



## Intellectual property and national security: the case of the hardcastle superheater, 1905–1927

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### ABSTRACT

This article explores the complex and changing relationship between technological development, intellectual property, and national security in late Victorian and Edwardian Britain. Its specific case study concerns an important invention developed by a naval officer. Technological innovations not only were vital to British security but also embodied commercially valuable intellectual property. The state's interest in acquiring control of the intellectual property to maintain Britain's naval supremacy was not automatically aligned with the interests of inventors. The alignment was especially fraught in the case of service inventors—that is, inventors in government service, rather than in the private sector. Service inventors, who played a crucial role in maintaining Britain's naval-technological edge, were governed by special regulations, and they invariably utilized state resources for their inventive work. Exploring these issues sheds important light on the attitude of the British state toward innovation and technological development from the 1850s through the 1920s.

### KEYWORDS

Intellectual property;  
national security; invention;  
innovation

### Introduction

One of the most important innovations in British naval technology in the decades before World War I was a torpedo propulsion system. It was developed by a British naval officer named Sydney Undercliffe Hardcastle. The Hardcastle 'superheater', as it was known, was among the last major technological breakthroughs to be principally the work of one person rather than a development team. The significance of this device went well beyond the realm of naval weaponry. It does not go too far to say that at the dawn of the dreadnought era, that seeming apotheosis of centuries of development toward ever more lethal and costly battleships, his invention threatened to revolutionize the metrics of naval power. By more than doubling the range of all existing torpedoes in the Navy's arsenal, the Hardcastle superheater took these weapons out beyond the effective maximum range of the big guns. The possibility that small, cheap torpedo craft could sink battleships from outside the latter's effective gun range called the viability of the capital ship into question. In the words of Reginald Bacon, the first captain of HMS *Dreadnought* and afterwards appointed to the Admiralty as head of ordnance, 'We have it now in our power to construct a torpedo which should effect considerable damage on

a line of ships outside practical gunnery range'.<sup>1</sup> Quickly recognizing the significance of Hardcastle's superheater, the Admiralty redesigned the navy's torpedo procurement policy around it.

Budgetary figures also testify to the invention's importance. The Royal Navy could have built roughly 10 more destroyers for what it spent on Hardcastle's invention in the five years before World War I. In terms of pounds spent, his superheater had a better claim than aircraft to be the cutting edge of technological innovation: on the eve of war, estimated spending to equip vessels with Hardcastle's torpedo was roughly 50% greater than on the entire naval air service.<sup>2</sup> Perhaps counter-intuitively, these expenditures offered potential fiscal relief. Compared to battleships, small ships armed with long-range torpedoes were cheap; for instance, a destroyer in 1905/1906 cost about one-twelfth as much as the *Dreadnought*.<sup>3</sup> Since torpedoes equipped with Hardcastle's superheater potentially threatened the supremacy of the capital ship, further development held out the possibility of major cost savings in the longer term.

While the government had compelling reasons to want to acquire and control Hardcastle's invention, doing so was not a simple matter. The process raised complex and important intellectual property issues which have been somewhat overlooked by historians, in Hardcastle's case as in others. Britain's commitments to liberal property norms, on the one hand, and to naval supremacy, on the other hand, were at the heart of its national identity. The intellectual property rights to naval-technological inventions sat at the nexus of these two commitments. How did the British government reconcile them?

The story begins in the aftermath of the Crimean War (1854–1856), which led to landmark, though not widely known, changes both in weapons procurement and in intellectual property law. Stirred by the lamentable performance of British artillery in the recent conflict, the newly created War Office, which was responsible for procuring both naval and military ordnance, began to sponsor private-sector artillery development. In 1859, it bought 100 new breech-loading, rifled guns from Sir William Armstrong of Newcastle. Still more significantly, it guaranteed his £12,000 investment in a new plant at Elswick, and began producing Armstrong guns under license in the Royal Gun Factory at Woolwich, providing Armstrong with facilities there to conduct further research and development at the government's expense.<sup>4</sup>

This sponsorship of private-sector development work, and the dealings with Armstrong in particular, had major implications for the state's handling of intellectual property.<sup>5</sup> The first piece of legislation to enable patents to be classified as secret explicitly on national-security grounds was the 1859 Patents for Inventions (Munitions of War) Bill, which was passed in direct response to Armstrong's acquisition of an ordinary patent for a percussion fuse the previous year.<sup>6</sup> Armstrong's patents in 1859 and 1861 for rifled and breech-loading ordnance were the first artillery patents acquired and classified as secret by the crown under the new 1859 legislation.<sup>7</sup>

The establishment of secret patents marked a watershed in the relationship between national security and intellectual property – or perhaps it would be more accurate to say that they created a new legal framework for the relationship between the two. Secret patents were a peculiar hybrid. On the one hand, they were like trade secrets, which sacrifice proof of discovery for secrecy; on the other hand, they were like patents, which sacrifice secrecy for proof of discovery. In effect, by combining proof of discovery and

secrecy, they merged two otherwise incompatible forms of intellectual property protection. Their character was hybridized in another way as well. They were intellectual property, and at the same time they were national-security information – that is, they were classified as secret because they contained scientific and technological information which the government wished to prevent from circulating for national-security reasons, regardless of any property interest. The establishment of secret patents reflected a conceptual breakthrough in the government that an intellectual property system designed for ordinary commercial practice was not well suited for national security in the modern era of industrial weapons procurement.

Despite their importance, secret patents have not been well studied, representing a lacuna in broad studies of the history of intellectual property in Britain.<sup>8</sup> T. H. O'Dell's valuable 1994 study *Inventions and Official Secrecy*, the only work of its kind, seeks to trace the history of secret patents and the Official Secrets Act with regard to intellectual property over more than a century, but of necessity he could not analyze particular cases in much detail.<sup>9</sup> Other historians have touched on secret patents in passing, but there are few case studies of major weapons systems covered by secret patents undertaken with special reference to the intellectual property issues involved. There are even fewer which attempt to establish the tactical or strategic significance of the inventions covered by secret patents: the military value of inventions is more commonly asserted or regarded as self-evident rather than demonstrated with precision.<sup>10</sup> Without making a real effort at establishing the military value, however, it is impossible to understand how national-security concerns and intellectual property rights were balanced.

Moreover, to the extent that the changing relationship between national security and intellectual property has been analyzed, this analysis has never been carried out with particular reference to a special group of inventors who played a critical but somewhat anomalous role in the defense procurement system. These were *service inventors* – that is, inventors (uniformed or civilian) in government service, as distinct from inventors in the private sector. Like other inventors, service inventors were entitled to be compensated for the use of their patents by the government after 1883.<sup>11</sup> But unlike non-service inventors, service inventors in the War Office and Admiralty were required by crown regulations to seek their departments' permission before applying for patents. In addition, if they were dissatisfied by the terms offered to them, they were prohibited from appealing their departments' rulings.<sup>12</sup> The rules governing the fighting departments' awards process also distinguished between service and non-service inventors.<sup>13</sup> In these respects, service inventors had a very different legal standing from non-service inventors.

Service inventors also had a different status relative to the fighting departments than did employees relative to their employers outside the government. In the private sector, the question of employee intellectual property had been viewed for centuries through the prism of the master-servant relationship. For the courts, the payment of a salary signified the existence of an employment contract, and the terms and conditions of the contract governed the rights to the fruits of employees' inventiveness. The employer, who set the terms of the contract and paid the salary, was the master, and the employee was the servant.<sup>14</sup> In the government, there was no straightforward master-servant relationship. For a naval officer, the Admiralty was the closest thing to a master – but the Treasury supplied the public monies used to pay his salary. The unitary master of

the private sector, who both set the rules of employment and controlled the money used to pay the employee's salary, was bifurcated in the public sector.<sup>15</sup> Hardcastle's case shows that this distinction is not mere pedantry. The Treasury was very much a third party in his case, alongside himself and the Admiralty.

In the absence of a systematic review of the archival evidence pertaining to the state's handling of service inventors over the course of the 19<sup>th</sup> century, it is impossible to generalize as to whether they were becoming more or less important in the late-19<sup>th</sup> century than they had been previously. The general trend in British defense procurement in the late-19<sup>th</sup> century was toward greater reliance on the private sector relative to the public sector, which would suggest a declining role for service inventors.<sup>16</sup> But the relative trend does not mean that service inventors became unimportant in absolute terms. The cases that we do know about suggest that they had an importance all out of proportion to their numbers. As the pace of technological change increased in the late 19<sup>th</sup> century, technically proficient officers became ever more valuable – as the Admiralty was keenly aware. Indeed, service inventors played key roles in what were probably the two most secret technology development projects in the Royal Navy before World War I: fire-control (computerized gunnery targeting) systems and miniaturized torpedo propulsion systems. As an American naval observer remarked in a 1912 report, 'From a confidential standpoint, torpedo subjects stand next only to fire control, in the British Service'.<sup>17</sup> In both cases, moreover, the service inventors held secret patents.

The case of Hardcastle's superheater is exceptionally well-suited to illuminate the history of secret patents, of service inventors, of World War I's effect on the state's attitude toward innovation, and of the relationship between national security and intellectual property. Of course, case studies raise questions of representativeness. The claim being made here is not that Hardcastle's case was representative of others. The number of potentially relevant cases is too large, and the secondary literature is not yet sufficiently well developed, to enable meaningful comparisons across a statistically significant set of cases. Rather, the claim is that the Admiralty applied existing procedures, as far as possible, to Hardcastle's case – even as it regarded him as exceptional in some respects – and thus that his case illustrates a norm. In addition, Hardcastle's case illuminates, as well as one case possibly can, a series of inter-connected issues involving national security and intellectual property in the World War I-era that leading policy-makers regarded as important but that have not been adequately studied by historians. To prove this claim, this article undertakes the first published exploration of the bureaucratic origins of the 1919 Royal Commission on Awards to Inventors (RCAI), as well as of two important subsequent inter-departmental initiatives.

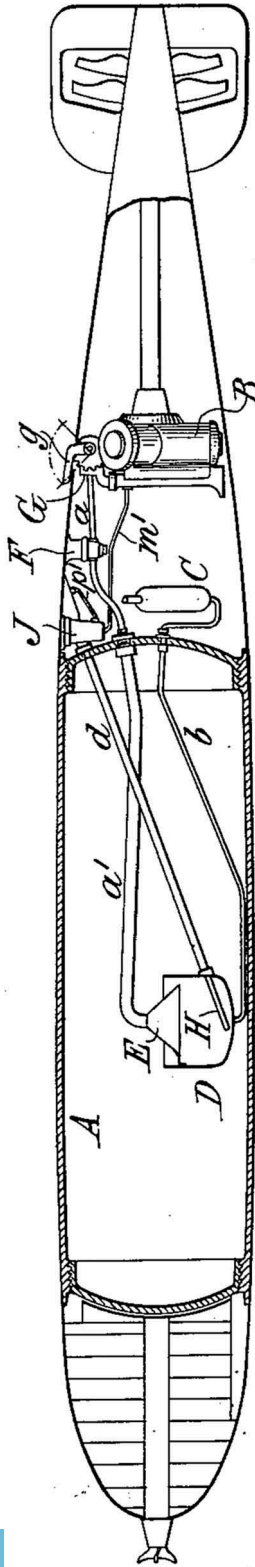
For these purposes, several aspects of Hardcastle's case are noteworthy. First, because Hardcastle was a naval rather than a military officer, his case provides insight into the procedures for incentivizing and rewarding invention of an immense institutional supporter of technological innovation, the British Admiralty.<sup>18</sup> Second, Hardcastle's invention had very significant tactical and even strategic implications, which can be established with some exactness. Third, as in the other case of a service inventor with a secret patent that we know in some detail, the intellectual property tensions within the state (i.e. between the inventor and the government) were mirrored by an intellectual property dispute between the state and a defense contractor. Fourth, Hardcastle had a prewar understanding with the Admiralty concerning the secret patents for his

invention which, in his view, broke down as a result of the war. His case, therefore, affords an unusual way to study the effects of the war on the state's treatment of inventors, a subject typically approached through the lens of wartime bureaucratic innovations for managing knowledge production – mainly the Admiralty's Board of Invention and Research and the Department of Scientific Research and Development – rather than by following an invention from the pre-war through to the post-war era.<sup>19</sup> Fifth, Hardcastle's case touched upon practically every one of the wrinkles identified by the committee that laid the groundwork for the establishment of the RCAI. Finally, notwithstanding the government's recognition of many of the issues involved in his case, it exposed conceptual disagreements within the government over how to deal with inventive officers, and, by extension, over how the government should pursue the maintenance of Britain's military-technological edge.<sup>20</sup> Thus, his case enables us to identify the parameters of the relationship between national security and intellectual property in a way that has not previously been attempted.

### The invention of the Hardcastle superheater

The modern torpedo played a more important role in British naval policy before World War I than is generally realized. The Admiralty watched and then supported torpedo development from the moment of the weapon's invention in the 1860s. Its commitment to stay at the forefront of torpedo development did not wane even after it supposedly became obsessed by the 'dreadnought revolution' and battleship race against Germany. Financial constraints were at least as important an influence on British naval policy as foreign-political factors, and the government regarded France and Russia as more dangerous threats than Germany well into the first decade of the 20<sup>th</sup> century. When Admiral Sir John Fisher became First Sea Lord in 1904, his most urgent task was to reduce Admiralty expenditures. The *Dreadnought*, far from constituting the centerpiece of his time in office, was unattractive to him, because it simply offered more of the same. Instead, Fisher sought to redefine the units and metrics of naval power, and torpedoes played a key role in his vision. They would provide the primary armament of flotilla vessels (destroyers and submarines) that would deny the North Sea, English Channel, and Mediterranean to enemy vessels. Contrary to conventional wisdom then and since, which portrayed torpedoes as the natural weapons of the weak, therefore, Fisher realized that they could be the weapons of the strong. Accordingly, the Royal Navy remained keen to stay at the cutting edge of torpedo development.<sup>21</sup>

In 1901, an American engineer named F. M. Leavitt made a quantum leap in torpedo technology by inventing a device known as the dry (or hot-air) superheater. At that time, torpedoes used unheated compressed air, stored in a large flask, to power their engines. It is a basic principle of thermodynamics that hot air does more work per given volume than cold air; Leavitt's achievement was to solve the engineering problem of how to exploit this principle in torpedo propulsion. As shown in [Figure 1](#) below, his device heated the air in a combustion chamber inside the torpedo's air flask and thereby dramatically increased the range and speed of torpedoes. Concerned by its safety problems, however, the Royal Navy elected not to acquire Leavitt's first-generation superheater.<sup>22</sup>



**Figure 1.** Leavitt's original inside superheater.

'A' is the torpedo's air flask, which carried the compressed air which powered the torpedo, and 'B' is the torpedo's engine. The chamber 'C', just outside the air flask, contained alcohol, which passed through the pipe 'b' to the ignition chamber, 'D'. There it was ignited by the igniter 'H', and ignition began to heat the air in the ignition chamber 'D'. Once heated, the air passed through the hood 'E' into the pipe 'a', thence through pipe 'a', and finally into the engine 'B'. (Image from F. M. Leavitt, "Propulsion of Torpedoes, &c., by Compressed Air," US Patent No. 693,872, patented 25 February 1902.)

Around 1903 or 1904, British engineers began working on an improved, second-generation superheater. In contrast to Leavitt's original version, the combustion chamber for heating the air was moved outside the flask and behind the reducing valve. Known as an 'outside' superheater to distinguish it from Leavitt's inside-the-flask superheater, it was both safer and more efficient. Although all outside superheaters shared these basic characteristics, there were two distinct lines of development in Britain. One came out of the armaments giant Armstrong, Whitworth & Co. (hereafter the Armstrong Company) and was invented by a civilian engineer named William Horace Sodeau. The other was invented by then-Engineer Lieutenant Hardcastle, Royal Navy.

These two lines of development began at roughly the same time. The earliest known date for Armstrong's development work is November 1904, when the company applied for its first superheater patent (GB 25,003/1904), but its research on superheaters must have begun some time before that. Hardcastle began thinking about superheaters in 1905, though not as part of his official duties, while he was stationed in the torpedo maintenance department at Chatham Dockyard.<sup>23</sup> That fall, he provided a description of his idea for an outside superheater – the exact contents of which came to be hotly disputed – to his superior officer at Chatham. This officer, a Captain Gibbs, took Hardcastle's description to the Torpedo Design Committee at HMS *Vernon*, the center of torpedo development work in the Royal Navy, which considered it at a meeting on 4 October 1905. The Committee found Hardcastle's concept sufficiently promising to recommend that he be moved to *Vernon* and allocated staff to help him develop the superheater further, and it also recommended that he take out a secret patent for work already done (which became GB 21,176/1905).<sup>24</sup> The Director of Naval Ordnance, who oversaw the torpedo portfolio at the Admiralty, approved both recommendations.<sup>25</sup>

In order to answer key questions subsequently at issue between Hardcastle and the government about how much help he received and how much compensation his invention merited, it would be desirable to know when exactly Hardcastle conceived various details of his invention. Unfortunately, it is very difficult to establish those details – but the reasons for the difficulty are themselves significant. The best available evidence consists of documents purporting to be copies of what Gibbs carried with him to the meeting of the Torpedo Design Committee on 4 October 1905 and of Hardcastle's patent application, but the provenance of these copies is open to question.<sup>26</sup> The lack of other evidence which might shed light on Hardcastle's inventive process was not accidental. Service inventors, who, unlike outside inventors, were required by crown regulations to secure approval before applying for patents, did not trust the approval process. Hardcastle later testified that he felt a need to be vague when submitting the information necessary to justify the application for a patent. 'I was very careful not to put too much through the office' at Chatham dockyard to give to Gibbs, Hardcastle explained, and it was 'very desirable' not to mention anything more than was necessary to obtain a secret patent.<sup>27</sup> Hardcastle was not alone in fearing that his ideas would be stolen by another officer if put on paper. In 1906, an inter-departmental committee charged with investigating the status of inventors in government service reported that the requirement of passing an invention through a long channel of communication in order to obtain patent protection 'is apt to arouse the suspicion of the inventor that the nature of his invention may be divulged before he has obtained protection'.<sup>28</sup> Subsequent investigations of government-supported innovation agreed.<sup>29</sup> Although Hardcastle's reluctance to commit his ideas to paper at this stage may have been prudent, it later hampered his attempts to establish when he had conceived the various components of his invention.

In the meantime, Hardcastle continued to develop his invention. Within two years, he commenced work on a third-generation superheater. Like its precursor, the third-generation model was located outside the air flask; but unlike its precursor, it used steam rather than hot air to act as the working fluid of the engine by injecting water into the combustion chamber. It was, therefore, known as the 'steam' (or 'wet') superheater to distinguish it from previous 'hot-air' (or 'dry') superheaters. According to Hardcastle's personal log-book, he first used water with his superheater sometime between December 1905 and January 1906, two to three months after his arrival at *Vernon*.<sup>30</sup> In December 1906, he submitted the first drawing of a steam superheater whose date both he and the Admiralty later accepted.<sup>31</sup> The captain of *Vernon* was sufficiently impressed to recommend Hardcastle's reassignment to the Royal Navy's torpedo factory in the Royal Gun Factory (RGF) at Woolwich, which had more extensive facilities.<sup>32</sup> Hardcastle moved from *Vernon* to the RGF in January 1907, where he began to fit his steam superheater to two torpedoes for test.<sup>33</sup>

In the late summer and early fall of 1907, the Admiralty conducted trials of Hardcastle's steam superheater and the Armstrong Company's new outside hot-air superheater.<sup>34</sup> Although Hardcastle's torpedoes performed better, the Armstrong Company offered to sign a contract with performance guarantees that Hardcastle could not yet attain, and therefore the Admiralty opted to place a small order for the Armstrong superheater.<sup>35</sup> When the Admiralty re-tested Hardcastle's steam superheater in February 1908, however, it performed so well that the Admiralty suspended purchase of the Armstrong superheater altogether.<sup>36</sup> While the Armstrong superheater could achieve 41 knots for 1,000 yards or 28.5 knots for 4,000 yards, Hardcastle's superheater could maintain roughly the same speeds for two to three times farther.<sup>37</sup> This was a staggering improvement. Indeed, it was so staggering that the Admiralty decided to suspend purchases of the Armstrong superheater and rely solely on Hardcastle's. The Armstrong Company considered responding in the form of a patent infringement lawsuit against Hardcastle, but instead worked out a deal with the Admiralty that enabled it to continue manufacturing torpedoes.<sup>38</sup>

The reason why the Admiralty so readily abandoned the Armstrong superheater – and was so determined to preserve the secrecy of Hardcastle's invention – was that it regarded the Hardcastle superheater as possessing very important tactical and even strategic implications. These fell into two categories: one concerning improvements in the torpedo's absolute performance as a weapons system, and the other concerning improvements in its performance relative to naval artillery. In both respects, Hardcastle's invention was a quantum leap. In absolute terms, it enabled short-range settings on new torpedoes that were roughly twice as fast and three times longer than the Navy's last pre-Hardcastle torpedoes; and it enabled long-range settings that were five times longer.<sup>39</sup> Perhaps more importantly, in relative terms, it extended the effective range of the torpedo at least to, and arguably beyond, the effective range of guns. Although statements about effective range are hazardous, it can be confidently asserted that, whereas the effective range of 18-inch torpedoes at 30 knots in the early 1890s had been well under 1,000 yards, and while a series of improvements by 1906 or so had increased their effective range to roughly 4,000 yards, the Hardcastle superheater, when placed in the larger 21-inch torpedoes that began to be developed in the first decade of the 20<sup>th</sup> century, took the effective range at 30 knots to 10,000 yards.

Despite the rudimentary nature of instruments for controlling torpedo fire, torpedoes nevertheless stood an appreciable chance of hitting their target, because at the range of 10,000 yards, their 'target' was not a single ship but the entire enemy battle-line. The logic was as



follows. A line composed of, say, eight HMS *Dreadnoughts* with two ship-lengths between each (the actual measurement would have been in cables) would have stretched over two miles. If a torpedo could reach this imaginary enemy line at a perpendicular angle, it theoretically stood a 36% chance of hitting.<sup>40</sup> A single torpedo hit was likely to cause significantly more damage than a single gun hit, or, put differently, multiple gun hits were likely to be necessary to achieve the same damage as a single torpedo hit. (The commander of the Channel Fleet wrote in 1904 that ‘one shot getting home from a torpedo tube is worth thirty from a gun’.<sup>41</sup>) Given that the targeting problem for guns at long range was vastly more difficult than the targeting problem for torpedoes at long range, it was far from outlandish to think that torpedoes armed with the Hardcastle superheater could reset the traditional metrics of naval power.<sup>42</sup>

In recognition of the Hardcastle superheater’s importance, the Admiralty remade its entire torpedo procurement policy around the device. This policy involved not only the construction of new stock but also the upgrading of old stock. Although new torpedoes had to be purpose-built to exploit the invention to its maximum, part of its value was that it could dramatically improve the performance of old torpedoes converted to take it – a capability sure to appeal to the Admiralty on financial grounds. For instance, when retro-fitted to the last torpedo to be built ‘cold’, the Hardcastle superheater tripled its range.<sup>43</sup> The cheapness of converting existing stock compared to building new stock, as well as the prolongation of the effective life of old stock, meant that the Hardcastle superheater offered significant cost-savings, even as the performance increases offered by new stock justified substantial expenditures there as well. Accordingly, the Admiralty began a program of converting old torpedoes to take the Hardcastle superheater in FY 1908/09, the first year in which the mature invention was available, when money for 50 such conversions was appropriated. Over the next five years, the conversion program was expanded, and a program of new construction initiated, at a total cost of roughly £900,000 – or the equivalent of 10 destroyers of the latest design.<sup>44</sup>

Even these numbers, though impressive, do not fully convey the significance of Hardcastle’s superheater in the Admiralty’s eyes. For some officers in responsible positions, the challenge posed by torpedoes fitted with Hardcastle’s invention to the supremacy of the gun called into question the viability of the capital ship. In late 1907, before the experiments with Hardcastle’s superheater were completed, the Assistant Director of Torpedoes, Bernard Currey, observed that long-range torpedoes ‘will tend to prevent close action, and, therefore, accentuate gunnery skill’. In late 1908, after the Navy had completed experiments with and placed a large order for its first Hardcastle torpedoes, Currey went a step farther: ‘In considering the use such long range torpedoes in ships can be put to it is pointed out that a “Fleet’s broadside of torpedoes” fired at the center of an opposing Fleet would be a very formidable means [of?] offence at a commencement of a battle *before even the guns come into action*’. The Director of Naval Ordnance (and first captain of HMS *Dreadnought*), Reginald Bacon, agreed.<sup>45</sup> He elaborated two years later, in attempting to predict the near future of naval combat:

[T]he introduction of the torpedo has brought about a very considerable limitation in the powers of the battleship. Not only is the battleship itself open to attack by small craft which it cannot engage on equal terms, but it is powerless to protect any form of vessel against the attacks of such craft. Whereas forty years ago the battleship was practically supreme, it can now only be looked upon as supreme against vessels of more or less

corresponding class, size, and speed.... In fact, in these days, the battleship has developed merely into a vessel for fighting other battleships, and it shuns, as far as possible, encounters with most other classes of vessels. It is this defencelessness against the torpedo which has changed, to a certain extent, the tactical and strategical use of battleships.<sup>46</sup>

‘[I]t is unnecessary to dwell on the tactical importance of long range torpedoes for the Fleet’, wrote John Jellicoe, the future commander of the Grand Fleet during World War I, in 1908.<sup>47</sup> The advent of high-speed, long-range torpedoes persuaded key decision-makers that a fundamental rethinking of the nature of naval combat was necessary.<sup>48</sup>

It is not hyperbole to say that Hardcastle’s superheater had revolutionary implications for naval warfare. For centuries, the capital ship armed with heavy guns had been the key metric of naval power. But the speed and range increases that Hardcastle’s invention made possible forced officers at the Admiralty to acknowledge the possibility that small vessels armed with torpedoes could rival capital ships with big guns in battle itself. The Hardcastle superheater did nothing less than call the capital ship’s *raison d’être* into question. Small wonder, then, that the Admiralty attached so much importance to keeping him in the Navy’s service.

### Compensating Hardcastle

While the Admiralty’s policy for procuring and exploiting heated torpedoes took shape, the question arose of whether and how Hardcastle should be compensated for his invention. It seems that Hardcastle had assigned his secret patents to the Admiralty without first negotiating terms. According to a Treasury lawyer writing after the war, this practice was not uncommon for service inventors.<sup>49</sup> In agreeing to take out secret patents and assign them to the Admiralty, Hardcastle had consented not only to let the Admiralty use his invention but also not to let anyone else exploit the embodied technology. In other words, as he put it, he had foregone ‘any benefits that may be derived from the commercial application of the system’.<sup>50</sup>

The question of an award was referred to the Admiralty Awards Council, an in-house body for recommending awards to naval employees. Its members were the Director of Naval Ordnance (Reginald Bacon), the Director of Naval Construction (Philip Watts), and the Director of Contracts (Frederick Black) and his principal assistant. ‘We prefer not to consider the case in the light of the ultimate success of the invention’, the Awards Council explained, ‘but rather from the point of view of what would have been a reasonable sum to have promised the inventor in the event of success at the time of his originally submitting his ideas to the Admiralty with a view to their development at the public expense’. In their view, Hardcastle had a right to be compensated for the fruits of his inventiveness so long as inventing torpedo technology was not part of his job – that is, until developing his invention was made his job in late 1905. This approach had an analogue in the private sector, where the courts held that employers had a right to the fruits of their employees’ inventiveness insofar as this inventiveness formed part of the employment contract (that is, insofar as the employees’ job was to invent things of the nature patented), but that employees owned the fruits of their own inventiveness when they invented outside of the employment contract (that is, when their job was either not to invent, or to invent things of other than the nature patented).<sup>51</sup> While this distinction was neat in the abstract, determining what ideas Hardcastle had submitted, and when, was complicated in practice, since, as we have seen, Hardcastle had avoided submitting all his ideas at once for fear that they would be stolen.

Instead of considering what Hardcastle could have obtained commercially for his finished invention, the Awards Council considered ‘what sum an outside firm would have been likely to have given for the crude invention before the details had been worked out and the ultimate practical success obtained’. Using its preferred metric, the Awards Council resolved that Hardcastle be awarded £5,000. In recommending this amount, however, the Awards Council factored into account a promise from the Second Sea Lord (who was responsible for personnel) that Hardcastle would be eligible for early promotion, indicating that its members did not regard £5,000 as adequate in and of itself.<sup>52</sup>

In December 1908, the Admiralty informed Hardcastle of his award. He would be marked for early promotion three years hence and receive a payment of £5,000 ‘in full discharge of all claims which he may have in respect of this invention’ (subject to Treasury approval), in return for which he must keep the award strictly secret.<sup>53</sup> Hardcastle confirmed ‘that the award of a grant of £5,000 will be accepted in full discharge of all claims in respect of this invention and every effort will be made to keep the matter strictly secret as directed’.<sup>54</sup> The Treasury approved the £5,000 award; it is unclear whether it was taxed.<sup>55</sup> In 1912, Hardcastle was duly promoted to Engineer Commander – approximately three years early.<sup>56</sup> Judging from his subsequent pursuit of foreign patent rights, it was also intimated to Hardcastle that there would be a third element to his compensation package sometime in the future: the ability to exploit his patents commercially once the Admiralty assigned them back to him, both sides having preserved their secrecy and thereby prevented anyone from duplicating his invention at home or abroad.<sup>57</sup> The Admiralty typically allowed the owners of non-secret patents to exploit them commercially.<sup>58</sup>

The first element of his compensation package – the cash award of £5,000 – was substantial in and of itself. It appears to have been made in a lump sum.<sup>59</sup> There is no obvious source other than the award to account for the significant investments that Hardcastle recorded in stocks and bonds and the money he placed in trust for his daughter, which, taken together, he valued at £4,066 in 1920.<sup>60</sup> One way to get a sense of the significance of the award of £5,000 is to measure it against his pay. According to Hardcastle’s account books (pages from which may be seen in [Figure 2](#) below), his base monthly salary after tax in January 1914, by which time he had been promoted to the rank of commander, was £40 – meaning that his cash award was equivalent to 125 of those monthly paychecks. Another way to gauge the significance of his award is to consider the monthly income that it secured him over and above his salary. In 1918, he recorded his income from salary as £618 and his income from private sources (payments from the investments he had made almost certainly with the 1908 award) as £367. Thus, the cash award allowed him to supplement his monthly income from pay by 59%.

Of course, the Admiralty did not make him an award out of generosity. In all likelihood, what drove Admiralty officials’ approach to Hardcastle’s case was their desire to keep him in the service and prevent him from bolting to the private sector. None of them questioned that Hardcastle should be compensated for his invention. They agreed that the relevant metric for judging Hardcastle’s award was not his naval salary, but what he could command for his invention and services outside the government – either as a private-sector employee, or by selling his invention on the open

Totalling	Chick 5% 1910	1 11 6
	Chinese Shanghai Rs	3 14 9
	Somerset Park	1 7 7
	New King Loan 5% 200	3 14 9
	London Savings Bank (Income Sept)	
	Pay	40 0 0
	Staph Red	5 13 4
		55 0 5
	Jan. 1918	5 0 0
	Feb. 1918	53 10 9
	Total	104 19 0
	104 19 0	104 19 0
	72 7 1	32 7 9
	26 5 11	16 5 11
	24 2 11	20 13 0
	35 19 2	10 18 2
	56 0 5	15 0 5
	423 13 6	138 2 0
	847 7 0	278 2 0

		1 11 6
		3 14 9
		5 0 0
		40 0 0
		5 9 4
		57 1 7
		29 3 4
		70 19 0
		55 10 2
		32 10 10
		50 17 5
		55 1 10
		111 6 0
		75 0 0
		50 15 2
		90 8 0
		50 15 2
		74 16 4
		238 16 0
		32 10 2
		270 2 2

Figure 2. Facing pages from one of Hardcastle’s personal account books, listing his income for December 1917 and December 1918, and including a tabulation of his estimated (pencil) and actual (pen) monthly income for 1918 (Courtesy of Mrs. Anna-Clare Priester-Reading).

market. ‘You must remember that the inventor may be lured away from the Government service for his brains’, an official at the Navy’s torpedo factory reminded an inter-departmental committee investigating service inventors in 1905, ‘and then the Government will have to pay a very much higher price for his inventions’.<sup>61</sup> This was not an abstract concern for the Admiralty: for example, two of its first three Inspecting Captains of Submarines left the service for the private sector, and the third one thought about it.<sup>62</sup> When officers left the navy for private industry, the Admiralty lost not only their inventiveness but also their expertise, broadly defined, which they had gained largely at the government’s expense.

The Admiralty’s agreement with Hardcastle can be seen as a sign of both its reluctance to leave the old defense procurement paradigm and a step forward into the new. On the one hand, the Admiralty’s determination to keep Hardcastle and other technically proficient officers in the navy suggested a certain discomfort with the brave new world of defense contracting. Preferable to broaden the old in-house system of royal arsenals and dockyards to encompass old technologies, the navy evidently thought, than to embrace the emerging military-industrial complex. This preference was not reactionary conservatism. The embrace of private industry may have made good sense for other departments, such as the Ministry of Munitions during World War I, which chiefly required cheap, mass-produced items like shells requiring no secrecy. Reliance on the export-oriented private sector made considerably less sense for a department which required highly complex and secret technology like gun mountings, fire-control systems, and torpedoes. The preference to stay in-house, combined with a desire to avoid paying royalties to contractors, may explain why the Admiralty had naval officers working on two of the most secret technology-development projects in the Royal Navy – torpedo superheaters and gunnery fire-control systems – alongside contractors. In both cases, tensions within the state over the intellectual property rights

to the inventions were accompanied by accusations from the contractors (the Armstrong Company in the superheater case, the Argo Company in the fire-control case) that the service inventors had infringed their patents.<sup>63</sup> This striking similarity between the two cases was probably no accident, but rather the outgrowth of a desire to avoid complete dependence on contractors for key technologies.

On the other hand, the compensation package awarded to Hardcastle demonstrated the Admiralty's ability and willingness to think creatively about an increasingly urgent challenge: how to retain technically gifted officers at a time when the pace of naval-technological change made them ever more important and private industry offered them ever more opportunities. The Admiralty realized that it needed a new kind of officer for a new kind of world; it also realized that its incentive structure was designed for the old world.<sup>64</sup> By including early promotion as part of Hardcastle's compensation package, the Admiralty found a way to give him a continuous annual payment within the confines of the existing system. Each year, he would collect higher pay, and accumulate more toward his pension, than he would have collected without early promotion. Using the promotion system as part of his compensation had the additional advantage of not requiring Treasury approval. Promotion decisions were the Admiralty's bailiwick alone; cash awards were not. Put more simply, through early promotion the Admiralty could commit public money to the retention of a technically proficient officer without incurring financial scrutiny. The possibility of profiting from commercial exploitation of the patents once their secrecy was lifted further sweetened the deal for Hardcastle. Thus the Admiralty found a way to adapt existing tools to the new need to compensate service inventors for their secret patents. However, compensation in the form of early promotion was predicated on the assumption of stability and a normal career path, while the possibility of commercial exploitation depended upon preserving the secrecy of the invention. The world did not cooperate in either respect.

### **The Admiralty vs. the Treasury**

World War I transformed Hardcastle's career and upset his expectations. In 1919, he asked the Admiralty to revisit the question of his 1908 award. He offered several reasons. First, it had been impossible to predict in 1908 how great an advantage his invention would provide to the Royal Navy and its allies during World War I. Second, after instructing Hardcastle to keep his superheater secret and thereby precluding him from taking out foreign patents, the Royal Navy had divulged his superheater design to allied navies during the war in the spirit of inter-allied cooperation, with the result that he could no longer obtain foreign patents for his invention and exploit their commercial applications for profit. By depriving him of this possibility, Hardcastle argued, the Navy had 'incurred an indebtedness' to him. Finally, he alluded to the fact that he had spent seven years on shore at the Royal Naval Torpedo Factory in Greenock ensuring that all torpedoes equipped with his invention were fit for service.<sup>65</sup> Indeed, his lack of sea service meant that he was ineligible for promotion to Engineer Captain.<sup>66</sup> Seven years in the same position on shore was not part of a normal career path for an engineer officer: it was a career cul-de-sac, the down side of being indispensable.

Hardcastle's missive made the rounds at the Admiralty. Officials acknowledged that the Admiralty had destroyed the secrecy of Hardcastle's patents by sharing his

superheater with allies, thought that Hardcastle merited additional compensation, and consented to refer his request to the Admiralty Awards Council. They also agreed to ask the wartime allies with whom the Royal Navy had shared Hardcastle's superheater to consider compensating him as 'a pure act of grace' for his inability to take out patents in their countries.<sup>67</sup> Unsurprisingly, their governments declined to do so.<sup>68</sup> More practically, the Admiralty did its best to elevate Hardcastle in the Navy's hierarchy so that he might qualify for higher pay and benefits. His account books suggest that he was given a bump in pay effective 1 February 1919 while still at the Royal Naval Torpedo Factory at Greenock, where he had spent the war.<sup>69</sup> In September 1919, he was transferred from Greenock to become the inspecting officer of torpedoes at Portsmouth.<sup>70</sup> This move appears to have taken his base monthly pay after tax from £40 to £48.<sup>71</sup> As the Director of Torpedoes and Mining observed, it was 'of first importance to keep him in intimate touch with Torpedo design, and, to this end, it is necessary to give him sufficient inducement to refrain from applying for sea-service and to give up his prospects of promotion'.<sup>72</sup> For this reason, the Admiralty was willing to engage in a long-running battle with the Treasury to secure a favorable arrangement for Hardcastle.

In July 1920, the Admiralty asked the Treasury to approve Hardcastle's transfer from Portsmouth to the Admiralty as Assistant to the Chief Inspector of Naval Ordnance. The transfer was administratively imperfect, however: the post was classified as civilian, meaning that the pay would be lower than Hardcastle's naval pay and his service would not accumulate toward his naval pension. As Hardcastle rightly pointed out, and his superiors at the Admiralty agreed, the reduction in pay would substantially reduce the value of the early promotion that Hardcastle had been awarded in 1908.<sup>73</sup> In view of these arrangements, the Admiralty asked the Treasury to allow Hardcastle to continue to receive naval pay in his new 'civilian' job at the Admiralty.<sup>74</sup> In doing so, the Admiralty tried to imply that Hardcastle's appointment would be exceptional and temporary. On those conditions, the Treasury was willing to sanction the continuance of naval pay, but it expected Hardcastle to change over to the civilian pay scale if the position became permanent.<sup>75</sup> The Admiralty wrote back that when the civilian pay scale had been approved, it had not contemplated having an engineer officer in the position.<sup>76</sup> This retort tipped the Admiralty's hand. 'It is clear that Admy. intend to retain Commander H. permanently and not merely as a stop gap until civilians can be trained', a Treasury official concluded, 'and that they are not going to put him on the inclusive civil scale unless they can help it'.<sup>77</sup> 'This is in fact the old argument... that it is desired to appoint a particular person and that in order to secure him something better than the authorised rate of salary must be offered', chimed in Gerald Pinsent, then a Treasury clerk. 'We have always opposed this opportunistic point of view, which allows no sort of finality or stability in emoluments and causes endless trouble with those appointed on the authorised scale'.<sup>78</sup> For the Treasury, back-door compensation created more problems than it solved, and thus was to be resisted.

There was more going on here than a departmental spat over the pay of a single officer. Two significant issues were involved. The first was that the Admiralty's requirement of sea service for promotion was not well suited to the industrial age, when it needed to keep service inventors with highly specialized technical expertise in shore positions at the same time that they could command large salaries in the private sector and higher pay by going to sea. The problem was not specific to Hardcastle, and it was

not the result of the war. 'As these civilian [pay] scales have to be fixed at a rate sufficient to attract suitable naval officers and the range of selection is probably limited', a Treasury official observed, 'we may be driven to a general increase of these scales as the result of the reduction of civil bonus while naval pay remains constant'.<sup>79</sup> From this perspective, the Admiralty Awards Council was essentially a stop-gap measure. The general unsuitability of existing compensation arrangements explains why the Admiralty kept trying to make end runs around Treasury-approved pay scales. 'I don't imply that such a course is never approved by us', an exasperated Pinsent wrote, 'but Adm. wd make it the rule rather than the exception'.<sup>80</sup> Hardcastle's case was thus one of several that exposed the difficulties in maintaining the status quo.<sup>81</sup>

The second significant aspect of this fight between the Admiralty and the Treasury was the conceptual gulf that it exposed between the two departments about the treatment of service inventors. As in 1908, the Admiralty believed it imperative to retain inventive officers, and was cognizant that new methods of compensating them had to be found – even if these new methods were found through the expedient of the Admiralty Awards Council rather than through a fundamental rethinking of naval promotion practices. While the Treasury's reluctance to sanction the new methods of compensation sought by the Admiralty in Hardcastle's case could be regarded as short-sighted, it is probably better explained by the difference in the two departments' perspectives. The negativity of the Treasury's attitude toward the spending departments has sometimes been over-stated, but nevertheless it is the case that the Treasury's priorities and functions were not those of the Admiralty.<sup>82</sup> Where the Admiralty saw a need to adjust traditional methods of compensation in order to retain technically gifted officers in an era of rapid naval-technological change and attractive employment options in the private sector, the Treasury saw an administrative headache and unwelcome demand upon the public purse.

It was a sign of the importance that the Admiralty attached to keeping Hardcastle that so long as it got its way in his particular case, it was willing to compromise on the general principle of pay scales.<sup>83</sup> Although the Treasury was impatient to settle the matter, it dug in.<sup>84</sup> Only a back-channel appeal from the Admiralty convinced the Treasury to give way. 'He is I am told quite an exceptional case', a Treasury official noted after speaking unofficially with Charles B. Coxwell, an Admiralty secretary. 'The whole modern torpedo is due to an invention of his for which he was specially promoted'.<sup>85</sup> Since the Admiralty promised to treat Hardcastle as an exception to the general rule forbidding naval officers from drawing naval pay in civilian-rated posts, the Treasury relented and allowed the exception to continue.<sup>86</sup>

Several months later, toward the end of 1922, Hardcastle alerted the Admiralty to yet another wrinkle in his situation. Although the Admiralty had reassigned Hardcastle's secret patents to him in 1921 and given him permission to seek foreign patents, he had been unable to do so as a result of a patent infringement lawsuit filed by the Armstrong Company. As we have seen, the company had been contemplating such a lawsuit since 1908, when the Admiralty's decision to stop buying torpedoes equipped with the Sodeau superheater dealt a blow to its sales. Company officials revisited the issue in 1921.<sup>87</sup> In January 1922, they filed a patent infringement lawsuit against Hardcastle, claiming £200,000 in damages. The case would not be heard until mid-1923.<sup>88</sup> In the meantime,

Hardcastle explained, he could not apply for foreign patent rights, thereby ‘almost completely nullif[ying] the benefit which Their Lordships intended to confer upon me by re-assignment of the Heater invention with the liberty of negotiating the foreign rights’. Accordingly, Hardcastle asked the Admiralty to revisit the question of an additional award to him, just as he had in 1919, or to commend his case to the Royal Commission on Awards to Inventors (RCAI).<sup>89</sup>

### **‘The conscience of the Admiralty’?**

Hardcastle’s case was one of many that exposed problems with the state’s existing procedures for dealing with inventors and convinced the government to establish a high-level committee to investigate. Although the end-product of this process, the RCAI, is well known to historians and universally acknowledged as important, its bureaucratic origins appear not to have been explored before in print, nor the key Treasury files illuminating those origins cited.<sup>90</sup> Reliance on published documents, including the Royal Warrant establishing the RCAI, the commission’s reports, and parliamentary debates, has limited our understanding of policy-makers’ intentions in establishing the commission. Archival documents reveal that the RCAI was established as a response not only to issues raised by the war, but also to issues which predated the war. Because Hardcastle’s case bridged the two periods and embraced nearly every one of the issues which policy-makers identified as pertinent to the commission, it both illuminates and is illuminated by the RCAI’s history. Indeed, no better example has yet been found.

The RCAI emerged from a series of inter-departmental deliberations in 1918, which began at the Admiralty’s urging to investigate the sharing of inventions with allies. The committee appointed under the chairmanship of Graham Greene, then the Permanent Secretary of the Ministry of Munitions and formerly the long-serving Secretary of the Admiralty, determined that the sharing of inventions with allies was closely related to the question of compensating inventors whose inventions had been used by the government during the war. The Greene Committee regarded the latter issue as so complex as to require a separate committee of its own. Accordingly, the Treasury set up a new inter-departmental committee under the chairmanship of Stanley Baldwin, then Financial Secretary to the Treasury, with a remit to study the question of awards to inventors from the ground up. This study entailed not only the setting of present and future policy but a review of the government’s prewar practices in dealing with inventors.<sup>91</sup>

The Baldwin Committee identified a number of difficulties with the operation of the various rules governing the crown’s relationship with inventors, some pre-dating the war, others resulting from it. First, the committee criticized the Treasury’s ‘double position’ under the 1907 Patents and Designs Act: the Treasury was responsible both for approving awards to inventors and for sitting as a judicial body in cases involving dissatisfied inventors. As the Admiralty noted, this dual jurisdiction created an obvious conflict of interest from inventors’ perspective and decreased their confidence in the awards process, potentially disincentivizing the technological innovation upon which British naval power rested.<sup>92</sup> Second, the war significantly increased the number of cases in which the state used inventions, and it required that settlement with inventors be made after rather than before use (‘user’) of the invention. Third, the various government departments did not follow the same procedures in dealing with inventors.



Fourth, the inventors were not all of one type: they might be service inventors, on temporary or permanent assignments, or they might be non-service. Finally, there was no less variety in the nature of the inventions used by the state: they could be useful only for government purposes or also commercially profitable; they could be patented or not patented, not patented but patentable, or neither patented nor patentable; and they could be registered or not registered, not registered but registerable, or neither registered nor registrable.<sup>93</sup> As it was ‘more important than ever to the public interest to encourage invention by giving inventors security for an adequate award’, some resolution to these difficulties was urgent.<sup>94</sup>

To these problems the Baldwin Committee might have added several others. As its predecessor, the Greene Committee, had noted, the British government had shared many British inventions with allies during the war, complicating their inventors’ ability to secure patent rights in those countries. In addition, the accumulation of surplus stocks during the war meant that the British government would want not only to make but also to sell patented articles – as indeed the Admiralty hoped to do with surplus torpedoes equipped with Hardcastle’s superheater – and existing procedures did not provide for the latter.<sup>95</sup> One Treasury official described as ‘a most alarming prospect’ the possibility that the government might have to pay inventors for the right to sell surplus articles containing their inventions over and above what it had already paid to use their inventions itself.<sup>96</sup> Existing procedures were even more unsuitable for inventions covered by secret patents, with which the notion of export was fundamentally incompatible. As the Assistant Treasury Solicitor, Sir Alexander W. Lawrence, pointed out, inventors whose inventions were declared secret lost the value of their foreign rights unless the secrecy was waived in time for them to apply for foreign patents, and even then they might lose foreign rights in countries to which the British government had communicated the inventions – precisely as had occurred with Hardcastle.<sup>97</sup> The interests of multiple stakeholders, liberal principles concerning property rights, policy questions about harnessing technological innovation to national security, and large sums of money were all at stake.

Recognizing the complexity and magnitude of the issues, the Baldwin Committee recommended the establishment of a royal commission to compensate inventors for the wartime use of their inventions in its report of November 1918. Its draft instructions for the commission, listing the issues which the commissioners were to consider in evaluating the awards for inventions, as well as the records of the Baldwin Committee’s deliberations, demonstrate that the government established the RCAI in recognition of the inter-connectedness of the relationship between the state and inventors, between national security and intellectual property, and between foreign relations and national security.<sup>98</sup> The establishment of the RCAI reflected an impressive degree of comprehension by the government of a complex set of problems – at precisely the nexus of which Hardcastle’s case existed.

Hardcastle’s appeal for a reconsideration of his original award depended on the outcome of the Armstrong case, which was finally resolved in his favor by the Law Lords in November 1925.<sup>99</sup> He wasted no time in re-approaching the Admiralty for an additional reward.<sup>100</sup> In reply, the Admiralty expressed its regret that it could not make any further award, but it agreed that he was free to approach the RCAI if he wished.<sup>101</sup> When Hardcastle requested the assistance of the Admiralty’s patent experts in

formulating his case for the RCAI, the Admiralty demurred.<sup>102</sup> This refusal marked a sharp change from the Admiralty's previously helpful attitude. How to interpret its significance is unclear. Having done their best for Hardcastle within the employment regulations overseen by the Treasury, Admiralty officials may have felt that the matter was now out of their hands. There may also have been less sympathy for him than previously. During the time that elapsed during the Armstrong litigation, there would have been some turnover in personnel at the Admiralty. Moreover, Hardcastle (who was born in August 1875) had reached retirement age in August 1925, meaning that the Admiralty could no longer keep him on staff even if it wanted to.<sup>103</sup>

On his own, therefore, Hardcastle began to ready his case for the RCAI in March 1926.<sup>104</sup> This forum placed him in an adversarial position vis-à-vis the Treasury, not the Admiralty. The 'Admiralty' counter-statement to Hardcastle's claim, though sent under the name of its Director of Contracts, was actually prepared by the Treasury Solicitor.<sup>105</sup> Similarly, the crown was represented before the RCAI by lawyers from the Treasury Solicitor's office, not the Admiralty. Thus the two sides in the case were not Hardcastle and the Admiralty, but Hardcastle and the Treasury.

Both sides had the opportunity to argue their respective cases before the RCAI in the spring of 1927. Hardcastle made a number of arguments, of which three were especially important. First, he claimed that the £5,000 and accelerated promotion which he had accepted in 1908 did not accurately reflect the value of his invention, because it had greatly increased during the war.<sup>106</sup> This claim was obviously problematic. As the then-chair of the RCAI, Lord Tomlin, asked, 'Is not that just the speculation which a bargain of this sort is meant to deal with[?]', adding,

That is to say both the inventor and the purchaser say we do not quite know what is going to turn out of this. We are going to take our chance. The purchaser takes the chance of its turning out to be of no use and the inventor takes the chance of it turning out to be of more use.<sup>107</sup>

Tomlin's reliance on an analogy to ordinary commercial practice to understand Hardcastle's argument is striking – a point to which we shall return shortly. In a more sarcastic moment, the chair observed that Hardcastle's position on this point boiled down to, '[B]y great good luck we have had a Great War which has resulted in my invention being of more use to you than it would have been if there had not been a war'.<sup>108</sup> One can picture the smirk on the Treasury Solicitor's face.

Hardcastle's second argument was that he had not been a free agent when he accepted the award in 1908. 'Owing to the known value to the navy of these secret inventions and the limits of the Patent Acts in force at the time', he explained,

whatever terms were embodied in the assignment had to be accepted with good grace by the inventor if serving in H.M. Service, or incur Their Lordships [sic] displeasure, a proceeding which no junior Officer with any regard for his future prospects in the Service dare to risk. Under these circumstances it is suggested that any agreement entered into under these influences could hardly be held as constituting a fair contract.<sup>109</sup>

Hardcastle's lawyer repeated this argument before the RCAI, observing that he himself had never heard of any officer challenging whatever sum the Admiralty offered him for the use of his invention.<sup>110</sup> Unimpressed, Tomlin retorted, 'That may be because officers are not so foolish as to do so' – which was Hardcastle's point.<sup>111</sup> In rejecting

Hardcastle's contention that his status as a service inventor compromised his bargaining position, Tomlin again interpreted his situation by analogy to ordinary commercial practice, assuming that Hardcastle could have rejected the offer and continued the negotiations like a non-service inventor. This was a dubious assumption, given that Section 415 of the *King's Regulations*, which governed patent applications by service inventors in the navy, required them to agree to the following statement: 'The terms of the payment, if any, for the assignment of the patent to the Secretary of State, or for its use in His Majesty's Service, will be decided by the Admiralty'.<sup>112</sup> In this respect, Hardcastle's claim that he was not free to reject or renegotiate the Admiralty's offer was justified.

Hardcastle's third argument was that his war-induced departure from a normal career path had nullified the value of his 1908 award. The second component of his compensation package, he rightly argued, was the 'method of extended payment' through early promotion.<sup>113</sup> As we have seen, Hardcastle spent the war performing essential inspection duties on shore, while many of his peers in rank received accelerated promotion simply by virtue of serving at sea or being in a combat zone, which he was prohibited from doing because he was too important. As his lawyer put it to the RCAI, '[B]y being taken as a specialist to overlook [sic] the production of his own apparatus he has been excluded from the ordinary opportunities of officers of the same rank'.<sup>114</sup> Had he made captain, he would have been allowed an additional five years' service and then would have retired with a higher salary and therefore a higher pension. Had he lived long enough, the difference between a commander's and a captain's pension would have been considerable. Thus, Hardcastle claimed, he had actually lost in pension the same amount (£5,000) that he had been awarded in 1908, meaning that the Treasury had effectively recouped the value of the cash award.<sup>115</sup>

It is impossible to say whether Hardcastle's numbers were correct, though the principle was unquestionably valid. Too many variables (pay, half pay, allowances, tax rates, and so forth) with unknown values would be involved in the calculations to quantify with precision. Hardcastle's personal account books do not contain the data necessary to prove or disprove his claim. Putting aside the issue of his pension, war-induced inflation and increases in taxation by themselves would have significantly cut into the value of his 1908 award. With the evidence presently available, the most that can be said is that his claim should neither be accepted at face value nor dismissed out of hand.

Regardless, the chairman of the RCAI, Lord Tomlin, simply refused to hear it. When Hardcastle's attorney first asked him to consider the promotion issue, Tomlin balked: 'That seems to me to be a matter for the Admiralty, not for us'.<sup>116</sup> This was nonsensical: the RCAI had been established by the Treasury precisely because the usual procedures for compensating inventors were deemed insufficient, and it had been the Treasury, not the Admiralty, which placed obstacles in the way of the Admiralty's postwar efforts to honor the spirit of its 1908 agreement with Hardcastle. Later, when Tomlin permitted the lawyer representing the Admiralty to ask Hardcastle about his accelerated promotion, Hardcastle's attorney objected, '[I]f my friend is entitled to go into that which is accelerated promotion, surely I am allowed to go into deceleration arising out of precisely the same thing'.<sup>117</sup> Tomlin demurred:

It is quite a different thing you know. An officer is admittedly promoted in an unusual way to mark his services. That is one thing. That may very fairly be taken into account, but when he comes and says at a later stage as the result of his connection with this affair he did not get to sea or something of that sort with the result that he lost something, I confess that seems to me to be a wholly different matter.<sup>118</sup>

Once again, Tomlin seems to have been thinking in terms of ordinary commercial practice, despite the fact that there was no clear analogy to early promotion along the naval rank ladder in the civilian world, and the Admiralty had de facto acknowledged that Hardcastle's expectations in 1908 regarding his career path were reasonable. Tomlin's position evinced a disinterest in the workings of the naval promotion system and in so doing ruled out what was probably Hardcastle's strongest argument.

In the end, the RCAI decided not to award Hardcastle additional compensation. Whether this ruling was right or wrong, the hearings exposed important information about the RCAI's conceptual approach. Surely it was not for a royal commission, Tomlin repeatedly fretted, to second-guess the Admiralty's decisions?<sup>119</sup> On the contrary, Hardcastle's lawyer retorted, it was precisely the RCAI's job to act as 'the conscience of the Admiralty'.<sup>120</sup> Both men failed to understand that it was not the Admiralty's decisions that the RCAI was second-guessing, nor the Admiralty's conscience that the RCAI was acting as, but the Treasury's. The Admiralty understood that Hardcastle's case simply did not fit within the compensation system overseen by the Treasury, and it labored mightily within the limits of that system to incentivize Hardcastle to remain in the naval service. Treasury officials, as we have seen, pushed back, insisting that their system was not designed to do what the Admiralty wanted to do, and refusing to change it because of the costs entailed. There was a fundamental mismatch between the Admiralty's and Treasury's outlooks: the former was trying to uphold what it understood to be the spirit of its 1908 agreement, while the Treasury was determined to stick to the letter of its regulations. The elevation of Hardcastle's case to the realm of 'conscience' by his lawyer was an appeal to the RCAI to consider the spirit of the agreement and not its mere letter.

This was an appeal that Tomlin resisted. Although the RCAI did not issue rulings on individual cases, his comments throughout the Hardcastle hearings show that he inhabited the same conceptual universe as the Treasury. Accordingly, the RCAI was ill-equipped to act as the Treasury's conscience in Hardcastle's case. Like the Treasury, Tomlin invariably tried to understand Hardcastle's situation by analogy to ordinary practice, in his case ordinary commercial practice. This is perhaps not surprising, given that his experience as a patent judge concerned ordinary commercial patents – but the analogy was ill-suited to the issues raised by service inventors and secret patents.<sup>121</sup> When an aspect of Hardcastle's case did not fit the analogy, such as the early promotion issue, Tomlin simply refused to consider it. He failed to realize that the compensation problems triggered by the stalling of Hardcastle's promotion were not within the Admiralty's power to fix, but the Treasury's. In effect, Tomlin tried to understand Hardcastle's case through the prism of the private-sector master-servant relationship, in which the Admiralty was the master and Hardcastle the servant – when in fact the 'master' in this case was as much the Treasury as the Admiralty. The only forum that Hardcastle could turn to against his dual master was the RCAI, but Tomlin refused to let it be used to make up for the crack in the system that Hardcastle's case exposed:

a mismatch between the new phenomenon of service inventors who assigned secret patents to the government, and the old system of compensating officers.

Thus, for all that the government had intended the RCAI to plug the holes in the state's position on inventive activity that the war had created or exposed, and for all the holes that it had correctly identified, it had missed an important one, which Hardcastle had inadvertently stumbled into. In Hardcastle's case, the Treasury was unwilling to adapt its ordinary compensation practices, and the RCAI was unwilling to depart from a model of ordinary commercial practice. In these respects, both entities had regressed from the conceptual breakthrough reflected in the 1859 legislation which had established secret patents and, in so doing, acknowledged the unsuitability for national-security purposes of an intellectual property system designed for commercial use. In a real sense, the state in the 1920s – or at least the Treasury and RCAI – tried to solve new problems with old methods.

## Conclusion

The government's consideration of the proper attitude for the state to take toward innovation and service inventors did not end with the establishment of the RCAI. In the interwar period, the importance of high technology for defense purposes was more pronounced than ever, as was the imperative to harness British inventiveness to the task of maintaining Britain's technological edge. Yet the nature of the problem confronting the state had changed. An increasing share of inventiveness was to be found in the private sector rather than in the state. Of the share remaining to the state, more and more was being done by employees whose principal job was to conduct research. Of the private sector's share, a growing portion was to be found in the civilian rather than the defense sector. The government's persistent attention to the question of harnessing inventiveness within the state reflects both the importance attached to the issue and the changing nature of the problem. The story as it unfolded during the interwar period deserves an article (or book) of its own, as the National Archives are replete with files relevant to the subject, but a tentative outline can be offered here, in order to put Hardcastle's case and the period in which it occurred into perspective.

In 1920, a new inter-departmental committee on an important aspect of the state's effort to harness inventiveness – 'the methods of dealing with inventions made by workers aided or maintained from public funds' – began meeting under the chairmanship of Kenneth Lee, one of the lesser-known 'men of push and go', who had been a member of the Imperial Shipping Committee during the war.<sup>122</sup> The initiative for the Lee Committee came from the Department of Scientific and Industrial Research (DSIR), and its outlook reflected its origins. Though defense imperatives had driven prior state-supported invention, and service inventors had been in the vanguard, the Lee Committee regarded them as old problems. The new problems involved the use of inventions not for war but the commercial exploitation of patents derived with government support, whether for war or otherwise, and not service inventors but 'research workers' – civilian government employees whose principal job was to research. To borrow Clive Trebilcock's famous concept, the committee was concerned with 'spin-off', and its recommendations reflected its concern. Its most tangible recommendation was the establishment of a new 'Inter-Departmental Patents

Board' to deal mainly with non-secret inventions made by government servants, regardless of the originating department.<sup>123</sup> The decision to keep inventions secret was to remain with the departments, but somewhat incongruously, the new Board was to decide the awards for secret inventions.<sup>124</sup>

From the Admiralty's perspective, the problems engrossing the Lee Committee were largely irrelevant. As an official in the Contract and Purchase Department put it, in the navy 'the researches are essentially for war-like services and any commercial value is purely a by-product'.<sup>125</sup> Service inventors – in this context, inventors in the naval service who invented outside the normal course of their duty, i.e. not research workers – remained an important source of innovation, and they still needed to be incentivized.<sup>126</sup> Indeed, while the Admiralty was willing to hand over decisions about research workers in its employment to the Lee Committee's proposed Inter-Departmental Patents Board, it insisted on keeping decisions about secret inventions and service inventors for itself.<sup>127</sup> Finally, whereas the DSIR's and the Lee Committee's goal was to ensure that cutting-edge scientific and technological information circulated throughout industry, the Admiralty's goal was often to keep it secret.

Given these fundamentally opposing viewpoints, it is not surprising that the Lee Committee's proposal for a one-size-fits-all board languished.<sup>128</sup> In its stead, the Treasury weakly directed the departments to consult the Board of Trade for advice on the commercial exploitation of patents derived with departmental assistance.<sup>129</sup> The departments responded to the directive as they wished, which is to say haphazardly.<sup>130</sup> In 1930, a committee established by the Civil Service National Whitley Council to consider the issues raised by the Lee Committee's report endorsed its call for an inter-departmental patents board (albeit one entirely different in composition from what the Lee Committee had contemplated). The Treasury approved the Whitley committee's report, and a new standing Central Committee on Awards under the presidency of Sir Harold Morris began meeting in 1931.<sup>131</sup>

This sketch of the government's treatment of state-supported invention in the interwar period suggests continuity as well as change from the prewar period, which we might take as running from roughly 1859 to 1914 and which Hardcastle's case helps to illustrate. First, the power to classify inventions as secret, and control over service inventors who invented outside the course of their duty, remained at the departmental level in both periods, despite the push to centralize the government's treatment of state-supported inventors. Second, whereas the state's support of innovation in industry during the earlier period was largely confined to the defense sector, it had expanded to the civilian sector as well by the later period – though it is important to bear in mind that this expansion was relative, and support for military R&D remained higher than for civil.<sup>132</sup> Third, within this relatively declining but absolutely largest military share of state support for R&D, the Admiralty had surrendered first place to the Air Ministry. This change occurred not only in the relative sense that the air-industrial complex was gaining at the expense of the naval-industrial complex but also in the absolute sense that the cutting edge of military-technological innovation had shifted from the sea to the air. One measure of this changing of the guard was that in the year after the Treasury directed the departments to seek the Board of Trade's advice on the commercial exploitation of patents derived with their assistance, the Air Ministry made 69 inquiries, while the Admiralty made only four.<sup>133</sup> Although the two departments may have been using different criteria for submitting

inquiries, the disparity likely reflected the greater dual-use potential of air rather than naval technology – ‘dual-use’ here in terms of its potential both for civilian (as opposed to military) use and for private-sector (as opposed to public-sector) production.

Accordingly, the details of the Hardcastle case were representative of a particular period of state-society relations but illustrative of an ongoing problem, stretching from the middle of the 19<sup>th</sup> century through until today. The nature of both this change and continuity cannot be grasped without examination of the sort of details involved in Hardcastle’s case. Given the distinctiveness of the ‘naval’ period in which it occurred, the same questions cannot be asked of it as of cases from the subsequent ‘air’ period. The ‘naval’ period, book-ended by two wars (the Crimean War and World War I), was defined by four related characteristics: heightened national-security concerns relative to the preceding decades, changes in the patent system, significant state support for technological innovation for defense, and the dominance by the navy of both the cutting edge of technological change and procurement from the private sector. While the novel feature of this state support was its extension to the private sector, state support for public-sector innovation remained important, especially for the most secret and important technologies. Hardcastle’s superheater was one such technology.

Hardcastle’s case both serves as a reminder of what much previous work has already demonstrated and points the way to future research. As is sometimes forgotten (though rarely by historians of technology), technological innovation cannot be reduced to ingenuity or demand: in Hardcastle’s case, the bureaucratic environment played a crucial role in shaping both the development of his invention and prevailing incentivization and reward structures.<sup>134</sup> At the same time, his case illuminates important but under-studied connections between national-security concerns, intellectual property rights, and public-sector innovation. Like Hardcastle’s superheater, modern British history cannot be understood in all its complexity without further investigation of these connections.

## Notes

1. Minute by Bacon, 17 December 1908, G18178/08, Ship’s Cover 224/F34, Brass Foundry, Woolwich, England [hereafter BF].
2. For the numbers for fiscal year 1913/14, see minutes on G01080/12, “Reserves of Torpedoes,” *Principal Questions Dealt with by the Director of Naval Ordnance* [hereafter PQ]12/F43/P330–36, Ja 397, Admiralty Library, Portsmouth, England [hereafter AL]; and Winston Churchill, speech to the House of Commons, 26 March 1913, *Parliamentary Debates*, vol. 50, col. 1775.
3. March, *British Destroyers*, 84; Sumida, *In Defence of Naval Supremacy*, Table 16.
4. Bastable, *Arms and the State*, 25–33, 60–61; and McNeill, *The Pursuit of Power*, 238–41.
5. William McNeill famously dubbed the results of these new arrangements ‘command technology’ (see McNeill, *The Pursuit of Power*, 278–80).
6. O’Dell, *Inventions and Official Secrecy*, 4–9.
7. *Ibid.* 19–24. See also Daniel LeClair, “Supervising a Revolution” – he does not deal with secret patents, but intellectual property is a recurring issue in his story, and he traces more carefully than any other historian the bureaucratic reforms in army ordnance procurement following the Crimean War.
8. See, e.g. Pottage and Sherman, *Figures of Invention*.
9. O’Dell, *Inventions and Official Secrecy*.

10. The major exception is Sumida's *In Defence of Naval Supremacy*, which pays careful attention to both secret patents and the military value of the patented technology.
11. Specifically, they were entitled by Section 27 of the 1883 Patents, Designs, and Trade Marks Act, which was repeated as Section 29 in the 1907 Patents and Designs Act.
12. See, e.g. Section 415 of *The King's Regulations and Admiralty Instructions for the Government of His Majesty's Naval Service* of 1906 and 1913.
13. See "Report of the Departmental Committee on Awards to Inventors," 1 November 1918, para. 3, Treas 8952/18, Docket "Minute. Awards to Inventors. Extension of Power of Depts to award up to £1,000 without reference to Treasury," T 1/12,325, the National Archives, Kew, England [hereafter TNA].
14. Fisk, *Working Knowledge*, 24–31; and Pila, "Sewing the Fly Buttons on the Statute," 269–75.
15. The patent lawyer Kenneth R. Swan, who would go on to lead major inquiries into the patent system during and after World War II, made precisely this point in a paper delivered in 1920, for which see Swan, "A Review of the Law Relating to the Use and Patenting of Inventions by Government Departments and Their Officials," December 1920, Folio B(6)a, p. 5, enclosed in Swan to Tindal Robertson, 24 February 1921, T 173/17, part 1, TNA.
16. McNeill, *The Pursuit of Power*, 223–306, esp. 271–72.
17. Babcock to Twining, 1 September 1912, B73-315, Naval Torpedo Station records, Newport, RI, USA.
18. Recent and valuable studies by Christine MacLeod and Graeme Gooday look at air and army, not navy, inventors, respectively. See MacLeod, "A Delicate Business': Wartime Airplane Designs"; and Gooday, "Combative Patenting."
19. See, e.g. Varcoe, "Scientists, Government and Organised Research"; MacLeod and Andrews, "The Origins of the D.S.I.R."; idem, "Scientific Advice in the War at Sea"; and Pattison, "Scientists, Inventors and the Military in Britain."
20. These last four features distinguish Hardcastle's case from the naval-technological case discussed in Zimmerman, "A More Creditable Way."
21. For further development of these points, see Epstein, "Scholarship and the Ship of State."
22. On Leavitt's superheater, see idem, *Torpedo*, chapters 1 and 3. On the Admiralty's rejection of Leavitt's superheater, see docket "Application of Heat to Compressed Air for Torpedoes," ADM 1/7657, TNA.
23. Transcript of proceedings in Hardcastle's RCAI claim [hereafter Hardcastle's RCAI claim], 28 March 1927, p. 5, T 173/649, TNA.
24. Briggs to Jellicoe, 5 October 1905, T 173/257, TNA. The originals of Hardcastle's three secret patents (21,176/1905, 16,929/1906, and 27,347/1908) no longer survive. What do survive are typed purported copies of the three patents in the records collected for Hardcastle's RCAI claim, which can be found in T 173/257, TNA.
25. Jellicoe to Briggs, 7 October 1905, T 173/257, TNA.
26. For the debate over the provenance of the copies used in the RCAI claim, now in T 173/257, TNA, see transcript of RCAI meeting of 28 March 1927, 7–12; examination and cross-examination of Gibbs and Hardcastle, 4 April 1927, 18–34; examination of Hardcastle, 34–39, cross-examination of Hardcastle, 55–61, 63–65, and re-examination of Hardcastle, 73–76, all in Hardcastle's RCAI claim, T 173/649, TNA.
27. Examination of Hardcastle by Moritz, 4 April 1927, Hardcastle's RCAI claim, p. 37; re-examination of Hardcastle by Moritz, 4 April 1927, *ibid*.
28. "Report of the Inter-Departmental Committee Appointed to Consider the Regulations as to the Taking out of Patents by Officers and Subordinates in Government Employment, with Appendices, 1905–06," 30 April 1906, 5, WO 32/5080, TNA.
29. Appendix VI, *ibid*. These suspicions were echoed after the war. See *Report of the Inter-Departmental Committee Appointed to Consider the Methods of Dealing with Inventions Made by Workers Aided or Maintained from Public Funds* (London: HMSO, 1922), para.



33. See also Civil Service National Whitley Council, *Report of the Patents Committee* (London: HMSO, 1930), para. 5.
30. Examination of Hardcastle by Moritz, 39, and cross-examination of Hardcastle by Whitehead, 65–69, 4 April 1927, Hardcastle’s RCAI claim, T 173/649, TNA.
31. For the Admiralty’s acceptance of the date, see Whitehead’s cross-examination of Hardcastle, 4 April 1927, Hardcastle’s RCAI claim, 71–72; *ibid.* See also hearing before the RCAI, p. 12, 28 March 1927, *ibid.*
32. Hardcastle to Gamble, 29 September 1908, enclosed in Hardcastle to Robertson, 15 April 1926, T 173/257, TNA.
33. *Ibid.*
34. Annual Report of the Torpedo School, 1907, 25–30 [hereafter cited in the format ART07/25–30], ART08/18. This was the superheater described in GBP 3,495/1905, Sodeau’s second superheater patent. Copies of the annual reports of the Torpedo School (HMS *Vernon*) may be found in several archives; the most complete run is in ADM 189, TNA.
35. Hardcastle to Gamble, 29 September 1908, enclosed in Hardcastle to Robertson, 15 April 1926, T 173/257, TNA; Gamble to Jellicoe, 28 October 1907, *ibid.* ART06/23.
36. See above 32.
37. For these performance figures, see ART08/19 and ART 09/11.
38. Bacon, “Paper Prepared by the Director of Naval Ordnance for the Information of his Successor,” 24 November 1909, G19535/09, 22, AL; Lees to SecAdm, 13 April 1907, enclosed in Lees to Albert Vickers, 13 April 1907, microfilm M306, Vickers Archive, Cambridge University Library, Cambridge, England; Armstrong board minutes of 30 May 1907, 25 July 1907, 18 June 1908, Accession 130/1267 (Minute Book #2), Tyne & Wear Archives, Newcastle, England [hereafter T&W].
39. ART06/23, ART09/11.
40. HMS *Dreadnought* was 527 ft long. The probability of hitting is the ratio of ship lengths to the total length of the line.
41. Quoted in Lambert, *Sir John Fisher’s Naval Revolution*, 79 (see also 330n51).
42. For further elaboration of these points, see Epstein, *Torpedo*, 94–98, 196–204.
43. ART07/19, ART10/12.
44. See “Paper Prepared by the Director of Naval Ordnance for the Information of his Successor,” 24 November 1909, G19535/09, 22–23, AL; minutes on G5891/09, PQ/08–11/3360/178–80, ADM 256/44, TNA; minutes on G18178/08, SC224/F34, BF; and minutes on G01080/12, “Reserves of Torpedoes,” PQ/12/F43/P330–36, Ja 397, AL. For the cost of *Acasta*-class destroyers, see March, *British Destroyers*, 124.
45. Minute by Currey, 22 October 1907, G16396/07, PQ/09/3345/156–57, ADM 256/44, TNA (contains first quotation); minutes by Currey, 17 December 1908 (contains second quotation; emphasis added), and Bacon, 17 December 1908, G18178/08, SC 224/F34, BF.
46. Bacon, “The Battleship of the Future,” paper read at the 51<sup>st</sup> session of the Institution of Naval Architects, 16 March 1910, published in *Transactions of the Institution of Naval Architects* 52 (1910): 2.
47. Minute by Jellicoe, 22 October 1907, G16396/07, PQ/09/3345/156–57, ADM 256/44, TNA.
48. For more on these tactical issues, see Epstein, *Torpedo*, 128–30, 204–11.
49. Lawrence memorandum, “Patents, Designs and Inventions,” para. 6, enclosed in Lawrence to Tindal Robertson, 9 December 1918, Treas 7388/19, Docket “Minute. Awards to Inventors. Memoranda by Sir A. Lawrence on legal difficulties of present position,” T 1/12,283, TNA.
50. Hardcastle to Captain of *Vernon*, 29 September 1908, enclosed in Hardcastle to Robertson, 15 April 1926, T 173/257, TNA.
51. Pila, “Sewing the Fly Buttons on the Statute,” 269–75.
52. Admiralty Awards Council, Report 26, “Award to Engineer Lieutenant S. U. Hardcastle,” 3 November 1908, ADM 245/1, TNA.

53. SecAdm to CINC Portsmouth, 3 December 1908, CP Patents 237/43,255/08, forwarded to Hardcastle on 4 December 1908, copy in T 173/257, TNA.
54. Hardcastle to SecAdm, 8 December 1908, *ibid*.
55. In a February 1918 memorandum, the Exchequer and Audit Department observed that “some uncertainty appears to exist as to the relation of awards to the assessment of income tax” (Secretary, Exchequer and Audit Department to SecTreas, 18 February 1918, Treas 7136/18, Docket “Exchequer and Audit Department. Grants of rewards and royalties for inventions,” T 1/12,325, TNA).
56. Minute by Toop [Engineer Admiral, Personnel], 6 January 1922, on Treasury letter S11342/22, copy in T 173/257, TNA.
57. See esp. Hardcastle to Director of Torpedoes and Mining, 5 May 1920, *ibid*.
58. See “Extract from Report of Conference held at the Office of the Department of Scientific and Industrial Research,” Docket “Scientific and Industrial Research Department. Tin and Tungsten Research Bd.’s investigations,” T 1/12,467, TNA; folio ‘O,’ “Admiralty Practice as Regards Service Patents,” n.d. but probably 1920, T 173/18, Part I, TNA; hand-written note on the document entitled “Licences Granted” (n.d. but probably c. June 1925), Treas S13017/01/2, Docket “Interdepartmental Committee on Patents,” T 161/556/4, TNA.
59. There is a ‘gratuity for an invention’ of £5,000 – presumably Hardcastle’s – appearing in the Navy Appropriation Account for fiscal year 1909/10 under Vote 11, Subhead K, ‘Gratuities for Special Services, etc.’ See *Navy Appropriation Account, 1909–1910*, House of Commons report no. 18 (London: HMSO, 1911).
60. Hardcastle’s account books, as well as certain other of his papers, are in the possession of his younger grand-daughter, Mrs. Anna-Clare Priester-Reading, who kindly let me consult them. There are two account books, one in a vertically bound notebook with an unmarked black cover and the other in a horizontally bound notebook with a black cover marked ‘Book B.’ When I viewed them, both were kept in a black tin box stamped with Hardcastle’s initials on the front. All of the figures used in this article come from the unmarked black book.
61. Testimony of Colonel H. C. L. Holden (Superintendent of RGF), 25 October 1905, Appendix VII, “Report of the Inter-Departmental Committee Appointed to Consider the Regulations as to the Taking out of Patents by Officers and Subordinates in Government Employment, with Appendices, 1905–06,” WO 32/5080, TNA.
62. Reginald Bacon, the first, joined the Coventry Ordnance Works. Edgar Lees, the second, joined the Whitehead Torpedo Company. S. S. Hall, the third, was discovered in the course of flirting with Yarrow.
63. The best account of the fire-control case remains Sumida, *In Defence of Naval Supremacy*, which has been corroborated by Friedman, *Naval Firepower*.
64. I am grateful to an anonymous referee for suggesting this formulation to me.
65. Hardcastle to Director of Torpedoes and Mining, 1 July 1919, copy in T 173/257, TNA. See also MacLeod, “A Delicate Business,” 270.
66. Minute by Toop, 6 January 1922, Treas S11342, copy in T 173/257, TNA.
67. Minutes by DTM and Director of Contracts, described and dated in Admiralty Awards Council, Report 243, “Proposed further award to Engineer Commander S. M. [*sic*] Hardcastle, R.N.,” n.d. but 1920, ADM 245/3, TNA.
68. Admiralty to French, Italian, and American naval attachés, 6 April 1920, CP G7734, and replies, copies in T 173/257, TNA.
69. An entry in his account book for December 1919 refers to “11 months at increased rate of pay + 1 at old rate of pay.”
70. See minute by Pinsent, n.d. but late May/early June 1921, CE12784/20, Docket “Admiralty. Engr-Commander S. O. [*sic*] Hardcastle, Assistant to Chief Inspector, Naval Ordnance Dept, Appointment,” Treas S11342, T 161/134, TNA.

71. Hardcastle entered £48 for his actual pay for December 1919 as compared to his entries of £40 for the war years, and as late as February 1919. There are no entries for March–November 1919.
72. Minute by DTM, 14 October 1920, CE12784/20, copy in T 173/257, TNA.
73. Minutes by Hardcastle et al., December 1921–January 1922, on Treasury S11342 of 19 November 1919, *ibid.* See also SecAdm to SecTreas, 28 February 1922, CE12783/21, Docket “Admiralty. Engr-Commander S. O. [*sic*] Hardcastle,” Treasury S11342, T 161/134, TNA.
74. SecAdm to SecTreas, 10 July 1920, CE4410/20; SecAdm to SecTreas, 28 February 1922, CE12783/21, Docket “Admiralty. Engr-Commander S. O. [*sic*] Hardcastle,” Treas S11342, T 161/134, TNA.
75. SecTreas to SecAdm, 16 September 1920, E805; SecTreas to SecAdm, 24 March 1921, E3326, *ibid.*
76. SecAdm to SecTreas, 3 May 1921, CE12784/20, *ibid.*
77. Minute by Medica [sp?], 11 May 1921, CE12784/20, *ibid.*
78. Minute by Pinsent, n.d., CE12784/20, *ibid.*
79. Minute by Mikar [sp?], 17 November 1921, CE6671/21, *ibid.*
80. Minute by Pinsent, 18 October 1921, CE6671/21, *ibid.*
81. See Lambert, *Sir John Fisher’s Naval Revolution*, 111–14.
82. For a nuanced exploration of the Treasury’s attitude towards the spending departments, see Roseveare, *The Treasury*, 199–210. Roy MacCleod’s excellent study of the Treasury’s attitude towards science from 1870 to 1885 (“Science and the Treasury”) is the only work I know of which seeks to analyze as such the Treasury’s attitude towards science and/or technology over any period of time.
83. SecAdm to SecTreas, 28 February 1922, CE12783/21, Docket “Admiralty. Engr-Commander S. O. [*sic*] Hardcastle,” Treasury S11342, T 161/134, TNA.
84. Minute by Ray, 21 April 1922, CE12783/21, *ibid.*
85. Minute by Mikar, 27 April 1922, CE12783/21, *ibid.*
86. SecTreas to SecAdm, 29 April 1922, S11342, *ibid.*
87. Armstrong Executive Committee minute of 21 December 1921, Accession 130/1298 (Executive Committee Minute Book #8), T&W.
88. See Hardcastle to SecAdm, 22 November 1922, enclosed in Hardcastle to Robertson, 15 April 1926, T 173/257, TNA; and 41 RPC 33, 36.
89. Hardcastle to SecAdm, 22 November 1922, enclosed in Hardcastle to Robertson, 15 April 1926, T 173/257, TNA.
90. Pila, “Sewing the Fly Buttons on the Statute,” 276–78, provides a good analysis of the Baldwin Committee’s final published report, but does not cite archival sources. Most recently, David Zimmerman mistakenly asserted that “records pertaining to the establishment of the Commission do not survive” (“A More Creditable Way,” 52). In fact they do survive, but in the T 1 (Treasury Secretariat) files, not in the T 173 files, where Zimmerman (and others) have looked.
91. Minutes of the first meeting of the Inter-Departmental Conference on Patents [Graham Committee], enclosed in Smallwood to Tindal Robertson, 11 April 1918, Treas 9237/18, Docket “Ministry of Munitions. Inventions and Patents. Decisions required. For Treasury representative at Interdepartmental Conference”; Greene to SecTreas, 4 March 1918, and enclosed memorandum on ‘Inventions and Patents’, Treas 9237/18, *ibid.* Waterfield to Barstow, 15 April 1918, para. 5, Treas 9237/18, *ibid.* SecMinMun to SecTreas, 26 April 1918, Treas 16,767/18, Docket “Ministry of Munitions. Methods of dealing with awards for inventions as to appt of formal Committee to draw up scheme”; SecTreas to SecMinMun, 1 June 1918, Treas 16,767/18, *ibid.* minute by Waterfield, 27 June 1918, Docket “Ministry of Munitions. Awards for Inventors. Committee to discuss methods of dealing with. Vice Admiral Sir R. H. S. Bacon and Sir Philip Henriques to represent Dept,” all in T 1/12,325, TNA.

92. SecAdm to SecTreas, 7 January 1919, para. 3, Treas 1089/19, Docket “Admiralty. Commission for dealing with awards to inventors. Remarks on proposed formation of,” *ibid.*
93. “Report of the Departmental Committee on Awards to Inventors,” 1 November 1918, Treas 8952/18, Docket “Minute. Awards to Inventors. Extension of Power of Depts to award up to £1,000 without reference to Treasury,” *ibid.*
94. “Proposed Instructions to Commission,” appendix to *ibid.*
95. “Report of Conference Called To Consider Various Questions in Connection with Patents” [Greene Committee], n.d. but c. April 1918, Docket “Ministry of Munitions. Patents. Report of Conference called to consider various questions in connection with,” T 1/12,325, TNA; Lawrence memorandum, 6 November 1918, sec. 1, *ibid.* SecAdm to Hardcastle, 21 January 1921, Adm G14590/25,271, T 173/257, TNA.
96. Waterfield to Barstow, 15 April 1918, para. 4, Docket “Ministry of Munitions. Inventions and Patents. Decisions required. For Treasury representative at Interdepartmental Conference,” T 1/12,325, TNA.
97. Lawrence, “Patents, Designs and Inventions,” enclosed in Lawrence to Tindal Robertson, 2 August 1918, Treas 7388/19, Docket “Minute. Awards to Inventors. Memoranda by Sir A. Lawrence on legal difficulties of present position,” T 1/12,283, TNA.
98. “Report of the Departmental Committee on Awards to Inventors,” 1 November 1918, Treas 8952/18, Docket “Minute. Awards to Inventors. Extension of Power of Depts to award up to £1,000 without reference to Treasury,” T 1/12,325, TNA.
99. 41 RPC 33–46; 41 RPC 189–200; 42 RPC 543–60.
100. Hardcastle to SecAdm, 9 November 1925, enclosed in Hardcastle to Robertson, 15 April 1926, T 173/257, TNA.
101. SecAdm to Hardcastle, 12 January 1926, CP Patents 2563/25/79, enclosed in Hardcastle to Robertson, 15 April 1926, *ibid.*
102. Hardcastle to SecAdm, 16 February 1926; SecAdm to Hardcastle, 25 February 1926, CP Patents 2693/26/413, enclosed in Hardcastle to Robertson, 15 April 1926, *ibid.*
103. Hardcastle’s service record, ADM 196/133, ff. 165–66, 176, TNA.
104. Hardcastle to Robertson, 25 March 1926, T 173/257, TNA.
105. Hardcastle to Robertson, 15 April 1926; Cobb (for Director of Contracts) to Robertson, 8 February 1927, CP Patents 2766/26/912; *ibid.* On the Treasury Solicitor’s role, see Cobb (for Director of Contracts) to Robertson, 18 December 1926, CP Patents 2827/26/2452, *ibid.*
106. Hardcastle to Robertson, 15 April 1926, T 173/257, TNA.
107. Comment by Tomlin, 4 April 1927, Hardcastle’s RCAI claim, 14–15, T 173/649, TNA.
108. Comment by Tomlin, 28 March 1927, Hardcastle’s RCAI claim, 16, *ibid.*
109. See above 106.
110. Comments by Moritz, 4 April 1927, Hardcastle’s RCAI claim, 2–3, T 173/649, TNA.
111. Comment by Tomlin, 4 April 1927, Hardcastle’s RCAI claim, 3, *ibid.*
112. *The King’s Regulations and Admiralty Instructions for the Government of His Majesty’s Naval Service, 1906* (London: HMSO, 1906), section 415, 127.
113. Hardcastle to Tindal Robertson, 15 April 1926, T 173/257, TNA.
114. Comment by Moritz, 28 March 1927, Hardcastle’s RCAI claim, 21, T 173/649, TNA.
115. Unfortunately, only a small fragment of what seems to have been a much larger file dealing specifically with Hardcastle’s pension has survived. For the fragment, see the extract from a minute by the Director of Torpedoes and Mining, 14 October 1920, CE12784/20, copy in T 173/257, TNA. For evidence that it was part of a larger file, see Hardcastle to Tindal Robertson, 15 April 1926, *ibid.*
116. Comment by Tomlin, 28 March 1927, Hardcastle’s RCAI claim, 21, T 173/649, TNA.
117. Comment by Moritz, 4 April 1927, Hardcastle’s RCAI claim, 43, *ibid.*
118. Comment by Tomlin, 4 April 1927, Hardcastle’s RCAI claim, 43–44, *ibid.*
119. See, e.g. Tomlin’s comments of 28 March 1927, 21–22, and 4 April 1927, 44, 107, Hardcastle’s RCAI claim, *ibid.*

120. Comment by Moritz, 4 April 1927, Hardcastle's RCAI claim, 107, *ibid.*
121. See Lord Millett, "Tomlin."
122. On Lee, see his obituary, "Sir Kenneth Lee," *Journal of the Royal Society for the Encouragement of Arts, Manufactures and Commerce*, 116, no. 5137 (1 December 1967): 71.
123. Baddeley to SecTreas, 9 May 1922, Adm CP1395/22/1476, para. 5, Docket "Inter-Departmental Committee on Patents: Report of," S13017, T 161/145/12, TNA; Creedy to SecTreas, 3 August 1922, War 84/Gen.No./4839 (C.1.), *ibid.*
124. *Report of the Inter-Departmental Committee Appointed to Consider the Methods of Dealing with Inventions Made by Workers Aided or Maintained from Public Funds*, para. 16.
125. Cobb to Pinsent, 16 July 1925, Treas S13017/01/2, Docket, "Interdepartmental Committee on Patents," T 161/556/4, TNA.
126. See the note on the document entitled "Licences Granted" (n.d. but probably June 1925), Treas S13017/01/2, Docket "Interdepartmental Committee on Patents," *ibid.*
127. Baddeley to SecTreas, 9 May 1922, Adm CP1395/22/1476, Docket, "Inter-Departmental Committee on Patents: Report of," S13017, *ibid.*
128. See Meiklejohn to Tindal Robertson, 6 April 1923, T 173/17, Part II, TNA; minutes and correspondence in Treas S13017/01, Docket "Interdepartmental Committee on Patents," T 161/556/3, TNA, esp. Barstow to SecTreas, 11 January 1923 and Ashley to SecTreas, 26 February 1923.
129. Treasury circular #10,124, "Exploitation of Inventions Made by Government Servants," 30 April 1924, copy in Treas S13017/01, T161/556/3, TNA.
130. See the correspondence in Treas S13017/01/2, Docket "Interdepartmental Committee on Patents," T 161/556/4, TNA.
131. For background, see Bunning to Scott, 30 September 1924, along with minutes and reply, Treas S13017/01, Docket "Interdepartmental Committee on Patents," T 161/556/3, TNA. For the Whitley committee's report and Treasury approval, see Treasury circular "Patents Committee of the Civil Service National Whitley Council: Application of Recommendations," 5 December 1930, Treas S36335, Docket "Patents. Central Committee on Awards," T 161/537/6, TNA. See also Pila, "Sewing the Fly Buttons on the Statute," 278–83.
132. The Lee Committee's *Report* makes this point nicely in para. 3. See also Edgerton, *England and the Aeroplane*, 56, and *idem*, "Liberal Militarism and the British State," 138–169.
133. SecBoT to SecTreas, 4 June 1925, Treas S13017/01/2, Docket "Interdepartmental Committee on Patents," T 161/556/4, TNA.
134. My thanks to Tiago Saraiva and Amy Slaton for suggesting this point to me.

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## Archival Sources

Admiralty Library, Portsmouth, England  
 Ships' Covers, Brass Foundry, Woolwich, England  
 Naval Torpedo Station records, Newport, RI, United States  
 The National Archives, Kew, England  
   ADM [Admiralty] 1, Admiralty Secretariat  
   ADM 189, Annual Reports of the Torpedo School  
   ADM 245, Admiralty Awards Council Papers  
   ADM 256, Principal Questions dealt with by the Director of Naval Ordnance  
   T [Treasury] 1, Treasury Secretariat  
   T 161, Supply Department Registered Files  
   T 173, Records of the Royal Commission on Awards to Inventors (Tomlin Commission)  
   WO [War Office] 32, Registered Files  
 Sydney Hardcastle Papers, courtesy of Mrs. Anna-Clare Priester-Reading  
 Tyne & Wear Archives, Newcastle, England  
 Vickers Archive, Cambridge University Library, Cambridge, England

## Bibliography

- Bastable, M. J. *Arms and the State: Sir William Armstrong and the Remaking of British Naval Power, 1854–1914*. Aldershot: Ashgate, 2004.
- Edgerton, D. “Liberal Militarism and the British State.” *New Left Review* 185, January-February (1991): 138–169.
- Edgerton, D. *England and the Aeroplane: Militarism, Modernity, and Machines*, 1<sup>st</sup> ed. London: Penguin, 2013. 1991.
- Epstein, K. C. *Torpedo: Inventing the Military-Industrial Complex in the United States and Great Britain*. Cambridge, MA: Harvard University Press, 2014.
- Epstein, K. C. “Scholarship and the Ship of State: Rethinking the Anglo-American Strategic Decline Analogy.” *International Affairs* 91, no. 2, (2015, March): 319–331. doi:10.1111/1468-2346.12237.
- Fisk, C. L. *Working Knowledge: Employee Innovation and the Rise of Corporate Intellectual Property, 1800–1930*. Chapel Hill: University of North Carolina Press, 1999.
- Friedman, N. *Naval Firepower: Battleship Guns and Gunnery in the Dreadnought Era*. Barnsley, England: Seaforth Publishing, 2013.
- Gooday, G. “Combative Patenting: Military Entrepreneurship in First World War Telecommunications.” *Studies in History and Philosophy of Science* 44 (2013): 247–258. doi:10.1016/j.shpsa.2012.11.005.
- Lambert, N. *Sir John Fisher's Naval Revolution*. Columbia, SC: University of South Carolina Press, 1999.
- LeClair, D. 2015. “Supervising a Revolution: British Ordnance Committees, Private Inventors, and Military Technology in the Victorian Era.” PhD dissertation, University of Houston.
- MacLeod, C. “‘A Delicate Business’: Wartime Airplane Designs and Their Post-War Evaluation, 1919–1924.” *Studies in History and Philosophy of Science* 44 (2013): 269–279. doi:10.1016/j.shpsa.2012.11.008.
- MacLeod, R. “Science and the Treasury: Principles, Personalities and Policies, 1870–85.” In *The Patronage of Science in the Nineteenth Century*, edited by G L'E Turner, 115–172. Leyden: Nordhoff International Publishing, 1976.
- MacLeod, R., and E. Kay Andrews “The Origins of the D.S.I.R.: Reflections on Ideas and Men, 1915–1916.” *Public Administration* 48, no. 1 (1970, March): 23–48.
- MacLeod, R., and E. Kay Andrews. “Scientific Advice in the War at Sea, 1915–1917: The Board of Invention and Research.” *Journal of Contemporary History* 6, no. 2 (1971): 3–40. doi:10.1177/002200947100600201.

- March, E. *British Destroyers: A History of Development, 1892–1953*. London: Seeley Service & Co., 1966.
- McNeill, W. *The Pursuit of Power: Technology, Armed Force, and Society since AD 1000*. Chicago: University of Chicago Press, 1982.
- Millett, L. “Tomlin, Thomas James Chesshyre, Baron Tomlin (1867–1935).” In *Oxford Dictionary of National Biography*. Oxford: Oxford University Press, 2004. doi:[10.1093/ref:odnb/36531](https://doi.org/10.1093/ref:odnb/36531).
- O’Dell, T. H. *Inventions and Official Secrecy: A History of Secret Patents in the UK*. Oxford: Clarendon Press, 1994.
- Pattison, M. “Scientists, Inventors and the Military in Britain, 1915–19: The Munitions Inventions Department.” *Social Studies of Science* 13 (1983): 521–568. doi:[10.1177/030631283013004004](https://doi.org/10.1177/030631283013004004).
- Pila, J. “‘Sewing the Fly Buttons on the Statute’: Employee Inventions and the Employment Context.” *Oxford Journal of Legal Studies* 32, no. 2 (2012): 265–295. doi:[10.1093/ojls/gqs003](https://doi.org/10.1093/ojls/gqs003).
- Pottage, A., and B. Sherman. *Figures of Invention: A History of Modern Patent Law*. Oxford: Oxford University Press, 2010.
- Roseveare, H. *The Treasury: The Evolution of a British Institution*. New York, NY: Columbia University Press, 1969.
- Sir Kenneth L,” *Journal of the Royal Society for the Encouragement of Arts.*” *Manufactures and Commerce* 116, no. (5137) (1 December 1967): 71.
- Sumida, J. *In Defence of Naval Supremacy: Finance, Technology, and British Naval Policy, 1889–1914*. Boston: Unwin Hyman, 1989.
- Varcoe, I. “Scientists, Government and Organised Research in Great Britain 1914–16: The Early History of the DSIR.” *Minerva* 8, no. 2, (1970, April): 192–216. doi:[10.1007/BF01553212](https://doi.org/10.1007/BF01553212).
- Zimmerman, D. “‘A More Creditable Way’: The Discovery of Active Sonar, the Langevin-Chilowsky Patent Dispute and the Royal Commission on Awards to Inventors.” *War in History* 25, no. 1 (2018): 48–68. doi:[10.1177/0968344516651308](https://doi.org/10.1177/0968344516651308).

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