WASC 1873
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Touchpaper Dec 2003
Article on K. J. Quinan and the Quinan Stove

+ Touchpaper June 2004
Appendix + pps 7/8/9.

NON-LISTED PRINCIPAL STRUCTURES OF THE ROYAL GUNPOWDER MILLS

Part III DEVELOPMENT OF CHEMICAL EXPLOSIVES

Section 4. 20th Century - Guncotton Drying

The history of K.B.Quinan and the Quinan Stove

K.B.Quinan was one of the great figures of the explosives industry and the following gives a brief synopsis of his career and the Quinan guncotton drying system before discussing the Quinan stove at Waltham Abbey.

K.B.Quinan

The story begins in the rich gold fields of South Africa, indirectly of vital importance to the British economy.

Blasting was a fundamental part of the mining operation and blasting explosives were a significant component in the mines cost structure. Following his development of the chemically based dynamite and blasting gelatine and their meteoric success in world mining Alfred Nobel had been assiduously creating the empire which was to bring him immense wealth, by building new factories, licensing, by absorption of other companies and the forming of trusts for specific markets to the point where Nobel enterprises were a dominant force in world explosives. Too dominant for some - in South Africa they came up against an equally forceful influence in the shape of Cecil Rhodes and the De Beers Mining Corporation.

For the South African market Nobel had manoeuvred to the position where one of his trusts the British South Africa Explosives Co. effectively controlled the market. Rhodes considered that the trust's pricing policy represented abuse of a monopolistic position and after fruitless negotiation on price ordered that De Beers should create its own explosives works. The site chosen was the village of Somerset West near Capetown. The General Manager of De Beers was an American, G.F.Williams, and he was aware of the high reputation of an ex US Army Colonel W.R.Quinan who had become in civilian life manager of the California Powder Co. Quinan was approached to become manager of Somerset West and he accepted, bringing with him vital supervisory staff and technicians. In 1901 on a trial

In 1903 the Cape Explosives Works commenced production. From the outset W.R. displayed high leadership and technical development qualities and the works became one of the prominent explosives works of the world.

There must have been some genetic trait in the Quinans suited to explosives management. The nephew K.B. exhibited the same qualities and as his uncle gradually stepped back from the day to day activity of the factory so the nephew moved in, becoming an 'extremely efficient ' works manager in 1904 and on the death of his uncle in 1910 becoming general manager. Space does not permit discussion of all of K.B.Quinan's achievements and innovations, but two give an idea of the scope of his activity. The first is an example of the strategic thinking which characterised him. The factory had been obtaining its glycerine from Holland and K.B. had ordered that a glycerine distillery be built at Somerset West. Although this was done on commercial grounds originally by an incredible chance the plant was completed on the day war was declared in Europe, thus avoiding reliance on what had now become the highly vulnerable sea lanes from Europe to Africa. The other was the system he had designed for drying guncotton which he had patented. The system was a substantial improvement on existing methods and there was sufficient interest to justify manufacture and marketing under licence by Fraser and Chalmers, engineers of Erith,Kent.

The Quinan system and its advantages are analysed in the Appendix.

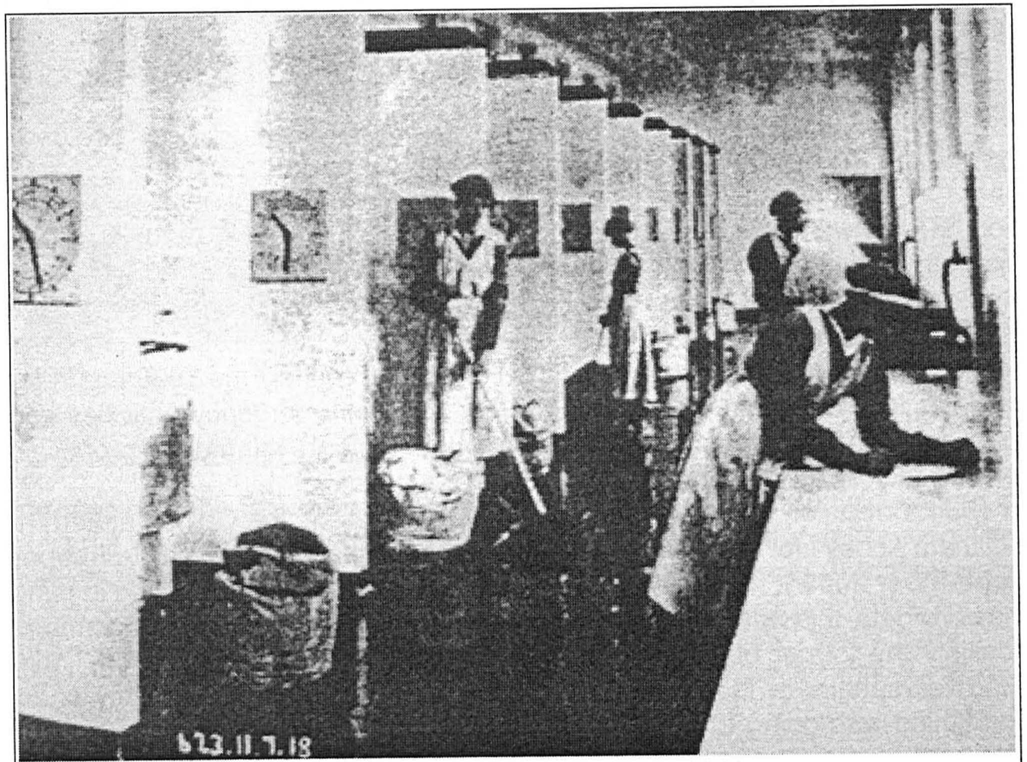
All this with Somerset West and his work highly respected must have caused Quinan some satisfaction. But war had come and fate decreed a wider destiny. By 1915 the British Army on the Western Front was in serious difficulty through lack of sufficient artillery ammunition and propellant. The Times called it 'The Shell Scandal'. Lloyd George was appointed Minister of Munitions with Lord Moulton heading the Committee on High Explosives to reorganise and significantly increase the output of the munitions industry. A telegram was sent to Quinan 'inviting' him to come to London to aid the effort with his advice. The telegram must have been persuasive - it was received in the morning, by half past four on the same day he was on the mail steamer for London. On arrival he was appointed Head of the Explosives Supply Department, charged with designing and overseeing the building of a series of factories which were to transform the munitions industry.

One of these came to be called the greatest explosives factory on earth The site chosen was in Dumfriesshire in southwest Scotland, with good rail and sea links and safe from attack. The logistics were mind boggling, involving a torrent of materials and most of the construction workers having to be brought in from outside, mainly Ireland. Reflecting the name of the settlement in the middle of the site the works was named H.M.Factory Gretna. Building Gretna was not for the faint hearted. Work continued round the clock and the workers toiled in a sea of mud and materials. Local accomodation was hopelessly inadequate. There were three shifts a day and workers shared a bed, one coming off shift occupying it as the other left to go on. Until they could find something newcomers had to sleep in the massive drain pipes they had built beside the roads. Very high wages could be earned, a substantial part of which immediately in time honoured fashion found its way into the coffers of the local breweries.

Construction began in August 1915 and a year later the factory was complete - stretching for 9 miles from the west at Dornoch on the Solway Firth in Scotland across the border to Mossband near Longtown in England, connected to 3 main rail lines, 90 miles of internal rail lines, 100 miles of water mains, its own powerhouse with four turbo alternators serving 22 miles of electric mains, 8 hydraulic plants, 8 hydraulic accumulators, 54 steam boilers.

The first cordite left the works in August 1916. The pressure for output was intense. In the initial stages the works did not permit itself the luxury of any set breaks for meals.

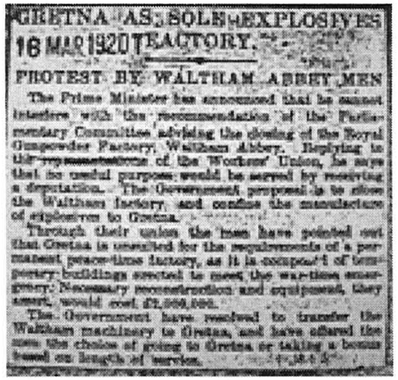
In the complex the guncotton drying stoves employed the system which Quinan had designed.



Quinan guncotton drying at Gretna 1918
(Drying time clock on each bay)

Gretna was an outstanding success. Productivity was excellent and by the end of the War a total output of cordite of 57000 tons had been achieved. After the War Quinan returned to South Africa. His contribution to the success of the munitions effort had been immense and he was awarded the nation's highest civilian honour, Companion of Honour; as a foreign citizen he could not be knighted.

After much debate on whether Gretna or Waltham Abbey would survive as the main Government cordite factory, at the last minute having decided it would be Gretna the Government changed its mind and Waltham Abbey continued. Gretna was largely dismantled in the early 1920's.



GRETNA AS SOLE EXPLOSIVES FACTORY.

16 MAR 1920

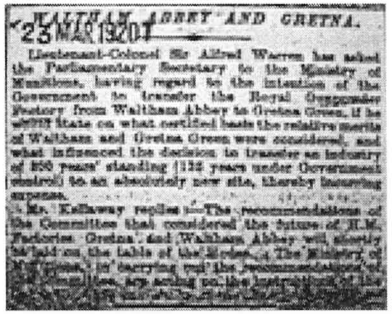
PROTEST BY WALTHAM ABBEY MEN

The Prime Minister has announced that he cannot interfere with the recommendation of the Parliamentary Committee advising the closing of the Royal Gunpowder Factory, Waltham Abbey. Replying to the representatives of the Workers' Union, he says that no useful purpose would be served by receiving a deputation. The Government proposal is to close the Waltham factory, and confine the manufacture of explosives to Gretna.

Through their union the men have pointed out that Gretna is unsuited for the requirements of a permanent peace-time factory, as it is composed of temporary buildings erected to meet the war-time emergency. Necessary reconstruction and equipment, they assert, would cost £2,000,000.

The Government have resolved to transfer the Waltham machinery to Gretna, and have offered the men the choice of going to Gretna or taking a bonus based on length of service.

1920
Newspaper
cuttings



WALTHAM ABBEY AND GRETNA.

23 MAR 1920

Lieutenant-Colonel Sir Alfred Warren has asked the Parliamentary Secretary to the Ministry of Munitions, having regard to the intention of the Government to transfer the Royal Gunpowder Factory from Waltham Abbey to Gretna Green, if he would state on what certified basis the relative merits of Waltham and Gretna Green were considered, and what influenced the decision to transfer an industry of 250 years' standing (122 years under Government control) to an absolutely new site, thereby incurring expense.

Mr. Kellaway replied:—The recommendations of the Committee that considered the future of H.M. Factories Gretna and Waltham Abbey will shortly be laid on the table of the House. The Ministry of Munitions, in carrying out the recommendations of the Committee, are acting on the instructions of the [illegible]

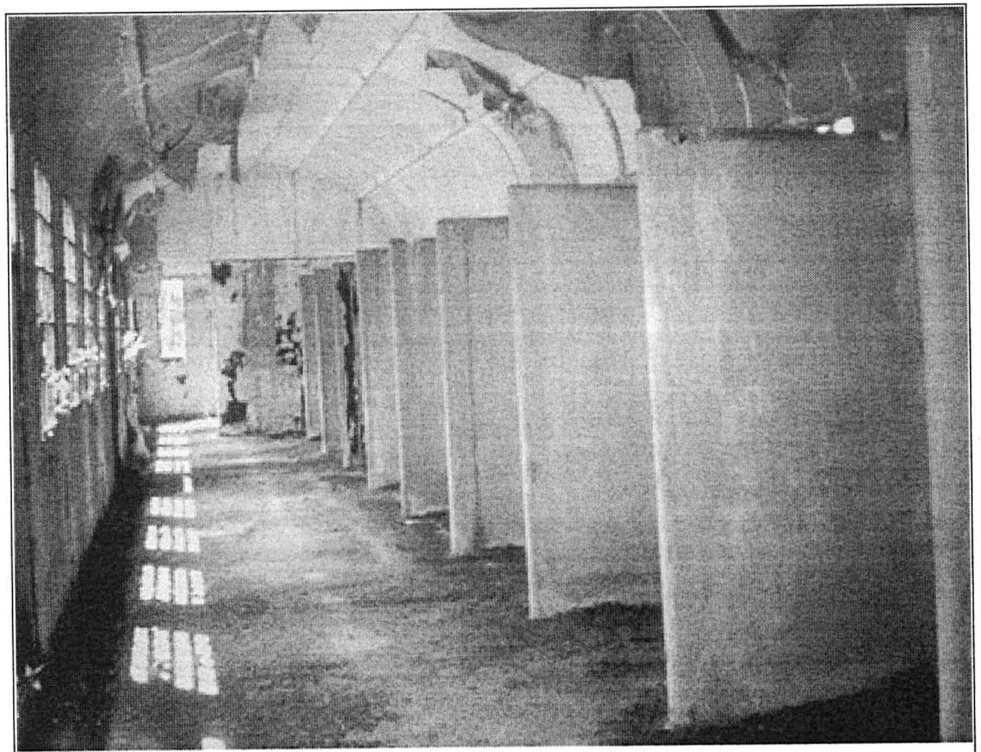
Installation of the Quinan Stove at Waltham Abbey

After the War the explosives industry turned again to civil use with the military side becoming again a largely unknown low key activity.By the 1930's however the first warnings of a tangible outside threat were being received within the Governmental machine and whilst the public, soothed by the speeches of Mr.Chamberlain, hoped for the best the military supply organisations behind the scenes quietly began to prepare for the worst. Revealingly the 1935 report for the Mills for the first time contained the phrase War Emergency Activities and mentioned uncertainty as to the 'removal of the factory', referring to proposals for new factory building in the safer west of the country.

In 1934 a decision was taken to install drying stoves on the Quinan pattern at Waltham Abbey (for location on the North Site see map in centre of **Touchpaper September 2003**). It is not entirely clear whether at that time,bearing in mind the early date, this was a basic plant update or part of a rearmament programme, possibly the former but overtaken by events as the 1930's moved on. Tom Gladwell speaks of the atmosphere influencing work in 1936 - 'They knew something was going to happen' (extract from Ron Treadgold's oral history archive).

Possibly partly arising from this increased tempo of rearmament activity, the Quinan development at Waltham Abbey attracted considerable interest in the national explosives activity. At the initial planning stage no less than five outside bodies participated - the Home Office, Government Research Department, Royal Naval Cordite Factory, Ordnance Factories, ICI.

It appears that considerable effort was directed to investigation of the structure and material of the building as a design exercise for future danger buildings, the basic advantages of the operating design being given.



Interior of Waltham Abbey Quinan Stove
showing drying bays and peeling painted calico.
2003

Waterways - The Stove was served by a cut off the main waterway system in the usual way. In 1936 two new boats were supplied with the description 'Dry Guncotton Boats - Quinan Type'. Swim headed both ends, at 26ft. they were 7ft. shorter than the standard dry guncotton boat and 2ft. narrower. The Quinan cut was already entering the maintenance work schedules. The Rivers and Cuttngs report for the year includes 'The dredging of shoals at Quinan Stove Cut'.

The Quinan Stove was built on the site of the previous Guncotton Stove No.17, building No.22a, and rather confusingly the new building retained the same number. 22a/3 was allocated to the Engine/Fan House.

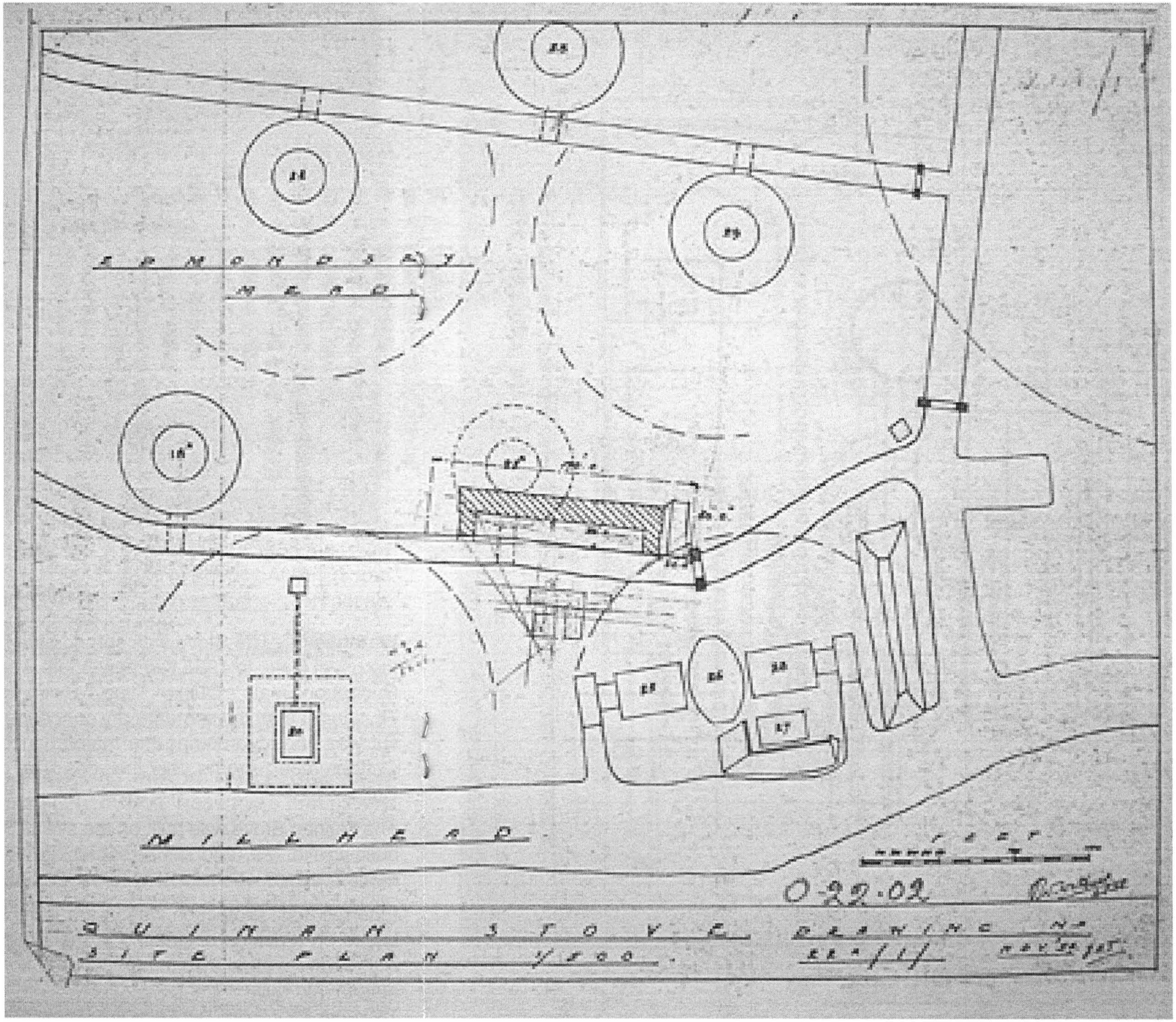
External blast protection was in the form of 'Chilworth mounds'. These were based on a design originating at the explosives works at Chilworth in Surrey, with earth revetted by bitumen covered corrugated iron sides,reinforced by flat bottom iron rails.

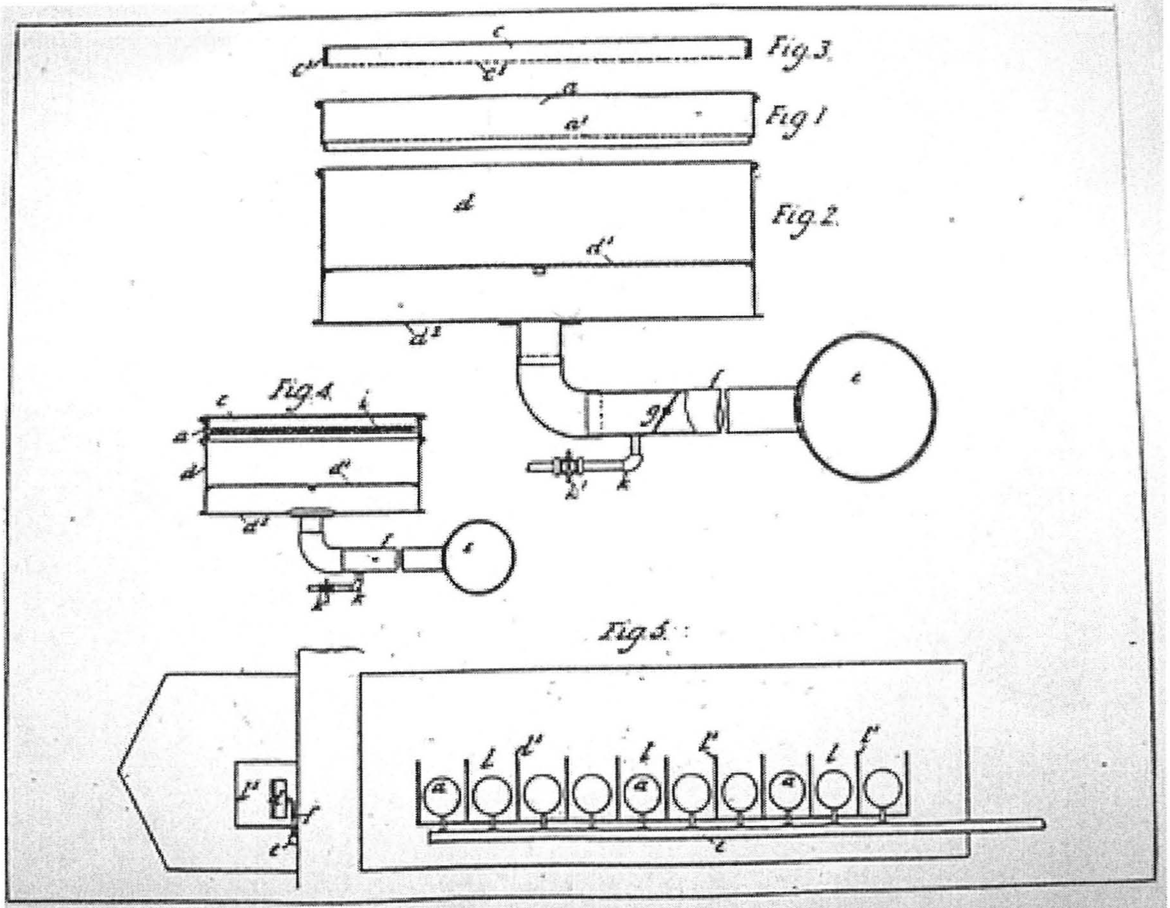
Traverse 22a/1 was between the Stove and the Engine/Fan House and 22a/2 protected the general area to the south of the Stove.

QUINAN SITE PLAN:

Originally drawn in 1934, the year the Quinan development was decided.

The stove, with its canal cut and the dotted line denoting the previous guncotton stove No. 17, is in the centre of the plan surrounded by older generation guncotton stoves.





A Fraser and Chalmers schematic diagram of a Quinan Guncotton drying installation with 10 drying bays

KEY:

a - basket
a1 - perforated metal sheet
c - basket retaining screen
c1 - basket retaining ring
c2 - cover for basket
d - galavanised iron air distributor/basket support
d1 - perforated false bottom
d2 - closed bottom
e - hot air main
f - hot air pipe
g - hot air valve
k - compressed air pipe
k1 - compressed air valve
i - alcoves
i1 - fireproof walls

What emerged, in 1936, was a building of decidedly modern appearance amongst what were becoming relics of the late 19th century. At that time in the wider world much experimentation was taking place in the use of concrete, both in the domestic and commercial fields, and this extended to the Quinan Stove. It was constructed of precast concrete with a barrel shaped roof, bitumen coated. The walls consisted of concrete panels on a steel frame anchored in the ground. Reflecting the need in a danger building to allow the passage of blast, the roof panels were relatively lightly secured and the walls were infilled with wire mesh concrete rendered. Natural light was provided through ten light sections in iron frames. Electric lighting consisted of the usual danger building system of wiring in small bore tube with lights hung on the outside walls. The standard shoeboards denoting clean and dirty areas were employed. There were 15 processing bays. The walls were covered in painted calico to facilitate cleaning.

A separate Engine/Fan House provided the warm drying air via pipes laid over the top of a protective traverse.

Quinan Stove - Waltham Abbey
(picture taken 2003)

'Chilworth mound' Traverse
Waltham Abbey - 2003

It can be conjectured that by this time it had become clear that future expansion of production would take place in the new factories being planned for the west of the country and no further Quinan Stoves were built at Waltham Abbey. Instead this became the test template for the new factories.

It succeeded in this function. In 1938 it produced 177 tons of dried guncotton and it was reported that 'the experience gained in operation has proved invaluable in the planning of the new cordite factory' (which would have been ROF Bishopton, Renfrewshire). Alf Nicholls recalls the smaller size pans, quicker drying and increased effeciency of the new installation and the design's successful transfer to Bishopton (extract from Ron Treadgold's oral history archive).

Some doubt has been raised as to the validity of perpetuating the Quinan system of drying when a system of cordite manufacture had been evolved which avoided the need for drying entirely by using a wet slurry of nitrocellulose pumped to the mixing house for blending with nitroglycerine. To examine this question is beyond the scope of this history of the Quinan Stove - did the designers decide to concentrate on the building, not wishing, under the pressures of war to change the whole manufacturing process ? *(comments please - Editor)* .

To-day and the Future

The Quinan Stove stands to-day in the deserted north of the site, threatened by encroaching vegetation, still looking modern compared with the surrounding relics.

As more explosives facilities disappear it is possible it is the sole surviving building of its type in Britain.

Until relatively recently it was in fair condition. However the fabric has now moved into a downward path. The roof bitumen has failed, the concrete on the walls is spalling, the window frames have rusted and most ominously the structural frame is rusting. Without attention to this the building will eventually collapse.

The building has recently been placed on the English Heritage Buildings at Risk Register. It is to be hoped that this will prompt some preservation action.

The Quinan Stove represented an important stage in development of chemical explosive processing and served the nation well in two World Wars, notwithstanding the possibility that, in ideal conditions, a new system development replacing it might have been introduced earlier.

It is :

⇑ **An outstanding example of enlightened process design involving a challenge to existing received wisdom leading to increased efficiency, safety and to reduced cost**

⇑ **A surviving physical reminder of the great political events of the 1930's when once again preparations for the unthinkable had to be made**

⇑ **A little known example of the application of 1930's precast concrete techniques to the very specialised industrial function of danger buildings**

⇑ **A memorial to the man of whom the *Times* said - 'It would be hard to point to anyone who did more to win the 1914-1918 war than K.B.Quinan'**

Les Tucker

Published by the Friends Association of the
Royal Gunpowder Mills Waltham Abbey
December 2003

The following Appendix was omitted from the article on the Quinan Stove in the December 2003 issue.

Appendix
The Quinan System for drying Guncotton

Pre-Quinan - The use of dried guncotton blended with nitroglycerine to make cordite initiated the building of guncotton drying stoves at Waltham Abbey.
These consisted of batteries of stoves served by Engine and Fan Houses. The Engine House powered a belt drive to the Fan House which blew air over heaters and into the stove. A later version comprised a central Fan House with blowers which blew hot air from a heat exchanger consisting of pipes served by steam from boiler houses.
Drying was a time consuming and expensive process and efforts were directed to increasing the amount dried at one time. By the late 1930's stoves were drying 5000lb of guncotton for 60 hours at a temperature of 35°C.
Quinan appraised this system, identified disadvantages, and produced a design which eliminated perceived disadvantages and improved performance.
The characteristics of the existing system were :

The drying of a large quantity at one time for a prolonged period led to super drying - continued drying of material after part is dry. This could lead to electrification of the batch

Handling of material in large unwieldy batches led to the risk of friction which in conjunction with electrification could lead to fire and explosion

'The GREATEST POSSIBLE CARE is to be taken when handling Dry Guncotton to carry out all operations as quietly as possible . FRICTION OF ANY KIND IS TO BE AVOIDED' [Extract from Factory Rules for handling Dry Guncotton]

Prolonged heating could lead to loss of product stability

Excessive drying times restricted throughput and increased utility costs

Quinan's design turned the existing system on its head, eliminating the disadvantages and conferring further advantages.

Electrification avoided by eliminating super drying. This was achieved by rapid, 60 minutes, drying of smaller quantities in smaller containers, 16lbs, at a much higher temperature, 61°C, with the warm air being passed directly through the guncotton, which was spaced out in thin layers

Danger of friction in handling at the unloading point substantially reduced by laying the material on a sheet in the drying basket with sheet only being lifted out complete with contents at the end of drying

Provision was made for the guncotton to be cooled before handling by circulating through the material compressed air which cooled as it expanded

Avoiding prolonged heating eliminated loss of product stability

Safety increased by separate drying bays with fireproof walls

Substantial reduction in cost of utilities

MORE ON THE QUINAN SYSTEM / STOVE FOR DRYING GUNCOTTON

Correspondence

Thanks to Steve Bell and David Hewkin for their letters on the Quinan article.

The Touchpaper articles so far have taken the story up to the late 1930's. When booklets are ultimately published information on the later period as in this correspondence and hopefully later responses will be included.

Regarding Steve's comments on the postwar use of the Quinan stove, its siting at Waltham Abbey was certainly a complete anomaly in manufacturing terms once Bishopton was established. By the late 1930's the powers that be would have concluded that it was only ever going to function as a building and system test bed for guncotton drying for cordite manufacture at Bishopton rather than as a component of any manufacturing at Waltham Abbey and that if, as it did very successfully, perform this function then leaving it merely for miscellaneous use after that was a small price to pay.

Now of course it has become a unique surviving artefact of the 20th century explosives industry. Whether drying guncotton for cordite manufacture was the correct route to follow is another matter, see below.

As David points out, my use of the word 'entirely' in relation to the wet mix process for cordite paste removing the need for drying was misleading - I should have written something to the effect 'when a system of cordite manufacture had been evolved which avoided the use of guncotton in the dried state'.

David notes ' The Quinan process involving moving hot air may have been evaluated as a means of increasing the throughput'. In a History of Chemical Engineering published by the American Chemical Society an article appears entitled 'The Role of Chemical Engineering in providing Propellants and Explosives for the UK Armed Forces'. In this it is stated:

> *The principle of preparing warm, dry, filtered air and forcing it through fluidised beds of guncotton restrained from escaping by covers of special fine cloth was a brilliant solution well ahead of its time.* ***It probably increased the output of the cordite factory*** (not specified) ***by 50% by reducing the throughput time.*** (my 'bold type').

The implication of this for wartime production does not need any explanation.

Wet Mix v Dry Mix

Any discussion of the Quinan guncotton drying system leads inexorably to consideration of the two systems of producing cordite paste, a mix of nitrocellulose and nitroglycerine - dry mix using dried guncotton or wet mix using a wet nitrocellulose slurry.

The Quinan drying system was devised because Abel's original cordite patent, which set the scene for Government cordite manufacture, called for dry guncotton in the mix. Dry guncotton was a very hazardous material and Nobel in his method had avoided it. Later events at Bishopton demonstrated the dangers of handling dry guncotton. There were two serious explosions in 1941 and 1943. It is evident that by the late 1930's a significant segment of opinion had arisen which said ' wet - good, ' dry - bad '. For example again quoting the Role of Chemical Engineering article, ' Developments did occur in the manufacture of solventless cordite and a feature of this at the RNCF Holton Heath was the overdue adoption of the principle of wet mixing of NC and NG as originally employed by Nobel. The dryimg of guncotton with its attendant risks therefore was eventually abandoned by the government factories at the end of World War II'.

That the controversy was in the forefront of official thinking on explosives at the time is indicated in the Proceedings of the Court of Inquiry into the explosion on 20.4.1940 in No.2 Mixing House at Waltham Abbey. Under the heading Observations No. (iv) reads :-

> *In view of this explosion and the two previous recent explosions at Waltham Abbey and Ardeer, the Court is of the opinion that full consideration should be given to the relative merits of the wet mix process and the method in use the R.G.P.F.*

Evidence given by Mr.P.G.Knapman, Superintendent of the Factory, and Dr. Rotter, Director of Explosives Research, Research Department shows that the matter was by no means clear-cut.

Mr.Knapman

> *With reference to the Wet Mixing Process he had given it a lot of thought,*
> *but said that if it was introduced you remove the risk at one point and put it on at another, he was not sure which was the bigger risk.*

Dr. Rotter

> *A great deal had been said recently about the substitution of a wet mixing process for the present dry paste mixing. He was not sure whether the Court was the proper body at which the relative merits of the two processes should be discussed, but he was clear that while the wet mixing process had some advantages it had also certain undesirable features which rendered its immediate adoption of very doubtful desirability. It was not clear to argue that the process which had been found satisfactory for cordite S.C. would be equally so in the case of cordite W as there were important differences in the character of the materials. He understood that a unit of plant was being fitted up at Ardeer to try out the wet mixing process and advocated that its further adoption in Government factories should be postponed until after experience had gained.*

Les Tucker

QUINAN STOVE

It is not that I have a bad memory through age you understand; I've always been thus afflicted. So the following is offered on the understanding that I am happy to be corrected.

The Quinan stove on P1 section was used for drying NC for two main purposes:

(i) For single based compositions, mainly NCNM, which was used in an aircraft ejector release unit (to eject wing fuel tanks from the Buccaneer aircraft?). NCNM was developed following incidents with the double based propellant that had been previously used in this application. This had given rise to NG distillation through temperature cycling (low temperatures at high altitude followed by high temperatures due to aerodynamic heating) and resulted in unplanned ejections. For many years P1 produced all the NCNM required for service use.

(ii) Richard Wallace, who was then the Principal in charge of gun propellants section, did not really trust the wet mix process to give him the required accuracy of composition in a finished propellant. Hence he introduced the following procedure: for a required 50/50 NG/NC ratio in a finished propellant he would order a paste made to a nominal 52/48 NG/NC ratio. After analysis of NG/NC ratio by the main lab the required amount of dry NC was added at the incorporation stage of manufacture. The dry NC of course coming from the Quinan stove. This practice carried on after Richard's retirement and hence Steve Bell, as the then superintendent, would have authorised it. Bad luck Steve, nice try. The group who made solventless compositions did not use this procedure. Perhaps it was something to do with the fact that it was they who operated the wet mix process!

Everyone, down to the most inexperienced process worker, appreciated the extreme hazards with dry NC and regarded the Quinan stoves as our most hazardous process. In fact, even now, I am surprised at how disciplined and knowledgeable our process workers were at Waltham Abbey. I have visited MoD sites all over the country and have never yet come across one as fortunate as we were with our workforce.

My memory, faulty as it is, tells me we had a dry mix room complete with NG burettes and a lead mixing table at N549. It was never used of course, other than for storage. I think our main concern, had we been asked to use it, would have been NG headaches. We had a great deal of plant on P1 which was never used; clearly when the site had been set out it was envisaged that we would have a much wider remit than we in fact had in the end. Just two that spring to mind are the ball powder plant and the alcohol dehydration plant for single base propellant manufacture.

Peter Stone
12/03/04