

Chapter 4 - The War of 1914-1918

CORDITE FACTORY

The production and use of any kind of munitions is dependent almost always upon the availability of the explosive, and consequently the Cordite factory should be the first to receive consideration in this chapter except that the Colonial Ammunition Company's factory must be brought in too to the extent that the demand for .303" ammunition affected the productive capacity for Cordite. By the middle of 1914 the factory had completed its second year of manufacturing and everything was in smooth-running order; the programme for 1914-1915 was 100 tons "Cordite, Mark I, Size 3 3/4", a continuance of the outturn attained during 1913-1914. The stocks on hand of raw materials and supplies were good, particularly in respect of those which normally had to be imported, it being the Manager's policy to carry sufficient always for a production of 2½ times the prescribed peacetime outturn of 100 tons annually. Similar foresight had been exercised in regard to the buildings and plant; duplicates were provided of anything likely to be damaged by explosion or other mishap: thus the vulnerable nitro-glycerine factory had been completely duplicated, and spare machines and parts of machines had been imported for reserves.

The Manager, Mr. A.E. Leighton, F.I.C., left for England on 14th April 1915. The circumstances associated with his visit are referred to elsewhere. Mr. N.K.S. Broodribb, Assistant Manager, assumed management of the Factory and was appointed permanently to the position on 1st February, 1917. Mr Topp acted as Assistant Manager from April, 1915, until in 1917 he departed for England. Mr. A.G. Hall then became Assistant Manager and continued for the remainder of the period. Mr. W.R. Kerr was Accountant until June, 1918, when, on taking up other duty, Mr G.E. Ravenhall, Stores Officer proceeded him. Other executive officers playing a part in the war time development and operation of the factory were Messrs E.G. Monk, Supervisor

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of Dungen Buildings, and J. B. S. Cochrane and A. K. Jack, Chemists. Mr. F.X. deBavay

After the declaration of war, large quantities of laboratory chemicals and glassware, much of which had been drawn from enemy countries, were purchased wherever possible, but Melbourne firms helped in meeting this requirement by undertaking local manufacture of glassware, and later the difficulties of importation eased so that at no time was the factory hampered for want of these necessities. There was concern however as to continuance of supply of some of the raw materials which had to be imported, particularly acetone and cotton waste, the local production of which I shall bring in shortly, but there was no difficulty about glycerine; the Australian product was tried at an early stage and found suitable, and later in the war large quantities were exported for use in explosives manufacture in England and South Africa. Nitrate of Soda was the one raw material of importance that was beyond reasonable prospect of local production, and although large stocks were held, advantage was taken of an opportunity to purchase several years' supply in one lot - in fact the complete contents of a ship - thus allaying all anxiety. It can be said also, though not within the period covered by this chapter, that investigations in after years have proved that all the Nitric Acid likely to be required can be produced from Sulphate of Ammonia available in Australia.

The first direct impact of the war upon our resources for production of munitions was a call in October 1914 by the Chief of the General Staff (Colonel J.G. Legge) for .303" ammunition at the rate of 100,000,000 rounds annually for two years. Obviously the brunt of this would fall upon the Cordite Factory, and Mr. Leighton reported that the outturn would have to be doubled - to 200 tons annually - and that the stocks of raw materials on hand and on order were good; enough in fact, coupled with the cordite on hand, to cover the first 100,000,000 rounds, but further large stocks would have to be ordered to maintain production on the same scale. He said also -

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Although Cotton Waste and Acetone have been promised, it is possible that England will not be able to release the amounts we want. I advise that we ascertain at once whether England can assure continued supplies of cotton waste and acetone to meet C.G.S.'s demands. If England cannot assure supply then we must make other arrangements, and if you will inform me of the exact amount of cordite required I will make all necessary enquiries and submit a detailed scheme.

He said further that sections of the Cordite factory would have to be enlarged to meet the additional demand, but it would be practicable to work these into the Gun Cordite scheme if later they turned out to be redundant in the .303" Cordite plant. By direction of the Minister, a

committee of advice met on 3rd December 1914 - the members being the C.G.S., the Quartermaster-General and Mr. Leighton, with the Manager of the Colonial Ammunition Coy. in attendance - and as a result of its conference the C.G.S. stated on 11th December:

1. 2,000,000 rds. .303" ammunition required weekly.
2. Cordite Factory to be advanced cash from the Ammunition Trust Fund to finance purchases of raw materials.
3. £8,000 to be provided on Supplementary Estimates for additional buildings and plant at Cordite Factory.
4. The output of the Colonial Ammunition Coy's factory not satisfactory. The matter to be considered again later.

In (1), the factory was now faced with a specific demand, and consequently Mr. Leighton examined afresh the necessities of materials supply; he advised that locally produced glycerine and sulphuric acid were available, and that nitrate of soda, carbonate of lime, carbonate of soda and mineral jelly, although in general all were imported could be obtained from local resources in that contracts for their supply has been arranged during 1914 before any anticipation of war, but that cotton waste and acetone would require consideration.

Cotton fibres converted into guncotton are the basic constituents of Cordite and prior to the war they had been obtained from England in the form of thoroughly cleaned cotton waste. Substantial shipments had come in recently and further offers had been received, shipment from England to commence in September 1915, but Mr. Leighton was doubtful whether any could be available as the war progressed; he recommended installation of a cottonwaste treatment plant at the factory with a view to the crude waste being obtained from India or Japan and cleaning and treating it on the spot. Provision for the plant was included in item (3), a decision which turned out to be the initial step for the manufacture in Australia of cotton wool for surgical purposes. Other decisions relative to item (3) were that new buildings and plant would be provided to raise the factory outturn to 250 tons annually working 24 hours daily, a spare incorporating house and a cordite stove were authorised, and a small factory was to be equipped for manufacture of fulminate of mercury; the explosive used with the percussion caps in firing small arms cartridges.

Up to 1915 the caps were imported, but thereafter the metal caps were made at the Ammunition Factory and filled there with the fulminate of mercury made at the Cordite Factory. As regards .303" ammunition, the Colonial Ammunition Company undertook to produce 2,000,000 rounds weekly by working two shifts, and this might have gone further after receipt in July of the following cablegram from the Secretary of State for the Colonies in London -

... Small Arms Ammunition, Minister for Munitions would be glad to learn what quantity could be produced (and what price).

but regretfully we had to inform him that only Mark VI .303" ammunition was being made in Australia, whereas the Mark VII - pointed bullet - had been introduced lately for the British Army; he was also advised that 2,000,000 rounds weekly was our projected output and that the whole of it was likely to be required for the Australian troops at the Front and in

In his reports Mr. Leighton stressed that the main problem would lie in obtaining adequate supplies of Acetone, hitherto obtained from England or Canada; he said that while the Acetone being produced on the wood distillation plant of Cuming Smith and Co. at Warburton, Victoria, was quite satisfactory for quality, the tonnage was small and consequently it was very costly. He had commenced discussions with the local manufacturers, and after prolonged negotiations agreement was reached that the Department would purchase all that could be made available up to 17½ tons annually for five years. That quantity however was only about one-third of the annual requirement, and importations had to be continued, with difficulty at times in securing sufficient for the cordite production programme - on one occasion, in response to an appeal from the Government of India, a shipment of 10 tons was diverted to that country - until finally the Acting Manager of the Cordite Factory (Mr. N.K.S. Brodribb) was given specific instructions - on 17th July 1915 -

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- (a) to plan for an annual outturn of 250 tons Size 3 3/4 Cordite;
- (b) to furnish estimates of cost of providing:
 - (i) an Acetone Recovery Plant;
 - (ii) a Cotton Waste Treatment Plant;
- (c) to ascertain the terms whereby local production of Acetone would be doubled (to 35 tons per annum).

This instruction was founded upon Mr. Leighton's report of the previous October, and when he embarked upon his mission of enquiry in April 1915, one objective was to enquire into Cotton Waste and Acetone supplies, and at the Indian Cordite Factory he arranged for details of the treatment plants in operation there to be sent to Australia:-

- a Cleaning and preparation plant for crude Cotton Waste;
- an Acetone Recovery plant whereby acetone that had been used in Cordite manufacture could be recovered to the extent of 40 per cent and used again.

Some of this information had been despatched promptly from India, and

soon Mr. Brodribb was able to

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arrived, he had sufficient to get on with some additions to buildings for the items of (b) above; the financial authority for which was included in a general proposal for building construction relating to the manufacture of Gun Cordite, for which reference should be made to Chapter 5. It can be said however that this had engaged the attention of a committee in 1912, and action in that connection was now to be taken. With regard to (c), as the question of local production of Acetone had become all-important, some space must be given to that now.

Acetone and the Acetate of Lime Factory

The process employed in the manufacture of Cordite during the early years of the century necessitated the use of Acetone as a solvent. Before the war it was mostly imported, from England and Canada, but when the Cordite Factory commenced operations in 1912 some ten tons annually were being produced at Warburton, Victoria, at the Cuming, Smith and Coy. timber distillation plant. The Department undertook to purchase all the Acetone becoming available locally at the uneconomic price of £150 per ton, only justifiable under a policy of self-containment; the Company itself having declined in 1912 to extend the plant for production of any more at the same price.

In December 1914, Mr. Leighton reported that about 50 tons of Acetone annually would be required to meet the programme of Cordite manufacture contemplated by the Chief of the General Staff, that he had discussed the possibilities of an increased production of Acetone with Messrs Cuming, Smith and Coy. and had been informed that it would involve capital expenditure on buildings and plant of about £7,000 to produce 35-40 tons per annum; that if the Department would undertake to purchase that quantity for a term of years at £150 per ton, they would face the investment. He pointed out that in considering this maybe only 20 tons would be required annually after two years (the estimated duration of the war), but on the other hand if manufacture of gun cordite were taken

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that probably a seven years contract would be necessary for amortisation of the capital investment. He said further that Canadian Acetone cost £85 per ton and that Australian manufacture at £150 per ton would add 1/3d to the cost of each lb. of Cordite, but against that there would be the benefit of having an Acetone factory in Australia and the employment of Australian labour. His conclusion was that reliance should not be placed upon Canada: "the visible supplies of acetone are so small that I feel sure the British Government will have first option on all that is available", and he recommended the Cuming, Smith and Co. proposal. The Minister approved of negotiations with the Company on the foregoing conditions and on 28th July 1915 a contract was signed for purchase of 17½ tons annually of Australian produced Acetone at £200 per ton subject to adjustment according to the landed cost of Acetate of Lime (Calcium Acetate), the actuating factor in the production of Acetone, which, it will be noted, had also to be imported. This meant that substantial quantities of Acetone were still to come from abroad and the Company was again approached by Mr. Leighton with a suggestion that more Acetone should be produced at Warburton but it declined because of the uncertainty in obtaining from overseas the necessary Acetate of Lime. Meanwhile, as shown elsewhere, an Acetone Recovery plant was being set up in the Cordite factory for extraction of Acetone from waste liquids and refined for use again. There had been close consultation in that connection with Mr. Leighton, who by now had arrived in England, and he had also been advised, on 28th July, of the proposal to double the production of Acetone being obtained by timber distillation. In replying to that communication on 23rd September he suggested that an investigation should be made of a method of producing Acetone by the acetic fermentation of alcohol and the distillation of the Calcium Acetate (Acetate of Lime). He said that the method appeared to be adaptable to Australian resources; that the cheapest and best source of alcohol for the process was molasses,

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a by-product of the manufacture of sugar, much of which was ploughed into the grounds as a fertiliser or dumped into the sea, although limited uses had been found in the form of treacle for human consumption or as a cattle food, and also it was mixed with megasse (sugar cane debris) as boiler fuel. Mr Leighton remembered a paper of some years previously which had appeared in the printed Papers of the Melbourne Society of Chemical Industry, and suggested to Mr. Brobribb to get in touch with the writer as being a bacteriologist likely to be able to advise on the subject. This proved to be Mr. Auguste de Bavay, well-known in the Mining world, and on being approached by the Minister Mr. de Bavay agreed that production of Acetate of Lime (Calcium Acetate) was practicable as suggested, and undertook to develop the process. By 20th November 1915, Mr. de Bavay was able to advise -

That there was no difficulty in producing 250 tons annually of Acetate of lime; that the only substance available in quantity to produce the tonnage was Vinegar of which 750,000 gallons would be required. He also forwarded two sample bottles of Acetate of Lime which he had already made from Vinegar.

Mr. de Bavay said also that there were alternative methods of establishing production -

Buy the Vinegar from existing manufacturers, who produce it usually from Malt grain with perhaps an addition of syrup;

or

Produce it from Molasses in a Government factory.

The latter he thought would be the cheaper despite the much greater capital expenditure on a factory.

On 27th November, replying to an enquiry about technical details,

Mr. Leighton cabled -

Advise you press on with experiments and give Brobribb every assistance he desires for rapid conclusion of work.

.../and on

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and on 13th December a letter arrived containing a considerable amount of technical and economic information obtained from British and American sources.

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On 21st December, the High Commissioner's office in London was asked to offer large quantities of Molasses to the Ministry of Munitions, and the reply indicated that the supplies were needed but freight was very costly owing to there being only four or five small ships in the business fitted with tanks. The idea consequently was not followed up in that form. Meanwhile the possibilities of utilising the Molasses for local production were being investigated in the light of the information supplied by Mr. Leighton and in conjunction with Mr. de Bavay, and on 20th January 1916, Mr. Broodribb submitted a survey of the position from which the following extracts are informative -

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From experience in this war it appears very desirable that the local production of Acetone, on a scale to meet any requirement for Cordite manufacture, should be undertaken.

The production of Acetone from Molasses has the following strong points in its favour:

- (1) Unlimited supplies of the raw material
- (2) Entire independence of outside supplies under war conditions.
- (3) The establishment of a new industry, by the Government, in the Commonwealth.

I am confident that Acetone can be produced at a cost far below that at which the Acetone of present local production can be obtained, and at or near the figure at which it can be imported under normal peace conditions.

Further, he pointed out that the factory should be situated as close as possible to the source of Molasses supply, that is in Queensland where it costs 10/- per ton to purchase, bearing in mind that freight per ton to Melbourne would alone cost 50/- per ton. He asked that enquiries be made by cable from England as to the cost of plant so that he might work out

E 162/4/139 the capital cost of a factory to produce 30,000 gallons of Molasses vinegar per week. With this report before him, on 24th January 1916 the Minister appointed a Committee to report upon the whole question, recommending a site for the factory, estimated cost of same, output of Acetone, and available supplies of Molasses, the members to be Mr. de Bavay, Chairman; Mr. Brodribb, Member; and Mr. R.J. Lewis (Chief Inspector of Explosives in Victoria) Member.

E.162/4/158 On 25th February 1916 a cablegram arrived from Mr. W.M. Hughes, the Prime Minister, from New York, enquiring about the possibilities of Molasses supply and the manufacture of Acetone in Australia for the information of the Imperial Munitions of War Committee. This was followed up by a reminder from Mr. Hughes from London, and then an enquiry came from Mr. Leighton dated 16 March arising out of the cablegram to him sent at Mr. Brodribb's request on 26th January, he wanted to know whether the proposed factory would be in the vicinity of the Molasses supply, or if not the cost of conveyance of the Molasses to the factory. He said also that the factory must be where the temperature does not rise over 100 degrees F. He asked also the freightage to Liverpool of 200 tons monthly of Acetate of Lime and of 500 tons yearly of Acetone; and the number of gallons of Molasses to a gallon of Alcohol. On 14th March 1916 Mr. de Bavay's Committee submitted a comprehensive report, which however was modified later in several important aspects in consequence of more searching investigation of details, and it would be misleading therefore to do any more than mention here that the Committee reached a conclusion at the outset that the proposed works should be in Queensland; that they should be limited to production of Acetate of Lime, and that they should be transported to the place where the Acetone would be required for retorting and distillation. The idea behind this was that the retorting should be done at the Cuming Smith Works at Warburton, Victoria, and the distillation at the Cordite Factory, but this plan was varied later for good reasons.

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As the Australian demand for Acetate of lime was comparatively small, it was obvious that an external market would have to be found for a large quantity of Calcium Acetate (or Acetone) if the proposal had to be studied from the economic standpoint, but if it were considered as a Defence measure - which it was - the resultant Acetone should cost £112-£122 per ton according to the cost of the Molasses (the outturn of which at the time was 225,847 tons), then estimated at a delivery cost of 10/- to 20/- per ton. It is suggested here that these delivery costs of Molasses should be borne in mind because in the final result they became an important factor in the decision after the war to close down the factory. Against that the Molasses necessary to produce the Australian requirement of Acetone was only 2000 tons per annum: about one-hundredth part of the available quantity. On receipt of this report, the Minister directed that the following cablegram should be despatched to the Prime Minister, Mr. Hughes -

Question of manufacture of Calcium Acetate from molasses has been considered and as result of investigation consider can undertake supply up to 5000 tons of Acetate composition about 92 per cent acetate 8 per cent water per annum. Capital cost of plant 2500 tons estimated £123,000 and acetate estimated cost £15/10/0 ton f.o.b. Commonwealth. Plant for 5000 tons will reduce cost to £12 ton. Cannot be ready for shipment under six months and it will require ten years agreement cover expenditure of capital. It is suggested you should confer with Leighton of Ministry Munitions who is acquainted with subject and submit foregoing offer to His Majesty's Government. Please reply by telegraph what quantity they are prepared to take in order to secure necessary molasses and commence erection of plant.

It will be obvious that this cablegram, which was despatched on 17th March and repeated to Mr. Leighton, would be the reply to the two cablegrams noted at the beginning of this paragraph. Mr. Leighton discussed the cablegram with Sir Frederick Nathan, Director of Propellant Supplies in the Ministry of Munitions, and explained the Australian position in regard to Acetone and the proposals for local manufacture of Acetate of Lime, but obviously it was a long range plan and no interest of a practical nature

was forthcoming from the interview. Meanwhile, under the direction of Mr. N.K.S. Broodribb, with Mr. de Bavay as Consultant, the design and construction of a factory was taken in hand - the objective being the production in Australia, from locally available raw materials, of some 125 tons annually of Acetone. To achieve this, acetate of lime, now being imported, would have to be manufactured at the rate of 500-600 tons per annum, and it was contemplated that such factory would be erected in the Brisbane district on the water front so that its raw material, molasses, to be brought by sea freight from Cairns, would be off-loaded directly into the factory. A site was found at Bulimba on the Brisbane River, adjoining the Australian Meat Export Coy's works and wharf. As molasses, otherwise raw treacle, was a by-product of the sugar industry, the principal seaport in the sugar-cane country: Cairns, about 1000 miles from Brisbane, was selected as the assembly point for the molasses, to which they were carried from the sugar mills in railway tank wagons and deposited in a large reception tank erected adjoining a wharf; the plan being that while the tank would be filled during the sugar cane harvesting season, a tank steamer would tie up alongside the wharf at regular intervals throughout the year and take on molasses to suit the processing requirements of the Acetate of Lime factory. Arrangements were made with a shipping company trading along the Queensland coast for one of its ships to be fitted with a large tank and pumping facilities for taking on and off-loading the cargo. In the event that a thought might arise as to why Brisbane was selected for the chemical plant, it is explained that the sea carriage forward, and the return of an empty ship to Cairns would have been very costly if the Acetate of Lime production were placed in a factory adjacent to the Victorian acetone factory, and it will be recalled also that Mr. Leighton advised locating the factory in an area where the general temperature would not be exceeding 100 degrees Fahrenheit. The Buildings at Bulimba and the tank at Cairns were constructed by the Commonwealth Works Branch according to plans

prepared by Messrs. Brodribb and de Bavay, and Mr. Brodribb arranged for construction and installation of the specialist plant upon advices he received from Mr. de Bavay and information and plans sent out from London by Mr. Leighton; it should be understood that manufacture of Acetate of Lime from products other than molasses vinegar, was quite well-known in Australia and it only needed adaptation of those processes upon a large scale to the use of molasses to obtain the desired results; in fact Mr. Leighton's suggestion was to convert the molasses into vinegar, and Mr. de Bavay advised that a much larger "acetifier" than customarily used would be preferable for carrying the vinegar into a large scale production of acetate of lime. By the middle of 1916 all the preliminaries had been settled and a commencement made with the buildings and plant, and negotiations were also opened with the Australian Meat Export Company for the use of its wharf pending the erection of a departmental wharf; similarly the Company was asked to allow the use of its railway line for a branch to connect with a siding in the yard of the Acetate of Lime factory thereby giving the latter access to the Queensland Government railway system. It may be of historical interest, although nothing came of the particular matter, if I mention here that in connection with his enquiries in respect of production of Acetate of Lime, Mr. Leighton had an interview with Dr. Chain Weizmann whose process for production of Acetone was said to be "full of promise, but has hitherto produced no considerable quantity of Acetone". It will be recollected that the gentleman in question became famous later in his position as first President of the State of Israel.

It will be recollected that the agreement with Cuming, Smith and Co. provided the price they would charge for Acetone should be based upon the landed cost of Acetate of Lime, and in July of 1916 the Company advised the Department that its latest shipment would warrant the price for Acetone being fixed at £555.6.8. per ton for the quarter ended 30th September 1916, this being evidence that overseas prices for Acetate of Lime had advanced considerably.

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However, on 26th July the firm offered to supply 20 tons of Acetone for the current year at £350 or alternatively, if offered to continue with the original terms of the agreement: £200 per ton, provided the Department adhered to 17½ tons per annum for the ensuing four years. In submitting these proposals Mr. Cuming explained -

We would like the Defence Department to feel that we do not wish to take advantage of the position to make any extra profit out of these works during war time

Mr. Brodribb recommended that the offer of 20 tons at £350 per ton for the current year only should be accepted; that he did not expect the current high price for imported Acetate of Lime to fall materially during the next twelve months, and it can be added that a contract for four years at £200 per ton was not acceptable to the Department because it was expecting to obtain much cheaper Acetate of Lime when the Brisbane works became operative.

Twelve months later, on 10th July, Cuming, Smith and Co. Pty. Ltd. advised the Department, with regard to supplies of Acetone, that it had not imported any Acetate of Lime for six months and cable enquiries had elicited that the material was unobtainable in the United States. However an offer had been received from Japan which would cost about £41 per ton landed in Melbourne; this would mean, according to the original agreement, that the price would work out at £368 per ton, but the Company offered to continue the 1916-1917 price for Acetone, namely: £350 per ton. The Defence Contract Board was now dealing with such matters and on the recommendation of the Manager, Cordite Factory, the Board and the Minister approved of the Company's proposal. In November however the Contract Board raised questions about the rate of £350 per ton as against the suggestion made by Cuming Smith in July 1916 for a four-year contract at £200 per ton, and it was agreed subsequently, with the concurrence of the Manager, Cordite Factory, that the Company should be approached with a view to reversion to the £200 proposal and that made retrospective. The suggestion was declined by the Company; its

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explanation being that when the offer was made it was gambling upon an early termination of the war and its main objection now was founded upon the fact that the Government having decided to build its own factory in Brisbane, their plant would have to be scrapped when that came into operation. The Manager, Cordite Factory, contested the Company's claims

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and the Contract Board submitted a review of the whole matter for the consideration of the Board of Business Administration; the Chairman of the Board, Mr. G. Swinburne, discussed the matter with Mr. Jas. Cuming,

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and the Company thereupon proposed £288.2.8d for its 1918-1919 contract. It is interesting in this connection that on 22nd August 1918, in a general

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report to the Minister for Defence upon the operations of the Board of Business Administration, the Chairman stated -

On account of the very one-sided contract for Acetone with Cuming Smith and Co. the Board went into the matter very closely with Mr. Cuming and was able to effect a reduction of £62 per ton on Acetone. This contract should never have entered into in the form it stood as it was absolutely one-sided in favour of the Contractor.

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However Mr. Cuming would not agree to a suggestion during the negotiations that the £288.2.8d per ton should also apply to the deliveries during the preceding financial year 1917-1918. On 15th August 1918, Mr. Cuming wrote

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to Mr. Swinburne advising him that the latest quotations for Acetate of Lime were higher than previously, and that the price of Acetone should be increased accordingly, he asked whether in the circumstances the contract could be cancelled altogether; his Company would very much prefer that.

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The enquiry was referred to Mr. Brodribb, but he was somewhat critical of the Company's attitude and arguments, and he asked that the contract should not be terminated until there was certainty that the Brisbane factory was a going concern.

Operations were commenced at the beginning of October under the management of Mr. F.X. de Bavay, who from the outset had been assisting his father in the initial experiments and then worked with Mr. Brodribb in the design of the works and plant and in the construction generally. The factory was operated as a subsidiary of the Cordite factory, Mr. de Bavay being designated as Works Manager, and within a year it had attained the output required; it had never been possible, the war having terminated, to ascertain its ultimate productive capacity. However it can be said that in 1918-1919, after making full allowance for all costs and overhead expenses - the latter including interest at the rate of 5 per cent on the capital expenditure and working capital £126,533 which amounted to £4,476, and Depreciation £3,824 - the price of Acetate of Lime was 12.70 pence per lb. and in 1921-1922 (the final year of production it was 9.57 pence per lb.). The capital expenditure upon the Brisbane factory and the Cairns storage up to 30th June 1919 was £105,353. The sales of Products and By-products amounted to £9,834. Having regard to the fact that the factory was built and equipped under war conditions, and labour and building materials were at their war-time peak, it was thought at the time that a very good job had been done bearing it in mind particularly that only £500 of the capital expenditure had been sent abroad. There was also satisfaction that this project had made Australia absolutely self-contained in the production of an essential war store. It will be obvious probably that the Acetate of Lime had to be carried a stage further, by a process of distillation, into the chemical Acetone, and plant for that operation was installed at the Cordite Factory, Maribyrnong, Victoria, in conjunction with other factory extensions in construction at the time.

It was contemplated that Acetate of Lime would also be available for sale for commercial purposes, and in this connection a letter dated 4th October 1918 was received by Mr. Swinburne, in his capacity as Chairman of the Board of Business Administration, from Mr. James Cuming -

I saw by the paper the other day that the Brisbane works has started to make Acetate of Lime. We shall be very glad to have some as soon as it is ready. If this can be supplied to us at £20 per ton landed here, the price of Acetone will come down to £200 per ton.

I was in the United States at this time and consequently I have no knowledge of the circumstances which influenced the suggestion but I have speculated whether there was anything mordant in it; surely he could never have imagined that an Australian factory would get anywhere near that price especially within only a few weeks of commencing operations. Mr. Brodribb was asked for his comments on this and they were not favourable but he preferred to await results from Brisbane before saying anything definite; he did however point out that if Mr. Cuming could get Acetate of Lime for £20 a ton, the cost of Acetone made from it should be £140 per ton, not the £200 per ton suggested in the letter - this calculation of course was based upon the agreement of 1915. On 28th October and 13th November Mr. Cuming pressed for advice as to the supply of Acetate of Lime from Brisbane, urging that we should not be continuing to buy it from Japan when it was being made in Australia, but the reply each time was that results from the Brisbane factory were not yet complete and sales must wait. On 19th November the Cordite Factory office advised the Department that Acetate of Lime could be supplied to Cuming Smith and Co. at the rate of £65 per ton. On 21st December the Factory Office notified the Department that the Brisbane factory was now producing all the Acetate of Lime required, which meant that the Cordite Factory was making its own Acetone, and that the contract with Cuming Smith and Co. could be terminated. Mr Swinburne approached Mr. Cuming accordingly, referring to his letter of 15th August, and asked him to set in motion the customary request, which came forward on 9th January, accompanied by a letter of protest as to their treatment - apparently they were resentful that the Brisbane factory had come into existence - but in looking through the correspondence afterwards in the light of the conditions obtaining in Europe in 1915-1916 it will be seen that the Defence Department might have been

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facing a grave responsibility if it had not gone on with the manufacture of
Acetate of Lime in Australia. On 30th July 1919, Cuming Smith and Co. asked
the Department to take over 1400 gallons of Acetone which remained on their
hands when the contract was terminated; later they reduced the request to
1,000 gallons and the Department having taken over this lot at the latest
purchase price: £288.2.8d per ton, dealings with the Company terminated.

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Manufacturing Plant and Production

Turning now to the plant generally, as distinct from the measures taken for provision of raw materials, its condition when Mr. Leighton went abroad is exemplified by a letter from the Australian Explosives and Chemical Company to the Secretary for Defence, dated 30th March 1915 -

We should be very much obliged if you would permit our Factory Manager, Mr. Charles Tilburn, to visit the Cordite Factory at Maribyrnong with a view to seeing your arrangements for nitrating Nitro-Glycerine. We are desirous of getting up-to-date in our factory, and believe could not do better than follow the good example set at your Cordite Factory.

The result of this inspection is contained in a letter received from the Chief Inspector of Explosives in Victoria during October of 1916 -

E.162/1/98

I would like to place on record my appreciation of the advice and practical assistance rendered by Mr. Brodribb, the Acting Manager of the Cordite Factory, and Mr. Monk, Head of the nitro-glycerine section, in connection with the starting up of the new nitro-glycerine section of the Australian Explosives Factory, Braybrook.

The Factory management had no practical experience in the working of nitrator separators, two of which are included in this plant, and I was in consequences, somewhat anxious about their being put into use.

The assistance given by Messrs. Brodribb and Monk, not only largely removed by anxiety, but gave confidence to the management in starting the first nitrations.

Mr. Leighton arrived in England towards the end of June 1915, and soon our curiosity was aroused by two cablegrams on successive days (30th June - 1st July).

Send by first steamer, personal notebooks, files, and any returns likely to be of assistance to Cordite Factory construction.

Send drawings plant layout also Home Affairs building drawings.

E.162/2/128

This matter was duly sent forward, it made up quite a shipment and its purpose soon became known: the British Government asked that this services should be made available for the duration of the war to the Department Explosives Supply in the Ministry of Munitions, for Factories construction, as to which a very large programme was in hand; it was evidence that they were drawing upon our experience.

On 26th July, Mr. Leighton was asked to enquire regarding the possibility of purchasing for Australia four presses for extruding Size 3 3/4 Cordite and he supplied this, but later, when asked regarding shipment of the already ordered acetone recovery plant, and other machinery and presses on order for additions to the Cordite Factory including production of Gun Cordite, the reply read -

Leighton recommends construction of presses and stills and plant Acetone Recovery in Australia. India reports that all drawings have been sent to you. Drawings Cordite press will follow. Particulars as to Acid Concentration plant will be sent later.

The English orders consequently were cancelled and steps taken for local manufacture of all the plant required for the extensions including a Sulphuric Acid Concentration plant: another recommendation by Mr. Leighton after his visit to India; primarily it was to conserve supplies, but also it was a measure of economy whereby spent Sulphuric Acid could be retained in the factory and brought up to strength, instead of being sold as factory wastes. Subsequently Mr. Leighton was asked to send out from England the working drawings of the hydraulic extrusion presses used in manufacture of gun cordite with the intention that they should be built in Australia; he was always strong in advocacy of local production of munitions plant and this was now to be further demonstrated in the following cablegram dated 16th September 1915 -

Can you help us with Hitro-glycerine plant. Nitrator 30 lb. Lead for 1200 lbs. Glycerine. Internal diameter 4 feet 9 inches, greater depth 5 feet 9 inches, lesser depth 5 feet 3 inches. Faucet 2 inches. Coils 1 1/2 inch bore, 1 3/4 inches outside, 2 1/4 inches between pipe centres, 22 turns Diameters between pipe centres inner 20 inches 3 supports second 30 with four third 40 with six outer 50 with seven. If lead available please start work at once overtime. Further details will follow next mail. Urgent reply as to probable cost and shipment. Assembling will be done.

Obviously this cablegram would be unintelligible to anybody but a Chemical Engineer acquainted with this type of plant, and it is only included here so that there may be understanding of the remarkable achievement by Mr. Brodribb and his staff in building up this highly complicated piece of chemical plant, made as it is entirely of lead, with such slender information at hand. A reply

Hope ship Nitrator Separator within forty days. Cost f.c.b. Melbourne £350. Will make dome and neck in proportion own plant unless required otherwise.

The response to this was an order for four Nitrator Separators, all of which were shipped by the middle of February 1916, and then further requests were made so that by June 1917 fourteen altogether had been manufactured and sent to England. Another plant achievement was the construction during 1916 of the first hydraulic power presses to be built in Australia; they were required for extrusion of cordite and were so designed that while the immediate use would be to extrude the .305" Cordite now being ordered from the Maribyrnong factory by the Government of New Zealand, they would have the power and the capacity also for production of cordite for artillery ammunition.

The question of making gun cordite had been raised originally by Senator G.F. Pearce during his first term as Minister for Defence, before even small arms cordite had been produced; at that time there was but one specification for all "sizes" of cordite, and the types only varied according to the size of the extrusion which in turn was determined by calibre of the weapon with which the cordite would be used, except that the design of the container used for loading the cordite into the gun also depended upon the weapon: brass cases for rifles and quickfiring guns, and textile cartridge bags for fortress guns, etc. It will be seen therefore that although the more powerful extrusion presses were assured, provision would have to be made also for production of the textile cartridge bags (made up usually in a cloth of pure silk woven from a coarse yarn) and the brass cartridge cases made in an ammunition factory; furthermore an artillery range had to be equipped for firing proof of the cordite after it had been assembled to the cartridge. However, it was decided during 1915 that the factory extensions for production of big gun cordite and cannon cartridges should proceed even though there might be no particular demand at this time for gun ammunition; the gun cordite buildings were completed in late 1916

and the cannon cartridge buildings in early 1917; as each house was completed it was re-assigned to the immediate need: the production of small arms cordite, and thus housing was available for the hydraulic extrusion presses as they became available from the contractors. Other factory extensions in hand during 1916-1917 included the Acetone Recovery plant - in operation September of that year, from which good yields of Acetone were being obtained - a commencement was made with the buildings for cotton-waste treatment, and the fulminate of Mercury factory was completed with production in full swing by the middle of 1918. During 1918-1919 further progress was reported: the Cotton Waste Treatment plant was completed and production commenced during the second half of 1918; as the Acetate of Lime factory at Brisbane was nearing completion at that time, a plant was erected at the Cordite factory for conversion of its Acetate of Lime into Acetone; and a Refinery plant was installed for conversion of Benzol being purchased from the Gas Companies (town gas) into Teluene: the raw material for the explosive Trinitreteluol (T.N.T.); the idea being that the Teluene might be shipped overseas for sale in England, or that it could be converted locally into T.N.T. It should be mentioned also that there had been discussions with the Broken Hill Proprietary Coy. Ltd. in regard to drawing Benzol or raw Teluene from their Newcastle Steelworks. During 1918-1919 the buildings for Sulphuric Acid Concentration were under construction and the plant, of local manufacture, were all installed in early 1920 and soon in full operation. Furthermore a commencement was made with building and equipping a Detenator factory, and also an experimental plant for leading explosives into gun ammunition fuzes was set up; it will be obvious from these notes that during the four years of the war, a much wider capacity for munitions production was now available from the Cordite Factory; that Mr. Leighton, on his return from England in early 1919, could feel indeed that in placing the factory in Mr. Brodribb's hands when he went abroad in 1915 he had done well. It should be added that the working drawings and technical data for all these new installations

were sent out from England by Mr. Leighton, and that the expenditure was nearly £80,000. As some of the products now within the scope of the factory were constituent parts of Artillery Ammunition, arrangements had to be made for firing proofs which served the purpose during the war; in a later chapter it will be shown that a standard Artillery Proof Range was established in South Australia.

I do not know that any special purpose can be served by taking up space in this narrative with elaborate details of the production attained at the Cordite factory during World War I, and it will suffice I think if it is placed permanently on record that the factory produced all the cordite required by the Australian Armed Forces, including the ammunition for the personnel embarking for active service overseas, and there was also a substantial capacity available in the factory for a greater production than had been demanded; it was offered to the British Government but utilised for good reasons: one being that it involved diversion of raw materials, and another that there were shipping complications. However the Government of New Zealand had difficulty in obtaining its requirements of Cordite from Great Britain and it was advised to draw upon Australia with the result that some of our surplus capacity was thus taken up. The price charged was 3/6d. a lb.; it was somewhat in advance of the English price c.i.f. New Zealand port, and was based upon the bare Australian cost of production, the Government factories do not seek to obtain profits but at all times an effort is made towards reimbursement of the actual manufacturing costs plus a percentage of the overhead expenditures. Our main objective at all times had been to match our costs of production with the British prices plus cost of landing in Australia, but it must be expected that these comparisons could scarcely ever come out in our favour; the costs overseas of labour and materials were always substantially lower than ever could be attained in Australia and there is the disadvantage also that the quantities of comparable products going through factories overseas were generally much greater than could be possible

with the limited Australian demand. These factors are applicable obviously to all classes of manufacturing but are accentuated when it is munitions production which is being considered. For these reasons there must be caution in quoting the actual costs of production at the factories at any given time, but it can be said that the New Zealand Government was quite satisfied to pay 3/6d. per pound for the cordite supplied from Australia during World War I.

In September 1915, in order to cope with the increasing demands for explosives and other chemicals, a "continuous shift" was introduced in a portion of the Factory, by which productive machinery was kept constantly in operation day and night, excepting Sundays. As stated the inclusion of too much detail is being avoided but the figures hereunder will give an idea of the contribution made to the war effort by the Australian Cordite factory having regard to the fact that the financial year 1912-13 was the first year of full production, and taking that year as the base for calculating the percentages of increases over that year for each of the succeeding years -

Financial Year	Comparative Production	Value of Production	Cost of Production of Cordite - per lb.
1912-1913	100%	£ 33,401) s. d. 5.1.72
1913-1914	174%	41,747) 3.8.16
1914-1915	192%	44,052) for Mark I, size 3 3/4 3.7.25
1915-1916	355%	82,796) 3.6.00
1916-1917	307%	71,890	3.4.07
1917-1918	243%	90,571	M.D.T. size 5-2 5.7.64

In 1914, cordite size 3 3/4 made in England was landed at Melbourne at cost of 2/5d. per lb. and it was thought that when in 1915/16 the cost of production of the same type of Cordite came out at 3/6d. per lb. the Maribyrong factory was doing very well. With the termination of the war in 1918 the factory ceased to be worked to full capacity, and no purpose could be served

It will be noted

that at the beginning of 1917 a new specification was undertaken; a tubular cordite "Size 5 minus 2 M.D.T." superseded the "Size 3 3/4" type hitherto obtaining; that meant a large amount of experimental work before full production was attained and the annual outturn was reduced through those delays and in consequence of the additional manufacturing operations necessitated by the new process. During 1917 also two other types of Cordite were undertaken for the Navy and it was not until 1918 that bulk supply commenced on that account. There had been some discussion too about the production of cordite for 18-pdr. Q.F. Artillery ammunition, but it was decided that the question should be deferred until the Arsenal proposal was more advanced. The only other product calling for note during 1917 was that the Fulminate of Mercury plant attained full production without incident notwithstanding its high sensitivity. Similar results were obtained from the Acetone Recovery Plant in 1918; of the acetone used in manufacture, 51 per cent was recovered for further processing, so that the reserves of materials were not well placed in regard to Acetone and we were enabled to offer 60 tons to the Indian Government - to it a very acceptable acknowledgment of the contribution it had made in 1915 in providing the drawings of the Acetone Recovery plant. In 1919, experiments were undertaken in the production of Aeroplane Dope, and they were so successful that by 1920 bulk manufacture was established. In 1920 also the factory engaged in experimental work upon filling explosive into the fuses for artillery ammunition and they successfully underwent the firing tests during the following year.

As regards the later years of the war there is little more to be said about raw materials except to place it on record that the supplies of glycerine were so good as to allow of commercial exports to South Africa; it was thought at the time that the destination would be probably to the Cape Explosives Company. One question however which came up during 1916-1917, although it was not a problem affecting in any way the actual manufacture of cordite, was the subject of a cablegram to Mr. Leighton in London - on 28th May 1917 -

Ascertain and report by telegraph whether spirit used manufacture of Cordite by Imperial Government is denatured and if so name and proportion of denaturant used. If not denatured is manufacturing Department debited amount Excise or Customs duty.

The reply read -

... no denaturent used. Customs Department permit use duty free but make rules as regards care of spirit by factory authorities so as to prevent illicit use within factory. Customs also gauge spirit at Cordite Factory as well as at distillery. There has been no illicit leakage either in transport or within the factory.

It can be added that information regarding the use of nitroglycerine as a denaturant was also obtained; it had been considered but was not accepted on account of the danger resulting from the evaporation of such denatured spilled spirit leaving a film of nitroglycerine on floors and plant. It was also mentioned that some factories were known to use petroleum spirit as a denaturant but "this in no way acts as a deterrent to the illicit use of the alcohol". The Cotton Waste Treatment plant was operated to full capacity during 1918 with crude engineering cotton waste imported from India and the product having been carried through the various chemical processes into Cordite, passed all tests entirely satisfactorily. At this time of writing in 1961, having regard to its place then and now in the trading world, it is interesting to recall that Messrs. Hicks Atkinson and Co. were the principal importers of crude cotton waste from India. With this success before him on his return to Australia, Mr. Leighton initiated investigations into the possibility of utilising Queensland grown cotton in the manufacture of guncotton, with particular reference to its use as a constituent of the particular type of cordite specified for Naval requirements. It will be recollected that the Royal Navy had adopted a more exacting specification for its bulk cordite following upon a disastrous explosion upon one of H.M. capital ships which was attributed to cordite of an inferior stability, and that all the constituents thereafter were subject to very searching tests as to quality and behaviour when made up into cordite.

Accordingly, soon after his arrival in Australia, Mr. Leighton sent a parcel of Queensland-grown cotton to me in England with instructions to send it to the Royal Naval Cordite Factory at Holton Heath for examination and tests; the results were satisfactory and thus another step towards self-containment was achieved, and later it will be shown that manufacture of Naval Cordite in Australia was fully established.

Another important matter brought up during the war, which should be recorded in connection with the Cordite Factory, was a proposal by the Directors of Munitions that commercial explosives and the detonators necessary thereto, should be manufactured under Commonwealth direction. The position as reported in January 1918 was that these products so essential to the Australian mining industry were strictly controlled by two great overseas companies; The Nobel Explosives Trust of Great Britain and the Cape Explosives Co. (De Barrs) of South Africa; and that only 30 per cent of the user requirement - 3350 tons - was manufactured in Australia by the Australian Explosives and Chemical Company, a subsidiary of the Nobel concern; the implications being that Australian Mining should not be dependent so much upon overseas for an essential product of the kind, and that local competition would be desirable for economic reasons. It was decided by Cabinet -

That Commercial explosives be manufactured at the Cordite factory and that the Committee make a further enquiry as to the advisability, practicability and cost of providing a Testion Station in Australia for Permitted Explosives or any other arrangement that will encourage the manufacture of permitted explosives by private enterprise.

Subsequently approval was given for installation of a small detonator factory but its production was confined to military requirements and no commercial detonators or explosives were ever manufactured.

Employment and Conditions of Labour.

Over the years the relations between this successive managements and the employees of the Cordite Factory were so invariably good that there is little more than that to be recorded. In July 1912, soon after the factory commenced manufacture, the seven employees of the production section asked for

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The increased cost of living high rentals, and the dangerous nature of the work.

and the matter was soon adjusted to their satisfaction. In June 1914 the Federated Engine Drivers and Firemen's Association lodged a statement of claim in pursuance of the intentions of the Commonwealth Conciliation and Arbitration Act, and had no difficulty in falling into line with all other employers in that connection. In February 1915, having regard to the possibility of an influx of employees into the factory and of claims for increased wages incidental to the war effort, a complete list of the rates of wages being paid at the Royal Gunpowder Factory, Waltham Abbey, England, was obtained through the High Commissioner in London. This was requested not so much for the purpose of fixing wages at Maribyrnong, but as guide to the relativity attached in England to the differing services rendered by the various operatives in cordite manufacture. Later in 1915, the employees' Union asked the Minister for Defence for a conference with a view to discussion of a log of wages and conditions of labour for all employees, and it was arranged that a Board of Reference should be convened at which the Minister would be represented by the Manager and Accountant of the factory, and myself as departmental industrial advocate, and three representatives of the Union. There was no difficulty in drawing up a memorandum of agreement and it was duly approved by the Minister.

As to employment, the peak period recorded for the war was on 30th June 1918 with 183 employees, of which 135 were men and 48 boys. The wages paid during the peak financial year amounted to £26,685; the average wage for adult employees being 65/2d. weekly. If comparisons are interesting, the corresponding employment figures for 30th June 1914 were 84, of which 61 were men and 23 boys; the average adult wage was 59/9d. weekly.

Capital Investment

The total amount of Treasury funds (i.e. Shareholder's funds) employed in the production of explosives and chemicals up to 30th June 1919, stood as follows:-

Factory	Invested by Treasury	Land	Buildings	Plant	Stock
	£	£	£	£	£
Cordite	342,548	11,085	80,728	72,144	167,579
Acetate of Lime	126,536	1,717	29,330	74,306	12,096
Total	469,082	12,802	110,058	146,450	179,675

The difference between the amount of investment and the totals of tangible assets is made up of unpaid accounts, mostly due by the Departments, and the cash in hand. The large stocks of goods held include also security reserves of materials and supplies; particularly acetone and nitrate of soda. The customary allowances for depreciation were made in arriving at the values of the assets.