

Gunpowder Mills Study Group

NEWSLETTER 16, FEBRUARY 1995

MEETING AT FORT NELSON PORTSDOWN HILL, FAREHAM, HAMPSHIRE SUNDAY 21 MAY 1995

Fort Nelson is one of the forts built around Portsmouth in the 1860s to guard the Dockyard against a feared invasion. It is being developed as the Royal Armouries Museum of Artillery.

PROGRAMME

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| 10.00 - 10.30 | Assemble at Fort Nelson |
| 10.30 - 13.00 | Introductory Lecture, Tour and free time to examine exhibits |
| 12.00 approx | Firing Demonstration of an 18 pounder gun of WWI vintage by the Brockhurst Troop of volunteer enthusiasts |
| 13.00 - 14.00 | Lunch at the Fort Canteen. Members to make their own decisions about level of consumption and payment for food and drink. |
| 14.00 - 17.00 | Group Meeting in private room. Talks will include: |
| Tony Yoward | "The History of the Fritham Gunpowder Works in the New Forest" |
| Bill Curtis | "The Pernambuco Gunpowder Mills in Brazil" |
| Alan Crocker | "British Gunpowder Labels at the Hagley Library" |

Please let Alan Crocker know, as soon as possible, if you would like to make a Member's Contribution (6 Burwood Close, Guildford, Surrey GU1 2SB, 01483 565821).

The cost of the meeting, intended to cover admission to the Fort, charge for the use of the room after lunch and administrative costs will be £7. This can be collected on the day but it would be useful to know in advance approximately how many people will be attending. So, please let Alan Crocker know, especially if you have transport problems.

A leaflet explaining in detail how to get to Fort Nelson by car is enclosed. In summary leave the M27 at Junction 11, take the A27(A32) towards Fareham and then the A27 towards Portsmouth. After half a mile turn left at traffic lights up Down End Road and on to Portsdown Hill. Fort Nelson is on the left and the car park on the right.

We are indebted to Bill Curtis for making the arrangements for this meeting.

PRELIMINARY ANNOUNCEMENT

The Autumn Meeting 1995 is being arranged by Jenny West and will take place at the Institute of Historical Research, University of London, on Saturday 14 October.

Twenty members attended the Group meeting held on 15 October 1994 at the Institute of Historical Research, University of London. On this occasion we had four major contributions followed by a business meeting. The first speaker was Wayne Cocroft of the RCHME at Keele who was the principal author of the Commission's Report on the Royal Gunpowder Factory, Waltham Abbey, Essex, reviewed in Newsletter 15, pp 15-16. He spoke on "The Production of Gunpowder at Waltham Abbey", following the many stages of the manufacturing process with slides either reproduced from historic documents or showing the surviving remains as they are today, in some cases following excavation. One topic which I thought was of particular interest was the fact that cylinder charcoal was not used at Waltham Abbey until 1794, some 10 years after the method had been developed. Also the Smeaton drawings of under-driven incorporating mills at Waltham Abbey and at the Worcester Park powder mills in Surrey, which are held in the library of the Royal Society, are very similar except that the former has the drive for the vertical shaft taken from the bottom of the pit wheel rather than the top. This seems to be an odd arrangement. Wayne reported that the stone edge runners at Waltham Abbey came from Derbyshire. It would be nice to do a survey of the places where gunpowder edge runner stones were quarried - please let me have any information available. The surviving Waltham Abbey hydraulic press generated 70 tons (and not 700 tons as incorrectly stated in the Report) and some copper plates used to sandwich the layers of gunpowder have been excavated. The foundations of a massive steam drying house have also been uncovered. Wayne gave us details of the manufacture of pellet, pebble and prismatic powders and explained how the *non-de-plume* "Salix" was used in notices stating that rye straw was needed, presumably because the fact that it was used for manufacturing brown powder was a secret. We also saw slides of a sunken cordite barge being rescued from a canal at Waltham Abbey only a few weeks before the meeting and of the one surviving magazine at Purfleet.

The second talk was by Peter Edwards, a member of staff of the History Department at the Roehampton Institute, who gave a preliminary account of a study he is making of "Gunpowder Supply in the English Civil War". For this he is using several hundred volumes of Commonwealth papers at the Public Record Office (SP28) for the Parliamentary side, Oxford Research Society publications for the Royalists and records in Holland of shipments of powder to England. He emphasised that gunpowder was only one of a range of munitions being supplied, that there were great fluctuations in demand and that the industry was largely based in the south-east, with some illegal manufacture elsewhere, particularly in Bristol. There were some very big dealers, who may or may not have been manufacturers. Frequent names in the records are Cordwell of Chilworth (2600 barrels), Beresford (6000 barrels) and Freeman (2 orders for gunpowder but many for "match" - the tapes used for firing guns). The Royalists relied on William Baber, of Bristol and perhaps Oxford, and later on Strode and Wandesford of Oxford. The main suppliers in Holland were Pieter Trip and De Geer, who operated large multi-national businesses. Peter Edwards demonstrated very clearly, by means of the data he had tabulated for us on overhead transparencies, the vast amount of information which is available and we look forward very much to seeing his detailed analysis of this in due course.

After lunch Brenda Buchanan gave a report on "Highlights of the Gunpowder Sessions at the 1994 Bath ICOHTEC Symposium". My own account of this meeting, which was arranged by Brenda, appeared in Newsletter 15, pp3-5. Brenda's paper was of course more personal. She has supplied a written version and this is reproduced in full at the end of this report. Note in particular that she has available a booklet of the abstracts of 24 of the papers

presented. This was distributed free of charge to members who attended the meeting. Other members who would like a copy should write to Brenda, c/o Centre for the History of Technology, University of Bath, Bath BA2 7AY - the Group will cover the cost.

The last talk was by Wayne Cocroft, who reported on "The RCHME National Survey of Selected Chemical Explosives Factories". He is at present working full time on this project and the intention is that, together with a survey of the gunpowder industry, it will be published within 18 months. He showed many slides taken in the previous 3 or 4 months of a large number of sites including: the Marsh Works, Faversham; Stowmarket, which was the chief supplier of guncotton; Uplees, near Faversham; Hayle in Cornwall, which was set up by Oscar Guttman; Perranporth; Cliff at Hooe, set up by Hay Merricks of Roslin but taken over by Curtis's & Harvey; Chilworth cordite factory; the Royal Navy cordite factory at Holton Heath, near Wareham, Dorset; Waltham Abbey; Caerwent in Gwent; Bridgwater RDX plant; Chorley in Lancashire, which was a filling factory; Cranfield test bed for rocket engines; Westcott, which was about to close but has a new order for rockets; and Summerfield near Kidderminster. This was all very new to most of us but very fascinating and clearly involves an enormous amount of research work.

Finally we had our business meeting. Glenys Crocker, who acts as our informal treasurer, revealed that our accounts are healthy (£500 in bank at end of September). Alan Crocker reported that he and Glenys would like to shed some of the load of administering the Group. They would be happy to continue to edit the Newsletter and Alan was prepared to chair meetings but others would have to take on their other roles. Jenny West had already volunteered to act as the Meetings Secretary for the autumn meetings in London and this was greatly appreciated. Also Brenda Buchanan would continue in her role as International Secretary. No offers were received at the meeting to take over the joint role of Membership Secretary and Treasurer but later Keith Fairclough volunteered to do so from 1 April 1995.

It was decided that next year the Autumn Meeting would be held at the Institute of Historical Research and that Jenny West would make the arrangements [subsequently booked for 14 October] and organise the programme. Three possibilities were considered for other meetings: (1) Visit to Tower of London in perhaps March to hear about and see the Armoury's "Feuerwerkbuch", arranged by Bill Curtis [later found to be impossible because the Armoury is moving to Leeds]; (2) All day tour of Waltham Abbey conducted by Wayne Cocroft after decontamination is complete, possibly in summer 1995; (3) Visit to Fort Nelson at Portsmouth, including firing of canon, in May or June 1995, arranged by Tony Yoward and Bill Curtis [subsequently arranged for 21 May - see page 1]. The possibility of a visit to see the mills at Dmitsana in Greece was discussed but it seems likely that very few members could participate. We are indebted to Jenny West for arranging the accommodation and are sorry that time did not permit us to hear some prepared members' contributions.

After the meeting Wayne Cocroft sent us more details about some of the points he made in his talk on gunpowder. The reference to edge runners from Derbyshire comes from F M Smith, *A Handbook of the Manufacture and Proof of Gunpowder*, Eyre & Spottiswood, London, 1870. On page 40 it is stated that "There is also a group of iron mills driven by water power with an auxiliary steam engine, and in addition 14 pairs of runners driven by water power; some of the latter are iron mills, some stone (the stone used being black Derbyshire limestone, which takes a very high polish) fitted with old-fashioned machinery placed overhead". The reference to the first use of cylinder charcoal comes from W Winters, *Centenary Memorial of the Royal Gunpowder Factory, Waltham Abbey*, the Author, Waltham Abbey, 1887. On page 41 he gives the following diary entry for April 6th 1794: "Barge returned with the first freight of cylinder coal. [This is noteworthy. Up to this time pit coal was regularly used in the factory]."

THE MANUFACTURE AND MARKETING OF GUNPOWDER Brenda Buchanan

At its meeting held in Bath on 30 July - 4 August, ICOHTEC did its best to live up to the dictionary definition of a symposium as a gathering of friends for intellectual discussion and convivial entertainment. Living in a Georgian terrace, with its broad pavements designed by the architects of the eighteenth century to promote meetings and conversations, was part of the cultural experience. Historians of gunpowder are indebted to ICOHTEC for making it possible for our specialist group to meet for the first time at an international level under its aegis. My own debt is particularly great because of the help received in finding others sharing this interest, since the matter was first raised at the Hamburg Symposium in 1989. The ICOHTEC Symposium in Bath has allowed the network built up since then to come to life.

There were 26 contributions to the gunpowder proceedings and abstracts of all but two of these papers were available at the symposium or have become so since. They have now been bound separately from the general *Abstracts of Papers*, and may be made available upon request. The number of contributors reveals the extent to which the style of the symposium was one of participation. We had a lively and continuing presentation and debate of papers, in the light of which the need to modify some views and amplify others was freely accepted. Indeed, the opportunity to participate was valued so highly that with few exceptions those prevented by personal circumstances from attending, nevertheless sent copies of their papers. This was the case with scholars from Spain, Germany, Hungary, India and Russia, and although it was suspected that they might be unable to join us, their evident efforts to do so were honoured by the inclusion of their names and subjects in the programme. Where possible these papers were presented at appropriate sessions by members with similar interests. Wayne Cocroft, Bert Hall and Owen Ward deserve special thanks for their help, as does Sarah Barter Bailey for adding illumination to the subject of the "Firework Book".

Some texts in Russian and German had to be translated, and here we are grateful for the skills of Lutz Haber, Nicholas von Behr and Sarah Allsop. This is but one indicator of the wide geographical base of the contributors, which ranged from Australia to the New World, and within Europe from Scandinavia to Spain. An Indian scholar's hopes of joining us were dashed at the last moment, but this contact and that with a Chinese expert offer the prospect of developing links with historians of gunpowder in these ancient civilizations. Such was the volume of correspondence and organization required by this project, and the intensity of the activity we all shared during the meeting, that there was little time for thought of failure. That came later, with the realization of the degree of trust expressed by colleagues who disrupted their vacations and travelled in some cases half way round the world, to attend a symposium of as-yet unproven quality. The fact that so many took this step was itself an important factor in ensuring success, and I am grateful to all who committed themselves for six days in this way.

For scholars of such different backgrounds came papers of equal diversity. There was a good chronological coverage, and a broad range of themes - civil, celebratory and military. Some of the papers were theoretical and problem based; some made use of documentary evidence; others revealed a practical concern with the recording of sites and their analysis and interpretation. At a "hands-on" session the deterioration of powder was discussed; samples and containers commented upon; and a firearms collection made available by the Bath Royal Literary and Scientific Institution was examined. The Gunpowder Salute by the Old Wardour Castle Garrison at the University was a great occasion, and an invitation to fire the cannon gave at least one historian of gunpowder a challenging "hands-on" experience.

A general overview of powdermaking from an American perspective provided a firm context within which other papers could present stimulating new ideas and interpretations,

some of which may necessitate re-interpretation of received notions. The early use of calcium rather than potassium nitrate as a main ingredient, evidence of which was provided by Gerhard Kramer's study of *Das Feuerwerkbuch* of Freiburg, is a good example. The question of the non-linear development of corning was examined, as were the practical consequences of the early outstripping of the understanding of gunpowder by that of weaponry. The problem of defining a pattern was illustrated by the case of the simple procedures at a Galician powder mill, governed by windpower to the mid-twentieth century. We also faced the intellectually demanding question of how the force of fired gunpowder was to be measured and analysed, a problem which underlay the failed efforts of English provincial and commercial powdermakers to secure Government contracts. Studies of the use of gunpowder in mining disposed of the idea that being on the geographical periphery of Europe, Norway for example, necessarily slowed down the adoption of technological change. Evidence of an early diffusion across the seas was found in the historical relations between Spain and her colonies, whilst from the Antipodes, that special case of the periphery, came insight into the world-wide links between mining communities.

A second paper from Australia was the only one to introduce the legislative aspects of powdermaking. Such laws are essentially a part of the social context of the industry, which was also the background to studies of powdermaking in France and Sweden. Both were concerned with the artificial production of saltpetre in peasant economies under a centralized control, which could organize this unwelcome duty and promote a scientific approach to the task. These accounts prompt the thought that the early abandonment of this system in England may have been due as much to a society of yeomen and burghers, as to the growth of a trading empire able to import saltpetre from India. Evidence from the Netherlands is potentially of importance in testing this thesis, for this too was a mercantile nation of independent citizens, supplying for example the kingdom of Hanover with gunpowder in the seventeenth century and raw materials in the eighteenth. But despite continuing efforts links have not yet been established with any Dutch historians of gunpowder.

Lastly, the importance of comparative evidence was also made clear by those papers concerned with the large, often state-controlled, explosives factories of the nineteenth century. Waltham Abbey in England and Ballincollig in Ireland were shown to be sites where archaeological and surveying techniques had revealed their early history, as well as, at Waltham, the later work on high explosives which in Ireland had developed at a separate establishment in Arklow; comparable work in Russia, especially in Petersburg, was shown to have taken place within a web of inter-related research by scientists in several European countries; whilst at Prussian Spandau possibly the most complete form of learning from others was shown to have occurred in the 1870s with the dismantling and carriage of the powder mill from Metz, captured from the French. Each contribution to the meeting had its own history, but that on Spandau was exceptional for the German text arrived unheralded one month before the symposium. It came from an unknown contact of an archivist to whom I had written at the suggestion of an ICOHTEC colleague, and its arrival showed how much work had gone on behind the scenes on our behalf. Despite the shortage of time the paper was translated and an abstract made, but only publication can ensure it gets the credit it deserves.

These papers submitted to the first international meeting of gunpowder historians provide an hitherto unavailable broad view of the subject. This circumstance, together with their high quality and originality, makes it desirable that they should be published as a collected work. Such a volume will have a high appeal in many countries. This aim is now being actively pursued. Once this is in hand the compilation of a gazetteer of international sites will be undertaken as a complementary project.

GUNPOWDER MACHINERY MANUFACTURED BY J & H GWYNNE

Alan Crocker

The entry on "Gunpowder" in *Spon's Dictionary of Engineering, Division V*, Oliver Byrne ed, London, 1872, pp1774-89, features gunpowder machinery manufactured by J & H Gwynne, Hammersmith Iron Works, London. In particular it is illustrated by engravings of complete sets of machinery supplied to the Japanese and Italian Governments, and these are reproduced here.

The Japanese plant was powered by cattle as there was concern about steam power increasing the danger of explosions and no water power was available. Figure 1 shows a series of cross sections of the buildings and, at small scale, the machinery they contained. The Italian plant was powered by two water turbines and fig 2 shows a schematic plan of the site and cross-sections of two of the buildings. The machinery in this case was on a somewhat larger scale. Sectional views of the pulverising and incorporating mills are given in fig 3. The runners and pan were of cast iron and the shafts of wrought iron, working in gunmetal bearings. The outside frame of the pan was wood and the drive was through a pair of bevel wheels. It will be noted that the arrangement is symmetric, the two runners being equidistant from the vertical shaft, and no ploughs are indicated. Engravings of a ball mill for pulverising sulphur and of charcoal cylinders are given in figures 4 and 5.

By chance I have four pages of a booklet advertising Schiele's Water Turbine Wheel as manufactured by John and Henry Gwynne, Engineers, London, in 1871. The firm's offices were at 89 Cannon Street, EC, and the works at Hammersmith, W. It is claimed that the turbines were used for driving paper, cotton, woollen, silk, flour, rice and coffee mills, mining and agricultural machinery, saw mills, rolling mills, for water drainage, reclamation, irrigation works etc but there is no mention of gunpowder mills. A manuscript inventory of the Chilworth gunpowder works (we have a copy) shows that it had a Schiele water turbine in 1881 but the manufacturer is not known. The only other information I have about Gwynnes is from Paul Wilson's paper "Early Water Turbines in the United Kingdom", *Trans Newcomen Soc* 31, 1958, pp219-40. He notes that in 1854 James Whitelaw, engineer of Glasgow, was making a turbine for Messrs Gwynne & Co, Engineers, London, but in a footnote states that Messrs Gwynnes have no record of purchasing this turbine.

Several questions remain unanswered. For example, where were the Italian and Japanese gunpowder mills? Also, for how long did Gwynnes make gunpowder manufacturing machinery and who else did they supply? Indeed, could we compile a list of British firms which made this type of machinery? Finally, what are the facts about symmetric and asymmetric incorporating mills? In this connection I have noted, for example, that the suspended edge-runner mills illustrated in Guttman's *The Manufacture of Explosives*, 1, Whittaker, London, 1895, pp196-8, are symmetric, whereas the non-suspended runners in Wardell's *Handbook of Gunpowder and Guncotton*, HMSO, London, 1888, plate IV and p47, are asymmetric. Patterson in his *Gunpowder, Terminology and Incorporation*, Faversham Society, 1986, p15 states "The runners are generally set at slightly different distances out from the vertical shaft, so that they cover a wider track". I hope very much that these notes will prompt members to research these topics.

I am indebted to John Day of the Surrey Industrial History Group for bringing my attention to the dictionary entry upon which this article is based.

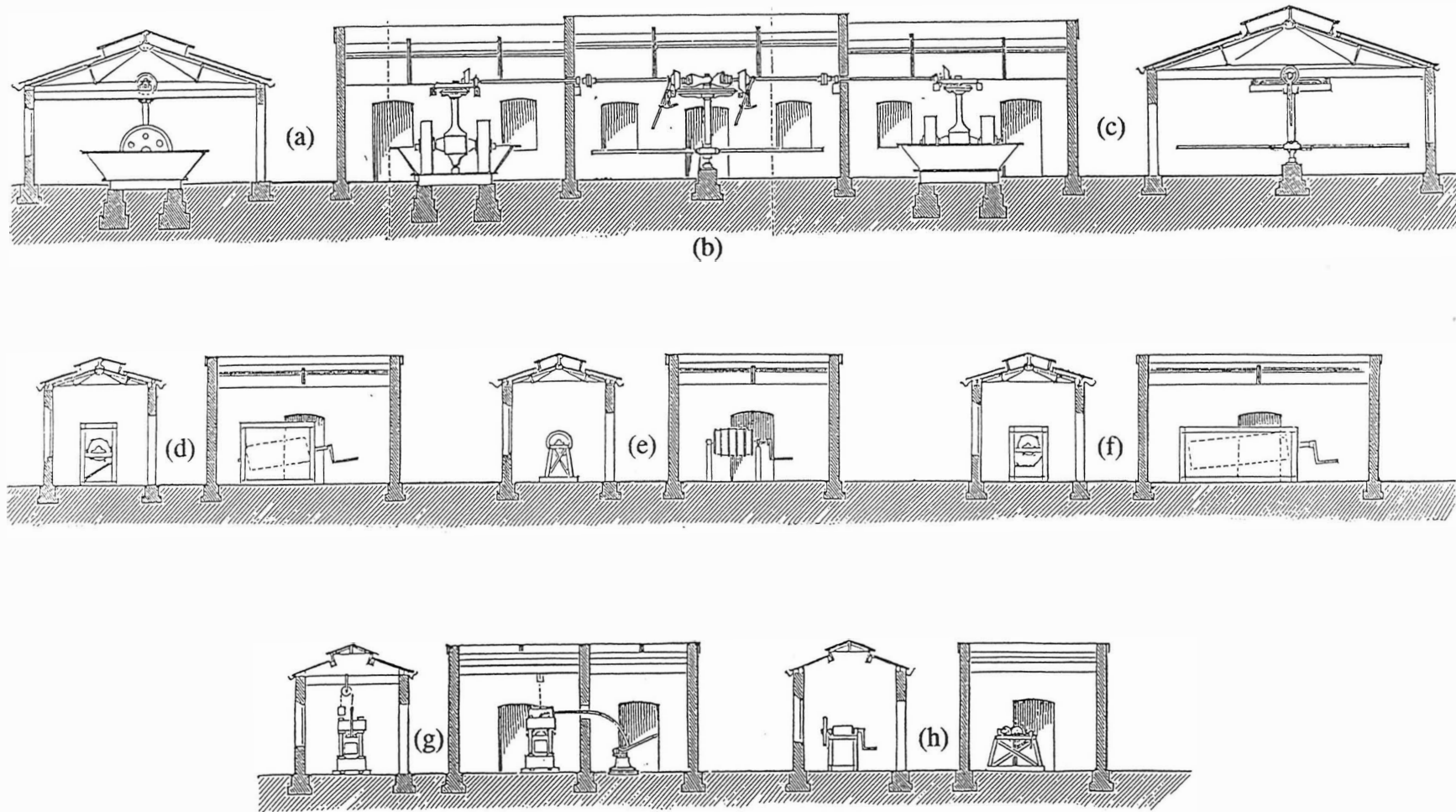


Figure 1. Gunpowder machinery manufactured by J & H Gwynne for the Japanese Government. (a) Pulverising mill. (b) Cattle track. (c) Incorporating mill. (d) Charcoal sifter. (e) Mixing barrel. (f) Glazing cylinder. (g) Hydraulic press and pump. (h) Breaking down cylinder.

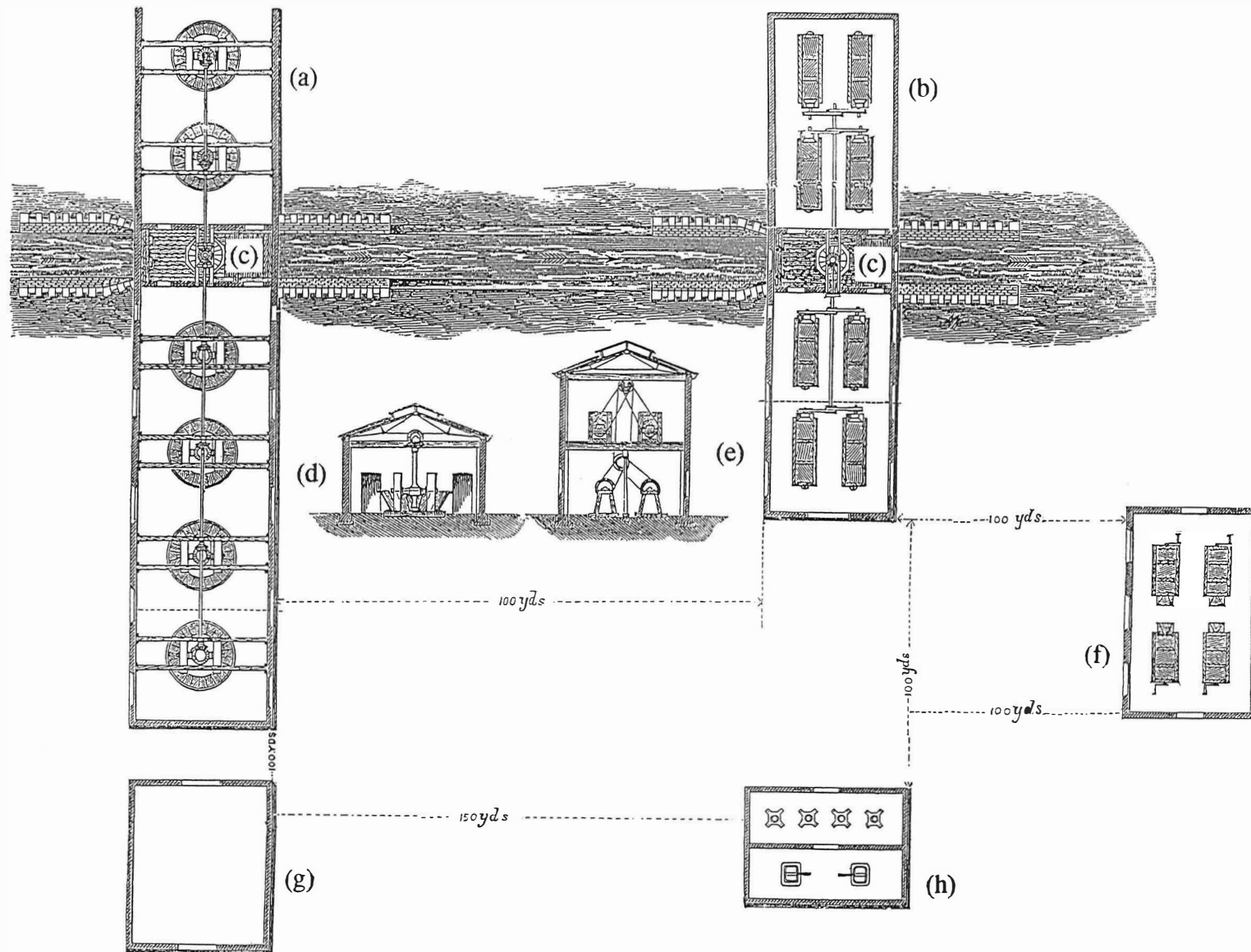


Figure 2. Gunpowder machinery manufactured by J & H Gwynne for the Italian Government. (a) Grinding mills (4 in number). (b) Mixing barrels and glazing cylinders. (c) Water turbines. (d) Incorporating mills. (e) Breaking down and sifting cylinders. (f) Charcoal sifting. (g) Packing house. (h) Hydraulic presses.

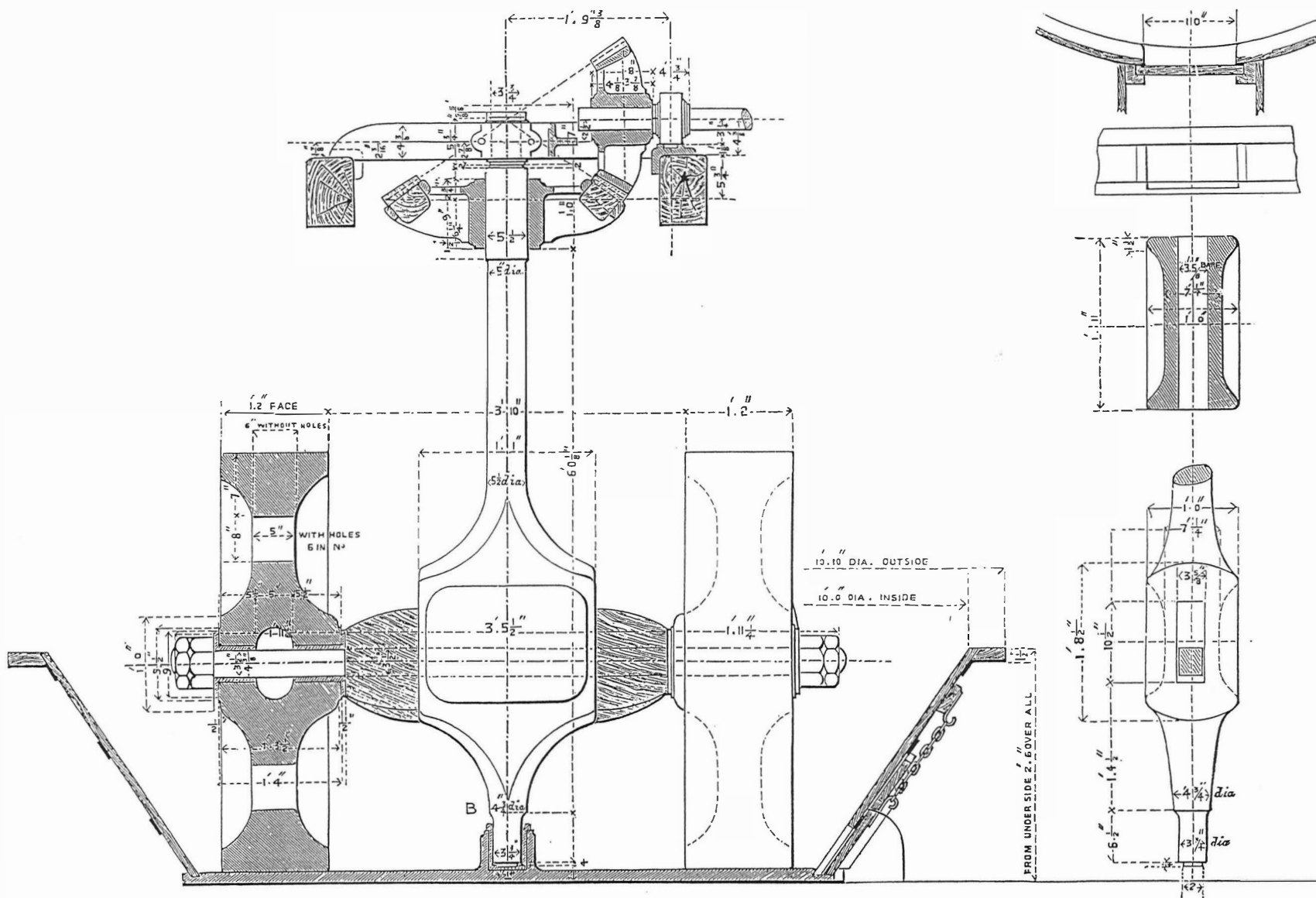


Figure 3. Sectional views of the pulverising and incorporating mills manufactured by J & H Gwynne for the Japanese and Italian Governments.

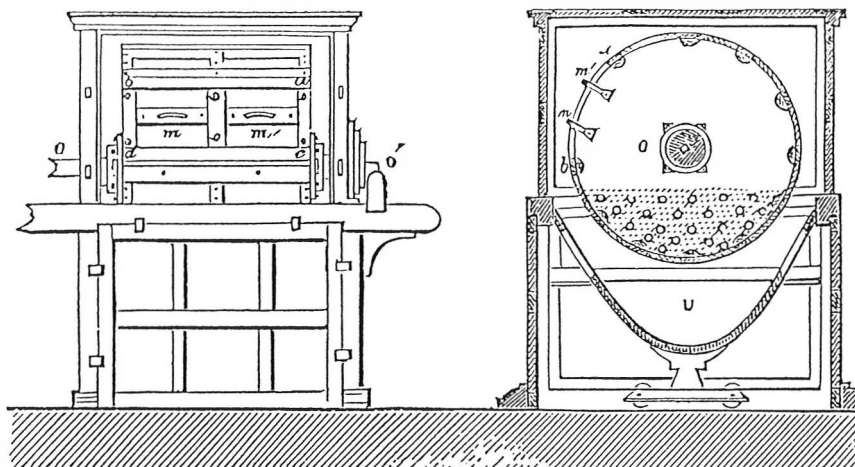


Figure 4. Ball mill, with a drum 1.15 m in diameter, for pulverising 30 to 40 kg of sulphur using 150 kg of brass balls, 5 to 8 mm in diameter.

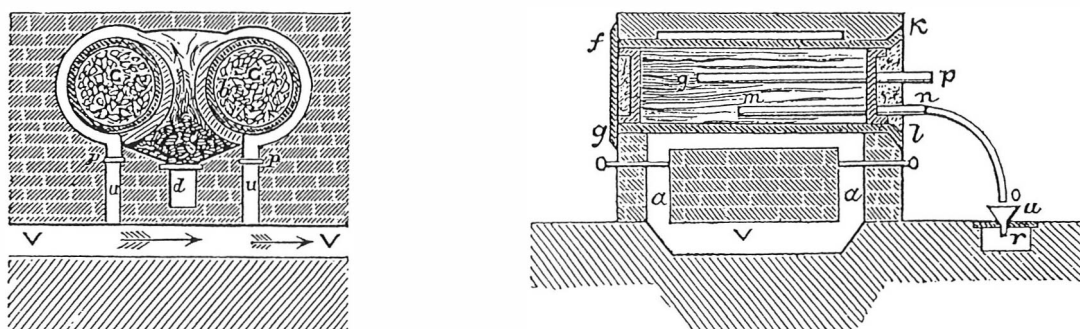


Figure 5. Pair of charcoal cylinders 2 m long and 0.70 m in diameter.

KYNOCHTOWN

Brenda Buchanan

Harold Mann's query in Newsletter 15 about the manufacture of gunpowder at Kynochtown has already produced two helpful references, one of which mentions the granting of a licence to make gunpowder at that place from 1897 to 1920. It may be appropriate to mention also the article by John S Davidson in the *Essex Journal* of Summer 1980, entitled "A History of Chemistry in Essex" (part 1), pp 38-46, which provides additional information about the setting up of a factory at Kynochtown near Corringham in 1897 by the Birmingham firm of Kynochs Ltd, to make cordite and blasting explosives. In 1918 this firm merged with Nobels to form Explosives Trades Ltd, later to become part of ICI. The article goes on to describe the response in Essex to the great demand for high explosives in the first World War. This was also met in part by the munitions factory at Arklow in Ireland, which had been set up by Kynoch Ltd at the end of the nineteenth century. This is described very fully in the book by our late colleague George Kelleher, *Gunpowder to Guided Missiles* (1992), which also contains several references to Kynochtown.

SOME GUNPOWDER MILLS ENCOUNTERED ON HOLIDAY**Gerry Moss**

While touring in Germany, I noticed a "Pulvermühle" on the River Eder, west of Aue. This is about 8 km west of Bad Berleberg (10 km on the sign post). Unfortunately the site was deserted as it was a Sunday so I could not enquire further. There were signs of sluices in the river (more a stream now) and I presume at some time it was a powder mill, now just an industrial site.

Other foreign mills I have encountered are in Brittany. There is still an explosives factory at Pont-de-Buis-les-Quimerch (25 km north of Quimper) which my Michelin Guide claims has been there 300 years. It is a typical site situated along a deep wooded valley. A more exotic location is on Monks' Island (Ile des Moines), off the north coast near Perros-Guirec. Part of the Sept Isles, it is about 15 km off the French coast. It was worked by the monks of the monastery who presumably had to bring all the ingredients from the mainland.

SEMINAR ON FORMING A WALTHAM ABBEY TRUST**Alan Crocker**

On 26 January about sixty people, including several members of the Group, attended an afternoon seminar, arranged by the Waltham Abbey Royal Gunpowder Mills Trust Steering Committee, in the lecture theatre on the site. The aim was to inform the audience about the proposed formal arrangements for setting up a Trust which would own and manage the site and be responsible for establishing a national museum of explosives.

The first speaker was Dan Bone of CIVIX, planning consultants to the Ministry of Defence. He set the scene by summarising developments since 1991. David Prince, of Prince Research Consultants, who are advisors to the Steering Committee, then reported on the proposed operational structure of the Trust. This involves creating a "Foundation" which will hold the freehold of the site and lease it to a "Charitable Company" with a wholly owned subsidiary acting as a "Trading Company". He also explained how other bodies, like the MOD, English Heritage, English Nature, local authorities, other charities, groups and visitors would relate to these three bodies. He outlined a 10 year development strategy but it might take 20 or 30 years to implement this fully. Initially the museum would be housed in the Lecture Theatre complex. Finally Mike Lowe, a chartered accountant who is Chairman of the Ironbridge Gorge Museum Trust, spoke on "Running a Heritage Trust". He emphasised the responsibilities which trustees now have, following relatively new legislation, and gave very helpful advice based on his Ironbridge experience. In particular he explained the need for a Trading Company, in order to take advantage of tax legislation, but emphasised that the activities of such a company had to be monitored carefully by the Trust.

The General Discussion which followed was all rather hypothetical. The problem seemed to be that when the meeting was arranged it was anticipated that the MOD would have already agreed to transfer the site to the new Trust when it was established. In practice this agreement had not been finalised. In any case we were not informed about how the Trustees were to be appointed or elected and it was not even known how large the Trust will be, although a figure of 16 was suggested. It was interesting to note that the scheduling of 100 acres of the site as an ancient monument and the listing of 20 historic buildings has meant that most of it can not now be developed as an entertainment complex or theme park. However, a relatively small strip of land at the south-west has been allocated for housing and the proceeds should provide some funding for the Trust but planning permission for this development has not yet been obtained. Still, it seems clear that, sooner or later, much of the site will become an industrial museum with an associated natural history conservation area.

THE PERNAMBUCO POWDER FACTORY, BRAZIL

In September Bill Curtis met the Directors and Chief Chemist of the Pernambuco Factory in Brazil and has provided us with some interesting information. The Factory was established in 1866 by Herman Lundgren, a Swedish immigrant. It was the nucleus of a business conglomerate whose principal interest is in textiles. However, the company continues to produce "Elephant Black Powder" and "Elephant Safety Fuse", dominating the Brazilian market. The factory covers 15,000 m² and has 7 km of railway track. It is located in a forest of 470 hectares in the metropolitan region of the city of Recife, in the neighbourhood called Pontezinha, in the municipality of Cabo, in the State of Pernambuco, in north east Brazil. The rudimentary equipment of the last century has been replaced by Krupp technology.

They manufacture the following types of powder:

Hunting and Sporting Powder: Fg(1.68-1.19mm); FFg(1.19-0.59mm); FFFg(0.84-0.297mm); FFFFg (0.42-0.149mm), in 1lb cans, 2lbs cans, plastic bags and plastic cartridges.

Black Powder for Mining: FA(8.0-4.0mm); 2FA(4.76-1.68mm); 3FA(2.0-1.19mm); 4FA(1.68-0.84mm); 5FA(0.84-0.297mm); 6FA(0.59-0.297mm); 7FA(0.42-0.149mm), in plastic bags.

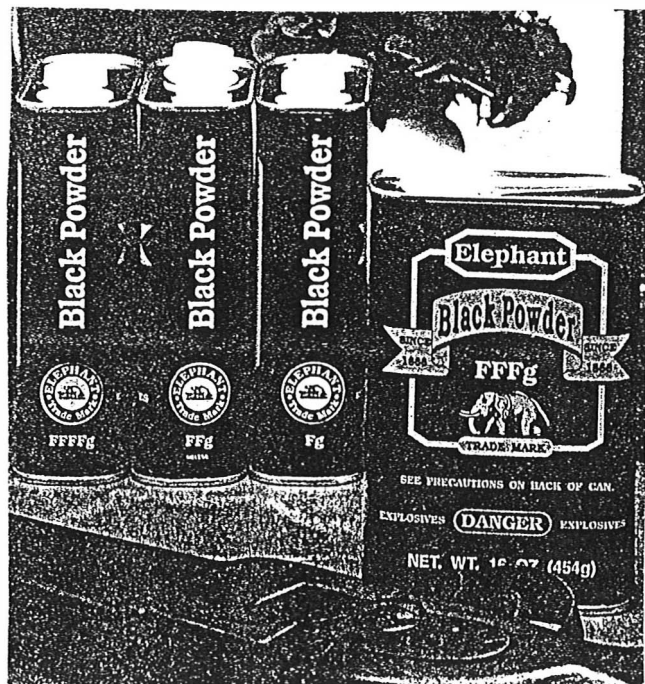
Fireworks Black Powder: PPF-FA(8.0-4.0mm); PPF-2FA(4.76-1.68mm); PPF-3FA(2.0-1.19mm); PPF-4FA(1.68-0.84mm); PPF-5FA(0.84-0.297mm); PPF-6FA(0.59-0.297mm); PPF-7FA(0.42-0.149mm); Fine Flour (0.149mm); Extra Fine Flour(0.105mm), in plastic bags.

Black Powder for Safety Fuse: Granulation 0.59-0.149mm; Burning [Inverse] Speed 90 to 150sec/metre, in plastic bags.

Black Powder for Military Use: Various international specifications.

The mill works on traditional British limes, rather than American. The management are very conservation conscious and are preserving old steam machinery. The Directors have presented Bill Curtis with a set of cans of their best powder in Cannon, Fg, FFg, FFFg and FFFFg sizes. Bill comments that it looks very nice with a high glaze but the granulation size parameters are too wide, particularly in FFg. The Cannon is exactly the same size as his sample of Colonel Hunter's grain for punt guns. Test shooting has shown the FFFg to be very good but it is difficult to say at this stage how the FFg compares with the best TPPH. Bill has the impression that it fouled the breech rather more. The FFFg was excellent as flintlock priming and would probably be a good pistol powder but Bill does not shoot pistol. He hopes to visit Pernambuco and if so will report on the mill.

[A note on the Pernambuco Factory by Ron Grosvenor appeared in Newsletter 14, pp15-16].



GUNS AND GUNPOWDER ON BOARD HMS WARRIOR

Brenda Buchanan

The annual autumn conference of the Association for Industrial Archaeology was held this year near Winchester, in comfortable premises in the grounds of an agricultural college. Much of the organisation was in the capable hands of our members, Tony and Mary Yoward. Lectures given during the weekend were nicely complementary, for there were practical talks by Ray Riley on the industrial archaeology of the area and Michael Hughes on the recording of this physical evidence, as well as offerings of a more philosophical nature from Angus Buchanan on "The Mill in History - Image and Reality" and Edwin Course on "Engineering Works in the Countryside". But the great triumph of the meeting was dinner aboard HMS Warrior on the Saturday evening.

There were heavy showers on the drive into Portsmouth, but as we walked towards Warrior on the last stage of our journey the storm clouds parted and we saw the ship gilded in the bright rays of the setting sun. Angus and I had been on board once before when she was a sad and rotting hulk at Hartlepool, but Warrior is now a ship transformed, restored to prime condition as befits the sole surviving capital ship of the nineteenth century in the world. Commissioned in 1861 she was the most formidable warship of her time - large, fast and designed both to give and to withstand great punishment.

HMS Warrior's battery of guns consisted of twenty-six 68 pounder muzzle loaders; ten 110 pounder Armstrong rifled breech loaders; and four 40 pounder Armstrong rifled breech loaders. The bores were respectively 8.12 ins; 7 ins; and 4.7 ins. Some originals survive, but most are convincing replicas. As we explored the ship we learnt that the main magazine on the lowest deck was inaccessible because waterlogged, but another on a higher deck had been transformed into the "Ladies", thus giving an entirely new meaning to the term "Powder Room". This presented a unique and unusual advantage to the female student of the subject. We later discovered that the powder was passed between decks through hatches with wooden covers.

Dinner was then served on the gundeck, where like the gun crews before us we sat at benches at long narrow tables hanging from the ceiling. Each table was a pool of light and animation between the dark and looming roped cannons, above which were suspended leather powder- and wooden water-buckets, and three long rods for clearing, sponging, and ramming home. Here in the "citadel" we were protected not only by this dormant firepower, but also by the "iron walls" made up of 4.5 inches of wrought iron and 18 inches of teak. In its heyday 75 stokers fuelled 40 furnaces to drive along this great ship with its crew of 700 men. However Warrior marked the beginning of a period of great advances in warship design and so it was soon overtaken by new developments. But it survived until 1979 as a naval barracks, a floating torpedo school, and an oil pontoon, indignities which in the long run have helped it to outlive later ships.

STONE EDGE-RUNNERS WITH IRON TYRES

Alan Crocker

In his book on *Cornish Explosives* (Trevithick Society, 1978), Bryan Earl notes on page 14 that "By the mid 19th century iron shod stone ... runners ... had been adopted by some powdermakers". Also on page 272 he states that "in some south of England mills a transitional type was put together consisting of stone runners shod with an iron tyre ring. Such iron-tyred mills were used at Chilworth in Surrey". Unfortunately no sources are given for these statements.

The topic is discussed more fully by Ted Patterson in his paper "The Incorporation Process in the Manufacture of Gunpowder and the History of Associated Explosions" (*Faversham Papers*, 27, (Faversham Society, 1986), where the following paragraph appears on page 17. "In the change from stone to iron mills, a transitional stage employed stone runners shod with an iron or steel tyre, working on an iron bed. Such "tyred runners" were in use at Chilworth and some other factories in the south of England (3). According to the factory Manufacturing Method Book, Hounslow had 3 stone mills "rung with steel" in the early 1920s: these were Mill No 1 in the Upper Cut Group, No 12 in the Penns Group and No 23 in the Barnfield Group (17). At Ballincollig a single stone of this type has survived (18). The adoption of such composite runners represented a conservative and experimental phase, when a safety-conscious management was still reluctant to commit production to iron mills and were prepared for only a limited amount of capital expenditure until experience was acquired. At present the extent of the adoption of stone runners "rung with steel" is not known, but it is not likely to have been universal." Here the references are to: (3) Bryan Earl's book, (17) the 1922 Method Book (privately issued) and (18) George Kelleher (private communication).

Wayne Cocroft has now drawn my attention to *Explosives Inspectorate Report*, 57, concerning an accident at Chilworth on 15 Nov 1883 in underdriven steam-powered incorporating mills 24 and 25, which had stone edge-runners with iron tyres. These are the mills labelled 20 and illustrated in fig 9 in Glenys Crocker's *A Guide to the Chilworth Gunpowder Mills* (Surrey Ind Hist Group, 2nd ed, 1994). There are approximately 24 stone edge runners and/or bed stones at Chilworth. None of these now have iron tyres and a study of them has not revealed if any of them had tyres in the past. It seems that the tyres for Hounslow were supplied by Hick Hargreaves of Bolton (see article in this Newsletter) and stones are still present on the site. Do any of these have iron rings or provide evidence for them? I found no reference to the Ballincollig edge runner in George Kelleher's book, *Gunpowder to Guided Missiles*, but John Kelleher has informed me that there is one with a tyre between the Old Saw Mill and the Charcoal Burning House. This is about 300 m from the nearest incorporating mill and could easily have been used for a different purpose. Does anyone have information about edge runners with iron tyres being used elsewhere?

GUNPOWDER MILLS IN ART

Malcolm McLaren

I was most interested to see the contributions in Newsletter 15 (pp 4 and 14) concerning the ceiling painting in the Uffizi Gallery, the Goya painting which was included in the recent Royal Academy exhibition (p 10) and the St Petersburg engravings (p 14).

It is due only to procrastination on my part that members were not alerted to the existence of the Uffizi painting earlier as I had photographed it some years ago. The official guide to the Uffizi confirms (in English!) the details of the artist, Ludovico Buti, but gives the date as 1588 [not 1558]. In addition to the description given in Newsletter 15 of the processes illustrated, my interpretation is that it also includes, at the far left of the painting, a single tilted edge-runner millstone rotating on a bed with a sloping pan.

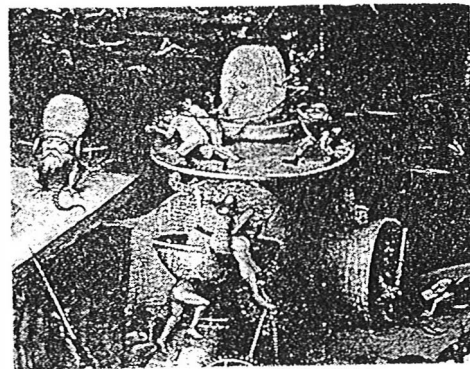
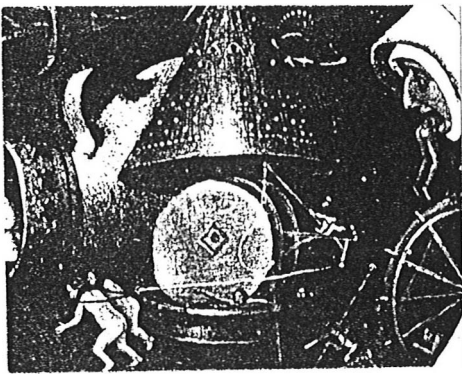
I wonder whether members have seen the painting "The Last Judgement" by Hieronymus Bosch in Groeningemuseum in Bruges. The central panel of the triptych clearly shows an edge-runner powder mill with two millstones. The theme of the panel is the symbolism and imagery of Hell and the place of the powder on the mill bed is taken by unfortunate sinners! I always knew that gunpowder making was considered to be a black art. The date of the painting is about 1500.

Are there any further contributions to the art gallery?

BOSCH'S LAST JUDGEMENT

Alan Crocker

After receiving the preceding article from Malcolm McLaren I looked at the book *Hieronymous Bosch* by Walter S Gibson, Thames & Hudson, London, 1973. This contains a chapter on "The Last Judgement" but the painting illustrated is in the Akademie der Bildenden Kunste, Vienna, and it is different to the one in Bruges, which is attributed to the workshop of Bosch. Indeed, the Bruges painting is said to be "obviously no more than a rather inept adaptation of Boschian motifs". The important point, however, is that the Vienna "Last Judgement" also features an edge runner mill. Details of the relevant parts of the paintings are reproduced here, the Bruges mill on the left and the Vienna one on the right. In both cases the mill occupies a central position in the middle distance and there are several buildings ablaze or perhaps exploding in the background. Clearly Bosch was familiar with these mills which suggests that there must have been one near 's-Hertogenbosch where he lived and worked. This is in modern Holland near the Belgian border.



I sought the advice of our member Michael Wilks on this matter as he is an authority on eschatology. Although Michael did not feel qualified to comment on edge runners, he did remind me of the excellent book *Oliemolens* by A J Bernet Kempers. This was first published in 1979 by the Netherlands Open Air Museum at Arnhem, which is 55 km north-east of 's-Hertogenbosch. I have the second edition of 1989 which has 108 pages including 65 illustrations and a 12 page summary in English. The book is based on a horse-powered oil mill with stone edge runners and stamps, which came from Lichtenvoorde, 45 km east of Arnhem, and has been rebuilt at the museum. However, it also contains chapters on oil seed (linseed, rapeseed, colesed and "gold of pleasure" ie *Camelina sativa*), and their applications, oil mills still or until recently in use and the history of oil extraction and its instruments. One of the illustrations for this last chapter is a detail of the Bruges "Last Judgement" showing the edge runner mill. Referring to this illustration the English summary states: "In two paintings by Jeroen Bosch, or possibly by an imitator, a roller-mill is pulled by naked sinners whipped on by a devilish driver. Instead of olives or linseed other sinners are being crushed by the stones". The reference to olives is a link to the previous illustration in the book, showing an Italian olive mill, and the implication is that the author believed that Bosch's edge runners were based on oil mills.

There are also interesting differences between the representations of the mills in the two paintings. For example, the Vienna version has a single edge runner with a small central hole for the axle whereas the Bruges painting has a pair of edge runners, on one of which can be seen a more characteristic large square hole for the axle but, surprisingly, not located at the centre. Also the Bruges mill is surmounted by a large cowl from which smoke is escaping. Clearly different mills were used as the basis for the two paintings but it remains to be decided whether one or both were gunpowder, oil or some other type of edge runner mill.

BARGES AND LIGHTERS AT WALTHAM ABBEY**Brenda Buchanan**

The Nautical Archaeology Society has been invited to record the boats in the canal at the Waltham Abbey Gunpowder Works, and its Chairman Alan Aberg, a retired member of the Royal Commission on the Historical Monuments of England, reports that, after a site visit to assess the situation, the work was planned in two phases. The first part was carried out in the autumn of 1994, when five partly buried lighters were recorded at weekends. It is hoped that in the summer of 1995 five lighters and one barge, not under such immediate threat, may be surveyed. With the help of grant aid from British Aerospace, work is being shared between members of the NAS and students, under the leadership of Gustav Milne and Col McEwan. Members of the GMSG will be kept informed of developments.

GARDNER FAMILY, POWDERMAKERS AT HOUNSLOW?**Brenda Buchanan**

In the summer of 1994, Professor Ian Rae of the Victoria University of Technology, Melbourne, Australia, presented a paper on "John Cyrus Martin and Australian gunpowder in the 1860s" to the ICOHTEC Symposium in Bath. He is now interested in the career of **Clemson Gardner**, who claimed that "my father and grandfather were proprietors and managers of the Hounslow mills previous to my birth for thirty years". Any information about gunpowder managers or workers of this name at Hounslow or elsewhere would be most welcome. The grandfather may have been a maternal one, possibly with a surname later to become a Christian name. Ian Rae is already in touch with colleagues at Ballincollig, near Cork in Ireland, for in 1865 Clemson Gardner claimed familiarity with the powder mills there. All information will be passed on to Ian Rae.

[The *Gazetteer* notes that Taylor, Gardner & Co were at Bedfont (not Hounslow) by 1801 and that John Gardner was one of five partners by 1810. In his unpublished report *The Gunpowder Mills at Hounslow*, Luke Over states that Taylor, Gardner & Co were at Bedfont from 1801 to 1820 - Eds.]

EXPLOSIVES USED IN CIVIL ENGINEERING IN TASMANIA**Brenda Buchanan**

Mr Charles Smith, formerly chief engineer of hydro-electric powder developments in Tasmania, has asked if anyone can shed light on the composition of **Cheddite**? This explosive was referred to in a paper read to the Sydney University Engineering Society in 1910 by Mr A J Debenham, who was the engineer in charge of the construction of the Frome dam. This was part of an integrated scheme to use water resources to supply power for mining machinery and to meet sluicing requirements at the mines. The explosives used were Gelnite, Powder, Rack a Rock and Cheddite. Information from the Department of Mines suggests that Cheddite was composed of: Potassium Chlorate 80%; Dinitro Toluene 20%; Nitro Naphthalene 10%; and Castor Oil 8%. Mr Smith points out that these proportions do not add up. Could it be that Dinitro Toluene should form 2% not 20% of the whole? All suggestions will be passed to Mr Smith in Tasmania.

[*The Rise and Progress* (1909) states that Cheddite, a chlorate explosive for quarry work (p354), was made by Curtis's and Harvey at Roslin (p363) - Eds.]

HICK HARGREAVES ENGINEERING DRAWINGS

Alan Crocker

Wayne Cocroft has located a major collection of historic documents relating to the engineering and millwrighting firm of Hick Hargreaves of the Soho Works, Bolton in Lancashire. This is held at the Bolton Archives Office and includes many thousands of large scale drawings of machinery and fittings including equipment for gunpowder mills. The firm was established by Benjamin Hick in 1832 and, when his son John took John Hargreaves into partnership in 1845, it became Hick Hargreaves & Co. Wayne was particularly interested in equipment supplied to the Royal Gunpowder Factory at Waltham Abbey and was able to see some 35 drawings of incorporating mills, curbs, runners, plates, tanks, breaking-down machines, a corning house, dusting slope reels, glazing mills, waterwheels, a turbine, a steam engine, accumulator cylinders, hydraulic pumps, shafts, pedestals, tubes, clutches, gearing, hoists, cranes, oil cups and wall boxes. He also saw drawings relating to the Royal Arsenal, Woolwich, and a few of machinery for gunpowder manufacture being supplied to Curtis's and Harvey. Glenys and I therefore decided that we would like to make a more extensive investigation of the collection.

When we visited the Bolton Archives Office the selection of drawings examined by Wayne Cocroft were still available and we were allowed to study them. They date from 1855 to 1878 and many are in a very poor condition, requiring major conservation work. The archivist-in-charge is therefore unlikely to allow these drawings and the rest of the collection to be used again until their condition has been stabilised. However, Wayne is hoping to arrange for some of the important ones to be photographed. Certainly we were very impressed by the enormous amount of technical information contained in these beautiful drawings. For example, those of incorporating mills show exactly the different radii of the paths followed by the two runners. In some cases these were similar and in others very different. Also, we were interested that in one drawing, two edge runners, being supplied together and presumably for one mill, had slightly different diameters (6'5½" and 6'4") and widths.

After examining these drawings we spent the rest of the time we had available looking at indexes of the material in the archive in order to discover which other gunpowder mills Hick Hargreaves supplied with equipment. These indexes cover the period from 1819, before the firm was founded, to 1958 and we discovered 114 entries, excluding those relating to Waltham Abbey. Of these 98 were for Curtis's & Harvey at Hounslow (18), Bedfont (10, including 2 for "Bedford"), Tonbridge (7), Glyn Neath (45), Tonbridge or Glyn Neath (7), Clyde (5) and unspecified (6). The earliest is dated 1847 and is for cast iron bedplates for Hounslow. However there is also an isolated and intriguing 1845 entry for a "plan for a mortar" for Messrs Curtiss & Sons. The last entries were in 1893 for a pellet mould, spindles and nuts, and a friction cone, all for Glyn Neath.

The largest contract was for the refurbishment of the Glyn Neath mills in 1862-65 (37). The *Rise and Progress* states that Curtis's & Harvey acquired these mills in 1864 but clearly they were involved two years earlier. These particular drawings include incorporating mills, sulphur mills, corning machines, a glazing house, steam engines, water turbines, hydraulic presses, iron aqueducts and sluices. The Hounslow entries include incorporating mills in 1860, cast iron runners in 1867 and bed plates and runners in 1886. Wayne Cocroft had looked at the 1860 drawing and we were able to see it as well. It shows three incorporating mills powered from above. Two of these, on one side of the millstream, were replacing two which had been destroyed and the third, on the opposite side, was completely new. For Bedfont there are two entries in 1871 for wood-framing for a corning machine, a steam engine and incorporating mills and six drawings in 1890 associated with a new incorporating mill. The Tonbridge entries include a curb for a powder mill in 1855, four years before the

Rise and Progress states that Curtis's & Harvey purchased the factory, brass shoes for ploughs in 1864, a glazing house and a waterwheel in 1870 and "powder works" in 1891. All of the entries for the Clyde works, which were at Glen Lean, were for water turbines (1864/5). Amongst the unspecified items are "rings for edge runners" (1875) and a "runner ring" (1883), which are thought to refer to stone edge runners with iron tyres for Hounslow.

In addition to the above Curtis's & Harvey items there are 15 other entries which appear to be for gunpowder machinery. In particular there are nine for F C Dickson including a charcoal mill (1861), granulation pillars and a press cylinder (1873) and a ground plan of the powder mills (undated). The only location mentioned is Reading, in one of the four 1861 entries, but it was Dickson who established the Blackbeck mills in Cumbria in 1861. There are also 4 entries for Mr Willet of London in 1858, all relating to a powder mill. It seems likely that this is a misprint for Mr Wilks of Dartford. Finally there are two entries for Ballincollig for an incorporating mill (1862) and a bed plate (1863).

Clearly Hick Hargreaves was an important supplier of machinery to the British gunpowder industry but this was a very small part of their business, the proportion of entries in the index of drawings suggesting less than 3 per cent. Indeed we were very impressed that one firm was able to design and manufacture such a wide range of machinery and fittings. Nevertheless they appear to have supplied only nine of the roughly 36 mills which were active in Britain in the second half of the 19th century. Another firm involved was almost certainly J & H Gwynne of Hammersmith, London, which, as indicated elsewhere in this Newsletter, exported gunpowder manufacturing equipment to Japan and Italy. It is suggested in that article that a list of manufacturers of gunpowder machinery should be prepared and I hope that members will be willing to research this topic and share information.

We were only able to spend a few hours at the Bolton Archives Office and others would probably be able to extract far more information from the indexes and perhaps note some names of gunpowder makers which we missed. Also there is much information for those interested in wider aspects of industrial history. For example we noted drawings of equipment being supplied to a paper mill and an electricity generating company in Surrey. If visiting it is probably wise to make an appointment. Address: Central Library, Civic Centre, Le Mans Crescent, Bolton BL1 1SE. Telephone: 0204 363224, ext 2179.

ADVERTISEMENT FOR THE ROYAL GUNPOWDER MILLS AT BALLINCOLLIG

John Kelleher has written to us about the advertisement for Ballincollig gunpowder reproduced on page 20 of Newsletter 15. He points out that, in his book *Gunpowder to Guided Missiles*, George Kelleher has stated that in 1893 the Ballincollig company embarked on what must have been the only promotional campaign in its entire existence. It seems that in 1894/95 there were regular advertisements in the London monthly trade journal *Sporting Goods Review*, and in about 1894, one in a rare book *The*

South of Ireland (Illustrated) Up to Date, Robinson, Son & Co, London. The showcard, which is shown here, is reproduced from George's book and also dates from the mid 1890s.



GUNPOWDER MILLS IN RUSSIA, 1867

Alan Crocker

Bill Curtis has sent us a copy of a chapter on "Powder", which occupies pages 74-84 of the book *Tour of Artillery Officers in Russia*, printed by Eyre & Spottiswoode for HMSO, London in 1867. It starts by noting that in Russia there were three Government gunpowder factories but no private ones. (A footnote indicates that a few small factories existed in Finland). The party visited the Okta factory near St Petersburg, which had the newest machinery and appliances, but not the one in Little Russia (the saltpetre district in the Ukraine), which was the largest, or the one at Kazan, on the Volga 700 km east of Moscow.

An interesting description is given of the Okta factory. It had some old houses and sheds, a row of brick and timber incorporating mills built to replace 20 destroyed by an explosion in 1864 and some new brick mills in the course of construction, surrounded on three sides by a 15 ft high earth embankment. There were canals and ponds between the buildings. These were "to check the vibrations caused by explosions" and not for transport. However, a good tramway was planned. The mills were powered by water but it was anticipated that auxiliary horse-power might be needed when the new buildings were finished. There were 14 waterwheels, each generating 12 hp and powering a pair of incorporating mills. A further 22 mills were being built.

The factory was operated by 1000 artillerymen of whom 350 were workmen. This was considered to be unsatisfactory and the workmen were to be replaced by civilians. Powder was made during only 7 months of the year, avoiding the extreme winter cold, but two shifts were used during the summer. The composition was 75% saltpetre, 15% charcoal and 10% sulphur. Saltpetre came from Little Russia and also from the banks of the Volga. No saltpetre was imported but some was exported to Austria. The sulphur came from Italy and the charcoal was produced in cylinders from alder. The sulphur and charcoal were mixed in metal drums containing 0.75" gunmetal spheres. The green charge for the incorporating mills was 72 lbs. The older mills had 3 ton edge-runners and beds made of gunmetal and brushes were used instead of ploughs. The new mills were of iron, with 5 ton runners and bronze ploughs. The 1864 explosion, which killed 12 people, occurred when an attempt was made to incorporate in metal cylinders. The mill cake was 0.75" thick and the charge was incorporated for 4 hours. There was no self-acting dowsing apparatus. About 27 layers of broken cake, each 6" thick, were placed between zinc plates in a screw press worked by hand, resulting in layers 0.55" thick. The corning machine was a shaking frame with sieves containing lead and brass bullets. The corned powder could then either be dried and glazed for use as ordinary powder or compressed to produce prismatic powder.

It seems that powder in cakes with holes to facilitate the transmission of gas was invented in the USA but the Civil War had delayed its development. The Russians had therefore taken the lead and produced hexagonal prisms of compressed powder pierced by an array of 7 round holes. The prisms were 1" high and had sides 0.8" across. The water-powered machine in which they were made, six at a time, is illustrated and described in detail. It was about 5.5 ft high and had an ingenious system of shafts, cog-wheels, cams, levers, slots, a hopper, funnels, a charger bar, channels, hexagonal pistons, steel wires and a counter-weight. The prisms were dried at 97° F for 14 days, the water content falling from 7% to 0.75%. The prisms were not glazed. Prismatic powder was said to be more regular in its action than ordinary powder. It also resisted moisture better, a prism having been immersed for 1 minute in cold water without damage. In 8" guns, 11% more prismatic powder had to be used than ordinary powder and, as it was dearer per pound, it was effectively 15% more expensive to use. However, all of the Russian officers were in favour of using it in 6" and larger guns. The chapter also discusses the testing of powder, including the use of Rodman plugs.

THE FAVERSHAM POWDER FACTORY IN 1896

The sixth article in the series entitled "The Sporting Powder Industry of Great Britain", published in *The Sporting Goods Review* in the mid-1890s, was on the "Faversham Factory". It appeared on pages 187-190 of the issue dated 15 August 1896 and reports visits to the Marsh and Oare works operated by John Hall & Son, which had just become a limited liability company. It is illustrated by three photographs which are not particularly instructive. They show the entrance to the Oare works with several buildings and a tall chimney, a beam engine house at the Marsh works, together with a tall chimney and the proof range at the Marsh works, consisting apparently of two sheds and a post about 5 ft tall.

The Marsh works was visited first. It was powered by steam and hydraulics, having 16 steam engines. It had a saltpetre refinery which reduced the impurity content of Bengal saltpetre from 5% to 0.01%, an extensive cylinder charcoal burning house, a brimstone refinery and all the normal processing buildings. There was a network of tramways with metal rails but, at an expense magazine which was seen, an embankment carried a raised spur with wooden rails. Covered trucks on this spur were rolled on top of open trucks on the main tramway for conveyance to other parts of the site. There was also a network of canals. Three types of traverse were used, concrete, brick and earth, and huge stacks of cordwood, ready for conversion into charcoal, also acted as traverses. The glazing house traverse, made of concrete, was perhaps the most impressive feature of the site. At a wharf, located on a creek of the Thames estuary, a powder barge, flying a red flag, was being loaded with gunpowder for transfer to the company's floating magazine at Tilbury. Visits were also made to a new cartridge loading department, using nitro-powder as well as black powder, and the box-making establishment.

At the Oare works, occupying about 300 acres, the manufacture of tin flasks and canisters was observed. No solder was used, all parts being joined by pressure on the interlocking edges. The containers were covered with several coats of paint, varnished and labelled, the brand names being "Field B", "FFF", Brilliant Glass", "Cannonite" smokeless and "Southern Cross". The factory also made pellet powder, compressed blasting cartridges and prismatic powder.

I am indebted to Bill Curtis for providing me with a copy of this article.

Alan Crocker

DARK SATANIC MILLS

This is the title of a popular account of the Hounslow Gunpowder Mills published by our member Luke Over in *Local History Magazine* No 41 (Nov/Dec 1993) pp13-16 (ISSN 02662698). It explains how he was asked to write a history of the site by the Ecological Parks Trust and how he discovered a large amount of information, at first in local libraries but later in the ICI archives at Millbank and the Duke of Northumberland's archives at Syon House. He then gives an account of the history of gunpowder and summarises the history of the Hounslow, Bedfont and Feltham sites. Four illustrations are included: a painting of Syon House and Hounslow Heath in 1670, a painting of a water-powered incorporating mill at Bedfont in 1860, an engraving of remains following an explosion at Hounslow in 1857 and a photograph of the Mill House, the reservoir and the so-called "Shot Tower" at Hounslow in about 1930. Finally, Luke explains how he became a founder member of the Gunpowder Mills Study Group. The article ends with the GMSG logo and a note encouraging readers to join.

TANGYE HYDRAULIC GUNPOWDER PRESS

Alan Crocker

Tim Smith of the Greater London Industrial Archaeology Society has given us copies of two pages of a catalogue issued by the Birmingham engineering firm Tangye in 1914. The accompanying illustration is taken from page 302 and shows a 400 tons hydraulic gunpowder press. Page 303 explains that the press consists of:

"Cast-iron **cylinder and base** cast together, bored for the ram, and fitted with a U leather packing.

Cast-iron **head**, planed on the under side, tied to the base by wrought iron bars with solid collars, top and bottom, turned all over, fitting into recesses bored in the head and base, and fitted with caps. Cast-iron **ram** turned and polished.

Cast-iron **platten**, bored to fit on the head of the ram, planed and covered with copper on the top face. **Mullet** of hard wood blocks, bolted together and faced with gun-metal.

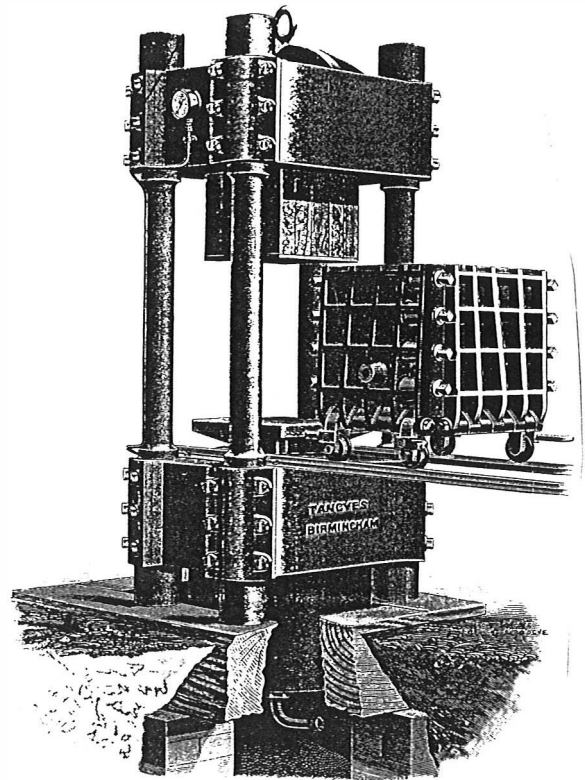
Gun-metal box, strongly ribbed, and faced with hard wood; it has planed joints with hinges on three sides. The box is fitted with four runners for running in and out of the press on two rails and is fitted with stops for holding it in position.

A **stop and release valve** and a dial pressure gauge are included."

An accompanying table explains that the box of the 400 tons press was 16½" long, 16½" wide and 20" high. The ram had a diameter of 17" and had a run out of 12". The approximate weight was 5 tons. The corresponding measurements for a ram tested to 600 tons were 30¼", 30¼", 33¾", 21" and 24" but the weight is not given, perhaps because they had not actually built one. The ram could be covered with gun-metal as an optional extra.

This description enabled me, more or less, to understand the illustration but I thought I would see what Guttman said about presses in his *The Manufacture of Explosives*, Whittaker, 1895, pp 204-10. He explains that there were screw-, roller- and hydraulic-presses. Screw presses had gone out of use, roller presses were first introduced in France but were then only being used in Germany. Hydraulic presses were being used elsewhere and he illustrates two types. The first is similar to the Tangye press except that the box does not have wheels. It does however have three hinged sides and Guttman explains that it was placed on its side for filling, which is probably why there is a lug on the left side of the box in the illustration. Vertical brass or copper plates were then placed in the box and the spaces between them filled with about 800 lbs of gunpowder. The hinged sides were then fixed, the box put upright, placed in the press and raised by the ram against the pressing block at the top. However Guttman then states that "Presses of this kind went out of use on account of their being too dangerous". This was published 19 years before the Tangye catalogue!

Guttman explains that the problem was that, after being pressed, the cake adhered so strongly to the sides of the oak box that it had to be removed with mallets. Also the box was so heavy that it was unwieldy to manipulate. Therefore the use of boxes had been discontinued. Instead, a stack of layers of gunpowder between plates of ebonite, which was



preferred to brass, was constructed inside a temporary frame on a four-wheeled truck on rails. This frame was then removed and the stack wheeled into the press. Using this method the powder at the edges of the layers is less well pressed than the middle so about an inch was cut away from the edges. The pressure used was 375 to 450 lbs per square inch, much less than could be produced by the Tangye press. Guttman's illustrations also show that, in the new type of press, as space is not needed to accommodate the box, more layers of powder could be pressed in a smaller press. Clearly the Tangye press overcame the manipulation problem, as it used a wheeled box, but one wonders how it avoided cake sticking to the sides of the hard wood box.

REVIEW

Wayne Cocroft, *Oare Gunpowder Works, Faversham, Kent*. Published by the Faversham Society in association with the Royal Commission on the Historical Monuments of England, 1994. Faversham Papers no 39, ISSN 0014-892X, ISBN 0 900532 62 9. 37pp, 27 illus.

As reported in GMSG Newsletter 9, pp5-6, the Oare gunpowder site was threatened by gravel extraction and by the establishment of a proposed gypsy site and the GMSG was consulted about its importance. The RCHME carried out a survey of the site in May and June 1991 and produced a report which has not previously been reviewed in the GMSG Newsletter. The new Faversham Paper is based closely upon this report and makes it available to a wider public. Additional illustrations are included in the new version. The original report contained maps of the site and drawings of equipment at Ardeer which had been transferred there from Oare when the works closed. To these have been added 19 photographs, of which 12 are of the works in the 1920s and 1930s and the rest show features on the site in 1991.

A brief outline of the history of the Oare Works, in the context of the explosives industry in Faversham and in relation to national developments which led to their closure in the 1930s, is followed by a short review of legislation pertaining to gunpowder.

The largest section of the report describes the remains on the site. This consists of an inventory of all the structures identified by the survey, followed by a description of the features which link the individual structures, in particular the earthworks representing the leat system. The inventory contains 36 entries each with four separate headings, which list the name or function of the structure, its cartographic depiction, its photographic depiction, and finally a description. The latter is in two parts, giving first a field description of the surviving structure and secondly a description of its former appearance and usage based on archival sources.

Next the chronological development of the buildings and plant of the Oare Works are discussed in relation to developments in technology. There are sections on the works in the early 19th century, rationalisation and reconstruction in the mid 19th century, late 19th century developments, the reconstruction of the works in 1926 following rationalisation of the explosives industry, and their closure in 1934.

The last sections of the book give details of the survey method, appendices on cartographic sources and drawings made by Nobel Industries Limited, and a bibliography covering legislation and published works.

The book is available from the Fleur de Lis Heritage Centre, Preston Street, Faversham ME13 8NS and at £1.95 (£2.95 including post & packing) is, like all the publications in the Faversham Papers series, remarkably good value.

Glenys Crocker

Bret, Patrice, "Lavoisier à la Régie des Poudres: le savant, le financier, l'administrateur et le pédagogue", *La Vie des Sciences, Comptes rendus de l'Académie des Sciences*, série générale, vol 11 (1994), no 4, 297-317.

The author of this paper is Secretary of the *Comité Lavoisier* of the French Academy of Sciences. We welcomed him as a member of the Group last year after the ICOHTEC conference in Bath, at which he gave a paper on "The organization of gunpowder production in France, 1775-1830". The abstract of his present paper has been translated as follows:

The *Régie des Poudres*, of which Lavoisier was one of those responsible from 1775 to 1792, provides an excellent demonstration of the working methods of the promoter of the revolution in chemistry and of the multiplicity of his skills. Lavoisier acted as a scientist, studying the reactions occurring in the production of saltpetre or the detonation of gunpowder, rationalising the empirical methods of the saltpetre makers by the introduction of chemical processes, and attempting to apply the discoveries of fundamental research to the production of gunpowder. He acted as a financier, transforming an ineffective state monopoly into a growing source of revenue for the Royal Treasury. He thus turned out to be an excellent administrator, organizing an efficient public service out of a badly managed private enterprise and deploying a modern industrial policy. Finally, he became a teacher, in order to set up the first theoretical and practical programme of education adapted to the needs of the commissioners for gunpowder, whom he made into a veritable body of chemical engineers.

The paper deals with the setting up of the new administration, its organization and the roles of the administrators; Lavoisier's work in collecting scientific literature, carrying out research and organizing the sending of instructions to those engaged in production; the publication of the administration's work and the setting up of a system of education in both theoretical and practical aspects of the subject.

In his assessment of the outcome of Lavoisier's work, the author notes that his strictly scientific achievement had limited practical results and the most significant advance was in the integration of applied and fundamental research. The financial and administrative results were more brilliantly successful and the educational achievement was of major importance in creating a new body of engineers.

The paper contains several interesting and attractive illustrations: contemporary views of the Paris Arsenal and powder magazine and of a powder boat being unloaded (by an incredible number of people) at Port Saint-Paul, and title pages of books: the *Recueil de Mémoires et de pièces sur la formation et la fabrication du sâlpêtre*, Paris 1786, and the second volume of Lavoisier's *Traité élémentaire de chimie*, Paris 1789. There are also illustrations of artificial *nitrières* from the archives of the Academy of Sciences. One shows plans and elevations of Swedish nitre beds, which served as a model for those introduced in France in 1777, and the other a view of a nitre bed showing the arrangement for circulating air in order to aid nitrification.

Many interesting points of comparison with British developments are brought to mind, in particular the determination at about the same time to put the manufacture of gunpowder on a scientific basis with the establishment of the Royal Laboratory in England. After reading of the British government's difficulties in obtaining powder supplies during the Seven Years War (1756-63) in Jenny West's book *Gunpowder, government and war in the mid-eighteenth century* (1991), it is interesting to read here that inadequate supply of powder to the French forces was one of the causes of their defeat - under the old system of the farm of gunpowder a situation had arisen in which financiers made large profits, especially from sporting powder and powder for the export trade, while the Royal Treasury received negligible returns and

supplies to the artillery and the navy were notoriously insufficient. There was also the major problem of obtaining saltpetre and the preoccupation with this aspect of gunpowder production is very evident from Patrice Bret's paper. In that connection, the use of a Swedish model for artificial nitre beds in France is an interesting detail, raising the subject of saltpetre production in the Baltic countries which has come up before in our discussions - in Brenda Buchanan's discovery of documentary evidence for saltpetre from the Baltic being imported into Bristol in the mid-eighteenth century, and in Bengt Åhslund's ICOHTEC paper on gunpowder production in Sweden.

This is a very interesting and stimulating paper. The French text presented this reviewer with something of a challenge, but the effort was worthwhile and if other members would like a copy, please send £1 to me in postage stamps.

Glenys Crocker

THE WIND AND WATERMILL SECTION OF SPAB

Enclosed with this Newsletter is a brochure about the Wind and Watermill Section (the Section) of the Society for the Protection of Ancient Buildings (SPAB). We know that several members of the Gunpowder Mills Study Group (the Group) already belong to the Section and we would like to encourage others to join.

The Section has supported the Group in several ways. In particular in 1988 it published the Group's *Gazetteer of Gunpowder Mills* and in 1992 used "Gunpowder Mills" as the theme of its annual Watermills Meeting. Gunpowder mills also featured in its weekend tour of Cumbria in 1992. Also the Group is a member of COGS, (the Committee of Groups and Section) which meets twice a year. This is very helpful as a small specialised organisation like the Group needs a larger and broader body to help it flourish.

Those who study the brochure will realise that the Section is itself part of the much larger SPAB. This Society was founded by William Morris in 1877 and he was responsible for its rather quaint but pertinent "Manifesto". It does not speak specifically about mills, just about the protection of buildings in general. However in 1929 a Windmill Section was formed and in 1946 this became the Wind and Watermill Section. This situation is rather anomalous as the main part of SPAB is concerned with buildings dating from before 1714 (other bodies such as the Georgian Group and the Victorian Society are concerned with later buildings), whereas the Section is largely concerned with mills dating from after 1714. Also the main part of SPAB attracts many architects as members whereas the Section has a very broad membership including engineers, millwrights, craftsmen, historians, geographers and indeed architects but mainly people who simply love mills.

The Section organises a one-day Windmill Meeting in March each year and a one-day Watermill Meeting in November (both in London), a one-day tour of mills in May (this year in Essex), a three-day week-end tour of mills in early September (this year in Gloucestershire) and a National Mills Day in May, when many mills are open to the public. In addition it publishes a quarterly Newsletter, with about 32 A5 pages, which Glenys and I currently edit. The main aim of the Section is however to ensure that mills and their machinery are protected. It is here that the close association with the Society is invaluable as SPAB is one of the statutory bodies to which planning applications for changes to listed buildings have to be sent for comment.

So, if you would like to support the protection of all sorts of mills and interact with a very extensive body of people interested in mills in general, please join the Section.

Alan Crocker

W A ADAMS'S WALTHAM ABBEY NOTEBOOK

Alan Crocker

We have purchased, through an antiquarian book dealer, a landscape-format manuscript notebook, measuring 80 x 110 mm, with 150 pages, boards covered with brown skiver and a brass clasp at the fore-edge. The opening leaf at the front is stamped "W. O. BOOK, No. 138" and has the penned inscription "Rl. Gunpowder Factory, Waltham Abbey. 20th October 1871". The same inscription, without the date, is also written, but in a different hand, on the opening leaf at the back. The dealer stated: "There is no clue as to the identity of the owner of this notebook". However in certain lighting conditions the inscription "W A Adams" can be detected on the skiver of the outside front cover. Also, beneath a band of ultramarine paint on the inside front cover, the inscription "William Arthur Adams, 20th October 1871" can just be deciphered. It is not known who this was and any ideas which members might have would be greatly appreciated. Perhaps there was a link with the Ewell gunpowder mills in Surrey, which were operated by Sharpe, Adams & Co in 1862 and closed in about 1875? (See *Gazetteer*, p23).

Of the 150 pages in the notebook, 125 have been used for notes, tables and six full-page drawings, two of which were in pencil and have been erased. The remaining 25 pages are blank and 19 of these separate a section of 106 pages, used from the front of the notebook, from 25 pages, used from the back. The content of the pages at the back duplicates, often using the same words, a selection of the material at the front. It appears that the notebook was used over a period of several years as the date "19th. Jany. 1875" is written at the head of page 68.

The notes are penned in a neat copperplate cursive hand and are easily legible. Most of them are in sections headed: "Brimstone Dome" (2 pages); "Cylinder House" (5); "Saltpetre Refinery" (24); "Mixing House" (2); "Incorporating Mills" (3); "Brimstone Refinery" (2); "Granulating" (2); "Pressing" (16). These include notes on procedures, the number of men employed thereon and their individual duties. There are also notes on the work at water and steam mills, RLG and RFG powders, pebble and cube powders, rocket composition, etc. There are 17 pages of tables supporting these notes. The four surviving drawings, which are in ink, show a detailed transverse section of a battery of three charcoal retorts, a simplified drawing of the same at the back of the notebook, a detailed longitudinal drawing of a single retort, and a densimeter, used to establish the density of pressed powder.

The following is an example of the type of information contained in the booklet:

Incorporating Mills.

Weight of the Runners.	Iron. 8 ton 10 lbs[sic].	Stone. 7 ton.
Diameter of Beds.	Iron. 2 ft 3½ ins.	Stone. 2 ft 3 ins.
Revolutions per Min.	Iron. 8½ per m.	Stone. 7½ per m

Time of Running the Charges under the Iron runners.

Dogwood - 4 hrs. Spec Dogwood "2" - 8 hrs. Dust - 40 minutes.

Common - 2½ hrs. Dust - 40 minutes.

Time of Running the Charges under the Stone runners.

Dogwood - 5½ hrs. Dust - 40 minutes.

Common - 3½ hrs. Dust - 40 minutes.

The 50 lbs Charge when sent from the Mixing house contains about 2 pints of liquor and requires from 5 to 7 pts of liquor in Milling.

The dust requires from ¾ to 1½ pts. On the Charge being properly distributed on the bed, the powder should be brushed clean away where the outside plough works and round the cheese, and if the powder adheres to the curb, when starting on a green Charge it may be scalded off with boiling water, then it may easily be spudded off and swept in and started.

When the mill has been at work about 20 or 30 minutes, the Millmen should go in the Mill and sweep the curbs and runners, in case there should be any Composition fall on the Curb that sticks to the outside of the runners. The Millman if he thinks that the charge has not got sufficient liquor to run it up to its proper time & moisture he will put some more on through the rose of his watering pot, and should then be mixed up with the Shover, if not when the charge is ready it might be spotted. When the charge is got to its proper moisture, it is spudded up, and put into a Charge tub, to go to the Breaking Down House.

Note. It appears that, originally, the notebook consisted of eight gatherings, each with six sheets of paper, plus a front end-paper. However the first leaf of the first gathering and the last leaf of the last have been almost entirely cut away and the stumps stuck to the boards. Also, the complete first leaf of the front end-paper and the surviving last leaf of the last gathering have been stuck to the boards. This means that the book originally had 94 leaves. However, 17 have been torn out and the first three have been stuck together so that now the notebook has 75 leaves, including the triple-thickness one at the front. Inside the front cover is glued a small printed table of weights and measures. Underneath this is a pad of paper which appears to have been cut from the notebook. At its edges it shows traces of a drawing in ink. The notebook is made from pale blue-grey laid paper with the watermark "CHAFFO..., SUPE...". Chafford Mill was in the parish of Penshurst in Kent and seems to have made superfine paper.

GLYN CEIRIOG GUNPOWDER MILL

We reported on this mill, which is mentioned in W J Milner's book *The Glyn Valley Tramway*, in Newsletter 15, page 19. Further information has now been provided by **Stuart Chrystall** of the Surrey Industrial History Group, who has made a special study of the industrial archaeology of North Wales slate quarries. In particular he visited the Ceiriog valley at New Year 1995 and saw a ruined sluice (NGR SJ 188344) which directed water into the leat to the gunpowder works. The course of the leat across a field was clearly visible. At the end of the field (SJ 188346) there were some ruins in the bank of the river which appeared to be those of a tailrace. Any remains of the mill were obliterated by work in progress to lay a pipeline through the site. The Ordnance Survey map, surveyed between 1900 and 1910, shows the leat continuing to a small building (SJ 190347). Beyond this point the area between the river and the hillside was even then covered by waste tips from Hendre granite quarry, which was established in 1875. Further spoil from the quarry, which continued to be used until 1952, and the pipe laying had obliterated any features of this part of the site. The re-growth of woodland made interpretation, even of features from the quarry period, very difficult. Stuart has also given us details of Appendixes 2 and 3 from Milner's book, which contain the information that, on average, 15 people were employed at the Blasting Powder Works between 1870 and 1879.