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WW1: New Technology in Ammunition Production
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Introduction

This seminar is based on 'New Technology in Ammunition Production'; a paper researched and drafted by LTCOL (Ret'd) David Brook.

The weapon of artillery is the projectile. The effect at a target depends on rate of fire, the total number of rounds, the type of round and the timing of their detonation.

Factors influencing ammunition improvements included a 'peer' enemy, deep entrenchment, concrete bunkers, barbed wire, defence in great depth, climatic conditions, industrialization, trained manpower, costs and shortage of essential materials.

Australian Artillery

The Australian Artillery in general adopted the methods, tactics, techniques, technologies, armament and organizations of the British Army throughout the First World War.

Lessons and Factors as of August 1914

Lessons: Lessons learnt regarding the employment of field artillery from the Boer War and earlier wars such as the Russo-Japanese War, the Franco-Prussian War and the American Civil War were not entirely embraced. The reasons for this include:

- The employment of the British Army as a `policeman' to safeguard the Empire, which influenced the choice of weapons and ammunition.
- The 'enemy' was imagined as poorly armed and equipped tribesmen.

Factors:

- The British Government, Army and heavy industry were not prepared for a long Continental war against a first class European power.
- The research and industrial base and capacity for the manufacture of armaments was limited and not ready for expansion.
- A belief the War would be over by Christmas!

Industrial Base

The Research Department at the Royal Arsenal at Woolwich established in 1907 had prime responsibility for technical design of gun and ammunition systems.

The organizations that had developed the specialist skills for ammunition manufacture were: the Royal Arsenal, the Royal Gunpowder Factory, Vickers, Elswick Ordnance Company and Coventry Ordnance Works in the United Kingdom.

The United Kingdom had a strong industrial base in 1914 but while it concentrated on some gun and ammunition making for the Army, the primary focus was warship construction and the associated guns, ammunition and mountings.

The Royal Artillery went to war with limited ammunition holdings and little in reserve. The holdings for 13-pr and 18-pr were – 1000 rpg, the 4.5-in how had 800 rpg while the newly introduced 60-pr was allocated 500 rpg.

There was only limited ammunition manufacture and for the field and horse artillery this was predominantly shrapnel. High explosive munitions were seen as being needed only for howitzers.

In the first year of the War, shortages of ammunition at the front became publicly and politically known as the 'Shell Scandal'. It was not until the Government created a Ministry of Munitions under the leadership of Lloyd George and fully mobilized industry to produce ammunition in a wide range of private engineering firms, the major armament companies and built new Royal Ordnance Factories that the `scandal' was brought to an end. By then the War was into its second year.

It took time for the Government and industry to gear up for the increased in production of ammunition to fight an industrial war. By War's end there were 12 National Filling Factories, 4 Projectile Factories, and 2 Explosives Factories in addition to private contractors. A huge increase considering there were only three Royal Ordnance Factories in 1914.

The Nature of Targets & Lessons

Major issues quickly became apparent:

- There was insufficient gun and howitzer ammunition available and stocks including reserves ultimately were severely rationed.
- Shrapnel was perfectly satisfactory for targets in the open but useless against fortifications and earthworks. Adjustment of optimum height of burst with powder burning time fuzes required considerable training to achieve a satisfactory result in service. With the entrenchment of the enemy and barbed wire entanglements, shrapnel was only partially successful. It was soon proved that beyond a range of 2000 yards shrapnel was of no use in wire cutting.
- The shortage of HE filled shells was a great restriction because it was only provided for howitzers to be used in plunging fire situations.

Ammunition Improvements

As the War progressed results in the field disclosed further problems:

- information in the Range Tables compared with the `Fall of Shot' was found wanting
- a high incidence of ammunition malfunctioning

The Research Department at the Royal Arsenal in conjunction with the Ordnance Committee started research programmes into metallurgy, high explosive performance, propellants and fuzes.

As part of this examination, specialized projectiles were designed. This work brought a range of carrier shells into service; namely screening BE smoke, parachute flare, star, incendiary and later chemical (gas and white phosphorous) shells.

Unfortunately some of the improvements caused additional difficulties as a result of research being rushed. For example:

- the interaction between different metals and chemicals used reacted which caused prematures
- the filling of gas shells and leakage of the liquid or reaction with the shell steel
- Safety problems with new fuzes, requiring incorporation of a shutter.

Projectile Metallurgy

Various grades of steel and cast iron were tried due to shortages of high grade steel; but many experimental types failed proof. Contractors were often unable to produce a finished product to the high specifications laid down, not only for ballistic performance or gauge in the bore but to function correctly.

Exterior Ballistics - Projectile Shape

CRH – Calibre Radius Head. Research was carried out to determine the best crh which at the time was almost universally `2' in the British service. The 18-pr gun crh remained at `2' for the duration of the War and did not change until afterwards whereas that of the 4.5-in was increased from `3' to `8'.

Streamlining. Experiments in streamlining the projectile by tapering the base below the driving band were carried out along with variations to the driving band to improve ballistic performance. However most projectiles remained un-streamlined for the duration of the War.

Wire Cutting

A shell filled with HE was produced and brought into service in September 1914 in limited quantities and despite the elevation limitation of the 18 pdr carriage proved to be quite successful for wire cutting and use against entrenchments.

Fuzes

Fuze action at the target is critical to the effect of the projectile. For example too much delay and a shell will penetrate the earth slightly before exploding with little effect on wire. There was considerable effort on improving fuzes throughout the war with mixed success.

The field artillery made extensive use of powder burning time and percussion fuzes. These fuzes were notorious for varying the height of burst due to climatic conditions and were not always reliable. Improvements occurred.

For example a composite arrangement of fuzes to obtain a `time' burst with HE shell was introduced by modifying the Fuze DA No 44 and combining it with the Fuze T & P No 80. This was known as the Fuze, Time No 80/44. Some 51 Marks of the fuze were contemplated or adopted during the war.

Propellant

Modified Cordite was introduced in the British Service in 1901 and remained the principal gun propellant throughout the War. However, due to the shortage of acetone, other propellants such as NCT, NCZ and RDB were introduced during the War as emergency powders.

Explosives

The safer Amatol explosive, a mixture of ammonium nitrate and TNT was introduced in 1915 to replace Lyddite. This was followed by Baratol where the ammonium nitrate is replaced by barium nitrate.

TNT was only able to be slowly brought into service with the heavier calibres due to detonator issues that had to be solved.

The Australian Experience in Manufacturing Munitions

The Australian Government spent considerable effort convincing the British Government that it could establish a munitions industry in this country. They volunteered to produce empty field gun shell bodies and sought the drawings and specifications. By June 1916 when production ceased, the total consignment sent to the UK was only 15,000 shrapnel shell bodies for the 18-pr gun.

Epilogue
The ammunition expenditure by the British Empire artilleries on the Western Front from start to finish was enormous and required the various governments involved to mobilize their respective dominions in every way possible – industry, transport, storage, control of materials, food, manpower and the list goes on.

Examples of total rounds fired during the War by individual guns or howitzers are:
18-pr gun – 99,397,670
4.5-in how – 25,326,276
60-pr gun – 10,125,321
8-in how – 4,189,165
9.2-in how – 3,119,158

Whilst additional guns were brought into service, only limited changes to basic ammunition design was introduced during the War otherwise production lines, inspection and gauges would have to be changed. There was a shortage of machine tools, gauges and inspectors in the new factories and it was not until 1917 that many of these deficiencies were corrected.

Conclusions
The driving issue was the question of target effect and how it could be improved. At War's outset the artillery gun and ammunition systems were not well matched to prolonged industrial scale Continental war; especially the size of the artillery arm and its sustainment.

A balance was managed between on one hand engaging targets with greater and greater quantities of ammunition using the gun and round systems available at the outset of the war, and on the other developing improved rounds (including fuzes) to increase target effect.

Increasing the industrial and technological capacity for artillery production was an enormous task in its own right – planners were at least working with proven systems; and more rounds on targets had a reasonably predictable effect. Adjusting the relative proportions of production of HE and shrapnel rounds was also able to be achieved to align with evolving fire planning methods.

There were uncertainties in the development of new gun and ammunition systems. The risks and costs of failure were high. The expert technical and manufacturing workforce was small and could not be grown rapidly. Whilst new research and design did take place during the War, little came of it and the results of the work were not considered until the War was over.

It has been established that the design of Field Branch artillery ammunition manufactured during the First World War by the industries of the British Empire did not change very much.
Certainly chemical shell and a few fuzes were introduced. Generally the result was that apart from a new chemical (gas) shell of the existing carrier design to satisfy ballistic requirements and modifications to fuzes and introduction of the DA fuze No 106, these were the limits of improvement.

In a most general sense it might be concluded that the major effort in meeting artillery ammunition requirements was for quantity over quality.

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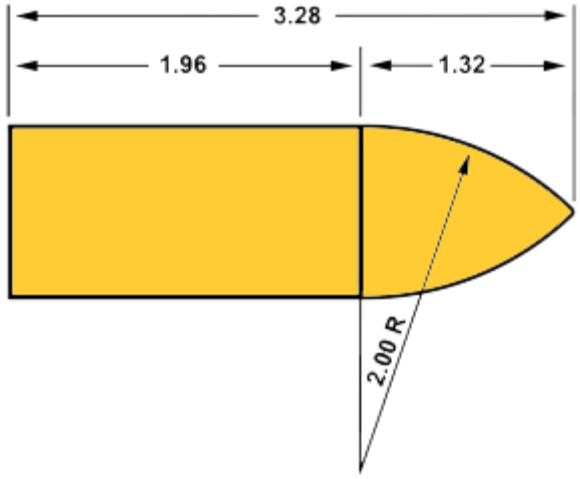
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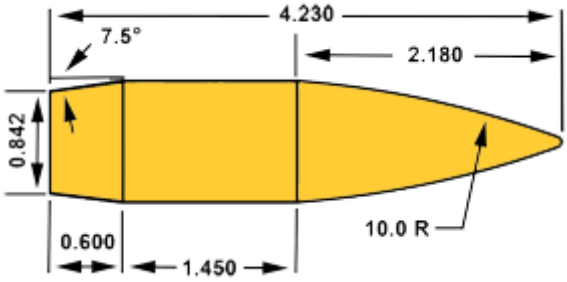
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