CHAPTER 4

Shocking Subjects: Human Experiments and the Material Culture of Medical Electricity in Eighteenth-Century England

Paola Bertucci[1]

In contemporary Western societies medical patients are accustomed to being tested or treated by means of electrical instruments. Their presence is so familiar that it would be unsettling to enter a hospital or a medical laboratory unfurnished with the high tech apparatus through which research, diagnoses and therapies are routinely carried out. The technologization of medicine has produced systems of trust that rely on black boxed instruments, which profoundly influence contemporary perceptions of the human body and of the self.[2] However, the applications of scientific instruments for medical purposes have a history of debates and controversies.[3] In the eighteenth century, when the medical profession was regulated by the guild system, the intersections between experimental philosophy and medical practices created uncharted territories that blurred disciplinary divides and gave rise to conflicting epistemologies of medical efficacy. The early applications of electricity as a medical remedy offer a striking case of the tensions that such intersections engendered.[4]

1 For comments on earlier versions of this paper I am grateful to: participants in the workshop "The makers' universe" at McGill University, participants in the symposium "Alternative therapies of the 18th century" at the Wellcome Institute in London, Sally Romano, Lucia Dacome, Jan Golinski, and the editors of this volume.

2 On the black boxing of scientific instruments see Bruno Latour, *Science in Action : How to Follow Scientists and Engineers through Society* (Cambridge, Mass.: Harvard University Press, 1985); on the social construction of technological systems: Wiebe E. Bijker, Thomas P. Hughes and Trevor Pinch eds. *The Social Construction of Technological Systems: New Directions on the Sociology and History of Technology* (Cambridge, Mass.: MIT Press, 1987); on medical technology see Joel Howell, *Technology in the Hospital : Transforming Patient Care in the Early Twentieth Century* (Baltimore: Johns Hopkins University Press, 1995); on medical imagining and self perception: Renée van de Vall and Robert Zwijnenberg eds. *The Body Within: Art, Medicine, and Visualization* (Leiden: Koninklijke Brill NV, 2010).

3 Jeffrey P. Baker, *The Machine in the Nursery* (Baltimore: Johns Hopkins University Press, 1996); Joel Howell, "Early Perceptions of the Electrocardiogram," *Bulletin of the History of Medicine* 58 (1984), 83–98; Bettyann Kevles, *Naked to the Bone : Medical Imaging in the Twentieth Century* (New Brunswick, N.J. : Rutgers University Press, 1997).

4 Paola Bertucci and Giuliano Pancaldi eds. *Electric Bodies. Episodes in the history of medical electricity* (Bologna: CIS, 2001).

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Beginning in the 1740s, electrical treatments were often offered by practitioners who did not make a mystery of their ignorance of medical theory. Their claims to authority were based on the success of their new methods as assessed by patients themselves, rather than on theoretical grounds. Often working at the fringes of the medical system, electrical healers attracted at best skepticism, but more often indifference, on the part of the medical establishment.[5] They were not the only "irregulars" who advertised unusual therapies riding the wave of the self-help ethos of the time. Yet electrical treatments were quite exceptional in their employment of instruments that came from the domain of the experimental sciences.[6] Electrical machines and Leyden jars were not simply aiding tools for surgical operations or for the preservation of health; they were understood as the means to collect an "electric fluid" that, when applied to the human body, elicited physiological responses. It was the action of such a fluid on the body that caused the healing process, even though no theory explained exactly how. In 1780, Fellow of the Royal Society Tiberius Cavallo explained that "hitherto it has not been discovered that the electric fluid acts within the human body by any chymical property, as other medicines do"; the prevailing view in England was that electricity exerted a mechanical action upon muscles and nerves, even though recent cases indicated that it could have "some other action upon the human body besides that of mere stimulus."[7] If there was no agreement on the theory of medical electricity, electrical healers were all aware that their treatments could only be applied by means of scientific instruments. The strategies they devised to build trust in electrical apparatus differed greatly. In the 1750s John Wesley, one of the first advocates of the healing virtues of electricity, strove to naturalize the electric matter: although it was produced by means of man operated machines, electricity was for him a natural power, whose healing properties bore testimony to divine benevolence. Wesley attempted to make the electrical machine transparent to his patients: what mattered most to him was the fact that electricity was

5 On the early applications of electricity to medicine see Bertucci and Pancaldi, *Electric Bodies* (ref. 4); Stanley Finger, *Doctor Franklin's Medicine* (Philadelphia: University of Pennsylvania Press, 2006); Harry Whitaker et al., eds. *Brain, Mind, Medicine: Essays in the History of Eighteenth-Century Neuroscience* (Boston: Springer, 2007).

6 On the medical marketplace in 18th-century England see Roy Porter, *Health for Sale: Quackery in England* (Manchester: Manchester University Press, 1989); Roy Porter, ed., *Patients and Practitioners: Lay Perceptions of Medicine in Pre-Industrial Society* (Cambridge: Cambridge University Press, 1985); Dorothy and Roy Porter, *Patient's Progress: Doctors and Doctoring in Eighteenth-Century England* (Oxford: Basil Blackwell, 1989).

7 Tiberius Cavallo, *An Essay on the Theory and Practice of Medical Electricity*, (London, 2nd ed., 1781) London, 1781, p. 7 and note.

a "primitive remedy" created by God before the Fall, which the machine only revealed.[8] This paper will show that instead, in the later part of the century, electrical practitioners attracted attention to the electrical apparatus that afforded the therapy, with an emphasis on their own ability to master its performance. Trust in the electrical machine could not be taken for granted: electrical treatments were lengthy and often painful, and even though the eighteenth-century upper classes played with shocks and sparks in their salons, it was widely known that electrical imbalances in the atmosphere were responsible for life-threatening phenomena, such as lightning, thunderstorms, and even earthquakes.[9] What strategies did electrical healers employ to build trust in their therapies? The technologies of consensus building devised and employed by seventeenth-century experimental philosophers in the validation of experimental results have been widely explored.[10] I will argue that late eighteenth-century electrical healers attempted to adapt such technologies to their own practice: they presented accounts of medical cases as reports of experimental results, providing trustworthy testimonies and calling for virtual witnessing.[11] The unpredictability of the human body's responses to electricity, however, destabilized their attempts.

The essay follows the trajectory of John Fell, a Quaker surgeon in the English province who, in his mid-career, decided to specialize in electrical treatments. The de-centered view offered by this case provides rare insights into the pragmatic demands of provincial audiences that fed on the public culture of science.[12] Fell was neither physician nor quack. His career as an electrical

8 Paola Bertucci, "Revealing sparks: John Wesley and the Religious Utility of Electrical Healing," *British Journal for the History of Science* 39 (2006), 341–62.

9 Simon Schaffer, "Natural Philosophy and Public Spectacle in the Eighteenth Century," *History of Science*, 21 (1983), 1–43; on spectacular demonstrations: Paola Bertucci, "Sparks in the Dark: The Attraction of Electricity in the Eighteenth Century," *Endeavour* 31 (2007), 88–93. For a general overview on the history of electricity: John Heilbron, *Electricity in the 17th and 18th centuries : a Study of Early Modern Physics* (Berkeley: University of California Press, 1979).

10 Steven Shapin and Simon Schaffer, *Leviathan and the Air Pump; Hobbes, Boyle, and the Experimental Life* (Princeton: Princeton University Press, 1985); Steven Shapin, S*ocial history of Truth : Civility and Science in Seventeenth-Century England* (Chicago: The University of Chicago Press, 1994).

11 On virtual witnessing see Steven Shapin, "The House of Experiment in Seventeenth-Century England," *Isis* 97 (1988), 373–404.

12 Larry Stewart, *The Rise of Public Science: Rhetoric, Technology, and Natural Philosophy in Newtonian Britain, 1660–1750* (New York: Cambridge University Press, 1992); Jan Golinski, *Science as Public Culture : Chemistry and Enlightenment in Britain, 1760–1820* (New York: Cambridge University Press, 1992).

healer did not result from the institutionalized paths of medical education or apprenticeship, or from heroic competition in the medical marketplace. His self-directed apprenticeship derived from the public lectures he attended and from the experiments he carried out on patients and instruments. As we shall see, he held high expectations about the new direction he took, keeping records of his expenses, treatments, experiments and correspondence.[13] These documents offer insights on the material culture of electricity and its role in fostering the cultural ambitions of provincial practitioners. By examining the range of skills Fell strove to acquire in order to establish himself as a trustworthy medical electrician, I will argue that the management of the electrical apparatus was the most relevant aspect of the training and practice of electrical healers. The combination of practitioner, patient and instruments constituted an unstable experimental system that turned medical treatments into trials aimed at testing the performance of electrical instruments.

Manufacturing Safety

The earliest applications of electricity for medical purposes dated back to the early 1740s. Fashionable salon demonstrations that employed the human body indicated that sparks and shocks caused physiological reactions, which several electricians throughout Europe hoped to convert into a new way of treating diseases. Although authoritative experimenters such as Jean Jallabert in Geneva claimed that electricity could restore voluntary movement to paralyzed limbs, controversial results undermined the credibility of medical electricity. The infamous controversy over the "medicated tubes," a miraculous electrical treatment hastily supported by the Bologna Institute of Science and subsequently discredited by the abbé Nollet, became a well known cautionary tale of the dangers that learned societies could encounter when endorsing the new remedies.[14] However, in the 1770s, studies on fishes such as the torpedo and the *gymnotus electricus* (or electric eel), whose "electric organs" were shown to produce sparks and shocks in the same way as the electrical instruments

13 Wellcome Library, London: Ms 1175, *Miscellanea Electrica* (hereafter Ms 1175). This notebook contains John Fell's expenses, income, experimental records and correspondence with a number of London electricians.

14 Paola Bertucci, "Sparking Controversy. Jean Antoine Nollet and Medical Electricity South of the Alps," *Nuncius. Journal of the History of Science* 20 (2005), 153–187; id. *Viaggio nel paese delle meraviglie. Scienza e curiosità nell'Italia del Settecento* (Turin: Bollati Boringhieri, 2007).

employed in fashionable entertainments, boosted new interest in the role of electricity in the animal economy. The new subject of "animal electricity" captivated Georgian Londoners, who crowded the displays of live eels brought from South America. The eel literally shocked audiences and inspired a number of erotic poems that played with the fish's shape and electric vitality.[15]

Such demonstrations pointed to a close relationship between electricity and life and revived interest in the medical applications of electricity. In 1780 Tiberius Cavallo, the author of the successful *Treatise of Electricity in Theory and Practice* (London 1777), published *An Essay on the Theory and Practice of Medical Electricity*, reprinted in a second edition the following year, in which he acknowledged that in recent years the medical applications of electricity had progressed enormously. In the same period in Bologna, the physician Luigi Galvani began experimenting on dissected frogs with the aim to understand the role of electricity in animal motion, even though his work became widely known only a decade later.[16] In 1782 the instrument maker Edward Nairne envisaged enough potential in the medical applications of electricity as to petition for a patent – the first in the class of electricity – for his improved electrical machine.[17] According to the surgeon John Birch, who had established the Electric Department at St. Thomas Hospital, since 1777 "the many improvements of the Electrical Machine…have furnished the practice of medical electricity with a variety of accuracy and application 'till then unknown": the technical improvements of electrical apparatus enhanced accuracy in electrical treatments to the point that the year marked a clear divide between the "old" and the "new" medical electricity.[18]

Birch's emphasis on instrumentation was widely shared, as the eighteenth-century term for the medical applications of electricity indicates. Calling themselves "medical electricians," those who offered electrical treatments wanted to

15 Stanley Finger and Marco Piccolino, *Shocking History of Electric Fishes: From Ancient Epochs to the Birth of Modern Neurophysiology* (New York: Oxford University Press, 2011); Christopher Plumb, "The 'electric stroke' and the 'electric spark': Anatomists and Eroticism at George Baker's Electric Eel Exhibition in 1776 and 1777," *Endeavour* 34 (2010), 87–94.

16 Marco Piccolino and Marco Bresadola, *Rane, torpedini e scintille: Galvani, Volta e l'elettricità animale* (Turin: Bollati Boringhieri, 2003); Marco Bresadola and Giuliano Pancaldi eds. *Luigi Galvani Proceedings* (Bologna: CIS, 1999).

17 On Nairne's patent electrical machine see Paola Bertucci, "A Philosophical Business: Edward Nairne and the Patent Electrical Machine," *History of Technology* 23 (2001), 41–58.

18 John Birch, *Considerations on the Efficacy of Electricity in Removing Female Obstructions* (London: Cadell, 1780), p. iv (note).

be perceived as practitioners with skills and expertise in the theory and, above all, in the practice of electricity. A number of them were instrument makers who specialized in electricity and subsequently devoted themselves to its medical applications. This was the case of William Swift, a turner who made electrical machines at Greenwich, or John Read, a cabinet maker who invented a portable electrical machine for medical uses, and of a number of fellows of the Royal Society who made or designed instruments, such as William Henly, the inventor of the homonymous electrometer, the public demonstrator James Ferguson, and the apothecary Timothy Lane. The association between instrument makers and medical electricians was so strong that Nairne had "respectfully to inform the public" that his "other avocations make it impossible for him to attend" to the many "patients desirous of receiving the benefit of medical electricity."[19] In his *Course on electricity*, the instrument maker George Adams made a visual statement on the relevance of instruments to the practice of medical electricity: the frontispiece represented a young girl undergoing electrical treatments to her paralyzed forearm at the presence of her mother; while the image portrayed the apparatus in full detail, the human figures were only sketched (Fig. 4.1).

Late eighteenth-century audiences had come to learn that electricity's relationship with life was a double-edged one: the electric fluid seemed to carry a vivifying principle that disappeared in dead bodies, yet it was also a natural power with potentially lethal effects. The case of the St. Petersburg electrician Georg Richman, who died struck by lightning while incautiously experimenting on the electricity of the atmosphere, showed that lack of expertise in the management of the apparatus could prove lethal. Salon demonstrations showed that strong shocks could kill small animals, so advocates of medical electricity attempted to persuade patients that there was no danger involved in electrical therapies.[20] The concern with "safe" electricity boosted invention and provided new business opportunities. If, in the 1750s, the earliest advocates of medical electricity described three methods for treatment and did not devote too much attention to the description of the apparatus, three decades later medical electricians emphasized that there were many more ways in which

19 Edward Nairne, *Description and Use of Nairne's Patent Electrical Machine* (London, 1786), 79. The association between medical electrical practice and expertise in the management of instruments also characterized the work of the itinerant demonstrator James Dinwiddie. See Larry Stewart and Jan Golinski's papers in Bernard Lightman, Gordon McOuat, and Larry Stewart eds., *Circulating Knowledge: East and West* (Leiden: Brill Publishers, forthcoming).

20 On lightning and electricity, see, P. Heering, O. Hochadel and D. Rhees eds., *Playing with Fire: Histories of the Lightning Rod* (Philadelphia: The American Philosophical Society, 2009); on eighteenth century electricity in general, see Heilbron, *Electricity* (ref. 8).

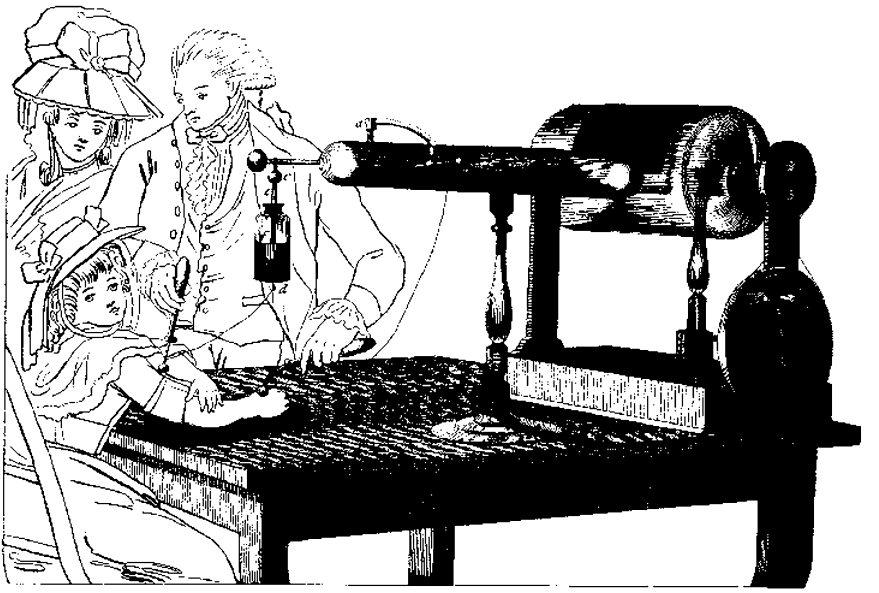

FIGURE. 4.1 *Frontispiece from George Adams's* An Essay on Electricity (*London, 1785*). *Notice the detailed representation of the electrical apparatus, in contrast with the human figures that are only sketched.*
COURTESY OF THE BAKKEN MUSEUM AND LIBRARY OF ELECTRICITY IN LIFE.

electricity could be made to act as a healing agent and several new instruments with which to offer "safe" treatments.[21] They launched a vocal campaign against the administration of strong shocks and described at length the soothing virtues of "gentle" electrification. In 1767 the London apothecary and FRS Timothy Lane presented to the Royal Society his invention of an electrometer especially designed to measure the intensity of electric shocks.[22] The "medical electrometer," as the instrument came to be called, could be used to set an upper limit to the intensity of electric shocks and met with success among medical electricians. Cavallo, for his part, designed special instruments to apply electricity in the form of "gentle streams" of sparks in order to reduce the pain associated

21 The three methods of applying electricity for medical purposes were: the electric bath, in which the insulated patient was connected to the electrical machine by direct contact or through a metallic chain; the drawing of sparks from the affected part through pointed metallic "directors;" the electric shock, administered by discharging a Leyden jar through the affected part. Richard Lovett, *Subtil Medium Prov'd* (London, 1756).

22 Timothy Lane, "Description of an electrometer invented by Mr Lane; with an account of some experiments made by him with it," *Philosophical Transactions of the Royal Society*, 57 (1767), 451–460.

with electrical treatments. Instrument makers differentiated their offer of electrical machines and marketed a variety of "directors" especially designed for treating toothaches and ailments of the eye or the ear.[23] The sheer quantity of new instruments demonstrates more forcefully than any textual source that in spite of controversy and skepticism by the 1780s medical electricity had become a thriving business and a tempting investment – one that required training in electrical experimentation. As Cavallo pointed out, the ability to manage electrical instruments was key to the success of medical electricity:

> That Electricity has been of great benefit in many cases, where the application of other medicines has failed, is beyond doubt, …its inefficacy in several cases is in great measure to be attributed to the injudicious application of it, indeed more than to any other cause.[24]

It is no surprise, then, that when Fell decided to become a medical electrician, his first preoccupation was to equip himself with good electrical apparatus. We do not know much about Fell's education or training, except that he worked as a surgeon at Ulverston in Lancashire (now Cumbria) when, at the beginning of 1783, he asked his brother-in-law, who lived in London, to seek the advice of some expert electrician. At the time, London was Europe's electrical capital. No other city hosted as many experts in the science of electricity active at the same time. London's reputation in matters electrical extended beyond the Channel: even well-reputed physicists such as Alessandro Volta embarked on long journeys across Europe in order to become acquainted with electricians whose expertise ranged from instrument making to meteorology, physiology, and the art of healing.[25] London's electric microcosm was diversified and widespread. The Fleet Street area was home to the workshops of electrical instrument makers such as Jesse Ramsden, Edward Nairne and George Adams, who attracted commissions from Europe and beyond. Fellows of the Royal Society who had greatly contributed to the science of electricity lived not far from Somerset House, in the Strand, the venue of the Society's meetings. The notorious quack James Graham had erected his Temple of Health and Hymen, an electrical extravaganza that combined electricity and sexual therapies, in Pall Mall. In Southwark, the surgeon John Birch was responsible for the newly founded Electric Department at St. Thomas Hospital. In Moorsfield, the

23 Tiberius Cavallo, *Essay* (*ref.* 7).

24 Tiberius Cavallo, *A Treatise of Electricity in Theory and Practice* (London, 1777). 88.

25 Giuliano Pancaldi, *Volta: Science and Culture in the Age of Enlightenment* (Princeton: Princeton University Press, 2003).

FIGURE. 4.2 *Electricity in London A. Miles Partington, Cavendish Square. B. Tiberius Cavallo, 8 Little St. Martin's Lane. C. Timothy Lane, Aldersgate Street. D. John Wesley's Electrical Dispensary, Moorsfield. E. Edward Nairne, 20 Cornhill. F. Mr. Long, Soho. G. James Graham, Pall Mall. H. George Adams, Fleet Street. I. William Henly, Borough, Southwark. L. John Birch, St. Thomas Hospital. M. Henry Cavendish, Great Marlborough Street. N. John Canton, Spital Square Academy. O. John Read, Knightsbridge. P. Michael Underwood, Cavendish Square. Q. William Swift, Greenwich* (*out of map*).

Dispensary founded by John Wesley offered free electrical treatments to the poor. In addition to such institutional or semi-institutional premises, a number of self-styled electrical healers practiced in their own homes all over the city.[26] Eighteenth-century sources mention a number of them who achieved some notoriety: Miles Partington at Cavendish Square, John Read at Knightsbridge, a Mr. Long in Soho, Michael Underwood at Cavendish Square, William Swift at Greenwich.[27] The electric topography of the city reveals that electrotherapeutics constituted the most common practice through which Londoners became familiar with the new science of electricity (Fig. 4.2).

On the other hand, in the market town of Ulverston no highly-skilled instrument maker or medical practitioner who lived on the healing virtues of sparks

26 On Graham see Roy Porter, "The Sexual Politics of James Graham," *British Journal for Eighteenth-Century Studies*, 5, (1982), 201–6; on Wesley: Bertucci, "Revealing Sparks" (ref. 8).

27 I found the medical electricians' addresses in: Tiberius Cavallo, *Complete Treatise on Electricity, in Theory and Practice* (London: Dilly, 1786), 186; [anon,], *New Thoughts on Medical Electricity* (Sevenoaks: Clout, 1782), 9; James Ferguson, *An Introduction to Electricity* (London, 1770), 127; relevant entries in *Oxford Dictionary of National Biography*, online ed., ed. Lawrence Goldman, Oxford: OUP, http://www.oxforddnb.com.

and shocks could help Fell set up his new business. However, Cumbria was not too far from the West Midlands of the English Industrial Revolution and it was a convenient stop for itinerant demonstrators heading to Scotland.[28] Lecturers travelling between London and the provinces offered courses of experimental philosophy that spread the cultural novelties that inflamed audiences in the capital.[29] Provincial audiences did not participate in these kinds of cultural activities simply as spectators: they expected to acquire practical knowledge to start new businesses and to become cultural protagonists on their turn.[30] Fell's self-guided apprenticeship in the domain of electricity was firmly grounded in such courses. In the 1780s he attended the lectures on electricity offered by a Mr Long, who arrived at Ulverston after working as a mechanical assistant for Adam Walker, a successful demonstrator in London.[31] A medical electrician by the name of Long was active in London roughly at the same time, and it is possible that they were one and the same.[32]

Fell's brother-in-law, Morris Birckbeck, was friends with Lane, whose reputation in matters electrical had escalated after the invention of his electrometer. In the 1770s Lane worked together with other fellows of the Royal Society on crucial electrical affairs, such as the experiments on the artificial torpedo conceived by Henry Cavendish and the controversy on lightning rods.[33] Birckbeck passed on to him Fell's commission. Being acquainted with Nairne, Lane set out to examine the new patent machine "with critical attention" and, after conversing "with several first-rate electricians on the new construction, who all acknowledged its superiority," he warmly recommended it to Fell, "in preference to all others." The examination of the machine took nine months and, since London makers worked on commission, Fell had to wait upon another two to have his machine at Ulverston. Once Fell decided to order the machine, Lane personally attended to its construction, visiting Nairne's workshop several times: he "tried the power of the cylinder, & examined every part of the apparatus, pronouncing the whole excellent."[34] The careful selection

28 Peter Jones, *Industrial Enlightenment : Science, Technology and Culture in Birmingham and the West Midlands, 1760–1820* (New York: Manchester University Press, 2008).

29 Stewart, *Rise of Public Science* (ref.).

30 Larry Stewart and Paul Weindling, "Philosophical Threads: Natural Philosophy and Public Experiment among the Weavers of Spitalfields," *The British Journal for the History of Science* 28 (1995), 37–62.

31 Long was "manager to the mechanical parts" of the Eidouranion, a spectacular equipment that Walker employed in his scientific lectures in London theatres: Ms 1195, f. 84.

32 Lancashire Record Office, DDX 317/83 (John Fell to unknown, 15 February 1798).

33 Henry Cavendish, "An Account of Some Attempts to Imitate the Effects of the *Torpedo* by Electricity," *Philosophical Transactions of the Royal Society* 66 (1776), 196–225.

34 MS 1175, ff. 2–3.

and testing of the machine is yet another instance of the crucial relevance of the apparatus in the practice of medical electricity.

The arrival of Nairne's patent electrical machine at Ulverston in October 1783 marked the beginning of Fell's career as a medical electrician. His initial investment is revealing of his expectation to profit from electricity, as the amount he spent on Nairne's machine complete with medical apparatus was on the higher end of the machine's price range. Being one of the first purchasers of the newly invented instrument, Fell had to learn how to use the machine without the *Directions and use of the patent electrical machine* that Nairne published in 1784. Since Fell engaged in medical treatments soon after the arrival of Nairne's electrical machine, it is reasonable to believe that he was not new to electrical instruments and experiments. He purchased eight of the most popular texts on electricity only the following year, and made a present of two of them, so his knowledge of electricity likely did not derive from texts, but mostly from the courses of experimental philosophy offered by travelling lecturers.[35]

The Proper Subjects for Electric Trials

Building trust in medical electricity at Ulverston required a trustworthy electrical practitioner. As Roy Porter pointed out, patients of fringe remedies often trusted therapies as a result of their trust in the practitioner, yet electrical treatments presented the additional challenge of being painful and not widely available.[36] In a small sized provincial village, trust was first gained through personal connections. The son of a surgeon, Fell enjoyed a reputation among his fellow Quakers, and it is likely that his religious affiliations brought him at least a few patients.[37] As scholars have shown, medical electricity spread quickly through religious communities and word of mouth.[38] Even if we cannot be sure about his patients' confessions, his list of "electrified patients" – as

35 MS 1175, f. 16.

36 See ref. 4 above.

37 Evidence about Fell being a Quaker in Backhouse Papers, Durham University Library, Archives and Special Collections, BAC/58 3 May 1764: Certificate of the marriage of John Fell of Ulverston, Lancashire, son of Stephen Fell, Practitioner in Physic, of Ulverston and Margaret his wife, and Sarah Birkbeck, daughter of William Birkbeck, merchant, of Settle, Yorkshire and the late Sarah Birkbeck, at the Quaker Meeting House in Settle.

38 Jonathan Barry, "Piety and the Patient: Medicine and Religion in Eighteenth Century Bristol," in Porter, *Patients and Practitioners*; Bertucci, "Revealing Sparks" (ref. 8); 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: Routledge, 1993).

he called them – suggests that family bonds and connections were crucial to the making of his authority as a medical electrician. Scrolling down the list, we find groups of people with the same family name, or patients indicated simply as somebody's sons, daughters, wives, brothers or maid-servants.[39] Yet, when he started his career in medical electricity, Fell was already known in learned Quaker circles even beyond Ulverston. The natural sciences figured prominently in the education of Quaker children, and they constituted one means of cultural exchange among communities living in different provinces.[40] Fell and his wife were interested in botany and exchanged specimens with fellow Quakers in other villages.[41] They were friends with the Manchester chemist John Dalton, himself a Quaker, with whom Fell also shared membership in the Manchester Literary and Philosophical Society.[42] Fell, as a non-resident, was a honorary member, a position held also by Alessandro Volta, Joseph Priestley, Jean Hyacinthe Magellan, and John Lettsom.[43]

This set of connections certainly played a role in establishing Fell's reputation as a cultivated surgeon. Yet it was not obvious that patients would accept undergoing electrical treatments as experimental subjects. Fell was not the first to confront this problem. Previous medical electricians had defined the "proper subject" for medical electricity as a patient who had nothing to lose, who had not benefited from the various traditional therapies, and who had been referred to electricity by somebody authoritative, possibly a physician. Medical electricians indulged in the descriptions of the miserable state of the patients who were sent to them, with the double result of presenting electricity as a harmless last-resort remedy, and acclaiming it as the one that succeeded where others had failed.[44]

Fell carefully selected his first case. The patient was a 19 year old woman who "contracted 'typhus nervosus' " several months earlier and had gradually lost her appetite, becoming "pale and emaciated." She was "seized with frequent faintings, and at last with the most dangerous debility," associated with the interruption of her menses. The woman had been treated by the London

39 Ms 1175, ff.21–25.

40 Geoffrey Cantor, *Quakers, Jews, and Science: Religious Responses to Modernity and the Sciences in Britain, 1650–1900* (Oxford: Oxford University Press, 2005).

41 John Fell to unknown, 15 Feb. 1798. Lancashire Record Office, DDX 317/83.

42 Arnold Thackray, *John Dalton: Critical Assessments of His Life and Science* (Cambridge, Mass.,: Harvard University Press, 1972): Letter by Fell to Dalton (dated 5 April 1801) published at pp. 149–50. On the Manchester Lit and Phil: p. 53.

43 *The Medical Register for the Year 1783*. London: printed for Joseph Johnson, No 72, St. Paul's Church-Yard, [1783].

44 Birch, *Considerations* (ref. 18); Cavallo, *Essay* (ref. 7); Miles Partington, "A Cure of Muscular Contraction by Electricity", *Philosophical Transactions of the Royal Society* 68 (1778), 97–101.

physician William Heberden who, after trying "preparations of the bark, bitters and iron," declared her incurable. After five months of failures, her father, himself a physician, lost hope of recovery and turned to Fell. Upon an "attentive examination of the case," Fell declared the girl "a proper subject for electric tryals." She spent four days at Fell's, during which she underwent five rounds of electric operations, consisting of "six very slight shocks from Os pubis to the upper part of the Os sacrum, and the same number from each Os ilium to the knee or foot of the contrary side." Her menses returned, she recovered completely and went back home "in perfect health," with her father calling the event "a resurrection from the dead."[45]

Fell's choice of a case of "suppression of the menses" points to his hope to start his new career with a success. The disease was often treated successfully by electricity. In 1779 John Birch published *Considerations on the efficacy of electricity in removing female obstructions*, a booklet that went through a second edition the following year and that was in Fell's library. Birch was a surgeon at St. Thomas Hospital, where he established an Electric Room in which he routinely received patients who had failed to respond to other, more traditional therapies. In his promotion of medical electricity, Birch repeatedly underscored the method's "certainty" against the suppression of the menses. Along with other advocates of medical electricity, he explained that shocks should never be applied to pregnant women.[46] This frequent warning – together with the emphasis on the method's infallibility – has been interpreted as an implicit advertisement for procuring abortions.[47] There are several elements that might support this thesis. Birch's accounts of successful cases show that medical electricians who offered remedies for the obstruction of the menses did not spend too much time on excluding the possibility of a pregnancy. As a disease unrelated to pregnancy, the "obstruction of the menses" was associated with debility, frequent fainting, and difficult digestion – symptoms that were very similar to those of early pregnancies.[48] The ambiguity of the diagnosis could certainly leave room for a don't-ask-don't-tell relationship between electrician and patient. In eighteenth-century England abortion was rarely prosecuted, even though it was legally a crime if performed after the quickening of the child: the proceedings of the Old Bailey of London do not record any indictment for abortion until 1823, when the laws started to become more

45 Fell's notes. Ms 1175, ff. 31–33.

46 Birch, *Considerations* (ref. 18), p. 3.

47 Porter, *Health* for sale, p. 148.

48 Birch, *Considerations* (ref. 18), p. 43 (Case V).

severe.[49] However, views on the subject varied greatly, and several English texts welcomed the severity with which Catholic countries condemned men or women who procured abortions. English audiences were familiar with the story of the Scottish "Doctor" Philip who, in 1770, was sentenced to be banished to the plantations for life after being found guilty of giving drugs and performing "desperate operations" to cause abortion in a pregnant woman.[50] The *Harrop's Manchester Mercury* listed several cases of people indicted for murder after forcing pregnant women to take abortifacients that caused death.[51]

Although it is possible that electricity was employed in this way, it would be too simplistic to conclude that the "removal of female obstructions" was synonymous with abortion. In line with recent studies on early modern conceptions of fertility and menstruation that have proposed a more nuanced interpretation of the "suppression of the menses," I believe that the employment of electricity in the treatment of this disease illuminates its function as a normalizing agent – a balancing power that, if managed properly, restored the body to its normal state.[52] Early-modern bodies were still understood within a humoral theory that prescribed a balance of bodily fluids to maintain physical as well as moral health. As Birch pointed out, women – much more frequently than men – were affected by diseases caused by their own body: "As the intention of nature in the formation of the female sex, was, among other things, for the nutrition of the child while in the womb," women were endowed with a "superfluous quantity of blood from the time they are capable of conception"; since blood was a stimulant, the periodical discharge through the menses defended women from the dangers of such accumulation.[53] Women's health was entirely dependent upon the regularity of the menstrual flux, whose obstruction immediately caused illnesses, infertility, and bad habits. Women affected by the suppression of the menses lacked the natural balance of bodily fluids that stood at the basis of physical as well as social health. Birch was not

49 *The Proceedings of the Old Bailey. London Central Criminal Court, 1674–1913*: www.oldbaileyonline.com; Richard Burn, *The Justice of the Peace, and Parish Officer*, London, 1764, vol. 1, 179–80.

50 *The Scots Magazine* 33 (1771), 499.

51 *Harrop's Manchester Mercury* (*and General Advertiser*), issue 475 (1761–1763), 850, 899 (1767–1769), 1201 (1773–1775).

52 Jennifer Evans, "'Gentle purges corrected with hot spices, whether they work or not, do vehemently provoke venery': Menstrual Provocation and Procreation in Early Modern England," *Social History of Medicine* 25 (2012), 2–19; Wendy Churchill, "The Medical Practice of the Sexed Bodies: Women, Men, and Disease in Britain, 1600–175," *Social History of Medicine* 18(2005), 3–22.

53 Birch, *Considerations* (ref. 18), 2.

the first to suggest that electric shocks could be applied to the site of the disorder to remove such obstructions: authoritative physicians, such as Van Swieten, Cullen and Musgrave, had pointed to electricity, understood as a mechanical "deobstruent," as a possible remedy against the disease. Birch's main goal was to argue that, even though the obstruction of the menses usually fell under the care of physicians, the application of electricity, being "an operation of the hand," required the skills of surgeons.[54]

The role of electricity as a normalizing agent extended to other diseases caused by imbalance of bodily fluids. Melancholy, which resulted from a "depression of the spirits," affected most commonly young and studious men. Usual therapies for this disease included moving to places with better climate and breaking the ordinary study routine, but such remedies were tried to no avail on a 19 year old student at Cambridge who was then sent to Fell. The surgeon found that the boy's "intense application to his studies" changed his attitude from cheerful to gloomy and timid; he was "so inattentive that it was sometimes necessary to ask him a question 3 or 4 times before an answer could be exorted." Observing "an almost constant uneasiness in his head," Fell decided to pass 50 small shocks in every direction through the boy's head, every morning and evening, for eleven days, "which restored him to his usual state of health and spirit."[55]

The idea that the electric fluid could act on the nerves was relatively recent: because of the involuntary motion that electric shocks imparted to muscles, electricity was initially regarded mainly as a remedy against paralysis. Fell's "trial" indicated that it could prove effective also in the so-called "English malady."[56] With his application of electricity to nervous disorders, in particular to the brain, Fell placed himself at the forefront of medical electrical research. Five years later, the Windsor physician James Lind would speculate with the President of the Royal Society Joseph Banks that electricity might prove useful in treating the King's madness, even though he explained that the subject needed further experimental inquiries:

> From a scrupulous investigation into what Authors have written upon the subject of Insanity I do not find that among the variety of means which have been employed in the cure of that malady, that Electricity has

54 Birch, *Considerations* (ref. 18), 8.

55 Ms 1175, ff. 40–41.

56 Fell was by no means the first to suggest that electricity could be used against nervous diseases. See Heather Beatty, *Nervous Disease in Eighteenth-Century England* (London: Pickering and Chatto, 2011).

> ever been tryed. If we may credit the accounts of the state of the Brain of insane persons found upon dissection I think there is great reason to believe that it might be of service in that disorder, and appears to me to merit a fair Tryal. I should be glad if we could find out any body that would make the experiment in London, where there are such frequent opportunities of doing it.[57]

As infrequently as electricity was applied to the brain, the treatment soon elicited critical responses. The Reverend Edward Harwood, who underwent electrical treatment for his recurrent melancholy, warned against its possible dangers: "I would advise persons labouring under any violent headach [sic], that they would be extremely careful about permitting a fluid of such omnipotent energy to be darted and dashed through their brains."[58] Harwood's warnings were one more instance of the fear that electrical treatments caused on patients. Electricity's "omnipotent energy" needed to be governed by qualified practitioners who would be able to extend their trustworthiness to their apparatus. Fell was trying to do just that. Soon after the arrival of the patent electrical machine at Ulverston, he ordered another set of instruments to train himself in the material practice of electricity. Meanwhile, he prepared a letter with the account of "a few cases where electricity was applied with success after other means had failed" that he addressed to Lane in London.[59] The letter contained not only the descriptions of his "electric trials" on patients but also specific details about the performance of the patent electrical machine. Fell noted that Nairne's machine made it unnecessary, for example, to uncover the patient and made the administration of mild shocks more comfortable for both patient and practitioner.[60] The bodies of Fell's electrified patients put Nairne's new instrument to the test.

The Human Body and the Electrical Machine

The human body was an essential component of eighteenth-century spectacular electrical demonstrations. Starting in the 1730s, when Stephen Gray invented

57 Fitzwilliam Museum Library, Cambridge. Mss H 140 (Lind to Banks, 27 November 1788). There is no evidence that electricity was ever tried on George III.

58 Edward Harwood, *The Obstinate Case of the Rev. Dr. Harwood: An Obstinate Palsy of Above Two Years Duration, Greatly Relieved by Electricity*, London, 1784.

59 Ms 1175, f. 31.

60 Ms 1175, ff. 33–34.

the experiment of the "flying boy," the property of the human body to conduct electricity engendered a vast range of experiments designed to display the properties of the newly discovered power of nature. Electrical practitioners staged interactive performances that allowed spectators to feel the effects of electricity on their own bodies: when electrified their hair raised towards the ceiling, their fingers issued sparks, the precious embroidery on their clothes became luminous. Contemporary texts explained how to set spirits on fire with an electrified finger, how to make chains of people jolt together, how to make ladies proffer electric kisses. Illustrated texts gave evocative names to these experiments – the "Venus electrificata," "setting spirits on fire," "electric commotion" – thus presenting them as standardized, even though it was well known that the responses of the human body to electrification were unpredictable.[61] Electricians knew that the outcome of their performances was highly dependent on the weather, the status of the apparatus, and even on clothing. Human bodies responded differently to electrization.[62] Although a number of medical electricians claimed that electricity increased bodily perspiration, temperature, and the pulse by a fixed, measurable amount, experienced experimenters such as Cavallo pointed out that those who underwent electrization, even just for entertainment, were generally afraid of electricity, and all the physiological alterations resulted from fear or apprehension.[63] When such anxieties about electricity were dispelled, no physiological changes could be observed: Cavallo underwent electrization himself, without ever noticing any change in his pulse. He did not intend to use his own body as conclusive evidence, though. Rather, he underscored that the practice of electrical experimentation demonstrated that there was no standard electric body.

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61 Bertucci, "Sparks in the dark"(ref. 9); Heilbron, *Electricity* (ref. 9); Simon Schaffer, "Self Evidence," *Critical Inquiry* 18 (1992): 327–362; Paul Elliot, "'More Subtle than the Electric Aura': Georgian Medical Electricity, the Spirit of Animation and the Development of Erasmus Darwin's Psychophysiology," *Medical History* 52 (2008), 195–220.

62 I am using here the term "electrization" in its eighteenth century meaning, to indicate all possible interactions between the human body and the electrical machine – not just the administration of electric shocks. A number of medical electricians believed that by connecting the human body (insulated from the ground) to the electrical machine's conductor, the electric fluid would run into the patient's body, accelerating his or her pulse, and increasing insensible perspiration. This method of applying electricity would still be indicated as electrization, even if it was by no means as painful as the drawing of sparks or the electric shock.

63 Cavallo, *Essay* (ref. 7), 2. On the increase of insensible perspiration as a medical therapy see Lucia Dacome, "Living with the Chair: Private Excreta, Collective Health and Medical Authority in the Eighteenth Century," *History of Science* 39 (2001), 467–500.

The variety of individual responses made it "impossible to prescribe the exact degree of electrization that must be used";[64] electrical treatments met with contrasting results because of the "variety of temperaments" and the "coincidence of circumstances": "not every disorder, nor every temperament…requires an equal, or perhaps any application of electricity."[65] Unlike other remedies, electricity was not a specific for particular disorders, with the possible exception of the suppression of the menses.

Medical electricity relied on an epistemology of efficacy grounded in integrated experimental settings where patient, practitioner, and instruments constituted an unstable unit. The operator could not rely on any electric pharmacopoeia that associated therapies to diseases: he had to "be instructed by experience," learning how to calibrate the intensity of electricity to the patient's constitution and temperament, and be able to apply the smallest degree of electricity that "the patient can conveniently suffer."[66] Experience could only be gained through the skillful use of electrical apparatus. As Birch emphasized, learning how to manage electrical instruments was as crucial to medical electricity as anatomy was to surgery, or chemistry to medicine.[67]

Fell was fully aware of the necessity of engaging in electrical experiments. A few months after the arrival of Nairne's electrical machine, he purchased several instruments from London. Although he remained a customer of Nairne and George Adams for eleven years, his "electrical expenses" show that his most consistent investments were made in the first two: in 1784, he spent on electrical instruments four times the amount he spent on the patent electrical machine, equipping himself with the most popular devices for electrical demonstrations.[68] He carefully studied the standard demonstrations of electrical lecturers: how to make a model house explode with an electric spark, how to make paper puppets dance on a metallic wire, how to compose words of (electric) fire in the dark (Figs. 4.3–4.6). For him, the instruments that arrived at Ulverston from London were objects of experimental enquiry in their own rights: he continuously modified and adapted them to his needs. As he progressed with his experiments, he realized that several practical details that were crucial to the success of electrical experiments did not find space in published accounts. So, he worked painstakingly on the making of lacquers,

64 Cavallo, *Essay* (ref. 7), 26.

65 ibid., 87.

66 ibid., 27.

67 Birch,*Considerations* (ref. 18), ix.

68 Ms 1175, ff. 12–20.

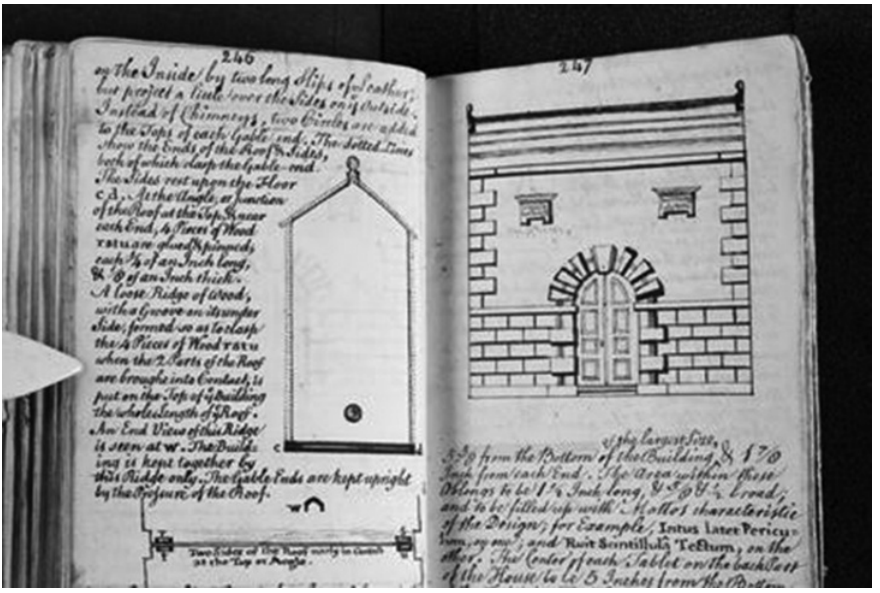

FIGURE. 4.3 *John Fell's sketch of the "powder house". Ms 1175,* Miscellanea Electrica. *Wellcome Library, London.*

varnishes, amalgams and other materials employed for the preservation of the apparatus, and studied the design of various electrical machines in order to optimize the laborious process of charging. The process of modification and adaptation led him to inventions, whose details he shared with Nairne and Adams.

Instruments created new channels of communication that made the experiments of a provincial surgeon relevant to metropolitan electricians: Nairne was impressed with Fell's "fire shooter," an amusing experiment that he found "very prettily devised" and started to review Fell's order personally, sending comments along with the apparatus (Fig. 4.7). He encouraged Fell to continue with experiments and explained that his patent electrical machine resulted from gradual improvements to the apparatus that he made while performing experiments similar to those described by the surgeon.[69] When Fell ordered special instruments for treating disorders of the ear, Nairne praised the choice, describing the successful test he had performed on himself, and did not charge the surgeon.[70] Adams was slower in his replies, but no less interested in Fell's

69 Nairne to Fell, Ms 1175.

70 Nairne to Fell, MS 1175 ff. 58–59.

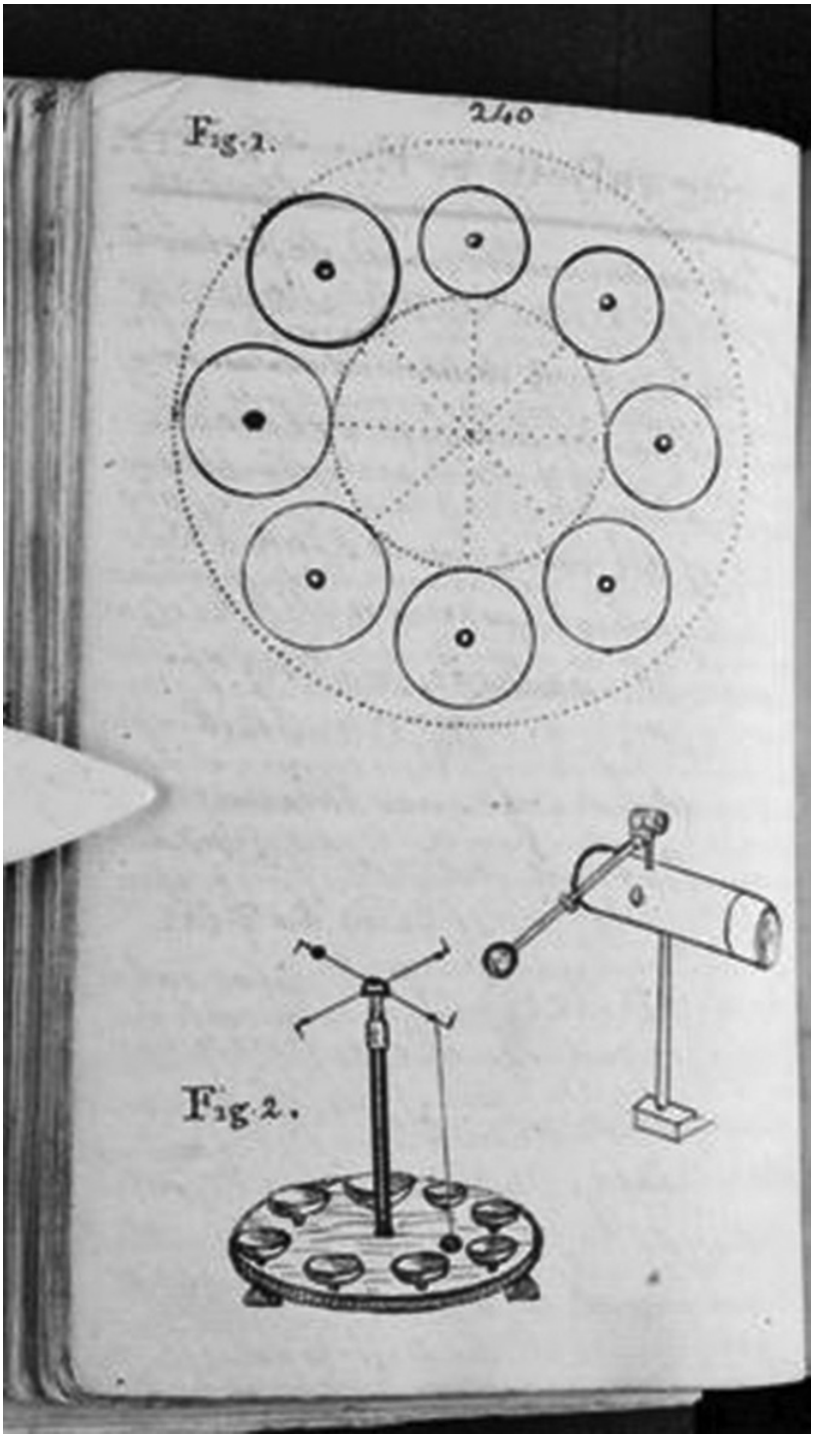

FIGURE. 4.4 *John Fell's sketch of "electric bells". Ms 1175,* Miscellanea Electrica. *Wellcome Library, London.*

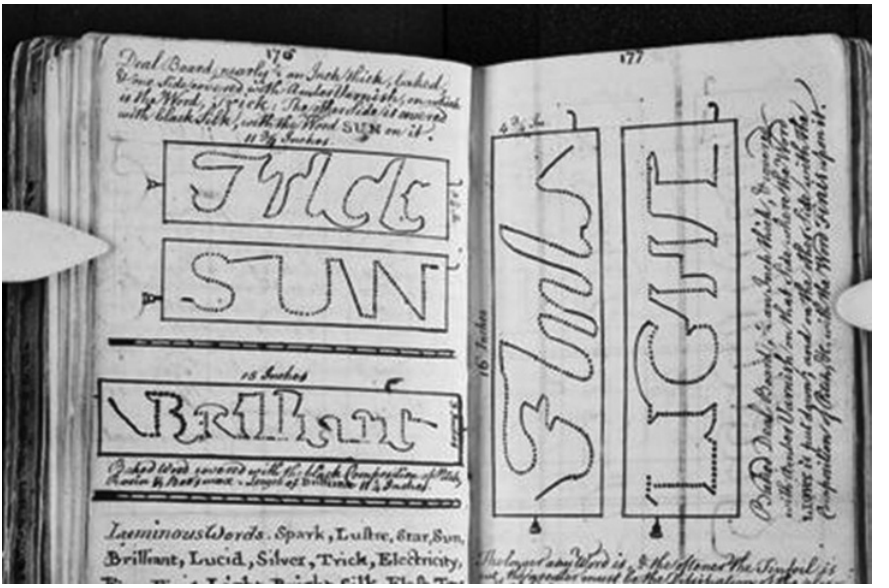

FIGURE. 4.5 *John Fell's sketch of "luminous words". Ms 1175,* Miscellanea Electrica*. Wellcome Library, London.*

original contributions: he was so enthusiastic about Fell's invention of a "double jar" as to publish it in the second edition of his *Essay on electricity*.[71]

Fell's engagement in what he called "rational recreations" was part of his self training to become a lecturer of electricity. He realized that the most effective way to spread interest in medical electricity at Ulverston was to familiarize his community with electricity: with time he noted that electric patients were hardly dependable and often discontinued treatment, with the exception of those who formed "a resolution to persevere, from an opinion of the practice."[72] In a few years, he became a sought after lecturer, who offered several courses to groups and individuals, such as John Dalton, and who played an active role in the scientific education of young Quakers in the area.[73] His self training raised his expectations on public lecturers coming from London, whose courses he attended with a critical eye, carefully observing the experimental demonstrations and pointing out their fallacies. Long, for example, added exotic drama to electrical shows by staging a "perpetual war" between an electric eel and a fly along the rivers of Surinam. He employed an artificial eel made of cork and

71 Adams to Fell, Ms 1175, f. 61; Fell's description of double jar: Ms 1175, ff. 75–76. George Adams, *An Essay on Electricity* (London, 1785), 128–29.

72 Lancashire record Office. Mss DDX 317/82 (Fell to Barton, 25 October 1787).

73 Lancashire record Office. Mss DDX 317/83 (Fell to unspecified, 15 February 1798).

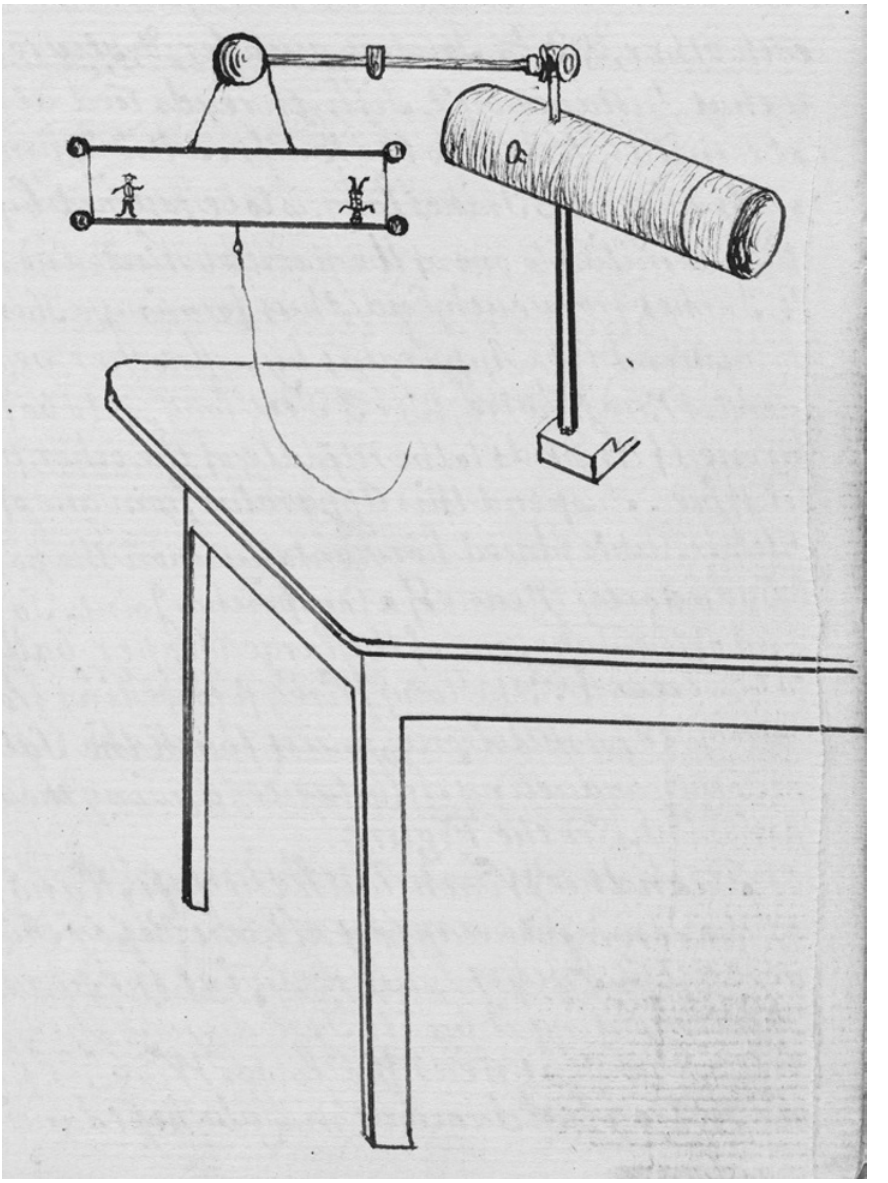

FIGURE. 4.6 *John Fell's sketch of the "electric dancers" apparatus. Ms 1175,* Miscellanea Electrica. *Wellcome Library, London.*

tinfoil together with a light feather to act as the fly; when charged, they attracted and repelled each other, simulating the chase. Fell sketched Long's apparatus and noted with great disappointment that the demonstrator failed to obtain shocks from the eel (Fig. 4.8). It was the ability to draw sparks from

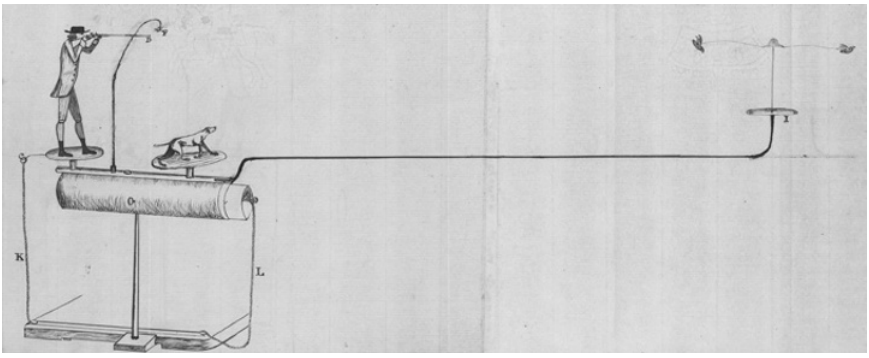

FIGURE. 4.7 *John Fell's sketch of the "fire shooter" apparatus. Ms 1175,* Miscellanea Electrica. *Wellcome Library, London.*

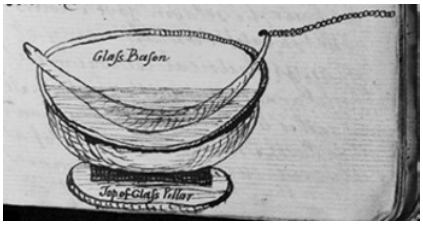

FIGURE. 4.8
John Fell's sketch of Long's artificial eel. Ms 1175, Miscellanea Electrica. *Wellcome Library, London.*

the fish that proved to London audiences that the eel was able to generate electricity. So, Fell contrived his own model that, he emphasized, never failed to give shocks.[74]

Fell's experimental activity elicited the attention of electricians in London. Lane read the letter with the description of Fell's "electric trials" to the Royal Society and, following his endorsement, other electricians became interested in Fell's medical experiments.[75] Inverting the direction of exchange between province and metropolis, Miles Partington, a London surgeon turned a successful medical electrician, introduced himself to his colleague at Ulverston, expressing hopes "to form a channel of communication for our mutual information."[76] Partington was the most visible metropolitan medical electrician. Praised by Birch as the practitioner who most effectively demonstrated

74 Fell's experiment with the electric eel are described in Ms 1175, ff. 82–86. On the history of electric fishes, see Stanley Finger and Marco Piccolino, *The Shocking History of Electric Fishes: From Ancient Epochs to the Birth of Modern Neurophysiology* (New York: Oxford University Press, 2011).

75 Ibid., 39.

76 Partington to Fell, Ms 1175, f. 49.

the efficacy of electricity in "the regulation of the animal economy," he was well known at the Royal Society.[77] In 1778 his report of a successful treatment of "a case of muscular contraction" by electricity was published in the *Philosophical Transactions* and his electrical cures were also described in Cavallo's *Essay on the theory and practice of medical electricity*.[78] Partington's business in London was so successful as not to leave him time to complete a treatise on medical electricity that he started to plan around 1780.[79] He was interested in Fell's activity as, he explained, "every new particular in this branch of practice may be productive of more important experiments."[80] The wording of this sentence reveals the epistemic functions that medical electricians such as Partington and Fell hoped their practice would serve. The "more important experiments" Partington referred to were new cases where electricity proved successful after other therapies had failed. Results of this kind could be achieved by studying how different experimental settings affected the treatment's outcome. In his own report of the successful treatment of a fistula lachrymalis – a disease that responded only occasionally to electricity – Partington detailed the "disposition of the apparatus": by arranging the instruments, the patient, and his own body in the way he described, "the effects of electrization are considerably increased, the pungency of the sparks is felt much deeper into the electrified part of the body: the heat occasioned by it is also greater, and therefore it seems more efficacious for internal complaints."[81]

In these accounts, medical electricity was presented as yet another kind of electrical experimentation, which resulted not only in new therapies, but also in the perfecting of instruments. Because of the uniqueness of each human body, the combination of patient, practitioner, and electrical apparatus could not be standardized. This instability gave practitioners the opportunity to experiment with the apparatus, trying new materials and new forms of applying electricity. Partington, for example, designed new "directors" for treating the fistula; the process of treatment thus became an experiment to test his instruments: "The short experience I have had with these directors does not enable me to determine how far they can be useful…they do not answer my most sanguine expectations; but yet in several instances they seem to have

77 Birch, *Considerations* (ref. 18), v–vi.

78 Miles Partington, "A Cure of a Muscular Contraction by Electricity," *Philosophical Transactions*, 68 (1778), 97–101.

79 Birch, *Considerations* (ref. 18), vii.

80 Partington to Fell, Ms 1175, f. 49.

81 Cavallo, *Essay* (ref. 7), 101.

afforded considerable relief."[82] Fell too regarded electrical treatments as unstable settings where instruments could be modified to improve the comfort and safety of patients and practitioners. As he explained to Nairne and Partington, the insulating stool that he designed with the collaboration of local artisans at Ulverston resulted from his work on electric patients (Fig. 4.9).[83]

Aware that electricity "was never seriously admitted as an article, by Practitioners of Physic, for the cure of diseases," Partington believed that the best way to advocate its medical efficacy was to compile a collection of experiments,

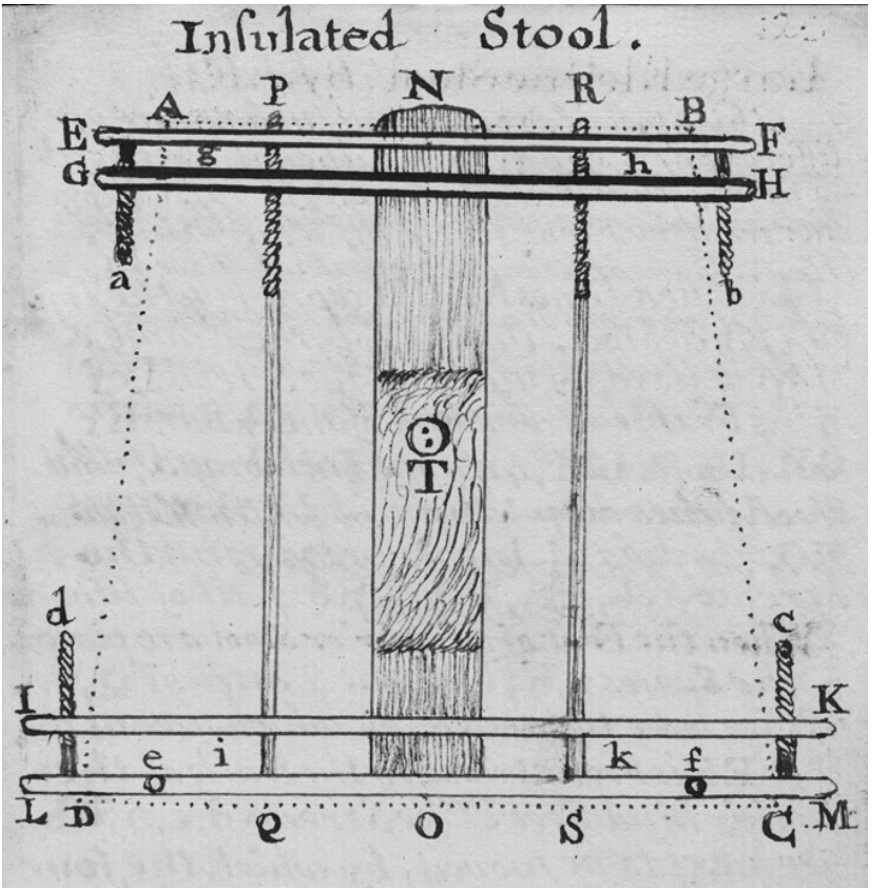

FIGURE. 4.9 *John Fell's sketch of his insulating stool. Ms 1175,* Miscellanea Electrica. *Wellcome Library, London.*

82 Cavallo, *Essay* (ref. 7), 102.

83 Ms 1175, f. 125–26.

in the style of the books of experimental philosophy. They would describe the disease, the apparatus, and how the practitioner used it. When put together, the sheer number of successful cases "would form a body of facts that would stamp conviction on all candid persons of the great use of this agent in the cure of diseases."[84] The numerous texts on medical electricity had already begun to conquer several practitioners who "have now machines in their possession" and contributed daily with accounts "of fresh advantages received from this agent, either as an auxiliary to medicine, or independent of other medical assistance."[85] Partington noted, however, that the physicians' resistance was hard to break:

> I am debarred too much from the necessary part of trying the effects of medicines combined with electricity, for want of zeal in our physicians with whom I generally have to act, and find not easy to persuade to experiments.[86]

As Cavallo explained, medical electricity, "different from other physical applications, requires quite a nicety of operation than a thorough knowledge of the disease."[87] The "nicety of operations" consisted in the skillful employment of "philosophical instruments," an approach that called for a new epistemology of medical expertise grounded in the material culture of electricity. Nairne emphasized that it was advantageous "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."[88] Partington, however, was aware that medical electricity's dependence on philosophical instruments constituted the source of its problematic status not only within the medical profession but also within the experimental community. The Royal Society, with its several electricians, was initially interested in publishing reports of electrical treatments. With time, however, and with the rise in number of controversial cases, the Fellows realized that discussions on medical electricity would inevitably turn to debates over the efficacy of treatments, which were best left to the medical profession. Partington felt obliged to warn Fell that the Royal Society would not publish any of the cases read by Lane: even though several fellows

84 Ms 1175, ff. 49–56.

85 Ms 1175, f. 138.

86 Ms 1175, f. 168.

87 Cavallo, *Essay* (ref. 7), 5.

88 Edward Nairne, *The Description and Use of Nairne's Patent Electrical Machine* (London, 1786), 66.

remained interested in the subject, reports of electrical cures were no longer published in the *Philosophical Transactions*.[89] Nonetheless, he was interested in any result the surgeon from Ulverston wanted to share. Although the numerous patients did not leave him time to engage in "rational recreations," he believed that "experiments of this kind indirectly furnish convenient & useful applications to the Human body." The usefulness of such applications did not so much concern the efficacy of the therapy as the perfecting of the apparatus: Partington explained to Fell that it was while he was performing "experiments for amusement" that he discovered that a wooden point on top of a metallic conductor worked miracles in the application of electricity to the eye.[90]

Conclusion

At the intersection of experimental philosophy and medical practice, medical electricity did not constitute a "trading zone" where objects could be exchanged independently of the various meanings that different groups attributed to them.[91] It was rather a liminal space where individual practitioners merged skills, traditions, and epistemologies, alienating established institutions. If Partington was convinced that the publication of numerous cases would eventually win the skepticism of the medical establishment, fellows of the Royal Society such as Cavallo realized that medical efficacy needed to be assessed in more general terms. The lack of a standard electric body made it impossible to stabilize therapies, matching diseases to treatments. Partington hoped to establish trust in medical electricity with a process of virtual witnessing, a practice that was commonly employed by experimental philosophers.[92] However, this strategy for building consensus could not be easily translated into the domain of medical practice. Cavallo explained that the account of a few successful cases "does by no means establish the reputation of the treatment, when a vast number of unsuccessful trials are concealed from the eyes of the public."[93] He claimed that in order to obtain "a proper estimate" of the

89 Ms 1175, ff. 50–51, 138.

90 Ms 1175, f. 136.

91 On the notion of the "trading zone" see Peter Galison, *Image and Logic: a Material Culture of Microphysics* (Chicago: The University of Chicago Press, 1997).

92 Shapin, "The House of Experiment" (ref. 11).

93 Cavallo, *Essay* (ref. 7), 54.

efficacy of any remedy, it was necessary to show the "proportion between the successful, and the unsuccessful trials."[94] So, he created a list of common diseases, indicating for each whether electricity was appropriate and which electrical treatment seemed most effective. In spite of all these efforts, the vast majority of physicians continued to ignore electricity. In 1787, Fell was dismayed that a man from Manchester, whose pain in the spermatic chord was so intense as not to allow hunting on horseback, had to be brought to Ulverston to receive electrical treatments: "there are 3 gentlemen of the faculty within 200 yards of him, yet, strange to tell, every one of them is totally ignorant of electricity."[95]

It was to dispel such ignorance that Fell engaged in public courses on electricity, familiarizing his audiences with electrical instruments. For him, as for Partington and other medical electricians, building trust in electrotherapeutics required building trust in the electrical apparatus. Not every patient was persuaded. In the span of a few years Fell became annoyed by the lack of perseverance of some of his electric patients who resolved to give up on electricity.[96] He noted, among his 65 electric patients, those who did not complete the entire planned treatment.[97] He did not note, with the exceptions of the cases he described to Lane, whether the others were cured. Instead, he filled his notebook with descriptions of experiments and new instruments that he invented in large measure as a result of his medical practice. His experimental activities brought him to the attention of various naturalists in the West Midlands, who asked his opinion to evaluate collections of instruments and requested his courses on electricity. At the turn of the century, Fell was more popular as an electrical expert than as a medical electrician.[98] By then, he had realized that his electric trials on humans did not bring the same kind of popularity or income as his other experiments. Medical electricity was an experiment that proved successful when it came to testing and perfecting instruments, or training oneself in the management of the apparatus. Yet, its therapeutic efficacy remained elusive, just as the electric body did.

94 Cavallo, *Essay* (ref. 7), 55.

95 Lancashire record Office, DDX 317/82 (Fell to Barton, 25 October 1787).

96 Lancashire record Office. Mss DDX 317/82 (Fell to Barton, 25 October 1787).

97 Ms 1175, ff. 21–24.

98 Lancashire record Office. Mss DDX 317/82 (Fell to Barton, 25 October 1787).