

# Battlecruisers at Jutland: A Comparative Analysis of British and German Warship Design and its Impact on the Naval War

A Senior Honors Thesis

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by

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## Introduction

The two most powerful battle fleets in the world—the British Grand Fleet and the German High Seas Fleet—departed their bases for what would become the largest naval battle of the First World War on 30 and 31 May 1916, respectively.<sup>1</sup> The German fleet had previously conducted a series of raids on the eastern British coast in an attempt to lure out a portion of the numerically superior Grand Fleet and destroy it.<sup>2</sup> The British, however, had acquired the primary German naval code book in 1914 from the cruiser SMS *Magdeburg*, after it ran aground in the Gulf of Finland and was captured by the Russian navy.<sup>3</sup> The ability to intercept and decrypt German radio traffic provided the British with valuable early warnings of major fleet actions. Aware that the German fleet was to sail on the 31<sup>st</sup> on yet another such raid, the British decided to sortie their fleet a day early in order to be in position to cut off their opponent from its bases in Germany.<sup>4</sup>

The main German fleet was composed of 16 dreadnought battleships and six pre-dreadnought battleships under the command of Vice Admiral Reinhard Scheer.<sup>5</sup> A scouting force of five battlecruisers,<sup>6</sup> commanded by Rear Admiral Franz von Hipper, screened the battle fleet.<sup>7</sup> The main British fleet, commanded by Admiral John Jellicoe, consisted of 24 dreadnoughts and three battlecruisers. Vice Admiral David Beatty's 1<sup>st</sup> and 2<sup>nd</sup> Battlecruiser

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<sup>1</sup> V. E. Tarrant, *Jutland: The German Perspective* (London: Cassell Military Paperbacks, 1995) , 62, 64

<sup>2</sup> Geoffrey Bennett, *The Battle of Jutland* (London: Pen and Sword Military Classics, 2006), 40–42

<sup>3</sup> Tarrant, op. cit., 31

<sup>4</sup> Tarrant, op. cit., 63–64

<sup>5</sup> A dreadnought battleship, so named for the revolutionary HMS *Dreadnought*, the first of its type, carried a uniform main battery of heavy guns intended for long range engagements. Pre-dreadnoughts were typically equipped with four heavy guns and a combination of smaller weapons, all to be used offensively at short ranges.

<sup>6</sup> Battlecruisers were armed similarly to dreadnoughts, though they were significantly faster. British battlecruisers traded armor for speed, while German designs retained heavier armor but were armed with somewhat smaller main battery guns. The first battlecruisers were created as an outgrowth of the armored cruiser type, and were designed to hunt down and destroy the armored cruisers of rival navies.

<sup>7</sup> Tarrant, op. cit., 62

Squadrons, totaling six ships, along with Rear Admiral Hugh Evan-Thomas's 5<sup>th</sup> Battle Squadron of four fast battleships, scouted for Jellicoe.<sup>8</sup> Both fleets were accompanied by cruisers of various types and dozens of destroyers.<sup>9</sup>

The battle began shortly before 1600 UTC,<sup>10</sup> when the British and German battlecruiser forces encountered each other.<sup>11</sup> The Germans turned south in an attempt to lure the British towards the main German fleet.<sup>12</sup> Admiral Hipper's ships, though they were out-ranged by the three leading British battlecruisers, fired first. The British 5<sup>th</sup> Battle Squadron was several miles astern of Beatty's battlecruisers, and as a result of communication errors failed to follow Beatty's turn to the south.<sup>13</sup> By 1630, German heavy shells had penetrated ammunition magazines in two of Admiral Beatty's ships, HMS *Indefatigable* and *Queen Mary*; the resulting magazine explosions tore both vessels apart and caused tremendous casualties. In the same span of time, HMS *Lion*, Beatty's flagship, nearly met the same fate. The British squadron was now heavily disadvantaged; however, Evan-Thomas' battleships quickly closed the distance and tilted the balance back in favor of the British.<sup>14</sup>

At approximately the same time, Admiral Scheer's battleships arrived on the scene. At 1640, Beatty turned northward to lure the German fleet towards the main body of the Grand Fleet.<sup>15</sup> The 5<sup>th</sup> Battle Squadron, still trailing behind Beatty's battlecruisers, bore the brunt of the

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<sup>8</sup> Tarrant, op. cit., 64

<sup>9</sup> Tarrant, op. cit., 62, 64

<sup>10</sup> UTC is Coordinated Universal Time; this time zone covers the United Kingdom and the majority of the North Sea, including the area in which the battle was fought. Germany is located in CET, Central European Time, which is one hour ahead of UTC.

<sup>11</sup> John Campbell, *Jutland: An Analysis of the Fighting* (London: Lyons Press, 1998), 38

<sup>12</sup> Bennett, op. cit., 69–70

<sup>13</sup> Campbell, op. cit., 32

<sup>14</sup> Campbell, op. cit., 43–46

<sup>15</sup> Tarrant, op. cit., 106

fire from the German battleships and battlecruisers during this portion of the battle.<sup>16</sup> Shortly after 1800, the three ships of the 3<sup>rd</sup> Battlecruiser squadron arrived to reinforce Beatty's ships.<sup>17</sup> During this segment of the engagement, the newly arrived British ships inflicted fatal damage on the German battlecruiser SMS *Lützow*, which forced it to withdraw from the action.<sup>18</sup> At the same time, however, *Lützow's* and *Derfflinger's* combined fire destroyed the battlecruiser *Invincible*.<sup>19</sup> The Grand Fleet reached the battle at approximately the same time and began to deploy to the east of the German fleet shortly thereafter.<sup>20</sup>

At 1830, Scheer realized that the entire British battle fleet confronted him, and ordered a simultaneous 180-degree turn that brought his ships on a westerly course.<sup>21</sup> Jellicoe, fearful of German torpedoes, decided to turn southward to maintain his ability to cut off any German attempt to break for the safety of their bases.<sup>22</sup> Just before 1900, Scheer turned his ships back to the east in an attempt to surprise the British, but the Germans found themselves facing Jellicoe's entire deployed line of battle. Scheer ordered the battle fleet to make another turn to the west; he directed the four remaining German battlecruisers and a torpedo-boat flotilla to charge the British line to cover the retreat. Between 2020 and 2035, the last major clash of the battle took place between the battlecruiser squadrons. Beatty had been able to catch up to Hipper's battered ships, though the German pre-dreadnoughts intervened and covered Hipper's withdrawal to the south.<sup>23</sup>

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<sup>16</sup> Tarrant, op. cit., 116

<sup>17</sup> Tarrant, op. cit., 126–129

<sup>18</sup> Bennett, op. cit., 102

<sup>19</sup> Tarrant, op. cit., 147–149

<sup>20</sup> Tarrant, op. cit., 135

<sup>21</sup> Tarrant, op. cit., 153–154

<sup>22</sup> Bennett, op. cit., 104

<sup>23</sup> Bennett, op. cit., 106–109

As darkness fell, both fleets assumed night cruising formations. A series of clashes between both sides' light forces and the German battle fleet occurred throughout the night.<sup>24</sup> *Lützow* had withdrawn by this time with a handful of escorting torpedo boats; the ship continued to take on water and was eventually scuttled in the early morning hours of 1 June.<sup>25</sup> Jellicoe was unsure of the exact disposition and location of the German fleet and was aware that the German crews had been trained more thoroughly than the British crews for night fighting. He therefore decided to avoid battle until dawn. As a result, Scheer was able to punch through the British destroyer screen in the darkness and make good his escape.<sup>26</sup>

Over the course of the battle, three British battlecruisers and three armored cruisers were sunk, along with eight destroyers. German losses totaled one battlecruiser, one pre-dreadnought battleship, four light cruisers, and four torpedo-boats. British losses were higher in terms of ships lost and men killed, but they retained control over the North Sea and were still able to impose a crippling naval blockade of Germany.<sup>27</sup>

The two fleets were not to engage each other again for the remainder of the war; an abortive advance into the North Sea by the German fleet followed on 18–19 August 1916,<sup>28</sup> and a second took place on 10 October.<sup>29</sup> The third and last post-Jutland fleet action took place on 23 April 1918. The operation was abandoned after the battlecruiser SMS *Moltke* suffered mechanical problems during the sail northward.<sup>30</sup> Admirals Scheer and Hipper planned a final sortie for 30 October 1918 that would have attempted to lure the British fleet south for a fight to

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<sup>24</sup> Campbell, op. cit., 273

<sup>25</sup> Tarrant, op. cit., 249

<sup>26</sup> Campbell, op. cit., 273–274

<sup>27</sup> Tarrant, op. cit., 276

<sup>28</sup> Paul G. Halpern, *A Naval History of World War I* (Annapolis: Naval Institute Press, 1995), 330–331

<sup>29</sup> Halpern, op. cit., 332

<sup>30</sup> Gary Staff, *German Battlecruisers: 1914–1918* (Oxford: Osprey Books, 2006), 17

the death. Hipper ordered the German fleet to assemble in Wilhelmshaven three days before. The ships' crews, whose morale had steadily declined due to inaction and a desire for peace, wanted no part in a glorious death for the Kaiser. Hundreds of sailors deserted, conducted peace demonstrations, and openly mutinied against their commanders; the crews of several of the ships refused to sail. The operation was canceled and the fleet was dispersed.<sup>31</sup> Ultimately, the majority of the High Seas Fleet was interned by the British at Scapa Flow; fearing the ships under his command would be seized as war reparations, Rear Admiral Ludwig von Reuter ordered them to be scuttled on 23 June 1919.<sup>32</sup>

After receiving the news that the battlecruisers HMS *Indefatigable* and *Queen Mary* had been destroyed by magazine explosions in the early part of the Battle of Jutland, Vice Admiral David Beatty made the famous remark, "There is something wrong with our bloody ships today."<sup>33</sup> Little did he know, design flaws were not the only cause for the catastrophic explosions, nor were they limited solely to the British ships, though their German rivals did not suffer from the same fatal shortcomings that plagued the Grand Fleet battlecruisers. The British reconnaissance force suffered from a number of serious problems, among them insufficient armor protection, less effective gunnery than their German opponents—mainly from lack of training—and defective main battery projectiles.<sup>34</sup> These flaws were of secondary importance compared to the dangerous ammunition handling techniques practiced aboard the British ships, and these were what ultimately led to the destruction of three of Beatty's battlecruisers.

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<sup>31</sup> Tarrant, op. cit., 281–282

<sup>32</sup> Holger Herwig, *"Luxury" Fleet: The Imperial German Navy 1888-1918*. (Amherst, New York: Humanity Books, 1980), 256

<sup>33</sup> Halpern, op. cit., 319

<sup>34</sup> The poor quality of British long-range gunnery is discussed in Appendix III and the problematic armor-piercing shells are examined in detail in Appendix II.

The German battlecruisers, though more stoutly constructed than their British counterparts, were not without weaknesses. A chief design fault was the torpedo bulkhead, which did not run the entire length of the hull.<sup>35</sup> The "soft ends" this system created were among the primary reasons the flooding aboard SMS *Lützow*, Vice Admiral Franz von Hipper's flagship, could not be controlled. The German ships were also equipped with lighter main batteries; while the guns were sufficiently powerful to penetrate the thinner armor of their British rivals, the maximum effective range of these guns was significantly lower than the larger guns of the *Tiger* and three *Lion* class ships. This turned out to be less of a handicap than might have been expected. Mistaken assumptions about the distance between the two squadrons and questionable decision-making by Vice Admiral Beatty caused him to hold his fire until after his German opponents had already reached effective gunnery range, and in doing so he discarded a crucial advantage.

Among the advantages enjoyed by the Germans were better-trained gun crews and more effective main battery ammunition, which allowed them to inflict serious damage early in the engagement. The German gunners also had more favorable conditions in the beginning of the battle. The ships' thicker armor also enabled them to take a heavier beating than their British opponents. Another sometimes overlooked advantage was the shorter distance from the battle area to German ports, compared to the distance to the fleet bases in northern Britain. The severely damaged SMS *Seydlitz* was able to limp back to Wilhelmshaven; it is questionable as to whether a similarly damaged British ship would have been able to make the longer voyage back to Scapa Flow or Rosyth.

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<sup>35</sup> A torpedo bulkhead is an interior armored wall that was intended to protect the ship from flooding due to underwater shell or torpedo hits.

Despite the design imperfections present in the ships of both forces, the most important difference between the British and German ships, and the primary reason the British suffered greater casualties during the battle, was the difference between the respective sides' propellant charges and gun handling techniques. Despite the thicker armor of SMS *Seydlitz* and *Derfflinger*, both ships had gun turrets penetrated by British gunfire. German gun crews generally adhered to stricter munitions handling techniques—a result of the lessons learned at the Battle of Dogger Bank in 1915.<sup>36</sup> Coupled with less volatile chemical composition of the German charges and the use of brass cartridges that were resistant to flash fires, the superior precautions aboard the German vessels prevented them from being destroyed by catastrophic explosions. Conversely, the British packed as many shells as possible in the gun turrets and working chambers in an attempt to increase their rate of fire. The nature of the British propellant compounded this dangerous situation; it had a tendency to become increasingly unstable as it aged. Finally, the British powder was stored in silk bags that easily ignited. This doomed the battlecruisers *Indefatigable*, *Queen Mary*, and *Invincible*, and nearly destroyed Beatty's flagship *Lion* as well. These factors will be discussed in detail in chapter three.

Although the Battle of Jutland was not a tactically decisive engagement, it had tremendous strategic significance. Indeed, it was strategically significant precisely because it was tactically inconclusive. The indecisive outcome of the battle convinced Admiral Scheer that the German fleet could not win the war; three days after the battle, he informed Kaiser Wilhelm II that "even the most successful outcome of a fleet action [would] not force England to make peace."<sup>37</sup> He therefore pressed the Kaiser to allow unrestricted submarine warfare to resume,

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<sup>36</sup> The Battle of Dogger Bank is addressed in detail in Appendix I

<sup>37</sup> Tarrant, op cit., 279

which the Kaiser authorized on 1 February 1917.<sup>38</sup> This ultimately led to the United States' entrance into the conflict, which hastened the Allied victory in 1918.

To properly understand the outcome of the Battle of Jutland, it is important to examine the technical characteristics of the warships—especially their design strengths and faults—and how they interacted with the decisions made by the commanders. These characteristics are best exemplified by the British and German battlecruiser squadrons, and will be examined in detail in this paper. As important as the impact of the differences in ammunition and gun crew drill just noted were, they took effect within the larger context of the technical characteristics of the two sides' ships, particularly those of the battle ships and battlecruisers and it is to those technical characteristics that we now turn.

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<sup>38</sup> Tarrant, *op. cit.*, 279

## Chapter I: Technical Characteristics

The technical characteristics of the ships that fought at Jutland, especially the armament and armor, are critical to gaining a thorough understanding of the outcome of the engagement. The capabilities and weaknesses of both the British and German battlecruisers, most importantly the power and range of their guns and the quality of their armor protection, directly impacted how the ships were employed during the battle. These characteristics also helped to decide the performance of these ships both against their corresponding adversaries and against other types of warships at the Battle of Jutland.

The battlecruisers that took part in the Battle of Jutland were equipped with a variety of armaments, including large-caliber main guns, small-diameter defensive guns, and submerged torpedo tubes built into the hulls of both British and German ships. The most important of these weapons were the large-caliber guns. The secondary guns were primarily used to keep light cruisers and destroyers at bay, while the torpedo tubes proved largely useless—not a single capital ship was able to maneuver into an effective firing position during the entire battle.

The German warships were armed with the following guns:<sup>39</sup>

<u>Ship</u>	<u>Gun caliber</u>	<u>Number of guns</u>
<i>Von der Tann</i>	11 inch SK L/45 <sup>40</sup>	8
<i>Moltke / Seydlitz</i>	11 inch SK L/50	10
<i>Derfflinger / Lützow</i>	12 inch SK L/50	8
<b>Total number of heavy guns:</b>		44

The British battlecruisers were armed as follows:<sup>41</sup>

<u>Ship</u>	<u>Gun caliber</u>	<u>Number of guns</u>
<i>Invincible</i> class / <i>Indefatigable</i> class	BL 12-inch Mark X <sup>42</sup>	8
<i>Lion</i> class / <i>Tiger</i>	BL 13.5-inch Mark V	8
<u>Total (excluding <i>Invincible</i> class):</u>		48
<u>Total (including <i>Invincible</i> class, excluding <i>Indefatigable</i> and <i>Queen Mary</i>):</u> <sup>43</sup>		56

<sup>39</sup> Erich Gröner, *German Warships: 1815–1945* (Annapolis: Naval Institute Press, 1990), 53–57

<sup>40</sup> German guns of the period were classified as "SK - Schnellfeuerkanone" (rapid-firing cannon); "L" refers to length of the gun in terms of calibers.

<sup>41</sup> Lawrence Burr, *British Battlecruisers: 1914–1918*. (Oxford: Osprey Books, 2006), 16

<sup>42</sup> Large British guns of the period were classified as "BL - Breech-Loading" with the bore diameter and the version of the design in that bore caliber.

<sup>43</sup> By the time the *Invincible* class ships arrived on the scene, both *Indefatigable* and *Queen Mary* had been destroyed.

The British advantage in heavy guns was mitigated to a degree by much heavier armor on the German ships. The strongest armored belt on the British ships was that of *Tiger*, which was 9 inches thick. All three *Lion*-class, two *Indefatigable*-class, and three *Invincible*-class ships were equipped with armor belts that were only 6 inches thick.<sup>44</sup> In comparison, the least protected German battlecruiser, *Von der Tann*, had an armored belt that was 9.8 inches thick. *Moltke*'s belt was 10.6 inches thick, while both *Seydlitz* and the two *Derfflinger*-class ships had 12-inch-thick side armor.<sup>45</sup> The difference in armoring was due in large part to the fact that the German ships were designed to be able to fight in the line of battle against an enemy fleet while their British counterparts were not.<sup>46</sup> Admiral Jacky Fisher, the creator of the British battlecruisers, envisioned his ships serving in rapid-response squadrons designed to hunt down enemy warships instead of fighting in a battle line.<sup>47</sup> This was a result of the numerical inferiority of the German battleships. Once contact with an opponent was made, the German battlecruisers were intended to join the line of battleships and fight the fleet action, where the two opposing lines would trade shots.<sup>48</sup> The advantage was further reduced by the poor quality of British armor-piercing shells, which caused many of them to break up or explode on impact.<sup>49</sup>

The 11-inch guns of *Von der Tann* were mounted in four gun turrets; one turret was positioned forward of the main superstructure on the centerline, two were placed in a staggered arrangement amidships—the first of the central pair was on the port side and the second was located aft of the first and on the starboard side—and the fourth was aft of the rear conning tower. The central turrets had the ability to shoot over the deck, which meant that all eight guns

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<sup>44</sup> Burr, op. cit., 16–19

<sup>45</sup> Gröner, op. cit., 54–56

<sup>46</sup> Staff, op. cit., 6

<sup>47</sup> Burr, op. cit., 4–6

<sup>48</sup> Staff, op. cit., 6

<sup>49</sup> Campbell, op. cit., 386

could fire on the broadside. *Von der Tann*'s turrets allowed gun elevation to 20°, which provided a maximum range of 22,300 yards. Rate of fire for these weapons was up to three rounds per minute. The armor-piercing shells fired by these guns weighed 670 pounds; a full broadside had a total weight of 5,360 pounds.<sup>50</sup>

*Von der Tann* was heavily armored; the 9.8-inch-thick main armored belt extended from just ahead of the forward main battery gun turret to past the rear gun turret, which covered approximately 350 feet of the hull, or nearly two-thirds of the length of the ship. Transverse bulkheads, 7 inches thick, capped the central section of the ship which was protected by the main belt. The remainder of the ship was protected by a thinner belt; the bow and stern sections of armor were reduced to seven inches immediately past the main belt, and tapered down to four inches at either end of the ship.<sup>51</sup> The main battery gun turrets, as well as the barbettes and ammunition rooms upon which they sat, were armored with 9-inch-thick sides. The gun turret roofs were only 3.5 inches thick.<sup>52</sup>

*Moltke* and *Seydlitz* were armed with an improved version of the 11-inch guns on the *Von der Tann*; the primary enhancement was a lengthening of the barrel: 50 calibers in length, compared to 45 calibers in the earlier guns.<sup>53</sup> This gave the shell a higher muzzle velocity; 2,887 feet per second versus 2,805 feet per second for the shorter weapons. They fired the same 670-pound armor-piercing shell as in the 45-caliber guns. *Moltke* carried her guns in turrets that allowed elevation only to 13.5°; the range of these guns was 19,500, significantly lower than *Von der Tann*. *Seydlitz*'s gun turrets had been modified to increase elevation to 16°, which gave the

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<sup>50</sup> Staff, op. cit., 5

<sup>51</sup> Norman Friedman, *German Warships of World War I: The Royal Navy's Official Guide to the Capital Ships, Cruisers, Destroyers, Submarines and Small Craft, 1914–1918* (Annapolis: Naval Institute Press, 1992), 98

<sup>52</sup> Gröner, op. cit., 54

<sup>53</sup> Caliber in this sense refers to the length of the gun relative to its bore diameter. Thus, the bore of a 50 caliber gun is 50 times as long as it is in diameter.

guns a longer range of 21,000 yards.<sup>54</sup> *Moltke* and *Seydlitz* carried ten guns in five turrets; the fifth turret in both ships was placed in a superfiring position above the rearmost turret.<sup>55</sup> The two ships each had a full broadside weight of 6,700 pounds. As with the shorter guns on *Von der Tann*, these guns fired at a rate of three shells per minute.<sup>56</sup>

*Moltke*'s armored belt was strengthened, relative to that of *Von der Tann*, from 9.8 inches to 10.6 inches in thickness. It was also more comprehensive; it extended some 15 feet above the waterline, compared to only 10 feet on *Von der Tann*. However, the belt stopped directly at the forward and rearmost gun turrets, which provided a length of approximately 370 feet of the 612-foot long hull. The bow section of belt was somewhat thinner, tapering from 6 inches to 4; the stern section was only 4 inches thick. The transverse bulkheads on either end of the central citadel was 8 inches thick.<sup>57</sup> The armor system protecting the gun turrets mounted on *Moltke* was the same as that of the turrets aboard *Von der Tann*.<sup>58</sup>

The armor system that protected *Seydlitz* was improved still more from that of *Moltke*. The main armored belt was increased in thickness from 11 to 11.75 inches; it was also approximately 20 feet longer than on *Moltke*. The bow and stern sections were less protected compared to the preceding design; armor thickness tapered from 4.75 to 4 inches at either end of the ship. The transverse bulkheads that connected the starboard and port sides of the armored belt were increased to 8.75 inches.<sup>59</sup> The gun turrets were modified from those mounted on *Moltke*; the thickness of the roofs was decreased to 2.75 inches while the sides were increased to 9.8

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<sup>54</sup> Campbell, op. cit., 342–344

<sup>55</sup> A superfiring arrangement superimposes one turret over another, so that the rear guns can fire over the lower turret.

<sup>56</sup> Staff, op. cit., 12, 21

<sup>57</sup> Friedman, op. cit., 96–98

<sup>58</sup> Gröner, op. cit., 54

<sup>59</sup> Friedman, op. cit., 94

inches.<sup>60</sup> As in the earlier vessels, the barbettes were 9 inches thick on the exposed sides and thinner on the ship's interior.<sup>61</sup>

The two *Derfflinger* class battlecruisers were equipped with eight 12-inch guns in four turrets each. The arrangement of these guns was also greatly superior to that of the earlier ships; all four turrets were mounted on the centerline in two superfiring pairs. This gave the ships a less restricted field of fire on the broadside. These guns were significantly more powerful than the smaller guns mounted on the earlier battlecruisers. They fired 894-pound armor-piercing shells at a muzzle velocity of 2,805 feet per second, up to three shots per minute.<sup>62</sup> Elevation in the turrets on these two ships was limited to 13.5°; the range at maximum elevation was 20,500 yards.<sup>63</sup> Although the number of guns on each ship had decreased from ten to eight, the broadside weight had been increased to 7,152 pounds.

The *Derfflinger*-class ships were protected by an even more comprehensive armor arrangement than their predecessors. The belt was thickened to 12 inches and ran from the forward barbette to approximately 10 feet past the rearmost gun turret, a length of roughly 400 feet. The transverse bulkheads that capped the armored belt on either end were thickened somewhat to an even 9 inches.<sup>64</sup> The turrets were armored similarly to those aboard *Seydlitz*, though their roofs were increased to 4.3 inches in thickness.<sup>65</sup> Protection for the barbettes was strengthened to 10.25 inches on the exposed areas.<sup>66</sup>

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<sup>60</sup> Gröner, op. cit., 55

<sup>61</sup> Friedman, op. cit., 94

<sup>62</sup> Staff, op. cit., 36

<sup>63</sup> Campbell, op. cit., 342–344

<sup>64</sup> Friedman, op. cit., 92–93

<sup>65</sup> Gröner, op. cit., 56

<sup>66</sup> Friedman, op. cit., 92–93

In total, all five of the German battlecruisers had a combined broadside weight of 33,064 pounds per salvo. At the maximum rate of fire, this amounted to a broadside weight of 99,192 pounds of armor-piercing ordnance per minute—but only on paper. During the battle, the typical sustained rate of fire—for both the German battlecruisers and battleships—was closer to one shot per gun per minute.<sup>67</sup>

Turning to the British battlecruisers, the six *Invincible* and *Indefatigable* class ships each carried eight BL 12-inch Mark X guns, mounted in four twin turrets in an arrangement similar to that of *Von der Tann*; two staggered wing turrets amidships and two on the centerline, forward and aft of the superstructure. The amidships turrets of the *Invincible* class were too closely positioned; they were incapable of firing across the deck. As a result, their broadsides were limited to six of their eight guns.<sup>68</sup> The *Indefatigable* class was built longer, in part to rectify this problem; all eight guns on these vessels could fire on the broadside.<sup>69</sup> The guns fired 850-pound projectiles at a muzzle velocity of 2,725 feet per second. The guns could be elevated to 13.5°, which enabled a maximum range of 18,850 yards. For the *Invincible* class, the full broadside weight was 5,100 pounds per ship; for the *Indefatigable* class, it was 6,800 pounds.<sup>70</sup> The rate of fire for these guns, as in most other British capital ships, was approximately two shots per minute.<sup>71</sup>

The *Invincible* class ships were protected by a thin waterline belt that was six inches thick amidships; it ran from the rear "X" turret to just forward of the "A" turret, about 58 percent of the 567-foot hull. Past "A" turret, the belt decreased in thickness to 4 inches and ran up to the bow.

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<sup>67</sup> Campbell, op. cit., 345

<sup>68</sup> Burr, op. cit., 15

<sup>69</sup> Burr, op. cit., 6

<sup>70</sup> Campbell, op. cit., 344

<sup>71</sup> Campbell, op. cit., 345

The belt itself was not particularly comprehensive; it had a height of approximately 12 feet, most of which was above the waterline. The main battery gun turrets and their supporting barbettes were protected with 7-inch thick steel plating.<sup>72</sup>

For *Indefatigable*, the belt was significantly modified: the central portion remained 6-inches thick, though it was shortened, and covered only a 298-foot section amidships, or slightly more than 50 percent of the hull. The belt sections shielding the "A" and "X" barbettes were reduced in thickness to 4 inches and capped on the ends by 4 and 4.5 inch thick transverse bulkheads in the bow and stern, respectively. Past the transverse bulkheads, the belt again decreased to 2.5 inches in thickness. The turrets and barbettes were armored as in the previous class.<sup>73</sup> *New Zealand* was built later and with a somewhat revised armor scheme. The belt segments that covered the "A" and "X" turrets were increased in thickness to 5 inches. Instead of extending the 2.5-inch thick sections to the bow and stern, they were shortened, but increased in thickness to 4 inches. The central portion of the belt and the main battery armor remained the same as on *Indefatigable*.<sup>74</sup>

The three *Lion* class ships carried their eight BL 13.5-inch Mark V guns in four twin turrets, all on the centerline. Two turrets were closely positioned in a superfiring arrangement forward of the superstructure. A third was located amidships between the second and third funnels, and the fourth turret to the aft of the rear conning tower. The amidships "Q" turret was partially restricted in its field of fire; the third funnel prevented it from firing directly astern. On the *Tiger*, this was corrected by moving the "Q" turret farther aft.<sup>75</sup>

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<sup>72</sup> John Roberts, *Battlecruisers* (Annapolis: Naval Institute Press, 1997), 99

<sup>73</sup> Roberts, op. cit., 101

<sup>74</sup> Roberts, op. cit., 102

<sup>75</sup> Burr, op. cit., 13–14

The guns on *Lion* and *Princess Royal* fired 1,250-pound shells at a muzzle velocity of 2,582 feet per second. *Queen Mary* and *Tiger* were equipped with more robustly constructed gun mountings; these permitted the use of heavier 1,400-pound projectiles. Muzzle velocity was slightly lower, at 2,491 feet per second. All four ships could elevate their main guns to 20°. The guns aboard *Lion* and *Princess Royal* could engage targets out to 23,820 yards; the lower muzzle velocity of the guns mounted on *Queen Mary* and *Tiger* resulted in a correspondingly shorter range of 23,740 yards, though the difference was negligible. *Lion* and *Princess Royal* had a broadside weight of 10,000 pounds, while the heavier shells that *Tiger* and *Queen Mary* fired gave a broadside of 11,200.<sup>76</sup>

In response to their better-armored German rivals, the armor plan for the three *Lion* class ships was dramatically strengthened, though it was still not as strong as that of their German counterparts. The central belt section was increased to 9 inches, though it covered an even smaller percentage of the hull than it did on *Indefatigable*: approximately 44 percent of the 700-foot long ship. This segment of the belt remained as tall as in the preceding ships, though it was augmented by 6-inch thick plating that extended to the main deck. Abreast of "B" turret, the belt was decreased to 6 inches, and again to 5 inches at "A" turret, and finally to 4 inches towards the bow. The belt was capped at that point by a 4-inch thick bulkhead. Aft of the main belt, the side protection was decreased to 5 inches and then to 4 past "X" turret. It was capped by a 2.5-inch thick bulkhead. The main battery turrets were armored with 9-inch thick plates, as were the above-deck portions of the barbettes. Below deck, the armor thickness was decreased slightly to 8 inches.<sup>77</sup>

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<sup>76</sup> Campbell, op. cit., 344

<sup>77</sup> Roberts, op. cit., 103

Of the British ships, *Tiger* had the most comprehensive armor system. The main belt was still 9 inches thick and covered a similar portion of the hull as in the *Lion* class, but it was augmented on the bottom edge by 3 inches of armor plate that extended armor protection further below the waterline. The ship's 6-inch thick upper side armor was also extended to the forecastle deck, though past the conning tower it was reduced to 5 inches. As with the *Lion* class ships, the belt was reduced to 5 inches at the forward and rear battery turrets and capped with 4-inch thick bulkheads. The main-gun turrets and barbettes retained the armor thickness of the former ships.<sup>78</sup>

Counting only the ships present during the initial battlecruiser engagement, the British battlecruiser force had a combined broadside weight of 56,000 pounds. All of the guns were capable of a rate of fire of two rounds per gun per minute. This was 112,000 pounds every 60 seconds for the six ships under Beatty's command. Again, this rate of fire was not met during the battle; as with their German opponents, the sustained rate of fire was approximately one shot per minute.<sup>79</sup> When the three *Invincible* class ships arrived later in the battle, they added a total broadside of 15,300 pounds.

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<sup>78</sup> Roberts, op. cit., 105

<sup>79</sup> Campbell, op. cit., 345

## Chapter II: Analysis of Performance

At the initial contact on the afternoon of 31 May, the German battlecruiser squadron, positioned to the southeast of the British reconnaissance force, was steaming northward. Beatty had also turned his ships north in order to rendezvous with the Grand Fleet; about 45 miles separated the two forces.<sup>80</sup> Once the opposing cruiser and destroyer screens made contact, the battlecruisers of both fleets turned to convergent courses, with Hipper's ships steaming in west-northwesterly and Beatty's squadron sailing northeasterly.<sup>81</sup> At 1522 UTC, observers aboard *Seydlitz* saw the tripod masts of the two nearest battlecruisers, which turned out to be *Indefatigable* and *New Zealand* of the 2nd Battlecruiser Squadron. The British had identified the Germans by 1530.<sup>82</sup>

Environmental factors favored the Germans in this portion of the battle; the westerly winds blew smoke from Beatty's battlecruisers towards the German ships, which obscured the view of the British gun layers. The British 9th Destroyer Flotilla, which was proceeding at full speed on Beatty's starboard side, also left a considerable cloud of smoke in its wake, which further hampered the British gunners' ability to spot their German rivals.<sup>83</sup> The German ships were also painted a lighter color, which made them harder to distinguish from the sea at long ranges.<sup>84</sup>

At this point, the Germans were well within the range of the 13.5-inch guns aboard Beatty's four leading ships.<sup>85</sup> Instead of ordering his longer-ranged ships to open fire, Beatty

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<sup>80</sup> Tarrant, op. cit., 70–71

<sup>81</sup> Tarrant, op. cit., 78

<sup>82</sup> Campbell, op. cit., 34

<sup>83</sup> Tarrant, op. cit., 79

<sup>84</sup> Campbell, op. cit., 38

<sup>85</sup> Tarrant, op. cit., 87

decided to wait until he had closed to within 18,500 yards, which was the maximum range of the 12-inch gunned *Indefatigable* and *New Zealand*. Beatty did so to ensure that all six of his ships would be able to engage the German force simultaneously. However, the rangefinders aboard *Lion*, Beatty's flagship, miscalculated the range and estimated it to be some 2,000 yards greater than it was. As a result, the German ships had been able to close to approximately 16,000 yards; they opened fire first at 1548.<sup>86</sup> The British battlecruisers were still in the process of deploying into combat formation, as Beatty was still under the impression that the German ships were only beginning to reach effective range.<sup>87</sup> At the time gunfire began, *Tiger* and *Lion* were still in the process of turning to the southeast, and were able to fire only their forward guns.<sup>88</sup>

It is unclear why Beatty decided to wait until all six of his ships could engage their targets. It is reasonable to suppose, however, that Beatty's loss of control over his ships at the Battle of Dogger Bank a year and a half earlier may have influenced this decision. At the battle, Beatty had ordered his ships to fire as they reached effective range; his leading ship, *Lion*, opened fire at a distance of some 20,000 yards at 0952. It took nearly 45 minutes for all of Beatty's ships to move into firing positions.<sup>89</sup> Between 1100 and 1120, *Lion* was hit three times. One shell penetrated the ship's side armor and allowed water to flood the feed tank for the port engines; this damage forced the engine-room crew to shut off the machinery, which significantly reduced *Lion*'s speed. Signal transmission errors caused Beatty's other ships to concentrate on the fatally damaged armored cruiser *Blücher* instead of pursuing Hipper's three battlecruisers.<sup>90</sup> Beatty may have viewed his decision to open fire haphazardly at extreme range as the root cause

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<sup>86</sup> Campbell, op. cit., 38

<sup>87</sup> Tarrant, op. cit., 89

<sup>88</sup> Campbell, op. cit., 39

<sup>89</sup> Tarrant, op. cit., 38–39

<sup>90</sup> Tarrant, op. cit., 40–41

for his loss of control over his squadron. When the opportunity to engage his German counterpart again presented itself, he surely was determined to avoid making the same mistake again.

Beatty's perception was reinforced by a long-standing pre-war consensus amongst British admirals that fighting would be done at medium range, that is, from approximately 9,000 to 10,000 yards. Only in 1912 had senior officers begun to push for longer-range gunnery practice.<sup>91</sup> Even then, many within the Admiralty assumed that the German fleet would quickly charge the British fleet at high speed before turning to a parallel course, at which point the battle would continue at medium range.<sup>92</sup> Indeed, Admiral Jellicoe issued the following directive for the entire fleet on 31 August 1914, some four weeks after the outbreak of war:

"on a clear day and unless the enemy opens fire earlier 13.5-inch gun ships will open deliberate fire at 15,000 yards, 12-inch gun ships at 13,000 yards. . . . At extreme ranges fire should be by deliberate salvos until the enemy is hit or straddled; the rate of fire should then be increased, but ships should not employ rapid fire at ranges over 10,000 yards without occasional checks to a slower rate until they are certain they are hitting."<sup>93</sup>

The tactical doctrine of the Royal Navy stipulated that capital ships were to move to closer ranges before opening fire. Beatty had experimented with firing at extreme range at Dogger Bank, without positive results. The negative experience at Dogger Bank reconfirmed for Beatty the value of holding fire until his ships were absolutely ready, or in this case, until his opponent had begun firing first.

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<sup>91</sup> Nicholas A. Lambert, "'Our Bloody Ships' or 'Our Bloody System'? Jutland and the Loss of the Battle Cruisers, 1916." *The Journal of Military History*, (January 1998): 33

<sup>92</sup> Jon Tetsuro Sumida, "A Matter of Timing: The Royal Navy and the Tactics of Decisive Battle." 1912–1916 *The Journal of Military History* (January 2003): 100

<sup>93</sup> Sumida, op. cit., 111

The initial German salvos were long for the most part, but within 1,000 yards of their targets, with the exception of those from *Von der Tann* and *Moltke*, which were about 1,700 yards long and 500 yards short, respectively. Conversely, *Tiger*, *Lion*, and *New Zealand* overshot their opponents by well over 2,000 yards; *Princess Royal* was the only vessel on either side to have made a somewhat accurate range estimate in the opening shots. As *Queen Mary* and *Indefatigable* were sunk with tremendous loss of life, there are no exact figures for their ranges; a survivor from *Queen Mary* reported the estimated range was 17,500 yards.<sup>94</sup>

In the span of three minutes, *Lützow* fired five four-gun salvos and struck its target, *Lion*, with the fifth. *Moltke* reported similar success; in the first three minutes the ship scored two hits on *Tiger*, and continued to do so for several minutes. After firing for 10 minutes, *Derfflinger* hit *Princess Royal* for the first time.<sup>95</sup> *Seydlitz* and *Von der Tann* also claimed hits on *Queen Mary* and *Indefatigable*, respectively. It was 1555, 7 minutes after the first shots were fired, by the time *Queen Mary* scored the first British hit, on *Seydlitz*; a second hit followed two minutes later. The second hit penetrated *Seydlitz*'s superfiring turret barbette and burned out the gun turret. *Lützow* was hit twice in the forecastle by a salvo from *Lion* at 1600, though to no noticeable effect at this early stage of the battle. In the first 12 minutes of the battle, and counting only those made on *Lion*, *Tiger*, and *Princess Royal*, the Germans tallied 15 hits, in comparison with four by the British.<sup>96 97</sup>

The advantage in range the four leading British ships possessed had been lost, largely because of Beatty's decision to hold his fire until all six of his battlecruisers could bring their

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<sup>94</sup> Campbell, op. cit., 39

<sup>95</sup> Campbell, op. cit., 40

<sup>96</sup> Campbell, op. cit., 41

<sup>97</sup> Hits claimed to have been made on *Queen Mary* and *Indefatigable* during this period cannot be confirmed, and so are not included here. Campbell states that it was "probable" that *Seydlitz* scored hits on *Queen Mary*, and that the gunners aboard *Von der Tann* claimed to have hit *Indefatigable* once during this period. See: Campbell, op. cit., 41

guns to bear. This problematic decision was compounded by inaccurate rangefinding aboard the flagship, which caused Beatty to believe he was farther from the Germans than he actually was. Had Beatty been correctly advised as to the distance to the German ships, it is almost certain he would have ordered his ships to open fire several minutes earlier than he did. While the early shooting of both sides was poor, the additional time this would have granted the British ships would have allowed them to correct their firing solutions under more favorable conditions. Most importantly, they would have been able to fire several salvos without having to maneuver erratically to avoid incoming German shells; the task of the gunnery officers was much easier when their base was moving in a smooth, predictable course. It is also safe to assume that, had the British gunners been provided with a more exact range estimation, their first shots would have been more accurate.

The ability to engage the Germans with relative impunity would have been a tremendous advantage. Had they made use of it, the British might have inflicted serious damage on their German opponents at the outset of the battle. Nevertheless, the 12-inch guns of the two *Indefatigable* class ships were out-ranged by at least 1,000 yards by all of the German main battery guns. By binding to them the longer-ranged 13.5-inch guns aboard his more modern ships, Beatty discarded a critical strength of his battlecruisers and all but ensured the Germans would have the opportunity to open fire first.

The result of Beatty's decision was that once the British ships responded, they were forced to make gunnery corrections while maneuvering under hostile fire, a task at which the Germans proved to be more adept. The Germans scored more than three times as many hits in the first 12 minutes of the engagement, and this imbalance continued for the rest of the run to the south. For the duration of this segment of the battle, *Lion* was hit 9 times, *Princess Royal* 6,

*Queen Mary* was hit at least 7 times before it blew up, *Tiger* was pummeled by 14 large-caliber shells, *New Zealand* was hit once, and *Indefatigable* was hit at least 5 times before a magazine explosion destroyed the ship. In response, *Lützow* was hit only 4 times, *Seydlitz* and *Moltke* were hit 5 times apiece, *Von der Tann* received a mere 3 hits, and *Derfflinger* emerged completely unscathed. This amounted to 42 hits on British battlecruisers and 17 on German ships, a ratio of nearly 2.5 to 1.<sup>98</sup>

In the course of the entire engagement, *Lützow* was hit approximately 24 times by large caliber shells, *Derfflinger* sustained 21 hits, *Seydlitz* was hit 22 times by main guns and once by a torpedo, and *Moltke* and *Von der Tann* were hit five and four times by heavy guns, respectively.<sup>99</sup> On the British side, *Lion* was hit by 13 large-caliber shells, *Tiger* was hit 15 times by heavy guns and four times by medium weapons, *Princess Royal* sustained 9 major hits, *Queen Mary* was hit seven times, *Indefatigable* and *Invincible* were both estimated to have taken five large-caliber hits apiece, and *New Zealand* was hit once.<sup>100</sup>

*Lützow* was the only vessel on either side to be sunk by gunfire alone, though the type of damage it sustained made it a unique case. At the head of the German battlecruiser line, and frequently targeted by multiple opponents simultaneously, *Lützow* was subjected to a terrific battering. There were five hits below the waterline in the forward section of the hull; none of the other ships on either side were severely damaged below the waterline. It was these underwater hits that doomed the vessel, though several other hits above the waterline and on the forecastle contributed to the fatal flooding.<sup>101</sup> The lack of a torpedo bulkhead in the bow and insufficient internal subdivision permitted flooding to occur unchecked. When the German navy began

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<sup>98</sup> Tarrant, op. cit., 108

<sup>99</sup> Campbell, op. cit., 355

<sup>100</sup> Campbell, op. cit., 354

<sup>101</sup> Campbell, op. cit., 356–357

rearming in the 1930s, it examined the loss of *Lützow* and determined this to be the cause of the vessel's loss. German naval designers applied this lesson to the construction of both the *Scharnhorst* and *Bismarck* class battleships.<sup>102</sup>

The loss of *Lützow* notwithstanding, their heavier armor allowed the German battlecruisers to endure much more damage than their British contemporaries. A significant portion of the major damage done to the surviving German ships happened during the charge against the British line shortly after 1900. During this period, *Derfflinger* had taken over the lead position and thus became the primary target; the ship was hit 14 times the span of approximately six minutes.<sup>103</sup> It is unlikely that the more lightly armored British battlecruisers would have been able to withstand such a tremendous hammering, even disregarding the tendency of their magazines to explode catastrophically.

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<sup>102</sup> William H. Garzke & Robert O. Dulin, *Battleships: Axis and Neutral Battleships in World War II*. (Annapolis: Naval Institute Press, 1985), 187, 289

<sup>103</sup> Campbell, op. cit., 220–226

### Chapter III: Propellant Charges

The most important issue that determined the outcome of the battlecruiser actions during the Battle of Jutland was the composition of the propellant charges for the main battery ammunition, and the manner in which it was handled. For the British heavy guns, four separate propellant charges were used for each shell fired. For the German guns, this consisted of a primary charge contained in a large brass cartridge and a smaller fore charge stored in a silk bag.<sup>104</sup> The composition of the propellant charges of both navies was directly related to the type of breech blocks fitted to the main battery guns, which were themselves a result of the international arms industry that began to flourish in the last quarter of the 19th century.

Prior to the 1880s, the Woolwich arsenal, a government arms manufacturer, supplied the Royal Navy's guns.<sup>105</sup> In the 1840s through mid-1860s, the Royal Navy experimented with large-caliber breech-loading guns, including the Armstrong and Lancaster guns.<sup>106</sup> One of the primary problems that had to be surmounted was how to obturate the breech chamber quickly and effectively. A swinging screw breech block could completely seal the breech, but it required a great deal of time to insert completely. In 1853, two Americans devised the interrupted screw system, which cut away two quarters of the screw threading. This allowed the breech block to be fully inserted; a quick quarter turn would then lock it in place. The one remaining problem was that the sections of removed threading created vents through which the propellant gas could escape, which rendered the system impractical.<sup>107</sup>

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<sup>104</sup> Staff, op. cit., 5

<sup>105</sup> William H. Macneill, *The Pursuit of Power* (Chicago: University of Chicago Press, 1984), 262

<sup>106</sup> Ian Hogg & John Batchelor, *Naval Gun* (Poole, Dorset: Blandford Press Ltd., 1978), 67–69

<sup>107</sup> Hogg & Batchelor, op. cit., 74

The Navy arrived at a short term solution to the problem by retaining muzzle-loading guns made of wrought iron, which were declared to be the standard armament for all major warships by 1864.<sup>108</sup> The ascendancy of steel breech-loading guns constructed by the German firm Krupp between the 1870s and 1880s, however, convinced the Royal Navy to switch to breech-loaders as well, which brought the obturation problem back to the surface.<sup>109</sup> The independent British firm Armstrong eventually settled on the de Bange system for sealing the breech. The de Bange system, which had been invented by a French Army captain in 1872, used an easily deformable cap in front of the breech block that would seal the breech under pressure from the detonation of the propellant charges.<sup>110</sup> The prohibitive expense of retooling the Woolwich arsenal in order to produce the new steel guns eventually led the Royal Navy to begin awarding contracts to Armstrong, which could provide the equipment at a lower cost.<sup>111</sup>

Meanwhile, in Germany, the Krupp firm experimented with a number of breech blocks starting in the 1850s. Instead of a swinging breech block, a sliding block was adopted in 1859. This fit into a mortise slot cut into the rear of the gun; the block was locked in place by a screw-threaded rod which passed through both the block and the barrel.<sup>112</sup> Krupp tested several variations on this system before deciding to use a brass cartridge case to seal the breech. By the 1880s, this system was standardized on all calibers of artillery produced by the firm.<sup>113</sup>

The xenophobic nature of the naval arms race that began between Britain and Germany in the late 1890s ensured that Armstrong would not sell its weapons to Germany; likewise Krupp would not do business with Great Britain. Moreover, the growing dominance of the French firm

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<sup>108</sup> Macneill, *op. cit.*, 265

<sup>109</sup> Macneill, *op. cit.*, 265

<sup>110</sup> Hogg & Batchelor, *op. cit.*, 75–76

<sup>111</sup> Macneill, *op. cit.*, 271–272

<sup>112</sup> Hogg & Batchelor, *op. cit.*, 74

<sup>113</sup> Hogg & Batchelor, *op. cit.*, 76

Schneider-Cruesot in the international arms market forced Krupp to focus its efforts on the German naval construction program, which would grant the company an assured source of contracts.<sup>114</sup> To help ensure that naval expansion met with increased support in the Reichstag, the German parliament, Krupp lent considerable financial support to create the German Navy League in 1898.<sup>115</sup> As the navy became more and more expensive, resistance grew within the Reichstag. Admiral Alfred von Tirpitz, the architect of the German battle fleet, needed every shred of political support he could muster;<sup>116</sup> therefore he could not consider awarding contracts for naval armaments to any firm other than Krupp.

Since the de Bange breech completely sealed the breech by itself, the propellant could be packaged in simple silk bags. The British cordite charges were stored two apiece in metal containers in the magazines. The igniters on top of the charges were protected by a thick paper cover that was removed prior to loading. Warrant Officer Grant, who was the Chief Gunner aboard HMS *Lion* after 1915, recounted in his unpublished memoirs that he found the gun crews to have repeatedly violated established safety regulations. The crews frequently removed the paper padding in the magazines, as opposed to waiting until loading; this allowed grains of propellant to leak out, which left a trail all the way from the gun turrets to the magazines. The charges were stacked by the dozens in the walkways of the magazine and in the handling rooms, where doors were left wide open during battle. All of these practices were developed in order to increase the rate of fire of the main guns, a priority Admiral Beatty emphasized after the Battle of Dogger Bank.<sup>117</sup> Grant noted that the turret commanders were well aware of these practices

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<sup>114</sup> Macneill, op. cit., 301–302

<sup>115</sup> Macneill, op. cit., 304

<sup>116</sup> Herwig, op. cit., 91

<sup>117</sup> Burr, op. cit., 41

and generally condoned them.<sup>118</sup> Grant reintroduced safety precautions to his gun crews, though his changes were not mirrored by the other ships in the squadron. Among the most important steps taken was the order to keep the magazine doors closed except when ammunition was passed through.<sup>119</sup>

The Royal Navy was dominated by a mindset that emphasized rapidity of fire. Vice Admiral Stanley Colville, commander of the 1st Battle Squadron, argued that, "rapid and sustained fire...is essential. The danger of the charges being ignited...may be disregarded."<sup>120</sup> Vice Admiral George Warrender, the 2nd Battle Squadron commander, concurred: "It is considered more important to have the ammunition provided and ready for immediate use and to risk the chance of a cordite fire, rather than to guard against a fire, and to have the ship unprepared for an attack."<sup>121</sup> Admiral Jellicoe's chief of staff, Rear Admiral Charles Madden, stated, "the risk of the explosion of stacked ammunition is secondary to maintaining a rapid fire."<sup>122</sup> At the Battle of the Falkland Islands in December 1914, the British armored cruiser HMS *Kent* was nearly destroyed by an ammunition fire. As a result, the Admiralty issued an order that forbade the stockpiling of ammunition outside of the magazines, although the directive was largely ignored in the fleet.<sup>123</sup> Commander Hubert Dannreuther, a gunnery officer from *Invincible* who had survived the destruction of the ship at Jutland, later confirmed to the Third Sea Lord that the gun crews aboard the ship continued to practice ammunition stockpiling.<sup>124</sup>

The Germans stored their main propellant charges in large brass cartridges equipped with protective metal covers. Smaller fore charges were kept in silk bags and stored in metal cases.

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<sup>118</sup> Lambert, op. cit., 43

<sup>119</sup> Burr, op. cit., p. 42

<sup>120</sup> Lambert, op. cit., 38

<sup>121</sup> Lambert, op. cit., 38

<sup>122</sup> Lambert, op. cit., 38

<sup>123</sup> Lambert, op. cit., 39

<sup>124</sup> Lambert, op. cit., 44

These characteristics rendered the German charges less prone to ammunition fires. As in the British ships, before the Battle of Dogger Bank, German gun crews were prone to breach safety regulations and remove the covers from the main charges.<sup>125</sup> A door that connected the ammunition handling rooms for the superfiring rear turrets was normally kept closed, but at Dogger Bank it was left open.<sup>126</sup>

The Germans, however, had taken a hard lesson from Dogger Bank, where the battlecruiser SMS *Seydlitz* was severely damaged by a flash fire in the rear ammunition magazine. During this battle, a large-caliber shell struck the rearmost barbette and dislodged a section of armor plate that started a fire inside the turret. More than six and a half tons of propellant burned in a matter of seconds; only the quick order to flood the rear magazines saved the ship. A subsequent investigation discovered that only the brass cartridges that had their lids still on did not burn.<sup>127</sup> The investigators issued a report that called for a number of new safety precautions. Among these was a mandate that the fore charges could not be removed from their metal containers and the main charges were to be safeguarded until they were both to be loaded. Also, propellant was not to be piled up in the turrets and the ammunition hoists were to be equipped with automatically-closing doors.<sup>128</sup> Of these recommendations, the primary steps adopted were to reduce the number of propellant charges in the turrets and limit the number of charges that could be removed from their containers. Anti-flash doors, however, were not installed in any of the ships, except *Lützow*, at the time of the battle.<sup>129</sup>

Another important difference between the propellant charges was their chemical compositions. Both charges relied primarily on nitrocellulose for their explosive power;

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<sup>125</sup> Staff, op. cit., 43

<sup>126</sup> Tarrant, op. cit., 39

<sup>127</sup> Staff, op. cit., 43

<sup>128</sup> Staff, op. cit., 43

<sup>129</sup> Campbell, op. cit., 374

problematically, nitrocellulose degraded over time and in the process became increasingly unstable.<sup>130</sup> In 1903, decomposed nitrocellulose in propellant charges aboard the German cruiser *Vineta* exploded. The navy subsequently held an inquiry that discovered the cause of the accident.<sup>131</sup> The navy therefore developed a new propellant formula that added a stabilizer to the nitrocellulose that significantly reduced the tendency toward decomposition, something the British failed to do.<sup>132</sup>

British propellant was shaped into cylindrical cords, while German propellant consisted of tubular grains. The grains provided a smaller initial surface area per pound of explosive than did the cords, which caused them to burn slower.<sup>133</sup> Of all of the differences between British and German charges, this proved to be the most fatal. Combined with the relaxed handling of the charges and their fragile silk containers, the much faster burn rate caused the exposed charges to explode rather than simply burn. The German brass cartridges were less prone to catch fire, and when they did, they did not explode.<sup>134</sup>

The differences between German and British propellant charges constituted the crucial factor that determined the outcome of the engagement. Indeed, both *Derfflinger* and *Seydlitz* suffered serious turret and barbette hits in the course of the battle, though neither ship exploded from an ammunition fire as the British ships had. In reference to a serious hit sustained during the charge against the British battle line after 1900, Georg von Hase, the gunnery officer aboard *Derfflinger*, later remarked:

"At [1913]...a 15-inch shell pierced the armor of 'Caesar' turret and exploded inside...the shell set on fire two charges in the turret, The flames from the burning charges spread to

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<sup>130</sup> Campbell, op. cit., 377

<sup>131</sup> Campbell, op. cit., 370

<sup>132</sup> Campbell, op. cit., 377

<sup>133</sup> Campbell, op. cit., 377

<sup>134</sup> Campbell, op. cit., 378

the transfer chamber, there [they] set fire to four more charges, and from there to the magazine, where four more were ignited. The burning cartridge cases emitted great tongues of flame which shot up out of the turrets...but they only blazed, they did not explode as had been the case in the enemy battlecruisers. This saved the ship..."<sup>135</sup>

British naval historian John Campbell concurred, arguing that "If British propellant charges had been used in the German ships, the *Derfflinger* would certainly have blown up as would in all probability the *Seydlitz*, and possibly the *Von der Tann*."<sup>136</sup>

Although the British charges were much more prone to catastrophic fires, proper handling could have mitigated this danger to a degree. John Campbell stated that the hit *Lützow* scored on *Lion*'s "Q" turret at 1600 would have destroyed the ship had her magazine doors not been shut.<sup>137</sup> The safety precautions put in place by Warrant Officer Grant after he arrived in 1915 in all likelihood saved the ship. Had the crews of the rest of the battlecruisers followed similar procedures, their ships might not have been destroyed.

The British Navy, however, failed to adequately absorb the lessons from the destruction of the three battlecruisers sunk at Jutland. Initial investigations, both by Beatty and by the Admiralty, discovered that improper cordite handling was to blame for the severe losses on 31 May.<sup>138</sup> As time passed, however, both Beatty and Admiral John Jellicoe, the Grand Fleet commander, altered their positions. Instead of crew negligence, they blamed the loss of *Queen Mary*, *Indefatigable*, and *Invincible* on insufficient armor protection and poor anti-flash systems in the gun turrets.<sup>139</sup> On 14 July 1916, Beatty sent a letter to Jellicoe insisting that, "either our methods of ship construction are seriously at fault or that the nature of the ammunition we use is

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<sup>135</sup> Tarrant, op. cit., 178

<sup>136</sup> Tarrant, op. cit., 380

<sup>137</sup> Campbell, op. cit., 378

<sup>138</sup> Lambert, op. cit., 47

<sup>139</sup> Lambert, op. cit., 48

not sufficiently stable to ensure safety."<sup>140</sup> The Admiralty protested these remarks and continued to insist that improper handling techniques were to blame. Jellicoe, however, was promoted to 1st Sea Lord on 28 November 1916. In this position, he was able to effectively suppress the findings of the Admiralty investigation and replace it with the explanation he and Beatty favored.<sup>141</sup> He deleted the memorandum that the Director of Naval Construction had written on the loss of the three battlecruisers, stating, "the memorandum should certainly not be issued—it does not at all represent the views of officers at sea and I do not agree with it."<sup>142</sup> Despite the insistence that unsafe propellant was not to blame for the disaster, in April 1917, the Royal Navy formulated a new version of cordite, which included a chalk-based stabilizer.<sup>143</sup> As tests would show in 1945, however, it was still not up to the standards of safety reached by the propellants of other navies.

The Battle of Jutland was not the last engagement that saw a British battlecruiser explode catastrophically at the hands of a German capital ship. On 24 May 1941, during World War II, the German battleship *Bismarck* and the heavy cruiser *Prinz Eugen* engaged the British battleship *Prince of Wales* and the battlecruiser *Hood*. In the span of approximately five minutes, *Bismarck's* 15-inch guns fired five salvos, the fifth of which struck *Hood* and penetrated the ship's belt armor into one of the aft magazines where it detonated; *Hood* exploded and quickly sank.<sup>144</sup>

That is, at least, the official version of events according to the Royal Navy inquiries held in the aftermath of the sinking. A number of other theories have been proposed for the sinking,

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<sup>140</sup> Lambert, op. cit., 49

<sup>141</sup> Lambert, op. cit., 50–52

<sup>142</sup> Lambert, op. cit., 52

<sup>143</sup> John Campbell, "Technical Topics No5" *Warship* 2 (1978): 139.

<sup>144</sup> David J. Bercusson and Holger H. Herwig, *The Destruction of the Bismarck*. (New York: The Overlook Press, 2003), 151–153

including that the fire started on the boat deck by an 8-inch shell from *Prinz Eugen* spread to a magazine and ignited the propellant charges, or that one of *Bismarck's* shells fell short but turned upwards and penetrated the ship's side below the armor belt.<sup>145</sup> After thoroughly examining the evidence, naval historian William Jurens concluded that the official explanation was the most probable.<sup>146</sup> He argued that the nature of the British propellant was to blame, pointing to tests conducted by the United States Navy Bureau of Ordnance in 1945. These tests examined the conditions under which propellant charges would ignite. A nozzle was designed to replicate the flash produced by the simultaneous detonation of several propellant charges. The Bureau of Ordnance discovered that the British double base cordite would catch fire when placed 530 millimeters from the nozzle, while the standard American single base charges would not burn unless they were within 120 millimeters. A new American "SPCG" flashless propellant had to be placed closer than 25 millimeters for it to ignite.<sup>147</sup> In practical terms, an explosion in a British magazine would detonate nearly 75 times as much propellant as the same explosion in an American magazine. Jurens concludes from this evidence that, "had *Hood* carried single base propellant instead of cordite, there is in fact a good possibility that the fatal explosion might never had occurred."<sup>148</sup>

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<sup>145</sup> W. J. Jurens, "The Loss of H.M.S. Hood—A Re-examination." *Warship International* XXIV, No. 2 (1987): 151-154.

<sup>146</sup> Jurens, op. cit., 155

<sup>147</sup> Jurens, op. cit., 151

<sup>148</sup> Jurens, op. cit., 152

### Conclusion

Admiral David Beatty has been both criticized and praised for his handling of the British battlecruiser squadrons at the Battle of Jutland. The battlecruiser force under Beatty's command was severely mauled during the engagement; three of his nine vessels were destroyed by German gunfire, and a fourth—his flagship *Lion*—nearly exploded as well. Ultimately, to a large extent Beatty can be blamed for the disaster. While the proximate cause of the explosions aboard the British ships was the highly unstable and poorly protected propellant charges—something entirely out of Beatty's control—he failed to ensure safety precautions in the magazine rooms were being followed. Furthermore, his own directives concerning the rate of fire of the main battery were the cause for the discontinuation of many of these safety procedures. The failure to enforce proper handling procedures virtually guaranteed catastrophic magazine explosions would occur. This was clearly demonstrated by the incident aboard his flagship *Lion*; the fact that the magazine doors had been closed—a practice implemented only on this ship—when the turret was penetrated allowed the crew enough time to flood the magazine, which prevented the ship from being destroyed.

Despite the seemingly overwhelming superiority of the British Battlecruiser Squadrons, in terms of numbers of warships and the number, caliber, and weight of shell of their guns, their German opponents emerged from the battle having inflicted much more destruction than they had absorbed. The German battlecruisers did enjoy several advantages over their British rivals; their heavier armor allowed them to stand up to more punishing fire. Their more highly-trained gun crews were on average more capable of dealing damage, even without the aid of a mechanical fire control system comparable to the Dreyer Table or Argo Clock on the British

ships. A still-greater advantage was the superior performance of the German armor-piercing shells compared to the British versions.

In the end, however, the performance of the ships' armaments and ammunition, fire control, and armor systems was of secondary importance. The deciding factor that led to the loss of three British battlecruisers at the hands of their German rivals was the physical differences in both sides' propellant charges and how they were handled. Both German and British battlecruisers had their turrets and barbettes penetrated and the ammunition inside ignited, though only the British ships suffered catastrophic explosions as a result. This was the direct consequence of the greater vulnerability and much faster burn rate of the British propellant and the unsafe manner in which it was handled. *Indefatigable*, *Queen Mary*, and *Invincible* might very well have survived the battle if their crews had followed the prescribed safety regulations for the handling of cordite.

### Appendix I: The Battle of Dogger Bank

The Battle of Dogger Bank was fought on 24 January 1915, between the battlecruiser forces of Rear Admiral Franz von Hipper and Vice Admiral David Beatty. The German forces intended to sweep the Dogger Bank, a shallow area in the North Sea, where British light forces were known to operate. The German forces consisted of Hipper's flagship *Seydlitz*, *Moltke*, *Derfflinger*, and the large armored cruiser *Blücher*; the battlecruiser *Von der Tann* was unavailable due to periodic maintenance requirements. Hipper was supported by four light cruisers and 19 torpedo boats. Arrayed against him were the 1st and 2nd Battlecruiser Squadrons, which comprised the battlecruisers *Lion*, Beatty's flagship, *Tiger*, *Queen Mary*, *Indomitable*, and *New Zealand*.<sup>149</sup> The ability to intercept and decrypt German wireless signals forewarned the British of the impending operation, so Admiral Beatty was able to ambush the German battlecruisers.

Both forces left their respective anchorages on the afternoon of 23 January and proceeded to the Dogger Bank, which they reached the following morning.<sup>150</sup> Shortly after 0700, the opposing forces encountered each other. Upon observing Beatty's battlecruisers approaching, Hipper decided to turn for port, in the assumption that the Grand Fleet was in the area as well.<sup>151</sup> The German ships were limited to a speed of 23 knots due to poor-quality coal and mechanical difficulties;<sup>152</sup> the British ships, meanwhile, were capable of 27 knots. In less than two hours, the British had closed the distance and began to enter effective gunnery range. *Lion*, the leading British ship, opened fire on *Blücher*, the rearmost German vessel. As more British ships came into range, they concentrated their fire on *Blücher*, scoring several major hits in the process. By

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<sup>149</sup> Tarrant, op. cit., 36

<sup>150</sup> Tarrant, op. cit., 36–37

<sup>151</sup> Tarrant, op. cit., 38

<sup>152</sup> Tobias R. Philbin III, *Admiral von Hipper: The Inconvenient Hero* (Amsterdam: Grüner, 1982), 110

0935, the four leading British ships had come into range, so Beatty ordered a distribution of fire against the four German ships. However, confusion onboard *Tiger* led to that ship engaging *Seydlitz* instead of *Moltke*, as had been intended. This allowed the latter to fire on the British without interference by return gunfire.<sup>153</sup> Shortly thereafter, *Lion* scored a serious hit on *Seydlitz*; a 13.5-inch shell penetrated the rearmost barbette and exploded inside. Most of the propellant charges caught fire, which rapidly spread into the adjacent turret through an open connecting door. The fire burned out both turrets and killed the majority of their crews. The magazines were flooded to prevent an ammunition explosion.<sup>154</sup>

Some twenty minutes later, *Seydlitz* and *Derfflinger* concentrated their fire on *Lion* and scored several hits that put the vessel out of action. An 11-inch shell from *Seydlitz* knocked out two of *Lion*'s three generators, while a pair of 12-inch shells from *Derfflinger* struck *Lion* at the waterline and disabled the port engine. At 10:48, *Indomitable* finally came into range; Beatty ordered it to finish off the battered *Blücher*, while he intended to continue pursuing the three German battlecruisers. To his consternation, *Lion*'s last generator failed, its speed dropped to 15 knots, and it rapidly began to fall behind; in an attempt to regain control over the situation, Beatty hoisted the signal "Engage the enemy's rear." The signal "Course north-east" still flew on *Lion*'s masthead, which confused Rear Admiral Moore, who interpreted it to mean he should concentrate on *Blücher*.<sup>155</sup> This allowed Hipper and his three battlecruisers to escape, though at the cost of having to sacrifice *Blücher*.<sup>156</sup>

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<sup>153</sup> Tarrant, op. cit., 38–39

<sup>154</sup> Tarrant, op. cit., 39–40

<sup>155</sup> Tarrant, op. cit., 41

<sup>156</sup> Tarrant, op. cit., 42

## Appendix II: Shell deficiencies

Throughout the course of the Battle of Jutland, armor-piercing large-caliber British shells struck the heavy armor of the surviving German battlecruisers twelve times.<sup>157</sup> Of these twelve hits, eight were 12-inch shells and four were 15-inch shells; only one of the twelve—a 15-inch hit on *Derfflinger's* 10.25-inch barbette armor at a range of 9,000 yards—managed to penetrate the heavy armor. This was to a limited extent a result of the thickness of the German armor: as ranges increase, the penetrative abilities of shells decrease. The primary reason British shells failed to function properly was the poor quality of the armor-piercing (AP) shells.

*Seydlitz* was hit three times in the 12-inch thick belt armor by 12-inch shells, at ranges of between 9,500 and 11,000 yards; the first broke up on impact and the other two exploded prematurely. The latter two holed the armor but their effects were largely outside of the ship. The 10-inch thick armor on one of *Seydlitz's* main battery turrets was also struck by a 15-inch shell at 19,000 yards; this shell burst on impact, and though it did hole the armor, its explosive effects were mostly kept out of the turret. *Moltke* was hit twice on the 10.75-inch belt armor by 15-inch shells at a range of 15,500 and 16,500 yards. Both shells failed to penetrate and instead exploded on contact with the ship. *Derfflinger* was hit six times: two hits on the 12-inch belt armor, one on the 12-inch conning tower armor, twice on the 10-inch side armor, and the previously mentioned hit on the barbette. These hits occurred at ranges between 8,500 and 12,500 yards. The two belt hits exploded on contact with minimal effect; the conning tower hit either shattered or exploded on impact without result, and the two hits on side armor failed to perform satisfactorily. There

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<sup>157</sup> Because *Lützow* was sunk, the effects of the hits made on the ship cannot be examined.

was a thirteenth shell hit on the 14-inch belt armor of the battleship *Grosser Kurfürst*, though it too exploded on impact without holing the armor.<sup>158</sup>

Two of the 12-inch shells—the conning tower hit on *Derfflinger* and the second hit on *Seydlitz*'s main belt—hit their targets at ranges beyond those at which they could be expected to defeat the thickness of armor they struck. Although the other two hits on *Seydlitz*'s belt failed to pierce the armor, they performed well, given that they too struck on the upper limits of their penetrative capabilities.<sup>159</sup> The rest of the British shells were within their capabilities. The failure of the 15-inch shell that struck *Seydlitz*'s starboard wing turret is particularly indicative of the problematic nature of British armor-piercing shells.

The problem with British shells is even more clearly demonstrated by the hits made on the thinner 6 to 9 inch medium armor. There were seventeen large-caliber hits on German medium armor; one 13.5-inch projectile was deflected and two shells—one 12-inch and one 15-inch—both hit obliquely and shattered on impact. Eleven hits detonated without fully penetrating the armor; five of these burst outside the plate and six exploded after partially penetrating. The effects of the former group were completely outside the ships, while the latter group holed the armor with limited effects inside the ships. The last three shells blew up after partially penetrating, with most of their effects inside. Only three of the seventeen hits—a pair of 13.5-inch shells and a 15-inch projectile effectively penetrated the medium armor and exploded inside.<sup>160</sup>

Tests conducted by the Royal Navy in 1914 before the outbreak of war demonstrated the failings of the British armor-piercing shells. The Royal Navy found during the tests that the AP

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<sup>158</sup> Campbell, op. cit., 386–387

<sup>159</sup> Campbell, op. cit., 386–387

<sup>160</sup> Campbell, op. cit., 387

shells could not reliably penetrate heavy armor, even at close ranges where the angle of impact was nearly head-on. At long ranges, where the angle of impact neared 30 degrees from normal, the AP shells were prone to disintegration on even 6 to 8 inch plating. However, the tests did not reveal that this tendency occurred at even lower angles of impact.<sup>161</sup> The fragility of British shells was compounded by the use of lyddite as the detonator. The lyddite bursters frequently detonated on or shortly after impact from the concussion effect of striking armor plate; this prevented the shells from penetrating as intended.<sup>162</sup> Inexplicably, the Royal Navy failed to address these deficiencies until after Jutland.

German shells, in contrast, were much more effective. There was only one hit on British heavy armor, by an 11-inch shell from *Von der Tann* on the belt of the battleship *Barham*. The shell failed to penetrate, but the hit was made at a range of approximately 17,000 yards, well outside of the performance envelope for a shell of that caliber.<sup>163</sup> Four hits were made on 9-inch armor in surviving British ships: a 12-inch shell that pierced one of *Princess Royal's* main battery barbettes, a 12-inch shell that destroyed *Lion's* "Q" turret, an 11-inch shell from *Moltke* that penetrated *Tiger's* "X" barbette, and another 11-inch shell that hit *Tiger's* belt but failed to pierce the armor, though this last hit may have been at too great a range. The hit on *Tiger's* "X" barbette was an example of exceptional performance, as the hit was made at a range of around 13,500 yards, which was near the theoretical limit for an 11-inch shell to penetrate this thickness of armor.<sup>164</sup> British 7–8 inch armor was hit three times; armor of this thickness was penetrated by a 12-inch shell, holed but not fully pierced by an 11-inch shell, while another 11-inch shell was

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<sup>161</sup> Campbell, op. cit., 385

<sup>162</sup> Halpern, op. cit., 328

<sup>163</sup> Campbell, op. cit., 384

<sup>164</sup> Campbell, op. cit., 384–385

ineffective. There were ten hits on 6-inch armor, of which six—four 12-inch and two 11-inch shells—penetrated, and four—three 12-inch and one 11-inch—did not.<sup>165</sup>

The tendency of British shells to either break up on impact or explode prematurely pushed the balance of power even further in favor of their German rivals. Due to the comparative lack of gunnery training, the British ships were much less accurate than their German opponents. When the fragile and unstable British shells did hit, they were much less likely to deal serious damage. The German shells, on the other hand, performed quite well, even at the upper limits of their penetrative capabilities.

The deficiency of the British shells was compounded by the differences in the propellant charges and the manner in which they were handled by both sides. The practice of storing as many shells and charges as possible in the gun turrets of British battlecruisers, coupled with the fact that the propellant charges were stored in highly flammable silk bags, effectively turned the turrets into powder kegs waiting for an errant flame. Conversely, propellant charges aboard German warships were stored in brass cartridges, which were much more resistant to flash fires. This resilience, along with the German practice to avoid over-filling their main batteries with ammunition, rendered the German battlecruisers less prone to catastrophic ammunition fires. As a result, the more effective German shells could quickly cause fatal damage to their targets; this heavily advantaged the German fleet, and all but ensured the lopsided outcome of the battlecruiser engagements.

Following the Battle of Jutland, the Royal Navy examined the AP shells and discovered the deficiencies in the lyddite bursters. By the summer of 1918, new, more effective "greenboy"

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<sup>165</sup> Campbell, *op. cit.*, 385

rounds were delivered to the fleet. The new fuse installed in these shells used a mixture of 60 percent lyddite and 40 percent dinitrophenol (DNP), known as shellite, which provided a much more stable detonator.<sup>166</sup> When the German fleet was scuttled in 1919, the battleship *Baden* was the only capital ship the Royal Navy managed to beach and prevent from sinking. In 1921, the ship was expended as a gunnery target after a pair of tests that examined new versions of the shellite-filled 15-inch AP rounds.<sup>167</sup> The majority of the shells were fitted with a fuse composed of a mixture of 70 percent lyddite and 30 percent DNP.<sup>168</sup>

The first test took place on 2 February 1921; the monitor HMS *Terror* fired seventeen 15-inch shells into the ship. Of these, five were Common Piercing, Capped (CPC), ten were AP, and two were Semi-Armor Piercing, Capped (SAPC); all of the AP and SAPC shells used the new 70/30 mixture of shellite.<sup>169</sup> The 10-inch thick main belt was hit twice, both by AP shells. The fuze detonated prematurely in the first instance, which allowed the torpedo bulkhead to absorb the explosion. The second penetrated the armor and caused significant damage inside the ship. *Baden's* gun turrets and barbettes were targeted as well; an AP shell penetrated the forward superfiring turret, while a SAPC failed to do so. Two CPC shells were fired at this turret: one holed the roof but failed to penetrate completely, while the other burst on the barbette. The rear superfiring turret was hit three times on the roof, by two AP and one CPC shells. All three failed to penetrate, though an AP shell penetrated the barbette. An AP shell burst on the conning tower without penetrating the heavy armor. The remainder of the shells were fired at medium armor, all of which caused significant explosion damage.<sup>170</sup> From this test, the Royal Navy concluded that

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<sup>166</sup> William Schleihauf, "The Baden Trials" in Preston, Anthony. *Warship 2007*. (Annapolis: Naval Institute Press), 83

<sup>167</sup> Schleihauf, op. cit., 81

<sup>168</sup> Schleihauf, op. cit., 83

<sup>169</sup> Schleihauf, op. cit., 84

<sup>170</sup> Schleihauf, op. cit., 83

the AP shells were satisfactory, while the CPC shells should be reserved for lightly armored targets.<sup>171</sup>

A second round of tests was conducted on 10 August 1921, during which fourteen 15-inch shells were fired. These included new versions of the CPC shells, which incorporated the new 70/30 shellite detonator. The test was designed to examine the efficiency of the three types of shells against less well-protected areas of the ship, so most of these shells were fired at the ship's superstructure. One AP shell did hit the thickest section, however—13.25 inches deep—of belt armor. This shell failed to penetrate and exploded on impact.<sup>172</sup> The Admiralty concluded after both tests that the new AP shell was satisfactory, while the SAPC shell should be abandoned, since it had no real advantage over the AP shell.<sup>173</sup>

These AP shells were then put into production for the fleet.<sup>174</sup> In the few surface engagements fought by British capital ships during World War II, these shells performed markedly better than their predecessors had at Jutland. British battleships engaged German heavy units twice during the war: the interception and sinking of the *Bismarck* in May 1941 and the Battle of North Cape on 26 November 1943. Two surface battles also took place in the Mediterranean: the Battle of Calabria on 9 July 1940 and the Battle of Cape Matapan on 27–29 March 1941. The new British armor-piercing shells allowed the Royal Navy to silence two powerful German commerce raiders and establish dominance in the Mediterranean.

Two British battleships, the 16-inch armed *Rodney* and the 14-inch gunned *King George V* engaged the German battleship *Bismarck*. During the battle, *Bismarck* had its two forward gun

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<sup>171</sup> Schleihau, op. cit., 84

<sup>172</sup> Schleihau, op. cit., 86–87

<sup>173</sup> Schleihau, op. cit., 88

<sup>174</sup> D. K. Brown, *Nelson to Vanguard: Warship Design and Development 1923–1945* (Annapolis: Naval Institute Press, 2000), 19–20

turrets destroyed by 16-inch shells from *Rodney*, and a third shell, from either *Rodney* or *King George V* struck the rear superfiring turret and disabled it. Shells from the two British battleships wreaked havoc on the German ship, though only one 16-inch shell penetrated the vessel's 13-inch thick belt armor.<sup>175</sup> This was due to the fact that the British ships had closed the range significantly; the short range flattened the trajectories of the shells and caused many of them to bounce on the surface of the water before striking *Bismarck*.<sup>176</sup> The engagement between the battleships *Duke of York* and *Scharnhorst* in December 1943 produced similar results. A 14-inch shell from *Duke of York* disabled *Scharnhorst*'s forward-most turret; another shell penetrated *Scharnhorst*'s thinner upper belt and exploded in a boiler room, which significantly reduced the ship's speed and contributed to its eventual sinking.<sup>177</sup>

At the Battle of Calabria, the battleships *Warspite* and *Malaya*, veterans of Jutland from the 5th Battle Squadron, engaged the Italian battleships *Giulio Cesare* and *Conte di Cavour*. *Warspite* scored one hit with its 15-inch guns on *Giulio Cesare*, which reduced the latter's speed to 18 knots. This prompted the Italian withdrawal, which permitted the safe passage of several British convoys to Alexandria.<sup>178</sup> A year later, in March 1941, *Warspite*, *Barham*, and *Valiant* attacked two Italian cruisers in ferocious night fighting at the Battle of Cape Matapan. The battleships' 15-inch rounds shattered the Italian cruisers, which were then left to be finished off by British destroyers. This action further pushed the balance of power in the Mediterranean in favor of the British.<sup>179</sup>

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<sup>175</sup> Garzke & Dulin, op. cit., 240–241

<sup>176</sup> Garzke & Dulin, op. cit., 243

<sup>177</sup> Garzke & Dulin, op. cit., 171–172

<sup>178</sup> Bernard Ireland, *The War in the Mediterranean*. (Annapolis: Naval Institute Press, 2004), 36–38

<sup>179</sup> Ireland, op. cit., 75–79

### Appendix III: Long-range gunnery

The British shooting in the initial phase of Jutland was atrocious. Visibility did indeed favor the Germans during the run to the south and the subsequent turn north, but poor visibility for the British during this segment of the engagement is not a valid explanation for the bad performance of Beatty's gunners on its own. This is clearly evident, as the gunners of the British 5th Battle Squadron achieved much better results under nearly identical conditions.<sup>180</sup> Much debate also has been made over the decision to adopt the Dreyer system over the Argo developed by Arthur Pollen, but this dispute isn't as important as Jon Tetsuro Sumida, a critic of the Dreyer tables, and others suggest.<sup>181</sup> The British battlecruisers' poor shooting resulted primarily from inadequate training of the crew, not the gun-laying equipment they used or the conditions in which it was operated.

This situation is best illustrated by examining and comparing the three British battlecruiser squadrons. The squadrons were stationed in Rosyth, which had no areas suitable to conduct long-range gunnery training.<sup>182</sup> Indeed, by the outbreak of World War I, little work had been done to ready the location as a major fleet anchorage.<sup>183</sup> After the poor showing at the Battle of Dogger Bank in January 1915, the Royal Navy decided to rotate the squadrons through the main naval base at Scapa Flow, which did have long-range firing ranges.<sup>184</sup>

In the six months prior to Jutland, the three battlecruiser squadrons only managed to complete one rotation apiece to Scapa Flow;<sup>185</sup> indeed, when the Royal Navy deployed to meet

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<sup>180</sup> Campbell, op. cit., 354

<sup>181</sup> This issue is too complex to completely cover in this work; John Brook's *Dreadnought Gunnery and the Battle of Jutland* represents the pro-Dreyer argument, while Jon Tetsuro Sumida criticizes the Dreyer system in his essay "Gunnery, Procurement, and Strategy in the *Dreadnought* Era," among other of his works, including *The Pollen Papers*.

<sup>182</sup> Lambert, op. cit., 42

<sup>183</sup> Halpern, op. cit., 10

<sup>184</sup> Burr, op. cit., p. 41

<sup>185</sup> Burr, op. cit., p. 41

the Germans, the 3rd Battlecruiser Squadron was still temporarily assigned to the Grand Fleet to conduct its gunnery practice.<sup>186</sup> Conversely, the Germans regularly detached ships from the High Seas Fleet to conduct gunnery training. The ships needed only make the short journey from their North Sea bases to Brunsbüttel and then pass through the Kaiser Wilhelm Canal to Kiel to utilize the gunnery ranges established there.<sup>187</sup>

For those ships that remained in Rosyth, the only training afforded the gun crews was speed-loading exercises. This was another practice that Beatty implemented after Dogger Bank. The training emphasized rapidity of fire, which Beatty felt had been insufficient compared to his German opponents at Dogger Bank. Speed-loading directed the crews to store as many shells and propellant charges as possible in the gun turrets in order to increase the rate of fire, instead of keeping them in the armored magazines.<sup>188</sup>

At the end of 1915, Admiral Jellicoe, concerned over the recent poor gunnery performance of the battlecruiser squadron that had just rotated through Scapa Flow, wrote to Beatty to address the issue. They agreed that the problem lay with the lack of practice of the fire control personnel, and in particular the range-finder operators. Indeed, the performance of HMS *Tiger* was so abysmal during its round of gunnery training that her captain was censured.<sup>189</sup> Jellicoe cautioned Beatty to focus on improving accuracy instead of rate of fire, stating that, "the rapidity idea was carried to excess."<sup>190</sup> Beatty replied that he intended to use the next rotation

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<sup>186</sup> Burr, op. cit., p. 34

<sup>187</sup> Richard Stumpf, Horn, Daniel. ed. *War, Mutiny and Revolution in the German Navy: The World War I Diary of Seaman Richard Stumpf* (New Brunswick, New Jersey: Rutgers University Press, 1967), 70–71

<sup>188</sup> Burr, op. cit., p. 41

<sup>189</sup> Lambert, op. cit., 43

<sup>190</sup> Lambert, op. cit., 42

through Scapa Flow to practice firing drills even faster, arguing that, "concentration is a luxury—whereas rapidity is the life and death matter."<sup>191</sup>

The arrival of Rear Admiral Horace Hood's three *Invincible* class ships of the 3rd Battlecruiser Squadron later in the Battle of Jutland dramatically improved the performance of the British battlecruisers. The three ships entered the battle from the northeast, with their German opponents to the west-southwest.<sup>192</sup> The combatants were then in opposite positions vis a vis the setting sun: it was the Germans' turn to be silhouetted against the horizon while the three British ships were obscured in the gathering darkness.<sup>193</sup> At around the same time, visibility for the Germans in the direction of Beatty's forces had significantly declined. Kapitän zur See von Egidy, the commanding officer aboard *Seydlitz*, later stated, "visibility had gradually become very unfavorable. There was a dense mist, so that as a rule only the flashes of the enemy's guns, but not the ships themselves, could be seen."<sup>194</sup> Even still, the exchange of hits between the British and German forces merely broke even. Including both the German High Seas Fleet and the British 5th Battle Squadron, the Germans scored 18 hits, while the British made 19. Of these, 11 of the German hits were made by Hipper's battlecruisers, while only one was scored by Beatty's battlecruisers.<sup>195</sup>

Over the course of the entire battle, the 1st and 2nd Squadrons scored hits with only 1.43 percent of the heavy-caliber shells they fired,<sup>196</sup> the worst of which was HMS *New Zealand*, which managed only two or three hits out of 422 shells fired, which amounted to at best .7 percent.<sup>197</sup> In contrast, the 3rd Squadron achieved 4.29 percent hits, the best sustained

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<sup>191</sup> Lambert, op. cit., 42

<sup>192</sup> Tarrant, op. cit., 120

<sup>193</sup> Tarrant, op. cit., 122

<sup>194</sup> Tarrant, op. cit., 122

<sup>195</sup> Tarrant, op. cit., 122–123

<sup>196</sup> Campbell, op. cit., 355

<sup>197</sup> Lambert, op. cit., 46

performance by any unit in the Grand Fleet.<sup>198</sup> While the favorable visibility conditions certainly did play a role, it was at most a contributing issue, not the central factor of the long-range gunnery question. Likewise, though the choice of fire directing equipment unquestionably had a role in determining the efficiency of Beatty's ships, it was not as critical as many would suggest. All three ships of the 3rd Squadron were equipped with Dreyer tables, as were the rest of Beatty's ships, with the exception of *Queen Mary*, which had an Argo Clock Mark IV.<sup>199</sup> It is important to note that *Queen Mary* had the highest accuracy of shot of the six ships assigned to Beatty, up until it was destroyed.<sup>200</sup> Regardless, it was the Dreyer-equipped *Invincible* that sank *Lützow*, the only capital ship sunk by heavy-caliber gunfire alone in the course of the battle.<sup>201</sup>

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<sup>198</sup> Campbell, op. cit., 355

<sup>199</sup> Halpern, op. cit., 328

<sup>200</sup> Halpern, op. cit., 328

<sup>201</sup> All of the other capital ships sunk during the battle were destroyed by magazine explosions; this includes the battlecruisers *Indefatigable*, *Queen Mary*, and *Invincible*, and the German pre-dreadnought *Pommern*.

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