MARCH 8th, 1917.

SOME NOTES AND OBSERVATIONS RELATIVE TO ENGINEERING IN GREAT BRITAIN DURING THE WAR.

(By Mr. Russell Sinclair.)

Mr. President and Gentlemen,—

When shortly after my return to Sydney from a visit to England, your President asked me to give a paper or address to the Association, I readily agreed, because at that time things were fresh in my mind, and I had brought with me a series of photographs of the work being done in the munition factories in England, which I had obtained after considerable difficulty from the Ministry of Munitions, for the very purpose of showing to this Association, with the permission of the Minister of Defence, as both by its members individually and also collectively the Association had beeen interested in the shell-making proposition. A report and the photos. were submitted to the Director of Munitions and the Minister of Defence in Melbourne, and an official exhibition and lecture given, at which members of both Federal and State Parliaments, as well as Government officials, were present, and many members of Parliament were moved to ask for copies of both the notes and the slides, offering to go through all the States if they had them, and exhibit them to assist in the recruiting movement. These copies have been made, and will, I hope, be made use of by those who then offered to do it. Meantime, as soon as possible after returning from Melbourne, a lecture was given in Sydney under the auspices of the N.S.W. Munition Committee, to which members of this Association were invited.

I had thought that this might have been taken to have fulfilled my promise to fill an evening with the Association, but your President did not see it in that light, and insisted on holding me to the letter of the agreement, and I have his assurance that the photos. will be appreciated, even though some of you may have already seen them. I trust that it will be so, as they must form the basis of my remarks; but so as not to weary you, I have cut out all the photos. which are not purely technical, as these latter in themselves will bear examination in detail, and many suggestions can be obtained from a closer study of them.

With this explanation I will proceed, but before doing so must say that my remarks are merely notes of my own personal impressions, and must be taken for what they are worth. It would be presumption in any man to formulate opinions and put them forward as final after only five months' stay in Great Britain at such a time as this. Great things are happening there, developments are taking place on such a colossal scale, and changes of such vast and great importance are occurring in all directions that no man can possibly give a full account of them, or dare to draw decisive conclusions. I can only note a few points and say how they struck me personally.

As you are aware, shortly after war broke out the necessity for shells and guns became urgent, and England started to organise her factories for that purpose, the movement being led by that marvel of energy and foresight, Mr. Lloyd George, to whom the whole Empire owes such a debt of gratitude as can never be adequately repaid during his lifetime—only history and posterity will fully understand it.

We in Australia felt the wave of anxiety and enthusiasm to help in this need for shells some months after they did in England, and to their credit many responded to it, and

an attempt was made to undertake the making shells here to help the Old Country; but we met with many difficulties, the first of which was that nobody knew just what to do or what was actually required. The committees which were formed could make little headway because of want of exact and definite information from authorities in England, and when, after considerable time had passed, definite designs and specifications were received of the particular size of shell which the authorities were then most in need of, and would welcome a supply from Australia of, it took a long time to get over the difficulties of the supply of the right steel, though the Broken Hill Proprietary, in a most patriotic manner, threw themselves into the matter with zeal, agreeing to make and supply it at a price well below the market value. By the time these, and other difficulties, such as a supply of gauges, etc., had been overcome, it was well on towards the beginning of 1916. At this time, having personal matters to warrant my visiting England, I offered my services to the Director of Munitions and the N.S.W. Munitions Committee to make enquiries in the matter when in England, and was empowered by these authorities to do so, being provided with letters of introductions which enabled me to see many munition factories and the work being done. Shortly after my arrival, it was decided to ascertain definitely from the Ministry of Munitions if supplies of 18 pdr. H.E. which were being made in Australia were still needed, and it was found the requirements of the military and artillery, as the result of actual experience in the war, had so altered that the Ministry of Munitions did not need the same quantity as originally arrived at; that the use of larger-sized shells was becoming more necessary, and the munition factories in Great Britain had increased their production to such an extent that they had overtaken the requirements for the small sizes. At this time no shell bodies had reached England from Australia.

Further, it was admitted that the dilution of labour and employment of women in Great Britain had developed the manufacture in such a way that the cost of production had been reduced to such an extent that it is not possible for Australia, where dilution of labour does not apply, to produce shells, or similar materials, at a price that could in any way approach the price of production in the United Kingdom.

This was definite enough for the Commonwealth Government to give instructions to cease the manufacture of 18 pdr. shells here. An effort was made to ascertain whether larger-sized shells could be made, or would be useful if made; but it was found that there would be just the same delay in the matter of specifications, drawings and gauges of the large sizes that would be useful; and, besides, the question of machine tools would in itself be a tremendous difficulty. The idea of our making shells having thus been disposed of, it appealed to me that those in Australia who had interested themselves in the shell-making work were entitled to know something of the reasons which led to their efforts being discontinued for the present, and after a good deal of time and perseverance with the munition officials, I obtained the series of photos. from the factories, and permission to make certain explanations to those interested.

The number of national factories under Government ownership or management is now as follows:—

3 Royal Factories.
47 Shell Factories (including projectile and shell factories, cartridge case, gauge and small tool factories).
18 Filling Factories and stations.
5 Small Arm Factories and Mills.
22 Explosive and Propellant factories. A total of
95

The number of persons employed in these establishments is over 185,000.

In addition to the above there are now 4631 controlled establishments in which 90 per cent. of the work is on Government orders. In these establishments there are nearly 2,000,000 persons employed.

The total number employed on Government work in munition trades, including Admiralty work, is over 2,250,000 of whom over 400,000 are women. Over £20,000,000 sterling have been expended in the construction of national factories alone, and the equipment of same.

Of the shell factories 12 are devoted to big shell making, and contain over 10,000 machine tools, and still more factories are being built. One factory is devoted to making gauges and one making nothing but machine tools.

When it is remembered that on the outbreak of war England was prepared with an organisation and supply of shell suitable for an army of only 200,000 men, and that since September, 1914, the output of 18 pdr. H.E. shells had been increased by over 170 times, and that for heavy shells by 2150 times, it will show how the requirements have changed from small shells to that of large shells, and help you to understand why the need for small shells was not so important by the time we in Australia had got to to the stage of being able to turn out finished shell bodies of the small size.

But also to show the rapid increase in the output from the factories, the following figures are instructive:—

The increase in the output of 18 pdr. H.E. shells in July, 1916, rose from 6½ times to 17½ times that of the corresponding month in the previous year.

The increase in heavy shells was 94 times that of the preceding year.

The factories of Great Britain are now producing every 4 days as much heavy shell as was produced in the whole of the year 1914.

In the production of guns the latest figures are that the output of heavy guns is now 365 as compared with 22 in 1915, and of lighter guns 76 as compared with 7½, while with machine guns it is over 14 times greater than when the Ministry of Munitions started.

At the beginning of the war the cost of munitions was very high, but the introduction of outside engineering shops resulted in an enormous reduction in the cost of manufac-

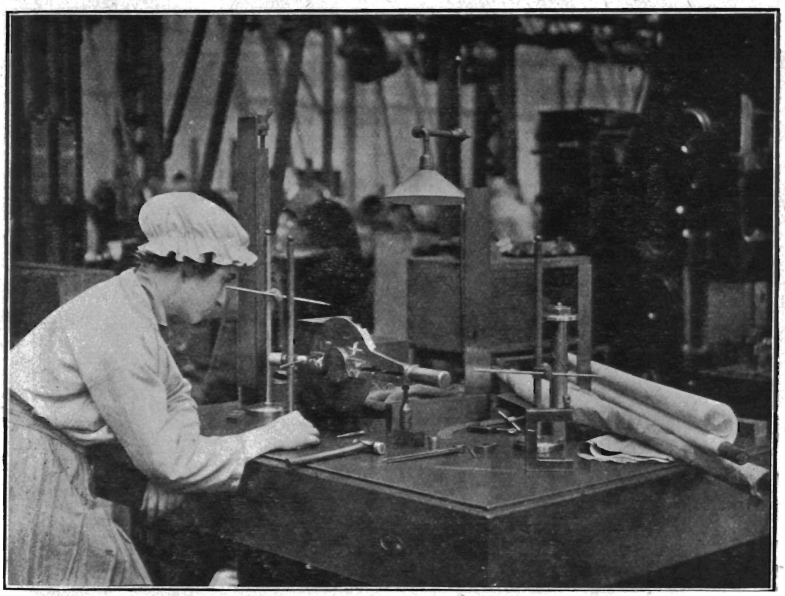
ture, while the expertness gained by the diluted labour is so wonderful that the Government estimate that the cost of building and equipping the national factories which I have already mentioned as over £20,000,000, has been more than saved by the reduced cost.

Take the 18 pdr. H.E. shells which we started to make here. The cost of machining, including the turning of the copper band, was found to be a non-paying proposition at 12s. 9d. I saw them being produced, and also 4.5 shrapnel in Canada, at under one dollar, and in England for 3s.

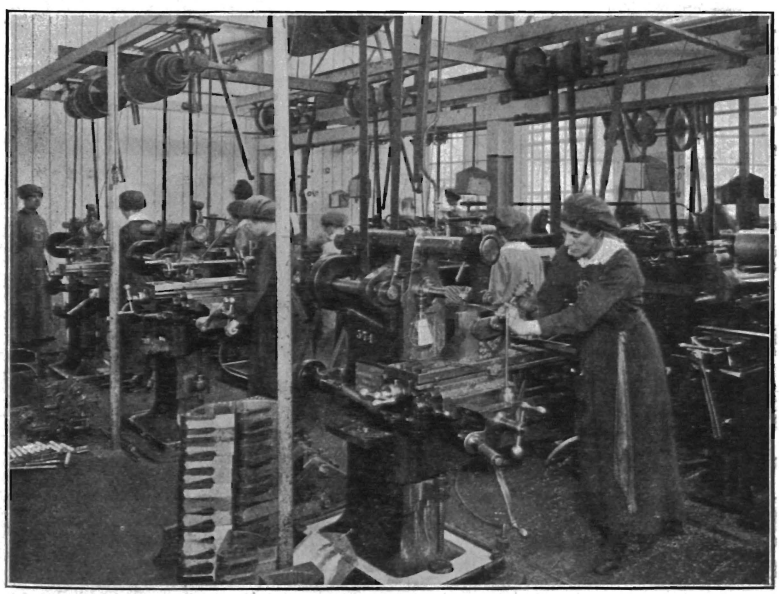
In addition to this, take into consideration the delay and cost of transporting the finished shell bodies from Australia to England, with the fact that after arrival there, the whole process of sorting, testing and supervising has to be gone through in such a way that the partially-made shells from Australia have to be interposed somewhere into the constant lines of communication and streams of shells which are coming from the thousands of factories producing shells, and you can understand the reasons which led to the decision to advise Australia that it would be better to discontinue the manufacture of shells and, instead, send as much steel as can be spared, and also to ask us here to use all our efforts to avoid having anything made in England which can be done without, or could be made in Australia, so as to relieve manufacturers in Great Britain, and the labour which might be employed, allowing it to be at the disposal of the Ministry of Munitions, to whom such labour is infinitely more valuable right on the spot, subject to the manipulation as requirements alter from time to time.

The views which I will now show* will help to explain something of what is being done, and support the reasons I have set out, and after showing the same I will add some further observations and conclusions.

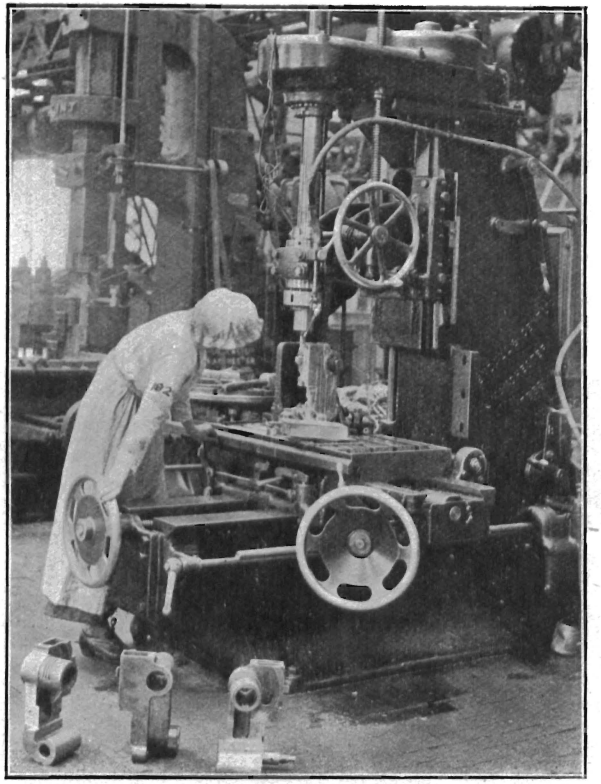
*NOTE—105 views were here shown, but space only permits of 9 being reproduced.



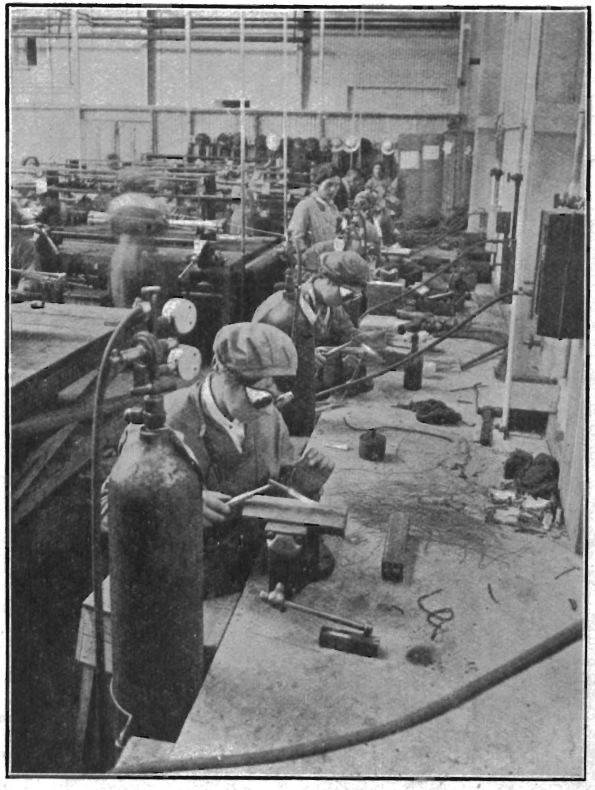
No. 2—Marking off the end plate of a 3 inch anti air craft gun The girl deals with all parts of breech mechanism for 8 inch and 60 pdr. howitzers as well as 3 inch anti-air craft guns.



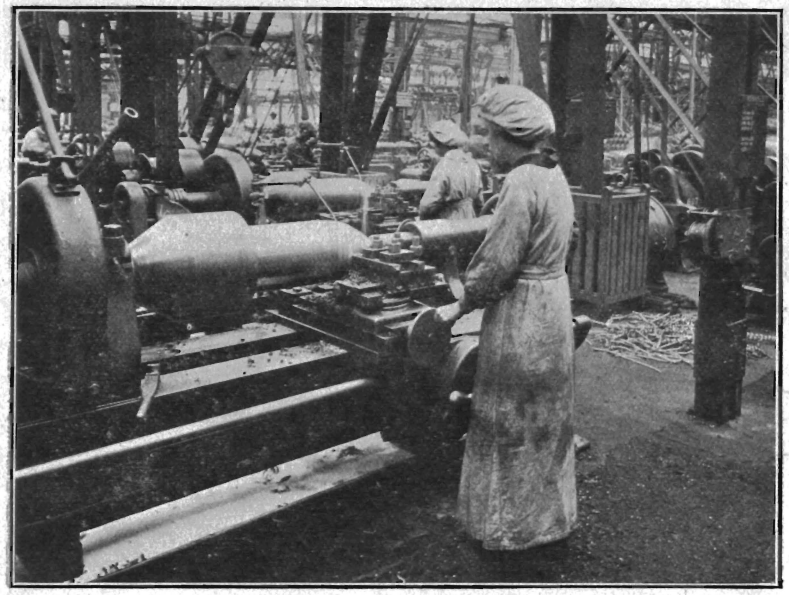
No. 13.—Horizontal milling machines. The girls are milling quadrants and cross levelling details. Each girl sets up her own machine and the work is finished to micrometer.



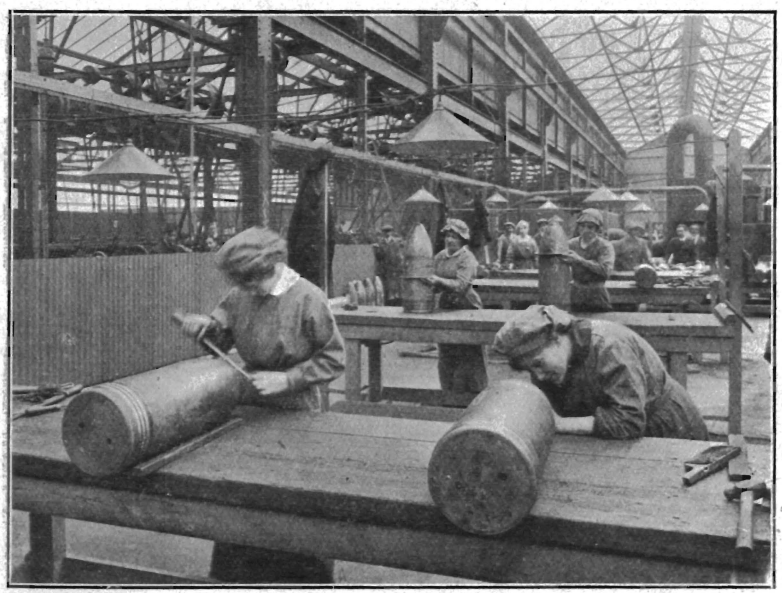
No. 3.—Operating vertical milling machine in carrier of 60 pdr. howitzer. Milling dove-tail at end of box.



No. 74.—Oxy-Acetylene Welding.



No. 26.—9,2 H.E Shell. Finished cut and turning radius head.



No. 35.—Inspecting 9.2 H.E. Shell. Inspecting is now invariably entrusted to girls

No. 36.—9.2 H.E. Shell Shop. General view of third bay.

No. 77.—Machine Gun Manufacture. Girls operating cross milling machine on machine gun parts.

No 78 —Machine Gun Manufacture. Girls working at benches adjusting machine gun parts.

After having seen something of the magnitude of the work being done, the great use being made of women, and the difficult processes which are being carried out successfully by such unskilled labour, one very naturally asks —How has it been accomplished, and to what will it end?

The development has only come about by the leaders in politics, industry and labour, by the rank and file, and the women of Great Britain realising the necessity of self-sacrifice in the interests of the nation. Leaders of industry have given up businesses, business connections, large incomes. Labour organisations, collectively and individually, have foregone and set aside their cherished rules and limitations, and unskilled and women labour have tackled new and hard work, of which they had no knowledge before the war. All this devotion could not have been utilised successfully without the system of organisation developed by the Ministry of Munitions.

At the beginning of the war there was almost an absence of organisation. True to the instincts of the British nation, each firm managed its own business in its own way; labour was suspicious and antagonistic—often I fear with some reason, and the output necessary to prevent disaster could never have been obtained unless for the organisation set in motion by Mr. Lloyd George. The dominating impression one gets of the engineering industry in Britain now is best summed up in the words "organisation" and "co-relation."

The Ministry of Munitions started with quite a few hands when it was first decided that such was necessary, and has grown into a department employing about 5000 of a central staff, all located in what used to be the Hotel Metropole and the Armament building, and in addition, an administrative staff of 38,000, of whom 14,000 are women. It is a wonderful organisation to be called into effect in the course of about 18 months. Many of the heads of the departments into which it is divided, and their assistants, are

men who have been, at the outbreak of the war, managers, directors, secretaries of large companies and factories, others, barristers earning large sums of money per annum—all of which has been put on one side for the merely nominal salary of about £400 per year paid by the Ministry of Munitions. These men and their staff know the output of each factory; they control the supply of the raw material from the forge, in the form of forged billets, to whichever of the national factories or of the 4600 controlled factories each day may require; they control when the finished shells are to be forwarded from these factories to whichever shell-filling factory they are to be despatched to be filled; they control from which factory the fuses are to be despatched to which shell-filling factory, where they are attached to the shell after filling with explosive. The department also controls the despatch to the transport officer of the filled shells, and so well is the thing organised, and so closely has it got its finger on the work being done that the department is able to tell practically from day to day what the output is; and on charts under his control the Minister of Munitions can see exactly how the output is rising or falling.

This was not all accomplished without many difficulties having to be overcome, e.g., the work of producing shells and munitions was, at the beginning of the war, in the hands of a very few firms, who jealously guarded the knowledge, and, as Mr. Gerald Storey, of the Advisory Committee, said:—

"If the armament ring in this country had taken a wide view of things when it was found what an enormous supply of munitions was required, it was doubtful whether there would have been such a shortage as there had been. Hundreds of firms were willing and anxious to help in the production of munitions, but when they offered their services they were met, in many cases, with a blank refusal, and in