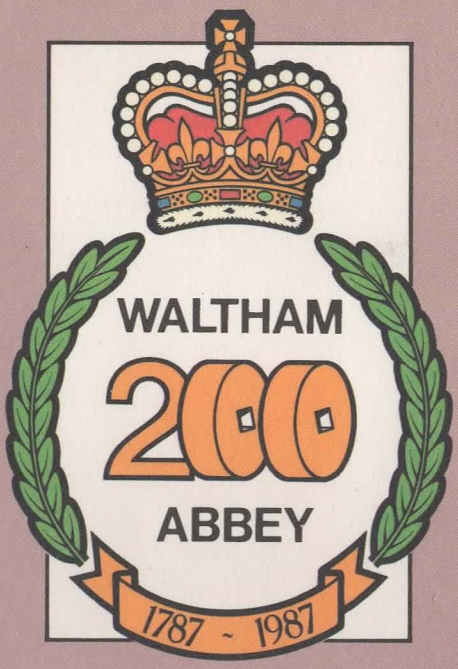


EXPLOSIVES—OHMS

BICENTENARY

EXPLOSIVES—OHMS

In 1787 Sir William Congreve made
successful proposals for the purchase of the Powder Mills
at Waltham Abbey for the Crown.
During the 200 years since then the site has made
important contributions to the defence of the Realm.

Royal Powder Mills
Royal Gunpowder Factory
1787–1945

◇

Experimental Station
of Armament Research Department
1945–1946

◇

Chemical Research
& Development Department
1946–1947

◇

Chemical Research
& Development Establishment
1948

◇

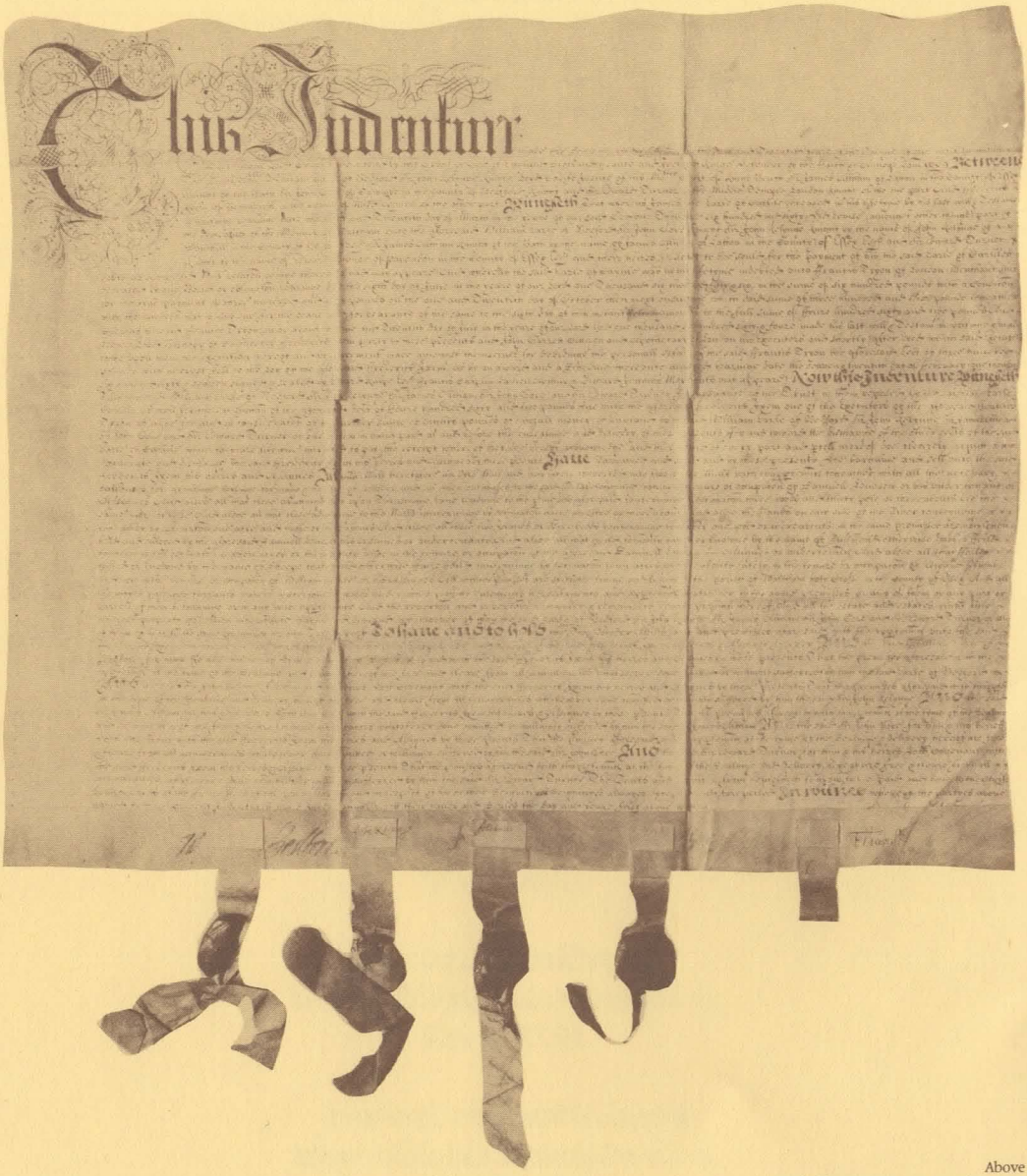
Explosives Research
& Development Establishment
1948–1977

◇

Propellants, Explosives
& Rocket Motor Establishment
1977–1984

◇

Royal Armament Research
& Development Establishment
1984–1987
onwards



Above
The title deed to the Powder Mills – 1669
Opposite
John Walton's Powder Mills on the site in 1735

Although gunpowder was used for the first time on the battlefield by the English at Crecy in 1346, it was not produced in this country in any great quantity until the middle of the 16th century when powder mills were established mostly in the south east of England. With the exception of a small scale operation in the Tower of London the entire gunpowder industry was in the hands of private manufacturers.

The mills at Waltham Abbey were no exception and were first operated by Samuel and Ralph Hudson from the middle of the 17th century to about 1700. The extent of their undertaking is to be gleaned from a title deed of 1669 which refers to two powder mills and outhouses for "grindinge, boylinge, corninge and dryinge of powder". The mills then passed into the hands of the Walton family who improved the processes by engaging the services of John Smeaton to design water-powered edge-runner incorporating mills to replace the more hazardous stamp mills which operated on a pestle and mortar principle. Edge-runner mills worked by horses were also in use at this time.

At a time of deteriorating international relations in the second half of the 18th century the Government sought to control at least part of the production and purchased the mills at Faversham in Kent. Other private manufacturers protested that they could make better and cheaper powder than the Government

but this was disputed by William Congreve, the Deputy Comptroller of the Royal Laboratory at Woolwich. So successful was he in his representations that negotiations were begun for the purchase of the Waltham Abbey powder mills from John Walton.

Above
Lt Gen Sir William Congreve, 1st Baronet
Top Right
Sir William Congreve, 2nd Baronet
Bottom Right
Saltpetre refining by recrystallisation

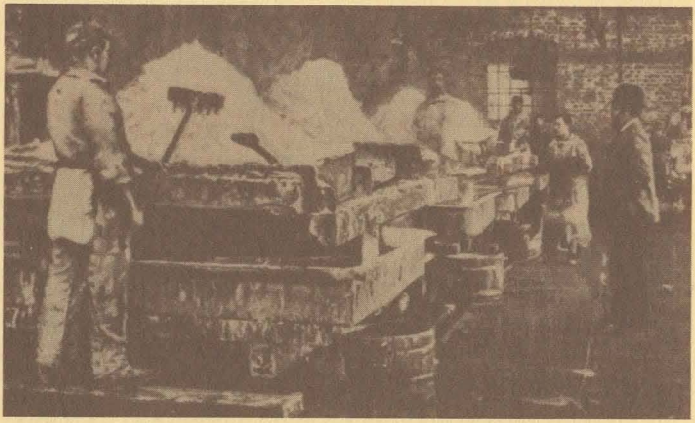
THE ROYAL GUNPOWDER FACTORY

"I yesterday went to the Powder Mills at Waltham Abbey with Mr Walton, and had the said Mills and appurtenances thereunto belonging delivered to me for His Majestys Service".

With these words William Congreve informed the Duke of Richmond, Master General of Ordnance, that he had taken possession of the Waltham Abbey Powder Mills for the Crown on 18 October 1787.

John Walton was paid £10,000 for the Mills but Congreve spent another £35,000 on repairs, improvements and extensions.

Congreve invited William Newton (remembered today in "Newtons Pool") to become Master Worker and employed Daniel Cornish, a carpenter, to recruit the best of Walton's millmen and labourers. The repairs, extensions and the recruitment and training of the workforce all took time and it was not until February 1789 that the first powder was made. Congreve issued a set of rules covering safety and discipline which, together with processes designed to produce a product of uniform performance, formed the basis of the improvement in quality and cost of the powder from the

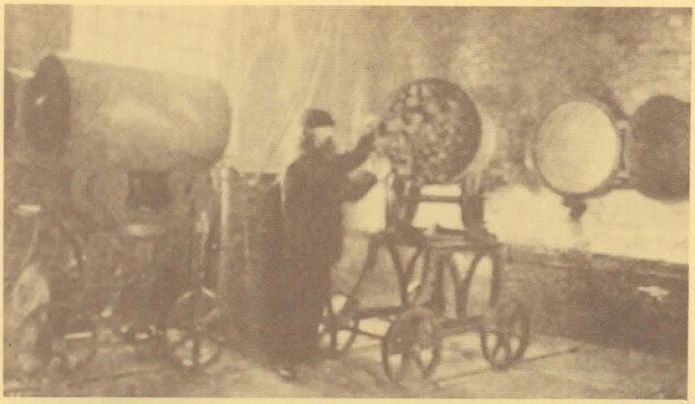


Royal Mills. Congreve was able to justify his earlier actions by publishing a statement of accounts in 1811 to show that even after deducting the £45,000 expended on the mills a saving of over £50,000 had been made. Further, he demonstrated the advantages of the improvements he had introduced in a series of trials on Marlborough Downs where 10-inch shells were fired by 9 lb lots of gunpowder from different makers including six private merchants. That from the Royal Gunpowder Factory had the greatest range of 4,430 yards exceeding its closest private rival by 160 yards and most of the others by over 500 yards.

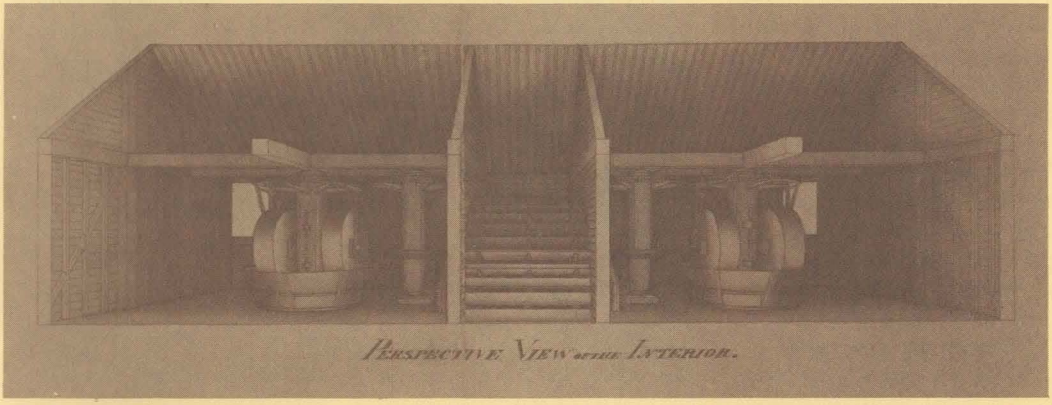
Sir William Congreve was succeeded as 2nd Baronet and Comptroller of the Royal Laboratory by his son, another William, who continued his father's improvements and invented the granulating machine which remained virtually unchanged in design for over one and a half centuries. He is probably better known for his development of the gunpowder rocket for military purposes. Although having terror and incendiary value as its qualities rather than accuracy, the Congreve rocket was used in several campaigns including Boulogne 1806, Copenhagen 1807, Leipzig 1813 and Waterloo 1815. Its use against Fort McHenry in 1814 is commemorated by the wording "the rockets' red glare" in the United States' national anthem.

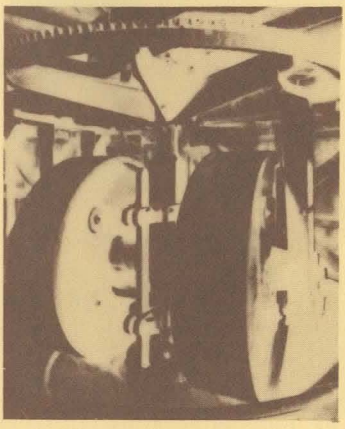
The Congreve era at the Royal Gunpowder Factory included the years of the Napoleonic Wars during which production mounted to an annual rate of 25,000 barrels, or about 1100 tons. It also saw the introduction of what became the definitive method of production. Gunpowder, an intimate mixture of saltpetre, sulphur and charcoal, was prepared by mixing the purified ingredients in the proportions 75, 10, 15 and incorporating the mixture under massive edge-runner millstones. The mill cake was then broken down and pressed before being granulated to the required size. The grains were dried, dusted, and glazed to improve the durability, stored in barrels ready for use and transported by sailing barge to the magazines at Woolwich and Purfleet.

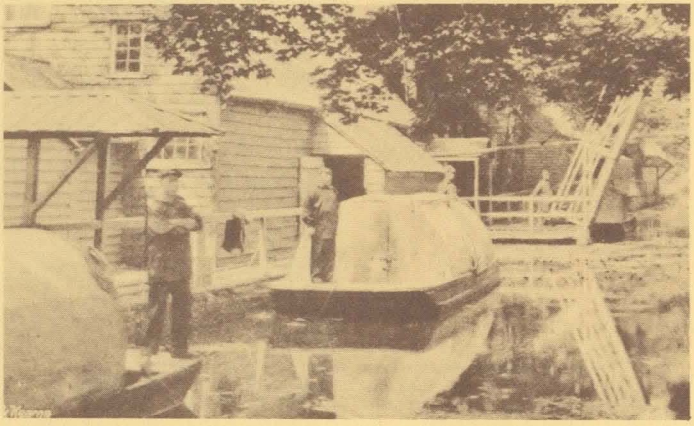
For decades the entire production of the Factory had been gunpowder but by the middle of the 19th century there was a growing interest in two new explosives: guncotton and nitroglycerine.



Bottom far left
Sulphur refining by distillation
Opposite
Charcoal burning
Centre
Water-powered gunpowder incorporating mills – 1830
Bottom left
Edge-runner millstones
Bottom right
Powder boats on the Millhead Stream



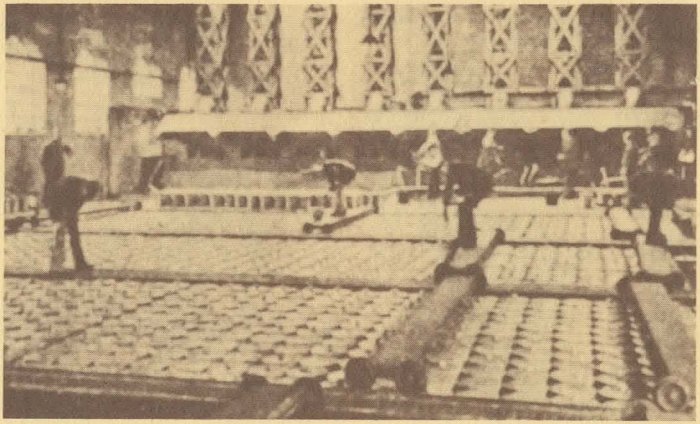




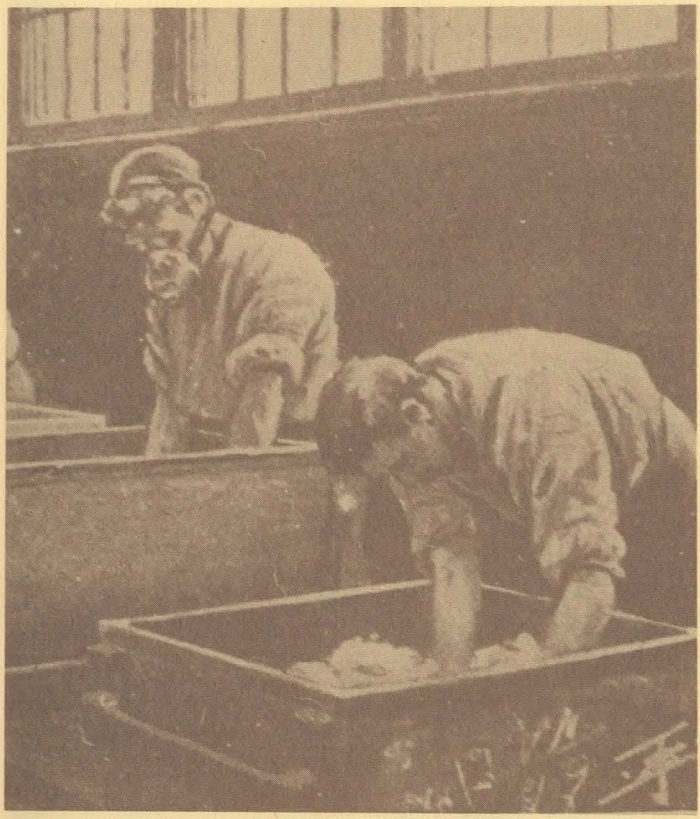
THE NEW ERA OF EXPLOSIVES

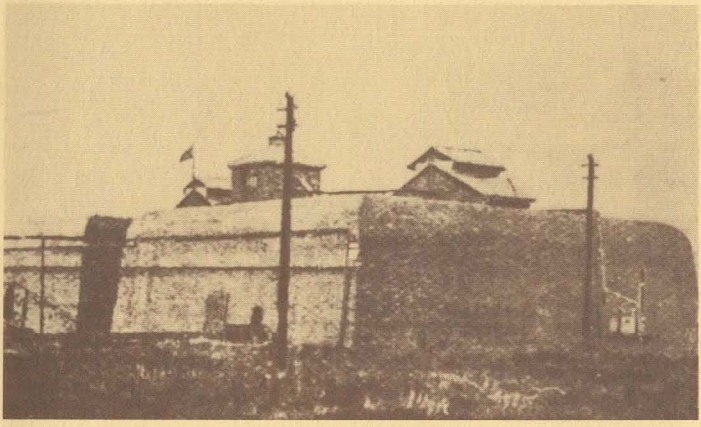
The new era of explosives began in 1846 when Schonbein of Basle, after earlier experiments by Pelouze, developed the production of guncotton as a commercial explosive.

Guncotton was prepared by the action of nitrating acids on raw cotton but unfortunately Schonbein's process did not include the vital stabilising stage and was doomed to disaster. Following serious explosions the commercial production was halted. Later the process improvements which had been introduced by the Austrians were continued by the British Government when, in 1863, Sir Frederick Abel, the War Office Chemist, set up an experimental plant at Waltham Abbey for the production of guncotton. The plant was successful and the product stable with



Above
Picking cotton for guncotton processing
Opposite
Early dipping process for guncotton nitration





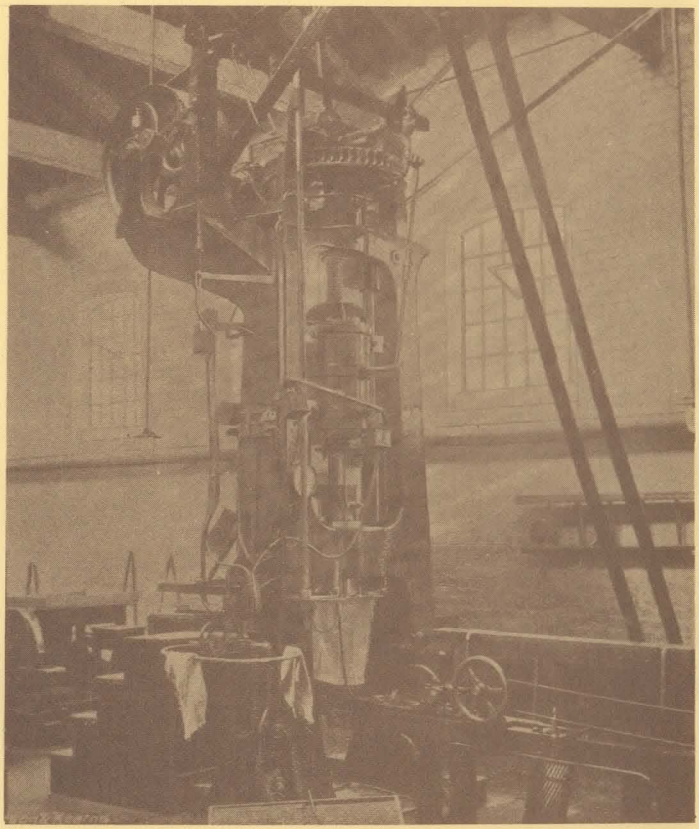
the result that production was increased to 250 tons per annum in 1872. Eventually this level of production was to prove inadequate and in 1885 a new site was acquired at Quinton Hill on the southern side of Waltham Abbey for the construction of an even larger capacity plant. More improvements followed including the introduction of the displacement plant at the nitration stage and by 1908 output had increased to about 2000 tons per annum.

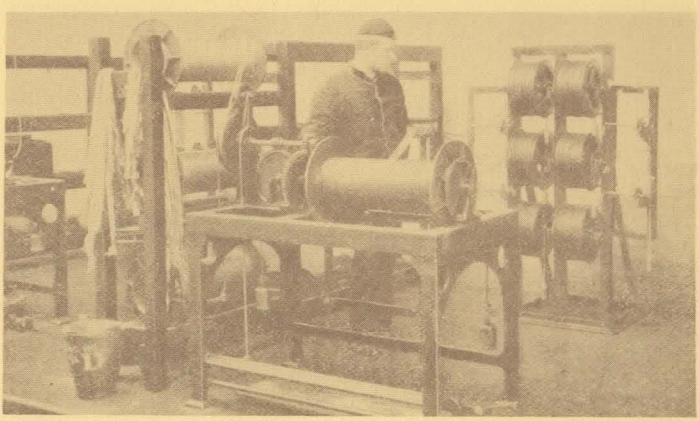
Nitroglycerine, a liquid explosive, first made by Sobrero in 1847 by the action of nitrating acids on glycerine and developed by Alfred Nobel, was an ingredient in a propellant composition devised by Sir Frederick Abel's Explosives Committee in 1890. With the other ingredients, guncotton and mineral jelly, it formed a

Above
Hand mixing of cordite dough
Opposite
The nitroglycerine factory

mixture which could be extruded into cords – Cordite. After the construction of a nitroglycerine factory on Quinton Hill, production of Cordite Mark I began in 1891. As with guncotton, improvements and extensions followed and another piece of land to the south of Quinton Hill was purchased for the new cordite factory in 1901.

The importance of the role of gunpowder, both as an explosive and as a propellant, declined with the introduction of guncotton and cordite. As a result the steam-powered gunpowder mills on the North Site were converted to cordite processing.





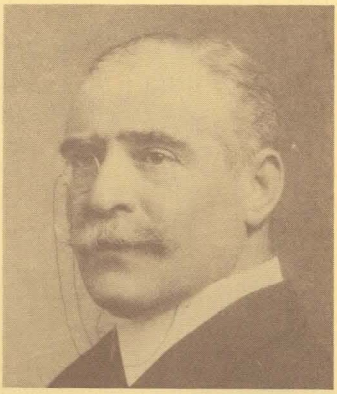
Above
Massive press for extruding cordite into cords
Opposite
Blending cordite by multiple winding
Top right
Col Sir Frederic Nathan, Superintendent RGPF 1900-1909
Bottom right
Women workers employed on improved production processes – 1917

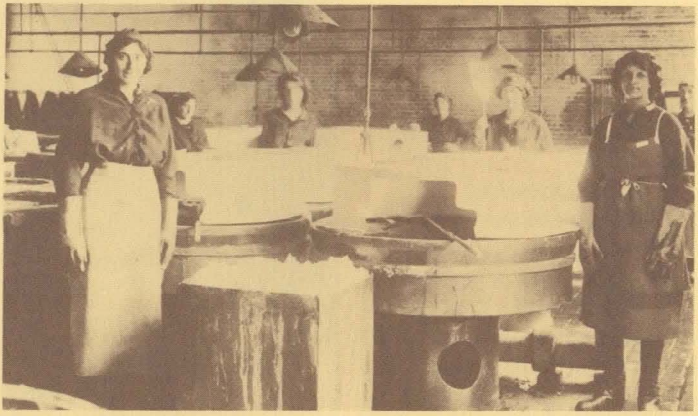
THE RGPF IN THE 20TH CENTURY

The first decade of the 20th century saw the introduction, under the direction of Colonel Sir Frederic Nathan, of a number of significant advances in the processing of guncotton and cordite, including the solvent recovery process for the recovery of acetone from the stoving of cordite, the acid concentration process for waste acid, the redesign of the nitration process in the manufacture of NG and the displacement process for the manufacture of guncotton. A plant was also set up for the small scale manufacture of tetryl, a booster explosive.

The benefits of these advances were very much in evidence during the early years of the First World War when the Royal Gunpowder Factory remained the only Government manufacturing site. Both production and employment mounted and by 1917 the workforce was over 5000, half of whom were women. A special bus service was introduced to bring the women workers from the railway stations and from outlying districts in Essex. For two and a half years the RGPF was operating on a "round the clock" basis seven days a week.

Eventually other Factories were set up elsewhere and not only did Waltham Abbey





Guncotton nitration by displacement process

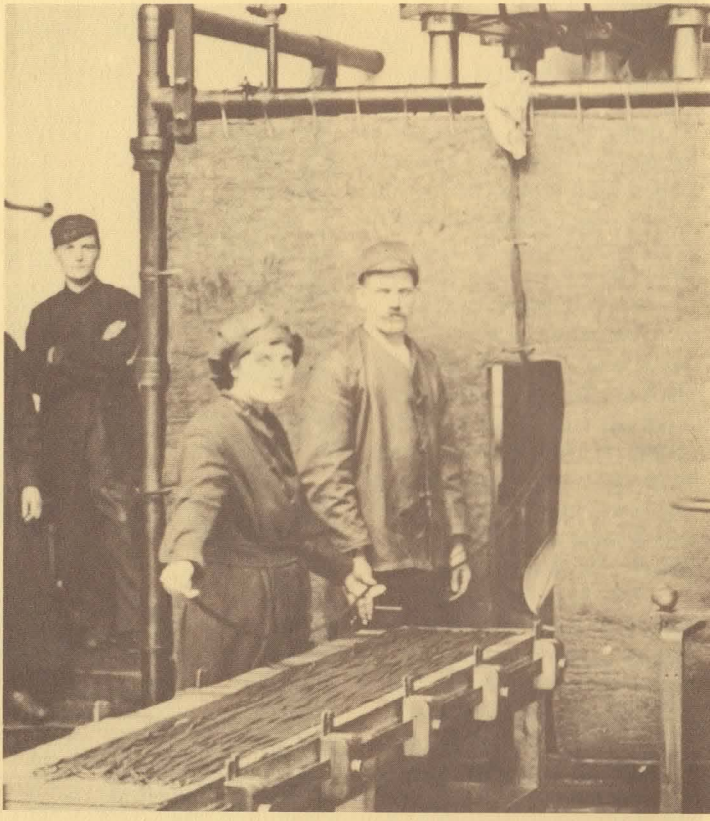
Guncotton pulping

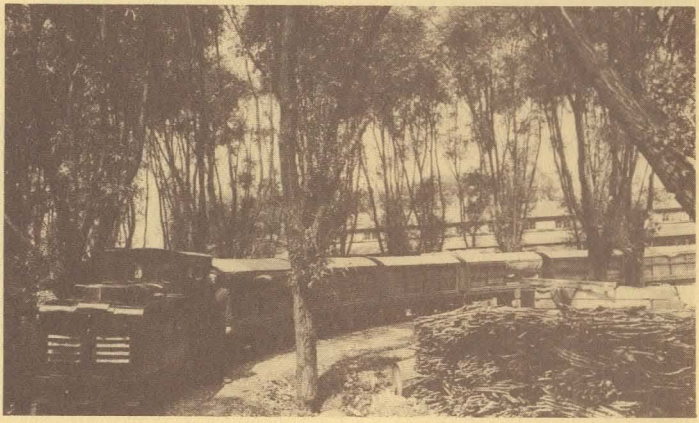
provide essential training for explosives workers elsewhere but many of the RGPF staff were transferred to supervise the new operations.

After the First World War both employment and production were reduced but effort on experimental and investigative work was increased which led to the development of solventless cordite, SR227 and RD202 fuze powders, picrite as an ingredient for flashless propellants, a continuous process for TNT, acid concentration plants and Cordite W which contained carbamite.

The rundown of production was reversed in 1933 when it was decided, because of the international situation, that the factory should be put into a complete state of readiness for full war-time output. The most important process which was introduced during this period was the production of the high explosive RDX by the nitration of hexamine. After initial investigation at the Research Department, Woolwich, plant was installed at Quinton Hill for its manufacture which began early in 1939.

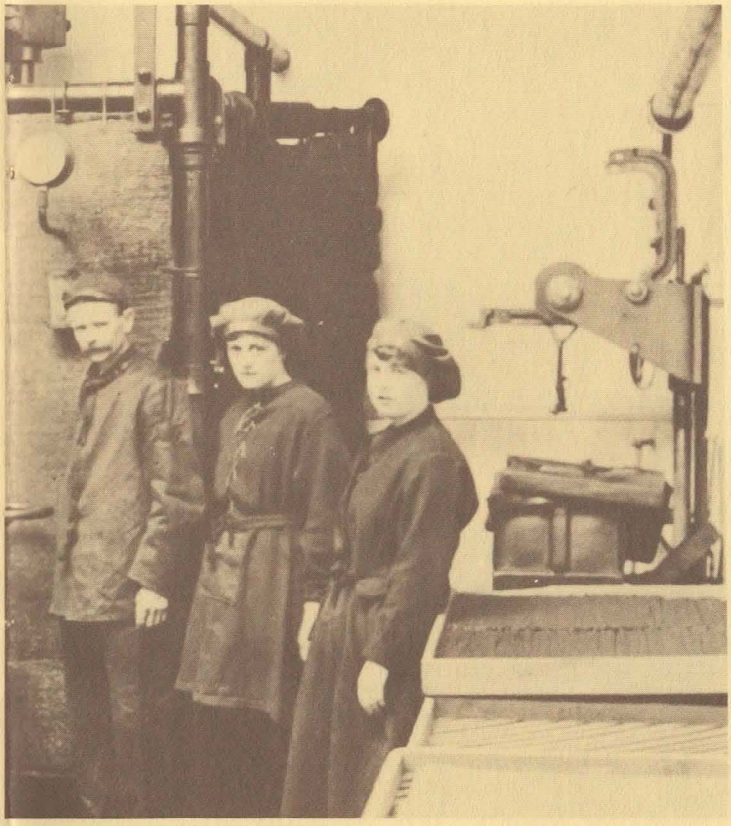
As in 1914, when war was declared in 1939 the RGPF was for two years in the forefront of explosives

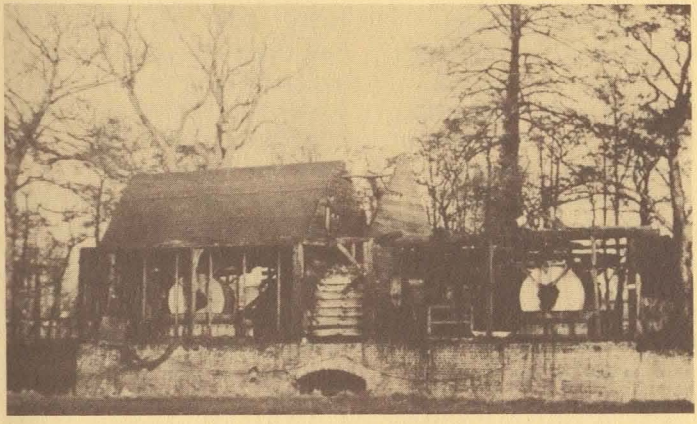




production until new factories could be erected and made operational. As the larger factories came on stream the processes were gradually transferred and the contribution of the RGPF declined with RDX and tetryl remaining as its principal products.

After the war the Royal Gunpowder Factory closed in July 1945 but not before the area had been surveyed by staff from the Armament Research Department as a site for its explosives research activities.



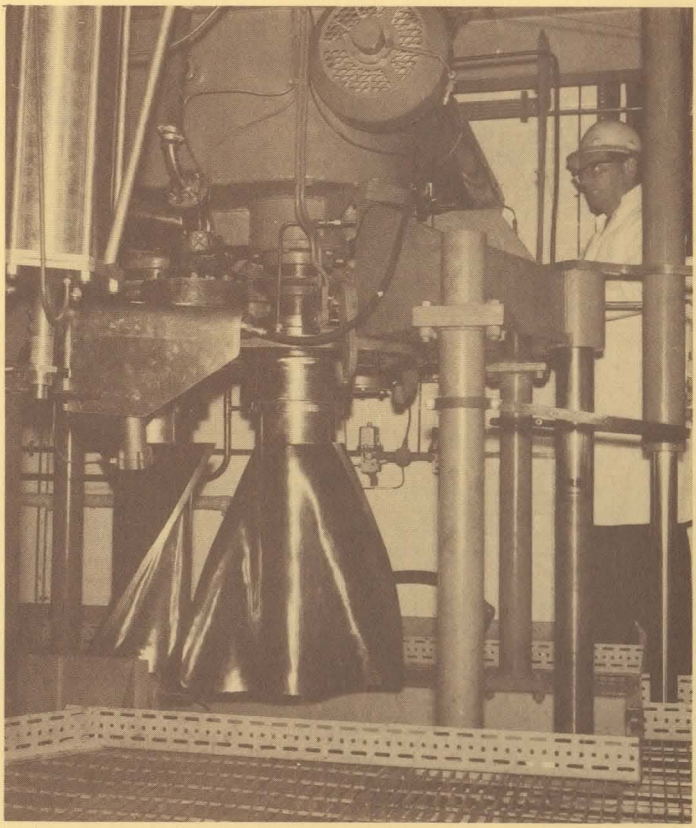


Centre
Extruding cordite strands
Bottom left
Transporting cordite to the drying stoves on the narrow-gauge railway
Below
The ruins of the last gunpowder mills – 1941

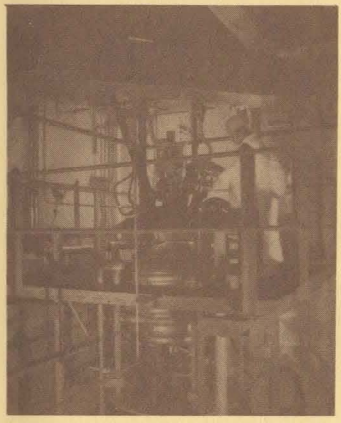
THE RESEARCH & DEVELOPMENT ESTABLISHMENT

Although the RGPF closed on 28th July 1945 the site reopened on 30th July 1945 as an experimental station of the Armament Research Department with the aim of setting up a separate organisation for research into explosives and intermediates from the fundamental stages to pilot scale production.

This came into existence on 1 October 1946 as the Chemical Research and Development Department with a nucleus of staff drawn from the Armament Research Department and with a programme which encompassed the fields of liquid propellant systems, plastic rocket propellants, colloidal rocket propellants, colloidal gun propellants, high explosives and intermediates, initiators, small arms and mortar propellants, unorthodox propellant systems, chemical engineering, materials including compatibility and non-metallic materials, chemical analysis and climatic trials. Each item of the research programme had a direct relationship to Service problems. The conversion of production buildings into research laboratories and buildings for process research took time but rehabilitation progressed and gradually the staff forming the new establishment were transferred from Woolwich.



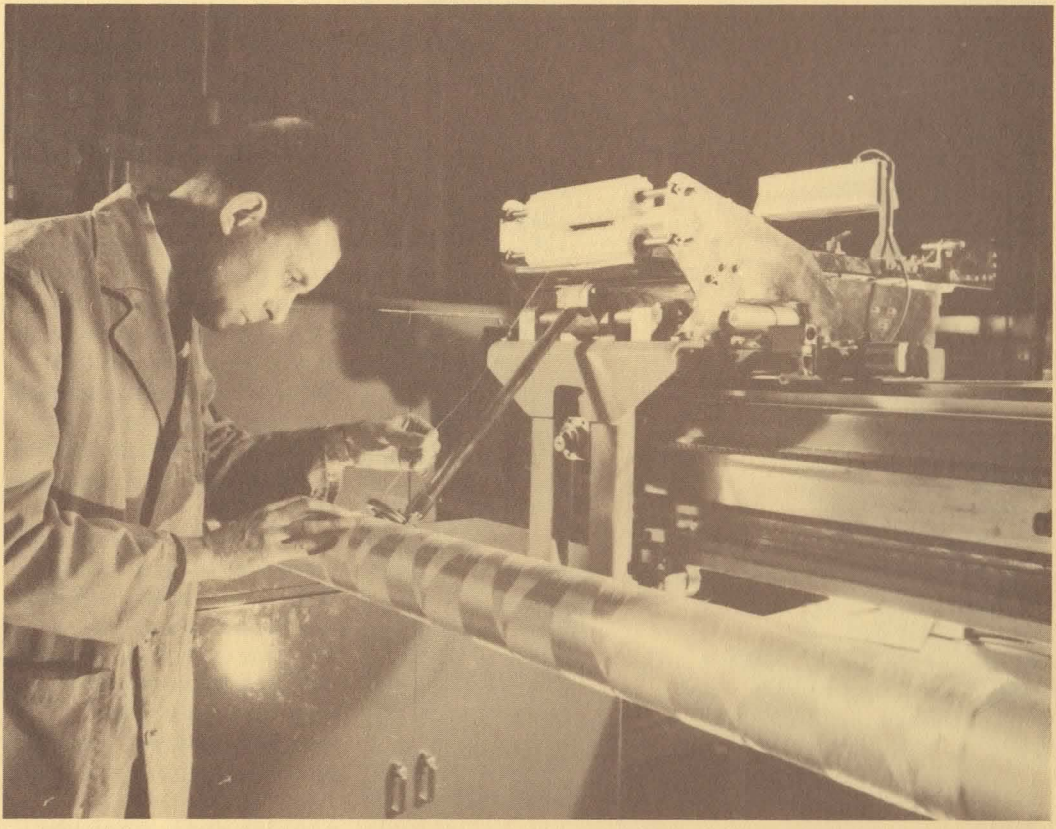
In 1948 the title was changed to the Explosives Research and Development Establishment (ERDE). The following years saw modifications in the research programme as the Establishment responded to Service requirements. The work on liquid propellants was transferred to the Rocket Propulsion Establishment (RPE) at Westcott and work on new composite propellants and composite materials was introduced. After several years of close association, ERDE at Waltham Abbey and RPE at Westcott were merged in 1973 and another reorganisation in 1977 led to the creation of the Propellants, Explosives and Rocket Motor Establishment (PERME). Work continued on the integrated PERME programme until 1984



when as part of a scheme to privatise the Royal Ordnance Factories the site at Waltham Abbey was divided between the Royal Armament Research and Development Establishment (RARDE) and what is now the Royal Ordnance plc. Once again the research programme has been modified to meet the revised requirements and, for RARDE Waltham Abbey, now covers the chemistry and physics of energetic materials together with research into associated chemical processes and polymeric and composite materials.

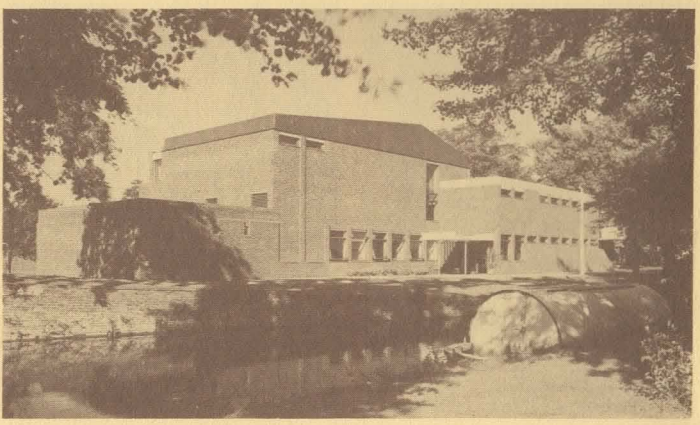
The work currently being carried out includes studies of the compatibility, stability and hazard assessment of energetic materials, adhesion, mechanical properties of propellants, propellant formulation studies, composite propellant chemistry, studies of environmental effects on materials and components, chemical synthesis of energetic materials and ingredients, pilot plant studies, the use of composite and polymeric materials in the designs of weapon systems, and the application of computational techniques.

Top left
Large scale mixer for composite propellants
Top
Underwater testing of explosives
Bottom left
Process optimisation of strategic chemicals
Opposite
Solid propellant gas analysis techniques



The area retained in Government ownership as RARDE Waltham Abbey is that part which includes the site of the Royal Powder Mills which were acquired by Sir William Congreve in 1787.

It is this continuous contribution to Crown service that forms the basis of the Bicentenary celebration.



Above
Filament winding of composite rocket motor cases
Opposite
The Library and Lecture Theatre

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