A Philosophical Business: Edward Nairne and the Patent Medical Electrical Machine (1782)

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In 1782, at the apex of his career, the instrument maker and FRS Edward Nairne (1726–1806) was granted a patent from the king for his new invention, a medical electrical machine. It was the first patent in the class of electricity, and it was the only medical instrument that Nairne's workshop produced.[1] The instrument was a great success, consolidating Nairne's fame as a maker of electrical instruments. This paper follows Nairne's work in electricity until and immediately after the invention of the patent medical electrical machine, reconstructing his successful moves to gain credit in the gentlemanly world of natural philosophy. With other London instrument makers, Nairne enjoyed special status in the natural philosophical community, where his contributions, especially in the field of electrical experimental philosophy, were widely acknowledged. I interpret the reasons for his 'being desirous of having the honour' of becoming a member of the philosophical community in terms of his involvement with the trade of philosophical instruments, and I shall be revealing his tactics to turn the exclusivity of the Royal Society to his own commercial advantage. These tactics consisted in transferring the authority that he gained in the world of experimental philosophy to the instruments that he made and sold, thus securing for his workshop an exclusive group of wealthy and prestigious customers. In the final part of the paper I shall examine Nairne's patent medical electrical machine as an instance of his concern both with the general and the elitist public. As an electrical instrument maker of repute, Nairne could not remain indifferent to the fashionable subject of medical electricity that, in the late 1770s and early 1780s, was swelling the pockets of a number of improvised practitioners. With his medical electrical machine Nairne aimed to reach the market of 'electrical patients', sealing with a patent his expertise in the manufacture of electrical instruments, regardless of whether they were employed for medical or philosophical purposes. Exploiting his role as an instrument maker and a member of various exclusive philosophical clubs, Nairne expanded the range of the potential

purchasers of his instruments so as to add to electrical therapists and patients also the wealthy natural philosophers, who, on their part, were sensitive to the prestige that a patent cast on new inventions. The different codes of behaviour that Nairne adopted in advertising his patent medical electrical machine in the different contexts were informed by his familiarity with the etiquette of philosophical circles and the rules of the market place.

THE PHILOSOPHICAL AVOCATIONS OF AN INSTRUMENT MAKER

It is well known that before writing his *History and Present State of Electricity* (1767), Joseph Priestley undertook a study of contemporary work on electricity, helped in this enterprise by the leading London electricians, whom he met on the occasion of his visit to the capital in 1765. Priestley soon realized the importance of the apparatus in electrical experimental practice and devoted a whole section of the *History* to the critical review of electrical instruments, from the earliest models to the most recent. He argued that the common tools of cabinet, clock and watchmakers would prove useful to electrical philosophers, who, as he urged, should attend more often to the construction of their own machines. The reason for this recommendation rested in Priestley's conviction that experimental philosophers should be as independent as possible of instrument makers, 'who are seldom men of science, and whose sole aim is to make their goods elegant and portable'.[2]

If this was Priestley's rule, Edward Nairne, FRS, mathematical, optical and philosophical instrument maker at Cornhill, London, was the exception that proved it. Nairne's reputation as a 'man of science' was undisputed among his contemporaries, and Priestley's friendship with him must have played a role in his choice of 'seldom' in the sentence above. In 1791, following the riots that destroyed his house in Birmingham, Priestley named Nairne and Blunt, 'Mathematical Instrument Makers of Cornhill in the City of London persons of great Eminence Experience and Competent Judgement', to make the inventory and valuation of the damaged instruments.[3]

In the second half of the eighteenth century, the collaboration between instrument makers and natural philosophers, despite Priestley's low opinion of the former, had its many successes. A number of studies, dealing with eighteenth-century instrument making, have emphasized that London was an exceptional case in Europe with respect to the 'philosophical' standing achieved by instrument makers, sometimes upgraded to Royal Society fellowship and even to the highest honour awarded by the Society, the Copley Medal.[4] The thriving market of mathematical, optical and philosophical instruments of the London makers extended to the rest of the world. Foreign visitors, intrigued by the exciting attractions of the British capital, made a point of browsing around the instrument makers' shops in various London quarters.[5] The numerous wars and expeditions the British Empire engaged in throughout the century meant a substantial increase in the state's demands for instruments. Between 1755 and 1762, during the war with France, the Board of Ordnance's request for mathematical,

surveying and navigation instruments made the fortune of the Adams's workshop.[6] The attendance at the meetings of the numerous London coffee houses and other philosophical clubs, such as the Royal Society, the Monday Club, the Chapter Coffee House Society – to mention only those of which Nairne was a member – played an important role for the instrument makers, as it enlarged their clientele, while also directing their attention towards specific details.[7] In the case of the electrical apparatus this was an important aspect. The performance of electrical experiments largely depended on the quality of the apparatus employed, and a few technical details could significantly simplify experiments.

Nairne was an optical, mathematical and philosophical instrument maker, with a shop at 20 Cornhill, London.[8] Apart from the manufacture of instruments, he also engaged in the performance of electrical, pneumatical, magnetic and astronomical experiments, his activity bringing him advantageous connections. In 1765 he was admitted for the first time to a meeting at the Royal Society and, in the course of the same year, together with John Bird and James Ferguson, he was employed by the council of the Society to make the instruments for the committee in charge of replicating John Canton's experiment on the compressibility of water.[9] He was also involved in the construction of the astronomical apparatus at the Royal Observatory at Greenwich. His experimental skills, combined with his ability in the manufacture of instruments, attracted the attention of various FRSs, who invited him with increasing frequency to the meetings of the Society. Previous to his election in 1776, leading experimental philosophers such as John Canton, Henry Cavendish, William Watson, William Henly, John Smeaton and James Ferguson, the Astronomer Royal Nevil Maskelyne and the Portuguese instrument dealer Jacynt Magellan, introduced Nairne to the Society.[10] On a number of these occasions, Nairne showed his inventions to the Fellows and read various papers related to experiments that he had carried out with his apparatus. All the papers were subsequently published in the *Philosophical Transactions*. In 1776, 27 Fellows recommended Nairne, 'well known to the Royal Society for his several Communications and in general for his Knowledge in Experimental Philosophy', as 'likely to prove an usefull Member of the same'.[11] He was elected in the course of the same year and was also admitted to the Monday Club, a select group of FRSs who used to meet again on the Monday after the Society's meeting.[12]

Nairne's engagement with the 'gentlemen of science' in experimental practice allowed him to identify his fellow experimenters' practical demands concerning the experimental apparatus and to manufacture appropriate 'improvements'. His contributions were soon acknowledged. In 1770, Ferguson, who had used Nairne's electrical machines since the 1760s during his itinerant electrical shows around the country, admitted that the models 'mostly now in use' were 'made in the greatest perfection by Mr Nairne'.[13] The 'perfected' design recently conceived by Nairne was a globe-machine, in which the cumbersome wheel was replaced by a small geared mechanism enclosed in a brass box – a small detail that made the instrument portable and particularly elegant, the latter being a virtue that,

when combined with power and efficiency, philosophers particularly appreciated.[14] His frequenting elitist philosophical circles brought Nairne distinguished acquaintances, enlarging his clientele so as to include a number of important national and international customers. In London, Henry Cavendish chose Nairne as his instrument maker and involved him in various experiments, including those on the artificial torpedo.[15] Nairne's fame also spread abroad. The Italian physicist Alessandro Volta, who met Nairne during his visit to London in 1782, ordered some of the instruments for his physics cabinet in Pavia from Nairne's workshop. Nairne returned the favour by building a model of Volta's electric lamp, or *accendi-lume elettrico*, for the Royal Society.[16] Another important acquaintance was Benjamin Franklin, who, besides being a friend of Nairne's, exerted an important influence on his electrical work. Thanks to Franklin, he was made a foreign member of the American Philosophical Society in 1770, six years before his election to the Royal Society.[17]

Nairne's work on electricity began with the study of the fashionable subject of 'atmospherical electricity', a choice that proved successful in consolidating his philosophical connections. His articles on the electricity of the atmosphere were published in the *Philosophical Transactions*, and in 1777 he was asked to join Cavendish, William Henly and Timothy Lane on the committee appointed by the Royal Society to investigate whether pointed or blunt conductors should be affixed on the Purfleet gunpowder magazines to prevent damage from lightning. The new committee, the third since 1769, focused on the specific issue of Benjamin Wilson's dissent about the former committee's choice of pointed rods, and was composed, with the single exception of Henry Cavendish, of electrical instrument makers.[18] Nairne tenaciously supported Franklin's theory on the properties of metal points to protect buildings from lightning and was personally involved in the controversy. Given the public dimension of the dispute, Nairne's involvement resulted in an excellent opportunity for him to engage in the public display of his experimental skill and to direct the attention of the gentlemanly and aristocratic audience to his apparatus. During the years of the controversy, Wilson, who championed the cause of blunt conductors, performed spectacular public experiments at the Pantheon, in which he employed impressively large instruments.[19] Nairne insisted that the experimental apparatus was the source of Wilson's fallacious conclusions and obtained permission to display his own dissent in public by performing experiments at the Pantheon with his own machines.[20]

Nairne's involvement in experimental philosophy was the most effective advertisement for his instruments. Previous to his election to the Royal Society, Nairne performed several experiments for the Fellows, using instruments produced by his workshop. This way he could show the quality of his workmanship and direct the Fellows' attention to his instruments, without offending the gentlemanly ideal of the disinterested pursuit of knowledge. In 1773 Nairne designed a new electrical machine that became a standard instrument, commonly known as the 'Nairne machine'.[21] In the

same year, he engaged in a series of electrical experiments for a number of FRSs (including Joseph Banks) on the passage of electricity through various living bodies in which he showed his machine at work. He insisted on the powers of his new invention, able to produce sparks 12 to 14 inches long, and showed its surprisingly fast action in killing a duck, a turkey and a cock. He also entertained the FRSs with an examination of the passage of electricity through exotic plants, brought to London by Joseph Banks on his return from his voyages of exploration.[22] Nairne concluded that 'in proportion as these vegetables were herbaceous and succulent, the sooner the parts of them, through which the shock passed, were observed to decay'.[23]

Nairne's electrical machine was a cylinder-machine with two conductors for the simultaneous production of both positive and negative electricity, an important detail that matched the most recent interest of electrical philosophers in the nature of 'negative electricity'. According to Hackmann, Nairne's machine was 'the most powerful and perfect generator that had been made to date',[24] and doubtless it brought Nairne national and international fame. Several natural philosophers boasted of having a Nairne electrical machine. Ferguson, Priestley, Franklin and Cavendish owned electrical machines made by Nairne,[25] while in Italy the name of Nairne became almost synonymous with spectacular electrical experiments. William Hamilton, the British ambassador in Naples, in a letter to the Royal Society remarked that his 'excellent' electrical machine by Nairne was 'the wonder of this country; as they had never before seen electrical experiments in perfection'.[26] When the Grand Duke of Tuscany requested Priestley to provide him with the best machine obtainable in England, Priestley had no hesitation in proposing Nairne as its maker, a favour that the instrument maker returned by giving Priestley a large electrical machine of the same kind.[27] The instrument was part of the outstanding physics cabinet of Lord Cowper, who described Nairne's machine as 'the biggest, I think, within and outside Italy', and who appreciated the fast destructive action Nairne boasted of: 'it draws sparks 18 inches long; combined with a very large battery of 34 jars of 17 Parisian inches each, it is able to kill any big animal and to destroy a reasonably thick iron wire.'[28]

ELECTRICITY UNDER THE GREAT SEAL

In 1782 Nairne obtained a patent from the king for his invention of a new improved electrical machine, 'which I call the patent medical electrical machine' (Figure 1).[29] It was the first (and the only) medical instrument that Nairne designed, and it was sold with a booklet of instructions in which he advocated the healing properties of electricity, completely bypassing his own conclusion, published in 1774, that 'electricity, accumulated to a certain degree, puts an end to vegetable as well as animal life'.[30] Instead, Nairne claimed that 'the Patent Electrical Machine [was] so constructed, that the strongest shock that can be administered by it can no way detriment the most delicate constitutions.'[31]

The patent medical electrical machine enjoyed considerable fame. Since

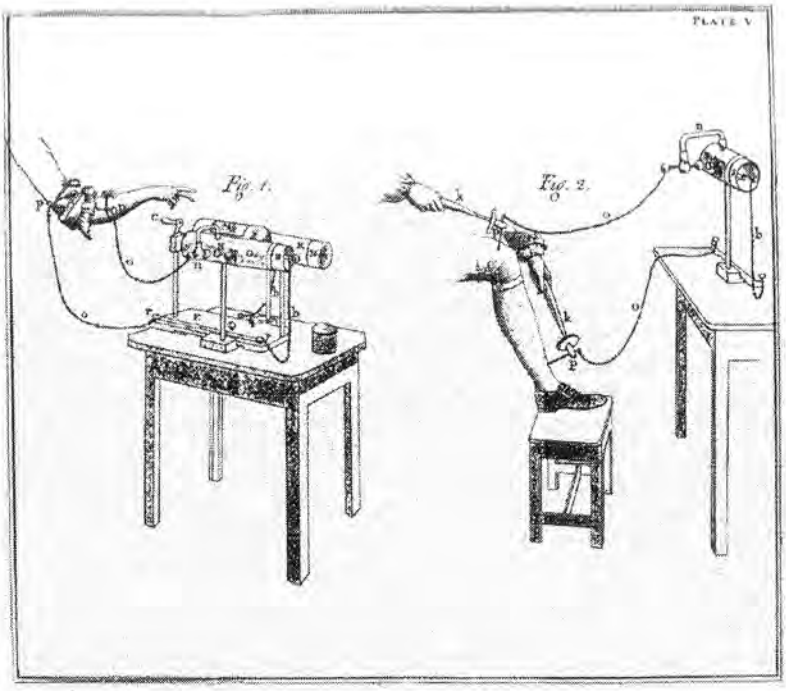

Figure 1 Nairne's patent electrical machine. From Edward Nairne, *The Description and Use of Nairne's Patent Electrical Machine* (London, 1782). Courtesy of the Bakken Library and Museum.

the beginning of the century, electrical machines had been best-sellers among electrical instruments. They were the *sine qua non* for any kind of electrical performance, from electrical experiments to medical electricity, and were purchased for both use and display. In the early 1780s, the models that instrument makers could offer complied with diverse pockets, meeting the requirements of the amateur as well as that of the expert electrician. Collectors of instruments made a point of including Nairne's patent machine among their instruments. In Florence, Lord Cowper, who already owned two machines by Nairne, also purchased the patent medical electrical machine for his cabinet. In London, the Third Earl of Bute had a Nairne's patent medical electrical machine among the 225 instruments that formed his expensive collection.[32] Extant models of the patent machine in several museums in Europe and in the USA suggest that Cowper's and Butes's were not isolated cases.[33] That the machine was popular can also be inferred by the number of editions and translations of the booklet of directions on how to use the machine published by Nairne in London in 1783: it went through eight editions before 1796, in 1784 it was translated into French and two years later into German.[34] All the existing machines

are well preserved, an aspect that points to the role of the new invention not just as a sophisticated instrument for electrical experiments and alternative medical treatment, but also as an icon of the most up-to-date physics cabinets. This is not to say that the machine was not used. On the contrary, Volta used Nairne's patent machine during his lectures,[35] and the London electrician Tiberius Cavallo, who was given a model by Nairne himself, admired the performance of his friend's 'excellent electrical machine and medical apparatus'.[36]

While the name of Nairne, punched in the machine, crossed the Channel, the Alps and the Pyrenees, at home the success of the machine earned him a Royal Appointment (1785) and election to the Chapter Coffee House Society, a club that cultivated experimental philosophy and for this reason attracted several instrument dealers and makers.[37] To what extent the machine's success should be attributed to the patent is difficult to assess, but it can be hardly doubted that the patent played an important role in adding value to the invention. Without entering the troubled waters of a discussion of Nairne's reasons for patenting, there are a number of aspects I wish to highlight in order to place Nairne's choice of turning an electrical machine into a medical instrument in the context of the different attitudes towards patents and the marketing of instruments that characterized the worlds that Nairne inhabited as a businessman and a 'man of science'. Although the law that regulated the patent system in the eighteenth century had remained unchanged since 1624, patent activity increased as the century progressed. From the inventors' point of view, patents could perform various functions, from securing the priority of an invention, to protecting its commercialization or granting prestige to the inventor. Often these functions were equally important in leading an inventor to petition for a patent and, in the case of instrument makers seeking to strengthen the volume of their affairs, the long process of patenting could result in a successful commercial achievement. Patents, however, were also looked upon with suspicion by the guilds, worried about issues of secrecy and individual monopoly in the guild-trade.[38] Nairne was an active member of the Spectaclemakers Company, whose internal structure consisted in the ruling elite of the Court of Assistants (a legally constituted court of the City and the Crown) and the yeomanry.[39] From 1750 he was among the assistants and attended assiduously the weekly meetings of the court.

In the course of the 1760s, however, after starting to attend the meetings of the Royal Society, Nairne began to negotiate between the interests of the guild and his personal ambition to carve a space for himself within the gentlemanly world of natural philosophy. As for other instrument makers who were also FRSs, natural philosophy for him was not just a matter of prestige, it was business. Access to the Royal Society meant direct contact with a large number of practitioners of natural philosophy and their international correspondents, who preferred to order instruments from makers also engaged in experimental work. This meant that, on certain occasions, surrendering one's immediate interest in a far-reaching objective

could prove a winning strategy. In 1764, John Dollond, FRS, obtained a highly contested patent 'for Making Object Glasses for Refracting Telescopes', which led most of the optical instrument makers of the Spectaclemakers Company to sign a 'Petition to His Majesty in Council for vacating a Patent granted to Mr John Dollond'. In the early years of his attendance at the Royal Society, Nairne, in spite of his commitment to the Company, decided not to sign the petition, paying instead a fee to Dollond, already an FRS. Nairne's 1770 trade card advertised his workshop as producing all 'Sorts of Optical, Philosophical, and Mathematical Instruments, of the newest and most *approved* Inventions'.[10] Doubtless, Nairne was sensitive to the advantages that patents might bring to inventors, but, as an aspiring FRS, he was also sensitive to the codes of gentlemanly behaviour of the Royal Society, whose gentlemen-fellows looked down on the litigious world of trade and commerce. As a corporate body, the Royal Society did not have a specific policy towards patenting, especially given its failure to arbitrate priority disputes in its early years. Nonetheless, a publication of the 'description and use' of a new instrument in the *Philosophical Transactions* would provide more kudos than a patent for those who, like Nairne, were carving a role for themselves within the philosophical world.[11] Apart from the formal acknowledgements of the Royal Society, news of the invention would reach foreign countries, consolidating the inventor's reputation as a trustworthy 'man of science' both at home and abroad. Nairne took advantage of this alternative strategy of securing his inventions on various occasions, and his career – as sketched above – progressed accordingly.

Towards the end of the century, however, when his position was already established, and competition in the market place was increasing, his attitude changed. At the time, interest in experimental philosophy was declining, and instrument makers (as well as public lecturers) were eager to 'cross boundaries' and establish connections with the thriving business of medical matters.[12] In line with the increasing number of patents granted each year, instrument makers became more sensitive to the prestige or the protection of the Great Seal for their inventions. For an electrical instrument maker such as Nairne, medical electricity was an opportunity not to miss. As an activity that crossed the domains of electrical experimental philosophy and medical practice, medical electricity was particularly attractive to electrical instrument makers, who could address simultaneously two kinds of customer: the philosopher and the potential patient. With a few additions, electrical instruments could conveniently become useful instruments for electrical treatments. In their catalogues, under the heading 'philosophical instruments', instrument makers listed 'electrical boxes', where medico-electrical apparatus was encased together with electrical toys. Purchasers would also find booklets of instructions on how to perform amusing electrical experiments and directions on how to treat various disorders by electricity.

The inclusion of potential patients in the public for electricity caused a change of attitude in the marketing of electrical instruments, as in the wild

market of medical matters a large number of charlatans and mountebanks, dictated the rules of the game. Their use of patents to add authority to their nostrums was notoriously indiscriminate and, even if the enforcement of the law in order to protect an invention from plagiarism was ineffective, a patent would associate the inventor's name with the medicine.[13] Or, as in the case of Nairne, with the electrical machine. The increasing popularity of medical electricity, and the consequent increase in the demand for electrical instruments from the various strata of London society, could induce a business-oriented philosophical instrument maker, such as Nairne, to look for some kind of official boost, given that his reputation as a skilled instrument maker derived in large measure from his experimental interactions with electricity. Moreover, the design of a medical electrical machine would associate explicit utilitarian value with the otherwise idle performance of electrical experiments. However, the patent did not prevent makers from copying Nairne's model, and there is no evidence that Nairne ever sued anyone for infringing the patent.[14] I want to stress this point, as it suggests that the patenting of the 'improvement in the common electrical machine', as Nairne himself termed his new invention, was also – if not exclusively – a commercial move addressed to the wealthy clientele that Nairne had attracted to his workshop during the previous decades of his philosophical frequentations. Obtaining the Great Seal for one's invention involved a tedious procedure and cost money, but many items in Nairne's workshop were more expensive than the £100–120 that were necessary to obtain an English patent.[15] Moreover, foreign natural philosophers on tour in London used to buy expensive instruments that otherwise would take time to reach their physics cabinets. In 1777, Thomas Bugge, professor of astronomy and mathematics at Copenhagen, during his visit to London paid Nairne £88 for the electrical, magnetic and pneumatic instruments that he bought.[16] In the end, the patent would be an affordable form of advertisement and, in the eye of the gentlemen (or patrons) of science, would increase the prestige of Nairne's workshop. Although Nairne petitioned for, and obtained, an English patent, expensive models of his 'Patent Medical Electrical Machine' reached the cabinets of wealthy collectors or of ambitious professors well beyond the geographical area covered by the patent.

ADVERTISING THE MACHINE

When Nairne patented his medico-electrical machine, medical electricity was enjoying great popularity. In London, both medical professionals and 'irregulars' engaged in electrical therapies. In the centre of the fashionable quarter of Adelphi, well-off patients could be treated by electricity at the Temple of Health, the baroque extravaganza of the notorious quack George Graham, while, at St Thomas's Hospital, the Electrical Department set up by the surgeon John Birch offered electrical treatments to the poor.[17]

The electric fluid was thought to be particularly effective in numerous

kinds of disorders: paralysis, rheumatism, nervous disorders, toothaches, eye and ear problems. With the exception of the 'electric bath', in which the patient sat on an insulated chair and was connected to the prime conductor of the electrical machine, electrical treatment was local. This implied that in some cases the administration of electricity could be uncomfortable for both patient and practitioner. Furthermore, the treatment of toothaches, eye problems and deafness, in particular, was not easily practicable with the electrical instruments available before the 1770s, when the attempt to simplify the application of the electric fluid to specific parts of the body resulted in the design of more specialized instruments.

Medical electricity was commonly regarded as one of the possible self-remedies for use at home. In 1770 James Ferguson, in his *An Introduction to Electricity*, reported the case of a turner in Greenwich who, following the prescription of a physician, had cured a woman of hemiplegia by means of electricity. The poet William Cowper (1731–1800) borrowed an electrical machine from his neighbour, after studying Cavallo's *Essay on the Theory and Practice of Medical Electricity* (London, 1780), and tried the effects of electrical treatments.[48] Instrument makers were often involved in the medical administration of the electric fluid, as in the case of Nairne's friend, William Henly, who, on behalf of the surgeon Miles Partington, administered electricity to his next-door neighbour. Natural philosophers were also interested in medical electricity, especially after 1746, when the introduction of the Leyden jar, allowing the administration of electric shocks to the body, raised questions on the relationship between electricity, animal motion and the principle of life.[49] The interactions with the practitioners of medical electricity provided Nairne with useful hints on how to improve the electrical apparatus so as to render electrical treatments more easily practicable. In 1782, together with the medical electrical machine, Nairne designed a series of jointed directors that could convey the fluid to the body 'without annoyance' and which could also be used in self-treatment (Figures 2 and 3). In eighteenth-century England, self-treatment was a best-selling genre. Booklets on how to be one's own physician abounded, and Nairne did not miss out on providing his readers with detailed instructions on how to administer the electric fluid to one's own body, according to the complaint.[50] In the booklet that accompanied the machine, Nairne described a range of electrical therapies to be performed with his patent machine that overshadowed the three methods of medical electricity popularized by the earliest practitioners in the late 1750s. However, Nairne warned his customers that he would not engage in the medical applications of electricity:

> The number of applications which have been made to Mr. Nairne, by patients desirous of receiving the benefit of medical electricity, renders it necessary for him to inform the public, that his other avocations make it impossible for him to attend to any applications of that nature.[51]

Nairne's 'other avocations' included attending the meetings of his

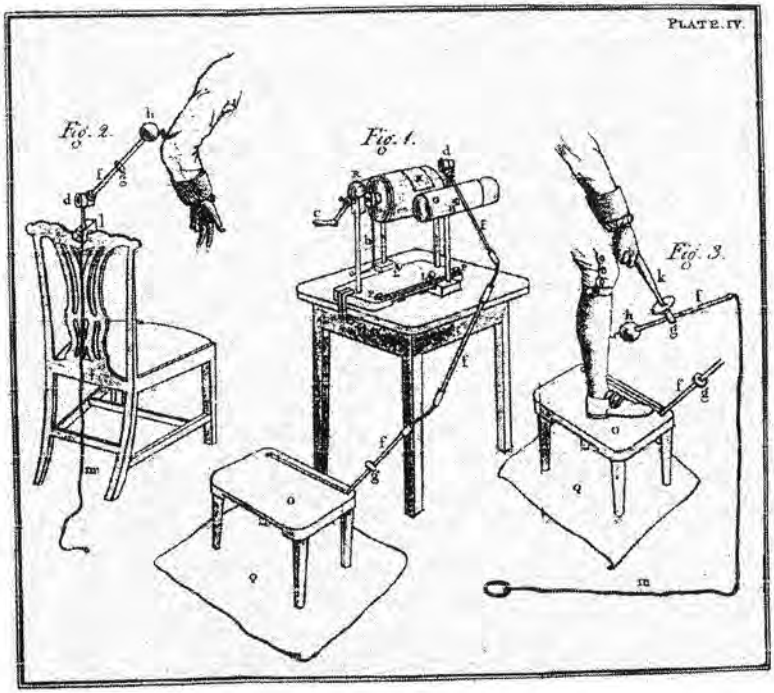

Figure 2 Nairne's jointed directors. From Edward Nairne, *The Description and Use of Nairne's Patent Electrical Machine* (London, 1782). Courtesy of the Bakken Library and Museum.

philosophical clubs, where he presented his patent machine as a highly sophisticated, multifunctional philosophical instrument, which could also perform electrical cures. He repeatedly emphasized that 'although the above Machines are constructed for medical Purposes, they are EQUALLY APPLICABLE TO PHILOSOPHICAL USES', and included a number of 'philosophical experiments and observations' that could be performed with the instrument.[52] The two conductors of the machine allowed the simultaneous production of equal quantities of negative and positive electricity, a practical question that was particularly attractive to experimental philosophers who, at the time, were especially concerned with the nature of 'negative electricity'. Hence, to his philosophical audience Nairne presented the machine as an invention that opened up the possibility of addressing new problems while also solving old ones, such as avoiding casual shocks to the operator during the management of the machine. Aware of the importance that the increased safety of the machine would have in the experimental world, Nairne presented to the Royal Society his booklet, *Description and Use of Nairne's Patent Electrical Machine* (significantly there is no mention of medical electricity in the title), and offered a model

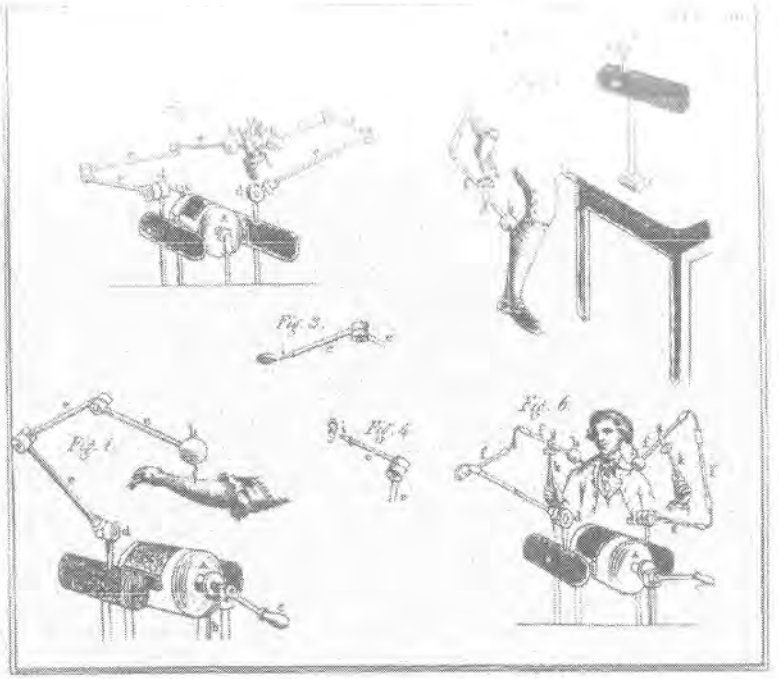

Figure 3 Nairne's jointed directors and their use in self-treatment. From Edward Nairne, *The Description and Use of Nairne's Patent Electrical Machine* (London, 1782). Courtesy of the Bakken Library and Museum.

of the patent machine to both Cavallo and Priestley.[53] The safety of the electrical apparatus had busied Nairne since the early 1770s, when he became aware not only of the dangers of casual shocks, but also of the breakage of the jars forming electrical batteries upon accumulation of large 'quantities of electricity'.[54] The particular arrangement of Nairne's patent electrical machine, with the Leyden jars enclosed in the conductors, avoided occasional sparks caused by an excessive charge of the jar, and the fixed position of the Leyden bottle within the conductors also prevented its breaking by accident.

The safety of the apparatus and the production of negative electricity were features that could be exploited in advertising his machine in the two contexts of medico-electrical practice and experimental philosophy. Nairne's booklet of instructions included directions on how to perform the most common electrical experiments and provided the purchasers with some theoretical background on the properties of electricity, the 'universal and principal agent in the system of the world'. Although the success of its applications to the cure of disorders had been 'exceedingly magnified by some writers and as much slighted by others', it was certain, Nairne

claimed, that electricity exerted an influence on the animal frame and that it acted as a specific aid for some disorders.[55] Addressing the self-trained medical electrician, Nairne explained that a satisfactory interpretation of the action of the electric fluid on the human frame had not yet been proposed. However, he explained, the numerous applications of electricity proved its therapeutic efficacy, which was not undermined by the lack of philosophical understanding:

> it is an advantage, that we are not under the necessity of waiting till a theory is established, before we can receive benefit from the powerful, though safe, application of electricity.[56]

In advertising his patent machine to the general public, Nairne exploited his own status as an FRS with prestigious acquaintances who could bear witness to his claims. In what he stated there was 'not a single assertion [which] has not been confirmed either by the author's own experience, or the testimony of a numerous acquaintance of ingenious and worthy men, who are ready to promote any undertaking which is intended to advance the public good'.[57] According to necessity, Nairne's machine could function as a philosophical instrument or as a tool for medical practice. As such, it would fit the philosopher's room for experiments, the collector's cabinet or the medical electrician's table. For this reason, the patent electrical machine was 'superior to others, by the means it affords of trying the medical effects of electricity'.[58] It was precisely this chameleon-like character of his invention that Nairne exploited in addressing the composite market of amateur electricians, professional and self-trained healers and electrical philosophers.

CONCLUSION

In 1782, when he obtained his patent, Nairne was an international authority as a maker of electrical machines. In the gentlemanly world of natural philosophy no one would have ever disputed his skills which, after all, had gained him access to that world. He had built up his reputation by observing the unwritten rules that regulated access to the philosophical elite and had gained a status as a 'useful' member thanks to his knowledge in experimental philosophy. One of these rules was that utility ought to be pursued for the benefit of mankind, rather than swell the pockets of the individual. Hence, Nairne shared his 'secrets' with the international community of natural philosophers, selecting the most advantageous among the ways in which the gentlemen of the Royal Society secured their claims of invention. He published detailed descriptions of his instruments in the *Philosophical Transactions*, thus fashioning for himself a public persona as an instrument maker and a trustworthy man of science. His engagement in experimental practice allowed him to devise instruments that responded to the philosophical fashion of the moment, while also linking his experimental skills to the apparatus he employed. This strategy made his workmanship partake of the prestige he was able to acquire. In the gentlemanly

world, whose members eagerly sought the most renowned instruments for their cabinets, the most effective publicity for an instrument maker's workshop was his reputation, and Nairne could boast of his own.

The practice of natural philosophy made Nairne's business, and it allowed him to secure to his workshop an exclusive range of international, wealthy customers. Yet instrument makers were commercial entrepreneurs and, as such, they were sensitive to the fluctuating demands of the market place. Nairne's patent electrical machine, with its double life as a philosophical and a medical instrument, was the result of his efforts to address simultaneously a gentlemanly clientele and the wild market place. For someone who was among the most well-known makers of electrical instruments in the world, the increasing popularity of the medical applications of electricity was an irresistible temptation, and a winning bet. Moreover, being perceived as a useful application of the science of electricity, medical electricity matched the ideal of the pursuit of science for the benefit of the public, which, in the years of Banks's presidency, the FRSs were expected to enact with renewed commitment.[59] On the other hand, in addressing the non-gentlemanly public, Nairne's strategy was to exploit his haunts in the philosophical world in order to make his instruments more attractive. In this respect, Nairne's price catalogue, included in the edition of the *Direction and Use of Nairne's Patent Electrical Machine* published in the last year of the patent's validity (1796), is an illuminating source. Taking up Heilbron's suggestion that instrument makers' catalogues are 'works of high rhetoric if of little eloquence', I want to focus briefly on the range of instruments that Nairne listed in the catalogue as they give clear hints of his advertising strategy directed to the general public.[60] The catalogue introduced the non-gentleman, potential purchaser to Nairne's virtual workshop, where all the instruments that he could make were simultaneously present. This was indeed a virtual experience, given that foreign visitors often reported their disappointment at finding the instrument-makers' shops empty.[61] Conversely, by turning the pages of Nairne's catalogue, purchasers of the patent machine could enter an impressive natural philosophical cabinet furnished with all the 'optical, mathematical and philosophical instruments, according to the latest improvements'.[62] Some of these instruments had the additional value of forming the 'standard equipment' for the practice of natural philosophy: Bennet's gold-leaf electrometer, Cavallo's multiplier, Nicholson's doubler, Volta's electrophorus, Hadley's quadrants, Knight's azimuth-compass, to name a few.[63] In this empyrean of philosophically minded inventors who created the standard instruments for natural philosophy, Nairne himself occupied a place. The reader would be reminded that, besides the famous Nairne electrical machines, Nairne's portable observatory too was described in the *Philosophical Transactions*. This was coherent with his advertising strategy in which his status as a 'man of science' was trumpeted in the market place in order to add value to his workmanship. He adopted the very same strategy in presenting his patent electrical machine to the general public. In the early 1780s, the broader appeal of medical electricity, perceived also as an attractive self-remedy,

created a demand for different instruments for different pockets, and Nairne's workshop could afford to differentiate the offer. The prices of his patent medico-electrical machine ranged from a little more than £5 for a cylinder of about five inches in diameter to £160 for the largest machines.

In his insightful analysis of electrical patents in Victorian Britain, Iwan Morus has pointed out that, at the time, electrical inventors 'sought to combine the moral status of the natural philosopher, the practical knowledge of the mechanic, and the commercial acumen of the entrepreneur'.[64] Over half a century earlier, these three aspects were already successfully combined in an instrument maker such as Nairne. He built up his career in the London philosophical clubs and, consequently, he gained an outstanding reputation in England and abroad as a trustworthy philosophical instrument maker. This assured a range of international clients to his workshop. Once his prestige was secure, Nairne directed his entrepreneurial concerns towards enlarging his market, seeking the protection and the prestige of a patent. Contrary to later electrical inventors, he did not have to negotiate his 'right to look for fame'. He had already gained fame, and the patent from the king enhanced it with the Great Seal.

Notes and References

I am grateful to Robert Fox, Anna Guaghini and Giuliano Pancaldi for their useful comments on earlier versions of this chapter.

1. Bennet Woodcroft, *Subject-Matter Index (Made from Titles Only) of Patents of Invention, from 1617 to 1852* (London, 1856). The next patent in the class of electricity was granted in 1841.

2. Joseph Priestley, *History and Present State of Electricity* (London, 1767), 505.

3. Douglas McKie, 'Priestley's Laboratory and Library and Other Effects', *Notes and Records of The Royal Society of London*, 1956, 12: 114–36, p. 126. One year after the riots, Priestley claimed damages in the King's Bench. The original claim, kept at the Birmingham Reference Library, was reprinted in McKie's article.

4. For a study of the instrument trade in London in the second half of the eighteenth century, see Anita McConnell, 'From Craft Workshop to Big Business. The London Scientific Instrument Trade's Response to Increasing Demand', *The London Journal*, 1994, 19: 36–53. Mary M. Robischon examines the broad context of the London instrument makers, beyond the less well-known cases, in 'Scientific Instrument Makers in London during the Seventeenth and Eighteenth Centuries' (unpublished PhD thesis, Michigan, 1983). For a comparison of eighteenth-century instrument making in Paris and London, see Anthony J. Turner, *From Pleasure and Profit to Science and Security. Etienne Lenoir and the Transformation of Precision Instrument-Making in France, 1760–1800* (Cambridge, 1989), 1–13; Patricia Fara makes the point for the makers of magnetic instruments, see P. Fara, *Sympathetic Attractions. Magnetic Practices, Beliefs, and Symbolism in Eighteenth-Century Britain* (Princeton, 1996), *passim*, especially 133–8. Richard Sorrenson examines the case of George Graham, FRS, Watch and Clock-Maker, see R. Sorrenson, 'George Graham, Visible Technician', *British Journal for the History of Science*, 1999, 32: 203–21. On the social composition of the Royal Society in the eighteenth century, see R. Sorrenson, 'Towards a History of the Royal Society in the Eighteenth Century', *Notes and Records of The Royal Society of London*, 1996, 50: 29–46.

5. Gerard Turner, 'The London Trade in Scientific Instrument-Making in the 18th Century', *Vistas in Astronomy*, 1976, 20: 173–82. For a study of the geographical distribution of the instrument makers in London, see Robischon, *op. cit.* (4), 169–94.

6. John R. Millburn, 'The Office of Ordnance and the Instrument-Making Trade in the Mid-18th Century', *Annals of Science*, 1988, 45: 221–293.

7. On London coffee-house culture, Larry Stewart, *The Rise of Public Science, Rhetoric,*

Technology, and Natural Philosophy in Newtonian Britain, 1660–1750 (Cambridge, 1992). For a list of eighteenth-century London coffee houses, see B. Lillywhite, *London Coffee Houses. A Reference Book of Coffee Houses of the Seventeenth, Eighteenth and Nineteenth Centuries* (London, 1963), 22–4.

8. Gloria Clifton, *Directory of British Scientific Instrument Makers 1550–1851* (London, 1995), 196. On the range of Nairne's activities, Debra J. Warner, 'Edward Nairne: Scientist and Instrument-Maker', *Journal of the Americal Scientific Instrument Enterprise*, 1998, 12: 65–93, esp. 66–7.

9. Christa Jungnickel and Russel MacCormmach, *Cavendish. The Experimental Life* (Bucknell, 1999), 124.

10. Royal Society Library, Journal Book, 1766–76 (hereafter JB).

11. Royal Society Library, Certificates of Election, CE, 3, f. 254.

12. Jungnickel and MacCormmach, *op. cit.* (9), 300.

13. James Ferguson, *An Introduction to Electricity* (London, 1770), 9.

14. Priestley, *op. cit.* (2), 529.

15. On the collaboration between Cavendish and Nairne, see Jungnickel and MacCormmach, *op. cit.* (9), 248 (experiments on the artificial torpedo), and 382–4 (chemical experiments).

16. Magellan to Volta, 31 December 1782, in *Epistolario di Alessandro Volta. Edizione Nazionale* (Bologna, 1949–52), Vol. 2, 146; Volta to Firmian, 25 October 1780, *ibid.*, 10; Cowper to Volta, 8 October 1778, in *Epistolario*, Vol. 1, 281; Landriani to Volta, 9 October 1788, *Epistolario*, Vol. 3, 11. Nairne included Volta's lamp among the instruments that his workshop made and sold at the price of three pounds and three shillings.

17. Warner, *op. cit.* (8), 65.

18. 'A Report of the Committee Appointed by the Royal Society, To Consider of a Method for Securing the Powder Magazines at Purfleet', *Philosophical Transactions of The Royal Society* (hereafter *PT*), 1773, 63: 42–7. Wilson's dissent at p. 48. On the controversy, see T. A. Mitchell, 'The Politics of Experiments in the Eighteenth Century: The Politics of Audience and the Manipulation of Consensus in the Debate Over Lightning Rods', *Eighteenth-Century Studies*, 1998, 31: 307–31.

19. Edward Nairne, 'Experiments on Electricity, Being an Attempt to Shew the Advantage of Elevated Pointed Conductors', *PT*, 1778, 68: 823–60. Criticism of Nairne's conclusion in 'Reasons for Dissenting from the Report of the Committee Appointed to Consider of Mr. Wilson's Experiments; Including Remarks on Some Experiments by Mr. Nairne. By Dr. Musgrave', *PT*, 1778, 68: 801–22. Musgrave's autograph report of the experiments performed at Nairne's in the presence of Wilson, Cavallo and Musgrave himself is in British Library, Add Mss 30094, ff. 208–9.

20. British Library, Add Mss 30094, ff. 208–9.

21. W. Hackmann, *Electricity from Glass. The History of the Frictional Electrical Machine, 1600–1850* (Alphen aan den Rijn, 1978), 104–42.

22. Nairne made instruments for Banks's voyages; see his invoice, dated 25 April 1772, State Library of New South Wales, Banks Papers, CY 3003/170. On Banks's collecting activity during the voyages of exploration through the South Pacific, see Rob Iliffe, 'Science and Voyages of Discovery', in R. Porter (ed.), *Cambridge History of Eighteenth-Century Science* (Cambridge, 2002), 703–34.

23. Edward Nairne, 'Electrical Experiments by Mr. Edward Nairne, of London, Mathematical Instrument-Maker, Made with a Machine of His Own Workmanship, a Description of Which is Prefixed', *PT*, 1774, 64: 85–7.

24. W. D. Hackmann, *op. cit.* (21), 129.

25. McKie, *op. cit.* (3), 117. Cavendish's Nairne machine is at the Whipple Museum, Cambridge.

26. William Hamilton, 'Account of the Effects of a Thunderstorm, on the 15th of March 1773, upon the House of Lord Tylney at Naples', *PT*, 1773, 63: 324–32.

27. Priestley, *Memoirs*, in J. T. Rutt, *Life and Correspondence of Joseph Priestley, LL.D, F.R.S., &c.* (2 vols, London, 1831), 1: 79.

28. Lord Cowper to Volta, 28 October 1778, in Volta, *Epistolario*, Vol. 3: 309. Cowper owned three electrical machines made by Nairne, one of which was the patent medical

electrical machine, as from the inventory of the apparatus in Lord Cowper's Museum kept in Archivio di Stato, Bologna, Assunteria D'Istituto, Diversorum, b.10, n. 13.

29. Nairne's original patent is at the Public Record Office, C66/16. The specification is in C210/23.

30. Nairne, *op. cit.* (23).

31. Edward Nairne, *The Description and Use of Nairne's Patent Electrical Machine: With the Addition of Some Philosophical Experiments and Medical Observations* (8th edn., London, 1796), 66.

32. *A Catalogue of the Capital Collection of Optical, Mathematical, and Philosophical Instruments and Machines, late the Property of the Right Hon. The Earl of Bute, Deceased* (London, 1793).

33. Models of Nairne's patent electrical machine are kept in the Coimbra Physics Cabinet, the Teyler Museum at Haarlem, the University Museum at Utrecht, the Science Museum and the Royal Institution in London, the Smithsonian Institution at Washington and the Bakken Museum in Minneapolis. Hackmann states he examined more than 30 patent machines; Hackmann, *op. cit.* (21), 134.

34. Edward Nairne, *The Description and Use of Nairne's Patent Electrical Machine: With the Addition of Some Philosophical Experiments and Medical Observations* (London, 1783). The French edition contains additions by the translator, a Parisian physician who took the opportunity to advertise similar machines by French makers (including his own) which differed from Nairne's only in the shape of the glass piece. *Description de la machine électrique de M. Nairne* (Paris, 1784, translated by M. Caullet de Veaumorel), 145 ff.

35. Diary of the Abbot Giuseppe Mangili, 5 May 1792, in Volta, *op. cit.* (16), Vol. 5, 480.

36. British Library, Add Mss 22897, f. 74 (Cavallo to Lind, 28 May 1787).

37. Museum of the History of Science, Oxford, Chapter Coffee House minutes, Ms Gunther 4.

38. On the development of the patent system, see Christine MacLeod, *Inventing the Industrial Revolution. The English Patent System, 1660–1800* (Cambridge, 1988), and Harold Dutton, *The Patent System and Inventive Activity during the Industrial Revolution, 1750–1852* (Manchester, 1984).

39. M. A. Crawforth, 'Instrument Makers in the London Guilds', *Annals of Science*, 1987, 44: 319–77.

40. Science Museum, London, Scientific trade cards, inventory No. 1934–118. Published in H. R. Calvert, *Scientific Trade Cards at the Science Museum Collection* (London, 1971), my italics. On the Dolloud patent case, see Robischon, *op. cit.* (4), 283–343. The petition is in PRO, Privy Council, MS PC I, No. 7/94 (X/LD 7933).

41. For a discussion of the Royal Society's lack of corporate attitude towards patenting, see MacLeod, *op. cit.* (38), 186–90.

42. A. Q. Morton and J. A. Wess, *Public and Private Science. The King George III Collection* (Oxford, 1993), 77–9.

43. On medical patents, Roy Porter, *Health for Sale: Quackery in England, 1660–1850*, (Manchester, 1990). Also MacLeod, *op. cit.* (38), 84–8.

44. On local makers infringing Nairne's patent, see Hackmann, *op. cit.* (21), 51. Thomas Webster, *Reports and Notes of Cases on Letters Patent for Inventions* (London, 1844); P. A. Hayward, *Hayward's Patent Cases, 1600–1883. A Compilation of the English Patent Cases for Those Years* (Abingdon, 1987), Vols. I and II.

45. Dutton, *op. cit.* (38), 35. The price of the patent medico-electrical machine, for example, reached £160, but other instruments by Nairne were also expensive. A large electrical battery could cost up to £100. Nairne's reflecting telescope reached £150, whereas Nairne's complete equatorial instrument 'or portable observatory' cost £80. In *Prices of Nairne's Patent Electrical Machines, and a Catalogue of Some of the Various Optical, Mathematical, and Philosophical Instruments Made and Sold by Edward Nairne* (London, 1796). See also Warner, *op. cit.*, (8), *passim*.

46. Turner, *op. cit.* (5), 174.

47. On Graham, see R. Porter, 'The Sexual Politics of James Graham', *British Journal for Eighteenth Century Studies*, 1982, 5: 201–6.

48. Quoted in Roy and Dorothy Porter, *Patient's Progress. Doctors and Doctoring in Eighteenth Century England* (Oxford, 1989), 50.

49. P. Bertucci, 'The Electrical Body of Knowledge: Medical Electricity and Experimental Philosophy in the Mid-eighteenth Century', in P. Bertucci and G. Pancaldi (eds), *Electric Bodies. Episodes in the History of Medical Electricity* (Bologna, 2001), 43–68.

50. On the commercial success of DIY medical therapies, see Porter and Porter, *op. cit.* (48), 33–52.

51. Nairne, *op. cit.* (31), 78–9.

52. *Ibid.*, catalogue of instruments, 82 (capital letters in the text).

53. JB, 6 March 1788, f. 139. British Library, Add Mss 22897, f. 74 (Cavallo to Lind, 28 May 1787).

54. Nairne, *op. cit.* (31), 74.

55. *Ibid.*, 63.

56. *Ibid.*, 66.

57. *Ibid.*

58. *Ibid.*, 74.

59. J. Gascoigne, *Science in the Service of Empire. Joseph Banks, the British State and the Uses of Science in the Age of Revolution* (Cambridge, 1998), Chs 2 and 5.

60. J. L. Heilbron, 'Some Uses for Catalogues of Old Scientific Instruments', in R. G. W. Anderson, J. A. Bennett and W. F. Ryan (eds), *Making Instruments Count. Essays on Historical Instruments Presented to Gerard L'Estrange Turner* (Aldershot, 1993), 16.

61. Turner, *op. cit.* (5), 180.

62. Nairne, *op. cit.* (31), 93.

63. On the distribution of 'standard equipment' and the marketing of natural philosophy, see Simon Schaffer, 'The Consuming Flame: Electrical Showmen and Tory Mystics in the World of Goods', in J. Brewer and R. Porter (eds), *Consumption and the World of Goods in the Eighteenth Century* (London, 1993), esp. 512–14.

64. Iwan Morus, *Frankenstein's Children. Electricity, Exhibition, and Experiment in Early Nineteenth-Century London* (Princeton, 1998), 179.