ROYAL
GUNPOWDER
MILLS
WALTHAM ABBEY

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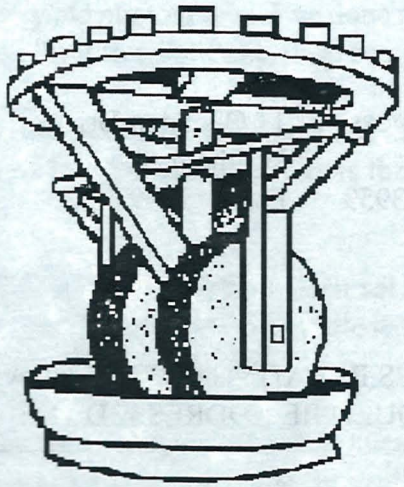
Touchpaper

The Newsletter of the
ROYAL GUNPOWDER MILLS WALTHAM ABBEY

FRIENDS ASSOCIATION



MARCH
2004

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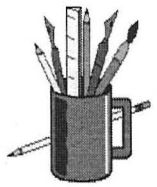
PLEASE NOTE: Deadline date for submissions to the next issue is 15th May 2004



EDITORIAL

Apologies for the lateness of this issue but a 3 week bout of flu has severely delayed any sensible editing.

This issue contains a further chapter in Les Tucker's articles - a rather long one this time. Further apologies if some of the accompanying pictures are a not of the best quality but they have been taken from photocopies of very old photographs. I've done my best to enhance them but there's a limit to what Photoshop can do!

This time of year always seems to bring a bad crop of sadness and we have lost several long standing members through illness in the past few months.

The AGM and Reunion date has now been set and members will find a booking form for the Reunion enclosed together with an addressed envelope for your returns.

Those of you who yet to renew will also find enclosed a reminder notice (You can use the same envelope for your renewal).

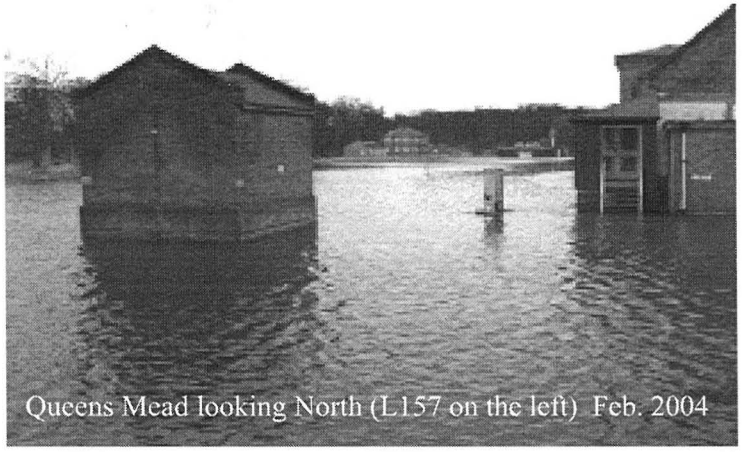
Norman Paul
Editor

CHAIRMAN'S CHAT

It is with great regret that we have to announce the deaths of several Friends (detailed elsewhere in this issue). In particular, Ernie Cooke died on the 27th January. He had been a committee member from the start and had always been most helpful and enthusiastic. He will be greatly missed. The Enfield Crematorium Chapel was packed full for his funeral on the 9th February.

We have started to prepare for the Friends exhibition in L157 Annex. Unfortunately there is a significant leak in the roof of the building which mans we shall have to arrange exhibits round it until it can be cured. Assistance from Friends in laying out the exhibition, providing laboratory artefacts and manning it at weekends during the season would be very welcome.

The melting snow and rain in early February caused water levels to rise in the Flood Relief Channel along the western boundary. Sensors in the river bank failed so the automatic control at the 'David Stoker sluice' did not open. As a consequence water overflowed the bank and flooded a substantial part of the site, including Queens Mead and the northern end. Building 83B, used for work on the railway had several inches of water inside and in L157 the tunnel containing the drive shaft is still flooded as I write (11th February).



Queens Mead looking North (L157 on the left) Feb. 2004

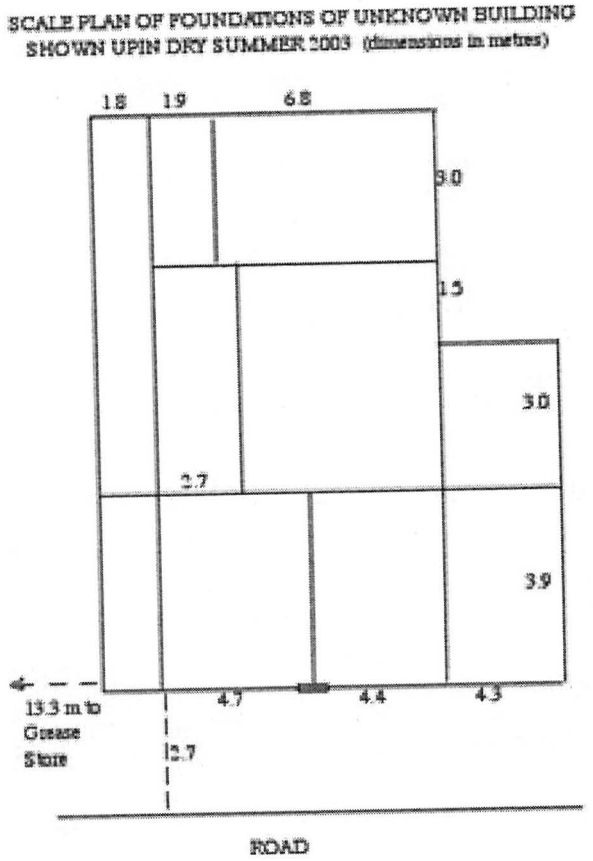
All the canal beds were flooded which gave a good idea of how the site would have looked before the flood relief scheme went into effect.

John Wright

MYSTERY BUILDING

In the last Touchpaper I mentioned the appearance of the outline of a building at the southern end of Queens mead. George Savill has suggested that might have been an air raid shelter. Other suggestions are welcome. An outline sketch is shown below to help with your ideas. The 1888 map showing the `Group A-F mills has a rounded building, presumably a magazine, close to the position of the mystery building but the outline sketch does not look like that of a magazine. There is no sign of any building in that position on the 1923 map although the Grease Store, also known as the Chapel, is shown. It's still an enigma!

John Wright



ANNUAL GENERAL MEETING

The Association AGM will be held at the Royal British Legion Hall, Waltham Abbey on Friday 14th May 2004 commencing at 11.00.

Nominations for Committee Members and Officeholders should be sent to the Secretary at least two weeks prior to the meeting.

Any motions or amendments to the Constitution should also be made in writing and be sent to the Secretary at least two weeks prior to the meeting.

If insufficient nominations to the Committee are forthcoming the meeting will accept nominations from the floor.

The current Chairman and Secretary have expressed a wish to continue in office but the meeting will be looking to elect a new Treasurer.

ANNUAL REUNION

Following the AGM at the Royal British Legion Hall, Waltham Abbey on Friday 14th May we shall be holding our Annual Reunion.

This will start at midday with a buffet lunch served at around 1pm.

As usual the bar will be open

We have held the price down now for a few years but have had to increase it this year to £8 per head. Members will receive a booking form with this issue and an envelope addressed to the Treasure to whom payment should be sent.

SITE OPENING 2004

The site reopens to the public on the 24th April until 26th September.

It will be open to general visitors every weekend and bank holidays from 11am to 5pm (Last entry at 3.30pm).

The cafe will open for snacks and refreshments from 11.30am to 4.00pm.

A full programme of events has yet to be finalised but those arranged so far include:

April 24/25	American Civil War
May 1/2/3	Ist in The Field
May 15/16	Napoleonics
June 26.27	Essex Militia
July 10/11	English Civil War
July 24/25	Royal Sussex Historical Group
Aug 28/29/30	American Civil War
Sept 11/12	Essex Militia

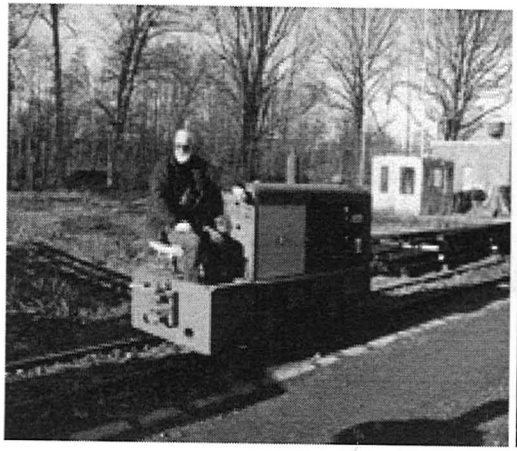
Living history events are costumed re-enactments, with demonstrations, activities ans some live firings.:

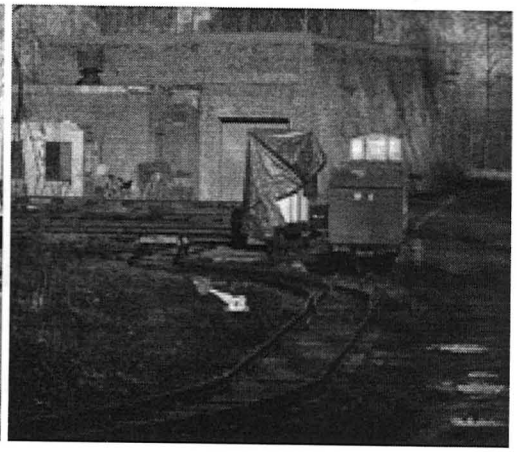
Check the web site for news and updates on events
www.royalgunpowdermills.com

RAILWAY NEWS

December and January have been busy months for the railway volunteers with Bob Bray making an excellent start on levelling the road bed prior to track laying. We have nearly completed the turntable and sidings so we will soon be able to clear the running track of parked wagons and give the Hunslet some real work to do moving track materials and tools from 83B to the rail head.

Sunday 25th January saw the visit of a small group from the Industrial Railway society. The left hand photo shows Bob Darvill, from the Society, trying out the Hunslet on what was a lovely sunny morning. The right hand photo shows the new sidings with a small works wagon sitting on the turntable.





I think Bob and his party were quite impressed with what we have achieved so far, given that we only started track laying in May/June of 2003 and did not get any rolling stock until late August. A 'WELL DONE!" to all the railway volunteers is most definitely called for.

Of course there is so much still to do but we can see real progress. `The main target at the moment is to push the rail head up to the sluice are and complete the points. We also have the car park and level crossing to build, the annex of 83B needs some roof repairs and the diesel generator 'shoehorned' into it. We have a lot of dead wood and brush laying around the work area which needs collecting and burning.

There is the cordite wagon, currently in pieces in 83B to be rebuilt, the Portacabin to make waterproof and the shells from the power house to be cleaned, painted and mounted on a wagon. So, I don't think we need worry about running out of work.

One other project completed in January has been the railway display in the L168 where you will find a Standard Gauge railway sleeper fitted with track of various gauges. A selection of 18" and 2'6" gauge wagons and photos of the railway dating from 1917.

John Wilson

NON-LISTED PRINCIPAL STRUCTURES OF THE ROYAL GUNPOWDER MILLS

Part III DEVELOPMENT OF CHEMICAL EXPLOSIVES AT WALTHAM ABBEY

Section 5. 20th Century - The Era of Smokeless Powders

Cordite

By the end of the 19th century the 600 year reign of natural based gunpowder in the West as the universal civil and military explosive was coming to an end.
Gunpowder science had risen to the challenge of larger guns and larger charges with moulded pierced prismatic powders, but it was not enough.
By the late 1880's the new organic chemical science was bringing changes which were to remove the old ways in military propellants for ever.

The 'Chemical Powders'

By the mid 1860's the new science of organic chemistry had, by the action of nitric and sulphuric acids on cellulose, produced practicable nitrocellulose explosives, more powerful than gunpowder - collodion cotton and guncotton, the latter with a nitrogen content of around 13.1% and collodion lower at around 12.6%.
However whilst suitable for applications such as naval mine and torpedo filling and general demolition a major difficulty stood in the way of use in the military propellant function. The nitrocottons were fibrous in form and in confined combustion the hot gases were forced by the pressure into the pores of the material, producing an excessive rate of burning and an uneven and excessive pressure on the gun.
The rate of burning can be reduced by mixing with cooling agents but the most effective method is to gelatinise the nitrocotton making it non porous.

The Smokeless Powders

Chemically based military propellants were termed smokeless powders. The Frenchman Vieille pointed the way to solution of the porosity problem in 1886 by gelatinising a mix of collodion cotton and guncotton with the solvent ether alcohol. The resultant paste was worked into a horn like material termed Poudre B,about three times as powerful as gunpowder. This was the first smokeless powder, apart from greater power conferring significant advantages of reduced gun calibre, greater range, better gun design. This development not

surprisingly aroused considerable interest amongst the military worldwide. Alfred Nobel produced the solution most relevant to the British experience. In 1864 he had produced the gunpowder detonated nitroglycerine based blasting oil and by 1867 had replaced this with the more effective mercury fulminate detonator. In 1887 he produced a military smokeless powder 'Ballistite'. The basic principle was again to eliminate the porosity of nitrocellulose, in this case collodion cotton, by gelatinising. The material which Nobel employed to gelatinise was characteristic of his scientific boldness and vision. In an action 'so startling that it was received with incredulity, which soon gave place to extreme astonishment' Nobel employed nitroglycerine as the gelatinising agent - thus using one powerful explosive to produce a more controlled rate of burning in another.

After the announcement of Poudre B the British Government had set up in July 1888 an Explosives Committee comprising Sir Frederick Abel, Prof.Dewar and Dr.Dupre to monitor developments and carry out their own experiments. They invited submissions from scientists and in December 1888 Nobel submitted samples of Ballistite, doubtless in the hope of Government contracts.

Cordite

Nobel's formulation included camphor, which was found to be subject to rapid evaporation, rendering the product unstable. The Committee pointed this out to Nobel, but for some reason he did not react. After intensive investigation the Committee produced and in 1889 patented what was originally called cord powder but later Cordite.

The core of the composition was a mix of nitrocellulose and nitroglycerine which then had the solvent acetone added to put it into a state suitable for extrusion, with vaseline added to reduce barrel fouling. The grade of nitrocellulose employed was dry guncotton. This was a hazardous material and it is possible the Committee were forced into using this by a wish to avoid a clash with Nobel's system which employed a safer aqueous slurry process for mixing.

The title cordite arose from the method of manufacture which was to extrude the material under pressure through dies to form threads and cords or hollow tubes in a rubbery state which were then dried to remove solvent.

The goal in propellants was to burn in a progressive manner to exert maximum pressure on the projectile when it was in the gun, but at the same time did not cause excessive stress on the gun. The cord form of cordite enabled precise control of dimension and length, permitting fine adjustment between surface area and weight, giving control of the rate of burning and consequent pressure of the gases, with the cylindrical form presenting sufficient surface area to achieve the rate of burning required.

Cordite at Waltham Abbey

Terminology

Where the cordite process had a broad similarity to an operation in gunpowder,the gunpowder term was translated to cordite, although the actual physical operation was of course quite different - incorporation for closer mixing, pressing for compressing, blending to obtain uniformity. This preservation of the old extended to the title of the establishment. Although the term cordite factory was used internally to describe what had become the main function the overall title of the establishment remained The Royal Gunpowder Factory to the end.

Chronology

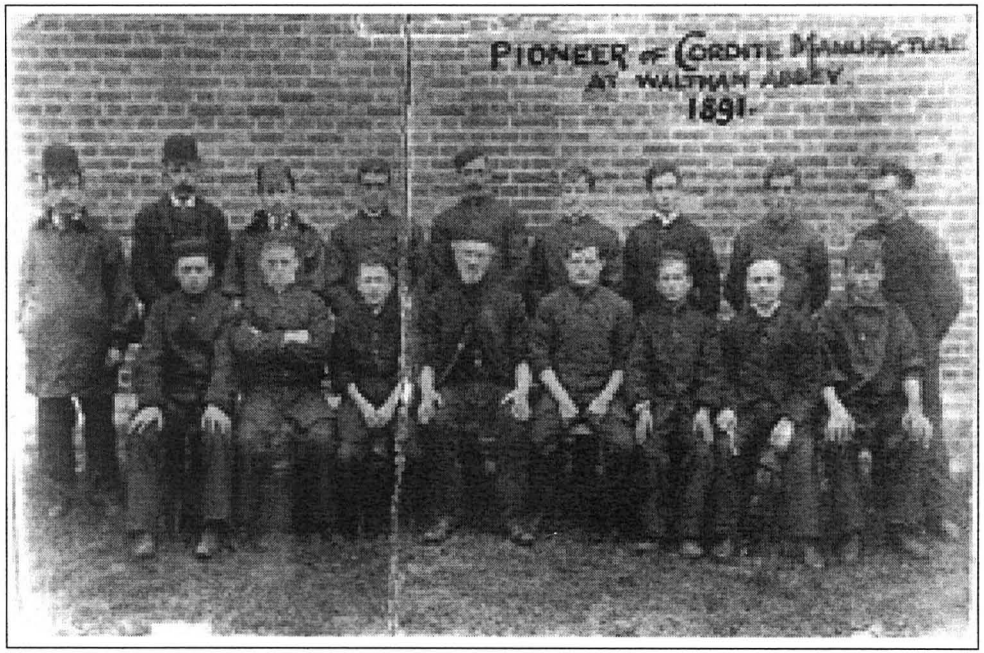
A summary chronology of the cordite buildings is given in the Appendix.

Initial development of the cordite manufacturing process was undertaken at the Research Department at Woolwich, with incorporated material transported from the Waltham Abbey nitroglycerine and guncotton facility at Quinton Hill, pressed at Woolwich and then back to Waltham Abbey for blending and transport out. The first shipment of incorporated material from Waltham Abbey to Woolwich was in March 1891. By May 1891 the necessary presses had been installed at Quinton Hill to enable the whole process to be carried out there.

The Start - Quinton Hill 17th June 1891

Pressing started at Quinton Hill on 17th June 1891.

We are fortunate in holding in the Mills Archive a unique photograph of the small band of workers who were responsible for this initial production and therefore starting of a train of supply to the Services which ultimately from Waltham Abbey and other sources ran into thousands of tons.



The North Site Cordite Factory 1898

Manufacture at Quinton Hill progressed steadily until a serious explosion occurred in May 1894, destroying or damaging many buildings, including No.2 Nitrating House. Following this although the Nitrator was re built it was decided to build a separate Nitrator and cordite production facilities on the original North Site. The work was completed bv 1898, much of it consisting of conversion of existing gunpowder buildings, and gradually this became the core cordite facility.

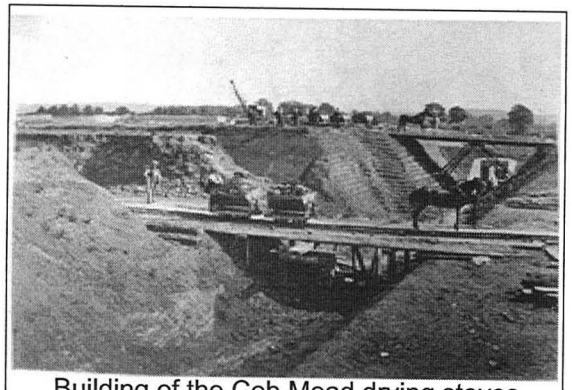
L149 which was successively: Hydraulic Accumulator House, Gunpowder Incorporating Mill, Cordite Incorporating House, Laboratory.

2nd Stage 1904, 1910 North Site

In 1904 three additional mixing houses and reel drying, reeling houses and reel magazine were built on the North Site and in 1910 three paste stores.

South Site Cob Mead Drying Stoves 1902-1904

Cordite had to be dried to remove acetone. Over 1902-1904 a battery of 40 drying stoves were built on Cob Mead at the southern boundary of the South Site.



Building of the Cob Mead drying stoves

The WWI Buildings 1915-1917 North Site

To cope with the massive increase in demand in WWI a series of cordite buildings - press houses and incorporating mills, were constructed along the eastern flank of the Middle Stream between 1915 and 1917, thus extending the factory southwards. These and the majority of the other cordite buildings were converted to laboratories when the Research Establishment took over after WWII.

Replacement Mixing Houses 1940 North Site

Following explosions in 1940, two replacement mixing houses were built in the same year.

The Manufacturing Process and its Buildings

The cordite manufacturing process involved:-
Dry guncotton from stoves to weighing house - mixed with nitroglycerine in mixing houses - incorporated with acetone in incorporating mills, mineral jelly (vaseline) added - pressed (extruded) - dried / acetone recovered - stored

(1) S27 The Weighing House

Dry guncotton for combination with nitroglycerine was transported from the guncotton drying stoves in hand pushed leather lined trucks to the weighing house. There it was weighed into rubberised bags and taken to the mixing houses.

(2) 46A, 46R, 62, 76 Mixing Houses

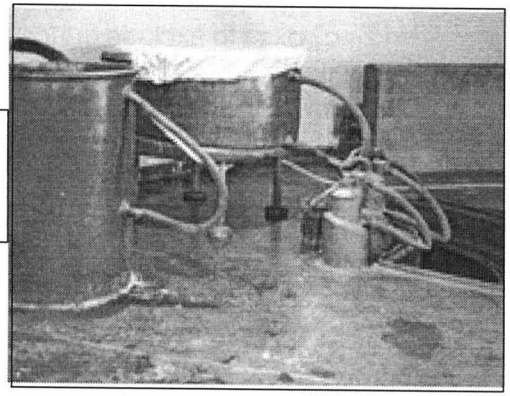
The mixing houses containing the tables at which operatives combined nitroglycerine and guncotton had lead floors and zinc lined walls. Radiators were encased in zinc boxes to exclude guncotton dust. Arising from the handling of dry guncotton the floors were subject to deposit of guncotton dust and no footwear was allowed, only socks.
Production was by batch. A typical batch of combined nitroglycerine and guncotton was around 3800lb. Sufficient nitroglycerine for one batch was run down guttering from the nitroglycerine wash house and led through the earth mound surrounding the mixing house and held in a storage tank in the mixing house. As soon as sufficient for the batch had been received the nitroglycerine supply inlet pipe was closed and outside staff called hillmen would immediately clean the guttering to avoid any explosive chain. At this stage a sample of the nitroglycerine was placed in a 2oz lead sample bottle to be taken to the laboratory for quality testing.
From the storage tank the nitroglycerine was measured into lead burettes, each of a different capacity according to the specification of the grade being prepared, and poured on to the guncotton in bags which were held in a well in the floor about 14in deep. The mixture was then emptied on to a lead mixing table, which was in a steel frame welded to the floor. There it was given a preliminary knead, much like a domestic bakery. It was then pressed and hand worked through a phosphor bronze 1/2in sieve into a hopper mounted calico bag below.

The material was now termed 'paste'. As the dry guncotton had now been moistened and the nitroglycerine made less liquid the two ingredients were in paste form to a degree less dangerous.

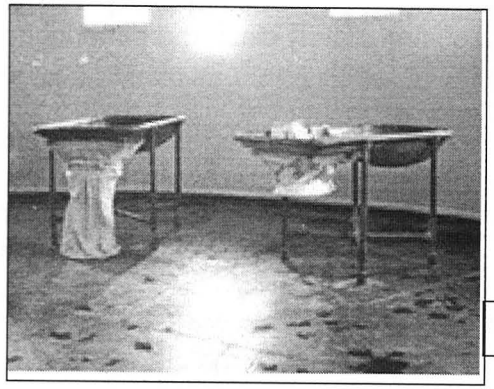
Each mixing house had a canalside loading bay protected by a porch and at intervals a barge would call to load the bags for onward transportation to the next stage - incorporation. Hillmen called at the mixing houses to collect the sample bottles for quality testing at the laboratory. The handover was always in the porch with each operative keeping to his side of the demarcation line between 'clean' and 'dirty' areas.

Mixing was therefore a somewhat crude process with a strong danger element, relying for safe operation on experienced staff and stringent safety discipline. In the overall production line by its nature it resembled a constricting into a narrow point after the relatively broader processes after and following it. It meant that at this point a substantial proportion of the propellant requirement of the British Forces all passed through the hands, literally, of a total of about ten men.

Interior of mixing house at Waltham Abbey



Mixing house interior showing arrangement of burettes and pouring on well



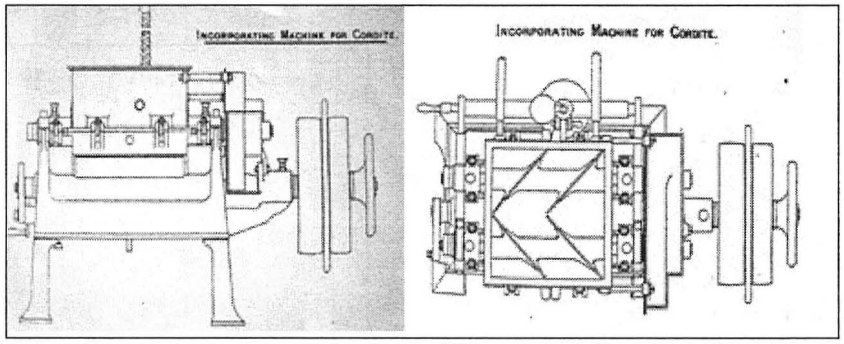
Mixing tables

(3) Incorporating Mills

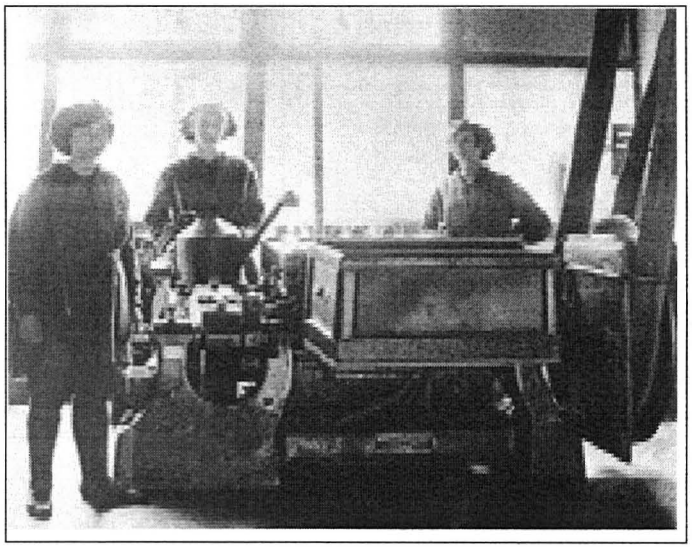
L145, I148, I149, I153 - all previously gunpowder mills, now listed buildings

L143, L146, L151, L155

The paste was taken to the incorporating mills either by barge and tramway via an interchange or tramway direct. There it was placed in an incorporator. These were modified bread dough mixers manufactured by Werner Pfleiderer Perkins of Peterborough. This pattern was extensively employed in the explosives industry. To put the material into the plastic state necessary for pressing, the solvent acetone was added and the mixture blended and kneaded for about three hours. Then the mineral jelly stabiliser was added and incorporation continued for a further three hours. Continuing the analogy with the baking industry, the material was now termed 'dough' and could now be taken to the pressing house.



CORDITE INCORPORATION MACHINERY



(4) L134, L157, L159 Press Houses

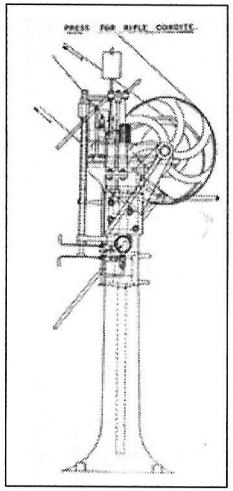
Cordite pressing was an extrusion process, in screw presses, hydraulically fed and belt driven for rifle grades and direct hydraulic for larger sizes.

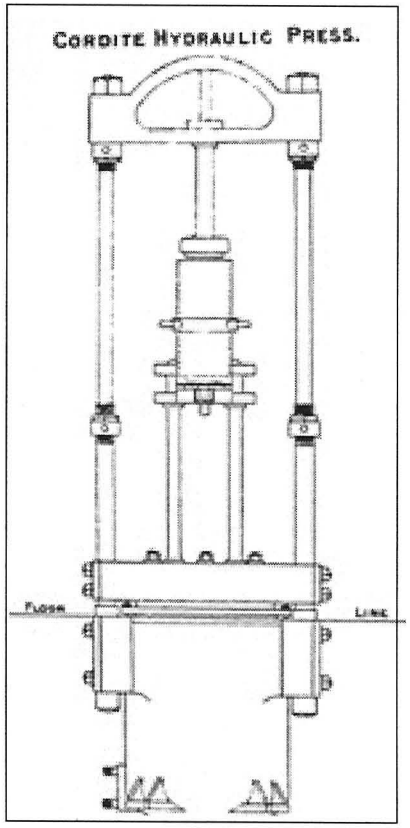
The operatives of the presses were protected by a heavy rope barrier, a 'mantlet', hung between them and the press with the cordite emerging from an aperture in the mantlet.

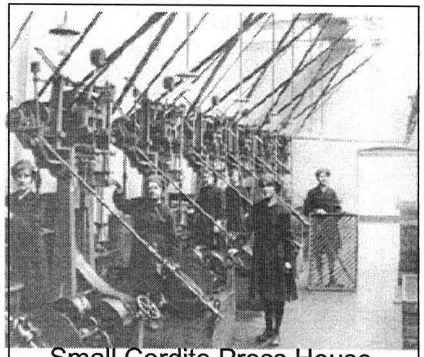
The presses extruded the dough through dies to produce the strands or cords of cordite. Again the process bore a similarity to a catering process, in this case spaghetti making. The dies for the rifle grades had a needle fixed in the middle to create a thin centre hole. The larger grades had as many as six holes. The finest grade was revolver cordite which was hairlike.

The thicker grades were collected by hand as they emerged and cut into lengths with a knife not dissimilar to a pastry cutter. These lengths were placed on wooden trays and taken by truck to the drying stoves.

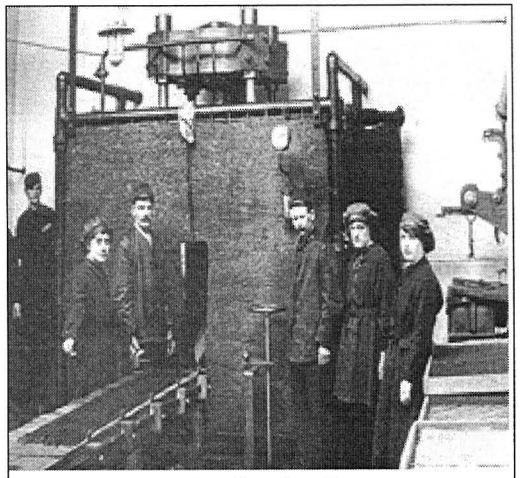
The thinner rifle grades were wound on to reels as they emerged from extrusion and taken to reel drying stoves.



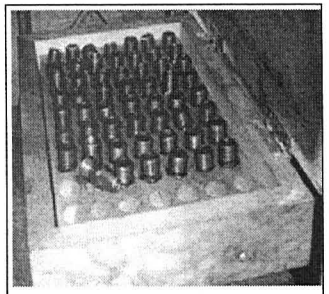




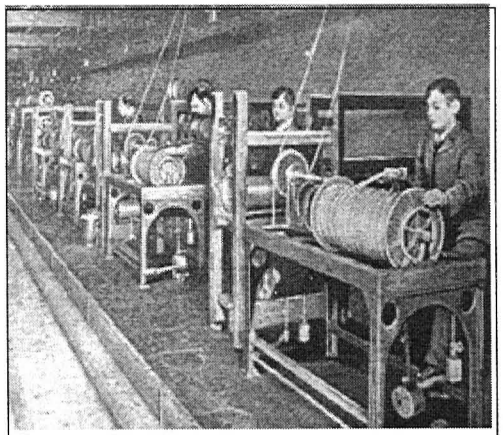
Small Cordite Press House
Waltham Abbey July 1917



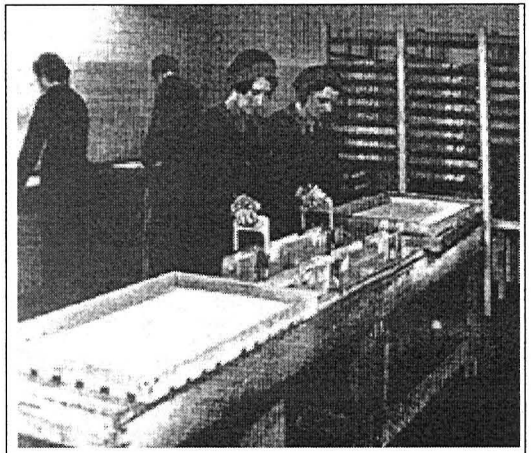
Hydraulic Cordite Press
Waltham Abbey July 1917



Cordite die nozzles



Cordite winding on to reels



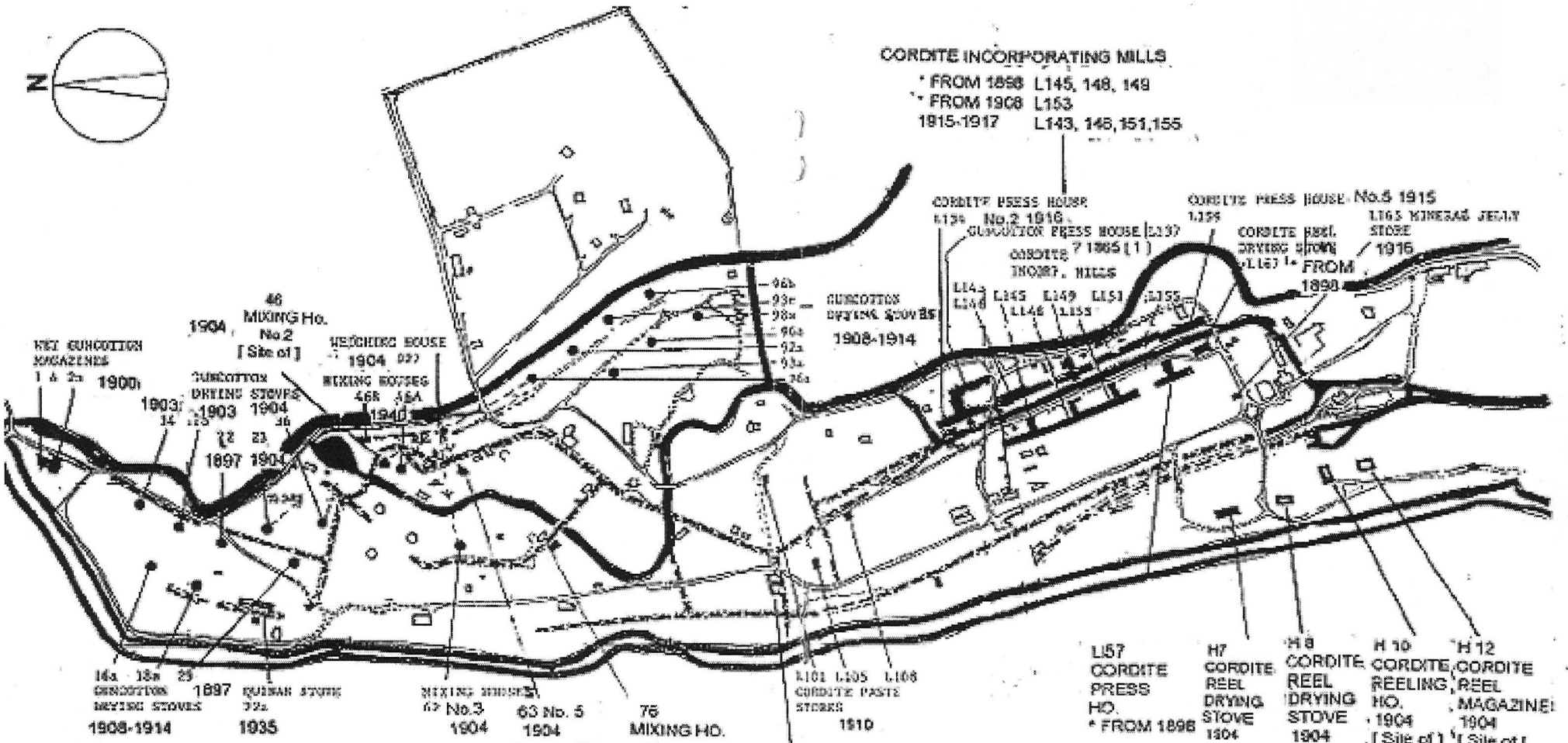
Cordite cutting at RNCF Holton Heath

ROYAL GUNPOWDER MILLS
WALTHAM ABBEY

NORTH SITE
THE GUNCOTTON & CORDITE BUILDINGS - FROM 1897

DIRECTION OF CORDITE PROCESS ⟶

MAGAZINE ⟶ DRYING STOVE ⟶ WEIGHING HOUSE ⟶ MIXING HOUSE ⟶ INCORPORATING MILL ⟶ PRESS HOUSE ⟶ DRYING HOUSE ⟶ REELING HOUSE ⟶ CORDITE REEL MAGAZINE



* FROM - Date of conversion to Cordite

(1) ? Originally experimental Guncotton Press House, later serving 1872 Highbridge SL Guncotton Factory

(5) Cobb Mead Drying Stoves
H7, H8, L167 Reel Drying Stoves

Trays of Cordite being pulled by Ruston Proctor petrol/paraffin loco

Acetone Recovery Plant

The acetone having fulfilled its incorporating purpose it was necessary to drive it from the cordite by drying. Cordite was first taken to the acetone recovery stoves which sent driven off acetone vapour to an acetone recovery plant. After acetone recovery there was a final drying in the Cobb Mead stoves. Thinner grades went to Reel Drying Stoves H7,H8, L167.

Acetone

Acetone was a scarce and valuable solvent and considerable effort was devoted to recovering it. Acetone was obtained form the distillation of calcium acetate derived from the distillation of wood by lime. In the early stages of cordite production on the South Site Waltham Abbey obtained its acetone from Germany then in 1895 erected its own acetone plant in part of the original guncotton factory at Highbridge St., which had become redundant in 1890. WWI brought intense pressure on supply, with competition for the product coming from other industries such as aircraft manufacture using dope and varnish. By 1915 the UK was burning 1400 tons of wood a week to obtain acetone. It was therefore of prime importance to recover as much as possible from cordite drying.

ACETONE RECOVERY

Dr.(later Sir) Robert Robertson, then Chemist in Charge of the laboratory at Waltham Abbey, and W.Rintoul developed and in December 1901 patented an acetone recovery process and this played an important part in assisting supply.

(N.B. The Main Lab building at the north end of Queens Mead was originally named the 'Robertson Laboratory' in his honour)

The Mills Archive holds a copy of a brief diary manuscript note which Dr. Robertson wrote at the time describing the process :

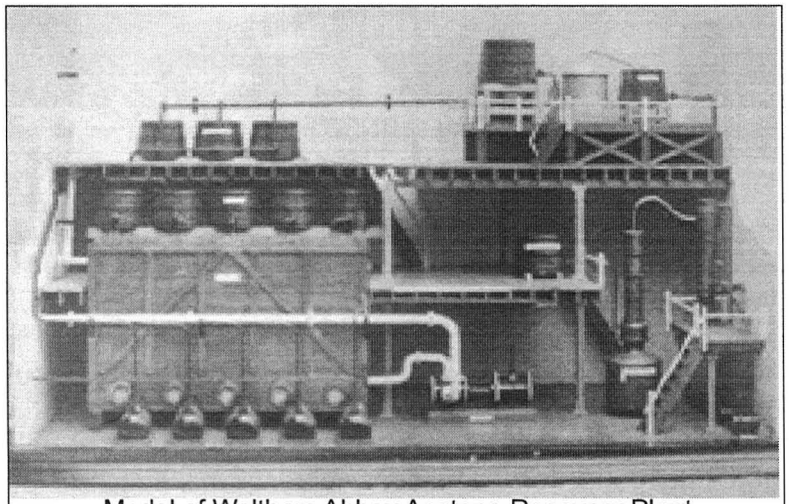
'This apparatus was made at home and consisted of zig-zag descending fibres held in a tall box. Solution of sodium sulphite descended the fibres and absorbed the acetone from its solution in air. The liquor at the foot of the tower could be distilled for acetone with little decomposition.

After a demonstration of the process in the RGPF a full scale acetone recovery plant linked up to all cordite stoves was erected and worked at the RGPF.'

The design was later employed at the Royal Naval Cordite Factory at Holton Heath and the Curtis and Harvey cordite factory at Cliffe.

After a seven year delay the Government awarded £4000 to Robertson and Rintoul. The Inland Revenue promptly took back £233 in income tax. An appeal against this was not successful.

[In a side note Dr. Robertson also recorded that on 10th October 1901 he got engaged to Kathleen Stannus, so his endeavours had not been entirely devoted to the weighty business of the recovery of acetone]



Model of Waltham Abbey Acetone Recovery Plant.
Brussels Exhibition 1910

(6) H10 Reeling House

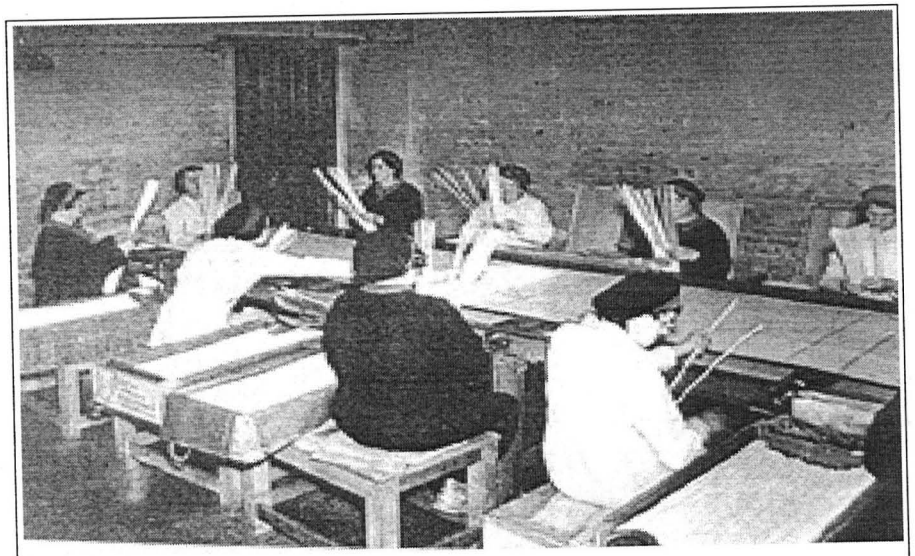
The reeling house took the reels of thinner cordite from the reel drying stove and wound it on to larger spools for thicker grades.

(7) 107,108 Blending House

The Blending House comprised Buildings 107 and 108, which were amongst the last of the gunpowder buildings built, moulding prismatic powders. Their life in this role lasted only about 15 years before conversion to cordite blending.

In order to obtain uniformity of performance cords of equal length had to be packed together. The matching of lengths was done by hand selection in the Blending House.

After blending the cordite was then ready for storage in magazines and ultimate use, in silk bags for large gun charges or the thinner rifle grades pressed into cartridge cases.



Cordite blending at RNCF Holton Heath

Safety

By the nature of the product explosives manufacture was replete with hazards and the closest attention was paid to lessening the risk. A wide spectrum of measures was employed - ranging from the familiar traverses, zinc lining of internal walls, leather covering on floors, clean and dirty areas, special footwear, limitation of personnel number in each building etc.etc., with a safety culture inculcated into all staff, all reinforced by a system of Danger Building Visitors.

In cordite manufacture the mixing process had particular dangers.

Dry Guncotton - dry guncotton was a dusty material very sensitive to friction and shock, requiring extreme care in handling, prone to gathering a thin film of dust on the mixing house floor.

Weather - In some cases pouring on was done in a separate building from mixing. That meant that the poured on material had to be transported outside to the mixing house. Nitroglycerine had a very high freezing point and was therefore vulnerable to freezing in transportation in very cold weather, putting it into a dangerous condition for hand mixing.

Samples - Nitroglycerine sampling procedure meant that sample bottles had to be physically handed over at the mixing house and carried to the laboratory, with attendant danger of dropping or tripping - one slip would be one too many.

Physical Handling - Outside observers might view with incredulity the hand forcing, however careful, of two powerful explosives, the product of the most advanced chemical science of the day, through a small sieve, smacking more of a dangerous mediaeval craft than the 20th century, with zero margin for error. However the view was that provided the staff were well trained and strict safety discipline was observed the work could be carried out safely.

Two serious explosions in the mixing houses in 1940 cast a blot over the scene. It is beyond the scope of this article to go into the conclusions of the subsequent Court of Inquiry. Not surprisingly it was found difficult to reach a totally firm conclusion since the staff who could have provided the answer regrettably had died but it is worth mentioning that all of the hazardous conditions outlined above figured in the reports on one or other of the explosions.

However taking a broad historical view and bearing in mind the material that was being dealt with the explosives industry reached a level of safety which matched many other industries - a particular achievement at Waltham Abbey was getting through the WWI period of massive increase in staff numbers and output without serious mishap, and was certainly superior to e.g.the mining industry.

Cordite Grade Development

Cordite history was characterised by an ongoing process of examination of formulation, quality, performance in the light of scientific advance and the changing operational demands of the Services. This process was based on co-operation between the Armament Research Department at Woolwich and Waltham Abbey.

Grades

Mark 1 - 1889

The grade patented in 1889 was mixture No.128 and was termed Cordite Mark 1. Its composition was:

Nitroglycerine	58
Guncotton	37
Vaseline	5

The intention of the vaseline was to reduce barrel fouling from cupro nickel deposited from passage of the bullet along the gun, but it was later discovered to have the very significant effect of preserving the chemical stability of cordite, which was susceptible to exposure to direct sunlight and high temperatures.

Manufacture of Mark 1 commenced at Waltham Abbey in 1891 and it quickly became adopted for British Service use.

MD - 1901

Mark 1 gave good service, but gun life was short, arising from the very high gas temperatures generated. The higher the nitroglycerine content the higher the temperature and in 1901 in order to reduce the temperature of explosion grade MD (Modified) was introduced, with the proportions of nitroglycerine and guncotton virtually being reversed. The composition was:

Nitroglycerine	30
Guncotton	65
Vaseline	5

The lower nitroglycerine content meant a longer drying time and the Cob Mead stove building programme was instituted as a result.

RDB - 1915

WWI placed enormous pressure on acetone supplies and the Research Department at Woolwich developed a grade which utilised the more readily available solvent ether alcohol in place of acetone. This grade, introduced in 1915, was termed RDB - Research Department formula B. Ether alcohol was a less powerful solvent than acetone and correspondingly a less nitrated grade of nitrocellulose with lower nitrogen content, collodion cotton, was produced. To compensate and maintain the ballistic properties of the cordite the proportion of nitroglycerine had to be increased. The composition was:

Nitrogycerine	42
Collodion Cotton	52
Vaseline	6

By 1916 RDB was being used for all larger gun sizes, i.e.cannon, with MDB continuing for rifle grades.

RDB served well in WWI. However it was still a passing expedient as it did not have good storage qualities.

W - 1933

Whilst mineral jelly was a useful contribution to chemical stability, a further problem was encountered in storage - 'corrosion spots' arising from small particles of included foreign matter, particularly those containing sulphur, which caused rapid local decomposition with accompanying rise in temperature and possible spontaneous explosion if this spread from stick to stick.

To meet this problem a new filtering and straining method during pressing was developed at Waltham Abbey (the description in reports of the work which had to be put in associated with straining improvement on such aspects as pressing pressures, die design etc. is a reflection of the constant process detail improvement which went on at Waltham Abbey).

In parallel with this experiments by H.A.Phillips and P.G.Knapman demonstrated that significantly greater chemical stability could be achieved by replacing vaseline with diphenyl diethyl urea, given the name Carbamite or in some areas Centralite. Reflecting both the above developments in 1933 the grade W - Waltham was introduced containing 6% carbamite in place of vaseline. This became the standard grade for cannon, with MD continuing for rifle grades.

RDN & Picrite - late 1930's

As the 1920's moved into the 1930's with growing pressure from the Forces attention came to be increasingly focussed on the problem of flash produced at the gun muzzle. This had two major disadvantages - it gave away the position of guns and it blocked the vision of gun layers.

Flash was due to hot gases from the exploded propellant re igniting. Consequently a means of reducing flash by introducing a composition which cooled the gases and/or contained a lower proportion of flammable material was investigated. Sir G.Beilhy had discovered in 1904 that a compound rich in nitrogen would achieve a flash suppressant effect. In 1912 Vieille, originator of Poudre B, found that such a material, nitroguadine, when included in the propellant reduced barrel erosion by a factor of two and in 1914 Wm. MacNab, later President of the Institution of Chemical Engineers, postulated that nitroguanidine combined with a tetranitro compound bound with rubber produced an effective flashless propellant. The idea was not pursued at the time - about 40 years later it reared its head again in composite propellant for rocket motors.

The high cost of the basic product required for nitroguanidine manufacture had militated against further consideration but advances in chemical engineering brought the price down and in 1921 Sir Robert Robertson, by now Chemist in Charge of the Woolwich laboratory, decided that the time had come to reinvestigate. He deputed J.N.Pring to carry out the research programme. This demonstrated that nitroguanidine was indeed an effective flash suppressant, but that it would be difficult to produce crystals of the fineness required to secure good ballistic performance. Nevertheless it was decided that trials at Waltham Abbey should continue with the relatively coarse form and from 1925 Waltham Abbey was producing coarse grains.

The manufacturing method was gradually refined to the following -

Water on calcium cyanamide fertiliser producing calcium bicyanamide

Reacted with hot water to produce after cooling and treatment in a centrifugal machine crystals of dicyandiamide

Dicyandiamide reacted in an autoclave with ammonium nitrate to yield guanidine nitrate

Guanidine nitrate treated with sulphuric acid in a nitrator to remove water elements and cooled to produce crystals of nitroguanidine.

Nitroguanidine dissolved in boiling water, filtered, and sprayed on to a revolving metal cylinder cooled with refrigerated brine. Crystals separated by centrifugal machine, dried and fine crystals separated by passing through a Schutz O'Neill disintegrator and milled. At this time the product was termed Petrolite.
Work continued and a series of process and crystalliser advances were made, e.g.a new vortex crystalliser was introduced, and by the late 1930's the crystals were fine enough to be incorporated in a new grade - RDN, with the crystals now termed Picrite.
This started a long chain of picrite based development,with plant being built at the Royal Naval Cordite Factory and ICI Ardeer and extending in recent times into rocketry.
RDN also contained carbamite and by the 1940's the composition had settled at:

Picrite	55
Guncotton	20
Nitroglycerine	20
Carbamite	4.7
Cryolite	0.3

SC - 1927

The use of the solvent acetone continued to present difficulties - supply shortages, lengthy and expensive drying times, and in 1927 the SC - Solventless Carbamite grade was introduced at the Royal Naval Cordite Factory. The key factor was the carbamite. It had been found that this had the important property of reinforcing gelatinisation, to the extent that solvent was not required. In addition it was found possible to avoid the use of dangerous dry guncotton by employing an aqueous slurry of nitrocellulose for mixing with the nitroglycerine. Another advantage of SC was that it was less prone to the irregular shrinkage which had been a problem with the older grades.
SC became the main RNCF grade, but it was not produced at Waltham Abbey, although experimental work was done.

Staff Numbers / Output

The history of staff numbers and cordite output at the Mills over the period 1931 to 1939 provides a neat snapshot of what was happening in the outside world over that time :-

	Staff employed	Cordite Output (tons)
1931/2	274	207
1935/6	819	662
1938/9	2263	3970

Although the usual warnings about proving anything with stastics apply, it is interesting to see the reversal of the staff/output ratio in the later year.

Cordite and the Chemical Revolution

One of the key characteristics of the western economies in the latter part of the 19th century was the application of science to large scale industrial processes resulting in large increases in production and a range of new products. An important aspect of this was the rise of industrial scale organic chemistry applied to a wide range of products - textile dyeing, photographic chemicals, anaesthetics, pharmaceuticals, coal tar derived intermediates, and nitro-explosives. Nitration based explosives were one of the founding organic activities and nitration extended across a wide spectrum.
The two basic elements of cordite were derived from nitration and cordite could therefore be regarded as a fundamental element in what has been termed the Chemical Revolution.

The name cordite appears to be recognisable, perhaps surprisingly, to a substantial proportion of the general public, although their notion of what it actually is might be somewhat hazy. Perhaps this is a measure of its success.
As an industrial product and in its propellant function cordite has been outstandingly successful.

- **The manufacturing process was, in the context of its day, an advanced application of organic chemistry and chemical engineering, scientifically soundly based and susceptible to effective supervision and operation**
- **The product was reliable, predictable and uniform in effect through the range of its application as a Service propellant**
- **It permitted fine adjustment and control of operation**
- **It was robust and safe in transportation and storage**
- **It was versatile and adaptable to a continuing process of scientific examination, improvement and variation**

In the 20th century the nation faced severe threats in two World Wars. Throughout this time cordite was the core propellant in British Services ordnance. It therefore lay at the heart of the country's defence capability and played a fundamental part in dealing with the threats.
Whilst outstripped in output by later Government factories, Waltham Abbey had the founding role and, in conjunction with the Research Department at Woolwich, remained the key centre for research and development of manufacturing processes.

Les Tucker

Appendix
The North Site Cordite Buildings

Bld. No.	Built for Cordite	Cordite Function	Converted to Cordite	Cordite Function	Previous Function	Built
L101	1910	Paste Store				
L105	1910	Paste Store				
L108	1910	Paste Store				
107) 108)	–		1898	Blending Ho.	Moulding Ho.	1882
L134	1915	Press Ho. No.2				
L143	1915-17	Incorp.Ho.				
L145	-		1898	Incorp.Ho.	GP Inc.Mill F	1879
L146	1915-17	Incorp Ho.				
L148	-		1898	Incorp.Ho.	GP Inc.Mill G	1889
L149	-		1898	Incorp.Ho	Hydraul.Accum. GP Inc.Mill E	1867 1877
L151	1915-17	Incorp.Ho.				
L153	-		1898 1908	Press Ho. Incorp.Ho.	GP Inc.Mill D	1868
L155	1915-17	Incorp.Ho.				
L157	-		1898	Press Ho.	GP Inc.Mill C	1861
L159	1915	Press Ho. No. 5				
L165	1916	Mineral Jelly Store				
L167	-		1898	Reel Drying Stove	Charcoal Store	1889
76	-		1898	Mixing Ho.No.4	Press Ho.	1856
S27	1904	Weighing Ho.				
46	1904	Mixing Ho.No.2 - destroyed 1940				
46A	1940	Mixing Ho.				
46R	1940	Mixing Ho.				
62	1904	Mixing Ho.No.3				
63	1904	Mixing Ho.No.5 - destroyed 1940				
H7	1904	Reel Drying Stove				
H8	1904	Reel Drying Stove				
H10	1904	Reeling Ho.				
H12	1904	Reel Magazine				

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Ken Bascombe

Ken Bascombe, who died on January 4th, joined ERDE in October 1961 and stayed for almost 30 years. Before coming to Waltham Abbey he'd gained an MA and Doctorate at Balliol College Oxford and had done post-doctorate research at Cambridge. Initially he joined Jack Powling's group in H10 and then transferred to E branch where he took over from Randall Wyatt as head of the Sensitiveness Section. Outside of work he took a keen interest in historical matters and served a chairman of the Waltham Abbey Historical Society for a number of years. Indeed, the whole character of vthe town centre owes much to Ken who campaigned against replacement of the old buildings in the Market Place and Sun Street by something 'modern'. Ken will be best remembered for a keen sense of humour and an encyclopaedic knowledge of a wide range of subjects. He will be much missed.

Anna Costen

The close-knit community of the Lea View flats was in a state of shock following the unexpected death of Anna Costen who was making a good recovery from a hip operation on the 20th January when she suffered a heart attack. We have lost a good neighbour and friend. Our sympathy goes to Anna's family, Moira, Ian and Boyd.
Bryan Howard

Ernie Cooke

It is with great sadness that we report the death of Ernie Cooke who has been a stalwart member of the Committee since the inception nof the Association. Ernie was born in India and started his education there then later at boarding school in England. He was a keen sportsman, playing hockey at county level. He joined ERDE in 1952 working initially in Rheology, then E Branch before moving to P2 to work on double base propellants. During his time in E Branch he was probably the last person to actually use the waterways for transport of explosives when samples were taken back to the expense magazine by punt at the end of each day's work.
Everything that Ernie did he did to the best of his ability with great dedication, be it scientific work, his participationn in sport, his bird watching work studying owls in the Lee valley Park and, of course, his work for the Association. In all this he always found time for his family and friends. After a long battle with leukemia Ernie finally succumbed on the 27th January. His funeral was held at the Enfield Crematorium on 9th February and the chapel was packed full with family and friends. He will be greatly missed.
Our sympathy goes to Sheila and the family.

G.W.C. TAYLOR (16th December 2003)

A PERSONAL VIEW

I am sorry to report that G.W.C. Taylor ('George' – or 'Gudge' to his intimates) has died in a Nursing Home near Harlow. Time had taken its toll in the last few years and he succumbed to pneumonia, following complications. We, old Friends of ERDE, can admire him for his qualities as a scientist, his understanding, his technical skill and his contributions to the expertise of the establishment.

I have undertaken to compile a little obituary in consequence of the quirks of fate that linked our joint lives for quite a while. I knew him "off and on" for upwards of sixty two years, the 'on' part from basically 1947 to 1991; the 'off' part regrettably the last twelve years which were consumed by failing health, for both of us.

We first met in April 1941 outside the gates of ROF Bridgend. I had been introduced to a chap called Llewellyn working, as I understood, out of the evacuated ARD group centred in Swansea University. George Taylor, who was also working from Swansea, came along on his motor bike at this time, and Llewellyn introduced us. It was the event of a moment for another six years passed before we met again. I always felt that George was a bit intrigued by Llewellyn because he spoke of him several times in later life.

In 1947 I had the chance to be transferred out of ROFS to the much more prestigious Research Department, to what I will now call ERDE for simplicity. I was into Materials Section, and divided most of my time then between Woolwich and Fort Halstead. In Woolwich one day came George Taylor on his motor bike again, out of Otford. I was detailed to attend a Government/ICI ongoing standing committee for Initiators and Pyrotechnics. George and I were the ERDE representatives (I had a materials watching brief). We attended jointly for thirteen years until I was posted elsewhere. I can't tell about the end of this committee. I took the view much later that in the end ICI got their way mostly. Money and power talking, the ICI compositions survived.

The next pivotal moment came with the completion of the new Monkswood Avenue housing estate in Waltham Abbey. Thither I and my wife Gladys and two young daughters found a home in The Cobbins (No. 5) in October 1952. Early in 1953 (to No. 7) came George Taylor and wife Doris, with two somewhat younger daughters – in time for the coronation. We remained neighbours there for 21 years.We got on very well, especially the ladies. The children all know each other still. I guess the chat between George and me was rather about deeper understanding than day-to-day stuff. He of course did a lot of travelling abroad – to Europe and to the United States, together with his expertise. He would tell us about amusing incidents. I remember particularly about a reaction chamber in a European plant which contained a religious icon (no doubt a safety measure)

There was increasing interest about children's education in Waltham Abbey and a sub-committee of the Estate's Residents Association was formed, with George as chairman and me as secretary. We succeeded in getting the Headman from Essex C.C. to talk to us, in the end. Did it do us some good? I don't know. I always felt my girls got a good deal before moving on to secondary education..

Time was moving on and in the mid seventies we both retired. George and Doris moved to Harlow, to a rather nice but older south-west corner. He travelled a short while to Waltham Abbey and filled in with a bit of desk work and admin

Afterwards my wife and I visited quite regularly (we to Harlow from St. Neots – not so much the other way). The wives would chat about what women chat about. I remember he and I would talk about underlying aspects, about our work, progress, people, modern attitudes (he got bits of news from one of his protégés who had made good) and there would be interesting recollections. There would be a nice lunch and later a cup of tea and slice of cake in valediction.

He, George, had more time to indulge in photography, both on his own behalf and by courtesy of Harlow Town Council, with whom he had a friendly agreement.

At this time came the publication of his "chef d'oeuvre", the monograph of his work on all those initiatory explosives derived from the interactions of heavy metals (e.g. lead) with suitable nitrophenolics (see your Physical Chemistry text books). In it were detailed production, inspection (note especially crystal-habit) and properties of those compositions which were listed under RD1300. The whole comprises a valuable 20th century record of a serious piece of work and he deserved all praise for it, and it was duly recognised in his status.

I also learned, later, of another piece of work that he wrote under the auspices of the Harlow Trust for the Furtherance of Education. It provided valuable recollections of his early work experiences starting in Woolwich Arsenal. It gave the clues to his later work, which had its origins in the laboratories. I was interested to find he wrote of people that I too came to know post-1947. Names such as George Welby, Joe Howard, D. Pullman, G.L. Hutchinson and Dr. Barker spring to mind – also C.S. Bryant whom I once met, briefly (he probably retired then).

The first serious interruption sadly to these get-togethers, was the death of my wife in the middle Eighties. I was glad enough, however, to return later by myself, for lunch visits.

All came to an end unfortunately in 1991 when I fell ill. I had serious troubles throughout the nineties (but am still here to say so). There were Christmas cards and telephone messages, but no visiting.

By the turn of the century Doris Taylor, who had been such a wonderful prop to his domestic life, fell ill herself, becoming unable to cope because of mind failure. With her death George became unable to cope himself. I know that life in the Nursing Home irked him. An old colleague of ours visiting a year or so back found him "poorly". I never saw him again after 1991.

Let me say in conclusion something his daughter said to me (this is my authority). "He was always proud of his working class origins, and he never forgot them all his life. He loved helping people, he made a lot of friends. Questions of money never came into it".

I would add myself that whenever he said "Our members", it was quite clear on which side of the fence he stood. All this in spite of the fact that his efforts were recognized with the promotion to 'Appleton' S.P.S.O. – and the award of the Imperial Service Order (ISO) which eventually he came to appreciate.

Pondering on all the issues touched on above, I fell to thinking that in the Armaments Industry (explosives especially) we have been fortunate enough in the last 150 years, say, to reap the benefits of the works of a whole lot of skilled chemists and others, who have developed modern explosives to such a fine 'state-of-the-art'. This has been a long 'heyday'; perhaps it is finished, I wonder, and the present 'cutting edge' is with designers and all those who know their hardware from their software. Guidance is everything.

What about initiatory compositions? Will their importance become paramount? I don't know. I have been too long away from the arena to give an answer. Please forgive me if I am wrong.

The purpose of all the above is to be a tribute to the late G.W.C. Taylor. He deserves our respect and admiration.

John Gooding

QUINAN STOVE

My main memory of the Quinan stoves was to wonder why the hell they bothered to build them at WA since we never seemed to use them. Paste drying was always in trucks and there was obviously no point is drying the NC before wet mixing. It is really only if you want to make single base that the NC for them needs to be dried before solvent incorporation of stabiliser, flash suppressant etc, and since responsibility for these formulations was usually left to Nobel at Ardeer or Powfoot, we never got involved. Nor did we, thank God, have to mix NC with neat NG by hand on a lead table, by rubbing through the sieve -- though I remember George Williams being a great advocate of this method as being "the safest of all the processes"! Me, I was never convinced and I don't remember ever asking for it to be done. Tell me if I did -- I could forget but I doubt if anybody who did it would!

Back to Quinans. I do remember we used them very occasionally but again I can't remember what for. It might be that we used what was basically an unused building for housing a lash-up of some other process. That would be more our style.

They certainly used Quinans at Ardeer and Powfoot, I presume for single base. Can anybody remember if single base was ever/normally wet mixed and truck dried?

Steve Bell

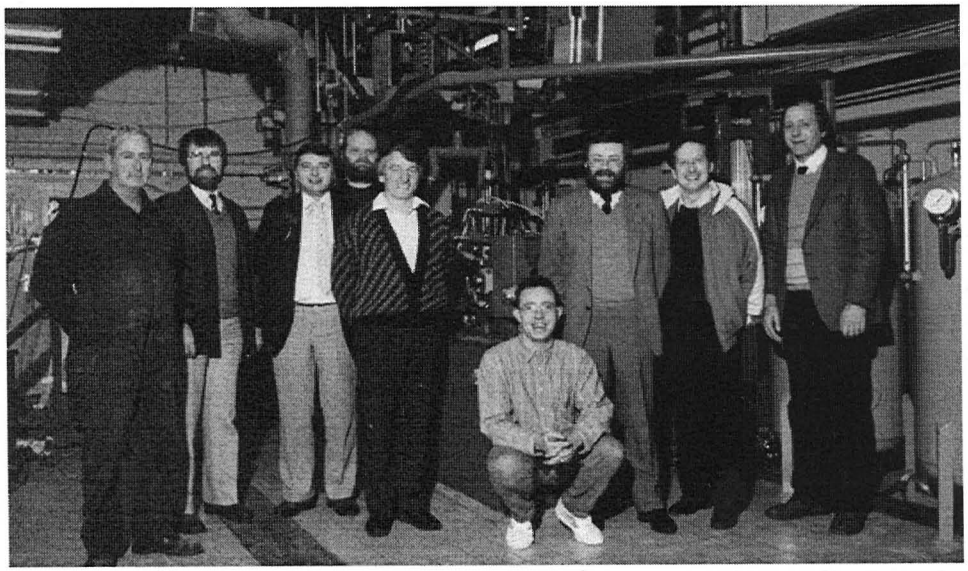
In his very interesting articles on the Development of the Quinan Stove, and the example at Waltham Abbey (Quickmatch Dec 2003), Les Tucker noted the decision to perpetuate "the Quinan system of drying when a system of cordite manufacture had been evolved which avoided the need for drying entirely". My memory (such as it is) of cordite manufacture only goes back to the 1970's, but I offer the following comment. Although the wet mix process does not require dry nitrocellulose, the resulting wet NC/NG paste still has to be dried –at least partially. Incorporation of many cordite compositions took place in an acetone/water mixture (92/8). Drying wet paste on trays in still air in stoves would be slow and was probably a bottleneck when anticipating wartime production. The Quinan process involving moving hot air may have been evaluated as a means of increasing the throughput. The disadvantages would include loss of NG from the paste and the doubtless unpleasant working conditions when loading and unloading pans when most of the other pans were still running. It seems to me that the familiar process of truck drying (ie passing heated (?) air through a tunnel of trucks containing trays of wet paste) might have been a more efficient and less unpleasant solution to the problem. Trucks could be loaded in the wet mix area, moved to the drying area, and allowed to cool before off-loading. This process was in regular use on the South Site until 1980's. I would be interested to learn of other members' views on the subject. The situation seems to be an early example of Waltham Abbey acting as a development plant for processes intended to operate at larger scale elsewhere. It may be worth recording that considerable amounts of dry NC would still have been needed to make single base propellants used in small-arms, aircraft cannon and some artillery rounds where continuous firing over long periods could lead to erosion problems with cordite compositions. The single base propellants were produced at Powfoot, using NC from nearby Dumfries in factories operated by Nobels (later ICI). Many of these gun propellants used an ether/alcohol (60/40) solvent with the High Nitrogen (mechanically nitrated) NC and so most of the water had to be removed before the incorporation stage. I would welcome corrections and additions to this- it is remarkable how quickly the information degrades with lack of use!

David Hewkin

Another photograph from the archives.

The question has to be "How many of this motley bunch can you identify? Its from about 1989 and is in Roy Carter's building in P1 Branch on South site where the twin screw extruder was set up. The easy ones are Roy Carter and Frank Baker but how many of the others...?"

Grant Privett



DON'T FORGET
DEADLINE FOR THE June 2004 ISSUE:
15th MAY 2004

A visit to Holton Heath .... The article on the RNCF Holton Heath in the last issue brought back memories of my brief stay there many years ago. When the German bombers first flew over the Royal Arsenal at Woolwich I had no bknowlwdg of the RNCF at Holton heath. A few weeks later I was included in a small party being evacuated to Poole. On reaching Poole by train we sought a restaurant and later asked the waitress if she knew where we might find lodgings. Shortly afterwards two of us were being cared for by a delightful family in a small house on the esplanade of a back water where ann old 2 masted galleon was moored about half a mile away. Our journeys to RNCF were by a train which travelled on a rail that crossed the backwaters on wooden stilts. A narrow road from the station to the establishment gates was through what appeared to be a pine forest. My first job was to sample water at a drilling site on a remote foreshore. The pile driver had not, by then, reached a level free from bacteria. Because of the environment and friendly people this proved to be one of the most eventful periods of my life but, a little more than six months later I was recalled to Woolwich.
Vic Clifford

Nitre Cake .... The item in the last issue relating to Nitre Cake interested me. I can remember just before the war, but only for a few months, that Nitre Cake was unloaded from barges on the river Lea behind the Old English Gentleman pub. It was slabs of yellowish colour. Men picked up the big slabs and shovelled up the small pieces into a big iron bucket and a small crane lifted it a dumped it into ann open lorry. Us boys were told that it "came from out of the Mills and was going to Harpics - wherever their factory was - for making toilet cleaner." The operation only lasted for a few months so where it went before or afterwards I have no idea. It may be, as quoted in the article. The contract was not deemed economic to continue.
George Savill

The Royal Aeronautical Society - Space Group events

Wednesday 24 March 2004 - a talk by Mark Shuttleworth

We are pleased to announce our next event on Wednesday 24 March 2004 when we are delighted to welcome the British Interplanetary Society (BIS) to Hamilton Place; and to host their 2004 L J Carter Memorial Lecture. 17:30 for 18:00. See full details at www.raes.org.uk/space/040324_BIS.htm

In April 2002 Mark Shuttleworth flew in space for the first time, as a cosmonaut member of the crew of Soyuz mission TM34 to the International Space Station. Mark was born and raised in South Africa, and is currently living in London, where he researches new projects and technologies. Mark will be talking about his experiences in training and flying on the Soyuz and ISS, with photographs; and on the emerging opportunities in space.

Our events are: public open lectures : all visitors welcome : no admission fee : no tickets required.