

WASC-2406

Illustrated Tour

THE ROYAL GUNPOWDER MILLS TODAY


Following closure of the site by the Ministry of Defence in 1991, a charitable foundation was set up to safeguard the site in perpetuity. The first stage of the works to restore some of the buildings and waterways, and open the site to visitors has begun. This has been made possible with the support of the Heritage Lottery Fund and the Ministry of Defence. With such a large site and many more buildings, the Trustees will be raising funds to begin the next stage of the process, so that visitors can experience more of this internationally important site.



Royal Gunpowder Mills
Beaulieu Drive
Waltham Abbey
Essex EN9 1JY

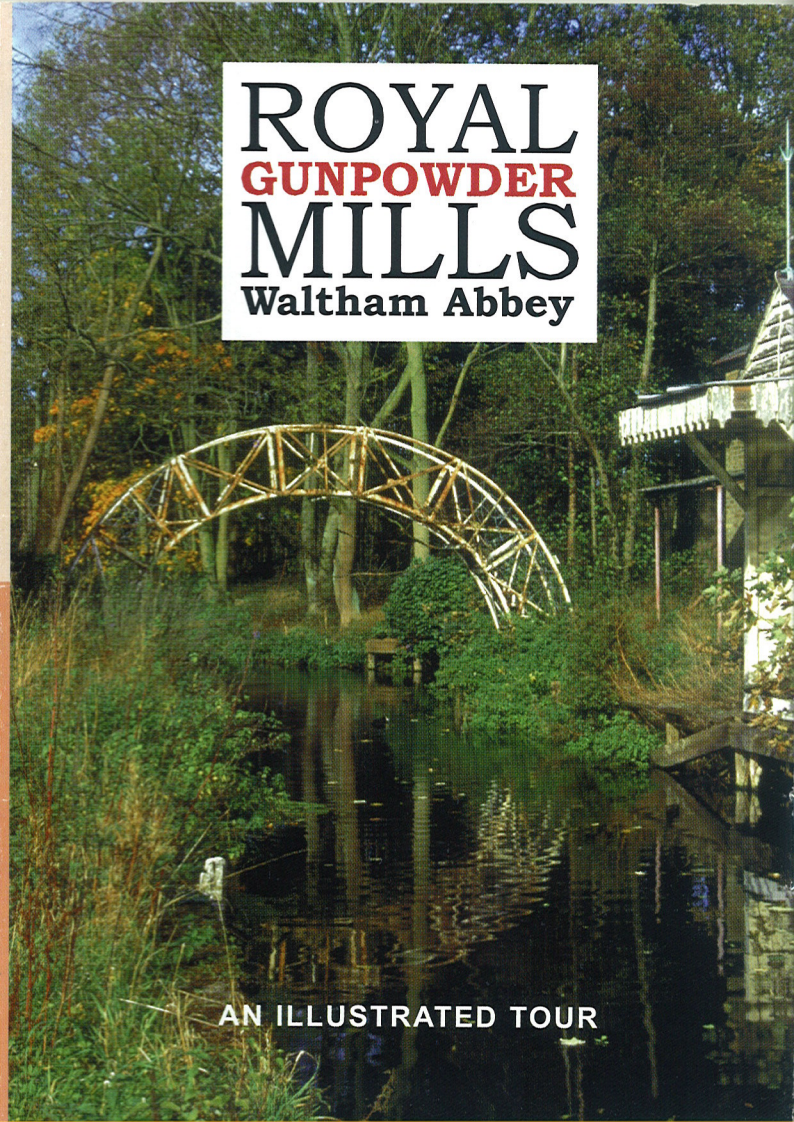
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Gunpowder Mills Company
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ROYAL GUNPOWDER MILLS Waltham Abbey



AN ILLUSTRATED TOUR

A TOUR OF THE ROYAL GUNPOWDER MILLS

The tour concentrates on the areas concerned with gunpowder and cordite manufacture. Other chemical explosives, nitroglycerine, guncotton and tetryl were manufactured in the northern part of the site which is now the nature reserve. These buildings have not been restored in this phase and cannot yet be visited.

Various systems were used to identify the buildings on site over the years. Many buildings are still identified using the final system and these letter and number codes are used in the text, in brackets, to aid identification.

- | | |
|----------------------------------|--------------------------------------|
| 1. CORDITE DRYING STOVE | 12. STORAGE AND TRANSPORT |
| 2. BETWEEN THE OLD AND THE NEW | 13. SAFETY ON SITE |
| 3. THE OLD ESTABLISHMENT | 14. GUNPOWDER MOULDING HOUSE |
| 4. THE 'ISLAND' | 15. THE BURNING GROUND |
| 5. THE FIRST STEAM POWERED MILLS | 16. PRESS HOUSE |
| 6. QUEEN MEADS | 17. DINING IN THE WOODS |
| 7. THE INCORPORATING MILL | 18. THE NATURE RESERVE |
| 8. THE 'NEW' ESTABLISHMENT | 19. ALDER PLANTATION |
| 9. MAGAZINE LAND | 20. SECRET RESEARCH AND LABORATORIES |
| 10. CANAL WALK | 21. THE LAST GUNPOWDER MILLS |
| 11. IDYLIC SETTING | |



Numbers refer to information panels on site and, for clarity, some of these have been omitted in the text.

AN INTRODUCTION

Gunpowder, and the explosives and propellants which followed it, provided a form of energy which changed the world by encouraging trade, exploration, mining, and civil engineering, as well as serving the military purposes of conquest and defence.

The Royal Gunpowder Mills at Waltham Abbey has been involved in the production and development of explosives for over 300 years. Gunpowder was the first, and for some centuries the only explosive and propellant. Later the site manufactured guncotton, nitroglycerine, cordite paste and the high explosive tetryl, and after World War II the site became a research establishment for non-nuclear explosives and propellants.

The site contains buildings and structures that were used in all these processes. Many of the buildings have been through a series of uses being converted to make new explosives or carry out new functions. Although it makes the history of the site complex, the continual re-use of the buildings allowed many of the earlier buildings to remain. This is one of the reasons why the Royal Gunpowder Mills is so important today.



Gunpowder press house in 1998. This unique survival has become an icon.

Gunpowder production began at Waltham Abbey in the mid-1660s on the site of a late medieval fulling mill. The gunpowder mills were privately owned until 1787, when they were purchased by the Crown. From that date the Royal Gunpowder Mills developed into the pre-eminent powder works in Britain and one of the most important in Europe.

The earliest works relied on water power to manufacture gunpowder. Under the ownership of the Crown from 1787, the site expanded and developed along the waterways at the south west of the site. Most of the buildings you will see were constructed during the period beginning in the mid-1850s. The site expanded at this time because the Crimean War (1854–56) required large amounts of gunpowder and steam power became available to power the machinery. This was the period when the Italianate incorporating mills were built around Queen Meads.

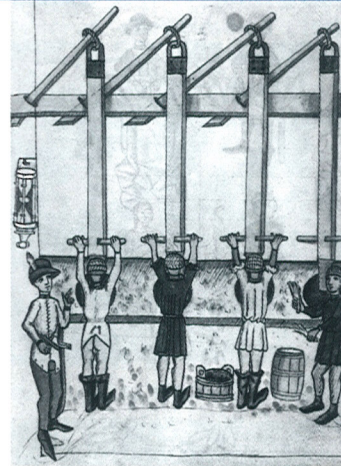
For safety reasons many of the other buildings were widely spaced, and those housing the more hazardous processes were surrounded by brick or earth embankments called traverses.

By the end of the 19th century chemical explosives were replacing gunpowder. The incorporating mills and other buildings were converted to produce these new explosives like cordite, and new buildings were constructed. After World War II the site changed again to a research establishment and many of the buildings were converted into laboratories.

The distinguished engineer John Rennie (1761–1821) coined the phrase 'The Old Establishment' in his 1806 report on the Royal Gun Powder Factory. This term refers to the gunpowder mills when they were still privately owned, before they were acquired by the Crown in 1787.

Making gunpowder involved a number of processes which were designed to mix the three ingredients – saltpetre (potassium nitrate), charcoal and sulphur – as well as possible. The process involved: initial crushing, mixing, incorporation, pressing, corning, glazing, drying and finishing.

The main illustration shows the site in 1735, viewed from the west, now the Beaulieu Drive entrance for visitors. The works had 21 buildings mainly constructed of wood, along Millhead Stream.



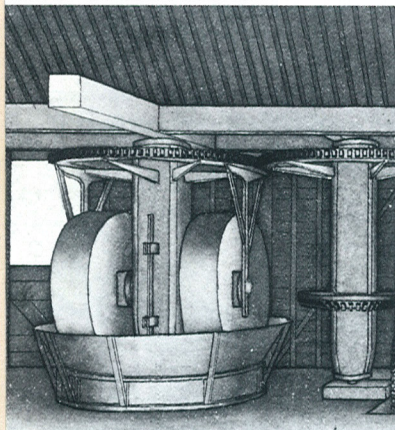
Foundations remain from a 19th-century mill which had been built on the site of two water-powered stamp mills. These giant, noisy, mortar and pestle mills were used to mix thoroughly the gunpowder ingredients. In the 1760s they were replaced by a pair of edge-runner mills known as the Head Mills. Stone edge runners from these mills were left around the site.

This 15th century German manuscript on firearms and explosives illustrates early stamp mills (Royal Armouries)



This reconstruction drawing by Peter Jackson is based on a 1735 engraving of the Waltham Abbey mills published by J. Farmer

The Head Mills were in the middle of the long line of manufacturing buildings – these included horse-powered mills for preparing the gunpowder ingredients, and probably at least one mill by the famous engineer John Smeaton. The Head Mills overlooked the Hoppit Pool, and opposite was the Loading House, where gunpowder was stored and then loaded onto barges to take it down to London, along the River Lea.



Edge runner incorporating mill at Waltham Abbey (detail) by Frederick Drayson, 1830 (Public Record Office)



Mixing house



The former Mixing House and Saltpetre House on the left are situated opposite Walton's House, 1999 © Terry Griffiths

This is the oldest group of buildings on site. Walton's House, the mixing house and saltpetre melting house were constructed soon after the government's purchase of the works in 1787. Walton's House was named after the last private owner of the works. Despite its domestic appearance it seems to have been constructed as a purpose-built office building. Various additions were made to the original two-storied structure. Throughout the 19th and 20th centuries, it was used as an office. It now houses the Archive and Study Centre.

The mixing house was where the ingredients – saltpetre, charcoal and sulphur – were mixed ready for the lengthy process of incorporation. The

building alongside it was for a melting house where saltpetre was melted for use in gunpowder manufacture. From the 1780s saltpetre was prepared, concentrated and crystallised in a refinery whose remains lie beneath the junction of Highbridge Street and Beaulieu Drive.

Saltpetre refinery (*Strand Magazine*, 1895)

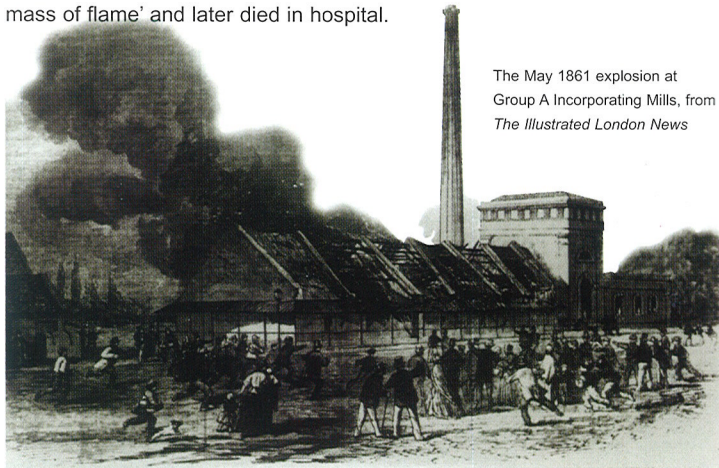


THE FIRST STEAM-POWERED MILLS

5

Up until the 1850s, the energy needed for operating the gunpowder mills came from water and manpower. The introduction of steam power dates from 1857 and the first steam operated mills – Group A mills – were built on this spot. Further Mills, the C, D, E, F and G mills were constructed around Queen Meads from 1861–1888. The location of these mills is shown on the map overleaf.

The Group A incorporating mills were seriously damaged in one of the most spectacular explosions in the history of Waltham Abbey on 27 May 1861, only four years after they were built. Men were clearing the mills when 'one of them, using a wooden handspike saw the powder flash'. He threw himself into the water to extinguish his burning clothes. Another was not so lucky: he 'was found lying on the long grass in front of the mill, his clothes in a mass of flame' and later died in hospital.



The May 1861 explosion at Group A Incorporating Mills, from *The Illustrated London News*

These mills were unusual in adopting an arrangement of interlocking trapezoidal bays as may be seen in the roof of the mills (see picture); all the other groups of mills were built with rectangular bays. The engine house and mechanics shop (L168) still exist, along with the boiler house which supplied them with steam (L176), although the chimney has been demolished. Further south stands the Power House, built between 1908 and 1915. It comprised a boiler room and an engine house.

QUEEN MEADS

6

Here you can see the results of the ambitious late 19th century building programme which had started with the Group A mills. This expansion started shortly after the end of the Crimean War (1854–56). Advancing armaments technology and the need to supply increasingly large amounts of gunpowder for massive new guns drove the building campaign. The introduction of steam power also freed the factory from its dependence on waterpower.



The Incorporating Mills on Queen Meads, 1999,
© Terry Griffiths

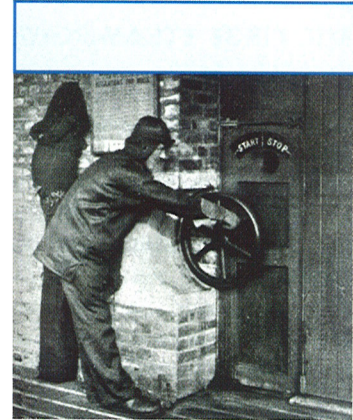
This whole area developed around Queen Meads like a village around its green. Group C mills (now L157) were built in 1861, followed by Group D in 1868, Group F and E in 1878, and Group G in 1889. This group of Italianate mills formed the largest and most impressive steam gunpowder mills in Britain.

This vast L-shaped mill formation contained at total of 30 mills, each able to process 50 lbs (22 kg) of 'green charge' every 3 or 4 hours. A hand operated tramway system was introduced at the same time and was operational from 1857 or 1858.

In the 1890s the steam gunpowder incorporating mills were converted to house cordite incorporators and presses. After World War II when the site became a research establishment, they were converted into laboratories.



Demolishing traverses at Group F Mills, post 1945



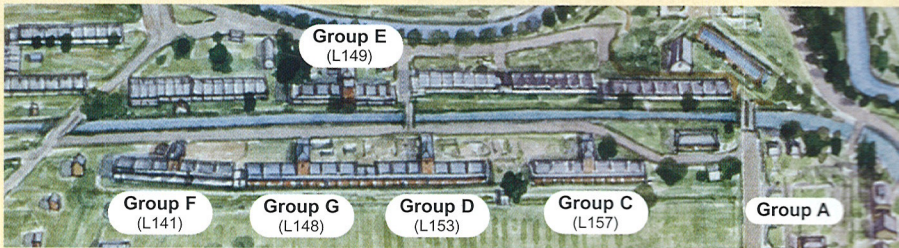
Worker wearing a suit of lasting is starting the incorporating mill. *Strand Magazine*, 1895



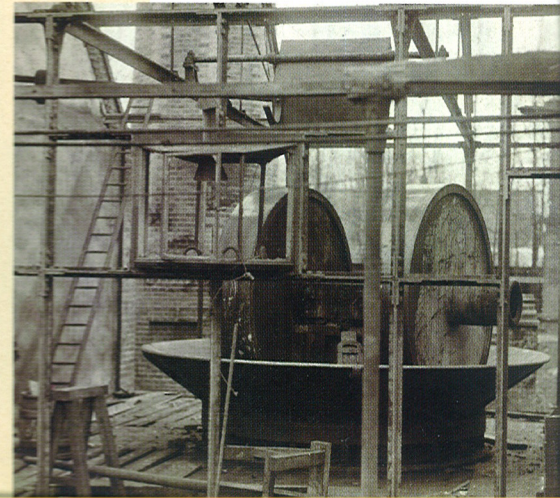
The building set back from the line of incorporating mills at the southern end was built in 1889 probably as a charcoal store. It was later used to dry cordite, with steam pipes passing into the building. Six blocked up steam pipes can be seen either side of the door.

The Waltham Abbey tramway: its wooden track and hand-propelled wagons are clearly visible in this illustration published in the *Strand Magazine* in 1895.

Explosion of Group G Incorporating Mills on 11 March 1892



Map showing named mills around Queen Meads

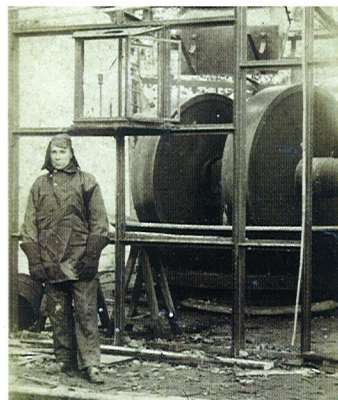
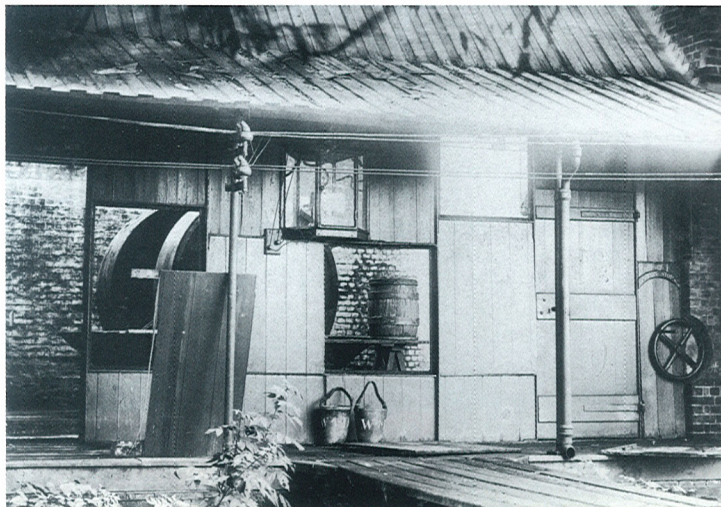


These mills (L157), built in 1861, were the prototype for the line of gunpowder incorporating mills that stretches along Queen Meads. Each unit of this Grade I listed building was T-shaped with originally two, and later three, mills on either side of a central engine house. There was a boiler room at the rear, a chimney (now demolished) and a coal yard.

The engine house contained a steam-powered beam engine which drove the edge runners in all six bays of each individual incorporating mill.

Gunpowder ingredients after blending in the mixing house were placed in the pan of the incorporating mills. The large steel wheels (edge runners) would then run over the mixture for hours until the 'green charge' had turned into a 'mill cake'.

Exterior view of the Incorporating Mill (Public Record Office)



The aftermath of an explosion on 21 October 1890. This photograph shows the iron runners of the incorporating mills and the overturned drenching pan above.

Should an explosion occur, each bay was fitted with a water drenching apparatus which would drop about 40 gallons (182 litres) on each of the mills in the group if one should 'blow'. The walls between each mill were thick and solid. If there were an explosion, the flimsy walls in that mill bay would be destroyed leaving the other bays intact.

CORDITE PRODUCTION

Shortly before World War I this gunpowder mill, and the others around it, were converted for manufacturing cordite.

Cordite propelled the millions of shells fired by the British Army during World War I. Vast quantities were needed and there was intensive production at Waltham Abbey.

The Royal Gunpowder Mills entrance building (H7), situated on the Great Hoppit, was built in 1904. It was originally used for drying cordite and is surrounded by earth traverses to contain the blast in the event of an accidental explosion. Cordite was dried by the heat from steam pipes which passed through the building.

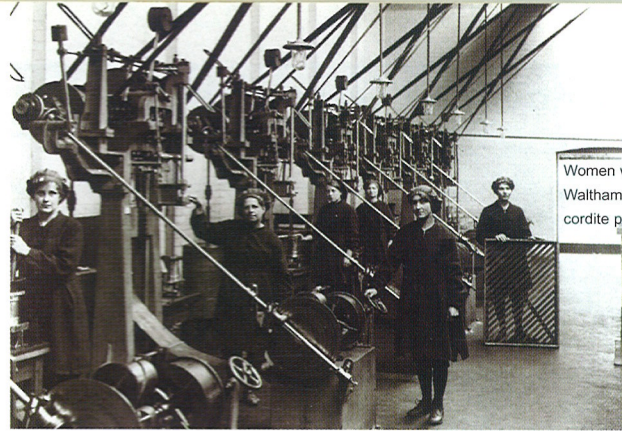
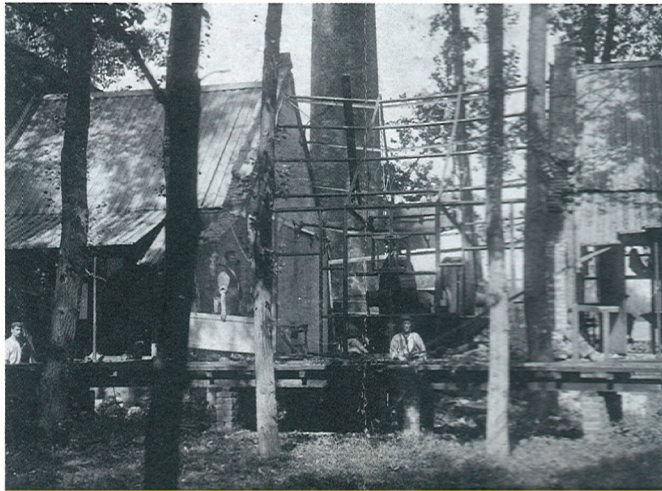
When in use the building had a barrier board fitted at the porch entrance. At this point workers changed into leather over-boots to prevent grit or dust entering the 'danger building' (see picture in section 9).

On 15 December 1902, a terrible explosion killed three men and severely damaged the Group G incorporating mills (L148). The risk of explosions was real throughout the site but with the great concentration of mills in this area the risks were higher (see map in section 6).

Between 1914 and 1917, during World War I, more buildings were constructed along the other side of the canal, with incorporating and press houses for cordite, the new explosive.

The Group E Mills (L149) have a distinctive accumulator tower which provided hydraulic power for the works, enabling gunpowder presses to be operated from a distance and so more safely. They were originally constructed in the 1860s to produce a type of gunpowder called pellet powder. Manufacture of this type of powder soon ceased and they were converted into incorporating mills. The accumulator tower contained a water tank with a weight-loaded ram which was connected by water pipes to hydraulic presses and another remote tower (L136). A steam engine pumped water into the accumulator to raise the ram, which provided the hydraulic pressure in the pipes to operate the presses.

This photograph shows well the aftermath of an explosion. How effective the design of the building could be by protecting the adjoining bays from being demolished.



Women workers at
Waltham Abbey: small
cordite press house, 1917

The cluster of small buildings on the western side of the canal is a noticeable feature. They were late additions designed for a variety of uses: L150, the largest building, was built in 1941 as an air raid shelter later converted to a solvent store. Behind it is an oven room built in 1959 (L164). The small building alongside it (L144) dates from 1960 and is one of the many solvent and waste stores dotted around the site.



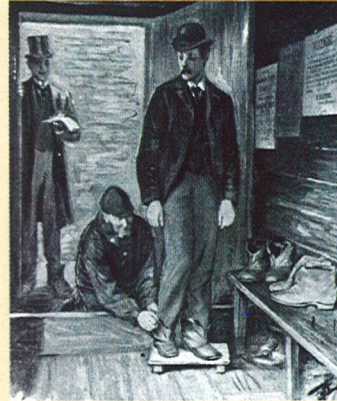
View of Building No L159 looking North with a
cluster of push trolleys in the foreground, 1940s

A great number of magazines, or stores for explosives, are spread around the site but this early cluster, overlooking Middle Stream, is particularly picturesque. The nearest to the viewing bridge (L138) is also the oldest, built in 1870. Further along is an 1882 tray store and across the canal from it stands an 1879 magazine.

Worker leaning over a balustrade by a canal, Waltham Abbey.
From Cassell's *Greater London*, published by Walford, c. 1885



Right: Man being fitted with safe leather shoes before entering a danger building, 1895 (From the *Strand Magazine*)



These have retained a number of characteristic original features such as the lightning protection devices on the roof, the porches to protect materials being loaded or unloaded, and in one, an elephant hide floor fixed with copper nails. All would have been fitted with removable shoe boards at the entrance to separate the 'dirty' from the 'clean' area.

Nearby stands Press House No2 (L134) built during World War I and associated with the cordite incorporating houses on the east of Middle Stream.

The 3-storey accumulator tower built in 1878 worked with the main accumulator in the Group E Mills (L149) described in the previous section, to supply hydraulic power to buildings at the north and west. The semi-circular bridge, built around 1904, has the same shape as the roofs of the powder boats which carried explosives along the canal network.

Much of the water network throughout the site is man-made. Water was crucial both to the manufacturing process and the transport of explosives. There were three water levels – high, medium and low. The canal lock near the tower was built in 1878 and lies at the junction of the upper and middle canal systems. The double gates at both ends controlled access and water was let into the lock through valves.

On 5 February 1902, this idyllic spot was the scene of a terrible explosion. The Blank Cutting House which blew up was immediately rebuilt and the result is the building you can see across the canal (L109). The traverse on one side, built to contain explosions, dates back to around 1865 and protected the gunpowder breaking down house which originally stood on this site. It was here that the 'millcake' was broken down into fragments before going to the press house.



Waltham Lock, 1899 from the *Navy & Army Magazine*

The small building on the right of L109 is a magazine (c. 1862). In the distance a proof stand and a firing chamber date from the 1950s.

Building L109 with traverse, 1999, © Terry Griffiths



Railway in the woods: oil locomotive and cordite trucks, 1917

STORAGE AND TRANSPORT

12

The magazine was built between 1908 and 1914 as a cordite paste store. Its survival with surrounding features affords a glimpse into its past layout. A small section of narrow gauge railway track may still be seen at the back of the building. The front of the store overlooks the canal and confirms the role played by water for moving explosives around the site. A single steam pipe is inside the magazine.

The earliest form of railway on site may be described as 'tramway' – a manually operated system which dates back to 1857 when the first steam incorporating mills at Queen Meads were linked to the mixing house. The narrow gauge railway suitable for lightweight locomotives was only built during World War I when it developed south from the Great Hoppit and then north to encompass this area.

The early 20th century paste store magazine (L105) was built at the same time as the previous store overlooking the canal. Here, however, the building is surrounded by an earth traverse on all sides.

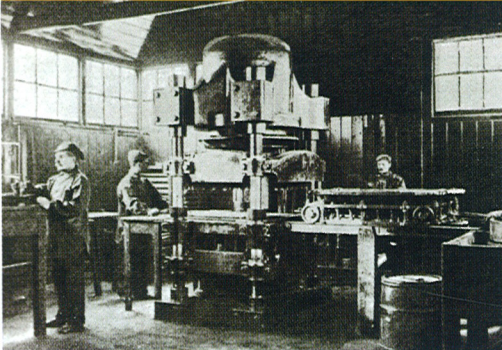
This magazine which appears buried deep in the woodland was also well connected. The sleepers for the 18 inch railway are still visible inside the porch. The section of railway track at the entrance near the canal must have been moved from its original site.



From a series of 20 photographs recording the strange visual effects created by steam pipes running through the landscape, c. 1946

At this intersection of waterways a varied and complex array of bridges can be seen. From south to north:

1. a late 19th century bridge carrying pipes over the canal
2. a footbridge dating from the same period
3. a mid-20th century bridge carrying pipes over the canal
4. a lifting footbridge now carrying a pipe built before 1940



Inside the Moulding Room, 1899. From the *Navy & Army Magazine*

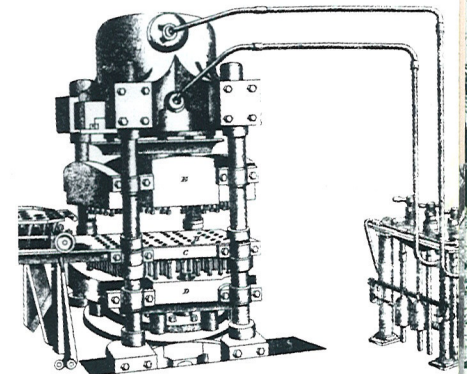
GUNPOWDER MOULDING HOUSE

14

The massive 'E' shaped concrete traverse formed two compartments in which there were two press houses. These would have been timber-framed structures set on brick foundations. Most of what remains today is the mass concrete traverse – an early use of concrete – which aimed to contain the blast in the event of an explosion. It was built in two phases, with the first on the left in 1882. The less well-finished right hand bay was added in 1884 and the marks made by the timber shuttering are still visible.

It is located alongside a canal, now dry. It was later converted to the production of cordite before becoming a packing house for tetryl after World War I.

Prismatic Powder Moulding Machine, from a 1900 *Treatise on Service Explosives*



THE BURNING GROUND

15

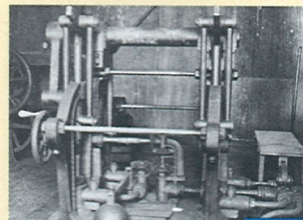
The Burning Ground dates from 1963 and is a relatively recent addition to the site. This is where various types of discarded explosives or unwanted materials were burned and destroyed.

This piece of triangular ground also has much earlier structures. The nearby Gunpowder Moulding House was served by two magazines (L102 and L103), overlooking the canal and separated by a mass concrete traverse. The oldest dates from 1885 and the other one was built seven years later.

The new planting on one side of the Burning Ground includes Alder buckthorn (*Frangula alnus*). It used to grow here – it makes the best charcoal and has now been re-introduced.



The Press house with traverse and gunpowder boat, 1895. From the *Strand Magazine*



Left: Hydraulic pump mechanism for press driven by water wheel, 1940

Right: Gunpowder press

PRESS HOUSE

16

These are the unique remains of a Victorian hydraulic press house (see picture in Introduction). Pressing made gunpowder more effective and less likely to disintegrate during transport. After it had been thoroughly incorporated, the 'mill cake' was crushed between rollers to form a powder. In the press house the powder was loaded between copper plates in a wooden box and pressed for 15 minutes.

The press now stands in complete isolation as shown in the picture. It would have been housed in a light wooden building such as the one shown on the left hand side of our main picture. This building was separated from the hydraulic pump house on the right by a thick traverse. Both of these features survive.

The pump house was roofed with corrugated iron, an early use of this material. The water driven hydraulic pump inside was powered by a low breast shot waterwheel made of cast iron, probably the only one surviving in England. The photograph shows the waterways which provided power to drive the waterwheel and the hydraulic press.



DINING IN THE WOODS**17**

The derelict building on this spot dates back to 1861. It performed a variety of functions. It started life as a box house but soon became a dining room for the workers.

When in 1993 it was first recorded by the Royal Commission on the Historical Monuments of England, the interior was still fitted with pigeon holes as well as a contraband box for such forbidden items as matches and cigarettes. All the window openings were still protected by canvas blackout shutters dating from World War III!

The bridge was built to carry a footpath over the canal in 1878 when the high-level canal system was extended. Its stone plaque bears the inscription:

RGPF Royal Gun Powder Factory
VR Victoria Regina

Further along the canal is an aqueduct built at the same time, one of three on the Waltham Abbey site. There are only 23 in the whole of England. The aqueduct used to carry a high level canal over the Old River Lea.

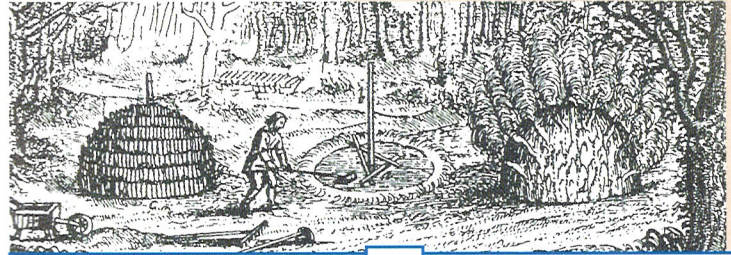


Heron. © Gordon Wyatt

THE NATURE RESERVE**18**

By 1907 there were around five miles of navigable waterways inside the factory. These waterways now attract a wide range of animals and birds, and we have Essex's largest heronry. Herons feed on aquatic animal life and breed here every year. In 1994 a survey recorded 36 successful breeding pairs. It is an important part of the Site of Special Scientific Interest (SSSI) within the Royal Gunpowder Mills site.

Otters, too, are known to live here as fresh spraints (the droppings they use to mark their territory) are sometimes seen.

**ALDER PLANTATION****19**

The woodland is common alder (*Alnus glutinosa*). After alder buckthorn this wood makes the best charcoal. It was the species most commonly used to make charcoal for military powder.

Charcoal is created by burning wood slowly and evenly with as little air present as possible. After a few days all that's left is a black carbon residue – charcoal.

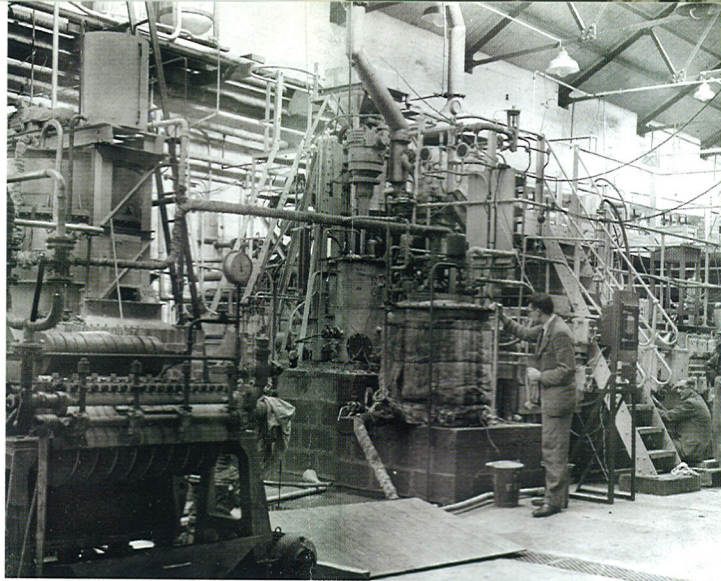


The most ancient method to make charcoal was to drive a pole into the ground and then stack neatly-cut lengths of wood tightly around the pole in the shape of a cone. The stack was covered with soil, fired and left to burn for several days.

At the beginning of the 19th century this method was superseded by the cylinder charcoal method which had been tried and tested a few decades earlier. The wood was charred in airtight cylinders as shown in the picture.



Making cylinder charcoal at Waltham Abbey, 1895
(From the *Strand Magazine*)



The Picrite plant (or Machinery Shop)
in the late 1950s

The building across the road from the Climatic Test Cubicles was a manager's office by 1912 but some time after World War I it had become a Heat Test Room. Its activities were connected with the adjoining blue timber-framed building (L122) built a little earlier in 1897 as a factory laboratory and extended in 1902. During all stages of cordite manufacture, each batch was tested there.

LABORATORIES AND SECRET RESEARCH

20

The Climatic Test Cubicles (L190) were constructed in 1951 by which time the Royal Gun Powder Factory had ceased to produce explosives. On 28 July 1945 the factory had formally closed its doors but had re-opened a few months later as a Research Establishment.

Entrance to ERDE, or Explosives
Research & Development
Establishment, in existence between
1948 and 1977 (Photo 1968)





Master Slave Manipulator Arms in the process of serving tea to John Clark and Gordon Bromberger in the X-Ray Bay, 1968

When production at Waltham Abbey switched from gunpowder to cordite towards the end of the 19th century, the gunpowder mills around Queen Meads were all converted to make cordite. With the outbreak of World War I new cordite facilities were developed on the far side of the Middle Stream.

But gunpowder production was not phased out altogether. Here, along the Millhead Stream was the last group of water powered gunpowder mills. Outdated facilities and seasonal water shortages would at times bring production to a complete standstill. Yet they produced gunpowder until the end of World War I. In 1941 they were damaged beyond repair by a German parachute mine though some had been dismantled prior to that date. The last gunpowder mill was demolished in 1956, an event which was

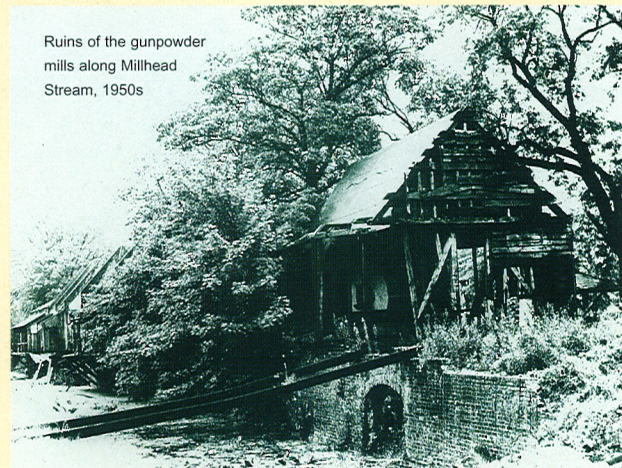
recorded in photographs.



The last of the gunpowder mills, destroyed in the late 1950s



Stokers, 'the Boiler House Gang', c.1900



Ruins of the gunpowder mills along Millhead Stream, 1950s