The Price of Invention: counting the cost of patents in Victorian Britain, a case study from steam engineering

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The Price of Invention: counting the cost of patents in Victorian Britain, a case study from steam engineering[1]

Throughout the nineteenth century the access of inventors to a British patent was restricted primarily by cost, not by examination. Until the Patents Act of 1902 introduced an official examination to check that the invention was new (in Britain), the British system was one of registration: the burden of scrutiny lay with the patentee and his or her agent. Contemporaries tended to place their trust in the economic rationality of inventors, assuming that only those with a novel and technically viable invention which promised to be commercially profitable would go to the expense of a patent. Consequently, any proposal to reduce the cost of obtaining a patent raised the issue of how else applications would be filtered, in particular the spectre of examination and the employment of a bureaucracy to conduct it. As an alternative to the system of high initial costs which prevailed until 1852, legislation in that year drastically cut the initial fees but instituted high renewal payments at the end of three and seven years—a

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1 The authors are indebted to the Leverhulme Trust which funded the research project, 'Dilemmas of a Maturing Technology: Boulton, Watt & Co. and nineteenth-century engineering'. They wish to thank Vivien Jones for extracting much of the occupation and location data on patentees; the staff of the Patent Library, Birmingham and of the Birmingham City Archives for their considerable assistance with the project; participants in the Economic History Workshop, UCLA (2001), and in the Franco-American Conference on the Economics, Law and History of Intellectual Property Rights, University of California, Berkeley (2001), for their insightful comments on a previous draft of the paper; and Dr Roger Middleton for his invaluable help in scanning and incorporating the graphs.

structure that was retained in 1883 when the initial fees were again reduced.[2] Despite the reforms of 1852 and 1883, therefore, Britain remained out of step with most other countries, which chose to filter patents by examination rather than by cost. Ian Inkster has calculated that 'By 1870, the cost in US dollars of securing patents, calculated on the basis of price per annum covered, was considerably higher than elsewhere, by a factor of three compared to Belgium and France, of ten compared to Prussia, and of thirty compared to the United States.'[3] Historians have followed contemporaries in trusting to the filtering effects of economic rationality: until 1852 the enormous fees payable on initial registration; from 1852 the high costs of keeping a patent in force beyond three years.[4] This paper will cast doubt on the economic rationality of patentees on both these points.

Although the Acts of Union of 1707 and 1800 brought the kingdoms of the British Isles into parliamentary union, it was 1852 before their patent systems were similarly united. Until 1852 three separate patents had to be obtained for England and Wales, Scotland,

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2 The first payment was deferred until the end of the fourth year.

3 Inkster, I., 'Machinofacture and technical change: the patent evidence', in I. Inkster et al, ed., The golden age: essays in British social and economic history, 1850-1870 (Aldershot, 2000), 121-42, p. 135.

4 Ibid., p. 136; Khan, B. Z., and Sokoloff, K. L., 'Patent institutions, industrial organization and early technological change: Britain and the United States, 1790-1850', in M. Berg and K. Bruland, eds., Technological revolutions in Europe: historical perspectives (Cheltenham and Northampton, Ma., 1998), 292-313, p. 298.

and Ireland. The total cost was over £300.[5] This was an enormous expenditure, at a time when a skilled worker earned about £1 per week and even a foreman or manager in an industrial enterprise was lucky to earn £2-3 per week It was also costly in time: prior to the establishment in 1852 of a dedicated Patent Office, inventors had to steer their application through a maze of government offices--by one estimate in 1850, twenty-eight stages, by another thirty-five.[6] Both estimates seem exaggerated for effect, but there is no doubting the length and complexity of the process. The diary for 1722-3 of a Manchester threadmaker shows him having to spend nearly £130 and six months in London to patent his invention.[7] There is no reason to believe the process had become

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5 One leading engineer in 1851 put the cost of patenting 'a complex machine, or system of machines' at £500-600, because of having to provide extended and complicated specifications: Select Committee of the House of Lords appointed to consider of the Bills for the amendment of the Law touching Letters Patent for Inventions, 'Report and Minutes of Evidence' (PP 1851, XVIII), p. 429.

6 The Times, 6 Dec 1850; Manchester Guardian, 18 Dec 1850. See also MacLeod, C., Inventing the industrial revolution: the English patent system, 1660-1800 (Cambridge, 1988), pp. 40-8.

7 Gomme, A. A., 'Patent practice in the eighteenth century: the diary of Samuel Taylor, threadmaker and inventor, 1722-3', Transactions of the Newcomen Society, 15 (1934-5), pp. 210-16; MacLeod, Inventing the industrial revolution, pp. 75-8.

any simpler in the next century, when Charles Dickens lampooned it in A Poor Man's Tale of a Patent. It had merely spawned a new profession-- that of patent agent.[8]

It is scarcely surprising, therefore, that the Patent Law Amendment Act of 1852, which reduced the initial cost of a patent for the entire UK to £25 and established the Patent Office, was hailed as a major reform.[9] One might have expected it to settle the debate over the patent system which had been erupting periodically for over half a century.[10] On the contrary, it ignited a fierce controversy which raged for thirty years, threatening the patent system with abolition, until finally laid to rest by the Patent Act of 1883.[11] The 1883 Act brought down the initial cost of a patent to an affordable £4 (£1 on

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[8]Dutton, H. I., The patent system and inventive activity during the industrial revolution, 1750-1852 (Manchester, 1984), pp. 86-96.

[9]15 & 16 Victoria c83. It was still necessary for 'seven personal applications' to be made to the Patent Office, reduced to two in 1883: Hansard, 16 Apr 1883, col. 356.

[10] Dutton, Patent system, pp. 26-8, 34-68; Robinson, E., 'James Watt and the law of patents', Technology and Culture, 13 (1970), pp. 115-39.

[11]The Patents, Design and Trade Marks Act, 46 & 47 Victoria c57. This change in climate was commented on by Joseph Chamberlain, as President of the Board of Trade, introducing the second reading of the 'Patents for Inventions Bill' to the House of Commons: Hansard, 16 Apr 1883, col. 351; also by Samuelson, in ibid., col. 369.

application, plus £3 on filing a specification) and introduced a limited degree of technical examination.[12]

The principal question at issue in the Victorian 'patent controversy' of 1853-83 was whether the system should be abolished or merely reformed.[13] At this high tide of free trade, proponents of abolition questioned whether patents for invention should be exempted from the general proscription of monopolies, contending that patents provided an unnecessary incentive to invention, while obstructing innovative industrialists in the conduct of their business.[14] Reformers agreed only on the necessity of retaining the system; they disagreed--as reformers tend to do--over how to improve it. One major dispute, to be considered here, concerned cost: introducing the 'Patents for Invention Bill' in 1883 Joseph Chamberlain referred to it as 'the most important

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12 Hewish, J., Rooms near Chancery Lane: The Patent Office under the Commissioners, 1852-1883 (2000), pp. 97-103.

13 Dutton, Patent system, pp. 17-26; Hewish, Rooms near Chancery Lane, pp. 77-83; Harding, H., Patent Office centenary (London, 1953), pp. 14-16, 22-4; Coulter, M., Property in ideas: the patent question in mid-Victorian Britain (Kirksville, Mo., 1992); Machlop, F. and Penrose, E., 'The patent controversy in the nineteenth century', J. Econ. Hist., X (1950), pp. 1-21; Batzel, V.M., 'Legal monopoly in Liberal England: the patent controversy in the mid-nineteenth century', Bus. Hist., 22 (1980), pp.189-202.

14 In this they were challenging the master: for Adam Smith's favourable views on patents, see MacLeod, Inventing the industrial revolution, p. 197.

question of all—the question of fees'.[15] Some had argued the fees were still too high, still a disincentive to patent that was depriving poor men of their just rewards and the public of many valuable inventions. Chamberlain agreed, calling £25 a discouragement to invention and 'an insurmountable obstacle in the way of the poorest inventors.'[16] Others had justified the continuing high cost as a barrier to a flood of frivolous patents that would otherwise swamp the system, driving industrialists to distraction and causing over-sanguine inventors to ruin themselves.[17]

Eventually, in 1883 the low-cost reformers won the day. But who won the argument? The sharp upturn in the volume of patenting that had succeeded the 1852 Act was dwarfed by that which followed the 1883 Act (Figure 1).[18] Patenting was evidently

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15 Hansard, 16 Apr 1883, col. 354.

16 Ibid., col. 355. Most speakers in the debate agreed with Chamberlain on this point but criticised his intention to retain the subsequent payments of £50 and £100 (at four and seven years respectively): ibid., cols. 364-91. Lewis Edmunds, of the Patent Office, read a paper entitled 'The taxation of invention' to the British Association for the Advancement of Science in Cardiff, in 1891, which claimed that, because of the retention of the subsequent payment, no form of property was so heavily taxed as invention: The Times, 24 Aug. 1891, 5c-d.

17 MacLeod, C, 'Negotiating the rewards of invention: the shopfloor inventor in Victorian Britain', Bus. Hist., 41 (1999), 17-36, pp. 18-21.

18 The phenomenon has been explored in a comparative context in Khan and Sokoloff, 'Patent institutions', pp. 298-302.

sensitive to cost, but did these two upsurges in patenting indicate a reservoir of previously repressed, technically sweet inventive activity, or a nation of tinkerers avid for fame as patentees and unrealistic in their dreams of instant fortune? This paper offers an insight into the question, through a case study of patents for steam power.

There is considerable anecdotal evidence to support both opinions, much of it brought to the Royal Commission and the two Select Committees on the patent system that Parliament instigated between 1851 and 1872. What is lacking is any modern scrutiny of the patents that were filed and of the impact on them of the legislation of 1852 and 1883. There are two good reasons for this. One is the sheer quantity of data: half a million applications for patents were submitted in the second half of the nineteenth century, the majority of them after 1883.[19] To deal with this, inevitably necessitates resorting to sampling. The second obstacle is that few historians possess sufficient technical knowledge to allow the discrimination necessary to judge patent specifications, an obstacle we were able to overcome by including in the team an engineer who possesses expertise in eighteenth- and nineteenth-century steam engineering.[20]

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[19] Approximately 528,400 applications were made in the period 1800-1900, of which 303,400 were sealed/enrolled.

[20] Our primary purpose had not been to explore this question of the responsiveness of inventors to the falling cost of patents. The study of patents was part of a project that investigated the previously neglected nineteenth-century history of the firm of Boulton, Watt and Company (1800-49) and its sucessor, James Watt and Company (1849-94).

Our analysis offers, first, a caution against the crude manipulation of data derived from patent abridgements; secondly, a picture of patenting behaviour in steam engineering that differs markedly from the general trends in patenting. While patentees in the field of steam-engineering participated fully in the upward trend in applications of 1852/3, they failed to do so in 1883; they were relatively insensitive to this second reduction in initial cost (Figure 2). It is this departure from the general picture that throws a thin beam of light on the Victorian controversy concerning the impact of changing the price of a patent. Naturally, the interpretation is not straightforward. Indeed, the study is perhaps most illuminating when its focus is turned back onto the first half of the nineteenth century, prior to the reform of 1852, and the usual question is turned on its head: did high charges filter out technically unviable inventions? A two-pronged approach to this question suggests they did not.

II

We were funded by the Leverhulme Trust to examine the firm's activities, in particular its capacity to maintain its technological leadership in steam engineering, once Watt's famous patent had expired in 1800 and the two founding principals had retired. This required, of course, that we compare the firm's record of innovation with those of its rivals, and what part their respective reputations for innovation played in attracting customers. Our engineering adviser, Dr Jim Andrew, consequently analysed the patent records initially to discover the sources of patented invention in nineteenth-century steam engineering.

First, we explain our sources and methods of analysis, before turning to the detailed results of our analysis and to their interpretation. To begin with our principal source, the abridgements of patents. The establishment of the Patent Office represented not only a major administrative reform but also the start of a massive publishing enterprise. This was the logical concomitant of continuing resistance to official examination, to make the tools of DIY patent examining available in every major public library. Bennet Woodcroft, the engineer and inventor who in 1852 became first Superintendent of the Specifications, had successfully impressed upon the Select Committee of 1851 the necessity of a means whereby inventors and manufacturers could easily check what had been patented in their field.[21] Previously there had been no official publication of specifications.[22] Now Woodcroft's team of clerks set about not only the publication of contemporary specifications and their annual indexing by name and subject, but also between 1853 and 1857 published the same information retrospectively to 1617 (a task facilitated by Woodcroft's private researches among the patent rolls before 1852).[23] The 14,360 patents, issued between 1617 and 1852 were now numbered sequentially for the

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21 PP1851, XVIII, pp. 460-1

22 A selection of specifications was published unofficially in such journals as The Repertory of Arts & Manufactures, 1795 to 1825, The Repertory of Patent Inventions, 1825 to 1856; The London Journal of Arts, Sciences and Manufactures, 1820 to 1847, and The Mechanics Magazine, from 1823.

23 PP1851, XVIII, pp. 460-1. See Harrison, J., 'Bennet Woodcroft at the Society of Arts, 1845-57', Journal of the Royal Society of Arts, 128 (1979-80), pp. 231-4.

first time. This task completed, in 1857 the Patent Office started a major project to summarize and to categorize by subject all patents in long-run time series, again from 1617. Thus began the Abridgements of Specifications, for which all subsequent researchers have been immensely grateful: because of the sheer number of specifications involved after 1852, they have little choice but to turn to the Abridgements. But the Abridgements were intended only as an index or rough guide to the specifications, for inventors who were trying to check the novelty of their idea.[24] There are many traps waiting for unwary researchers, particularly those who engage in simple counting exercises.

The first, well-flagged trap concerns changing categorization over time. The first series of Abridgements, published between 1866 and 1883, classified most inventions into 103 categories.[25] A new categorization of abridgements was established in 1888 which sorted patents into 146 classes. A second series using this new system, which was retrospective initially to 1877, began to appear in the 1890s; it included illustrations, mostly photo-reduced from the published patent specifications by the relatively new process of photo-etching. Very few of these 146 classes of invention were identical in subject matter to the earlier 103 groups. Eventually, in 1905 these new abridgements were made retrospective back to 1855. (This was just in time for a third classification in

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24 Board of Trade, Committee on the Working of the Patent Acts on certain specified questions, 'Report', (PP 1901, XXIII), p. 631; Hewish, Rooms near Chancery Lane, pp. 38-44.

25 Van Dulken, S., British patents of invention, 1617-1977: a guide for researchers (1999), p. 125. Several fields, including glass, cutlery and machine tools, were never covered.

1909 which subdivided patents into 271 fields.) These changes obviously mean that any analysis of abridgements needs considerable care when the analysis crosses from one system to the other.

The second problem concerns multiple counting. Prior to 1852 a patent could legitimately cover many different inventions--a practice encouraged by its high price. Thus, different aspects of one patent could be summarized in several different volumes of the Abridgements. Moreover, a single invention might legitimately bridge two or more of the 103 subject categories, leading to its entry in both. When Harry Dutton used the abridgements to analyse inventive activity between 1750 and 1850, he found that 12,750 patents produced 17,100 entries in the Abridgement volumes.[26] Although the 1852 Act required that a patent should protect only one invention, patentees took advantage of the lack of specialist policing until the 1883 Act provided for technically trained examiners to check that only one invention was being described. One patent of 1880, for example, was found to be summarized in no fewer than fourteen different volumes of Abridgements.[27] Some of the post-1883 inflation may be accounted for by the enforcement of the 'one invention per patent' rule, but it is unlikely to carry much explanatory weight.

The third source of inaccuracy results from patents having been wrongly categorized, which, as we shall see in the case of steam, was sufficiently frequent to demand

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[26]Dutton, Patent system, pp. 206-8

[27] Patent 474 of 1880.

notice.[28] The fourth problem is the hardest for the non-technical researcher to surmount. It is a problem that arises when one shifts from measuring patenting activity to gauging inventive activity, and it raises complex issues about what should and should not be deemed 'an invention'. One aspect of this was novelty; another was technical feasibility. Prior to the Patent Act of 1902 there was no examination for either.[29] Examination for novelty was introduced from 1905 by this Act, following the Fry Committee's detailed scrutiny of 900 patent specifications which found that 42 per cent were wholly or partly anticipated by earlier patents.[30] The Committee was given examples of identical inventions that had been repeatedly patented in the previous two decades: 8 for soda water; 7 for pneumatic heads on crutches; 14 for channels on billiard tables to return the balls to the players.[31] A similar exercise, conducted by Woodcroft in 1864 at the behest of the Royal Commission, found that up to a quarter of patents were potentially invalid for want of novelty.[32] The 1907 Act extended the examination to exclude 'frivolous' patents that were 'contrary to natural laws'.[33]

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28 See below, p. 14.

29 2 Edw VII, c. 34; Van Dulken, British patents of invention, p. 5.

30 Davenport, N., The United Kingdom patent system (1979), p. 48; PP 1901, XXIII, p. 602.

31 PP 1901, XXIII, p. 632.

32 Hewish, Rooms near Chancery Lane, p. 80.

33 7 Edw VII, c. 29; Van Dulken, British patents of invention, p. 5.

All these problems are well exemplified by patents for steam engineering. For the period from January 1800 to December 1854, class 49, entitled 'Steam engines', contains abridgements of some 1,370 patents which, in theory, relate to steam power. Class 62, entitled 'Air, gas and other motive power engines', contains a further 350. From 1855 to 1900 the second Abridgements series included four relevant categories. Class 122, covering 'Steam engines', summarizes 9,650 patents, but its full title is 'Steam engines including details common to fluid pressure engines'. Thus not only were there many non-steam engines in this class but the Patent Office clerks had been prompted by key words into the erroneous inclusion of such inventions as pistons for hypodermic syringes, connecting rods for looms, and flywheels for bicycles. Class 110 covered 'Rotary engines, pumps, blowers, exhausters and meters', of which only a portion of the 2,650 patents were for steam-power inventions. Class 123, for 'Steam generators', included not just boilers for steam power but boilers for heating-systems, some designs of furnace and fire box, as well as unlikely ideas such as burning metals as fuel. Furnaces, as such, are found in yet another class but relatively few have relevance to steam power. Finally some developments in steam-engineering were found in Class 57, 'Governors'. This was an important area because controlling the speed of engines was fundamental to some processes, particularly in the textile industry. Thus four classes of patent in the second series needed to be studied, containing some 22,600 abridgements to the end of 1900.

Given these large numbers, sampling was unavoidable. All abridgements (in classes 49 and 62) for the period 1800 to 1830, a total of 240, were analysed; subsequently, we sampled every fifth year from 1835 to 1860, and every tenth year from 1870 to 1900. The problem of multi-entry of patents in different classes--some appeared in all four--caused a further check for this to be made for the years 1865, 1875, 1885, and 1895. This information was integrated into the annual totals of power patents for the years on either side of the five-yearly sample dates, which are plotted in Figure 3.[34]

The removal of mutiple entries reduced the total of roughly 24,000 abridgements for power-related inventions, for the period 1800 to 1900, to about 21,000. In itself this is an indicator of the problems which can arise if abridgements are simply counted for those classes which appear to contribute to an industry under study. This exercise produced a clearer jump in patenting after the 1883 reduction in fees (Figure 3), but it was closer to 20 per cent than to the increase of nearly 200 per cent for all patents (Figure1).

Patents for power sources other than steam were next eliminated from the data, a relatively straightforward exercise. In the 1800 to 1830 abridgements these amounted to nine in 240, about 4 per cent, but by 1900 they had risen to 45 per cent of the power patents (Table 1). As with the removal of multiple-counting, the ratio of non-steam patents was applied to the years either side of each sampled year to generate the annual

[34] It must be remembered that this does not include non-steam power patents prior to 1855 (the category 62 abridgements).

totals of steam-engine patents; these are plotted in Figure4. This analysis brought the 24,000 abridgements and 21,000 patents in the power category down to approximately 14,500 patents for steam power--representing 4.2 per cent of all patents sealed during the nineteenth century (recognizing that other categories of abridgements have not been similarly 'cleaned'). This cannot, of course, be taken as evidence of 14,500 patentable ideas during the century because of the lack of examination for novelty. Even when such examination was introduced in 1905, the examiners only checked an application against relevant patents from the previous fifty years.[35] The Fry Committee's finding in 1901 that 42 per cent of recent patents had been wholly or partially anticipated was borne out, during our analysis, by the casual recognition of many repeated ideas, particularly those which had not proceeded beyond 'the drawing board' and so had not come into use or common knowledge.

Is there any danger that patents concerning steam power were wrongly allocated to other abridgement categories? Clearly a complete check would be impossible. Instead, we were fortunate to have two lists of patented inventions in the books on steam engines published by Ross in 1828 and by Galloway in 1830.[36] Combining their lists gave the same number of patents as those included in the abridgements for 'steam engines' to 1830. They contained, however, ten steam-power patents that were missing

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[35]Boehm, K. and Silberston, A., The British patent system (Cambridge, 1967), p. 72.

[36]Ross, J., A treatise on navigation by steam (1828); Galloway, E., History and progress of the steam engine (1830).

from the Abridgements, while abridgement class 49 contained ten patents that did not cover steam power. On the basis of this comparison the selection to the Abridgements appears to be approximately 96 per cent accurate. For the later period, we were able to cross-check the two sets of abridgements where they overlapped. It will be remembered that the second categorization (into 146 classes), made between 1888 and 1905, was eventually backdated to 1855. Assuming that it was unlikely that the later allocation of patents into categories was based on the earlier, we compared the two sets for 1855 and for 1865. Volume 49 in the first series, for 1855, missed nine steam patents found in the four classes of the second series, giving an accuracy of 96 per cent, while the second series missed only six steam patents found in Volume 49 (close to 98 per cent accuracy). For 1865, accuracy improved to slightly better than 98 per cent in both directions.

No doubt there will have been errors made in our present analysis. At various times during the project, certain sections of the listings have been repeated or sample checked, which revealed errors of up to 2 per cent on some occasions. While the possible combination of errors remains a concern, we can be reasonably certain that they are much smaller than the adjustments being made to the totals. They do not affect the overall conclusion that the number of steam-power patents obtained in the nineteenth century is some 40 per cent less than the total indicated by simple counting of abridgements. It is these adjusted data which we have used in the composition of Figures 3 and 4. Figure5 shows an attempt to reduce the jumps and growth shown in Figs. 1 and 4 to a simple set of data which can be compared. It clearly demonstrates

that steam engines were not attracting as much increase in attention as were other fields of inventive activity. The proportion of patents granted for steam power fall from 7.6 per cent between 1800 and 1853 to 5.8 per cent between 1854 and 1883, to 3.1 per cent between 1884 and 1900.

IV

This brings us to the key question. How should we interpret the relative insensitivity of steam-power patents and--to a lesser extent--all power patents to the reduction in initial cost in 1883? One hypothesis is that, by the 1880s, steam was an old technology, which had been exercising inventive brains for two centuries: improvements were becoming harder and harder to find, and inventors were turning their attention to newer sources of power, such as gas engines and electric motors. The steeper rise in 'all power' patents than in 'steam-power' patents (Table 1) would lend credibility to this interpretation. Patents for steam power as a proportion of all power patents fell from 96 per cent to 65 per cent between the start and the end of the nineteenth century. A second hypothesis is that the initial fee for a patent that prevailed between 1852 and 1883 (£25) was already low enough not to deter from patenting the type of men who were inventing in the field of steam power. While the reduction in 1852 from over £300 (or approximately £100 for England and Wales) to £25 had first brought the price of a patent into their orbit, the further reduction in 1883 to £4 expanded only marginally its range of affordability. Steam-engines were items that were met with in the industrial workplace, not the home, the garden, or the shop: inventors were more likely to have had an occupational

relationship with them and, if not themselves principals of a firm, to have enjoyed the sponsorship of employers in patenting. Furthermore, in comparison with the amount of capital invested in a steam engine, the cost of a patent, whether at £25 or £4, was low. A third hypothesis is that patents for steam-engines were relatively stable in number because they offered little scope for 'frivolity'. It was notorious that many patents were sought less to protect the intellectual property in an invention than to lend a specious guarantee or kudos to a product. The Comptroller of Patents recognized this in 1901, when agreeing with the hypothesis that 'a good many of these trivial patents' were obtained 'merely in order to enable a man to have the advertisement that he gains by saying that he has got a patent'.[37] It seems likely that this function would have been restricted largely to those products which were marketed to the general consuming public. One might expect purchasers of capital goods to have been in a better position to scrutinize the product behind the patent. If the pessimists were correct, that cheap patents meant an explosion of patents for 'better mousetraps', then sober steam-power, by bucking the upward trend, may simply provide a counter-example in support of their case—the exception that proves the rule.

Testing these hypotheses is, of course, anything but straightforward, especially since there are no other case studies with which to compare our findings. Further analyses *within* the category of 'steam power' do, however, offer a little more insight. Our first attempted test proved to be a cul-de-sac, if an illuminating one. While the 1852 Act reduced the initial cost of a patent, it imposed further charges, of £50 after three years

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37 PP 1901, XXIII, p. 638. See MacLeod, Inventing the industrial revolution, pp. 85-8.

and £100 after seven years, to keep it in force up to the maximum fourteen years. We hypothesised that only the more profitable patents would be kept in force after three years, and only the most profitable after seven years; moreover, that it might be reasonably assumed that financially valuable patents were also technically viable ones.[38] If a higher proportion of steam-power patents than patents in general were 'kept alive', that might be evidence of their being less subject to 'frivolous' activity. Unfortunately, we were disappointed both by the quality of the data available and by strong indicators that our assumptions were incorrect.

Renewal details were published in the Patents Journal. For a few years these were summarized in quarterly tables that showed the patents which had been declared void because of failure to pay the renewal fees.[39] The Journal stopped publishing these

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[38]This is not an unusual assumption. See, for example, Hansard, 16 Apr 1883, col. 356; PP 1901, XXIII, p. 632; and more recently Inkster, 'Machinofacture and technical change', pp. 135-8.

[39]Many patents before 1883 appeared in the Abridgements 'under false pretences', having already fallen at the first fence. A listing of all pre-1852 patents, published in 1863, shows that about 775 of the 14,360 patents, 5.4 per cent, were 'not enrolled' (Patent Journal, 24 March 1863, pp. 401-53). Presumably enough evidence of these inventions was recorded for them to be numbered and to feature in the Abridgements but, without a complete specification, they were not reprinted in the 1850s. Between 1852 and 1876 34 per cent of the patents accepted and appearing in the Abridgements were given only 'provisional protection', which lasted six months, and were not sealed (Dutton, Patent system, p. 209). After 1883, failure to file a

tables, however, in the middle of 1862. Thereafter renewals were only notified individually, when the fees were paid, and then patents made void by non-payment were listed week by week. Within the context of our project, this method of publication made the task of finding renewal statistics too protracted, although individual patents could be examined without too much trouble. Furthermore, failing to find a patent listed as void implies its having remained in force for fourteen years, but without finding a mention of payment it is not possible to be sure of this.

Finally and crucially, the outcome of our analysis of the 245 records of renewal available for patents obtained in the first half of 1855 suggested the exercise was not worth the effort.[40] Of patents for power sealed in 1855, 98 per cent were in force after three years, 32 per cent were in force after seven years, and only 8 per cent[41] continued for the full fourteen years. These results are very close to the figures (published in 1901) for all patents which had been sealed in 1855: 97.4 per cent, 26.9 per cent, 9.5 per

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completed specification meant the provisional application was not published and details were destroyed. Since the patent number had already been allocated, gaps in the numerical sequence remain. Twenty six per cent of the power patents in the 1855 sample from the Abridgements received only provisional protection.

[40]Eighteen were not traced.

[41]16 per cent if all the doubtful ones are treated as valid for 14 years.

cent.[42] Contrary to expectations, however, our close technical scrutiny of the minority of patents that were renewed to fourteen years revealed that several were of dubious utility, including some which would not have succeeded either because of the existing state of technology or because, like perpetual motion, they were technically impossible.

On the other hand, we cannot assume that patents which lapsed at the three and seven years' barriers protected inventions that were invariably weak, either technically or commercially. As Richard Roberts, the Manchester engineer and patentee of the self-acting spinning mule, pointed out in 1863, the cost of a patent kept in force for fourteen years under the 1852 Act was higher than one previously obtained (as the majority had been) for England and Wales alone--£175 compared with approximately £110. The Royal Commission's report endorsed Roberts's evidence, judging that the total cost was still too high: it was 'an insuperable bar to the poor inventor'.[43] Roberts claimed that he had allowed four or five patents to lapse, even though 'I think they are quite equal to anything I ever did'. It was hard, he said, to decide whether or not to keep paying the fees because 'hardly any of them ever become productive within seven years'; his most

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42 Controller General of Patents, Designs and Trade Marks (CGPDTM), 'Eighteenth Report', (PP 1901, XXIII); tabulated in Dutton, Patent system, p. 209. It was said in 1883 that 'The second payment killed two thirds of all the patents, and the third payment killed nineteen per cent of those left, leaving only eleven per cent which went on for fourteen years': Hansard, 16 Apr 1883, col. 356.

43 Commissioners appointed to inquire into the Working of the Law relating to Letters Patent for Inventions, 'Report' (PP 1864, XXIX), pp. 429, 325.

famous and successful invention, the self-acting mule, took nine years to repay his costs.[44] Similarly in 1883, Mr Anderson, the MP for Glasgow, sprang to challenge Chamberlain's belief that renewal fees weeded out the weak; the problem lay with the system, he contended, not the inventions. 'Why, he asked, should so many be killed off? The fact that only ten per cent of patents lived for half the time that patents were granted was a proof that the system was bad. Killing off at seven years was simply robbing inventors, and even for the country, was a short-sighted policy.'[45] In conclusion, it can be stated that the renewal of a patent does not seem in itself to be a sound indicator of either technical or business success.

The second line of analysis drew upon our categorization, by type of engine, of all the sealed steam-power patents in our samples. Owing to the number of patents involved, this had been an unavoidably speedy and subjective exercise, but it proved to be a suggestive one. Because we were interested primarily in the innovative activities of Boulton Watt & Co., whose principal products were stationary and marine engines, we had wanted to know what proportion of the steam-power patents were relevant to this field. The remainder of the patents we categorized either as 'locomotives and road vehicles'; or as 'rotary engines', an interesting but basically unproductive group of patents (apart from a few viable steam turbines); or as 'technically impossible', those which overtly would have been excluded by a patent examination if one had been in

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44 Ibid., p. 427.

45 Hansard, 16 Apr 1883, col. 364.

place.[46] The most striking result of this analysis, shown in Table 2, is the steady, though not uninterruped, increase in mainstream 'stationary and marine engines' throughout the century, from less than 40 per cent of all steam-power patents until mid-century, to more than 60 per cent from 1860. As Table 2 makes clear, there is no disproportionately sharp upturn in their share in either the early 1850s or the 1880s. Their growing relative, as well as absolute, increase was at the expense principally of patents for rotary engines, most of which were pursuing a technically unattainable goal,[47] and of 'perpetual motion machines'--many of which defeated the Patent Office clerks' capacity for summarizing, leading to the tactful standard phrase, 'Some parts of the specification are not clearly expressed'.

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This analysis has resulted in the reduction of 24,000 abridgements in steam-related categories to approximately 9,000 patents for stationary and marine engines (based on

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46 Andrew, J., Tann, J., MacLeod, C., and Stein, J., 'Steam power patents in the nineteenth century—innovations and ineptitudes', Transactions of the Newcomen Society, 72 (2001), 17-38, pp. 31-3.

47 Approximately 10 per cent of patents in this category, however, covered the turbine technology that led, in the 1880s, to the introduction of steam turbines. By no means were all patents for stationary and marine engines technically viable: see, for example, Andrew et al., 'Steam power patents', pp. 27-31.

an approximation of 61.5 per cent of 14,500 steam-power patents).[48] It is impossible to say whether a close analysis of other abridgement categories would produce similar results. Nor can one say whether the large upward jumps of the aggregate figure for all patents following the Acts of 1852 and 1883 would be smoothed away by similar exercises. There is nothing here to refute convincingly the claim that the reduction in patent fees would open the flood-gates to frivolous patenting, except that it seems not to have occurred in the field of steam engineering, which was perhaps less vulnerable to 'frivolity' from its being heavily capitalized and technically complex. On the other hand, the field may simply have been attracting fewer inventors because it was obsolescent.

To deny the opponents of cheap patents the last laugh, however, let us conclude by remarking on the high proportion of technically dubious inventions that were patented under the unreformed system, before 1852. As late as the 1840s our analysis (Table 2) suggests that well over half of all steam-power patents protected either rotary or perpetual-motion engines or other technically unviable ideas that would not have got past a competent patents examiner.[49] This supports the testimony of Richard Roberts, the engineer and patentee, to the 1851 Select Committee. Roberts complained that he had nearly 100 patentable inventions 'lying upon the shelf' because he could not afford to patent them. Meanwhile, he protested, 'Our patent list now contains a great number

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[48] See Table 2, and above, p. 16.

[49] Post, R. C., '"Liberalizers" versus "Scientific men" in the antebellum Patent Office', Technology and Culture, 17 (1976), pp. 24-54.

of very silly things, which no man, who had been long in a workshop, would ever think of patenting; and the reason is, that the patentee has money, though deficient in experience and mechanical talent; probably he thinks he cuts a figure by being in the patent list.'[50] To paraphrase Roberts in a north-country phrase, many patentees had 'more brass than sense', and were therefore not deterred by silly prices.

To Richard Roberts it was clear that, while many inventors were not possessed of economic rationality, many others were denied the opportunity to exercise it by the high costs of patenting. Although this paper has not illuminated the second, notoriously grey, area,[51] it has added some weight to the former claim. Contemporary surveys, by Woodcroft in 1864 and for the Fry Committee in 1901, revealed that the requirement of novelty was not respected in a large proportion of patents: despite the free and widely diffused provision of official patent literature to allow patentees and their agents to

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50 PP 1851, XVIII, pp. 422-3.

51 MacLeod, C., 'The paradoxes of patenting: invention and its diffusion in 18th- and 19th-century Britain, France and North America', Technology and Culture, 32 (1991), pp. 885-910, p. 893.

check for prior patenting, some ideas were registered repeatedly. Our scrutiny of the abridgement data in steam engineering adds evidence of a further shortcoming in the system. Neither the high initial cost of patents before the 1852 Act, nor the high charges for renewal at three/four and seven years thereafter, guaranteed that only technically viable inventions would be patented. The financial filter was not an effective substitute for official examination.

TABLE 1. POWER PATENTS, 1800-1900

Year	Number of Steam-power Patents	Number of non Steam-power Patents	All Power Patents	Steam-power as % of All Power Patents
1800-30	220	9	229	96
1835	20	0	20	100
1840	34	2	36	94
1845	26	1	27	97
1850	50	5	55	91
1855	191	51	242	79
1860	211	49	260	82
1870	189	63	252	75
1880	267	140	407	66
1890	369	218	587	63
1900	432	352	784	55
Total	2009	890	2899	69

'Non-steam power patents' = non-steam power patents listed in the same *Abridgements* classes as steam power patents.

TABLE 2. STEAM-POWER PATENTS ASSESSED BY TYPE, 1800-1900

Year	Number of Steam-power Patents	No. a	% a	No. b	% b	No. c	% c	No. d	% d
1800-30	220	95	(43)	47	(21)	28	(13)	50	(23)
1835	20	7	(35)	2	(10)	3	(15)	8	(40)
1840	34	8	(24)	8	(24)	6	(18)	12	(34)
1845	26	10	(38)	4	(15)	1	(4)	11	(42)
1850	50	25	(47)	9	(17)	5	(9)	11	(21)
1855	191	100	(52)	18	(9)	17	(9)	56	(29)
1860	211	137	(65)	12	(6)	17	(8)	45	(21)
1870	189	111	(59)	15	(8)	23	(12)	40	(21)
1880	267	170	(64)	27	(10)	19	(7)	51	(19)
1890	369	280	(76)	42	(11)	8	(2)	39	(11)
1900	432	286	(66)	62	(14)	42	(10)	42	(10)
Total	2009	1229		246		169		365	

a) Stationary and marine steam engines

b) Rotary steam engines and turbines

c) Locomotives and road vehicles

d) Perpetual motion and other ideas judged technically unviable

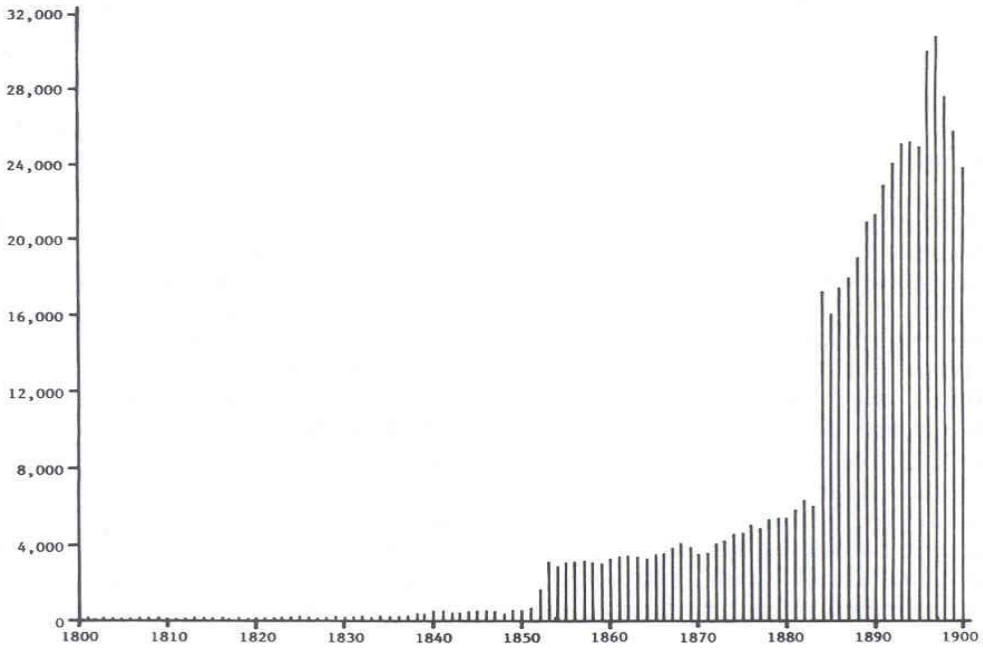

Fig. 1. Annual totals of patent applications.

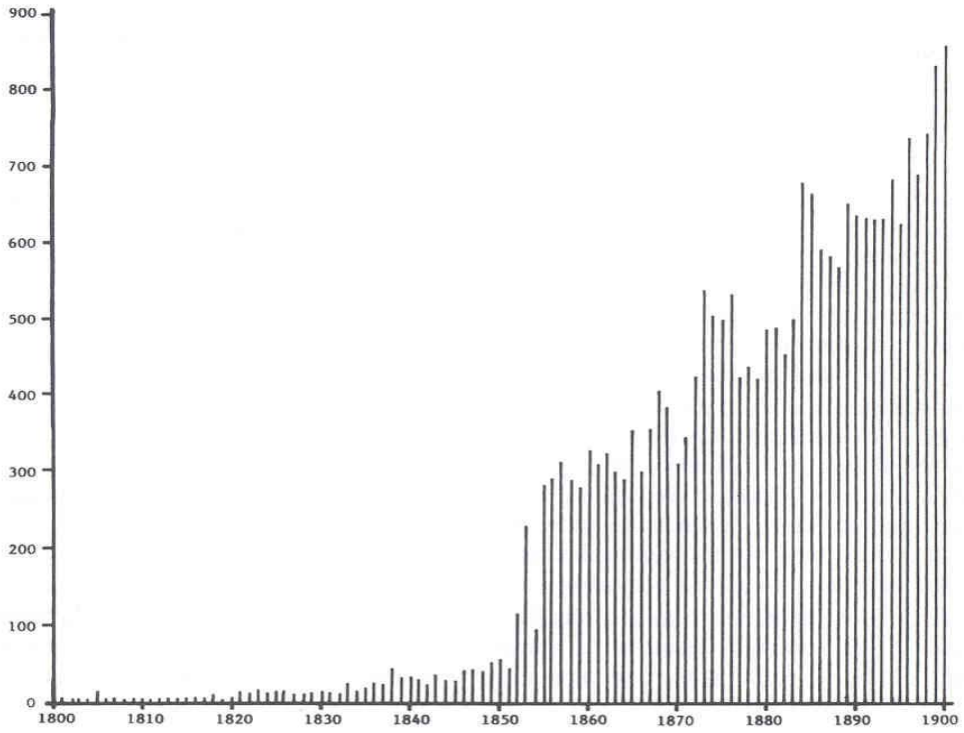

Fig. 2. Annual number of abridgements for power patents.

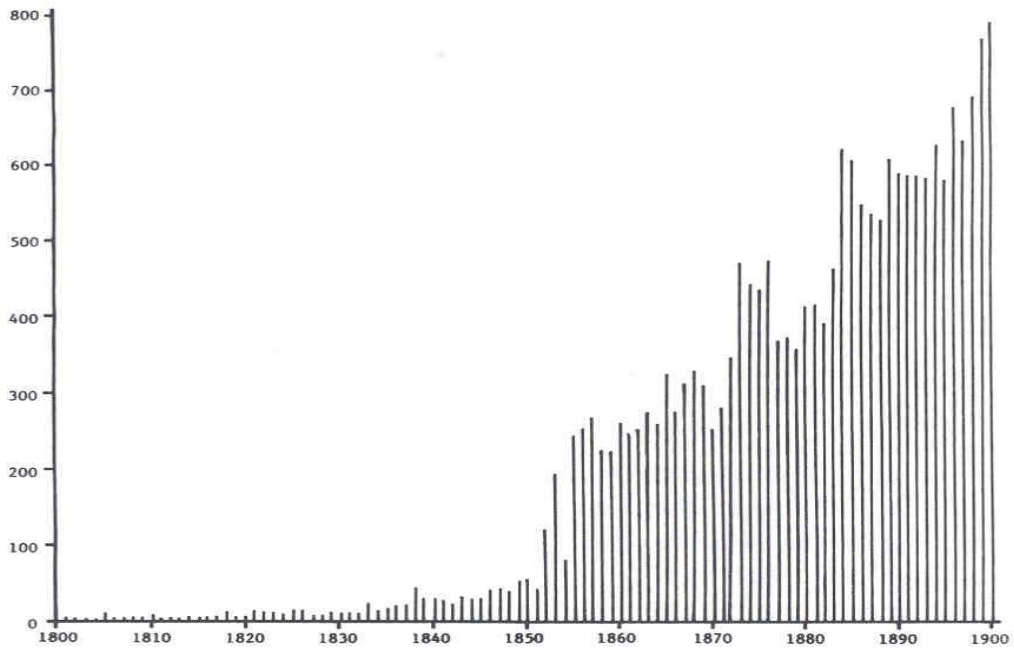

Fig. 3. Annual number of power patents.

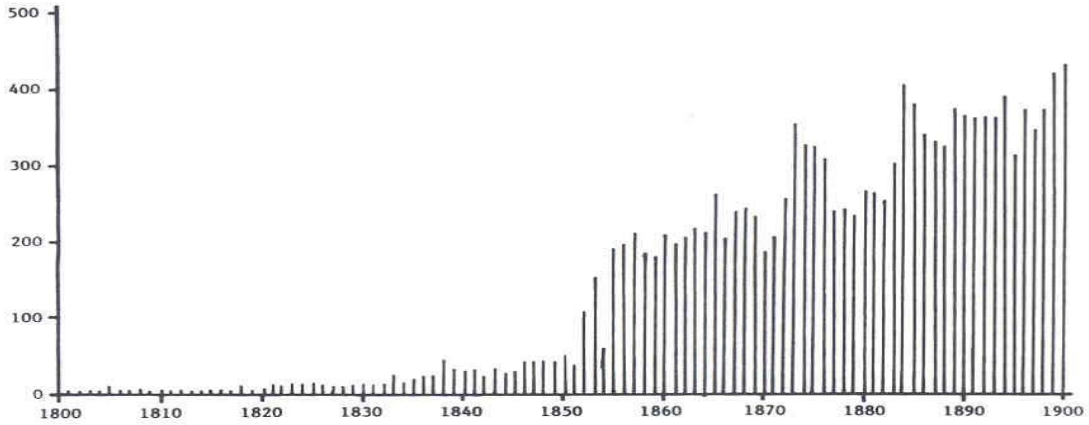

Fig. 4. Annual number of steam power patents.

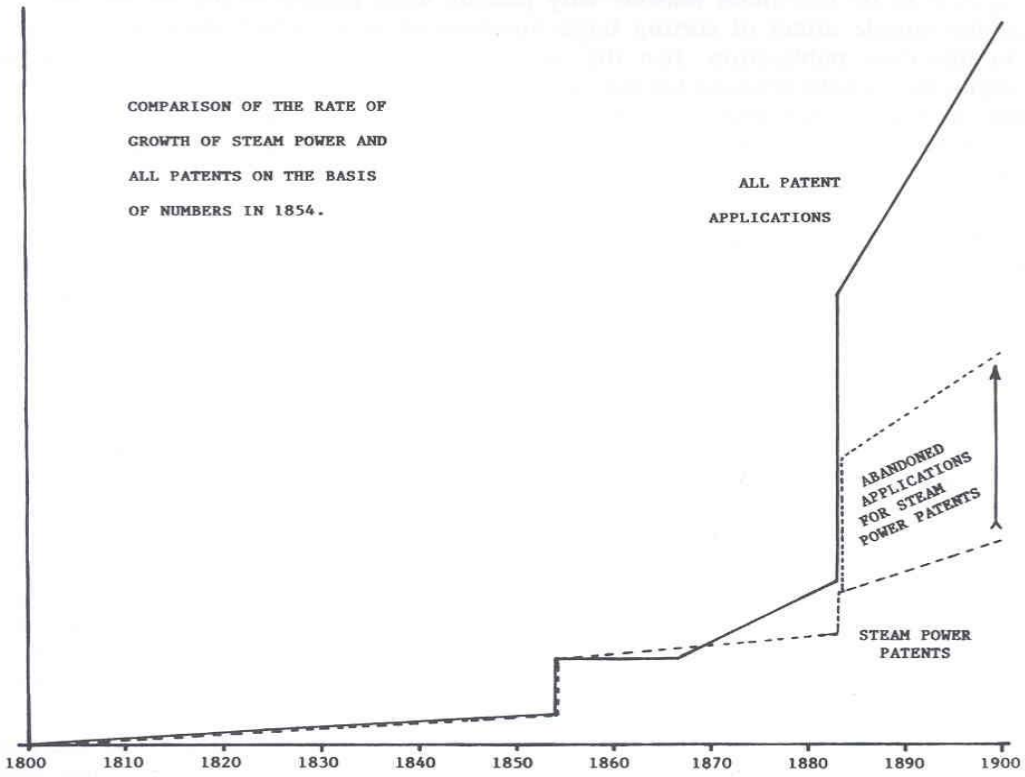

Fig. 5. Growth in patent numbers.