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The
History of the Manufacture of
Gunpowder at Waltham Abbey

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Contents

Introduction	<u>page</u> 1
The History of the Manufacture of Gunpowder at Waltham Abbey	2
Appendices	16
Bibliography and Acknowledgements	22

Introduction

This project traces the technical development of the manufacture of gunpowder at Waltham Abbey from the seventeenth century to the end of the Second World War.

In the course of my research I have obtained copies of various early documents, records and photographs and these have been included where relevant. Many of them give intriguing glimpses into the changing social, economic and industrial conditions over the years.

The Early History

The early history of the powder mills of Waltham Abbey are very obscure due to the lack of positive documentary evidence and so the early days of the mills are largely a matter of conjecture and legend.

One legend suggests that gunpowder from Waltham Abbey made by monks was used at the Battle of Crecy in 1346, the first time that gunpowder was used by English soldiers in warfare.

Another legend suggests that when Britain was being threatened by Spain, Queen Elizabeth ordered the building of some powder mills. So the question is asked: 'were the Waltham Abbey mills in operation at this time?'

The First Evidence to Connect Waltham Abbey with Gunpowder

From State Papers of 1560/61, there is a contract for the supply of Sulphur, Saltpetre and Bow-staves to the Government from a Marco Antonio Erizzo of Italy. A letter from this contract (Appendix I) addressed to John Thomworth (or Tamworth) gives the connection with Waltham Abbey, because he was thought to be the owner or manager of a powder mill there.

This particular piece of correspondence tells us about a dispute over the payment for the Sulphur, Saltpetre and Bow-staves. Mr Erizzo wanted £1141 for the sulphur and bow-staves, and the letter says that he would not reduce his price of £3.10s per 100lbs for the saltpetre.

The Gunpowder Plot

The most famous legend about the Waltham Abbey powder mills suggests that Guy Fawkes bought his gunpowder from Waltham Abbey, to blow up the Houses of Parliament and so kill James I in 1605.

There is no positive evidence to prove that

the powder came from Waltham Abbey, but it is known that the conspirators were frequent visitors to White Webbs (two or three miles away) in the months before the plot.



Effigies 7. Productorum qui in cuniculis sub Domo Parliamenti, Wythmonasterij prope Londinam, agendis, operam posuere: ad ipsam a fundamentis evertendam pulvere tormentario, cum maxima parte Wythmonasterij, ac in ea non solum Regem visum priandum, verumetiam principes Proceres totius Regni tam Ecclesiasticos quam Seculares, potissimum Nobilitatem, ac principes Ministros Regni, cum qualis Spectatorum millibus. Robertus Catesby Armiger primus immanis huius coniurationis fuit auctor. Thomas Percy Nobilis in hoc negotio mire vehemens fuit: Cellam sub Aedibus Parliamenti condixit, ac valde diligens fuit in cuniculis perficiendis. Eius caput nunc Aedibus Parliamenti impositum conspicitur. Thomas Winter a R. Catesby ad hoc facinus incitatus et adactus est. Guido Fawkes in partibus Belgij quae sunt sub obedientia Ducis Alberti, cum esset, ad hoc flagitium a Thoma Winter impulsus est: ac in Angliam veniens, cum iurasset cum aliis super codicem Evangeliorum desilensio, Sacramentum quod vocant Eucharistiae a Sacrificio accepit. Ioannes Wright nobilis. Christopherus Wright. Robertus Winter. Atque hi numerum septenarium complerere. Quibus accessit Bates Roberti Catesby famulus.

The Gunpowder Plot Conspirators.

Until 1978, there was no documentary proof of the plot to kill James I. However a receipt which records the arrival at the Tower of London of 1,800 lbs of gunpowder from a cellar beneath Parliament House was found in the Public Records Office in May of that year.

First Genuine Records of the Powder Mills

It is not until 1662 that any definite record of the Waltham Abbey powder mills was made. In that year, the perpetual curate of the Abbey, Thomas Fuller, wrote a book called 'The History of the worthies of England'. In this publication there was a piece about Gunpowder in Waltham Abbey (Appendix II).

In this article he mentions that 'more made by mills of late erected on the River Ley, betwixt Waltham and London than in all

England besides'. He goes on to say 'The mills in my Parish having been five times blown up within seven years, but, blessed be God, without the loss of any one man's life'. So we can conclude from this that there were powder mills in Waltham Abbey in 1655, and it can be assumed that they were erected between 1650 and 1655.

Three years after the publication of Fullers book, the first accidental deaths occurred at the powder mills. The parish records of October 1665 (Appendix III) state that:

Tho. Guttridge, killed with a Powder mill, ye 4 day.
Edward Simmons, Carpenter, so killed, ye 5 day.

These entries into the register of burials were unusual at the time, because the cause of death was not normally entered.

Farmers Illustration

In 1735, John Farmer wrote a book called 'The History of the Town and Abbey of Waltham' and in this he included an illustration of the general view of the factory (Appendix IV).

He described the factory as being 'esteemed the largest and completest works in Great Britain'.

In his book, Farmer does not describe the manufacturing processes, but the illustration clearly shows the buildings needed at different stages during the manufacture of gunpowder.

In 1735, the only machines powered by water were the coming and Glazing engines in building two, but by 1770 water power had spread to the powder mills.

The Faversham Mills

In 1760, the Government realised the importance of controlling much of the powder production of the country and bought the mills at Faversham in Kent from Thomas Pryce. In 1783 however, following statements that private merchants could make better and cheaper powder than the

Government, the Prime Minister, Pitt, was about to recommend the sale of the Faversham mills, but Major William Congreve, Deputy Comptroller of the Royal Laboratory at Wodwich, informed the Government that a profit could be yielded, and that if this were expended properly, a more durable, powerful gunpowder could be made.

The Government Takeover

In 1787 the Waltham Abbey powder mills were owned by a John Walton, the fifth generation of his family to own the mills since 1675.

The mills at this time were in a poor state and John Walton was trying to find a buyer for the site. In October of that year he wrote to the Government offering the powder mills, refining house and fisheries at Waltham Abbey for £10,000. His offer was accepted and by 22 October, Major Congreve had officially taken over. He had been active at the mills before this time and he employed Daniel Cornish, a carpenter, to recruit the best of the millmen and labourers who had been employed by Walton.

After the site had been purchased, the Government had to spend another £35,000 due to neglect, and the need for enlargement and improvement.

Although this purchase was made in 1787, it was not until 14 August 1795 that the deed of release was issued. (Appendix B). The start of the deed concerns the buyer and seller in the transaction and the agreed purchase price. The rest of the deed then goes into great detail about the land and equipment etc that had been purchased.

The Manufacture of Gunpowder

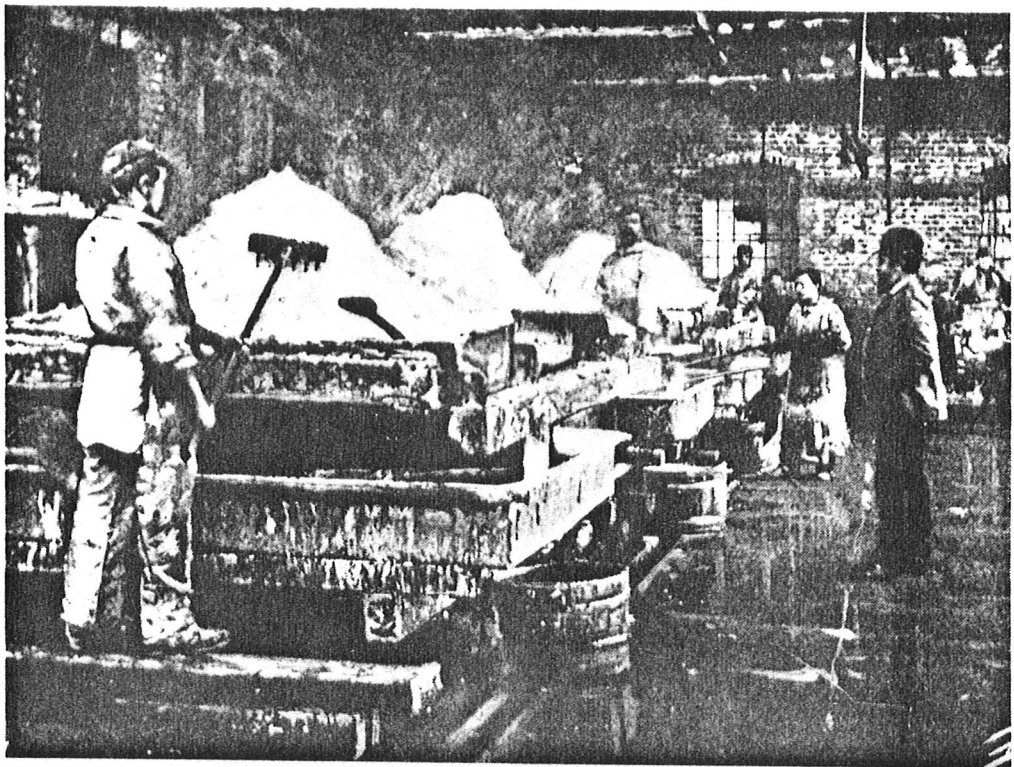
Although the mills had been bought in October 1787, it was not until February 1789 that gunpowder was first made at the Government factory. It was delayed for so long, because extensive repairs and extensions had to be made

to the site, the most lengthy being the building of a new mixing house and saltpetre refinery. The work at the factory was also delayed by the river that powered the water wheels, it was in a poor state and not under proper control.

In July 1788, Mr William Newton was appointed Master Worker, and optimistic about an early start, Congreve wrote to him telling him the ingredients, the manufacturing processes for the making of gunpowder and the precise steps to be taken to ensure maximum safety and the best quality powder.

The proportions of each ingredient were Saltpetre 75 lbs,
Sulphur 10 lbs
Charcoal 15 lbs.

The first powder was finally made on 9 February 1789. This was followed on the 12th by the first accidental explosion. Fortunately nobody was hurt and there was little damage to the mill.



The Saltpetre Refinery

Progress made from 1787 to the Napoleonic Wars

When Congreve took over the factory, one of his first steps was to increase its capacity by building new given stoves. This was surprising at the time,

because they were unreliable and caused many accidental explosions, but at Waltham Abbey they were successful for many years.

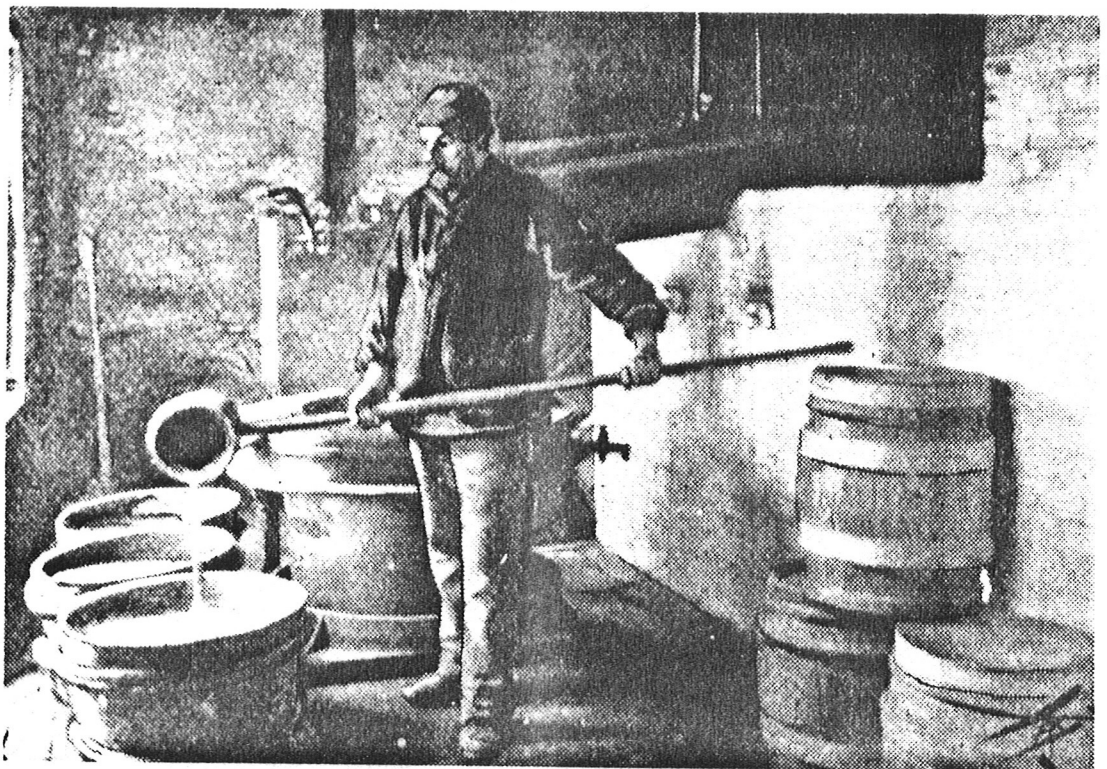
This and other improvements to the factory made the quality and durability of the powder much better.

In 1810 on Marlborough Downs, Congreve demonstrated his gunpowder in trials with other factories from all over the country. A 10 inch shell fired by 9lbs of Waltham Abbey gunpowder went the greatest distance (4430 yards). This was 70 yards further than the Faversham gunpowder and 160 yards further than that produced by the best of the six private factories.

From the time of the Government takeover, until the start of the 19th Century, accidents were frequent, but nobody was killed.

The first serious accident under Government ownership occurred on 18 April 1801. The new cornig house on Horse Mill Island blew up, killing nine men and four horses.

The next serious and probably the largest accidental explosion took place on 27 November 1811.



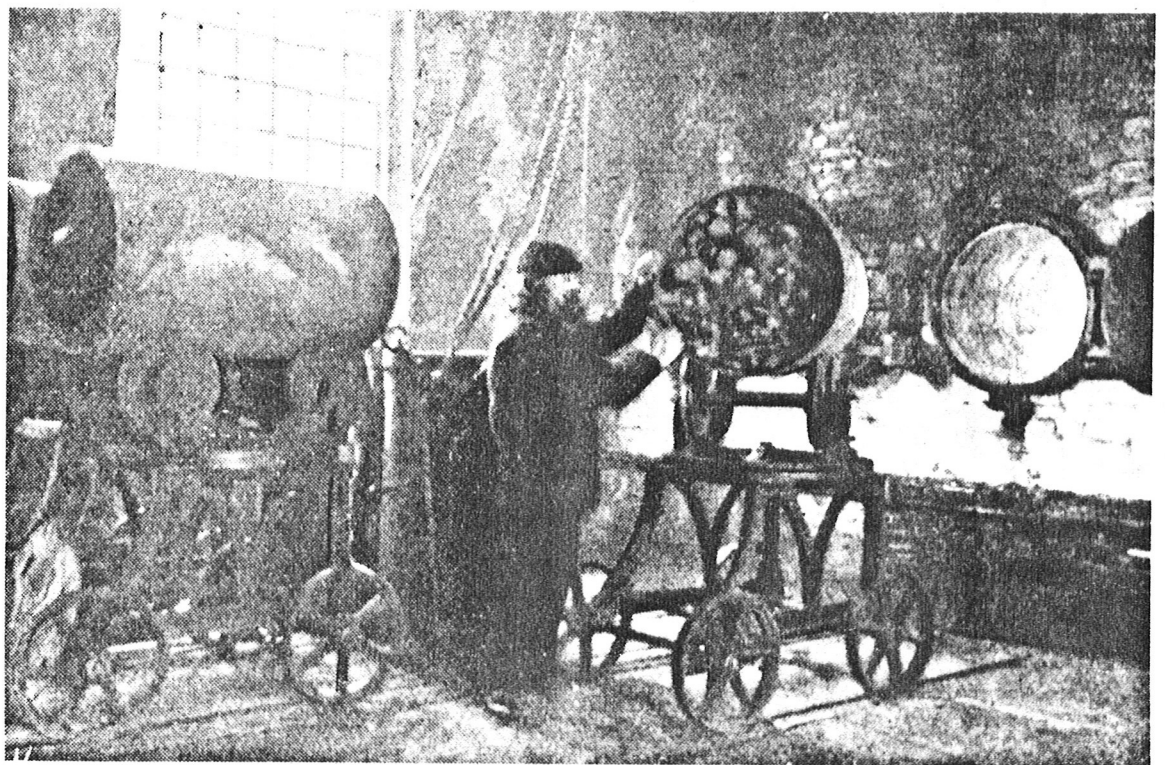
The Sulphur Refinery.

Eight men were killed when a powder mill on Lower Island exploded. This explosion caused great distress in the surrounding area, because it caused damage as far away as Blackwall and Marylebone in London. Some of the morning papers even thought there had been an earthquake.

The Profit Made by Congreve

In 1783 Major Congreve had prevented the Government sale of the powder mills at Faversham, because he said a profit could be made by making better gunpowder and in April 1811, he published a report to show the profit that had been made.

The report says that between 1 January 1789 and 31 August 1810, the Royal Mills at Waltham Abbey and Faversham produced 407,408 barrels of gunpowder, each of 100 lbs. The savings to the Government, being the difference between the merchants price and Actual cost, amounted to £288,357. 6s. 0¹/₄d. Taking the factory at Waltham Abbey alone, even after deducting the £45,000 spent on the mills, a saving of over £50,000 was made.



Making charcoal.

The Napoleonic Wars

During the last decade of the 18th century and the first of the 19th century, most of Europe was plunged into war by Napoleon of France. This meant that production at the Royal Gunpowder Factory was mounting.

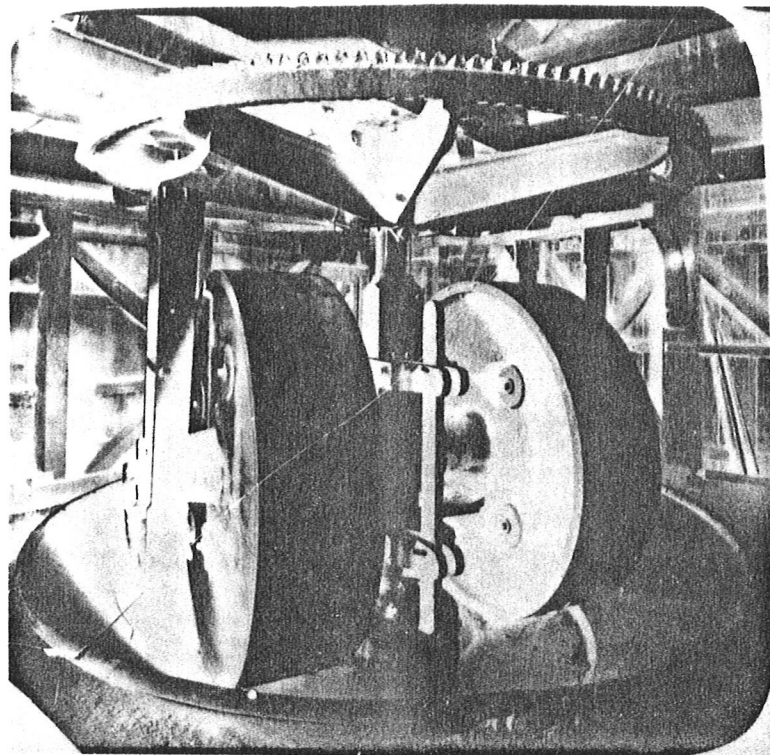
In 1787 the annual production of gunpowder was thought to be about 2,000 barrels. In 1809, 20,050 barrels were produced. This rose to 21,252 in 1811, 21,033 in 1812 and 22,398 in 1813.

Even this rate was increased in the first few months of 1814, but after Wellington's victory, every effort was made to cut down and only 10,161 barrels were produced.

Napoleon's escape from Elba in 1815 resulted in the mills production being maintained and 15,790 barrels of powder were made. Immediately after Waterloo output was reduced drastically to 4,000 barrels in 1816 and 1,000 barrels in 1819.

During the wars 250 people were employed in the factory, this figure went down to just 34 in 1822.

In 1825 the Faversham mills were sold and Waltham Abbey became the only Government owned gunpowder factory.

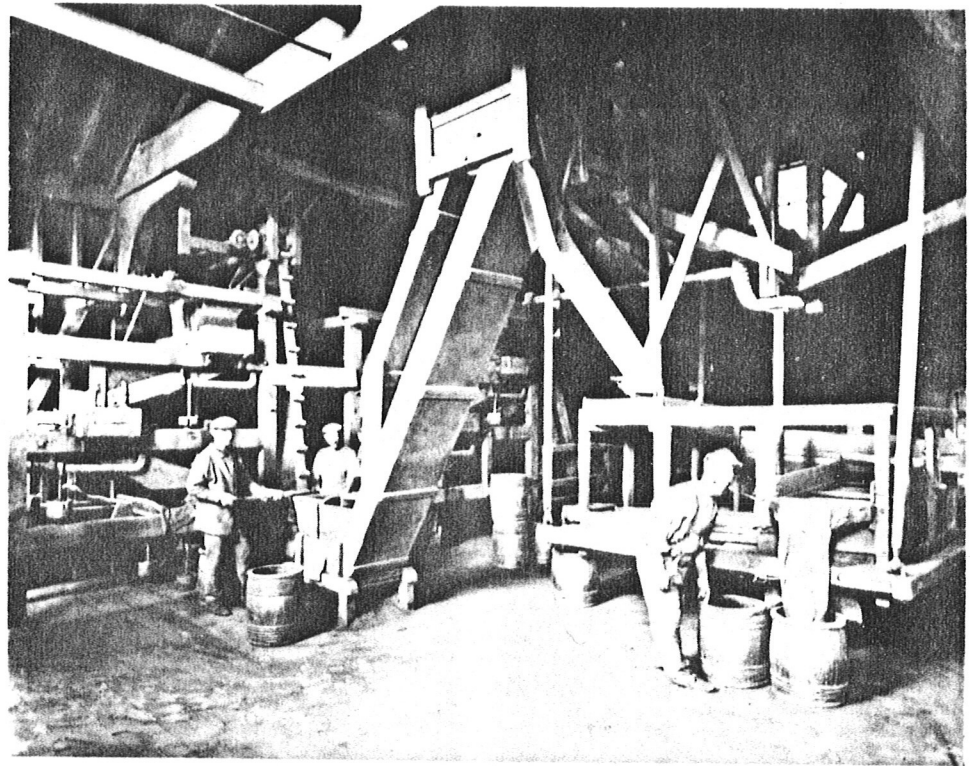


Gunpowder Incorporation.

The Factory until 1863

After the sale of the Faversham factory, Government money was short and a committee was set up to report on the improvements necessary to bring the factory to its upmost efficiency. The committee consisted of Col J.T. Jones, C.B., R.E.; Col Sir Hugh Frazer, K.C.B., R.A. and Major Thomas Moody, R.E.

After the wars, when some buildings had to be demolished, the only machinery remaining in working condition were seven powder mills, three corning houses, a glazing mill and a dusting mill.



The granulation of gunpowder in a corning house.

At this time, the annual production was not more than 3,500 barrels, but after the improvements to the factory made by the committee, it had risen to 18,000 barrels in 1853.

From the end of the wars until 1863, there were only two serious accidents. In April 1843, seven men were killed when a corning house exploded, and one man was killed in an accident in May 1861, when a powder mill blew up.

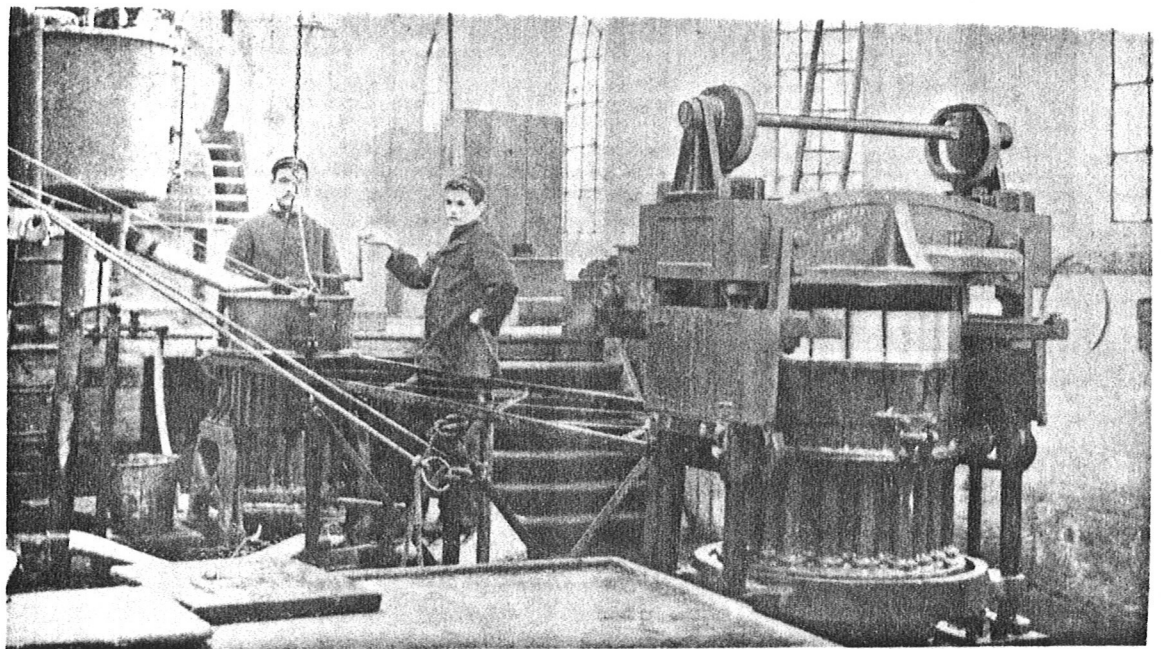
Guncotton

From the earliest times of the factory only gunpowder had been manufactured, but in Switzerland in 1846, a new more powerful and durable explosive was invented.

Professor Christian Schönbein of Basle University, invented guncotton by the action of nitrating acids on cotton.

The first place in England to manufacture guncotton was Faversham, now in private ownership, but this ended when the plant was destroyed by a serious explosion.

In 1863, the first experiments with guncotton were made at Waltham Abbey by Frederick Abel, and these were very successful.

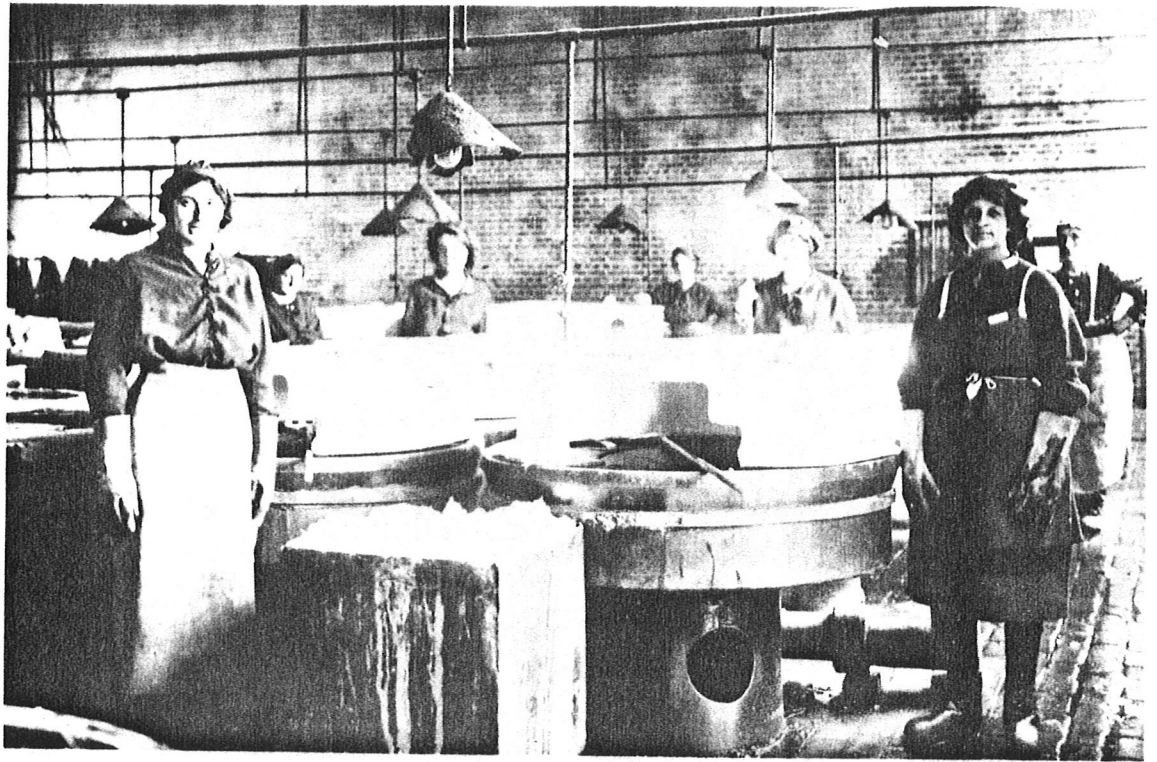


moulding gun-cotton discs.

Between 1863 and 1868, 1000-2000 lbs were made each summer.

Frederick Abel also developed his own process for pulped guncotton which could be compressed into any shape.

In 1872 a plant was set up to produce 250 tons a year.



cotton nitrating during the First World War.

Nitroglycerine and Cordite

In 1891 a nitroglycerine plant was set up at Waltham Abbey, together with the buildings necessary for the making of cordite.

In 1847 nitroglycerine was first made by Professor Ascanio Sobrero of Turin University, by nitrating acids on glycerine. This was tested by Alfred Nobel who wanted to make it more stable than in its liquid form.

To overcome this he prepared a mixture of nitroglycerine, soluble nitro-cellulose and camphor.

Frederick Abel was also experimenting with nitroglycerine at this time and he made a mixture of nitroglycerine, guncotton and vaseline. This mixture was very successful and it could be made into a charge of cords or rods and so received the name cordite.

From 1891 to 1899 and the outbreak of the Boer War, there were two serious explosions (December 1893 and May 1894). These caused the death of 13 men and serious injuries to 21 others.

Between October 1899 and May 1902, the Boer War was taking place in South Africa and

the nitroglycerine plant was steadily producing $18\frac{1}{2}$ tons per week.



Picking cotton for cordite.

The Strand Magazine - March 1895 (Appendix VI)

In 1895, the first account about the processes involved in the manufacture of gunpowder was published. It was written by William G. Fitzgerald for the 'Strand Magazine' following a visit he had made to the gunpowder factory at Waltham Abbey.

His account describes accurately the workings of the factory, but also his thoughts and fears about the immense size and dangers of the explosives stored there.

His fears are best emphasised by the last sentence of his account, 'The tremendous energy that lay dormant in every building oppressed us, even though that energy slept behind massive traverses and walls 10ft. thick; so we came away.'

This is telling us of his relief to get away from the factory and all the dangerous high explosives it contains.

Other High Explosives

After the manufacture of nitroglycerine and cordite at Waltham Abbey, new and more powerful explosives were frequently being developed and manufactured at the factory.

Tetryl (Tetranitrodimethylaniline)

This was first manufactured in 1910 as a booster powder. At first it was made on a small scale, but production was greatly increased in 1914 at the start of the war. Until 1917 Waltham Abbey was the only factory making tetryl and because of this, it was working at full capacity.

T.N.T. (Trinitrotoluene)

T.N.T., probably the most widely known high explosive is made from the action of nitrating acids on toluene. It was first used during the First World War, but due to a curb of Government expenditure, it was not until 1933 that it was made at Waltham Abbey.

R.D.X. (Cyclonite, cyclo-trimethylene-trinitramine or Research Department Explosive)

Probably the most famous high explosive of the Second World War, R.D.X. was first made at Waltham Abbey in 1938. This was only a pilot plant, but when war broke out in 1939, production was greatly increased and Waltham Abbey was the only factory in Britain manufacturing R.D.X.

The End of the Gunpowder Factory

When the war came in 1939, Waltham Abbey was the country's only source of production, so other factories took over the production of the explosives and the contribution of Waltham Abbey decreased.

In the winter of 1940/41 an enemy bomb blew up the last remaining powder mill and production was not resumed. During the war the plant was being run down and it finally ceased the production of explosives on 28 July 1945.

However, in 1944 the site had been surveyed for use as an experimentation plant and this opened in October 1946. This was given the name Explosive Research and Development Establishment (E.R.D.E) in 1947. In 1976 the title became the Propellants, Explosives and Rocket Motor Establishment (PERME), the name by which it is known today.

APPENDIX I

1560

M. Antonio . b

M. S. Carmichael

WMSL 101

Most great and honoured Lord,

Being desirous of seeing the conclusion of my proposition and not knowing whether you have returned I am compelled to send you this bearer, not being able without great trouble to come myself, to inform you of what has happened. You should therefore know that the day after your audience I went as ordered to present the letter to Mr. Brunfil and then to speak with the Lord Secretary who, as soon as he had the information from Mr. Brunfil, sent for me and gave me the schedule which Mr. Brunfil had given to him and said that if I was willing to be satisfied with the prices given in the schedule he would not fail to bring forward the matter to Her Majesty and have it immediately settled; he told me to consider it and then give him my views on that schedule, which is here enclosed, so that your Lordship may see the difference between my offer and that which he would like, which, though small to Her Majesty, is a great deal to me, assuring you, my Lord, that the offer of service which I have made no man can serve at a lower price who wishes to serve well as I do; and this I have done for two reasons, as I told you orally; one being that I have the desire and need to return to my country, the other being to finish the jewel which has been made especially for this Kingdom, as I should not wish in any way for my honour and integrity to have to worry anyone or gnaw my own mind over a matter of such small importance. With regard to that jewel the Lord Secretary said that he wished to mull it over, so that he left me with my mind greatly confused, because if I had known that this jewel was not to be included in the agreement I should not have offered to supply Her Majesty at such a low price, and although the desire which I have to return to my country makes me content to lose something, I should not like to put my situation bluntly to you. I do not wish to believe that Her Majesty nor even the Lord Secretary desires my ruin, but in order for it to be known that I wish to settle the matter reasonably, since the Lord Secretary does not want anyone to speak about the price of the jewel, I am satisfied that it should be put into the hands of someone whom Her Majesty wishes to safeguard it; for the fourth part of the money which I ask for, for that amount of my price the twenty thousand pieces of timber for making

bows, the six thousand strong bows and the two thousand one hundred pounds of sulphur, which does not amount to more than £1141, and for fulfilment of the arrangement, until I have delivered half of the above amounts of sulphur and bows in the manner offered earlier, because in fact I desire very much to make this agreement without being obliged to anyone who promised me the most, since the amount is so small that it would seem that Her Majesty has so little faith in me; and then let that jewel be considered by two free and unprejudiced men, one chosen by Her Majesty or one of her Ministers and the other my myself or my lawyer, and if the two do not agree, let them have authority to choose a third man, and let that which the three, or two of them, agree be put into effect. Since I ought to be paid for that jewel as declared in my offer, let me also either immediately be given the assignment, or else allow me to receive the tin and lead foil, putting as security that sum which is received and adding the consignment of bows and sulphur, or let me be given a guarantee in the Records Office of the manner in which I can obtain such an amount of goods with a rebate, such as foreigners pay, or give me ready money; with regard to the saltpetre I certainly have no authority to set a lower price than £3 10s per hundred pounds, hence I do not ask anything at present, except when I promise, or cause a firm promise to be made, to supply it, the quarter of which I shall give as security until it is despatched in accordance with the time which we shall agree and for the amount because it has not yet been declared. Thus, my Lord, I declare to you in confidence my wish that you should recollect what has passed between us in this agreement. I beg and supplicate you in your mercy that, since I cannot so soon return to Court, you should be so kind as to write to the Lord Secretary and desire him to be so good as to be favourable to the hastening of this business, so that moreover I shall be permanently obliged to you and to him and that you will be satisfied with my matter; and with this, in order not to give you any more trouble, I shall end for now, wishing all prosperity to you and especially to Her Majesty and to all her Kingdom.

Your devoted servant,

Marco Antonio Erizzo

March 1561

in London.

APPENDIX II



D. Leysan sculp

The Graver here hath well thy Face design'd.
But no hand FULLER can expresse thy Mind
For That a RESURRECTION gives to those
Whom Silent Monuments did long enclose.

THE
HISTORY
Francis OF THE *Hargrave.*
WORTHIES
OF
ENGLAND.

Endeavoured by
Thomas Fuller, D.D.



LONDON,
Printed by J. G. W. L. and W. G. MDCLXII.

tion presented in Parliament, in the reign of King *Henry* the sixth, against the wicked weed called *Hopps*. Their back-friends also affirm, the *Stone* never so epidemicall in *England*, as since the generall reception and use of *Hops* in the beginning of King *Henry* the eighth.

* See the Statute 1. *Jacobi* cap. 18.

But *Hops* have since out-grown and over-topped all these accusations, being adjudged wholesome, if *Statutable* and *unmixed* with any powder, dust, dross, sand, or other soyl whatsoever, which made up two parts* of three in forraigne *Hops* formerly imported hither.

They delight most in moist grounds, no commodity starteth so soon and sinketh so suddainly in the price, whence some will have them so named from *hopping* in a little time betwixt a great distance in valuation. In a word, as *Elephants*, if orderly, were themselves enough alone to gain, if disorderly; to lose a victory; so great parcells of this commodity, well or ill bought in the *Crisis* of their price, are enough to raise, or ruine an estate.

Puits.

There is an Island of some two hundred Acres, near *Harwick* in the Parish of *Little-Okeley*, in the Mannour of *Matthew Gilly* Esquire, called the *Puits Island*, from *Puits* in effect the sole inhabitants thereof. Some affirm them called in Latine *Upula*, whilst others maintain, that the *Roman Language* doth not reach the Name, nor Land afford the Bird. On Saint * *George* his day precisely they pitch on the Island, seldome laying fewer then four, or more then six Eggs.

* So am I informed by Capt. Farmer of *Newgate-Market*, Copyholder of the Island.

Great their love to their Young ones. For though against foul weather they make to the main land, (a certain *Prognostick* of *Tempests*,) yet they always Weather it out in the Island, when hatching their young ones, seldome sleeping whilst they sit on their Eggs, (afraid it seems of *Spring-tides*) which signifieth nothing as to securing their Eggs from the *Inundation*, but is an Argument of their great Affection.

Being young they consist onely of *Bones*, *Feathers* and *Lean-flesh*, which hath a raw Gust of the Sea. But *Poulterers* take them then, and feed them with *Gravel* and *Curds*, (that is *Physick* and *Food*,) the one to scour, the other to fat them in a fortnight, and their flesh thus recruited is most delicious.

Here I say nothing of *Eringo Roots*, growing in this County, the candying of them being become a Staple commodity at *Colchester*. These are Sovereign to strengthen the *Nerves*, and pity it is, that any vigor acquired by them should be otherwise employed then to the Glory of God.

Manufactures.

* Pro. 31. 19.

This County is charactred like the good wife described by * *Bathsheba*. She layeth her hand to the spindle, and her hands hold the distaffe. *Bays*, and *Says*, and *Serges*, and severall sorts of *Stuffles*, which I neither can or doe desire to name, are made in and about *Colchester*, *Coxal*, *Dedham*, &c. I say, desire not to name, because hoping that new kinds will daily be invented, (as good reason) and by their Inventers intituled. I know not whether it be better to wish them good Wares to Vent, or good Vent for their Wares, but I am sure, that both together are the best. It will not be amiss to pray that the Plough may go along, and wheel around, that so being fed by the one, and clothed by the other, there may be by Gods blessing, no danger of starving in our Nation.

Gun-Powder.

Why hereof in this, rather then in other Counties? Because more made by Mills of late erected on the river *Ley*, betwixt *Waltham* and *London*, then in all *England* besides. Though some suppose it as antient as *Archimedes* in *Europe*, (and antienter in *India*,) yet generally men behold the Frier of *Mentz* the first founder thereof, some three hundred years since. It consisteth of three essentiall ingredients:

1. *Brimstone*, whose office is to catch fire and flame of a suddain, and convey it to the other two.

2. *Char-cole*.

2. *Char-coal* pulveriz'd, which continueth the fire, and quencheth the flame; which otherwise would consume the strength thereof.
3. *Salt-petre*, which causeth a windy exhalation, and driveth forth the bullet.

This *Gun-powder* is the embleme of polirick revenge, for it *bite*th first, and *bark*eth afterwards, the bullet being at the mark before the report is heard, so that it maketh a noise, not by way of warning, but triumph. As for *white-powder* which is reported to make no report at all, I never could meet with Artift who would seriously avouch it. For, though perchance the noise may be less and lower, yet no sound at all is inconsistent with the nature of *Salt-petre*, and the ventosity thereof causing the violent explosion of the bullet. It is questionable, whether the making of *Gun-powder* be more profitable or more dangerous, the Mills in my Parish having been *five* times blown up within *seven* years, but, blessed be God, without the loss of any one mans life.

The Buildings.

This County hath no Cathedrall, and the Churches therein cannot challenge to themselves any eminent commendation. But as for private houses, *Essex* will own no Shire her superior, whereof *three* most remarkable.

1. *Audley-End*, built by *Thomas Howard*, Earl of *Suffolk* and Treasurer of *England*, as without compare the best Subjects house in this Island. Yet is the *structure* better then the *standing* thereof, as low on one side, so that it may pass for the embleme of *modest merit*, or *concealed worth*; meaner houses boasting more, and making greater show afar off in the eyes of passengers.
2. *New Hall*, built by the *Ratcliffs*, Earls of *Sussex*, but bought from them by *George Villiers*, Duke of *Buckingham*; surpassing for the pleasant shady approach thereunto, and for the appurtenances of Parks round about it.
3. *Copt Hall*, (in Records *Coppice-Hall*, from the Woods thereabouts,) highly seated on an hill in the mid'st of a Park, built by the *Abbot of Waliham*, enlarg'd by Sir *Thomas Heneage* and others; and it is much that *multiform* fancies should all meet in so *uniform* a fabrick. Herein a Gallery, as well furnish'd as most, more proportionable then any in *England*, and on this a story doth depend.

In the year of our Lord 1639. in *November* here happened an *Hirecano* or wild wind, which entring in at the great East-window, blew that down, and carried some part thereof, with the picture of the Lord *Coventry* (singled from many more, which hung on both sides untouch'd) all the length of the Gallery (being about 56. yards) out of the West-window, which it threw down to the ground. It seems the wind, finding this room in form of a *trunk*, and coarctated therein, forced the stones of the first window, like *pellets*, clean thorough it. I mention this the rather, because pious Doctor *Fackson*, Head of *Corpus Christi Colledge* in *Oxford*, observed the like wind about the same time as ominous, and presaging our civil dissensions.

The Wonders.

This Shire affordeth none properly so called, unless some conceive the bones reducible thereunto digged out of this* County at the *Ness* near *Harwich*, which with their bigness and length amazed the beholders. I cannot see how such can maintain them to be the bones of men, who must confesse that according to the proportion of the doors and roofs of antient building, (either as *extant* or *read of*) they must *Ingrede* & *incedere prout*, go in *stooping*, not to say *Lye along*. Except the *Avouchers* be as Incurious of their Credit as the Travellor was, who affirming that he saw *Bees* as big as *Dogs*, and yet their *Hives* of our ordinary size; and being demanded what shift they made to get in; *Let them* (said he) *look to that*.

More probable it is, that those were bones of Elephants, store whereof were brought over into *England* by the Emperour *Claudius*. Indeed some *Sciologists* will boast

* *Camdens Brit.*
in *Essex*.

THE WORTHIES OF ENGLAND.

GUN-POWDER.

Why hereof in this, rather than in other Counties? Because more made by Mills of late erected on the River Ley, betwixt Waltham and London, than in all England besides¹. Though some suppose it as antient as Archimedes in Europe (and antienter in India); yet generally men behold the Frier of Mentz the first founder thereof, some *three hundred* years since. It consisteth of *three* essentiall ingredients:

1. *Brimstone*, whose office is to catch fire and flame of a suddain, and convey it to the other *two*.
2. *Char-coal* pulverized, which continueth the fire, and quencheth the flame, which otherwise would consume the strength thereof.
3. *Salt-petre*, which causeth a windy exhalation, and driveth forth the bullet.

This *Gun-powder* is the embleme of politick revenge; for it *biteth* first, and *barketh* afterwards, the bullet being at the mark before the report is heard; so that it maketh a noise, not by way of warning, but triumph. As for *white powder*, which is reported to make no report at all, I never could meet with Artist who would seriously avouch it; for, though perchance the noise may be less and lower, yet no sound at all is inconsistent with the nature of *Salt-petre*, and the ventosity thereof, causing the violent explosion of the bullet. It is questionable, whether the making of *Gun-powder* be more profitable or more dangerous; the Mills in my Parish having been *five* times blown up within *seven* years, but, blessed be God! without the loss of any one man's life².

APPENDIX III

October. 1665.

Funerals. x /.

day

Willm Davis, servant to Tho: Eaton,	2.
Sildenham Tinley, of St Leonard Shorditch,	3.
Tho: Gutridge, kill'd with a Powder-Mill,	4.
Edward Simons, Carpenter, so kill'd,	5.
Thomas Vincent, Husbandman	6.
Edward, son of Willm Peacock,	6.

October. 1665.

Funerals. x /.

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Siddenhams Tinley, of St Leonard Shorditch,	3.
Tho: Gutridge, kill'd with a Powder-Mill,	4.
Edward Simons, Carpenter so kill'd,	5.
Thomas Vincent, Husbandman	6.
Edward, son of Willm Peacock,	7.

APPENDIX IV

1. A Horse Mill
2. The Corning and Glazing Engine
3. } Three Horse Mills
4. }
5. }
6. The Stables
7. The Coal Mill and Composition House

8. The Carpenters and Mill-wrights work house
9. The Clerks Counting house and the Watch house
10. The Loading house
11. } Two Stamping Mills
12. }
13. } Two Dumb Mills
14. }

15. The Charging house
16. The old Composition house
17. The Store house
18. The Duffing house
19. The Little Store
20. Three Sun Stoves, or drying Leads
21. The great Store



To John Walton Esq. Proprietor of these Mills this Plate is



humbly dedicated by his Obedient humble Servant J. Farmer
 Jas. Mundis

APPENDIX V

DATED

14th August

1795

JOHN WALTON, Esq.

- to -

HIS MAJESTY

Copy

R E L E A S E

of Powder Mills and premises situate
at Waltham Abbey and Barking Creek
in the County of Essex.

Treasury Solicitor,
Storey's Gate,
Westminster, S.W.1

T H I S I N D E N T U R E made the 14th day of August in
the 35th year of the Reign of our Sovereign Lord George the
Third by the Grace of God of Great Britain France and Ireland
King Defender of the Faith &c and in the year of our Lord
1795 B E T W E E N JOHN WALTON of Upper Seymour Street
in the Parish of St. Mary le bone in the County of Middlesex
Esqre (Nephew and heir at law and also devisee in fee and sole
executor named and appointed in and by the last Will and
Testament of James Walton late of Newman's Court Cornhill in
the City of London Esqre deceased and likewise eldest son and
heir at law of William Walton late of Burgh Castle near
Yarmouth in the County of Norfolk Esqre deceased who was the
eldest son and heir at law of Philippa Walton Widow deceased
and which said John Walton is likewise the Nephew and legal
personal representative of Philippa Walton Ann Walton and
Elizabeth Walton Spinsters Daughters of the said Philippa
Walton Widow all deceased) of the one part and HIS MOST
EXCELLENT MAJESTY OUR SOVEREIGN LORD KING GEORGE THE THIRD
of the other part W H E R E A S the principal officers
of His Majesty's Ordnance did some time in the year 1787, for
and on behalf of His Majesty contract and agree with him the
said John Walton for the absolute purchase of the freehold
and inheritance in possession of and in the several powder
mills messuages landstenements islands or ozier grounds
hereditaments and premises situate at Waltham Abbey in the
Parish of Waltham Holy Cross in the County of Essex herein-
after particularly mentioned and described Subject to the
claims of Sir William Wake his heirs and assigns and of Thomas
Jessop his heirs and assigns to certain easements to which
they claim a title to and also of and in the hereditaments and
premises situate at Barking in the said County of Essex here-
inafter also particularly mentioned and described at or for
the price or sum of £10,000 of lawful - - - - -

money of Great Britain and did thereupon (by and with the
privity and consent of the said John Walton) take possession
thereof for His Majesty's use and have ever since received
and enjoyed the Rents Issues and Profits thereof but no
Conveyance of the said Hereditaments and premises was then
executed by the said John Walton by reason of certain
Objections made by or on behalf of the said Principal Officers
touching the title of the said John Walton to some parts of
the said hereditaments and premises and until such Objections
should be removed it was proposed and mutually agreed that
the said sum of £10,000 should be issued out of the Treasury
of His Majesty's said Office of Ordnance and invested in the
purchase of Stock and that the Dividends of such Stock should
in the mean time be paid to or received by the said John
Walton A N D WHEREAS in pursuance of the said Agreement
the said sum of £10,000 was in or about the month of January
1789 issued accordingly and laid out and invested in the
purchase of £13,628. 12. 6d. Three per cent Reduced Annuities
in the joint names of the said John Walton William Smith
Esquire (Treasurer of the said Office of Ordnance) and
Augustus Rogers Esquire (then Secretary to the said Board
of Ordnance but since deceased) and the Dividends thereof
have been from time to time retained and received by the said
John Walton A N D WHEREAS the said Objections so made to
the said Title of the said John Walton have been by him
lately removed or satisfactorily indemnified against and in
consequence thereof the said Stock hath by and with the
consent and direction of the said Principal Officers been
this day transferred and assigned by them the said John
Walton and William Smith (surviving Trustees as aforesaid)
unto and in the proper name of the said John Walton for his
own use and benefit which he the said John Walton doth hereby
acknowledge and declare N O W THIS INDENTURE WITNESSETH
that in pursuance of the said contract and of such subsequent

proposal and mutual agreement as aforesaid and for the
 considerations aforesaid and which the said John Walton
 doth hereby acknowledge to be in full for the absolute
 purchase of the Fee Simple and Inheritance in possession of
 and in the said hereditaments and premises with the appur-
 tenances hereinafter particularly mentioned and described
 and of and from the same and every part thereof doth acquit
 release and discharge as well the said Principal Officers
 and their Successors Principal Officers of the Ordnance for
 the time being as also his said Majesty his Heirs and
 Successors for ever by those presents He the said John Walton
 Hath granted bargained sold aliened released and confirmed
 And by these presents Doth grant bargain sell alien release
 and confirm unto His said Majesty (in his actual possession
 now being by virtue of a Bargain and Sale to him thereof
 made by the said John Walton in consideration of Five
 shillings by Indenture bearing date the day next before the
 day of the date of these presents for one whole year commenc-
 ing from the day next before the day of the date of the same
 Indenture and by force of the Statute made for transferring
 uses into possession) and to his Heirs and Successors ALL
 THOSE three Powder Mills wrought by three wheels heretofore
 1. an Oil Mill and a Messuage or Dwellinghouse with the appur-
 tenances and the several outhouses used for the working
 corning and drying Gunpowder and all the outhouses and edifices
 to the said Mills and Dwellinghouses belonging heretofore
 in the tenure or occupation of Ralph Hudson and Nicholas
 Falcon successively and afterwards in the possession of the
 said Philippa Walton Widow deceased her undertenants or
 2. assigns And also ALL THAT close abutting East upon Thrushings
 Lane leading to the aforesaid premises containing by estima-
 tion 3 roods and 30 perches or thereabouts be the same more
 3. or less And also ALL THAT close adjoining to the said Mills
 containing by estimation half an acre or thereabouts and the

- Banks on each side of the River containing together by estimation one acre and an half or thereabouts And all those two Islands or Ozier Beds containing together one rood or
4. thereabouts together with the water of the River to the said Powder Mill and premises belonging and appertaining commonly called or known by the name of the Fulling Mill River extending itself in length from the Lock above the said Mill at the North end of a Mead or Meadow there called Edmondsy Mead and formerly called the Fulling Mill Lock unto the said Mills and beneath the said Mills unto the River there heretofore called Mr. Blett's and afterwards Mr. Raddon's River together with the aforesaid Lock or the water passage and the fishing and Liberty of Fishing in the said River And also ALL Tythes and Tenths happening coming growing or renewing in or out of the said hereby granted and released Mills Lands and premises or any part thereof formerly belonging to the Parsonage or Vicarage of Waltham Holy Cross in the said County of Essex
 5. And also ALL THAT Field or Close now or heretofore called or known by the name of Rushfield alias Hooksfield containing
 6. by estimation 7 acres or thereabouts And also all that Field or Close now or heretofore called or known by the name of Sheepcoat Field otherwise Fair Field containing by estimation 10 acres or thereabouts heretofore in the occupation of John Bell his undertenants or assigns and which said two Fields or Closes or some part thereof were some time since converted into four closes and were heretofore in the tenure or occupation of Mary Bell her assigns or undertenants all and every of which said Mills closes lands and premises are situate lying and being in the said Parish of Waltham Holy Cross in
 7. the said County of Essex And also ALL THAT Powder Magazine together with the Cooperage and a messuage or tenement used as a dwellinghouse of him the said John Walton situate and being on the East side of Barking Creek in the Parish of Barking in the said County of Essex together with the yards

and appurtenances thereunto belonging and which for many years past have been held by the said John Walton and his ancestors as their share and allotment upon a partition which was made of a large piece of ground and Buildings and of which the Ancestors of the said John Walton were entitled to one undivided fourth part such partition having been made in pursuance of a Decree of the High Court of Chancery bearing date on or about the 3rd day of May 1737 in a Cause wherein Thomas Pearse and Robert Norman were Plaintiffs and the said Philippa Walton Widow John Walton Bythia Fogg and Catherine Fogg were

8. Defendants And also ALL THAT messuage or tenement situate lying and being in West Street in Waltham Abbey aforesaid abutting South on the said Street and East West and North on the Powder Mill Stream and all Barns Stables Buildings Yards Gardens Orchards Backsides Closes Lands and Appurtenances to the said Messuage or Tenement belonging or in anywise appertaining or therewith usually held occupied or enjoyed
9. And also ALL THAT plot of Meadow Ground containing by estimation 1 acre more or less abutting North on the said Street over against the said Messuage or Tenement and East on the said Stream and South on the main river and which said messuage or tenement piece of Meadow Ground and premises were formerly in the tenure of William Dean and James Logg And also
10. ALL THAT water or Fishing commonly called or known by the name of Cesnore or Fisher's Wear with all the Islands or Ozier Grounds thereunto belonging or appertaining lying and being between Hallefield Marsh Bridge and the Black Ditch in the said Parish of Waltham Holy Cross in the said County of Essex (that is to say) All that Island or Ozier Ground that lyeth West of the River of Lee and is bounded on the East and North by the said River and on the South and West by Frithy Mead
11. containing by estimation seven poles And also ALL THAT Island or Ozier Ground that lieth west of the said river of Lee and is bounded East and North by the said river and South and West

- by Frithy Mead containing by estimation 24 poles And also
12. ALL THAT Island or Ozier Ground bounded by the said River of Lee on the West North and South and on the East by a Meadow belonging to Fisher's Farm containing by estimation 1 rood
 13. and 6 pole And also ALL THAT Island or Ozier Ground bounded by the said River of Lee on the East and North and on the West and South by a Meadow belonging to Hookes Farm containing
 14. by estimation four pole And also ALL THAT Island or Ozier Ground bounded by the said River of Lee on the East and on the North and West by Hooke's Marsh and on the South by the Powder Mill Lock containing by estimation 2 roods And also
 15. ALL THAT Island or Ozier Ground bounded by the said River of Lee on the West and North and on the East and South by North
 16. Mead containing by estimation 43 pole And also ALL THAT Island or Ozier Ground bounded by the said River of Lee on the South and West and on the East and North by North Mead
 17. containing 14 pole And also ALL THAT Island or Ozier Ground bounded by the said River of Lee on the East and North and on the West and South by Edmondsey Mead containing by estimation
 18. 14 pole And also ALL THAT Island or Ozier Ground bounded by the said River of Lee on the West and on the North East and South by North Mead containing by estimation 20 pole
 19. And also ALL THAT Island or Ozier Ground bounded by the said River of Lee on the East and on the West North and South by Edmondsey Bank containing by estimation five pole And also
 20. ALL THAT Island or Ozier Ground bounded on the North by Waltham North Marsh on the West by the Common Marsh on the South and East by a parcel of Ground called Waltham Hoppitt and Waltham North Marsh aforesaid containing by estimation
 21. 1 acre and 2 roods And also ALL THAT Island or Ozier Ground bounded on the West by the Common Marsh aforesaid and on the South East and North by Waltham Hoppitt aforesaid containing
 22. by estimation 3 roods and 8 pole And also ALL THAT Island or Ozier Ground bounded on the West by the aforesaid River of Lee

- and on the North East and South by a certain Meadow heretofore
belonging to the Heirs of Edward Greene containing by estima-
23. tion 2 rood and 20 pole And also ALL THAT Island or Ozier
Ground bounded on the West by the aforesaid River of Lee
on the North by the Meadow late Edward Greene's aforesaid on
the East by Town Mead and on the South by Cobbin Brook
24. containing by estimation 2 acres And also ALL THOSE fishings
and Watercourses of that Wear upon the said River called
Hooke Wear with all and singular their and every of their
appurtenances to the said premises or any part thereof
belonging or appertaining or in whatsoever other situation
state plight or condition, the said Wear Fishery Islands and
premises or any part or parts thereof may by length of time
and the currency and effluxion of the said River or otherwise
be now in all which premises are situate lying and being in
the Parish of Waltham Holy Cross alias Waltham Abbey in the
County of Essex aforesaid and were some time parcel of the
Demesne of or belonging to the Manor of Waltham and were
heretofore in the tenure or occupation of Boulton
Widow William Jones and Peter Hudson their assigns or under-
25. tenants And also ALL AND SINGULAR other the Powder Mills
messuages or tenements Dwellinghouses Warehouses Lands
Meadows Closes Tithes Fishings Islands or Ozier Grounds
Hereditis and premises of him the said John Walton (party
hereto) situate at Waltham Abbey and Barking aforesaid or
either of them Together with all and singular the Buildings
erections and Improvements now standing and being thereon and
made thereto by whatsoever name or names Metes Bounds
quantities or Descriptions the same or any part thereof now are
or is or at any time heretofore have or hath been known called
or distinguished and all Houses Outhouses edifices Buildings
yards Gardens Orchards Stables Woods Underwoods and the
Ground and Soil thereof Hedges Ditches Mounds Fences Waters
Watercourses Ways Paths Passages Liberties Immunities

privileges profits commodities Rights Easements advantages
emoluments and appurtenances whatsoever to the said several
Powder Mills messuages or tenements dwellinghouses warehouses
lands meadows closes tithes Fishings Islands or Ozier Grounds
hereditis and premises belonging or in any wise appertaining
or therewith now or at any time heretofore held used occupied
or enjoyed or accepted reputed deemed taken or known as part
parcel or member thereof or of any part thereof and the
reversion and reversions remainder and remainders yearly
and other rents issues and profits thereof and of every part
thereof and all the estate right title interest inheritance
use trust property possession claim and demand whatsoever
both at law and in equity of him the said John Walton of in
to or out of the said several Powder Mills Messuages or
tenements dwellinghouses Warehouses lands meadows closes
Tithes Fishings Islands or Ozier Grounds hereditis and
premises or any of them or any part or parcel thereof and
also all Deeds Muniments and Writings whatsoever relating to
or concerning the same hereditaments and premises or any
of them or any part thereof now in the custody or power of
him the said John Walton or which he can come at or procure
without suit at law or in equity TO HAVE AND TO HOLD the said
several Powder Mills messuages or tenements dwellinghouses
warehouses lands meadows closes tithes Fishings Islands
or Ozier Grounds hereditaments and premises hereby granted
and released or mentioned or intended so to be with their
and every of their appurtenances unto His said Majesty his
heirs and successors To and for the only proper Use and
Behoof of His said Majesty his heirs and successors for ever
AND the said John Walton doth hereby for himself his heirs
executors and admors covenant promise and agree to and with
his said Majesty his heirs and successors in manner following
(that is to say) that (for and notwithstanding any act deed
matter or thing whatsoever by the said John Walton or any of

his ancestors heretofore had made done committed or executed or knowingly permitted or suffered to the contrary) he the said John Walton now at the time of the sealing and delivery of these presents is and standeth lawfully and rightfully seized of and in the said several Powder Mills messuages or tenements dwellinghouses warehouses lands meadows closes tithes Fishings Islands or Ozier Grounds hereditaments and premises hereinbefore mentioned and intended to be hereby granted and released with their and every of their appurtenances of a good sure perfect absolute and indefeasible estate of inheritance in Fee simple in possession without any condition contingent proviso trust power of revocation or limitation of use or uses or any other matter restraint or thing whatsoever to alter change charge revoke defeat incumber or make void the same And also that for and notwithstanding any such act deed matter or thing as aforesaid he the said John Walton now hath in himself good right full power and lawful and absolute authority to grant release and convey the said several Powder Mills messuages or tenements dwellinghouses warehouses lands meadows closes tithes Fishings Islands or Ozier Grounds hereditaments and premises with their and every of their appurtenances unto and to the use of His said Majesty his heirs and successors according to the true intent and meaning of these presents AND FURTHER that it shall and may be lawful to and for His said Majesty his Heirs and Successors from time to time and at all times hereafter peaceably and quietly to enter into and to have hold use occupy possess and enjoy the said several Powder Mills messuages or tenements dwellinghouses warehouses lands meadows closes tithes Fishings Islands or Ozier Grounds hereditaments and premises hereby granted and released or mentioned and intended so to be and every part and parcel thereof with the appurtenances and to receive and take the rents issues and

profits thereof to and for his and their own use and benefit without any the lawful let suit trouble denial eviction interruption claim or demand whatsoever of from or by him the said John Walton his heirs or assigns or of from or by any other person or persons whosoever having or lawfully or equitably claiming or to claim any estate right title trust or interest of in to or out of the same several premises or any of them or any part thereof by from under or in trust for him the said John Walton or by from or under any of his ancestors and that free and clear and freely clearly and absolutely acquitted exonerated and discharged or otherwise by him the said John Walton his heirs executors or admors well and sufficiently saved defended kept harmless and indemnified of from and against all and all manner of former and other gifts grants bargains sales leases mortgages assignments jointures dowers thirds right and title of dower and thirds uses trusts wills intails statutes recognizances judgments extents executions annuities rents arrears of rent surrenders forfeitures reentries cause and causes of forfeiture and reentry and of from and against all and singular other estates titles charges and incumbrances whatsoever had made done committed occasioned or suffered by the said John Walton or any of his ancestors or any other person or persons claiming or to claim by from through or under him or them or any of them or by from or through his their or any of their act deed means assent privity or procurement (save and except the claim of Sir William Wake his heirs and assigns to certain easements heretofore enjoyed by the said John Walton and his ancestors at a yearly rent and the right of Thomas Jessop his heirs and assigns to certain other easements heretofore enjoyed by the said John Walton and his ancestors at a yearly rent and save and except the repairing the Bridge near the House of the said Thomas Jessop and which rents and the said repairs and

all other charges to which the premises hereinbefore mentioned and hereby released or intended so to be may be liable the said Principal Officers for and on behalf of his Majesty have agreed to take upon themselves) AND moreover that he the said John Walton and his Heirs and all and every other person and persons having or lawfully or equitably claiming or who at any time or times hereafter shall or may have or lawfully or equitably claim any estate right title interest use trust or demand whatsoever of into or out of the said several Powder Mills messuages or tenements dwellinghouses warehouses lands meadows closes tithes Fishings Islands or Ozier Grounds hereditis and premises hereby granted and released by from under or in trust for him the said John Walton or by from or under any of his ancestors (other than and except the several persons claiming in respect of the said several easements respectively and of the reparations of the said Bridge as aforesaid) shall and will from time to time and at all times hereafter upon the reasonable request and at the proper costs and charges in the law of his said Majesty his heirs and successors make do acknowledge levy suffer and execute or cause or procure to be made done acknowledged levied suffered and executed all and every such further and other lawful and reasonable act and acts deed and deeds things devices conveyances and assurances in the law whatsoever for the further better more perfect and absolute granting releasing and assuring of the same several Powder Mills messuages or tenements dwellinghouses lands meadows closes tithes Fishings Islands or Ozier Grounds hereditis and premises

with their and every of their appurtenances unto and to the
use of his said Majesty his heirs and successors for ever
be the same by fine Feoffment Common recovery or otherwise
howsoever as by his said Majesty his heirs or successors or
his or their Counsel learned in the law shall be lawfully
and reasonably devised or advised and required so as such
further assurances contain in them no further or other
warranty or covenants than against the person or persons his
her or their heirs who shall make or do the same And so as
the person or persons who shall be required to make do or
execute the same be not compelled or compellable for the
making or doing thereof to go or travel above five miles
from his her or their then most usual dwellings or places
of abode IN WITNESS whereof the said parties to these
presents have hereunto set their hands and seals the day and
year first above written

SEALED AND DELIVERED (being)
first duly stamped) in the)
presence of)

JNO. WALTON (L.S.)

Robt. Smith
Atty at Law,
Basinghall Street,
London.

Henry Smith,
Atty at Law,
Drapers Hall,
London.

APPENDIX VI

How Explosives are Made.

BY WILLIAM G. FITZGERALD.



IN writing to a Government Department for assistance in literary matters, there is a delightful uncertainty. You may be refused—let down gently, it is true—but still refused. The refusal, on the other hand, may be chilling, or even severely aggressive. If the reply is none of these, it surely contains official assent—formal, gracious, comprehensive. Such was the letter sent by Dr. W. Anderson, Her Majesty's Director-General of Ordnance Factories, in answer to our application for official permission to visit the famous Royal Gunpowder Factory, whose main gate is almost under the shadow of the ugly Norman tower of Waltham Abbey.

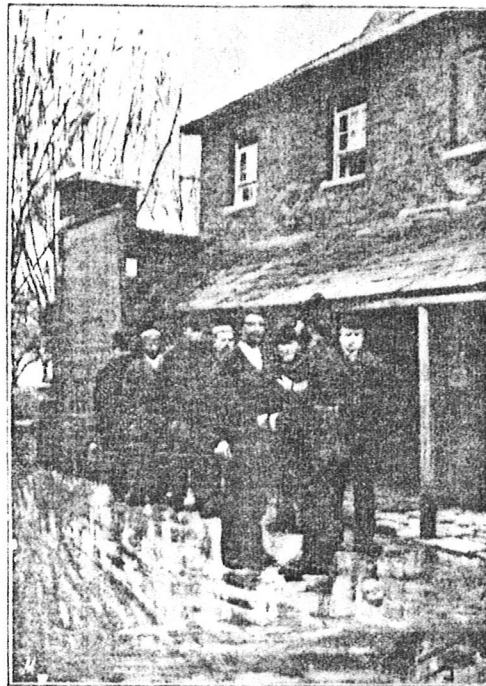
Here, indeed, is the most extraordinary factory in the world. Factory is quite a misnomer applied to this lovely and picturesque domain. The establishment consists of about four hundred acres of wooded land, intersected by four miles of crystal streams, which would fill the angler's heart with delight.

As a matter of fact, the place was bought by the Government, in 1787, from John Walton, a direct descendant of the immortal Izaak; and the name of the former may yet be seen inscribed on a sundial in the quadrangle near the office of the superintendent, Colonel Ormsby. This sundial, by the way, is robbed of much of its quaint and picturesque nature by eight big shells, which are symmetrically arranged about the base, and which, we need hardly say, are not described in any work on conchology.

It goes without saying that Waltham has its stirring and exciting moments. Quite apart from the fact that the vast powder factory is, to put it mildly, a continual menace to the local public peace, there are a surprising number of streams about the place, which overflow in winter, and occasionally compel the inhabitants to go a-punting down High Bridge Street.

Nevertheless, Waltham is a pretty town; and, as one turns off from the main street into the lane leading to the principal entrance of the factory, one cannot help admiring the pastoral scenes of woodland and meadow, which render it difficult to believe that the

most dangerous industry in the world is carried on within a few hundred yards. Passing in at the gate we beheld an avenue of stately poplars, at the end of which the Union Jack floated proudly from a flag-staff. This gave rise to a train of thought from which we were rudely aroused by a sharp challenge from the inspector of police. We were then requested to enter the police quarters, where we were plied with questions as to our business, and whether we possessed any matches, pipes, or steel implements. Then we turned out our pockets, just as Lord Sandhurst had to do when he



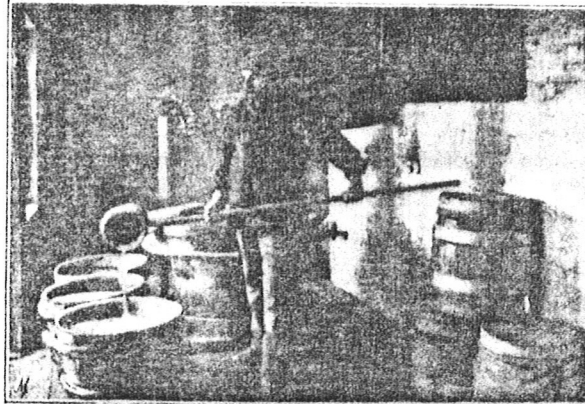
NO. 1. "ANY MATCHES?"

visited the factory for the purpose of opening the hospital. In fact, all comers, from the Prince of Wales down to the humblest factory lad, are interrogated by the police at the gate with a strict regard for duty that reminded us of certain anecdotes in our school-books. Our illustration (No. 1) shows one of the sergeants of police searching the men at the main gate.

The gallant colonel assured us that the way was long, and therefore it would be better for us to set off on our personally conducted tour at once. He was right. The buildings seemed to be scattered far and wide, as though it were the primary intention of the authorities to occupy every available square foot of land. We walked miles; we plunged into thickets, crossed innumerable streams, and occasionally glided from one building to another in a swift electric launch, the panting of whose screw scared the birds and rabbits that abound in this extraordinary place.

But we must commence *ab initio*. The first place we visited—and we were calm and appreciative then, not knowing the extent of the appalling task that lay before us—was the saltpetre refinery shown in No. 2. To the right in the photograph is Mr. Knowler, the "father of the factory," as he is called from the fact of his forty-three years' service. The saltpetre comes from Scinde in bags of 100 lb., and in this state it contains about 5 per cent. of impurities. It is dissolved in large quantities in water heated to 230 degrees, and, after careful skimming, the solution is pumped into the coolers shown in No. 2. The saltpetre crystallizes in these coolers, and is then raked from the bottom in the form of wet snow, which is piled up, and subsequently undergoes a wash-

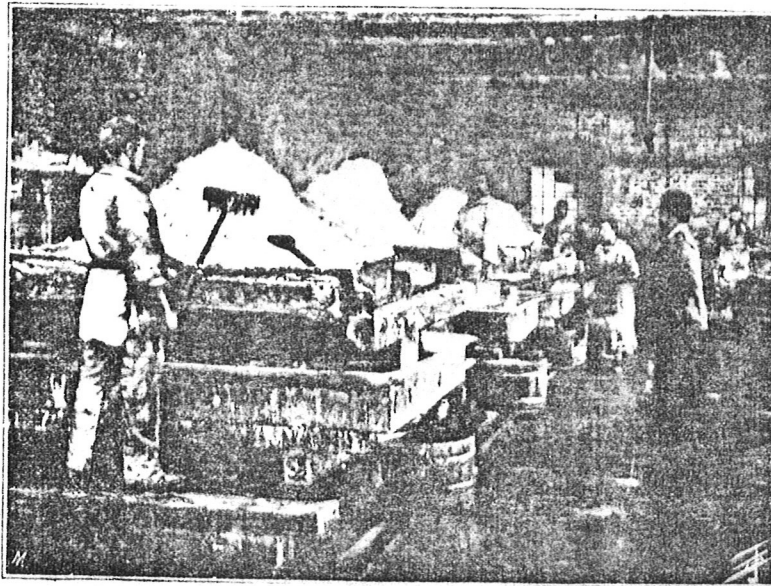
ing process by means of a continuous stream of water. There are four refining coppers and seven evaporating pots in the refining-room. The saltpetre is ultimately sent to the mixing-house in barrels, with a certificate showing that it contains between 3 and 6 per cent. of water. The saltpetre refuse is bought by farmers for from 8s. to 12s. per ton. We next called at the sulphur refinery (Illus. No. 3), but found it almost impossible to breathe within its evil-smelling precincts.



NO. 3.—THE SULPHUR REFINERY.

As regards the worthy man we found there, he was as unconcerned as though he were inhaling the ozone on Brighton Pier; more, he proceeded to give us, out of the fulness of his twenty-six years' experience, a few details concerning his own department in quite a

graphic manner. Six hundredweight and a half of Sicilian sulphur is shot into the retort, seen to the right in the picture, and after it has remained there about three hours it passes in vapour from the retort, through cold-water jacketed pipes, into the receiving-pot, where it arrives in a treacly mass. Our friend is seen ladling this viscous matter into the casting tubs, in which it is left for about eighteen hours. Next morn-



NO. 2.—THE SALTPETRE REFINERY.

ing these tubs are emptied, and out of each comes two hundredweight of purified sulphur, which resembles a monstrous custard. This also goes to the mixing-room, after having been ground in the sulphur mill.

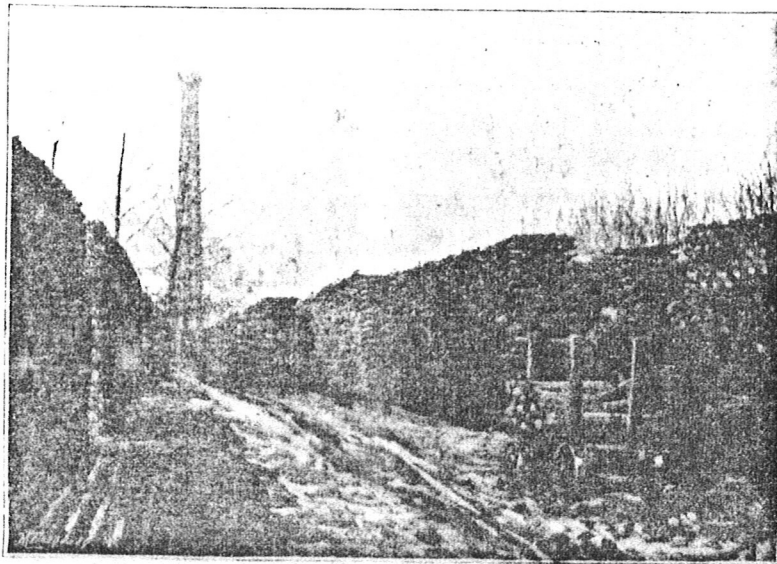
There remains one other constituent of powder to be investigated — namely, charcoal. Why, we asked, are there such extensive groves and forests of willow, dog-wood, and alder within the boundaries of this strangest of factories? One reason is that the wood is converted into charcoal; and another, that a dense growth of trees serves to locate the effects of a possible explosion.

No. 4 is a view of the wood stacks, many of which are from three to ten years old.

Now let us see what these workmen are going to do with the seasoned branches they are loading on to the trolley.

No. 5 is a view of the charcoal-room. The wood is placed in the cylindrical

drums, and the latter are then run into furnaces shaped to receive them, by means of travelling cranes. After from three to eight hours of very great heat, during which time the very gases from the burning wood

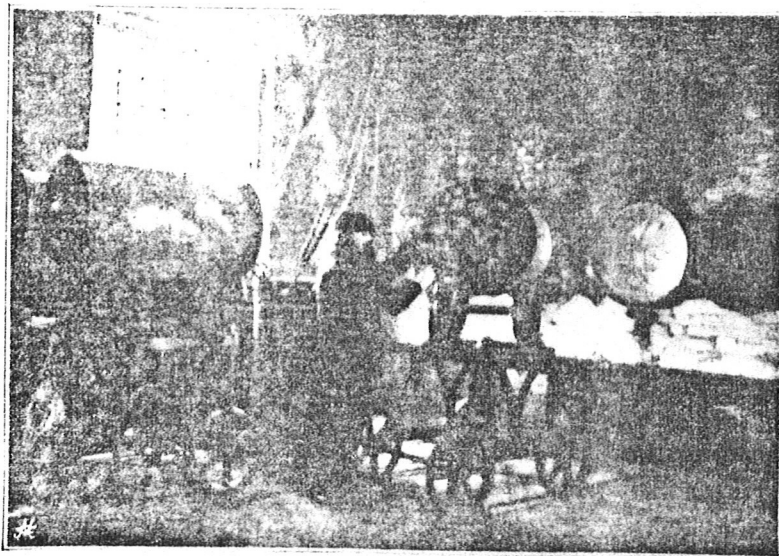


NO. 4.—THE WOOD STACKS.

are utilized as fuel in the furnace below, the drums are withdrawn and their contents shot into air-tight iron vessels to cool for four hours. The charcoal is subsequently removed to smaller coolers, where it remains another twelve hours, after which it is taken by boat to the store. Here it remains for a day or two before being

picked over by hand, in order to see that there are no nails or pieces of iron in it. The responsibility of this last-mentioned work may be judged when we state that, if the smallest particle of gritty matter of any sort is inadvertently passed over, it infallible means an awful explosion and certain loss of life.

The sulphur is ground so as to pass through a sieve having 36



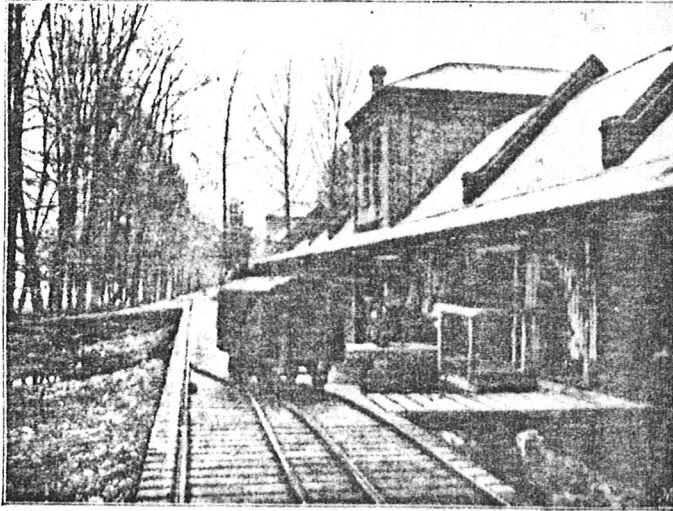
NO. 5.—MAKING CHARCOAL.

openings to the square inch; the charcoal is passed through a mesh 32 to the inch. Now we are ready for the mixing-room. Of this strange place it was impossible to obtain a photograph, owing to the darkness that prevailed. Grimy men flitted through an almost tangible gloom; and in one corner an expert was weighing up the saltpetre, sulphur, and charcoal in parts of

which revolve two enormous wheels, each weighing four tons.

Into this bed is shot the contents of the half-charge sack brought from the mixing-house. A wooden "plough" is then fixed from the centre, so as to keep the powder continually under the rollers, and then all is ready for starting the machinery. Even in this stage the mixture is highly inflammable, and therein lies the *raison d'être* of the "flash-board," which is seen over the bed. In the event of an explosion, either through the wheels meeting with gritty particles in the mixture, or from other causes, this board would be violently thrown upwards on hinges, and in its descent backwards would automatically overturn tanks of water, not merely on to its own bed, but also on the beds of its working neighbours, who might otherwise be tempted to join in the riot.

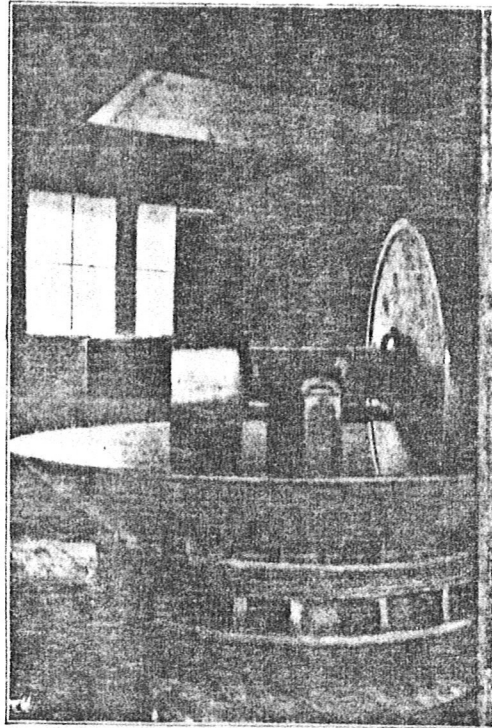
Indeed, the risk is so great, that in order to



NO. 6.—INCORPORATING MILLS: EXTERIOR VIEW.

75, 10, and 15 respectively. For powder for big guns, however, the proportions are 79, 3, and 18. These constituents were shot into a revolving drum fitted with blades inside. The mixture is afterwards packed in half-charge sacks of 60lb. and sent to the incorporating mill—the first of the "danger buildings."

In No. 6 is shown a set of incorporating mills, which are built in groups of six, and are worked by independent machinery. Except for the division walls, these mills are constructed of the flimsiest material possible, the roof being of wood, and the fronts of canvas, buttoned on to a slight iron framework; this is in order that no resistance may be offered to a possible explosion. It will be noticed that the arms of the danger signals are raised, in order to show that the mills are working; when these signals are up, no barrow or truck-load of powder, in any stage whatsoever, is allowed to pass by the mills. Yet the interior of any one of the incorporating mills is not calculated to strike awe or terror into the heart of the visitor. As will be seen from No. 7, there is nothing in the place but a big, circular iron bed, round



NO. 7.—INCORPORATING MILL: INTERIOR.

start the incorporating mill, the operator prudently draws down the flaps of his cloth helmet, puts on his gauntlets, and retires outside, as is shown in No. 8. The man is



NO. 8.—STARTING THE INCORPORATING MILL.

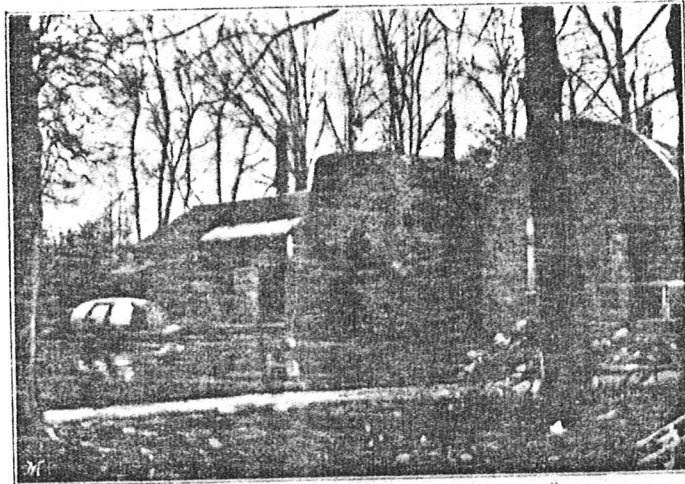
clothed in a suit of "lasting"—that curious leathery material affected by the London apprentices in the days of Queen Elizabeth. There are no pockets in this suit, and the buttons are of bone; no powder adheres to this material. The men are even forbidden to cultivate long beards, lest perhaps these hirsute appendages should contain particles of grit, harmless enough in themselves, but more deadly than cholera bacilli when introduced into a powder mill.

After being three and a half hours beneath the incorporating rollers, the mixture becomes "mill-cake," and is removed in covered trucks to the breaking-down house. This building, in common with most of the other danger buildings, is lighted at night by electric lamps, immersed in water, and placed outside the windows. In the breaking-

down house the mill-cake is placed in a hopper, drawn up on an endless band, and crushed into meal powder by two pairs of gun-metal rollers. Only twelve charges of 120lb. each are allowed in this house at one time.

The next department is the press-house, an exterior view of which is shown in No. 9. The machine-house is on the left, and the men's retiring-room on the right. Between these two buildings is placed the "traverse," a mighty mass of masonry, concrete, and earth, which is intended to protect the workmen; these latter are compelled to remain in the lobbies while the machinery is in motion. In the press-house one of the most dangerous operations takes place. Copper plates are fixed in a rack in a huge iron box, and about 750lb. of meal powder is strewn between them. A hydraulic ram of from 63 to 500 tons pressure is then brought to bear upon the plates for half an hour, during which time the men are congregated in the shoe-room on the other side of the traverse. It is no exaggeration to say that there is an awful uncertainty about this operation.

A bell rings when the pressure gauge reaches a certain point, and the men then return to the machine-room and remove the "press-cake," as it is now called, from the plates. The regulations caution the men against "undue haste" in removing the cake, and the authorities have thoughtfully provided



NO. 9.—THE PRESS-HOUSE, SHOWING "TRAVERSE."

deep wells outside each danger building, into which men who have been badly burnt may plunge. No more than 900lb. of powder may be kept in the press-house at one

time. No. 9 also shows a covered powder boat on the left. There are thirty-six of these boats altogether, and no one is allowed to go over a bridge while one of them is passing beneath, lest any dirt or grit should fall upon the immaculate deck.

The press-house is the parting of the ways, so to speak, of the various kinds of powder, which are made from press-cake treated in different ways. For pebble powder the press-cake—which, by the way, resembles thick black slate—is cut into strips, and these strips are further cut into “ $\frac{5}{8}$ cubes.” The rest of the cake is reduced to coarse powder by three pairs of graduated rollers.

All sorts of fearsome notices and cautions abound in the retiring-room of the press-house, which is depicted in No. 10. A rigorous line of demarcation is formed by an upright board, before passing which every visitor, from the Government inspector downwards, is compelled to put on a pair of enormous boots over his own. In No. 10 the chief foreman is seen undergoing this operation. This precaution is taken in order that no gritty particles may be introduced on to the soft leather floor of the danger buildings. Having put on these boots, you shuffle shamefacedly round the traverse to the machine-room. We say shamefacedly advisedly, for we defy any man to walk a dozen yards in these safety-boots and yet maintain a semblance of dignity.

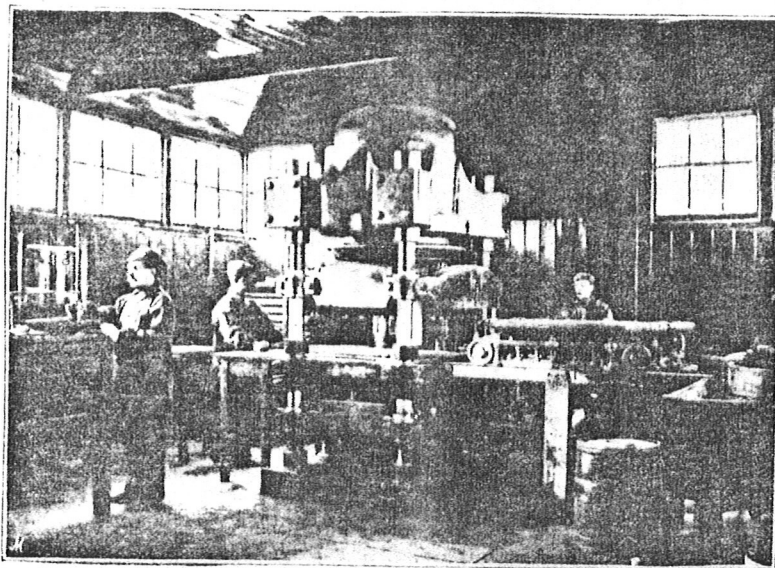


NO. 10.—ENTERING A DANGER BUILDING.

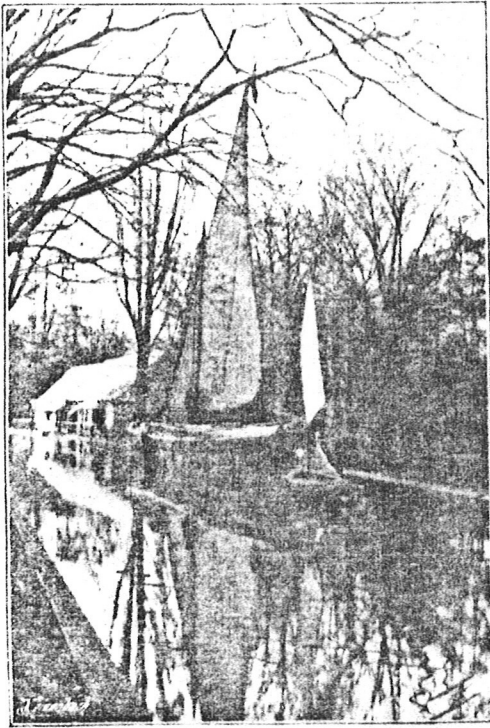
The glazed and granulated powder (the dust from which has been removed by another process and sent back to the incorporating mills) is now ready for moulding into prisms for the built-up charges used in

big guns. The interior of the moulding-room is shown in No. 11. Coarse-grained powder is fed into the compartments of the wheeled tray to the right, and it is then pushed under the hydraulic press, which has corresponding plungers. The hexagonal prisms emerge in batches of sixty-four, or 13,000 per day. To the left in our photograph (No. 11) a skilled workman is seen weighing a specimen from each batch in air and mercury. And “if the scale do turn (literally) but in the estimation of a hair,” the whole batch is rejected.

In the drying-rooms, ordinary grain powder is left for from one to three hours; pebble powder, however, takes from twenty-four to forty hours to dry, and S.B.C. (“slow burning cocoa”), for 110-ton guns, about sixty hours.



NO. 11.—THE MOULDING-ROOM.



NO. 12.—A POWDER BARGE.

The last-mentioned powder is proved in 11in. guns with a charge of 360lb., and gives a muzzle velocity of from 2,010ft. to 2,050ft. per second. Finished powder of all

of each kind are blended so as to give uniformity, and the powder is then conveyed to Purfleet and Woolwich in special barges, which fly a red flag and can be sunk in five minutes. One of these craft, together with a typical view of the Waltham Abbey establishment, is shown in No. 12.

Altogether there are about 900 men employed in the factory, and the annual wages bill comes nigh unto £70,000. One thousand four hundred tons of saltpetre are stocked; 100 tons of sulphur; and enough wood to make 40,000 barrels of powder. The annual consumption of coal ranges from 8,000 to 10,000 tons. Very significant is the photograph we reproduce (No. 13). It shows the interior of the little hospital opened by Lord Sandhurst quite recently. The hospital stands close to one of the myriad streams that intersect the vast grounds of the factory, and is intended solely for the benefit of injured workmen. By the way, it seems strange that, in spite of innumerable precautions and all that science can do, frightful explosions should take place—explosions as disastrous as they are inexplicable. Truly, these grave, quiet men, who are turning out by day and by night material for the defence of our country, "know not the day nor the hour."

Let us now turn to the manufacture of cordite, that new and terrible explosive which eminent experts tell us will increase a hundredfold the carnage on the battle-field of



NO. 13. INTERIOR OF THE HOSPITAL.

sorts is sent to the splendidly-fitted laboratory to undergo various tests; it is then proved in the guns at the butts attached to the establishment. Finally, large quantities

Vol. ix.—41.

the next European war in which we are engaged. The following facts attest the tremendous power of this explosive: The charge of ordinary black powder for the

service rifle is 70 grains, and this gives a muzzle velocity of 1,850ft. per second. A cordite charge of 30 grains gives a velocity of 2,000ft. Again, the powder charge for the 12-pounder gun is 4lb., while the cordite charge for the same weapon is $15\frac{3}{4}$ oz.; and the latter gives far better results.

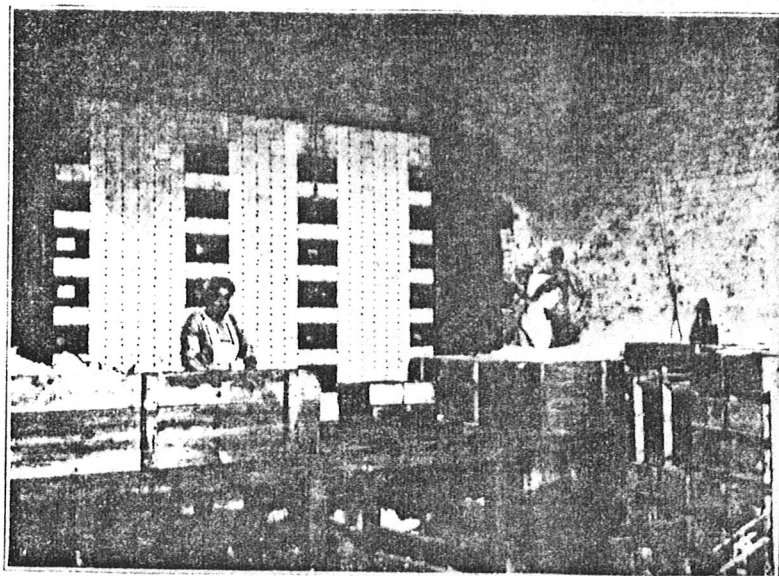
As cordite is primarily founded on gun-cotton, we first visited the picking-room, under the courteous guidance of Captain Nathan, the cordite superintendent. In No. 14 the girls are seen picking over the cotton waste, which comes from the Manchester spinning mills in hundredweight bales, and costs about £30 per ton. It will be seen that the connection between peaceful trade and this formidable explosive is as close as it is curious. The stuff is picked carefully; in order that fragments of wood, rope, wire, and rag may be removed. The cotton waste is then thrown on to a powerful teasing machine, which rends and tears its fibre; after this



NO. 14.—PICKING COTTON FOR CORDITE.

it is cut up by another machine, and then it passes on an endless band into a drying-room heated to 180 degrees. The cotton is then weighed up into lots of $1\frac{1}{4}$ lb., and each lot is placed in a tin cooling box; these operations are shown in No. 15. After twenty-four hours, the lots, or charges, are ready for dipping. Each dipping pan contains 220lb. of mixed acid—three parts of sulphuric and one of nitric acid. The operator simply throws the dry cotton into the acid and leaves it there for about five minutes, during which time each charge of $1\frac{1}{4}$ lb. will have absorbed $13\frac{1}{2}$ lb. of acid.

The workman now takes his implements from the cold water in which they are kept immersed, for fear that repeated contact with the acid should corrode them, and he proceeds to remove the saturated cotton from the bath or pan. As will be seen from No. 16, he has an



NO. 15.—THE WEIGHING AND DRYING ROOM.



NO. 16.—THE DIPPING TANKS.

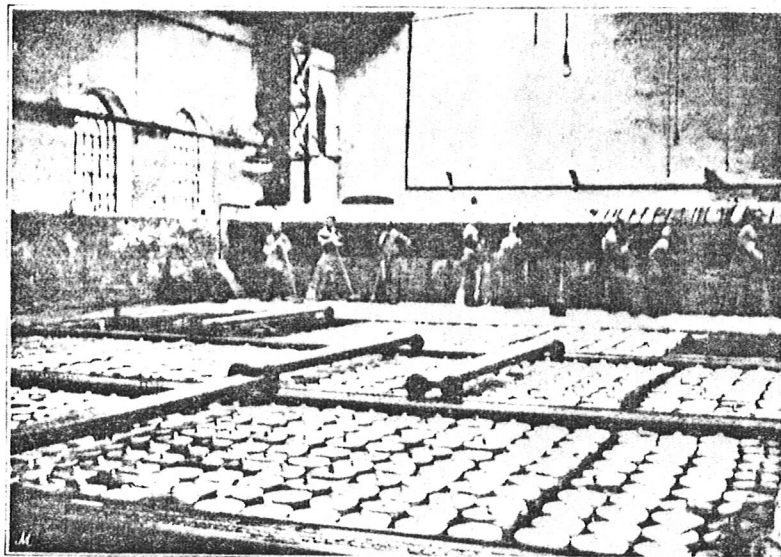
earthenware pot ready to receive the charge. The earthenware vessels containing the charges are then allowed to stand in shallow water for some little time. No. 17 is a general view of the cooling tanks, with the dipping baths in the background.

From the earthenware vessels the cotton is shot into a centrifugal machine, whirling round

at a speed of 1,200 revolutions a minute. In a very short time the cotton is comparatively dry; and the waste acid removed by the machine is allowed for by a contractor. The next operation is the washing of the cotton in a wooden tank full of water, which is agitated by a revolving bladed wheel. When the foreman thinks this washing has gone on long enough, he *tastes* the cotton, and if no flavour of acid remains, it is taken out by a man who wades in in big boots. The water is wrung out and the cotton is then removed to the vat-house, where it is boiled in monstrous vats for four or five days. Each vat holds about 18 cwt. of cotton; and the interior of this department is shown in No. 18.

From the vats the long-suffering cotton comes out like wet oatmeal; then comes more churning and washing, until at length the moulding process is reached, and the cotton is pressed into big cubes of $2\frac{1}{2}$ lb. These cubes are veritable gun-cotton, and when pressed flat and furnished with a dry cylinder and a fulminate of mercury detonator, they are quite ready for torpedo work. The gun-cotton press-house, depicted in No. 19, is furnished with what is called a protective rope mantelet, or wall of rope, such as is used in fortifications.

To make cordite, the dry gun-cotton is taken to the nitro-glycerine house, a wholly extraordinary building, literally buried under a mound or hill, and approached by a burrow-like, brick-lined passage in the earth. The two most dangerous nitro-glycerine houses are



NO. 17.—THE COOLING TANKS.



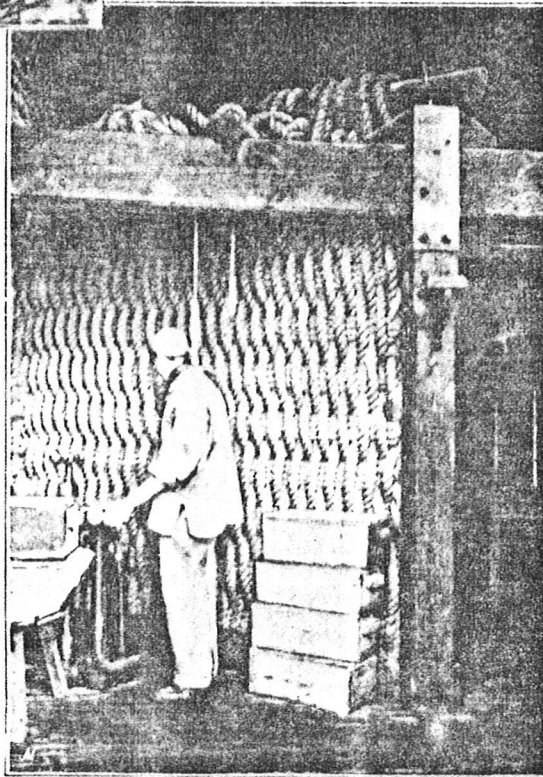
NO. 18.—THE BOILING VATS.

shown in No. 20. Beneath the mound on the left is the washing-house; the other building to the right is the nitrating-house. The dry gun-cotton, as we have said, is taken to the nitro-glycerine house in boxes, and it is there saturated with nitro-glycerine, an almost colourless liquid. Should a single drop of this fall on the leaden floor, it is instantly wiped up with a damp cloth.

The saturated gun-cotton is now called "cordite dough," and it is taken direct to the kneading-house, which is shown in No. 21. The men, as may be seen from the photograph, wear curious respirators as they bend over the sticky mass, which gives forth nauseous and deadly fumes. When thoroughly kneaded, the dough is sent to the incorporating-house and placed in drums, which have slow revolving screw blades; this mixing process goes on for seven hours. The component parts of cordite, by the way, are as follows: nitro-glycerine 57 parts, gun-cotton 38 parts, and five parts of mineral jelly, this latter being added three and a half hours after the

dough or paste has been in the incorporating machine. Acetone is also added in quantities of 15lb. 10oz. to every charge of 75lb. One of the final operations takes place in the moulding-house. There 1¼lb. of cordite paste is pressed and moulded; the mould and its contents are then placed in another machine, and, to the amazement of the onlooker, out comes 2,000ft. of what looks like brown twine, with a diameter of .0375in. This is finished cordite, and it is wound upon a reel. For 6in. quick-firers, cordite with a diameter of .3in. is turned out, and as it emerges from the machine it is cut into 14in. lengths.

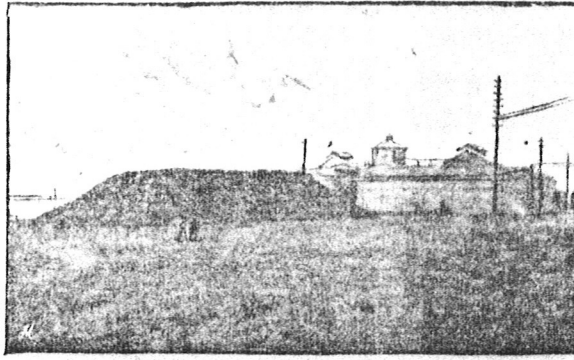
No. 22 shows the interesting operation of "ten-stranding." Ten reels of cordite, just as they come from the machine, are fixed in a rack (the lad in our illustration is about to fix the tenth reel) and are wound simultaneously on to a single reel, the object being to secure uniformity of explosiveness. Furthermore, six "ten-stranded" reels are afterwards wound



NO. 19.—THE CORDITE PRESS-HOUSE.

upon one, and the "sixty-stranded" reel is then ready to be sent away. Minute details as to whose hands it has passed through accompany each reel; and the end of the thread is secured with a band of webbing. Ultimately, the cordite is cut into little bits and made into bundles for the cartridge cases, but this work is not done at Waltham.

A pool adjoining the cordite works is



NO. 20.—THE NITRO-GLYCERINE WORKS.



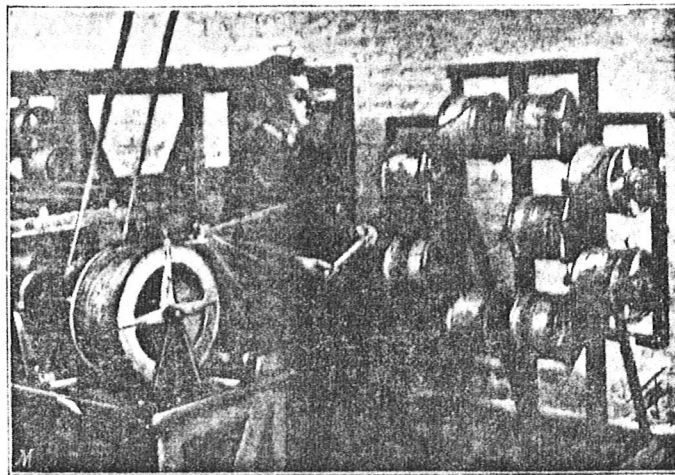
NO. 21.—MIXING CORDITE DOUGH.

shown in No. 23. Into this pool all water from the various nitro-glycerine houses is most carefully drained, since such water contains a certain quantity of nitro-glycerine. Every Saturday this extraordinary pond is blown up by means of a dynamite cartridge, in order to get rid of the explosive matter it contains. After the terrible explosion in the nitro-glycerine house, on the 7th of May, 1894, when four men were blown to pieces, such a large quantity of nitro-glycerine

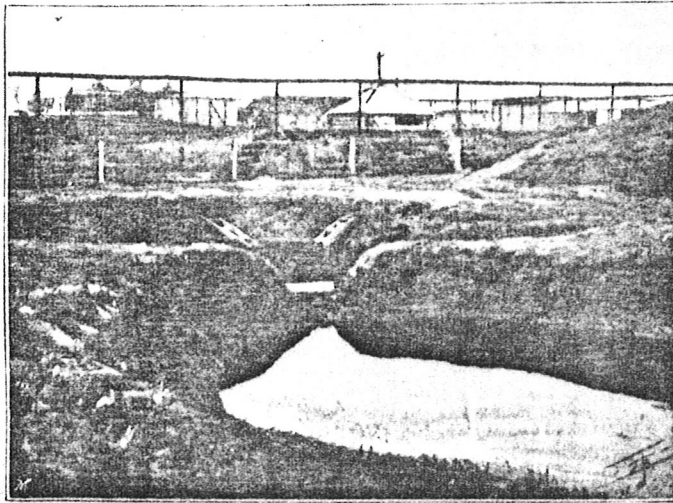
accumulated in the pool that, when it came to be blown up, the result was really startling. Colonel Ormsby, the general superintendent of the works, has lent us, for reproduction, a photograph (No. 24) taken immediately after this

particular blowing-up. A glance will reveal the tremendous force of the explosion, which blew holes 20ft. deep around the pond.

The testing armoury and proof range are at Quinton Hill, but are within the boundaries of the factory. It is most interesting to behold the array of field artillery and naval quick-firers, all clean and bright and with a business-like appearance. On the occasion of our visit, a 6in. quick-firing gun was mounted in a sort of cave formed of earth and masonry so as to minimize danger in case of the weapon bursting. Remember, the powder is being tested, and no one knows what may happen. When the gun is ready to be fired, every person leaves the vicinity;



NO. 22.—"TEN-STRANDING."



NO. 23.—THE SETTLING POND.

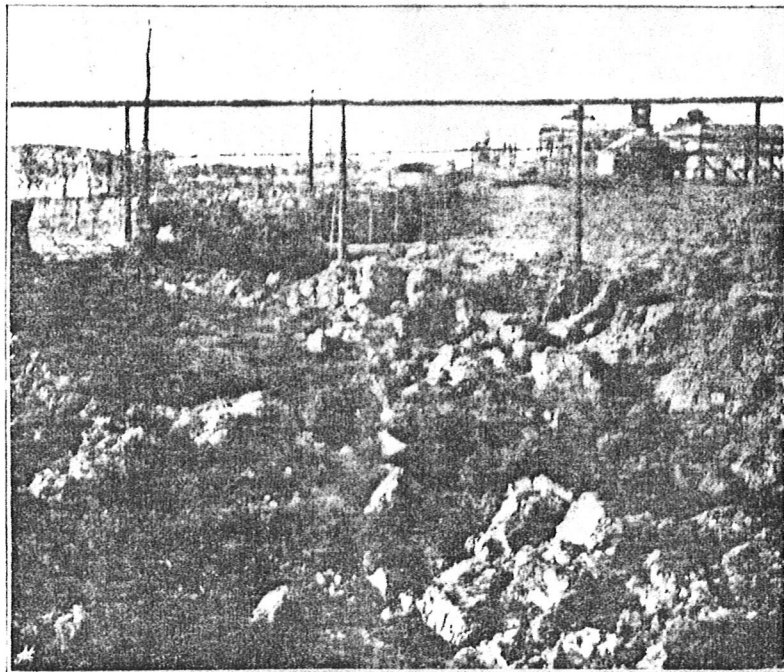
the electric switch is moved in the instrument-room some distance away, and with a terrific roar, accentuated by the confined space, the gun hurls its projectile 17ft. into the sand of the distant butt. A blank cartridge, by the way, is first fired so as to warm the gun. Standing here, listening to the roar of the Waltham quick-firers, which is answered by the sharp, crackling fusillade from the Maxims at the Enfield Small Arms Factory close by, it is not difficult to imagine that a modern battle is in progress.

The Royal Gunpowder Factory turns out about 500 tons of cordite and 5,000,000 lb. of black powder every year, though the output varies according to orders received. For our own part, we would far sooner work in the cordite factory than in the powder mills, for once the dough is mixed, cordite is abso-

lutely safe to handle; indeed, you might hold a piece of it to a lighted match without causing any excitement: it would simply burn.

When we had concluded our tour of inspection, twilight was falling upon the woods and streams of this strange place. Night-watchmen, armed with wonderful little electric hand lamps, flitted mysteriously here and there, and the electric lights immersed in water outside the windows of the danger buildings began to glow softly. We passed the explosive pond with a shudder of nervous ap-

prehension, and left behind, as speedily as possible, the buried nitrating-house, wherein scarlet-clad men were manipulating the terrible liquid. The tremendous energy that lay dormant in every building oppressed us, even though that energy slept behind massive traverses and walls 10ft. thick; so we came away.



NO. 24.—THE POND AFTER AN EXPLOSION.

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Acknowledgments

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