A LITTLE NEGLECT

DEFECTIVE SHELL IN THE ROYAL NAVY

1914–1918

BY

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ABSTRACT

One result of the growth of the military industrial complex before 1914 was that the dealings of
the armament companies with one another and with Service procurement departments came to
exercise an increasingly direct influence on the fortunes of war. It is likely, for example, that the
Vickers-Krupp fuze agreement of 1902 had more important consequences for the fighting on land
and sea than has hitherto been acknowledged.

A little neglect may breed mischief . . .
for want of a nail, the shoe was lost;
for want of a shoe the horse was lost;
and for want of a horse the rider was lost.
Benjamin Franklin; Maxims

Introduction

It is a truism that in the first world war 'for the first time . . . battles were as much tussles between competing factories as between contending armies. The production of weapons more than the conscription of men was the deciding factor . . . God marched with the biggest industries rather than with the biggest battalions . . .' In particular the pre-war expansion of naval power presented the European armament companies with a unique challenge which, like the earlier railway boom, was met by a combination of collaborative as well as competitive enterprise. As part of a general increase in their activities the companies entered into a complex maze of patent-sharing agreements with one another, enabling them to save on expensive research and development and to incorporate in their products the latest components and mechanisms. In Britain until about 1908 no official objection appears to have been raised to this free trade in weaponry. The list of Patents for Inventions (Ordnance and Machine Guns), 1905–08 includes hundreds of inventions, naval and military, exchanged between British and foreign companies. Admiralty regulations provided that serving officers were 'at liberty to apply for permission to patent any invention which they may originate', and although technically subject to obligations of secrecy such patents commonly resulted in inventions finding their way into foreign hands.

At the turn of the century the world's navies were devoting much thought to the development of armour-piercing projectiles without which the heavy guns of the new battleships and battle cruisers could not be fully effective. Despite pressures exerted from without by the press and the Navy League and from within by Sir John Fisher, Britain lagged behind. As late as the spring of 1902 the Royal Navy was still equipped with stocks of shell imported from France and a range of obsolescent blunt-nosed projectiles virtually useless against modern armour plate. By contrast the French, Russian and American navies had made significant advances in the development of steel shells equipped with a variety of time and percussion and delay action fuzes, though it was the
Germans, with their greater experience of land artillery, who established a lead they were to maintain until 1918.

The Vickers/Krupp Fuze Agreement

Fisher shared a widespread prejudice against the official dockyards and arsenals, which he regarded as inefficient and lacking in enterprise. Resenting the influence of the War Office at Woolwich, and ‘well aware of the advantage of large capacity in the private armaments factories, even if this meant supplying weapons to possible enemies’\(^2\), he preferred to rely on a small group of companies dominated by Vickers-Maxim and Armstrong-Whitworth to build and equip the ships of the Grand Fleet. Thanks to a talented management team led by their German chief executive Sigmund Loewe and the skills of their foreign adviser Basil Zaharoff, Vickers had over the years developed a network of contacts with foreign governments and armament concerns, including the giant firm of Krupp. For many years Krupp had concentrated on the development of heavy artillery, adapting their expertise after 1895 to the demands of large naval guns. With the encouragement of Lord Rothschild, mutually
advantageous arrangements had been made between Vickers and Krupp with regard to Maxim machine gun and other patents and the German firm licenced the manufacture in Britain of their cemented armour, of which by 1902 Vickers and others were producing large quantities for the construction of warships. It was therefore natural that Vickers should turn to Krupp when called upon for designs of armour-piercing and other shell for the 12-inch naval guns.

For the Vickers engineers who worked closely with successive Directors of Naval Ordnance the task of coming up with an effective armour-piercing projectile was no less of a challenge than producing the guns themselves. There were snags with the steel casing and explosive filling and above all with the base fuze on which the whole exercise ultimately depended. The manufacture of fuzes presented special problems. The only industry involving work at all comparable was that of clock and watch making, practically non-existent in Britain, and during the South African war the supply from the trade failed almost entirely. Vickers, having made unsuccessful attempts to develop a fuze of their own, decided to adopt the Krupp igniferous design, then regarded as the best available.

The fuze agreement of October 1902 was negotiated by Trevor Dawson, naval officer and gunnery specialist soon to replace Sigmund Loewe as Vickers' general manager. It was to last for fifteen years and authorized the company 'to make in England and sell in Great Britain and abroad all sorts of time fuzes and combined time and percussion fuzes according to the designs used by Friedrich Krupp . . .'. The German firm undertook to supply Vickers not only with details of their existing fuzes but of all future designs and improvements, subject to any security conditions imposed by the German government and provided that Vickers's officials were bound to secrecy. In return Vickers were to pay royalties of £1 2s on each of the shorter burning fuzes up to S.22 and £1 6d for all fuzes over S.22. Vickers were entitled to manufacture the fuzes only in their own works and lost no time in setting up a subsidiary for the purpose, the Electric & Ordnance Accessories Co. They were not to instruct any other maker or the British government in such manufacture without the consent of Krupps, but evidently such consent was given, for in 1904 Vickers licensed the War Office to arrange the manufacture of Krupp fuzes by the Ordnance Factories and by the Indian government as well as by Armstrongs, Cammell Laird and, by a separate agreement in 1905, the Coventry Ordnance Works.

Nonetheless Vickers remained the German company's exclusive representatives in Britain for all matters relating to the Krupp fuze, receiving from Krupp one third of all monies paid as royalties by the War Office and other sublicensees. They were therefore directly or indirectly responsible for the whole range of fuzes fitted in shell supplied to the British armed services. Since Vickers designed the guns for the new battleships and battle cruisers, many of them built by Armstrongs at their Elswick yards, it follows that the heavy projectiles manufactured for the Admiralty in the Sheffield and Barrow works or under contract to other firms and the government ordnance factories were fitted with Krupp fuzes in the same way as the ships were protected by KC (Krupp Cemented) armour.

**AP Shell Problems**

The technical difficulties involved in producing an armour-piercing shell capable under all conditions of carrying its bursting charge through thick armour before exploding were thought by many to be insurmountable. Greater penetration was achieved by the use of a mild steel cap but this made little difference at oblique angles of attack consequent on firing at long range, when shell usually exploded or broke up on impact. While the Department of Naval Ordnance was aware of the problem, its naval staff relied on Vickers, Armstrongs and the specialist shell manufacturers to come up with a solution.
Hadfield and Firth did indeed succeed in evolving a number of improved projectiles, including the 'Rendable' and the 'Eron'. While not wholly satisfactory, as the Edinburgh trials of 1909–10 revealed, these were accepted as adequate, especially since it was assumed that at longer ranges CPC rather than APC shell* would be used. In any case the system of proof was far from rigorous, AP shell being tested at normal rather than oblique angle to the plate. The technical experts of the firms collaborated closely with their naval colleagues, and all concerned were anxious to avoid the cost and delay resulting from wholesale rejections of shell which under peacetime conditions were unlikely to be fired other than in practice.

With regard to the fuzes fitted in these and other shells, the position continued to be that their manufacture was undertaken only by those concerns licensed by Vickers under the agreement with Krupp, an arrangement extended in 1908 and 1911 to cover Fuze Setters, Fuze Setting Keys and Primer Caps. Since Vickers were fully engaged in the profitable business of building warships, their inclination was to continue with established lines rather than to incur additional expenditure on what from a purely commercial point of view could be seen as unnecessary research and development. Their privileged position vis-à-vis the Admiralty enabled them effectively to exclude the products of rival concerns, and in the matter of the fuze the agreement with Krupp meant that they had little incentive to encourage the development of more advanced designs likely to threaten their monopoly.

**Wartime Complaints**

In consequence the Grand Fleet put to sea in 1914 with its stock of heavy projectiles inadequately proven and of doubtful effectiveness at fighting ranges. The Fleet's Manual of Gunnery for 1915 states that: 'These shell seldom penetrate even medium armour unbroken if striking obliquely, and in the case of the APC filled HE [i.e. lyddite] this marked tendency to break up lessens materially the chance of obtaining the detonation of these shell actually clear of, and behind, armour . . .'

Serious doubts about the quality of British service shell first arose on the western front early in 1915. From the outset the War Office had decided 'to place orders with the usual armament firms to the extent of which their managers thought they were capable . . . the system was to take the most difficult component, viz. the fuze, first, and when orders had been placed for the fuzes the orders to balance up the remaining components were entered into.' Vickers were provided with credit for the building of additional plant to extend the manufacture of Krupp shell fuzes, and from royalty figures later agreed by both Services it is possible to calculate the number of fuzes produced by Vickers and the ordnance factories and actually fitted in shell during the first two years of the war. These figures, subsequently confirmed when during the 1920s Krupp brought a claim against Vickers for unpaid royalties, suggest that 4–5 million fuzes were supplied to the Army and some 400,000 to the Navy.

As complaints multiplied about faulty shell, widely supposed by artillery officers to be due to defective fuzes, debates in both Houses of Parliament drew attention to the poor quality of British fuzes and to the fact that they were based on Krupp designs for which royalties were still being paid. In the Commons on 20 July J.S. Higham MP declared that: '. . . the disadvantages of our fuzes are so manifold that the makers of munitions have not hesitated to say that the use of this shell can only be due to a great mistake on the part of someone making it

*APC: Armour Piercing Capped
CPC: Common Pointed Capped
While our fuzes were being changed almost every week, moreover, the French artillery fuze, perfected in 1908, 'has stood the test of seven years manoeuvres and of eleven months warfare, and has never been changed . . .'

Partly as a result of these strictures, the Vickers-Krupp agreement of 1902 was deemed under the Trading with the Enemy Act to be cancelled as from the outbreak of hostilities. The Ministry of Munitions took over responsibility for the supply of war material to the Army, the technical staff of the Ordnance Committee designing two successive replacement fuzes for the field artillery. Starting as they did virtually from scratch formidable production difficulties had to be overcome, and not until the spring of 1917 was Haig able to report that the shell was satisfactory. For production of the new fuzes in sufficient quantity the Ministry had to look overseas, and by the war's end over 50 million fuzes had been manufactured in Switzerland, France, Canada and the United States.

Since the Navy persisted in standing apart from the Ministry of Munitions, it was not directly involved in these developments. However, questions about the performance of naval armour-piercing shell were raised following the actions at the Falkland Islands and the Dogger Bank, and after the battle of Jutland the issue was brought forcibly to the attention of the Admiralty. Many reasons were adduced to account for the Fleet's perceived failure, but from the outset F.C. Dreyer, Jellicoe's Flag-Captain and in his view the greatest gunnery expert of the day, put the blame squarely on the ineffectiveness of the British projectiles: 'It was obvious to us that there must be something very wrong with our APC shell . . .'. Four days after the battle a Committee was appointed under Dreyer's presidency to 'report on the gunnery information derived from or confirmed by the action of 31st May . . .' and this in turn led to the setting up of a Projectile Committee to look into the shell question.

The Projectile Committee

During the second half of 1916, while the Projectile Committee mounted trials of APC and CPC shell, Dreyer, supported by Jellicoe as well as Beatty and his Flag Captain Ernle Chatfield, pressed for an improved armour-piercing shell with a delay action fuze on the German pattern. When Beatty was promoted to C-in-C Grand Fleet, he at once wrote to the Admiralty drawing attention to reports that APC shell for 13.5-inch guns 'will not penetrate 13\" armour at an angle of impact of 20 degrees or more except at ranges of about 7,000 yards or less'. These 'surprising results' meant that enemy ships could not be effectively engaged at longer ranges, and: 'The disappointing results obtained by our gunfire at the Battle of Jutland and Dogger Bank are now explained'. Beatty shared the general view that the over-sensitive lyddite filling of the British shells was responsible for their exploding on contact with the enemy armour instead of penetrating and bursting behind it, and he went on to declare that: 'The excellent guns mounted in our ships are entirely wasted if the projectiles supplied with them cannot even defeat a 10-inch plate at modern fighting ranges. It is therefore of the utmost urgency that an improved type of burster using TNT or some other insensitive substance be provided for the Fleet. The matter should be pushed forward night and day until the problem is solved . . .'.

This gave rise to a controversy which, while kept a close secret, reverberated through the senior ranks of the Service. The reports of the Projectile Committee broadly rejected the arguments of Beatty and Dreyer, declaring that the British shell, even without a delay action fuze, 'have been generally very effective . . . The latest German battleships and battle cruisers are heavily protected . . . In spite of this the ships were heavily damaged, and this result must be regarded as . . . a tribute to the effectiveness of British A.P.C. and C.P.C. shells . . .'
Officers at the Admiralty connected with the Department of Naval Ordnance and pre-war procurement policies resented the imputation that defective shell had been supplied to the Fleet. Others were sceptical of criticisms directed at the shell, aware that those making them were not without prejudice. Gunnery officers such as Chatfield naturally inclined to the view that defective shell rather than failings in gunnery had been responsible for the disappointing result at Jutland, especially since they believed they had scored more hits on the German ships than turned out to be the case. Nor was it surprising that Dreyer should prefer blame to be laid on the shell rather than the Dreyer tables, the system of range plotting he had succeeded in introducing in the Fleet to the exclusion of the rival Pollen instruments.

**Dreyer as Director of Naval Ordnance**

The impasse was resolved after Jellicoe became First Sea Lord. In February 1917, persuaded of the urgency of the situation and impatient at the slow progress being made by the Projectile Committee, he appointed Dreyer Director of Naval Ordnance with specific responsibility for the shell problem. Dreyer was aware through his older brother Lieut. Col. J.T. Dreyer RA, of the Army's difficulties with artillery fuzes and with the investigations of enemy shell carried out by the Ordnance Committee. These revealed that Krupps had introduced a number of radical changes including a range of new fuzes, details of which they had failed to pass on to Vickers as stipulated in the 1902 agreement. In fact as early as 1906 it had become evident to the Germans that their fuzes were unsatisfactory, and the Krupp technicians had worked in the closest secrecy to improve them, responding to the fresh challenges posed by long range artillery and anti-Zeppelin guns.

In the light of these revelations Dreyer, with the backing of Jellicoe and Beatty, ignored the conclusions of the Projectile Committee and virtually took matters into his own hands. A second committee, subsequently referred to as the Shell Committee, was formed under his direction. Traditional Service rivalries were put aside, the other members, Col. Dreyer and Lt. Col. Haynes, Superintendent of Experiments at Shoeburyness, being Royal Artillery officers. Its purpose was: ‘To determine the most suitable nature of projectiles and their filling and fuzing for use in the Navy for turret guns 12-inch and above.’

Drawing on the experience of the Army, the Shell Committee embarked on a critical analysis of the Navy’s projectiles. As Dreyer wrote later, ‘I personally handled the Shell problem; Colonel Dreyer (my brother) handled the Filling. Colonel Haynes carried out our Plate Trials and reported and advised in regard to results achieved’. It also examined the German shell, discovering that Krupp had stolen a march on Vickers by evolving a completely new design of heavy AP projectile. This, the L/3.4, was revealed to be of advanced design, strengthened by means of a sheath hardening technique which set layers of toughened steel one within the other, filled with pressed blocks of TNT desensitized by means of beeswax and a wooden plug and fitted with a gaine* and delay action fuze. In his memoirs, published in 1919, Grand Admiral von Tirpitz maintained that from the outset the German navy was aware of the superiority of its projectiles, for: ‘To the manufacture of these armour piercing shells we had devoted particular care and labour’. Very soon Dreyer and his colleagues decided that the nettle had to be grasped: there was no alternative but to replace the Fleet’s entire stock of heavy AP shell.

This was easier said than done. The scepticism in some quarters of the Admiralty was shared by the civilian led committees responsible for allocating scarce resources at a time of acute crisis on the military fronts. Both Lloyd

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*gaine: fuze-booster
George and Winston Churchill, who succeeded him as Minister of Munitions in July 1917, were inclined to question the demands of the Navy. There was opposition from Vickers and the specialist shell manufacturers, already resentful of official intervention, who insisted that it was not possible to produce APC shell capable of passing proof at 20° to the normal. However, the recommendations of Dreyer's Committee had the backing of the Admiralty and carried serious implications for the strategical handling of the Fleet. It was clearly advisable to avoid being drawn into major engagements with the Germans until the new projectiles could be made available, and this consideration, together with the fear of mines and submarines, played its part in deciding the Admiralty to adopt, despite much criticism, a mainly defensive posture for the rest of the war.

The New AP Projectile

At Woolwich and Shoeburyness Dreyer and his team worked with feverish energy on the new type AP projectile. The shell manufacturers were instructed to pool their resources to achieve maximum progress in the shortest possible time. By mid-May 1917 the design process was sufficiently advanced for orders to be placed for trial shells featuring a reduced bursting charge and hardened steel nosecaps to aid penetration. Eventually a new filling ('Shellite', a mixture of dinitrophenol and lyddite) was decided upon following a formula used by the French for land service shells. Trials had revealed that contrary to earlier assumptions lyddite was not significantly more sensitive than TNT, and this concentrated attention on the fuze as the source of the trouble. After an unsuccessful attempt had been made to add a delay to the existing No. 16 fuze, the more advanced delay action fuze in the German shell (Fig. 3, on p. 147) was adapted as the No. 16D (Fig. 2), the inertia-actuated burning fuze which, using 'a tortuous channel for the flash to pass through', enabled a projectile to burst from 20-40 feet behind the armour of an opposing ship at ranges up to 15,000 yards. Since doubts persisted about the reliability of work carried out at Woolwich, 'I requested . . . Elswicks [i.e. Armstrong's Elswick Ordnance Co.] . . . to make these fuzes with the greatest possible accuracy,' wrote Dreyer; '. . . the Inspector of Steel, Northern England, watched over this and a result very high standard fuzes were produced'.

Despite the exhortations of the Board of Admiralty, full production of the new projectiles turned out to be fraught with difficulties and delays. The first batches (painted a distinctive green) started to pass proof in February 1918, although to speed up the process it was found necessary to reduce the mean battle range on which the striking velocities at oblique proof were based. In July Geoffrey Blake, gunnery officer of the Queen Elizabeth, wrote to Dreyer: 'The "Green Eggs" are a pleasure to gaze on, and if I may say so, I think that you deserve full numbers for their production in the face of great difficulties. As you always used to say of Scheer and Co., "If they wait long enough, we shall be ready for them!" ' However, not until shortly before the Armistice was Dreyer able to claim that the Fleet was fully equipped with 'Twelve thousand new-type highly efficient armour piercing shell, with insensitive bursters and delay action fuzes, for guns 12-inch and above'. In Jellicoe's opinion the new shell 'certainly doubled' the offensive power of the heavy guns, but they were delivered too late to be used in action.

Effect of the Fuze Problem on the War

It is difficult to assess the extent of the damage caused to the armed services during the first two years of the war by obsolete fuzes in British shell. Could
these, for instance, have made a critical difference at Jutland? The Kaiser thought so, judging from his telegram to Gustav Krupp von Bohlen:

Wilhelmshaven, 5th June 1916: As an immediate result of the impression made on me by the eye-witnesses' accounts of the battle in the North Sea, I wish to place on record that our success was due to our excellent guns and armour and more especially to the destructive effect of our shells. The battle is, therefore, also a day of triumph for the Krupp works.

More recently, Arthur Marder affirms that the British AP projectiles were 'fitted with fuzes which burst them on oblique impact with armour, so frequently doing no damage at all to the enemy's vitals . . . There can be no question about the superior quality of the German high explosive shell . . . They were not abnormally destructive, but they had a very effective delay action fuze which enabled them to penetrate British ships' sides and burst well inside the ship.'5 According to Ian Hogg and John Batchelor: ' . . . there is no doubt that the improved oblique performance of the German shells, combined with their more reliable fuzes, gave the German gunners a considerable advantage.'6 John Campbell ascribes the failings of the British projectiles to 'the use of lyddite as the burster for which it was quite unsuitable, and to the shells being too brittle, while the fuzes, which had no delay, were also unsatisfactory, and it would seem carelessly manufactured by Woolwich.'7 However, he judges from the evidence of damage to ships that survived the battle that German AP shell was only 'adequate', and not markedly more effective than the British in terms of penetration.

The view of naval officers involved in the battle on both sides continued to be that the poor quality of the British AP shell was a major reason for what Fisher described with conscious exaggeration as the 'disaster' at Jutland. After the war Commander Paschen, gunnery officer of the Lützow, wrote that the British 'proved the weight of their large calibre [AP projectiles]; where they hit there was a mighty shock and a large hole. There, however, it stopped; the effect of the explosion was comparatively slight . . . the effect of our shells was quite different; a natural result of every hit (as one of the survivors of the Queen Mary told us) being that 'Every 12" shell blew up a quarter of the ship' . . . how much work, time and money had been spent on these projectiles by the Gunnery Division of the Navy and good old Fried. Krupp & Co.!'8 In The Grand Fleet, 1914–168, published in 1919, Admiral Viscount Jellicoe of Scapa summed up the position:

The Jutland battle convinced us that our armour-piercing shell was inferior in its penetrative power to that used by the Germans, and immediately after the action I represented this with a view to immediate investigation. A Committee sat to investigate the matter. In 1917, as First Sea Lord, I appointed a second Committee.

With one of the old type of A.P. shells . . . the shell would, with oblique impact at battle range, break up . . . A shell of the new type, as produced by the 1917 Committee, could at the same oblique impact and range pass whole through a plate of double the thickness before exploding, and could therefore, with delay action fuze, penetrate to the magazines of a capital ship. Had our ships possessed the new type of armour-piercing shell at Jutland, many of the enemy's vessels, instead of being only damaged, would probably not have been able to reach port.

Nonetheless the effectiveness of the new projectiles was never tested in battle, and after the war the Admiralty acknowledged that the No. 16D Mark IV fuze was still 'not entirely satisfactory'. Trials therefore continued, but it appears that a fully satisfactory fuze-booster combination was not developed until 1928, when the British and Americans used the powerful but sensitive explosive 'tetryl' to achieve a high degree of reliability9. The Germans, content with their existing pattern of heavy AP shell, failed to make this advance, which may be the reason why in World War II the tables were turned, and German naval projectiles performed less well than their British counterparts.
Fig. 2—British delay action fuze as developed under the direction of the Shell Committee, 1917–1918

FIG. 3—GERMAN 12-INCH ARMOUR-PIERCING SHELL L/3, 4 (i.e. 3.4
CALIBRES IN LENGTH) DEVELOPED BY KRUPPS c.1912; WITH
(RIGHT) DELAY ACTION BASE FUZE
Imperial War Museum Collection, London

Sources
Details of the Vickers-Krupp fuze agreement are to be found in the Vickers Archive, Cambridge
University Library. For the development of AP shell see Admiralty papers in the PRO, notably the
"Record of the Principal Questions dealt with by the Director of Naval Ordnance"; for the work of
the 1917 Shell Committee the Admiralty Technical History TH29: Ammunition for Naval Guns
(May, 1920) and the Dreyer mss. in the Archives Centre, Churchill College, Cambridge.

References
4. Beatty to Admiralty, 10 December 1916. PRO ADM 137/3834.
(p. 386).