europe through the Arab countries where saltpetre was unknown before the early part of the 13th century but later became known as "Chinese Snow". In Europe, Roger Bacon, a Franciscan friar, is credited with the earliest experimental investigations of gunpowder but he was so apprehensive of the consequences of his discoveries that in his account written in the mid 13th century he concealed the details of the composition in an anagram which, surprisingly, was not deciphered until 1904! Despite this secrecy the composition and its propellant properties became more widely known and led to the development of the gun, the earliest known illustration of which appears in a manuscript dated 1326 by Walter de Milemete, chaplain to Edward III. Twenty years later, after further development, the gun was being used for the first time on the battlefield by the English at Crecy in 1346.

Although some gunpowder was being made at the Tower of London, most of that used in the next two hundred years was imported from Europe where Antwerp and Hamburg were the main trade centres. It was not until the second half of the 16th century that the gunpowder industry began to expand, possibly as a result of the Queen's Ministers advocating, in 1560, the construction of new Powder Mills to overcome the shortage of gunpowder at a time of deteriorating international relations.

It was at this time that the earliest link between Waltham Abbey and gunpowder was established, appearing in the form of a letter from an Italian to John Tamworth of Waltham Abbey concerning the supply of saltpetre and sulphur. The early years of the Waltham Abbey Mills are shrouded in uncertainty but a legend exists that the powder used in the "Gunpowder Plot" came from Waltham Abbey. It is known that, just before that fateful day in 1605, the main conspirators were frequent visitors to White Webbs a house in the nearby hunting district of Enfield Chase. The powder could have been purchased without suspicion and then transported by water down the River Lea to the Thames.

The importance of the Mills appears to have flourished as by 1662 Thomas Fuller, the local minister, was writing in his "History of the Worthies of England" that more gunpowder was made by the mills in his parish "than in all England besides". Fuller recognized that the manufacture of gunpowder was a dangerous occupation stating that the Mills had blown up seven times in seven years but without the loss of life. It was however only three years later, in October 1665, that the local Parish Registers recorded the burials of two workmen killed in a mill explosion, a tragedy which must have been viewed with some concern as it was most unusual for the cause of death to be given in the registers.

The gunpowder industry was in private ownership and the Waltham Mills were no exception. Little is known of the early owners but the names of Richard Stock and John Berisford both appear as "powdermakers" in a land transaction of 1648. Samuel Hudson was the powdermaker in 1669 at the time of the earliest known, but still extant, title deed to the site in which details are given of buildings used for the processes of "grindinge, boylinge, corninge and dryinge of powder". The Mills then passed into the possession of the Walton family in whose hands they remained for three generations. By 1735 the Mills were owned by John Walton and were described in that year by John Farmer in his history of Waltham Abbey as being "esteemed the largest and compleatest works in Great Britain", and although no details of manufacture are given it is known that the powder mills were worked by horses but that water power was used for the "corning" and "glazing" engines. By 1770 the use of water power had spread to the powder mills which were then supplying "near one hundred barrels weekly for Government Service, each barrel containing one hundred weight".

NEXT ISSUE - Nationalisation of the Waltham Abbey Mills.

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PART II

GOVERNMENT OWNERSHIP

In the 18th century the Government had realised the importance of controlling much of the gunpowder production and had, in 1759, purchased the mills at Faversham in Kent. However, following statements that the "private merchants can make better powder than the Government and that they can make it more cheaply" the Prime Minister, Pitt, was about to recommend the sale of the Faversham Mills in 1783, back to private enterprise ! Representations were made, through the Master General of Ordnance by Major William Congreve, who was Deputy Comptroller of the Royal Laboratory at Woolwich, to show that Government manufacture did, in fact, yield a profit, and that, if this profit were properly expended in improving the mills, it would be possible to make a powder which was more powerful and more durable than had ever been made previously. Fortunately and justifiably - as shown later - he received a sympathetic hearing and not only were the Faversham Mills reprieved but negotiations were opened with yet another John Walton for the purchase of the Mills at Waltham Abbey. Walton's Mills were purchased by the Government in October 1787 for £10,000 and placed under the control of Major Congreve who expended a further £35,000 on improvements and enlargements as the Mills were in a state of neglect. By 1811 Congreve was able to justify his actions by publishing a statement of savings arising from the manufacture of gunpowder at the Royal Mills. Between 1789 and 1810 407,408 barrels of powder, each of 100 lb were produced at Faversham and Waltham Abbey. The savings to the Government, being the difference between the merchants price and actual cost, amounted to £288,357 6s 0d. Taking the Waltham Abbey Mills alone, even after deducting £45,000 spent on the mills, a saving of over £50,000 was made. Much was also done at this time to improve the quality of the powder produced and Congreve demonstrated the improvements by trials on Marlborough Downs where 10-inch shells were fired by 9 lb lots of powder from different makers including six private merchants. That from the Royal Gunpowder Factory at Waltham had the greatest range of 4,430 yards exceeding its closest rival by 160 yards and most of the others by over 500 yards.

During the Napoleonic Wars the annual gunpowder production mounted. By 1809, 20,000 barrels were produced, by 1811 21,000 and by 1813 it had risen to 22,000. After Wellington's victory in 1814 every effort was made to decrease output and only 10,000 barrels were produced. On Napoleon's escape from Elba in 1815 powder production was maintained but, after Waterloo, output was reduced drastically to 3,000 barrels in 1816 and to 1,000 barrels and less in 1819 and the following years. Employment in the factory had been 250 in 1813 but by 1822 the figure was down to 34! Waltham Abbey survived this contraction but the other Government factories at Faversham and Ballincollig in Ireland were sold back into private ownership.

Details of the processes for the making of gunpowder were given in a pamphlet by Major Fraser Baddeley entitled "The Manufacture of Gunpowder, as carried out at the Government Factory, Waltham Abbey" which was published in 1857. It is significant that this pamphlet, and by implication the work by the Waltham Mills, could have influenced world history. At the start of the American Civil War only three powder mills are known to have been in existence in the Southern States. Major George Washington Rains was given the task of supplying the Confederate Army with gunpowder and it is recorded by him that he had the "great good luck" to come by Baddeley's Pamphlet. Both Rains himself and the United States Ordnance Manual of 1862 express the opinion that "nobody makes better powder than the British". The one drawback of Baddeley's pamphlet is that, whilst it gives precise details of all the processes, it contains no drawings of machinery or equipment. Major Rains however, managed to obtain the services of a James Wright, the grandson of the first Storekeeper of the Waltham Mills, who had emigrated to Tennessee. Rains wrote: "But one man -Wright- could be found in the Southern States who had seen the making of gunpowder by an incorporating mill; he had been a workman in the Waltham Abbey Mill in England ... I was much indebted to his knowledge and experience". But the Royal Gunpowder Factory appeared to have been backing both sides for it is known that Antoine Biderman and his nephew Lamot du Pont, both of the large Northern powder company of Du Pont, paid separate visits to Waltham Abbey before the Civil War.

Mention has been made of the accidental explosions referred to by Fuller and the first fatal accident. Although other explosions did occur in the era of private ownership very little is known about them, but from the time the Government took over the Mills the records of explosions are virtually complete. There was a change of attitude from one of inevitability of explosions to one of understanding why they took place. In the early years of government ownership regulations were made tighter and precautions were introduced whenever they were seen to be necessary and advice was sought from the leading authorities in the country. Explosions in the incorporating mill were frequent but not usually serious because the "green" charges had weaker explosive power and did not damage the machinery. It was in the later stages of manufacture that the possibility of a serious explosion was greatest. The first of these occurred in 1801 when a corning house blew up killing nine men and four horses. After this incident an approach was made to the Royal Society to suggest the best floor coverings and a visit was made to the mills by a party which included the President, Sir Joseph Banks, Count Rumford and Henry Cavendish. Their report stated that there was no hazard from "electrical excitations in the practice of rolling-barrels on floors covered in hide nor from the use of silk dusting screens", but recommended the use of painted floor cloth to cover the whole floor. In 1893 after an explosion in a building in which granulated powder was being pressed had caused the loss of nine lives, there was serious public concern. The Press was critical and questions were asked in the House of Commons. The report of the Committee of Enquiry, which included Lord Sandhurst and Sir Frederick Abel, can be said to be the basis of modern safety practice in explosives manufacture, for not only did it indicate the probable cause of the incident, but it discussed at some length the deficiencies of procedures and regulations.

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IN THE NEXT ISSUE: The Third and Final Chapter will deal with the introduction of alternative explosives and subsequent decrease in the importance and production of gunpowder; the closure of the

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HISTORICAL BACKGROUND

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PART III UP TO THE PRESENT DAY

For centuries the entire production of the Factory had been gunpowder but by the middle of the 19th century there was growing interest in two new explosives: guncotton and nitroglycerine.

Guncotton had been made by Schonbein of Basle in 1846 by the action of nitrating acids on cotton, and a plant for its production was set up at Faversham, now once again in private hands.

Unfortunately, a serious explosion destroyed the plant and following explosions elsewhere in Europe little interest was shown in guncotton except in Austria where the processes were improved. So much so that the Austrian Government offered details to the British Government and Frederick Abel, the War Office Chemist, was instructed to examine these improvements. Abel commenced experimental production at Waltham Abbey in 1863 according to the Austrian recipe. Later, he developed his own process for pulped guncotton which could be compressed into any desired shape suitable for use in mines and torpedoes or for blasting purposes. In 1872, he was authorised to set up a plant to produce 250 tons a year. Eventually this plant proved to be inadequate to meet the ever increasing demand and a new site on the southern side of Waltham Abbey was acquired - the South Site.

In 1872 Colonel Younghusband, the Superintendent of the Royal Gunpowder Factory wrote: "A great future may fairly be anticipated for Guncotton. As regards safety in manufacture, storage, transport and use, it is unrivalled by any other explosive, while in power it has not been surpassed by any substance with which it has been compared".

Nitroglycerine, a liquid explosive, first made by Sobrero in 1847 by the action of nitrating acids on glycerine, was the subject of much experimentation by Nobel but after several accidental explosions its importation and manufacture were prohibited by many Governments. Nobel's experiments were directed towards making nitroglycerine more easily handled than it was in its liquid state and one product he prepared was a mixture of nitroglycerine, guncotton and camphor. At this point Abel took up the action for the Government and made a mixture of nitroglycerine, guncotton and mineral jelly which gave promising results. This mixture which could be made into a charge of cords or rods received the name cordite. In 1891 a nitroglycerine plant was erected at the Factory together with the necessary buildings for the making of cordite. A second plant was built shortly afterwards and during the Boer War the production of nitroglycerine was about 18 tons a week.

Modifications to the original processes were introduced for all three products; guncotton, nitroglycerine and cordite, and for cordite there were variations in the ingredients. Production of cordite was about 40 tons per week in 1907 but at the height of the 1914-18 war it was about 64 tons per week.

The time between the wars were lean years for the Factory but even with a depleted staff research continued and improvements made including the introduction of nitroguanidine, or picrite, into the cordite to lessen flash and smoke. Also a solventless process, which was safer and eliminated a drying stage was introduced.

Although Colonel Younghusband had spoken in 1872 of guncotton in such glowing terms this did not prevent the search for other explosives. Abel comes back on to the scene again for it was he who suggested "picric powder", a mixture of saltpetre and ammonium

picrate, and arranged for its manufacture at Waltham Abbey.

TNT, probably the most widely known high explosive, is made by the action of nitrating acids on toluene, but, although it came into use in the British Services in the First World War, it was not until 1933 that it was made at the Royal Gunpowder Factory.

At this time the Factory was a production unit, whilst at the Research Department at Woolwich, work was being carried out to improve old processes and to introduce new explosives. One line of research led to the Research Department Explosive -RLX, and plant for its production was set up at Waltham Abbey in 1938. RDX or cyclotrimethylene trinitramine, has been called the high explosive of World War II. It is therefore significant that for the first years of the war the Waltham plant was this country's sole source of production.

As the war continued so other Ordnance Factories took over the production of the various explosives and the contribution of the Royal Gunpowder Factory decreased. In the winter of 1940-41 an enemy land mine put out of action the last of the gunpowder mills and the production of gunpowder which had given the factory its name was not resumed. Towards the end of 1943 most of the plant was being run down and on 28th July, 1945, the Royal Gunpowder Factory was formally closed after nearly 160 years.

However in 1944 the factory site had been surveyed and a report submitted recommending use of the site as an Experimental Station of the Armament Research Department at Woolwich. On the 1st of October 1946 there came into being the Chemical Research and Development Department with a nucleus of scientific staff drawn from the explosives and propellant branches of the Armament Research Department. Thus the link with Woolwich which had begun with Sir William Congreve, was continued.

In 1947 the name of the department changed to the Explosives Research and Development Establishment. Conversion of the factory site to the new Establishment was an immense task but gradually rehabilitation proceeded. The first programme of the new Establishment was divided into eleven items each of which was a distinct branch of research having a direct relationship to Service problems: Liquid Propellant Systems, Plastic Rocket Propellants, Colloidal Rocket Propellants, High Explosives and Intermediates, Initiators, Chemical Engineering, Small Arms and Mortar Propellants, Materials, Unorthodox Propellant Systems, and Ancillary Chemical Services.

But change has never been far from the Establishment's activities and the passage of time has seen it in six different Ministries with the number of branches increasing in the 1960's (9 in 1963) and decreasing in the 1970's reflecting the changes in those activities. Following the formation of a joint Establishment with the Rocket Motor Establishment at Westcott in 1973 a reorganisation in 1977 led to the creation of PERME.

Even now change is once more in the air - but as Churchill stated in his History of the English Speaking Peoples - "The future is unknowable but the past should give us hope".

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