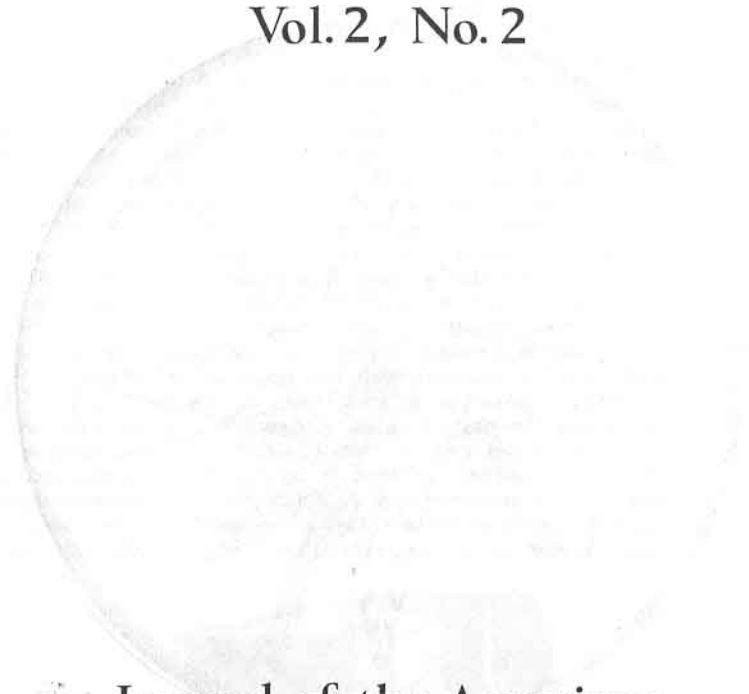


# RITTENHOUSE

Vol. 2, No. 2



Journal of the American  
Scientific Instrument Enterprise

CHARLES PAGE, DANIEL DAVIS,  
AND THEIR ELECTROMAGNETIC APPARATUS

Roger Sherman

Most transactions between scientists and instrument makers have consisted of simply buying, selling, shipping and repairing standard pieces of apparatus. Other transactions, however, suggest complex relationships of mutual support and interchange of ideas. An interesting example is that of Charles Grafton Page, one of the first Americans to investigate the phenomena of electromagnetic induction, and Daniel Davis, Jr., the first American to make a business of manufacturing apparatus for demonstrating electromagnetism in its various manifestations. A study of the relationship between these men can help answer such questions as: Where did the ideas for the devices featured in catalogs come from? and, How could an experimental scientist benefit from the skills and facilities of an intelligent and energetic craftsman?



Charles Grafton Page. Photo courtesy  
Mrs. Joseph W. Hazell.



Daniel Davis, Jr. Electrotype copy  
(1845) of a clay medallion by E. A.  
Brackett of Boston. NMAH photo

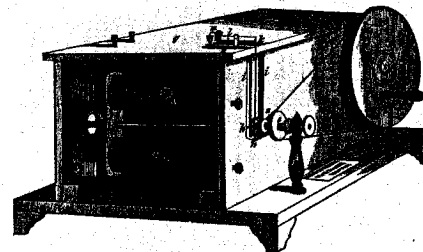
Page was born in Salem, Massachusetts, 15 miles northeast of Boston, in 1812.<sup>1</sup> At an early age he developed an interest in electricity, made apparatus, and did experiments. After graduating from Harvard in 1832 he took an M.D. degree, but electricity, not medicine, attracted him. He carried out a series of experiments, making several discoveries relating to induction, and invented many devices to demonstrate them. About May 1838 Page moved from Salem to the vicinity of Washington, D.C. He became an examiner in the Patent Office in 1842, but still found the time to give lectures on electromagnetism and to construct an electric locomotive with a motor of his design. In April 1852 Page resigned from the Patent Office and went into business as a patent agent. By this time his period of creative scientific work had ended. He returned

to the Patent Office in 1861, working as an examiner until his death on May 5, 1868.

Davis was born on February 8, 1813, in Princeton, Massachusetts, 15 miles north of Worcester.<sup>2</sup> He moved to Boston in 1833 and soon began working for William King, a manufacturer of lightning rods and static electrical machines. By 1837 he was in business on his own, making electromagnetic apparatus. The success of this business permitted Davis to sell out after 15 years and retire to a farm in Princeton. He died on March 22, 1887.

In 1838 Davis issued his *Descriptive Catalogue of Apparatus and Experiments, To illustrate the following Branches of Science, Namely: Galvanism, Electro-Dynamics, Magnetism, Electro-Magnetism, Magneto-Electricity, Thermo-Electricity*. This 72-page booklet described in some detail 68 instruments, with a three-page list of traditional electrostatic apparatus at the end. The following year Davis brought out a *List of New and Improved Magnetical Instruments, Made since the publication of the catalogue in 1838*.<sup>3</sup> Many of the 41 items in this *List* are improved or modified versions of apparatus from the earlier *Catalogue*, but some are entirely new.

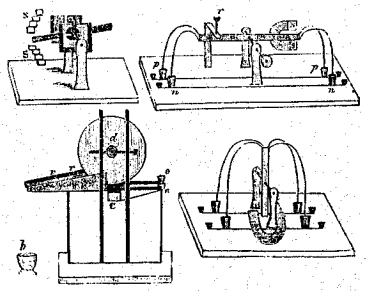
*Davis's Manual of Magnetism. Including also Electro-Magnetism, Magneto-Electricity, and Thermo-Electricity. With a Description of the Electrotype Process. For the Use of Students and Literary Institutions* came out in 1842. A greatly expanded catalog in the form of a regular book, it provided clear woodcut illustrations and full, lucid explanations of every piece of apparatus. Dropping electrostatics entirely, it restricted itself to "galvanic electricity" and its electromagnetic effects. Silliman's *Journal* and the *Scientific American* praised the *Manual*; the U. S. Military Academy and other colleges adopted it as a textbook.<sup>4</sup> A second edition, enlarged and extensively rewritten, came out in 1848<sup>5</sup> and stayed in print through at least 12 "editions" (the "13th" is the same as the second) until 1872.



Page's New Magnetic Electrical Machine of Great Power<sup>6</sup>

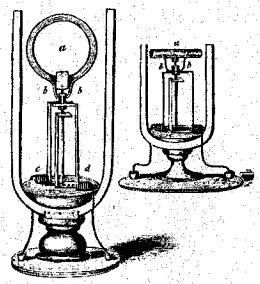
This illustration of a magneto, published by Page in 1838, is the first direct evidence that he and Davis had found each other. Although the text of Page's paper does not mention Davis, Figure 1

(above) shows the machine with a label reading "D. Davis Maker No. 11 Cornhill Boston." Figure 3 in this paper illustrates another device which lacks the Davis name-plate, but shares the characteristics of most Davis apparatus: feet at the corners of the base-board, turned pillars, gracefully curving conductors, and balanced arrangement of components.

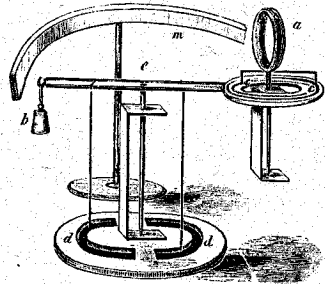


Page's early devices: Revolving and Vibrating Interruptors, Revolving Plate Battery, and Oscillating Interruptor.<sup>7</sup>

Davis may have been making apparatus for Page as early as the summer of 1837. The illustrations (above) of Page's electro-magnetic devices before then show plain, somewhat crudely assembled constructions. They look "home-made," and may in fact have been.



Page's Revolving Ring and Revolving Helix

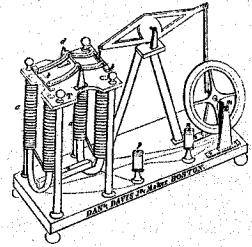


Page's Apparatus for Showing the Motions of De la Rive's Ring

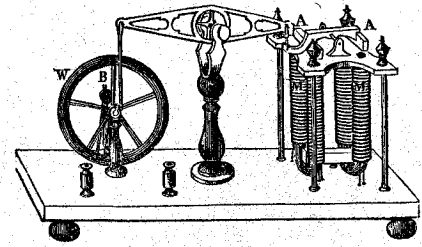
But a paper dated August 23, 1837 shows three devices (above) which, in their compact, symmetrical form and finished ornamental quality, differ from Page's earlier instruments, and resemble to some extent the style of Davis' apparatus of later years.<sup>8</sup> Furthermore, these three instruments appear in Davis' *Catalogue* of 1838, whereas Davis never offered any of Page's earlier electromagnetic devices.

Page's first explicit acknowledgement of Davis appears in a paper of June 2, 1838 where he credits Davis with the discovery that very fine steel wires serve almost as well as iron ones in one of Page's experiments.<sup>9</sup> This remark shows that Davis was repeating Page's experiments and making investigations of his own. The same paper contains an illustration of another machine with Davis' label prominently displayed. This one is of interest as the first to have a characteristic Davis feature: small balls under the corners of the base as feet.

In a paper dated November 13, 1838 Page describes and illustrates six new devices.<sup>10</sup> All of them appear in Davis' 1838 *Catalogue* duly credited to Page, and several also in the *Manual of Magnetism*:

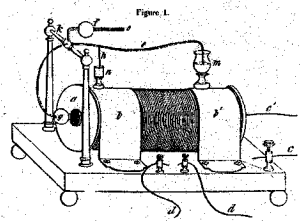


Page's Reciprocating Armature Engine (Page's illustration)



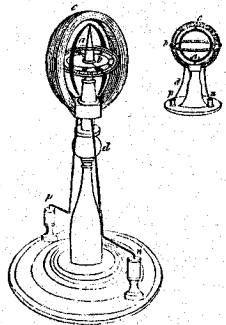
Page's Reciprocating Armature Engine (Davis' illustration, 1842)

1. In Page's paper the "Reciprocating Armature Engine" appears with Davis' name inscribed prominently on the base-board. Page remarks, "Several of these engines have been made by Mr. Daniel Davis, Jr., philosophical instrument maker, of Boston; and are beautiful working models. As a proof that electro-magnetism is susceptible of useful application where only a small power is wanted, a small engine was made by Mr. Davis in the month of July last, by the aid of which, an individual gains fifteen dollars per day by the simple operation of drilling the steel plates for gas burners."



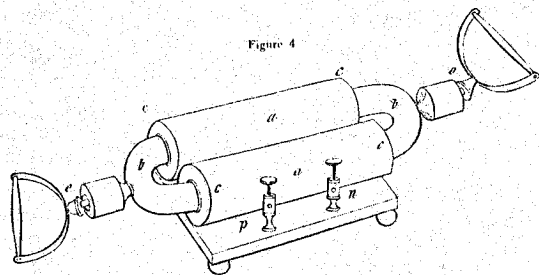
Page's Compound Magnet and Electrotome (Page)

2. Historically more significant is Page's "new form of apparatus, consisting of a compound electro-magnet and electrotome; completed April, 1838." This is the induction coil for which he obtained an unusual patent 30 years later.<sup>11</sup> Page does not mention Davis in connection with it, nor does the illustration (above) show Davis' name, but the Davis style is clear, and the device appears in the *Manual* of 1848 as Fig. 183.



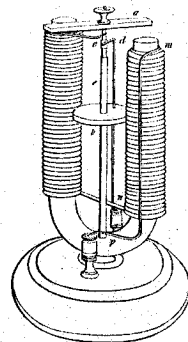
Page's Circular Galvanometer

3. Page next introduces a new form of galvanometer with the needle bent into a circle. It has a Davis-style turned base and pillar supporting the instrument proper on top. Page remarks, "The whole appearance of this instrument, (though a trivial consideration,) is somewhat in its favor for purposes of general exhibition to a class." Here is the aspect of design which Davis recognized, and which helped make his apparatus popular. The Page galvanometer, however, appears only near the end of Davis' 1838 *Catalogue*, as one of a few late additions, and disappears from Davis' catalogs thereafter.

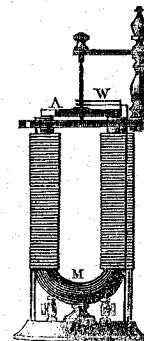


Page's Double Helix for Inducing Magnetism (Page)

4. To demonstrate the force attainable with properly arranged electromagnets Page devised a "Double Helix," or two solenoids set side by side, with two bent iron bars fitted with handles, sliding into the solenoids. Page says, "A small apparatus of this kind will resist the strength of two stout men pulling by the handles." His illustration shows the device mounted on a Davis-style base with ball feet and binding posts. Davis' 1838 description corresponds, but by 1847 Davis had altered the apparatus, enclosing it in a box, lengthening the poles of one of the cores, and fixing it in place.<sup>12</sup>

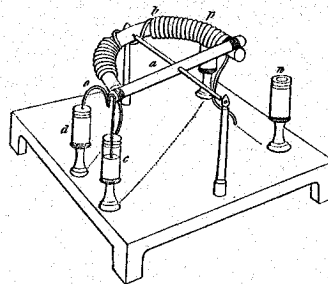


Page's Revolving Armature (Page)



Page's Revolving Armature (Davis, 1842)

5. In February 1838 Page invented a Revolving Armature "for exhibiting motion by magnetism without change of poles." Davis includes it, together with an adaptation for giving shocks, in his 1838 *Catalogue*, and in the 1839 *List*. In 1840 Joseph Hale Abbot, a school teacher and scientific lecturer, illustrates a paper of his with "a modification of Page's revolving armature" serving as an interrupter for a large induction coil. This and the other instruments in Abbot's paper "are all manufactured by Mr. Daniel Davis, Jr., a very ingenious maker of magnetical instruments."<sup>13</sup> Davis' *Manual of Magnetism* illustrates a further slight modification (above) of the design and shows its use as an interrupter for induction coils. It is not clear how credit for these ideas should be allotted among Page, Abbot and Davis.



Page's Vibrating Armature

6. The last device in Page's paper of November 1838 is a "vibrating armature, to be used as an electrotome, in connexion with an apparatus affording sparks or shocks." The illustration of this somewhat clumsy-looking interruptor shows fewer Davis features than usual. Yet, as "Page's Vibrating Electrotome" it appears in Davis's 1838 *Catalogue*. Perhaps it did not sell well, for it disappears thereafter.

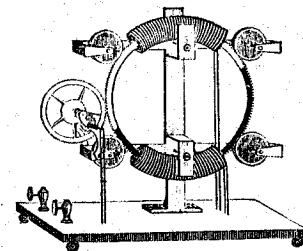
In October 1838, several months after moving to Washington, Page made a trip back to Boston and carried out some experiments on the action of frictional electrostatic generators, probably in Davis' shop. Page says, "My attention was called to this subject by a singular experiment shown to me by Mr. Daniel Davis, which for some time appeared rather enigmatical."<sup>14</sup> Page also made some observations "concerning the most advantageous form and size of magnets and armatures."<sup>15</sup> In his account of these he does not mention Davis, but again, Davis' shop seems the most likely place where Page would have access to the magnets, materials and drilling and shaping equipment needed. Davis himself later describes one of the phenomena, explaining it clearly.<sup>16</sup>

In the latter part of 1837 Page invented a battery in which the hydrogen given off would depress the electrolyte below one of the electrodes when the battery was out of action, making unnecessary the messy and awkward removal of the plates. The next year he had Davis build one. "After constructing and testing one of these instruments, Mr. Davis informed me by letter, that it involved one difficulty, viz., too much time was required to bring the plates into action, for the purpose of obtaining the spark."<sup>17</sup> Page, writing 14 years afterwards, gives no indication that he solved this problem. The battery does not appear in Davis' catalogs.

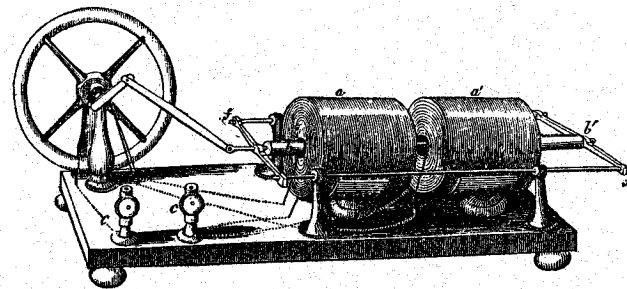
Just as Davis' work often appears in Page's writings, so most of Page's electrical inventions appear in Davis' publications. Of the 21 items in Davis' first *Catalogue* which bear an inventor's name, 14 are attributed to Page. The runner-up is Faraday himself, with two; Ampère, Barlow, De la Rive, Marsh and Sturgeon each have one instrument. In the supplementary list of electrostatic apparatus Page is honored once again with "Dr Page's Electrical Syringe, \$4.00," his first published invention.<sup>18</sup> Five items in Davis' 1839 *List* bear Page's name (and only one that of someone else--Barlow). These are not new. A typical item reads: "27. Page's Revolving Magnet. See Catalogue, p. 30. Much improved in size, form and construction Price \$5." And, for the first time, Davis leaves Page's name off one of his creations: "4. Reciprocating Engine."

The 1842 edition of the *Manual of Magnetism* contains only nine of Page's devices, several in the 1838 *Catalogue* having been dropped, and no new ones added. Even so, Page's total matches that of all the other named physicists put together. Ampère, Barlow, De la Rive, Henry, Marsh, Oersted, Ritchie, Sturgeon and Volta are each represented by a single piece of apparatus. The greater part of Davis' instruments were either devised in his shop, or were considered in the public domain and have no one's name attached to them. The 1848 edition contains 18 of Page's inventions. Nine of these are new, but Page is credited only six times altogether.

Several of the new devices appear earlier in the *Manual of Magnetism* than in any other publication. Page communicated his invention of a rotary axial engine "in confidence to a few friends" before mid-1845, but aside from a few brief references<sup>19</sup> he never got around to describing it in print. Davis, who must have been one of the "few friends," includes it as the "Axial Revolving Circle" in his *Manual* of 1848, with no mention of the inventor. Did this publication constitute a violation of Page's "confidence"? Page's reaction is not on record, although two decades afterwards he claimed the invention, referring to Davis' figure.<sup>20</sup>

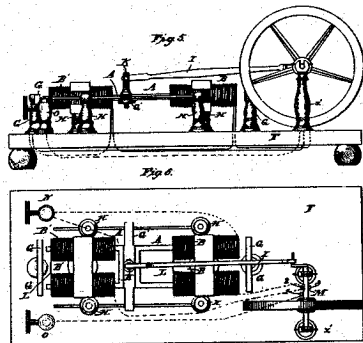


Axial Revolving Circle (Davis, 1848, Fig. 118)



Page's Axial Reciprocating Engine (Page, 1845)

Somewhat different is the case of Page's Horizontal Axial Engine.<sup>21</sup> He devised it in 1838 as a development of his Double Helix, but laid it aside, "owing to a want of suitable batteries," until late in 1843. Thereafter it took hold of his imagination, each successive model becoming larger, more powerful and better designed, until it culminated in his electromagnetic locomotive of 1851. Page's first illustration of the engine (above), published in 1845, represents a model in the Davis style, presumably dating from the initial work in 1838. His second illustration, also of 1845, shows an improved version with four helices instead of two, but in a different style. It was probably built in Washington. A still further improved design appears as Fig. 123 in Davis' *Manual* of 1848. Page himself does not describe this one until 1853.<sup>22</sup> A year after that he took out a patent for it (#10,480), whose drawings show the very machine illustrated by Davis in 1848.



Page's Electromagnetic Engine. Patent Drawing (1854)

No. 10,480.

O. G. PAGE,  
ELECTROMAGNETIC ENGINE.

Patented Jan. 31, 1854.

3 Sheets—Sheet 1

Besides designs for demonstration apparatus, Page furnished Davis with terminology and scientific ideas. For example, after Page introduces the term "pole changer" (a commutator) in 1838,<sup>23</sup> Davis uses it in his *Catalogue* of that year, in explaining how the current is reversed in Page's Revolving Magnet (#35). Page first uses "axial" to denote his solenoid principle in 1844;<sup>24</sup> Davis uses it freely in the *Manual* of 1848, giving Page credit for the idea. For more abstract ideas, Davis usually does not give acknowledgment, but the source of some is clear. Page, for instance, attributes the superiority of a bundle of wires or thin bars to a single thick one, in his induction experiments, "chiefly to the action of their similar poles upon each other, when the exciting cause is withdrawn." Davis gives this reason, a little more clearly, perhaps, as "the more sudden change in the magnetism of the wires, when the battery current ceases, from the neutralizing influence of the similar poles of the wires on each other."<sup>25</sup> Page describes how the inductive action is annulled if a conducting cylinder is placed either inside or outside the coil, and how the action is restored if the cylinder is slit lengthwise, to prevent short-circuited induced currents from flowing in it. Davis describes the same phenomena, pointing out their importance in the construction of the apparatus, and gives Page's explanation.<sup>26</sup> In discussing difficulties in designing electric motors, Page points out: "Now the approximation of two electromagnets attracting each other, occasions an additional movement or accumulation [of "magnetic forces"] towards the poles, and consequently develops a secondary current flowing against the battery current. The power of this current is in proportion to the velocity with which the magnets approach each other." Davis is more succinct: "The motion of the attracting poles of two electromagnets towards each other, actually lessens the attractive force in proportion to the velocity with which they approach..."<sup>27</sup>

Page's move to the Washington area diminished his interactions with Davis, but their relationship did not come to an end. In 1844, for instance, Page ordered supplies for his "popular course of lectures" from an instrument dealer who knew Davis, adding "By the way Davis has some things to send before that time and if he has not already put them on the way please quicken his memory and send them all at once."<sup>28</sup>

Five years later, after securing a Congressional appropriation to develop his axial reciprocating engine, Page was looking for "some person, skilled in the construction of electro-magnetic machinery, to superintend the work."<sup>29</sup> He found not Daniel Davis, but his brother Ari, a machinist with experience making philosophical instruments. Page had Ari construct a "Thermo-Galvanometer,"<sup>30</sup> a new instrument "designed to measure the quantities of galvanic currents by their heating powers." Its round base, turned pillar and symmetrically placed binding screws demonstrate a stylistic affinity with Daniel Davis' apparatus. Ari also helped Page in his public lectures,<sup>31</sup> and maintained a friendship with him for many years.<sup>32</sup>

After Daniel Davis retired in 1852 he dropped out of Page's life, but Page still valued his labors, even as late as 1867. In that year Page wrote a *History of Induction*, claiming as his own inventions almost every feature of the induction coil apparatus. Five of the book's eleven illustrations derive from Davis publications. Page also reprints the description of his Compound Magnet and Electrotome from Davis' 1838 *Catalogue*, and remarks that Davis' account is both fuller and earlier than his own paper on the device.<sup>33</sup> Page published this book to gain support for a special act of Congress permitting him to patent his induction coil, despite his status as a patent examiner and the coil's status as an invention long known to the world. He succeeded. In the patent Page cites the *Manual of Magnetism* in support of a statement about the design of coils, and illustrates six pieces of apparatus in the Davis style, most of them familiar from Page's papers or the *Manual*. The patent (#76,654) was issued on April 4, 1868. Page died three weeks later.

Page's life embodied several themes, which changed with time and sometimes led to tensions, conflicts and disappointments.<sup>34</sup> One of these is Page as a pioneer in a new discipline. Electromagnetism, even when Page's most creative period ended, was less than 20 years old, counting from Oersted's discovery in 1820. In Europe the new subject spawned elaborate quantitative investigations such as those of Ampère and Biot, explicitly linked with theory in the tradition of Newton and Coulomb, but others such as Faraday and Sturgeon took an empirical approach emphasizing observable phenomena and the construction and manipulation of apparatus. This latter style was more popular in the U.S. Joseph Henry's work in many ways ran parallel to Faraday's, and Page's resembled Sturgeon's. Electromagnetism was a new field in the 1830s, the existing body of knowledge

small and readily assimilated, the apparatus simple to make and use, and the phenomena exciting: powerful magnetic attractions, loud sparks, strong shocks. These factors undoubtedly drew Page to the subject, stimulated his work, and enabled him to make important contributions.

Davis too was a pioneer. In the 1830s the manufacture of scientific instruments in the U.S. was growing more rapidly than ever before, owing largely to an expansion of the market for educational apparatus.<sup>35</sup> Taking advantage of this growing market, Davis was further fortunate enough, or astute enough, to pick out what at the time was a new and nearly nonexistent specialty--electromagnetic apparatus. Perhaps he saw his own interest in the subject--both intellectual and financial--reflected in associates and potential customers like Page. In any case, through initiative and imagination in choosing collaborators, designing apparatus, and writing the *Manual of Magnetism*, he developed the new field and had it virtually to himself for several years. He owed his success in part to being far in advance of possible rivals, both in the U.S. and in Europe. (It would be misleading to imply, however, that Davis limited himself to the manufacture of electromagnetic apparatus. Other stories await the telling, of his part in the introduction of the daguerreotype, electroplating, the electrotype process, and Morse's telegraph.)

Page and Davis worked together because they shared interests and saw that they could benefit each other. Although Page was good with his hands and could make his own apparatus, he no doubt welcomed the skilled help, materials and equipment offered by Davis' shop. The same would be true of the publicity that he received by getting his apparatus, with his name, in Davis' publications. Post even suggests that he received royalties.<sup>36</sup> Davis, on his side, benefitted from Page's creativity in developing gadgets he could sell. Page also must have been a good customer in his own right. And just as Page would appreciate seeing his name in Davis's *Manual*, so would Davis appreciate seeing his in a paper of Page's, either embellishing an illustrated piece of apparatus, or better, incorporated in the text in an explicit recommendation.

In the domain of scientific instruments in antebellum America it would be difficult to find a better match of needs and abilities than those of Charles Page and Daniel Davis. In fact, with the exception of Ari Davis, no other instrument maker associated with Page is known. On Davis' side relationships were different. His obituary says: "The writer has seen Dr. Hare, Professors Webster, Hitchcock, Silliman, Henry, Abbot, Farmer and Channing and most of the scientific men of the time in his store. Mr. Davis would be in his shirt sleeves trying some new experiment, with the professors crowding around him as much interested in his work as himself."<sup>37</sup> What is this but a reenactment two centuries later of the gatherings, first pointed out by Derek Price, in the instrument makers'

shops of London, of "a clientele of scholars and professional practitioners as well as amateurs of science who were excited by 'the new philosophy'"?<sup>38</sup> Surely a careful look at the lives of the men who crowded around Davis will reveal further links between American scientists and the men who made the tools of their trade.

Acknowledgment: I would like to thank Bob Post for putting at my disposal material on Page, and discussing Page's relationship with Davis; and a friend for giving valuable help.

1. The best study of Page's life is Robert C. Post, *Physics, Patents and Politics* (New York, 1976).

2. *Vital Records of Princeton, Massachusetts, to the End of the Year 1899* (Worcester, 1902). An obituary of Davis by "T.H."--perhaps Davis' successor, Thomas Hall--appeared in the *Boston Evening Transcript* shortly after March 22, 1887. This is the basis for the obituary in *Scientific American* (April 23, 1887). See also the *Transcript*, March 28 and 29, 1887; Francis Everett Blake, *History of the Town of Princeton in the County of Worcester and Commonwealth of Massachusetts, 1759-1915* (Princeton, 1915), pp. 297-99; Z. E. Stone, "The Introduction of the Telegraph, the Telephone, and the Daguerreotype into Lowell," *Contributions of the Old Residents' Historical Association, Lowell, Mass.* 5 (1894): 166-9, 176, 185-8.

3. I know this only through a manuscript copy made at the Patent Office in 1868, at the time of Page's efforts to obtain a special patent for his induction coil. It is now in the Dibner Rare Book Library, National Museum of American History.

4. *American Journal of Science* (hereafter *AJS*) 43 (1842): 381; *Scientific American* (April 23, 1846): 127; Blake, *op. cit.*, p. 299. A copy of the 1842 edition in the Dibner Library is signed "J. G. Foster, U.S.M.A. April 17th 45."

5. Although published in 1848, its copyright notice and preface are dated 1847.

6. Page, "New Magnetic Electrical Machine of great power, with two parallel horse-shoe magnets, and two straight rotating armatures, affording each, in an entire revolution, a constant current in the same direction," *AJS* 34 (1838): 164, Fig. 1.

7. Page, "On the use of the Dynamic Multiplier," *AJS* 32 (1837): 356, Figs. 1-4 (written April 24, 1837). See also Page, "Method of increasing shocks, and experiments, with Prof. Henry's apparatus....,"

8. Page, "Electro-Magnetic Apparatus and Experiments," *AJS* 33 (1838): 190-2.

9. Page, "Researches in Magnetic Electricity and new Magnetic Electrical Instruments," *AJS* 34 (1838): 368.

10. Page, "Magneto-Electric and Electro-Magnetic Apparatus and Experiments," *AJS* 35 (1839): 252-68, figs. 1-7.

11. Post, *op. cit.*, pp. 171-181; Page, *History of Induction. The American Claim to The Induction Coil and its Electrostatic Developments* (Washington, D.C., 1867).

12. Davis, *Descriptive Catalogue...*(1838), p. 16, no. 10; and *Manual of Magnetism* (1848), pp. 186-7, fig. 128.

13. Joseph Hale Abbot, "A Description of several New Electro-Magnetic and Magneto-Electric Instruments and Experiments," *AJS* 40 (1840): 108 and 104.

14. Page, "Observations on Electricity," *AJS* 36 (1839): 354.

15. Page, "Magneto-Electric and Electro-Magnetic Apparatus and Experiments," *AJS* 35 (1839): 265-6.

16. Davis, *Manual of Magnetism* (Boston, 1848), pp. 147-8.

17. Page, "The Economical Constant Battery," *AJS* 2d ser. 13 (1852): 257-60.

18. "Notice of some New Electrical Instruments; invented by Charles G. Page, Student in Medicine" *AJS* 26 (1834): 110-1.

19. Page, "New Electro-Magnetic Engine," *AJS* 49 (1845): 135; "Axial Galvanometer, and Double Axial Reciprocating Engine," *ibid.*: 139, 142; "Electro-Mechanics," *American Polytechnic Journal* (hereafter *APJ*) 1 (1853): 11.

20. Page, *History of Induction*. p. 121.

21. Page, "Magneto-Electric and Electro-Magnetic Apparatus and Experiments," *AJS* 35 (1839): 261-2; "New Electro-Magnetic Engine," *AJS* 49 (1845): 131-5; "Axial Galvanometer, and Double Axial Reciprocating Engine," *ibid.*: 139-42; Post, *op. cit.*, pp. 81-2, 96-9.

22. Page, "Electro-Mechanics," *APJ* 1 (1853): 10, fig. 5.

23. Page, note 6, p. 165.

24. Notice of meeting of Association of American Geologists and Naturalists, *AJS* 47 (1844): 131.

25. Page, note 6, p. 168; Davis, *Manual of Magnetism* (Boston, 1848), pp. 290-1.

26. Page, note 10, pp. 254-5; Davis, *Manual of Magnetism* (1848), pp. 289-91.

27. Page, "On Electro-Magnetism, as a Moving Power," *AJS* 35 (1839): 110; Davis, *Manual of Magnetism* (1848), p. 222.

28. Ms letter from Page to unknown addressee, Dec. 14, 1844 (Dibner Library, NMAH).

29. Page to William Ballard Preston, Oct. 2, 1849, *House Ex. Docs.*, 31 Congress, 1 Session, p. 445.

30. Page, "On a New Thermo-Galvanometer," *APJ* 1 (1853): 84.

31. "Dr. Page's Lecture on his Electro Magnetic Engine," *Scientific American* 7 (1851): 65-8.

32. Post, *op. cit.*, p. 159.

33. Page, *History of Induction*, pp. 32-33, 36. Figs. 2 bis, 3 and 8 are from *Manual of Magnetism* (1848); Fig. 7 is from *The Medical Application of Electricity* (1846); and Fig. 4 is from *Manual of Magnetism* (1842), p. 186. Page's copy of the latter has pin-holes in the corners of this page, presumably for holding tracing paper. (Dibner Library, NMAH).

34. Post, *op. cit.*, pp. 47, 104-7, 128-9, 140, 170-2.

35. D. J. Warner, introduction to *Pike's Illustrated Catalogue of Scientific & Medical Instruments* (Dracut & San Francisco, 1984).

36. Post, *op. cit.*, p. 40.

37. T. H., "Daniel Davis," *op. cit.*

38. Derek J. Price, "Some early English instrument makers," *Endeavour* 14 (1955): 90.