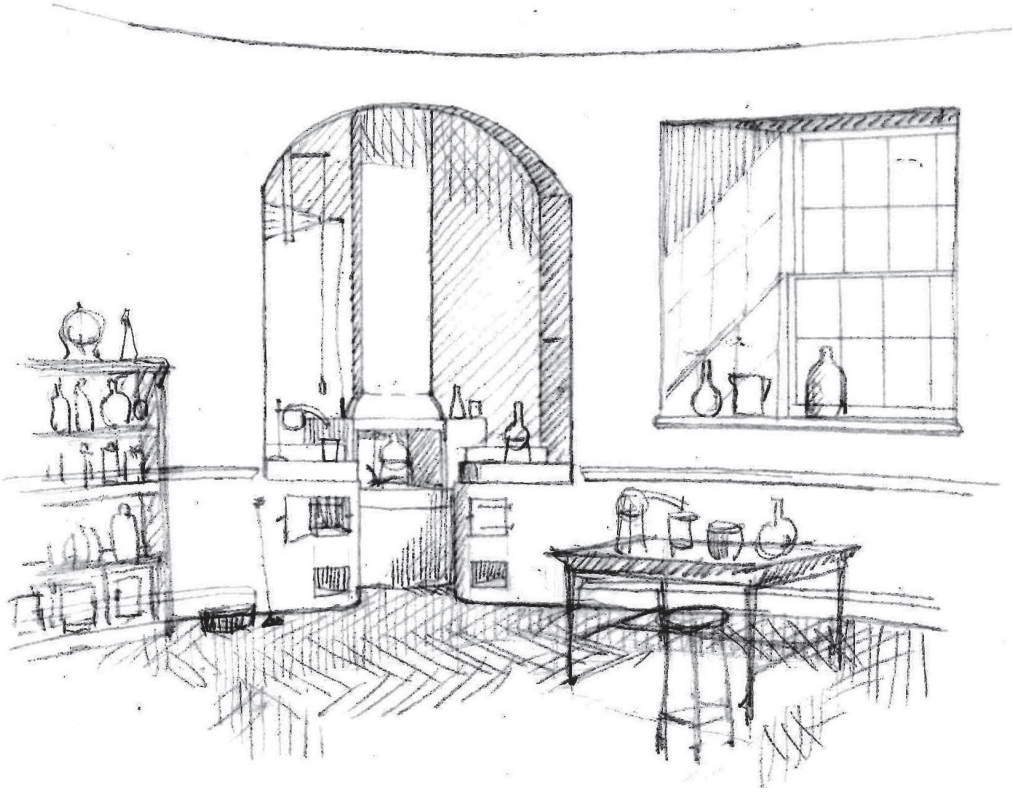
UNIVERSITY OF VIRGINIA

THE ROTUNDA

CHEMICAL HEARTH



HISTORIC STRUCTURE REPORT

ROTUNDA

UNIVERSITY OF VIRGINIA

CHEMICAL HEARTH

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JANUARY 2017

JOHN G. WAITE ASSOCIATES, ARCHITECTS PLLC
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Figure 1. Portrait of John Patten Emmet by James Westhall Ford. From Thomas Addis Emmet, MD, LLD, A Memoir of John Patten Emmet (privately printed, 1898).

THE ROTUNDA

CHEMICAL HEARTH

AND THE FIRST CHEMISTRY TEACHING LABORATORIES AND LECTURE ROOMS AT THE UNIVERSITY OF VIRGINIA

Central to Thomas Jefferson's comprehensive plan for the layout of the University of Virginia were the ten pavilions that faced the Lawn; each pavilion would be assigned to a professor, who would conduct classes in the building and also live there with his family. This scheme worked relatively well for professors teaching ancient and modern languages, mathematics, moral philosophy, and law, but less well for those who needed space for scientific demonstrations and laboratories when teaching anatomy and medicine, natural philosophy (physics and astronomy), and natural history (initially including botany, zoology, mineralogy, chemistry, geology, and rural economy).[1] Among those needing a better facility than his pavilion offered was Dr. John P. Emmet, the university's first professor of natural history.[2]

LOCATING THE SCHOOL OF CHEMISTRY IN THE BASEMENT OF THE ROTUNDA

By February 5, 1823, both houses of the Virginia General Assembly had approved a loan of $60,000 for constructing the Rotunda. Jefferson was said to be in "high spirits," knowing that the centerpiece of his design for the university could now get underway. The loan, however, was not sufficient to cover the entire cost of the building. Contractor John Neilson, who with James Dinsmore held the contract for carpentry work at the Rotunda, suggested some cost-cutting measures. Among them was the idea that the basement could be finished "in a very plain manner" but still "afford ample convenience for lecture rooms."[3] The university's first facilities for teaching chemistry would be located there, in the basement of the Rotunda. The topmost level of the Rotunda would house the library, and the large oval rooms on the first floor would be used for lectures and examinations.*

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* In this report the historic terms, rather than the current designations, have been used for the lower levels of the Rotunda: basement (for what is now called the first floor) and first floor (for second floor).

CHEMICAL HEARTH

In April 1823 Joseph Cabell, a member of the Board of Visitors, wrote to fellow Visitor James Madison about the "plan & interior distribution of the Library House," as he called the Rotunda.[4] Cabell brought some special knowledge to the arrangement of spaces where science was to be taught, for Cabell had, in Jefferson's words, "attended particularly to chemistry" during his travels in France.[5] Cabell was especially concerned about the "plane," or level, floors that Jefferson was planning for the lecture rooms. Cabell suggested that

> If it should not interfere too much with Mr. Jefferson's architectural views, might it not be well to have at least one of the rooms fitted up with seats run[n]ing around the rooms parallel to the walls & rising one above another, so that the Lecturer's eye & voice would distinctly reach the eye & ear of every student present? Such is the approved modern construction of large lecturing rooms at the principal Universities in Europe & in this country. It seems to me that on no other plan can a class of some hundreds be conveniently accom[m]odated. For my own part I should suppose it would be proper to fit up both the large rooms on this modern plan. Nor would it unfit them for any of the purposes ever contemplated unless for dancing, and I presume that it would be no disadvantage to the Institution, if this art should be taught rather more in the background of the scene.[6]

Cabell was also concerned about space for accommodating the professors' scientific apparatus:

> Is it not also to be apprehended that the Apparatus will require rather more space than Mr. Jefferson seems to be preparing for it. In some of the Universities of Europe which I visited I found the Apparatus occupying considerable space. As well as I can recollect, in none that I saw was there less than one large room, & in some, as at Bologna, a suite of rooms was, appropriated to this object. Perhaps on this [head?], some eminent Professors might be advantageously consulted.[7]

Finally, Cabell continued,

> To make the University compleat, within the limits heretofore proposed, is highly desirable; and with a view to this object, I should think it essential to provide in the larger apartments of the Library House convenient accommodation for the greater classes of Chemistry, Natural Philosophy &c which from their numbers require space, & from the necessity of witnessing experiments demand seats rising one above another.[8]

Cabell had already discussed these issues with Madison while they were both at Monticello, and he now asked Madison "to communicate with Mr. Jefferson on these subjects, and trusting in your superior judgments, shall entertain no doubt that your decision will be for the best."[9]

Madison passed Cabell's letter along to Jefferson. On April 30, 1823, Jefferson replied to Madison, responding in detail to the three points that Cabell had raised. First, he wrote,

> if we could have foretold what number of students would come to our University, and what proportion of them would be in attendance on any one Professor at one time, lecturing rooms might have been constructed exactly to hold them. But having no data on which we could act with precision, we were obliged to assume some numbers conjecturally. The ordinary lecturing rooms were therefore adapted to an audience of about 150 students. I question if there ever were more than 25 at any one school of Wm. & Mary, at one time, except the Grammar school. I doubt if in Harvard even they have 100. in attendance, in any one school, at a time in the great Medical schools of Philadelphia, N. York &c there are doubtless more. If any school should go with us beyond the contents of the ordinary lecturing rooms, the oval rooms in the Rotunda will accommodate double that number but no human voice can be habitually exorted to the extent of such an audience. We cannot expect our Professors to bawl daily to multitudes as our stump orators do once a year. They must break the numbers into two or more parts accommodated to voice and hearing, & repeat the lecture to them separately.[10]

Responding to Cabell's second point, the need for the storage of apparatus, Jefferson was at this time assuming that the professor of natural philosophy would be lecturing from his pavilion; he believed that the "apparatus for Natural Philosophy, even the fullest does not occupy much space, not more than may be arranged on shelves along the walls of the lecturing rooms, if more space however should be wanting, a door of communication with the adjacent dormitories will supply it to any extent." Jefferson realized, however, that the space required for the teaching of chemistry would pose special circumstances. "For the Professor of Chemistry," Jefferson wrote in this same April 1823 letter,

> such experiments as require the use of furnaces, cannot be exhibited in his ordinary lecturing room. We therefore prepare the rooms under the oval rooms of the ground floor of the Rotunda for furnaces, stoves &c. These rooms are of 1000 square feet area each.[11]

Thus, at this point, Jefferson was planning to locate the spaces for the teaching of chemistry in the two large oval rooms in the basement of the Rotunda.

Regarding the arrangement of the seats in the lecture rooms, Cabell's third issue, Jefferson acknowledged that

> some schools require them to be steps, one above another, others not. Natural philosophy, Chemistry, anatomy will be the better with rising seats; but such are not at all necessary for lecture on languages, history, ethics, metaphysics, belle letters, Law, Politics &c.

> Whenever it shall be known what particular Pavilions will be allotted to the Professors of the former schools, the rising benches for them can be readily set up.[12]

Refusing to give any ground on this issue, Jefferson added:

> No doubt that were the numbers to be prepared for are so totally uncertain, conjectured accommodations will be found to have been miscalculated in some instances, and will require modifications to actual facts when they shall become known. In the meantime, our plan is such as to admit much facility of adaptation to varying circumstances.[13]

Madison, in turn, then passed Jefferson's responses along to Cabell. The "rooms in the Pavillions [sic] will contain as many students viz 150 each, as can be conveniently addressed by the Professors," Madison wrote, while "the oval rooms in the Rotunda which will hold 300 are considered too large for the Lecturing voices." Where there was not enough space for the full class, Madison endorsed Jefferson's proposal of "a repetition of the Lecture by the Professor." "For the Chemical Experiments requiring furnaces &c," Madison continued, "rooms can be prepared under the oval rooms of the ground floor of the Rotunda where there will be abundant space." Madison told Cabell not to worry: "Should anything in these ideas be found inapplicable, there will be time & opportunity for readjusting them, particularly in reference to the manner of furnishing the interior of the Rotunda rooms."[14]

In October 1824, when the Board of Visitors formalized the topics to be taught in the various schools of the university, they determined that "In the school of Natural history are to be taught, botany, zoology, mineralogy, chemistry, geology, and rural economy." At this same meeting the Visitors also officially set forth the use of the various spaces in the Rotunda. The "upper circular room" was designated as the library; the large oval rooms on the main level were to "be used for annual examinations, for lectures to such schools as are too numerous for their ordinary schoolrooms [in the pavilions], and for religion [sic] worship, under the regulations allowed to be prescribed by law." Finally, the "rooms in the Basement story of the Rotunda, shall be, one of them for a Chemical laboratory; and the "others for any necessary purpose to which they may be adapted."[15]

This assignment of just one room in the basement for the chemical laboratory superseded Jefferson's statement in his April 1823 letter to Madison that "the rooms under the oval rooms of the ground floor of the Rotunda for furnaces, stoves &c." would be assigned to the professor of chemistry.[16] Furthermore, the space that would become Emmet's first chemical laboratory apparently was not one of the large oval rooms in the basement, as Jefferson's

1823 letter seems to have indicated, but the small oval room to the north of the two large oval rooms.[17] The first chemistry lecture room would occupy the larger east oval room.

No drawing of the basement level of the Rotunda dating from the 1820s has been located. However, some type of flue for ventilating the laboratory in the small north room may well have been located at the west end of that room; Jefferson's drawing of the first floor of the Rotunda indicates a recess for a fireplace at the west end of the small oval room located directly above the small oval room in the basement.

The first professor to utilize the rooms in the basement for teaching chemistry, John P. Emmet, would find them highly unsatisfactory, especially the laboratory, because it was not aligned with his up-to-date ideas about the teaching of chemistry.

ESSENTIAL FEATURES OF EARLY CHEMICAL LABORATORIES

Locating lecture rooms and chemical hearths for teaching purposes in the basement was a typical practice in the late eighteenth and early nineteenth centuries, in part because water necessary for laboratory operations would not have to be pumped up to a higher story. In some medical schools, such as Davidge Hall at The College of Medicine of Maryland, the lecture room and chemical hearth were situated on the floor beneath anatomical theaters, which were given priority for skylights. Providing satisfactory ventilation of fumes from the lower story, however, could be difficult, and moisture could also be a problem.[18]

Since fire was the chief method of effecting chemical change and thus the "chemist's most basic tool," the chemical hearth and its chimney were the "operational heart of the chemical laboratory." Individual furnaces, whether fixed or portable, were designed to produce the different temperatures and different types of heat needed for successful experiments.[19]

Temperatures needed for experiments could vary greatly; some experiments, such as the "dry distillation of minerals," needed a high temperature, sometimes requiring a bellows to produce a hot blast. In other cases, where "slower or more organic processes" were involved, the heat from the furnace had to be controlled carefully, and the flames could not come into contact with the vessel holding the chemicals; in those cases, a water bath or a larger, more complex furnace with "chambers heated by currents of hot air from the fire box" were used. Sand baths were utilized where temperatures higher than those produced by water or steam were required. Reverberating furnaces had a "heating chamber with a hemispherical top in which the heat was supposedly reflected or 'reverberated.'"[20]

Flues and fresh-air intakes made it possible to control the range of temperatures by regulating the draft across the fuel. The type of fuel, as well as the way the fire was constructed, also produced different temperatures; charcoal, for example, yielded higher temperatures than wood. Some furnaces had "separate chambers at various distances from the fire to give several degrees of heat at one time." The ability to carefully control the heat in the furnaces and baths was a highly important skill for chemists to attain.[21]

The other essential elements of a chemical laboratory, in addition to a supply of chemical reagents, were sufficiently large work surfaces and vessels that could "bear without breaking the sudden application of great heat and cold, be inpenetrable to every substance and inalterable to any solvent, be unvitrifiable and capable of enduring the most violent fire without fusing." Glass, metal, and earthenware vessels were used.[22] These containers and other apparatus were often stored on shelves across the front of the ventilation hood and in glass-fronted cases or on open shelves around the walls of the laboratory.

THE APPOINTMENT OF JOHN P. EMMET, THE FIRST PROFESSOR TO TEACH CHEMISTRY AT THE UNIVERSITY OF VIRGINIA

John Patten Emmet was the third person to be offered the position of teaching chemistry at the University of Virginia. In March 1819, a full six years before the university actually opened, the Board of Visitors had appointed Thomas Cooper as professor of chemistry, mineralogy, and natural philosophy; he was also to be the professor of law.[23] A graduate of Oxford University, Cooper had experimented with chemical bleaching of calico in Manchester, England, but subsequently became a lawyer and engaged in radical political activities in Europe and later in the United States. In 1794 Cooper settled with his family in Northumberland, Pennsylvania, where he would work with fellow scientist Joseph Priestley. Cooper taught chemistry at Carlisle (now Dickinson) College beginning in 1811; there he "developed new laboratory experiments for his students and also annotated several chemistry texts." In 1815 he became a professor at the University of Pennsylvania. When his appointment at the University of Virginia in 1819 became enmeshed in controversy over his religious beliefs and when the opening of the university was postponed, Cooper accepted a professorship at South Carolina College in Columbia and also became its president.[24]

Five years later, in 1824, as the University of Virginia was preparing to open, the position of professor of natural history was offered to John Torrey, an 1818 graduate of the College of Physicians and Surgeons in New York (now part of Columbia University). He declined

the post at the university in favor of a professorship at the U.S. Military Academy at West Point. Torrey, however, recommended a young man who had been trained at West Point and had recently graduated from the College of Physicians and Surgeons in New York, John P. Emmet (see Figure 1). Torrey wrote that Emmet's "talents as chemist and scholar and standing as a gentleman, were of the first rank." "I know him well," Torrey continued, "and know none before him."[25]

Meanwhile, the university had engaged Francis Walker Gilmer as an agent to recruit professors in Europe. While Gilmer was successful in hiring professors for other disciplines, he was not able to secure a professor of chemistry in Europe. In a letter dated December 3, 1824, Gilmer told Jefferson that, after Torrey, the "next best person I can hear of, and undoubtedly superior to any I saw in G[reat] B[ritain] is Dr. J. P. Emmet, son of the eminent counsel of New York." John Emmet, Gilmer predicted, would accept the position "with alacrity":

> He is an excellent chemist, mineralogist, geologist, & pretty well informed in Zoology, & Botany. I doubt if we can procure a more fit person. Should the appointment be made speedily I have only to desire, that you consider me as giving the preference to him. Meanwhile if I learn that you can make a better choice I will write to you. Emmet is young & will certainly be distinguished. He is also strong in mathematics, which shews [sic] he has *stamina*.[26]

In the same letter Gilmer mentioned to Jefferson that "Emmet is very strong in chemistry which will of course put an end to Dr. Dunglison's pretensions to that chair" and that he had drawn up the contract for Dunglison, an Englishman who was to teach anatomy and medicine, very carefully so as to give "him no assurance that chemistry should be attached to his professorship." Gilmer also provided Jefferson with another argument in Emmet's favor: Emmet, he wrote, "has a valuable chemical apparatus which will be important."[27] Gilmer assured Jefferson that Emmet would "make quite as able a lecturer" as Torrey and that in chemistry Emmet "is superior." And, Gilmer, wrote, he had himself interviewed Emmet and believed that he "will certainly accept it."[28]

John Emmet had been born in Ireland in 1796 and was eight years old when he arrived in New York, where his father, Thomas Addis Emmet, an outspoken Irish patriot, had decided to seek political asylum. As a child, John Emmet had contracted severe cases of smallpox, measles, and whooping cough, and as a teenager he was forced to leave school because of a debilitating lung disease. Nonetheless, he was admitted to West Point as a cadet, where as a student he became an assistant instructor of mathematics; Emmet's poor health, however,

forced him to leave the military academy before completing his studies. In an attempt to regain his health, Emmet spent a winter in Naples, Italy, where he studied music, painting, sculpture, and Italian.[29]

When he returned to America in 1819, Emmet enrolled at the College of Physicians and Surgeons in New York and became an assistant to Dr. William J. MacNeven, the professor of chemistry and a friend of Emmet's father. When cold weather forced Emmet to remain indoors during the winter, he devoted himself to studying chemistry and fitted up a room in his parents' house as a chemical laboratory; he also began "to show the same taste for mechanical pursuits." Emmet was awarded his medical degree in January 1822. A few weeks later, in search of a warmer climate, Emmet moved to Charleston, South Carolina, where he established a medical practice, which would prove somewhat disappointing, but he also "delivered a course of lectures" on chemistry, "which were very well received in that cultivated and intelligent community." Emmet remained in Charleston through the winter of 1824-1825.[30]

Meanwhile, Thomas Emmet had been trying to assist his son with his job search. In November 1824 the elder Emmet had written hastily from New York to John C. Calhoun, then the U. S. Secretary of War and soon to be U.S. Vice President, noting that Calhoun already knew of his "anxiety to procure a professorship in some more Southern situation for my son." Emmet told Calhoun that he had "just this instant accidentally heard that the Professorship in Chemistry for Mr. Jefferson's College in Virginia is not filled up" and explained to Calhoun that it was "an object very near my heart to procure the situation for my son." "I do not believe," Emmet continued, "I overrate his Chemical knowledge, when I speak of it as inferior to that of no other person here—& say that he is very expert as a maker of experiments & demonstrator—which to Pupils is a matter of great importance." He asked Calhoun for help by means of "recommendation & influence in my son's favor wherever it would be most likely to avail him--& as speedily as your convenience will permit," fearing that "when the fact of a vacancy shall be known, the applications will be numerous, & some of them may anticipate mine." Calhoun forwarded Emmet's letter to Jefferson, noting that although he was not "personally acquainted with young [M]r. Emmet, but from the recommendation of gentlemen of science, and on whose judgement I can rely, I feel persuaded, that his qualifications for the professorship, for which he applies, are of the most respectable character."[31]

Jefferson, in turn, passed Thomas Emmet's letter on to James Madison. In his cover letter to Madison, Jefferson wrote that since Torrey had turned them down and since Gilmer had found Emmet highly qualified, he now doubted "if we can make a better choice, and if you approve it I will write to him that subseq. inform. enables me to say that Professorship is still open to our appmt and that I will propose him to the Visitors."[32] The negotiations for the professorship of chemistry were, however, complicated by the fact that Robley Dunglison also wanted to teach chemistry. Madison was concerned about disappointing Dunglison and suggested that Jefferson find a way to prevent Emmet from accepting another post while arrangements with Dunglison could be confirmed. Dunglison's Atlantic crossing had been delayed by bad weather, and he did not arrive in Richmond until mid-February 1825 and did not arrive in Charlottesville until later that month.[33]

Jefferson was finally able to write to John Emmet on March 6, 1825, announcing his unanimous appointment by the Board of Visitors on March 4 as "a professor for the school of Natural history." Jefferson explained that "under the generic term of Natural history," the board "comprehend Zoology, Botany, Mineralogy, Chemistry and Geology; that of Chemistry however being considered as the branch most eminently distinctive of the school." The "emoluments," Jefferson explained, were a "fixed salary" of $1,500, "tuition fees from those of your school from 25 to 50 D. each according to circumstances, and an excellent house and convenient garden-grounds for your residence." It would take a vote of five of the seven Visitors to remove a professor from his post, meaning, Jefferson assured Emmet, that "it is therefore a freehold in fact." Only one vacation was allowed, from December 15 through January 31, and professors were expected to lecture "every other day during term." There was not much time for Emmet to consider the offer. "The Institution opens tomorrow," Jefferson continued, "so that in the hope that you will accede to our wishes, we shall request your attendance as early as possible, and in the meantime, ask an answer which may place us on a certainty."[34]

Emmet, then in New York, replied on March 13, 1825, just a week after Jefferson had sent his invitation:

> I have just received your letter announcing my election to the Professorship of Chemistry and Natural History, in the College over which you preside. I beg to express my strong feeling of gratification at the result, and hope, by attention and zeal, to compensate for the disadvantage of not being on duty, as early as my Colleagues. As various arrangements, no doubt, yet remain for my own particular attendance at the University, I shall loose

> [sic] no time in entering upon the duties which have been assigned to me, and may limit my delay to a fortnight or three weeks.[35]

Emmet's father followed up two weeks later with his own letter to Jefferson, confirming that his son "is now about to proceed to the College, & undertake the duties of his office." He told Jefferson that "It is an object very near my heart that he should merit & receive the approbation of all connected with the Institution, but most especially of you, Sir, whom for five & twenty years I myself have respected & esteemed as one of the most useful & enlightened Citizens of the United States." Emmet closed his letter with an appeal, asking "May I solicit the countenance & kind consideration of such a man for one in whose fame & prosperity I have so deep an interest & indulge in a parent[']s longing hope, that you will permit him to regard you as a Patron & friend."[36]

In an April 4, 1825, accounting of the credentials of the new professors, Jefferson described John Emmet as the "son of the celebrated Emmet of N. York, said to be highly accomplished as a Chemist, who will teach botany also and zoology."[37] Emmet may have arrived in Charlottesville to take up his post as early as April 8, 1825, the day when Jefferson signed the certificate of Emmet's appointment as "Professor of the school of Natural History."[38]

In any case, Emmet was definitely at the university by April 12, 1825, and he must have been surprised at the unfinished state of the Rotunda and concerned about the facilities for teaching chemistry.[39] On May 6 he wrote to his sister Jane apologizing for not having written more regularly: "I am particularly anxious to give such a description of the University as would be satisfactory to Papa, but we are yet so much in infancy, that it must be an imperfect and unjust one." Emmet hoped that his younger brother, William, would enroll at the university (Emmet anticipated that it "will be ranked among the very first in this country") but advised William to wait until the next year, as the "students are still without text books and altho' attentive and orderly have very many disadvantages in the prosecution of their education." Nevertheless, he continued, "I do not know that I ever entered on Business with more pride and satisfaction and the day will yet come when it will be a noble source of Pride to be known as the Professor of this promising University."[40]

Thomas Emmet's wish that Jefferson would permit his son "to regard you as a Patron & friend" seems to have been fulfilled to at least some degree. In his May 6, 1825, letter John Emmet also told his sister that

> Mr. Jefferson is down with us almost every day, and as often invites to call without formality at his house. But I have already found that Monticello does not signify a *small*

> Mountain as might have been expected. I have dined, however, twice with his family since my arrival, and would go oftener, notwithstanding distance and altitude, were it not for [my need to prepare] lectures, lectures, lectures, &c. He has a most charming prospect from the *clouds*, and commands a full view of the University, which is now his only hobby.[41]

By mid-June 1825 Emmet had settled in, telling his sister that he was "going on very well in my new vocation." He already had a "class of twenty-eight and a most flattering prospect for next year." He was taking "a great deal of pains" with his lectures, writing "them out at length." Even though his "room" was at this point "not opened publicly to others than my class," he continued, it was "generally filled and not infrequently so much so, as to render the temperature oppressive. This is a flattering circumstance and sufficiently proves that my subject is popular."[42]

THOMAS JEFFERSON AND THE FIRST CHEMICAL LABORATORY AND LECTURE ROOM

John Emmet had arrived at the university in April 1825 and had begun lecturing soon thereafter. There was some type of chemical hearth already in place, for he mentioned the facilities in a letter to Jefferson.[43] No early drawing of the ground floor of the Rotunda, by Jefferson or others, showing details of this lecture room or the chemical laboratory has been located. Jefferson had sought advice from two experts about identifying and procuring the proper apparatus for outfitting the chemistry facility; however, no correspondence between Jefferson and chemists or other experts on the arrangement or construction of a chemical laboratory or lecture room in the Rotunda has been located.

It may well be that Jefferson felt confident in his understanding of chemical hearths and lecture facilities. Much earlier, in 1784-1789, when he was representing the United States in Paris, Jefferson was aware of new developments in chemistry and its presentation to audiences. Jefferson may have visited the sizeable new medical facilities there, such as those at the Ecole de Chirurgie (Jacques Gondoin, architect; built 1769-1774), which had a magnificent, domed anatomical theater and a chemical laboratory on the floor below. Perhaps more relevant to the chemistry laboratory and lecture room at the Rotunda were the numerous small private laboratories then in use in Paris. John Perkins, retired Dean of Arts and Humanities at Oxford Brookes University, has identified more than 300 laboratories that existed in Paris in the 1780s, some at public institutions but most in private residences.

Some were simply "portable laboratories that students set up in their rooms or visitors in their hotels where they would repeat and discuss the experiments they had seen that day in chemistry courses." Others were maintained by apothecaries and physicians. Chemistry, as Perkins has written, "was very much the science in vogue in the last two decades before the Revolution and many aristocrats and rich bourgeois had chemistry labs." Given this popularity and given Jefferson's own interest in science, it would seem likely that he would have known of these small laboratories and attended chemical demonstrations in Paris. [44]

The best known private laboratory in Paris was that of Antoine-Laurent Lavoisier, one of the founders of modern chemistry. Jefferson was a member of the Société de 1789, where Lavoisier was also a member and where lectures on science were given.[45] Jefferson owned a first edition of Lavoisier's book entitled *Traité élémentaire de chimie*, which was published in Paris in 1789, with illustrations by his wife and collaborator, Anne-Pierrette Paulze, an accomplished author and engraver.

Jefferson was aware of Lavoisier's work but did not agree with his approach. In 1788, while in Paris, Jefferson wrote the Rev. James Madison, his friend and then the president of the College of William and Mary, about one of their topics of common interest—new developments in science in Paris:

> The dispute about the conversion and reconversion of water and air is still stoutly kept up. The contradictory experiments of Chemist leave us at liberty to conclude what we please. My conclusion is that art has not yet invented sufficient aids to enable such subtle bodies to make a well defined impression on organs as blunt as our: that it is laudable to encourage investigation, but to hold back conclusion. Speaking one day with Monsieur de Buffon on the present ardor of chemical enquiry, he affected to consider chemistry but as cookery, and to place the toils of the laboratory on a footing with those of the kitchen. I think it on the contrary among the most useful of sciences, and big with future discoveries for the utility and safety of the human race. It is yet indeed a mere embryon. It's [sic] principles are contested. Experiments seem contradictory: their subjects are so minute as to escape our senses; and their result too fallacious to satisfy the mind. It is probably an age too soon to propose the establishment of system. The attempt therefore of Lavoisier to reform the Chemical nomenclature is premature. One single experiment may destroy the whole filiation of his terms, and his string of Sulfates, Sulfites, and Sulfures may have served no other end than to have retarded the progress of the science by a jarbon from the confusion of which time will be requisite to extricate us. Accordingly it is not likely to be admitted generally.[46]

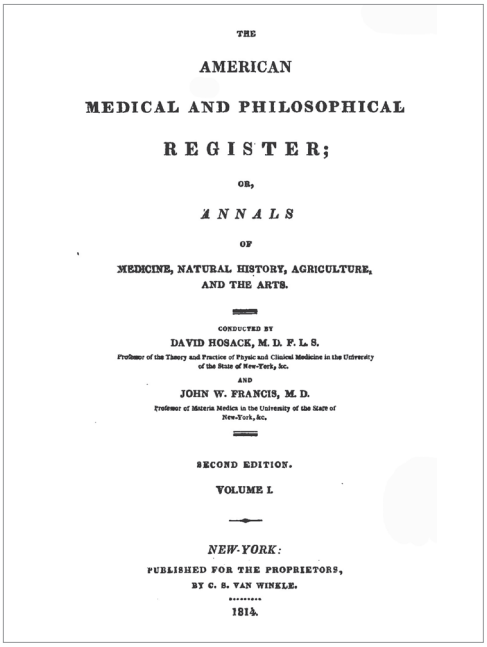
During his time in Paris, Jefferson was also involved with promoting the study of chemistry in Virginia. He became involved with the establishment of a French academy of the sciences and fine arts in Richmond, which sent one professor to America in 1788, Jean Rouelle, as the chair of chemistry and natural history. The nephew of a Guillame-Francois Rouelle, a well know French apothecary and chemist, Jean Rouelle lived near Richmond for a decade before returning to France. Jefferson would also have known other chemists through his involvement with the American Philosophical Society in Philadelphia.[47]

Jefferson's personal library included many books on pure and applied chemistry. He was very interested in science and especially its practical application to industry and daily life. In 1812, as he was about to begin reading a copy of *The Introductory Lecture of Thomas Cooper, Esq. Professor of Chemistry at Carlisle College Pennsylvania*, a gift from the author, Jefferson told Cooper that he expected that he had "a feast before me." "You know the just esteem which attached itself to Dr. Franklin's science," Jefferson continued,

> because he always endeavored to direct it to something useful in private life. The chemists have not been attentive enough to this. I have wished to see their science applied to domestic objects, to malting, for instance, brewing, making cyder [sic], to fermentation & distillation generally, to the making of bread, butter, cheese, soap, to the incubation of eggs, &c. And I am happy to observe some of these titles in the syllabus of your lecture. I hope you will make the chemistry of these subjects intelligible to our good housewives . . .[48]

A catalogue of the books that Jefferson sold to Congress in 1815 had 31 titles that he had organized under the heading of "Chemistry"; included were volumes that he had acquired while in Paris, as well as titles published in the United States and Cooper's *Introductory Lecture*.[49] A second catalogue, related to the sale of Jefferson's "retirement library" in 1829, three years after his death, listed eight titles on pure and applied chemistry.[50]

At least two of the volumes that Jefferson owned contained illustrations of recently constructed chemical laboratories and lecture rooms. One featured plates of the furnaces at the new combination chemical laboratory and lecture room at the College of Physicians and Surgeons in New York, which had been constructed for William J. MacNeven, the professor of chemistry and John Emmet's mentor. The college had purchased a three-story warehouse in 1813 and remodeled it into classrooms. On the first floor was a new "combined lecture room-laboratory," which essentially followed the layout of the college's previous chemistry lecture room and laboratory. It was an oblong hall, where



THE

AMERICAN

MEDICAL AND PHILOSOPHICAL

REGISTER;

OR,

ANNALS

OF

MEDICINE, NATURAL HISTORY, AGRICULTURE,
AND THE ARTS.

CONDUCTED BY

DAVID HOSACK, M. D. F. L. S.

Professor of the Theory and Practice of Physic and Clinical Medicine in the University of the State of New-York, &c.

AND

JOHN W. FRANCIS, M. D.

Professor of Materia Medica in the University of the State of New-York, &c.

SECOND EDITION.

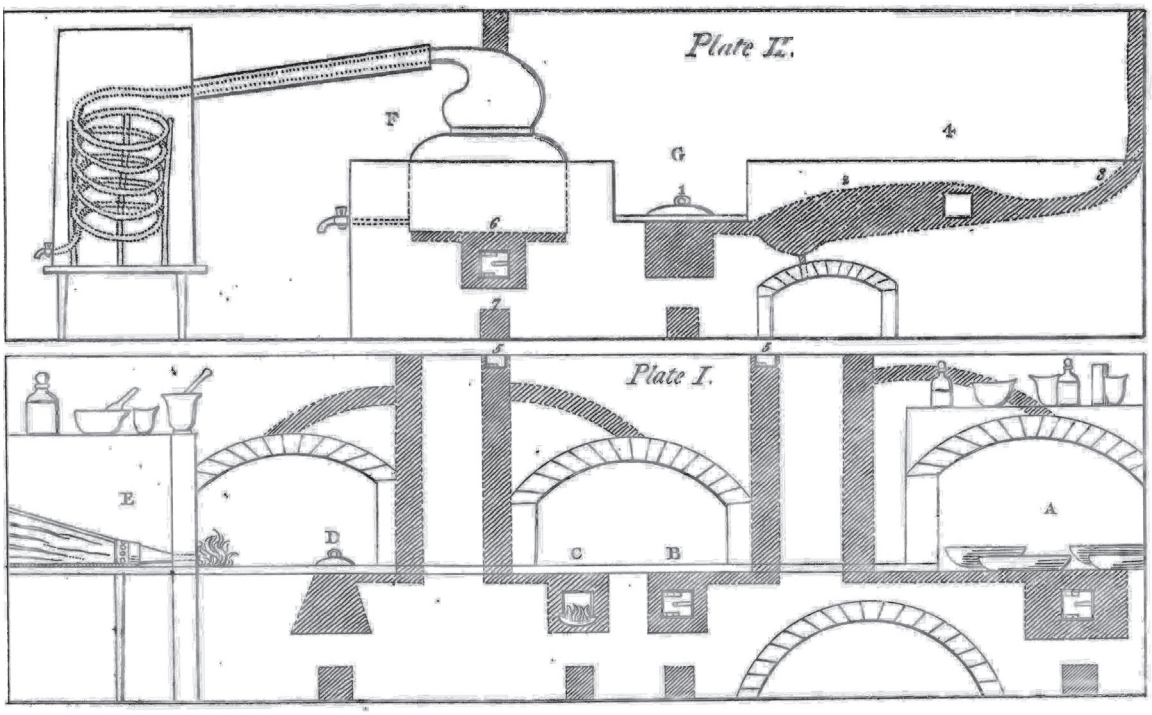
VOLUME I.

NEW-YORK:

PUBLISHED FOR THE PROPRIETORS,
BY C. S. VAN WINKLE.

1814.

Figure 2. William MacNeven's drawing of the furnaces in the lecture room at the College of Physicians and Surgeons, from The American Medical and Philosophical Register *4 (1814), 284-288.*



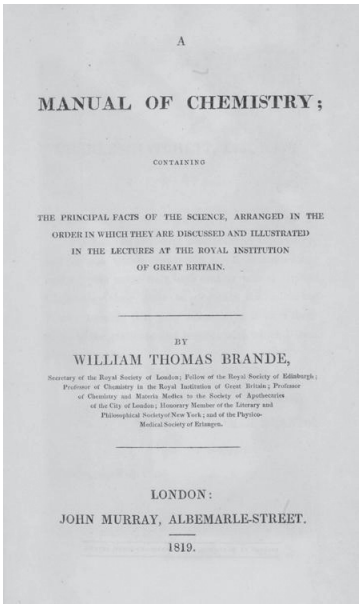
> From one end of the hall to perhaps the middle were rows of backless benches on which students sat, facing the laboratory at the other end. Before the benches was a heavy mahogany table upon which MacNeven or his assistant performed lecture demonstrations. At the laboratory end was another heavy mahogany table upon which MacNeven and his students assembled apparatus for these analyses and experiments.[51]

While the arrangement of the seating area in the lecture room underwent little change during the rebuilding, MacNeven did make an important improvement at the laboratory end of the space: along two walls he added "a Range of Fixed Furnaces." He published two elevations and a written description of these furnaces in *The American Medical and Philosophical Register* in 1814 (see Figure 2). Jefferson owned copies of this journal, including the fourth and final volume, which contained the article and plates of MacNeven's laboratory. These two plates are believed to be the earliest images of an interior of a laboratory in America. [52]

Among the components of the fixed furnaces shown in the plates were a "flat sand-heat, to hold evaporating vessels"; a "furnace with a cast iron pot" intended to be "used as a sand bath, for distillation, or as a boiler"; a muffle furnace; a "very powerful draught-melting furnace"; a forge hearth with a "blast pipe and bellows"; an "eight gallon still and worm tub" with a water bath; and a reverberating furnace. These new "furnaces were supplied with cold air from withoutside the building, by means of channels under the floor"; there were several recessed conduits for venting fumes through the chimney.[53]

Jefferson also owned a copy of *A Manual of Chemistry Containing the Principal Facts of the Science, Arranged in the Order in Which They Are Discussed and Illustrated in the Lectures at the Royal Institution of Great Britain*, written by William T. Brande, a professor of chemistry at the Royal Institution in London (see Figure 3). Intended for chemistry students, his *Manual* was originally published in London in 1819. Jefferson's copy was the first American edition of the *Manual*; it was published in New York in 1821 and contained "Notes and Emendations" by William J. MacNeven, who had remodeled the chemistry facility at the College of Physicians and Surgeons in New York.[54] MacNeven had, in fact, provided Jefferson with a copy of his *Manual*; in acknowledging this gift, Jefferson remarked upon MacNeven's "valuable notes and amendments" and explained that "without memory enough now for Sciences of <u>fact</u> I shall find the value of this work in occasional references, still more in contemplating it as a mark of your goodness and attention."[55]

Brande's *Manual* provided detailed information about the arrangement of the chemical laboratory and lecture room at the Royal Institution in London, which had been completed



A

MANUAL OF CHEMISTRY;

CONTAINING

THE PRINCIPAL FACTS OF THE SCIENCE, ARRANGED IN THE ORDER IN WHICH THEY ARE DISCUSSED AND ILLUSTRATED IN THE LECTURES AT THE ROYAL INSTITUTION OF GREAT BRITAIN.

BY

WILLIAM THOMAS BRANDE,

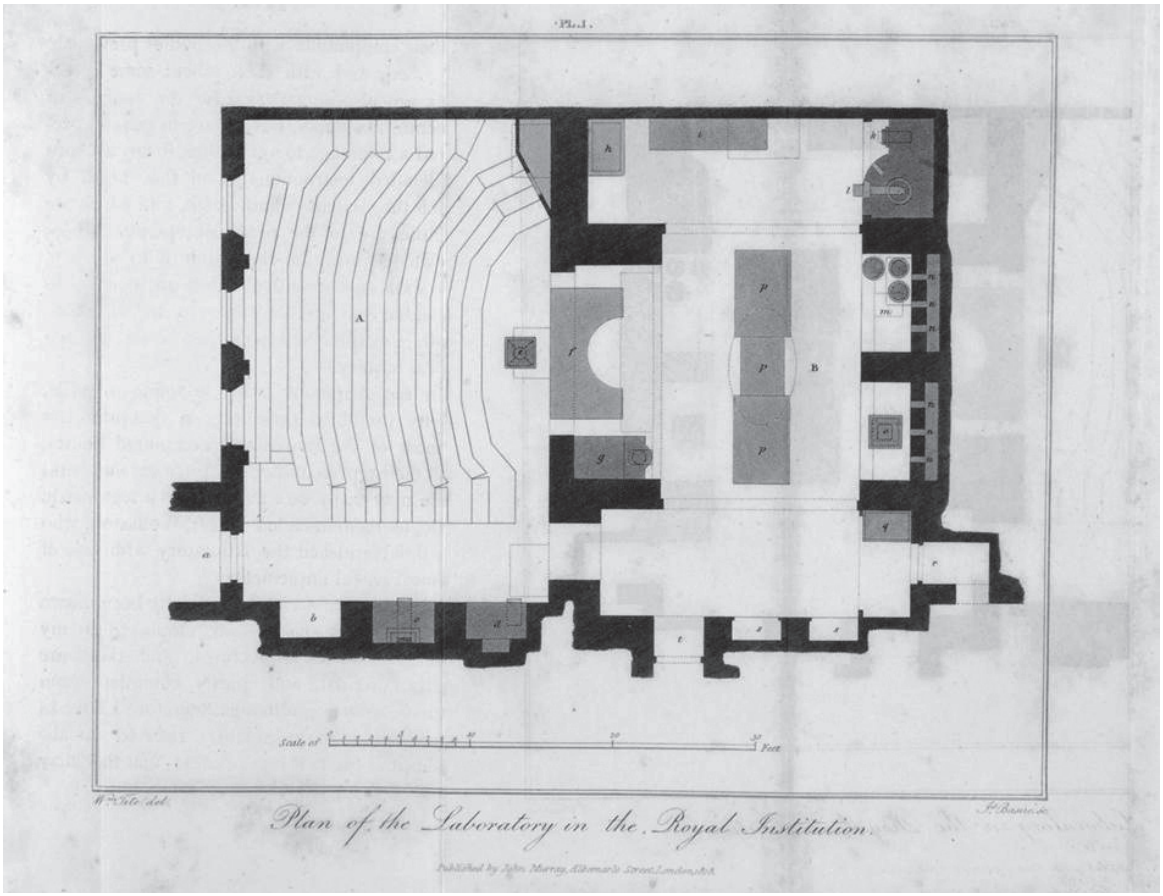
Secretary of the Royal Society of London; Fellow of the Royal Society of Edinburgh; Professor of Chemistry in the Royal Institution of Great Britain; Professor of Chemistry and Materia Medica to the Society of Apothecaries of the City of London; Honorary Member of the Literary and Philosophical Society of New York; and of the Physico-Medical Society of Erlangen.

LONDON:

JOHN MURRAY, ALBEMARLE-STREET.

1819.

Figure 3. William T. Brande's fold-out floor plan of the laboratory and lecture room at the Royal Institution of Great Britain, from his A Manual of Chemistry Containing the Principal Facts of the Science, Arranged in the Order in Which They Are Discussed and Illustrated in the Lectures at the Royal Institution of Great Britain *(New York: George Long, 1821), vii-viii.*



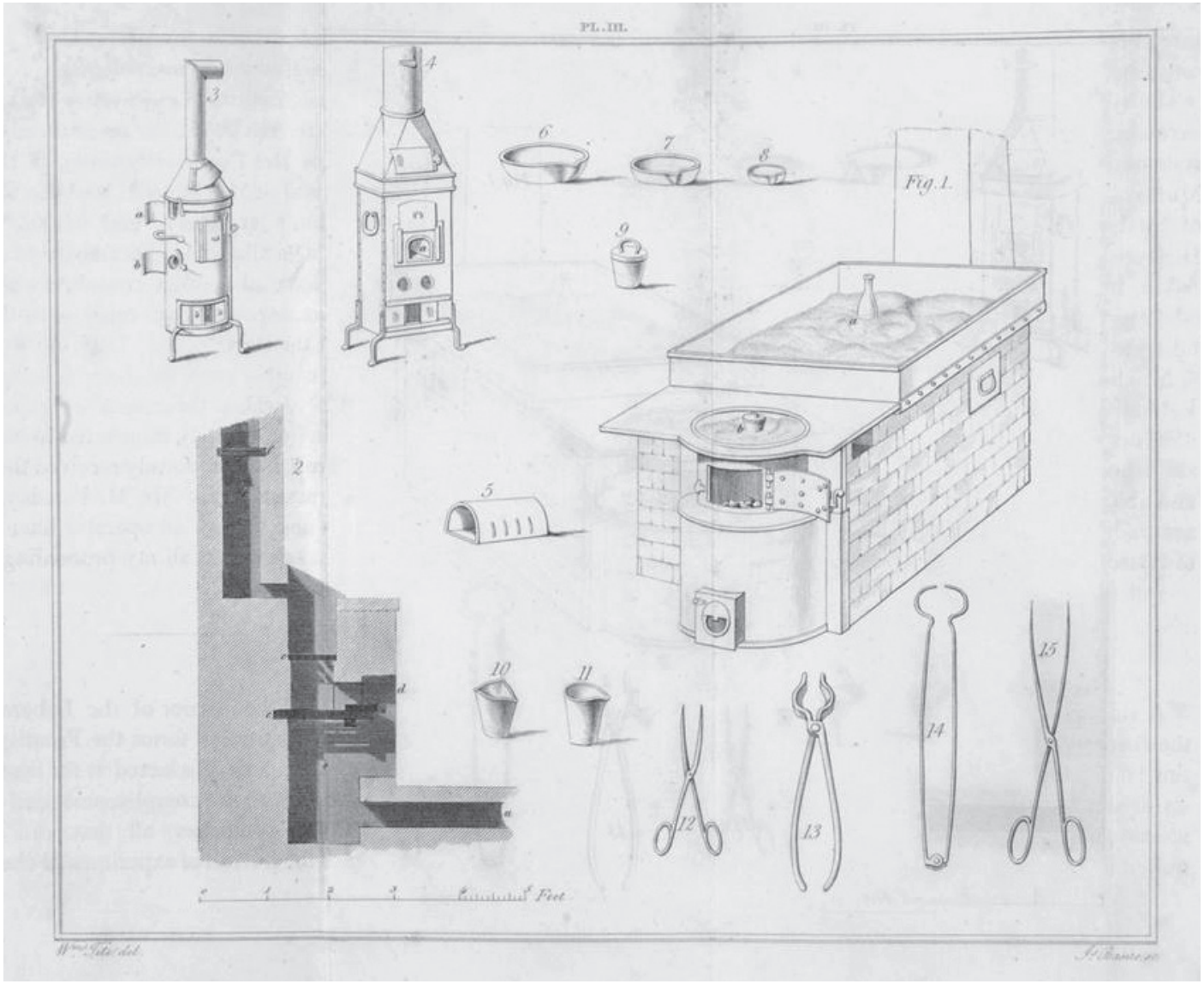


Figure 4. Plate III from Brande's Manual of Chemistry, *illustrating furnaces and equipment used in the laboratory. Note figure 2, the "Section of the wind-furnace," which is similar in configuration to the furnace conditions at the chemical hearth (see Figure 27 of this report). Brande's key for figure 2 identifies the wind-furnace components: "a is a flue communicating with the exterior of the building, for the admission of cold air to the fire-place; b the ash-hole; c c two grates, the upper of which may be removed when a deep fire-place is wanted; d an aperture which may be closed by a moveable fire-brick; e the chimney; f a register."*

Figure 5. The first edition of Brande's Manual of Chemistry *included a frontispiece with a perspective view of the laboratory at the Royal Institution of London.*

in 1808 (it was used by chemists Humphry Davy and later by Michael Faraday).[56] The illustrations and text could have supplied Jefferson with ideas and practical information for the laboratory and lecture room to be constructed at the Rotunda.

Like the British editions, the American edition of Brande featured a foldout floor plan of the laboratory and lecture room at the Royal Institution with a detailed explanation of its features (see Figure 3). The "audience" sat in an auditorium-like space (*A*) with rows of benches, elevated on risers with iron railings, to listen to the professor and observe his demonstrations. Immediately in front of the lecture and demonstration table (*f*) was a "stove with a sunk flue, for warming the Laboratory" (*e*). High above the table was a broad archway, part of the wall that separated the audience from the "body of the Laboratory"(*B*). Behind the demonstration table, in the "body of the Laboratory," was a row of three "Tables with drawers" (*p*); above these tables was an oval opening in the ceiling, perhaps a skylight or combination skylight and vent, which was operated with a pull cord. A recess (*m*), which was "lighted from above," contained "a bellows-blowpipe" and "gas purifiers"; it had three flues (*n*) "for the reception of the chimneys of portable furnaces." An adjacent second recess also appears to have had a skylight; it held a "forge furnace" (*o*), a rectilinear masonry structure that rested directly on the floor. Suspended beside the forge furnace was a large bellows. A "sand furnace" (*g*) was shown beside the professor's demonstration table in the floor plan, but the text explained that it had "lately been transferred to the place of the centre table" (*p*) behind the professor's table; it, too, had a "descending flue." This laboratory was unusual in that it had skylights even though it was constructed in a basement space.[57]

Also in the "body of the Laboratory" were a "furnace for the production of gas from coal, *&c.*" (*k*), a "cast-iron steam boiler for the abundant supply of hot water, and of steam when required" (*l*), and a "gasometer from which tubes issue for the supply of the Laboratory, and of the lecture room, with coal gas" (*q*) for illuminating the laboratory. In one corner was a large rectangular "sink with a plentiful supply of water" (*h*). There were three more furnaces arranged along one side of the auditorium: an "open chimney for the reception of moveable furnaces" (*b*), a "wind furnace" (*c*), and a "reverberatory [sic] and assay furnace" (*d*). Along other walls were a "table with cupboards below it" (*i*) and "Recesses for apparatus" (*s*); there was additional storage in a "small store-room and cellar for fuel, *&c.*" (*r*) and in an "apartment for apparatus, *&c.*" (*t*). Other plates in this book illustrated equipment used in the laboratory and provided more details about sand and wind furnaces, "Knight's portable furnace," evaporating basins, crucibles, and tongs (see Figure 4). The first edition

of Brande, which had been published in London in 1819, also had a frontispiece that was a perspective view of the laboratory (see Figure 5).

For information on the layout of laboratories and lecture halls at other American colleges, Jefferson may have turned to experts like Thomas Cooper, who had taught chemistry at Carlisle College beginning in 1811 and at the University of Pennsylvania starting in 1815. When Cooper was in early negotiations about joining the faculty at the University of Virginia, he told Jefferson that the University of Pennsylvania had "provided and furnished for me at my direction a Laboratory—a chemical lecture room—a room for my minerals & lectures on mineralogy—and a room for my library: all of them convenient and extensive."[58]

It is also possible that Jefferson consulted John Torrey, the chemistry professor at West Point. Jefferson may have learned from architect Benjamin Henry Latrobe about the chemical hearth and lecture room that Latrobe had designed for the medical school at the University of Pennsylvania in 1805; he may also have known about its subsequent enlargement by William Strickland in 1817. Jefferson may also have been familiar with the chemical hall in Davidge Hall, the original building of the medical school at the University of Maryland at Baltimore, constructed in 1812 (see Figure 6).

In October 1823 Jefferson contacted another professor of chemistry and natural history, John Griscom, who was then teaching at Queens College in New Jersey (later Rutgers University), about obtaining a copy of a book on codes of regulations "for the administration and discipline" adopted by European universities that might serve as a model for the University of Virginia (the tone of the letter suggests that this was Jefferson's first contact with Griscom).[59] Jefferson wrote Griscom again in March 1824 about securing the proper apparatus for instruction in chemistry. While Jefferson did not ask about the arrangement of lecture rooms or laboratories, Griscom's answer did touch briefly on the layout of a lecture room: "The operation of a Chemical Lecture Room," he volunteered, "may be greatly facilitated by a judicious arrangement of its permanent fixtures, such as air furnaces, flues, ventilations, drying oven, etc. but for these no specific directions can be given without a knowledge of the locality."[60]

Eight months later, in November 1824, Jefferson entertained his longtime friend the Marquis de Lafayette at the still unfinished Rotunda during his tour of the university. One wonders whether Lafayette and Jefferson may have included a visit to the basement rooms in their tour, discussed the latest developments in chemistry in France (especially since Lafayette's father-in-law was an eminent French chemist).

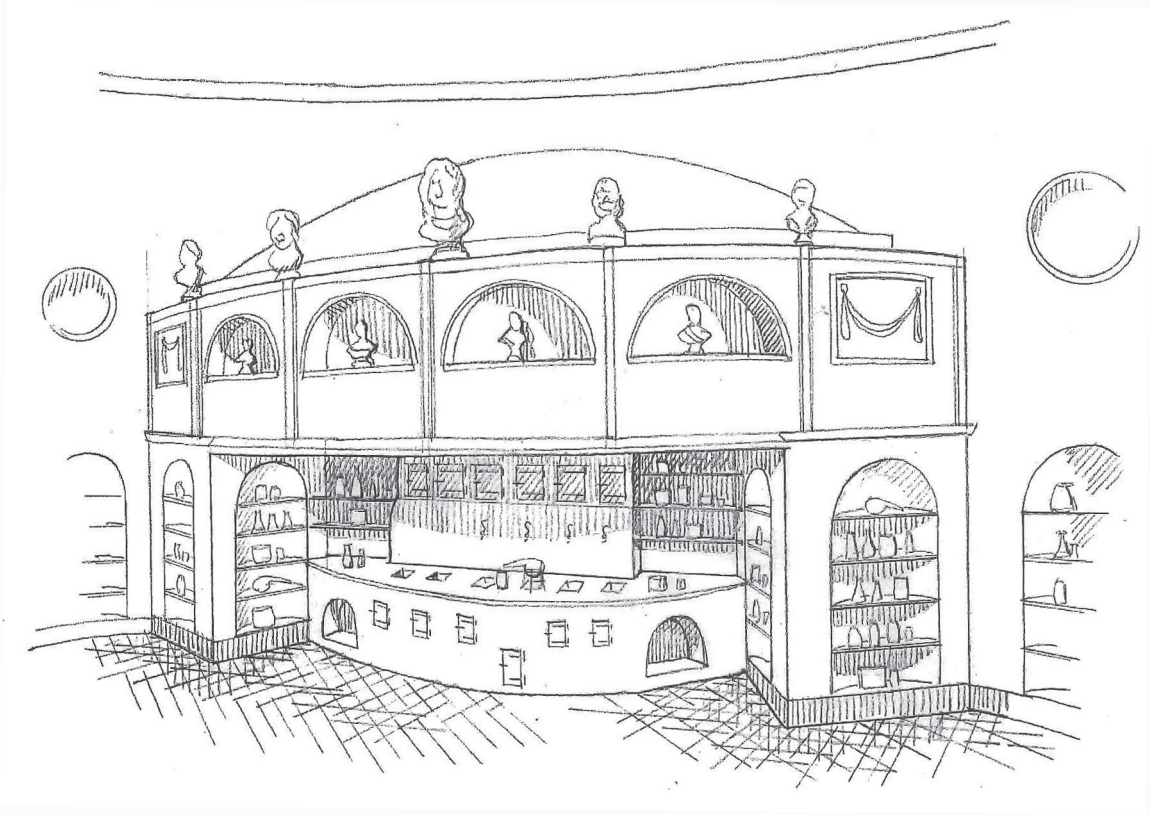


Figure 6. Conjectural sketch of the Davidge Hall chemical hearth. [JGWA, courtesy of The Medical Alumni Association of the University of Maryland, Inc.]

A chemical hearth of some type was in place by the time Professor John Emmet arrived to begin teaching in April 1825. Most likely, it had been built to Jefferson's directives, perhaps with some input from newly arrived Professor Robley Dunglinson, who had studied medicine in Europe, or from Visitor Joseph Cabell, who had observed existing chemistry teaching facilities in Europe.

Jefferson is known for seeking the ideal in many aspects of his work but finding a practical solution in the available resources. A solution for teaching chemistry that Jefferson may have settled on was a lecture room in the east oval room of the basement, having a fairly simple chemical hearth, with a stove-like brick structure at the center of the east wall, where the arc of the oval was the flattest; in an even more modest arrangement there could have been one or more freestanding iron chemical furnaces rather than a masonry hearth.[61] A

hood above the hearth or furnaces would have had flues tied into the chimney to provide ventilation. In front of the hearth would have been a table, where the professor would conduct his experiments. Rows of benches for students, on a "plane" floor, would have faced the bench. The small oval room, which received little light or air, may have served as Emmet's laboratory.[62]

Compared to the teaching facilities at his alma mater, the College of Physicians and Surgeons in New York, with its two 17-foot-long walls of fixed furnaces and forge, the facilities at the Rotunda must have appeared very modest to John Emmet. In a letter to Emmet written soon after his arrival at the university, Jefferson acknowledged the facilities were incomplete. Having been "uninformed of the conveniences requisite and of their arrangement," he wrote, "we could only prepare space in which they might be erected" and then rely upon the professor to "accommodate to it the conveniences necessary to it's [sic] purposes" and then complete construction.

JEFFERSON'S REQUESTS FOR ADVICE ON PURCHASING CHEMICAL APPARATUS, 1824

In 1824 Jefferson consulted two experts about obtaining the requisite apparatus for teaching chemistry in the Rotunda—Robert Hare and John Griscom.

From the early years of the university, there had been discussions about acquiring apparatus that would be required for the teaching of science. Thomas Cooper, when considering joining the faculty at the University of Virginia in 1818, had warned Jefferson about the high costs of chemical apparatus.[63] As early as 1819 Jefferson had been approached with offers of apparatus.[64] In 1822 Joseph Cabell had discussed with Jefferson the timing of such purchases in light of the funds needed to complete the construction of the Rotunda.[65] There was some expectation that any science professors coming from Europe would need "means of bringing out with them from Europe the necessary apparatus."[66]

In February 1824 Joseph Cabell, then serving in the Virginia legislature, asked Jefferson about how much in public funds should be sought "for the purchase of books & apparatus." Jefferson replied that it should be "certainly the largest you can obtain." Forty or fifty thousand dollars, he continued, "would enable us to purchase the most essential books of text and reference for the schools, and such an apparatus for Mathematics, astronomy, &

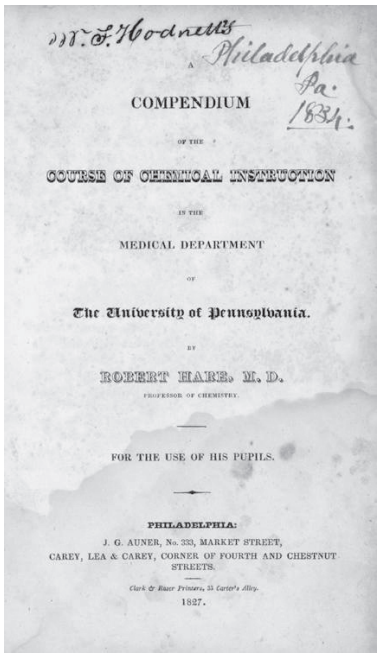
Chemistry as may enable us to set out with tolerable competence, if we can, thro' the banks or otherwise anticipate the whole sum at once."[67]

As construction of the interior of the Rotunda got underway in the early spring of 1824, Jefferson focused attention on equipping the chemistry facilities. On March 12, 1824, he wrote to Robert Hare, the well known professor of chemistry at the University of Pennsylvania, asking for help in identifying and ordering chemistry apparatus, so that the items could be obtained in time for the opening of the university:

> We have been some time preparing buildings for an [sic] University in this state, and we have now a prospect of being able to open it with the beginning of the next year. It's [sic] Chemical school will need an apparatus adapted to the course of experiments necessary in that school. It is necessary therefore for us to provide them in time, and it must probably be from Europe, but what they are I know not, and in my inland situation is no one from whom I can obtain satisfactory information. The family of science through the world is one, and yourself a well-known and liberal member of it. On that ground I presume to request you to sketch for us a list of articles, such as you think sufficient and necessary for our purpose; and that you will be so kind as to give me some idea of the probable amount of their cost in Europe, there [sic] it is necessary we should place the proper sum for their purchase. [68]

Jefferson also explained that he needed an answer by the end of March, "so as to lay it before the Visitors of the University," who were to meet in early April.[69] In this letter Jefferson did not ask for suggestions on constructing a lecture room or laboratory, nor would Hare offer any such advice in his reply.[70]

A week later, on March 31, 1824, Hare replied from Philadelphia to Jefferson's letter, enclosing a "list of the apparatus which I suppose adequate for a course of chemical instruction, in your new College." He also sent along "some pamphlets, which I have referred to in the catalog, or which contain engravings of apparatus, referred to, or which may be desirable." His citations to catalogs dealt primarily with catalogs published by the Paris firm of Pixii and to "Knight's catalog." He estimated that about $2,000 "would be a competent provision, for the requisite expenditure," although Hare's own "outfit" had cost him at least $5,000, but, he explained, "my class being very large it has been necessary to have every thing on a scale proportionately great." (Hare's impressive laboratory and lecture room were illustrated in his 1827 text book entitled *A Compendium of the Course of Chemical Instruction in the Medical Department of the University of Pennsylvania*) (see Figure 7). "In addition to the apparatus mentioned in my list," Hare continued, "about from $300, to $500, might be advantageously laid out



A

COMPENDIUM

OF THE

COURSE OF CHEMICAL INSTRUCTION

IN THE

MEDICAL DEPARTMENT

OF

The University of Pennsylvania.

BY

ROBERT HARE, M. D.

PROFESSOR OF CHEMISTRY.

FOR THE USE OF HIS PUPILS.

PHILADELPHIA:

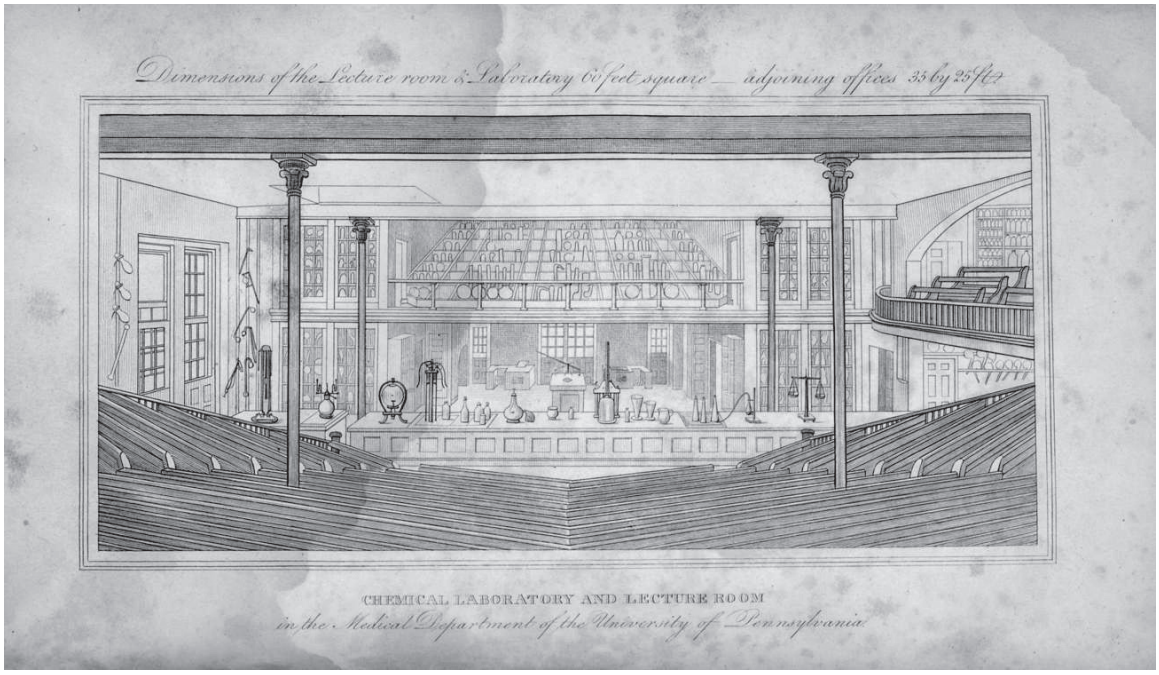
J. G. AUNER, No. 233, MARKET STREET,

CAREY, LEA & CAREY, CORNER OF FOURTH AND CHESTNUT STREETS.

Clark & Raser Printers, 35 Carter's Alley.

1827.

Figure 7. Robert Hare's laboratory and lecture room at the University of Pennsylvania, from his 1827 textbook.



in tools, implements, agents or materials, of which a complete[?] stock should be provided, in a place where deficiencies are not easily supplied." He recommended buying chemical agents in sufficient quantity to get "the wholesale price."[71]

Jefferson sent a second query to John Griscom, the Queens College professor, on March 12, 1824, the same day that he wrote to Hare.[72] Like Hare, Griscom replied promptly, on March 24, explaining that he had "gone over a file of Catalogues of Chemical & philosophical apparatus of London & Paris & have selected such articles as my own experience, together with an acquaintance with the chemical arrangements of most of our eastern Colleges, induces me to believe will be best adapted to the wants of your new Institution." "The furniture of a Laboratory," Griscom continued,

> is just as indefinite as the furniture of a dwelling. Refinements in Science like those in manners, convert luxuries into necessities; and the more acute the experimentalist, the greater his desire to multiply & to vary his instruments of research & illustration. It is very possible to make a parade of apparatus even without indulging in things that are absolutely supernumerary; or a little display is by no means without its use, more especially before a popular audience.[73]

Griscom enclosed a list of apparatus for Jefferson's consideration, annotated to show priorities and estimated prices.[74] In his letter Griscom provided Jefferson with some additional advice, stating that

> I took no inconsiderable pains in London & Paris to make myself acquainted with the merits of different workmen in Phils. apparatus; & the whole enquiry resulted in the conviction that we are more dependent on Europe than we need to be,—that many instruments constantly sought for abroad, can be just as well obtained at home. Hence, even I [under?] the necessity of refurnishing my own rooms, I should endeavour to bring into contribution the talents of our own workshops for the greater portion of the articles. We now have two glasshouses in the vicinity of the City at which Chemical ware of almost any kind can be obtained, i.e. made to order. We have also the workers in brass & other metals qualified to execute many things as well as they need to be done. There are however various kinds of apparatus that can be obtained better & cheaper in Europe, & some that are procurable no where [sic] but in London or Paris.[75]

At their April 5, 1824, meeting, the university's Board of Visitors agreed to arrange for the sum of $6,000 to be made available in Great Britain "for the purchase of such chemical, astronomical, physical and mathematical apparatus, and for such text books, as on consulta-

tion with the respective professors, each for his department, shall be deemed indispensable for a beginning."[76]

Jefferson apparently called on Francis Walker Gilmer to purchase such apparatus in Britain during the same trip when he was recruiting professors for the university. In his letter to Jefferson about recuiting John Emmet to teach chemistry, Gilmer wrote that since he had not been able to recruit a professor of chemistry in Great Britain, he had "confined myself to such things as I knew we must have."[77]

PROFESSOR JOHN EMMET'S PROPOSAL FOR A NEW CHEMISTRY BUILDING, 1825

John Emmet had had considerable firsthand experience with studying and working in chemical laboratories and lecture rooms, and he had arrived at the University of Virginia with clear ideas on how the subject should be taught.

Emmet had been trained at the College of Physicians and Surgeons in New York, studying under William J. MacNeven shortly after MacNeven's "materially improved" chemical laboratory had been constructed.[78] Emmet had had a chemical laboratory built in his father's home in New York so that he could continue his classwork on cold days when he could not go outside because of his frail health. He would also have had some type of laboratory facility in Charleston, South Carolina, where he gave public lectures before his appointment to the University of Virginia. These experiences undoubtedly influenced Emmet's proposals to Jefferson for better facilities for teaching chemistry: the first, to build a new chemical teaching complex, and the second, at least to be allotted more space within the Rotunda.

The facility that Emmet found at the Rotunda when he arrived at the university in 1825 clearly fell short of the quality of laboratories where he had previously studied or worked. Emmet had briefly mentioned the "oppressive" heat in his lecture room at the university in a letter to his sister. On May 12, 1825, just a month after taking up his post, Emmet had written Jefferson a letter frankly presenting the problems with the arrangement of the lecture room:

> Having now entered upon experimental chemistry for the instruction of my class, I feel the strongest conviction that I may with propriety address you upon the necessity of making further provisions for me. I do not think for the present year but for the next; and am even desirous of devoting the best part of my House [Pavilion I] for class purposes.

> I speak feelingly when I say that even a Small furnace, when in operation, makes my room [in the Rotunda] oppressively hot & myself even more so, for, from its necessary position I am compelled, almost, to sit upon it.[79]

"These considerations," Emmet continued, "have induced me to beg that you would consider my department ere the season be too far gone; and lest I might seem to be over burthering your time, I have ventured to suggest a plan for your inspection," which he illustrated and described in his letter. "In the arrangement," he continued, "I have had in view, what I consider of prime importance to the students of Chemistry, namely that they should operate for themselves. This they can always do in leisure hours under my own direction."[80] Recalling his own experience as a student in the new laboratory at the College of Physicians and Surgeons in New York, Emmet continued:

> Having been an inmate of a complete Laboratory for 3 years I cannot speak too sanguinely of the rapid improvements there to be acquired. And I have often met with intelligent young men who after 2 or 3 courses of Lectures but without this practice, were utterly ignorant of even the most trivial chem.l [sic] operations.[81]

Emmet then focused his argument for a new building on an area important to Jefferson—the practical application of knowledge:

> I need not say, how desirous I feel that my class should furnish practical chemistry, nor can I even hope to realize this feeling unless this valuable mode of instruction be allowed to me. It is the great character of chemistry to be useful to Society and I feel more anxious to place it upon this footing than to make it popular by showy Lectures & experiments.[82]

Emmet was also sensitive to the architectural design of the Rotunda and used that point to argue for a new, separate building devoted to chemistry: he wrote Jefferson that "You have determined that the room originally intended for me, should be fitted for a museum, and with great propriety, for a chemical Laboratory would ruin any room in the Rotunda."[83]

With these principles and goals in mind, Emmet enclosed in his letter to Jefferson a detailed drawing with both an annotated plan and perspective of his scheme, explaining that it had been "drawn up without any reference to a scale and merely presents the outline of a Lecture room & Laboratory"[84] (see Figure 8). Very importantly, however, the drawing represented the overall arrangement and particular features that Emmet felt were essential to teaching chemistry successfully—a lecture room and a separate teaching laboratory where students could conduct their own experiments.

CHEMICAL HEARTH

In his drawing a high-ceilinged lecture room was linked at ground level by a one-story hyphen to a two-story laboratory. Emmet felt strongly that the complex should be arranged with "two rooms," a lecture room and a laboratory, "for when compelled to operate in one, I will suffocate my class and ruin the apparatus."[85]

Emmet had planned the lecture room "so as to accommodate a full class," telling Jefferson that he had become "persuaded that if the measure be at all worthy of your consideration, it is the best economy to build it ample." The lecture room was oval in plan, with an entrance at the rear of the room flanked by four large arched windows, which were to be secured with "iron Bars." The floor of the lecture room was to be "more elevated than the Lecturing desk," or table, and have a "gradual descent." The benches, arranged in six rows, were separated into four sections. The broad aisles in between the benches were intended "to convey light to the Lecturing table." Additional light for the demonstrations would be provided by high oculus windows, a domed skylight directly over the lecture table, and tall windows in the walls of the hyphen. The windows in the laboratory were also "to be secured with iron Bars."[86]

The lecture table itself, generously sized and slightly curved in plan, was positioned opposite the entrance to the lecture room. The curved walls of the lecture room were fitted with "cases for chem: apparatus and for minerals &c." Behind the lecture table was a "furnace for the Lecturer"; immediately behind that was a "water bath heated by the smoke" of the furnace. Behind the water bath, in the laboratory itself, was the "common chimney stack with wind furnaces built round *v v v* &c." The "charcoal grates for students" were "to be covered over by a Shed, and the wall above them to be perforated with holes for ventilation – under *v v v* &c to be depositories for charcoal.[87] Around the perimeter of the laboratory were "operating tables for students," and in the center were two "large tables for Chem: tests, preparations &c." There was also provision for cisterns for water and distilling apparatus.[88]

In the bottom right corner of the drawing Emmet explained the principle behind his scheme:

> In this plan the principal object has been that Students should practice all the operations of chemistry relating (among others) to the analysis of minerals, the reduction of ores and the Preparations employed in Medicine. They are to pay $ annually for the use of the Laboratory under certain restrictions, and it is conceived that such contributions will Keep the Laboratory furnished. This seems the only method of making such Knowledge useful to Society.[89]

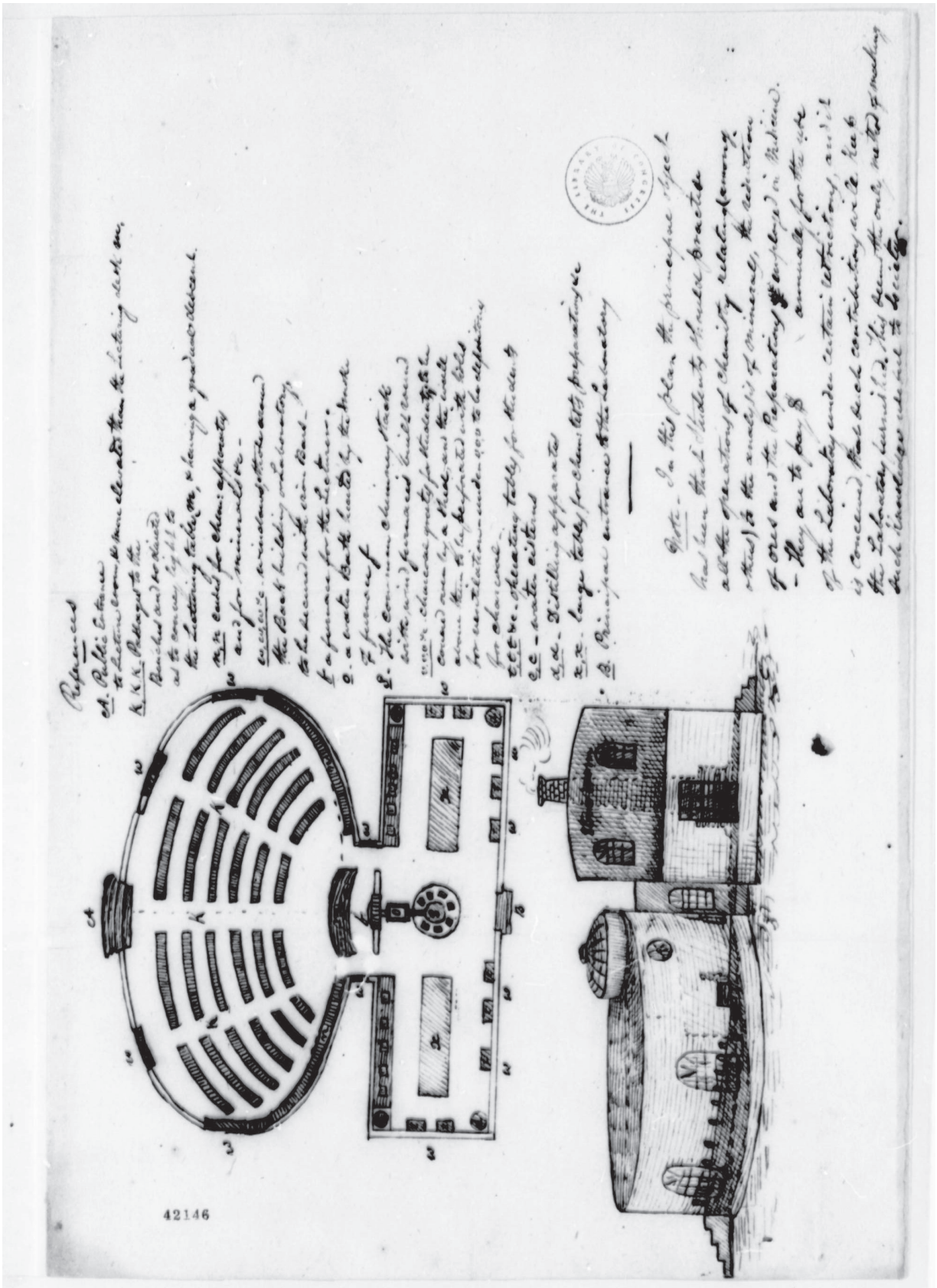


Figure 8. John Emmet's annotated proposal for a chemistry laboratory, in a 1825 letter to Thomas Jefferson. [John Emmet to Thomas Jefferson, May 12, 1825, TJP]

Emmet included a storeroom over the laboratory, thinking it would "be always useful in holding supplies." He ended his letter to Jefferson with some hesitation, fearing that "My anxiety may have carried my suggestions too far."[90]

Jefferson studied Emmet's proposal carefully and drafted a response four days later, on May 16. "I have duly re[ceive]d and considered your letter proposing to erect a distinct building for the Chemical Laboratory & lecturing room," Jefferson wrote, "and with it the plan you have been so kind as to suggest." "This appears," he continued, "to contain all the articles called for in such a building and arranged with great convenience."[91]

However, permission to construct such a facility, Jefferson wrote, "is beyond the powers delegated to me, and there will be no meeting until Oct. of the Visitors who alone could give authority"; in any case, even if the Visitors approved the proposal, there was no funding available for construction "nor any prospect" for securing funding "within any definite time." All that could be done at this point, Jefferson continued, was "to make the most of what has been provided." He also explained to Emmet how he and others at the university had planned the spaces to be used for teaching chemistry: "uninformed of the conveniences requisite and of their arrangem[en]t, we could only prepare space in which they might be erected, and trusting that in whatever form this was provided, the Professor could accom[m]odate, to it the conveniences necessary to it's [sic] purposes." They had "reserved the means only for compleating [sic] our work in whatever way he should deem best."[92] "This," Jefferson told Emmet, "I am in hopes you will still accomplish."[93]

Jefferson could not, however, resist putting his own hand to drawing up a scheme incorporating the features that Emmet desired into the spaces that had been allotted to chemistry. Jefferson enclosed a drawing with his letter, telling Emmet that in it he had tried to see "how far it might be practible [sic] to bring what might be necessary within the compas[s] provided." Jefferson told Emmet that he had "taken the particulars specified in your plan, and have effected an arrangem[en]t now inclosed [sic] which seems to comprehend them all[,] with some convenience." Jefferson, however, assured Emmet that he was not wedded to the scheme he had drawn:

> I do not propose this for actual adoption because I am sure you will devise a much better plan; my only object was to try it's [sic] practicability. I must therefore request you to study out the best arrangement which the rooms provided will admit, and whatever constructions in them you shall think best of, shall be immediately executed.

Jefferson also told Emmet that he "would greatly prefer that whatever we do should be done where it will be permanent," rather than relying on temporarily converting any space in his pavilion "other than the lecturing room." Finally, in a statement that reflected his overall philosophy about knowing when to compromise, Jefferson wrote that "with entire confidence therefore in your kind accom[m]od[atio]n to the circumstances which controul [sic] us, and that not being able to do what is absolutely best, you will concur in doing the best we can."[94] Jefferson's drawing of his proposed scheme for the chemistry facilities has not been located.

Emmet 's plan had illustrated his belief that it was essential for students to be able to perform experiments themselves, not just watch the professor's demonstrations, and Jefferson apparently did not disagree with this approach. This method of teaching was forward thinking for its time, both in America and in Europe. One account of early chemical education in the United States between 1820 and 1870 stated that students at this time saw very little "actual laboratory instruction"; students "witnessed the experiments performed in the lecture room, but were not permitted themselves to handle apparatus." The illustrious Benjamin Silliman, who taught chemistry at Yale University, stated that "Many times I have said to those who as novices have offered aid to me that they might come and see what we were doing, and I should much prefer that they should do nothing; for then they would not hinder me and my trained assistants, nor derange nor break the apparatus."[95]

While this preference for lecturing over laboratory instruction was the case at other American colleges, there were, however, some notable exceptions, particularly in William MacNeven at the College of Physicians and Surgeons in New York and Amos Eaton at what would become Rensselaer Polytechnic Institute, in Troy, New York. Chemist Justus Liebig is often credited with being the founder of chemical laboratory instruction in Europe when he offered a course for students at the University of Giessen in Germany in November 1824. However, Friedrich S. Stromeyer had been offering laboratory courses at the University of Gottingen beginning in 1805, at about the same time that Thomas Thomson began offering laboratory instruction at the University of Edinburgh; even earlier teaching laboratories were established in St. Petersburg, Russia, and Uppsala, Sweden. Liebig's laboratory is credited, nevertheless, as being "the most influential center from which the new method of teaching chemistry spread."[96] Liebig's teaching laboratory was established only a few months earlier than the student laboratory constructed at the University of Virginia, in 1825.

CHEMICAL HEARTH

IMPROVED FACILITIES AND A SUPPLEMENTAL HEARTH FOR TEACHING CHEMISTRY IN THE ROTUNDA, 1825-1828

In his May 16, 1825, response to Emmet's plan, Jefferson had enclosed a drawing showing how Emmet's teaching requirements could be accommodated in the basement of the Rotunda. Apparently, Jefferson was thinking that the small oval room would continue to serve as the laboratory. Emmet, however, remained unhappy with this arrangement. He complained to the proctor, Arthur S. Brockenbrough, who, in turn, wrote to Jefferson on June 6, 1825, that Emmet was still "much dissatisfied with the proposed arrangement for his laboratory. He thinks the small room in the basement of the Rotunda will not answer the purpose for the want of room & light – he wishes to have the use of both of the large oval rooms in the basement[,] one for his lecture room the other for a laboratory." If this be granted him," Brockenbrough asked Jefferson, "where then shall the room for a Museum be fit[t]ed up?"[97]

In his reply to Brochenbrough, written the next day, on June 7, Jefferson at last granted Emmet's wish for more space. "Dr. Emmet can have both the large basement rooms & to be arranged as he pleases for his chemical purposes," Jefferson wrote; "In that case we will use one of the upper oval rooms for a Museum."[98] Thus, while Emmet did not receive Jefferson's approval for constructing a large separate building for a chemistry complex, he finally did win Jefferson's permission to occupy both the east and west oval rooms in the basement, and he must have welcomed Jefferson's confidence that he could lay out the facilities properly. Earlier that spring, shortly before his birthday on April 13, Jefferson had written chemist Thomas Cooper that "now within a few days of fourscore and two, with a weakened body and waning mind, working is become slow and unpleasant."[99] Perhaps if Jefferson's health had been better, he would have taken a more active role in working with Emmet to effect the changes to the chemistry facilities.

With Jefferson's approval secured, Emmet must have then focused his energies on turning the two large oval rooms into a facility where he could teach chemistry as he believed it should be taught (see Figure 17). From his correspondence with Jefferson, it is clear that Emmet believed that students needed to have the opportunity to conduct experiments themselves and not just observe an instructor performing demonstrations. It was of "prime importance," Emmet had told Jefferson that the students "should operate for themselves"; it had been Emmet's observation that students who had attended only lectures, though intelligent, nevertheless "were utterly ignorant of even the most trivial chem.l operations."[100]

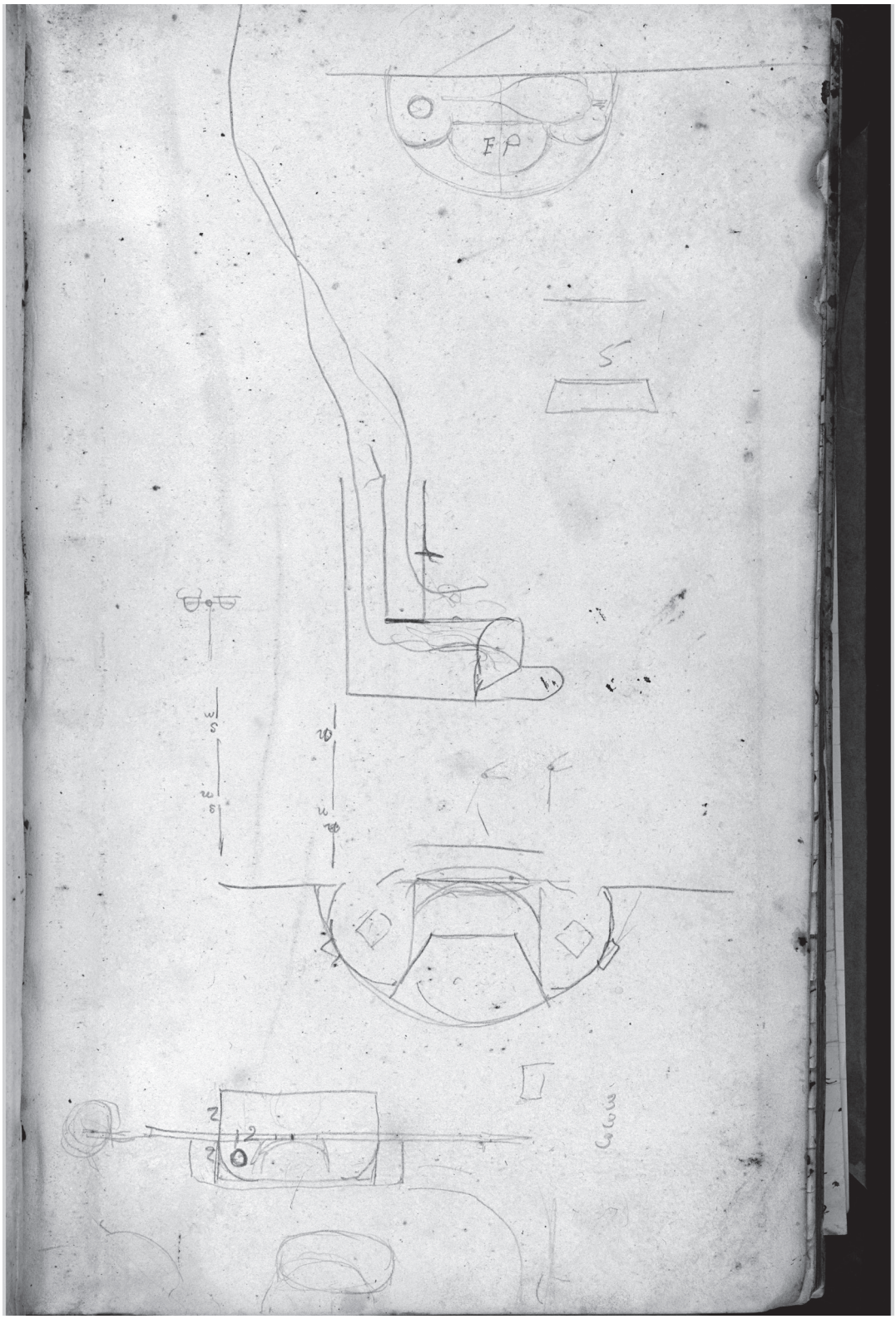


Figure 9. Emmet's pencil sketches for a new chemical hearth. [Notebooks of John Patten Emmet, Ledger 3, Mss. 12713-a, UVSC.]

CHEMICAL HEARTH

Emmet evidently set to work immediately to reconfigure the chemistry facilities. He decided to move the lecture room from the east oval room to the west oval room and then to set up a laboratory for students in the east oval room. He apparently believed that it was necessary to increase the available sources of heat for experiments in the laboratory and may have decided that the best way to do that was by constructing a second, supplemental chemical hearth at the north end of the room.

The construction contractors had left a half-moon-shaped void behind the north and south ends of both large oval rooms. Emmet chose the void behind the north end of the east room in which to insert a small chemical hearth, apparently with the intention of supplementing the chemical hearth or the portable furnaces at the center of the east wall of the same room. Once the wall in front of that void was removed, the void would form a small alcove to accommodate a compact, supplemental chemical hearth to provide the different types of heat needed for experiments. Flues were then extended up through the same void to the roof of the Rotunda; at ground level, fresh-air intakes were also created. The new hearth in the alcove would prove to be a very cramped space and would project very little into the room; it would not have been large enough to serve as the main hearth in a student laboratory. Emmet may also have used this supplemental hearth for his own experiments and at the same time be on the spot to supervise students during their laboratory work.[101]

Drawings in a notebook that Emmet kept during the mid-1820s suggest that he had been thinking about the design of a new chemical hearth; they are pencil studies for a hearth-like arrangement in an apsidal-shaped void like the one at the north end of the east room (see Figure 9). Another of his sketches appears to relate to a firebox and vent that would be part of the hearth.[102]

Furthermore, among the surviving financial records of the university is an invoice from Benjamin Blackford of Isabella Furnace in Virginia dated August 1825 that included charges for "5. plates different sizes," "6. Boxes with grates," and "18 Bars."[103] This invoice was dated two months after Jefferson had given Emmet permission to arrange the basement rooms as he saw fit and assured him that "whatever constructions in them you shall think best of, shall be immediately executed." The boxes with grates and the bars may well have been part of the equipment needed for the supplemental chemical hearth: five cast-iron bars used as furnace grates remain within the chemical hearth, and a drawing of this bar in Emmet's hand was recently found among the Proctor's Papers (see Figure 10). In November 1825 Blackford was paid $128.29 "for castings for rotunda and laboratory," suggesting

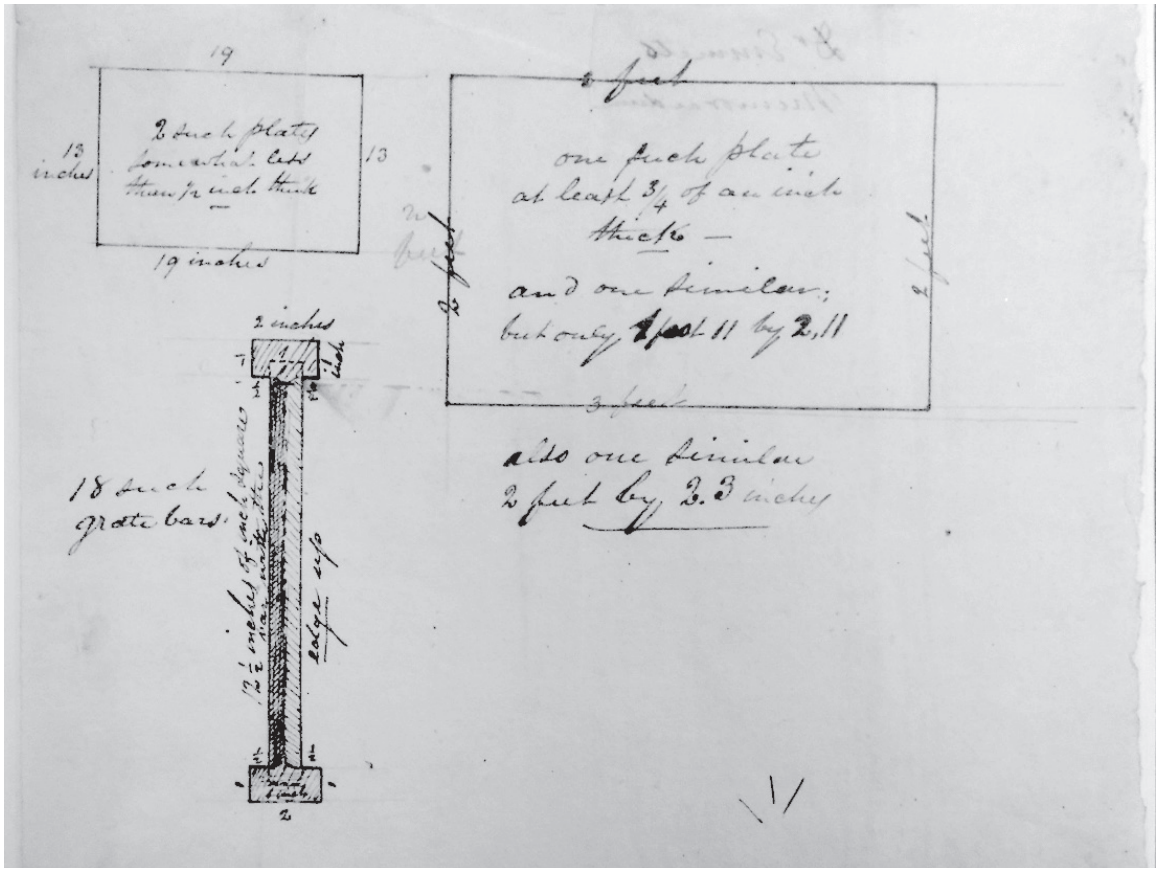


Figure 10. Drawing by John Emmet for a cast-iron bar used in the furnace grate of the supplemental chemical hearth. [PP]

Figure 11. A surviving cast-iron bar from the hearth. [JGWA]

that iron components for the hearth were complete by that time.[104] Emmet may have also made changes to another chemical hearth that would have been connected to the flues on the east side of the oval room.

In installing a new hearth and improving an existing one, Emmet certainly would have been influenced by his experiences at William MacNeven's lecture room and laboratory in New York and may have discussed with Jefferson the plates and written description of it in the issue of *The American Medical and Philosophical Register* that Jefferson already owned. Emmet would, however, have had to take into account a very major difference with the New York facility: the MacNeven furnaces extended for some distance along two sides of a rectilinear laboratory, whereas at the Rotunda any chemical hearth(s) had to be fitted to rounded walls.

Nevertheless, the surviving fabric of Emmet's new chemical hearth in the alcove bears similarities to the range of furnaces in the MacNeven laboratory. The cold-air intakes that run through channels under the floor of the Rotunda, as well as the exhaust passages, are similar to those used in the MacNeven laboratory, and a tin-plate pipe associated with the chemical hearth at the Rotunda may have been part of a forced-air bellows system similar to that used by MacNeven.[105] In addition, the stepped-arch masonry hood above Emmet's chemical hearth collected and carried away fumes much like the angled screen in MacNeven's laboratory.[106]

The annual report for the university that Jefferson submitted to the Literary Fund on October 7, 1825, stated that the Rotunda was still not complete. However, "indispensable" work was proceeding on the dome room, so that the library could be put into operation. The "other apartments of indispensable use" were listed in this annual report as "two for a chemical Laboratory, one for a museum of Natural History, and one for examinations, for accessory schools and other associated purposes."[107]

The minutes of the October 2, 1826, meeting of the Board of Visitors, the first to be held after Jefferson's death in July, stated that by that time the books had been placed in the library on the top floor of the Rotunda; and "two rooms for the Professors of Natural Philosophy and Chemistry, and one large lecture room, have been fitted for use."[108] Lectures for natural history (which included chemistry) were held Mondays, Wednesdays, and Fridays and those for natural philosophy on the intervening days—Tuesdays, Thursdays, and Saturdays.[109]

The faculty had requested in December 1825 that "fuel be provided by the University for the fires in the Rotunda"; this request about fuel was reiterated at a meeting of the faculty

in March 1826, who urged that the matter be brought before the Board of Visitors.[110] In the fall of 1826 Emmet, as chairman of the faculty, wrote to the proctor asking him to let Emmet "know the Instructions of the Visitors respecting Fuel for our Lecture-rooms."[111] Heat apparently continued to be a problem in the Rotunda, for the faculty passed a motion in September 1827 directing the chairman of the faculty to appeal to the Board of Visitors "for stoves in the lecture room and the anatomical Theatre the fire places being found by experience to be insufficient to warm the rooms in the Rotunda."[112] These problems were apparently not resolved, for in January 1828 the faculty asked the proctor to "suggest to the Executive Committee" of the Board of Visitors "to have the lecture rooms furnished with stoves—the fire places having been found insufficient for warming and drying the apartments—hence they are exceedingly disagreeable and unwholesome, especially in the morning."[113]

Meanwhile, Emmet was having difficulties with repairs to his pavilion, as well as his laboratory and lecture room. Writing from New York in January 1826 during the university-wide vacation, he begged the proctor "to set my House in some order" during the weeks while he was away; the "garret stair-case" in his pavilion needed to be "finished & the Kitchen & cellar room plaistered [sic]." He was also concerned about his laboratory in the Rotunda:

> I feel very anxious also that the Laboratory should be looked to. The tin-man promised most seriously to have the stove-pipe made & put up as well as the dampers, grate doors &c. In [nailing?] the stove pipe, let him secure the hanging shelf with thick iron. He may then fasten the pipe to the shelf.[114]

Apparently troubles with this stovepipe continued, for, according to one account, "on one occasion, Emmet had on his counter a row of various metallic solutions illustrating the different degrees of affinity by successive precipitations, when a stove pipe, which passed over his head, fell on him." Emmet, who was known for his ready wit, quipped, "You see plainly, gentlemen, that iron can be precipitated."[115]

In the spring of 1826 Emmet wrote the proctor about doors inside the Rotunda:

> I have also to state that the Students have forced their way into the Museum in consequence of the imperfection of the door & a suitable door has been made for months and I wish it were put up as everything in the room is now at the mercy of the Students. I wish also that the doors for my lower rooms were put up as I want more light in the passage and more security to the property. When my class have commenced their operations it will be greatly inconvenient to be interrupted.[116]

Other evidence that the Rotunda was still not complete in 1826 appears in a proposal from August 1826 submitted by plasterer Joseph Antrim; he wrote that he was "willing to put stucco cornice and do the plastering that remains undone inside the rotunda."[117] The proctor predicted that the "plastering of the Rotunda will be finished during the vacation," and Antrim was paid $75 for plastering in the Rotunda in September 1827.[118] In the 1826 annual report for the university, the first prepared after Jefferson's death on July 4 of that year, Rector James Madison wrote that the "library room in the Rotunda has been nearly completed," the books put in place, and "two rooms for the Professors of Natural Philosophy and of Chemistry, and one large Lecture room, have also been fitted for use." Still to be completed in the Rotunda were "finishing one other large oval room, one small one, and the entrance hall."[119]

In July 1827 the Visitors agreed to the hiring of a "suitable person to work the Lithographic press" and "to attend the professors of Natural Philosophy & Chemistry, in their lecture rooms & in the laboratory" at an annual salary of $120.[120] The description of this position was changed a year later to include "keeping in order & repairing the chemical and philosophical apparatus," at a salary of $200.[121]

In February 1827 a payment of $38.09 was made to Robert M'Cullock "for lumber for lecture rooms."[122] Another possible improvement may be associated with a payment of $2.50 in April 1827 to John Smith "for a cistern for laboratory."[123] John Vowels was paid in July 1827 for painting the chemical laboratory.[124] At its next meeting, held in February 1828 the faculty asked that the "Proctor be directed to have Locks put upon the Lecture rooms of the Rotunda."[125]

Evidently still not satisfied with his spaces in the basement of the Rotunda, Emmet brought up the issue of a new chemical laboratory in a letter to the Board of Visitors, which was read at their meeting in July 1827, a year after Jefferson's death.[126] In response, the Visitors asked Emmet "to prepare and to lay before the Visitors at their next meeting, the plan of a chemical laboratory and of a Lecture room connected therewith, large enough for the accommodation of a class of 200 Students." The Visitors also asked the proctor "to present an accompanying estimate of the expense of erecting the same, of durable materials, and in a plain & neat style of architecture."[127]

A second, possibly unfinished, drawing by Emmet may be the plan he was asked to provide to the Visitors in the summer of 1827 (see Figure 12). Labeled "Ground Plan of a Chemical Lecture room & Laboratory," the building was to be constructed west of the Rotunda, across

the street from Hotel A and near the anatomical theater. Emmet's drawing shows a building rectangular in plan, measuring 40 feet wide and about 60 feet long. The lecture hall, 40 feet square, was designed to hold approximately 210 students. It had about a dozen rows of seats divided by two aisles that radiated from the lecturer's table; each seat was to be 24 inches wide and 30 inches deep. Presumably the furnaces needed for demonstrations were to be placed directly behind the lecturer's table. The laboratory area, 20 by 40 feet in plan, took up a third of the building, but the drawing did not show any details of the arrangement of furnaces, baths, or storage areas. The construction cost was estimated at $3,000.[128]

Despite Emmet's proposal, the Visitors did not agree to have a separate building erected for the teaching of chemistry. However, beginning in 1829 they did agree to some improvements to the chemistry facilities in the Rotunda.[129]

CHANGES TO THE CHEMICAL LABORATORY, 1829-1835

Emmet had placed the chemical laboratory in the east oval room in the basement of the Rotunda. In July 1829 the Board of Visitors passed a resolution directing that the "fire place in the Chemical Laboratory" was "to be altered, so as to improve the draught, in the mode thought most expedient by the Professor of Chemistry."[130] The fireplace may have referred to the chemical hearth in the alcove at the north end of the room or the chimney mass on the east side of the room.[131]

At the same time the Visitors agreed to other improvements for the school. The "collection of subjects in Materia Medica" was to be augmented.[132] The executive committee was "authorised [sic] to procure the occasional attendance of a servant, for such portion of time as they may deem necessary, not exceeding four hours per day, for three days in every week during the year, to clean and oil the metallic objects in the Chemical apparatus, and to aid the Professor of Chemistry in preparing his apparatus for his lectures, and to clean up the apartments after use."[133]

The improvements continued into 1830. In the chemical laboratory the "wood cistern" was to be "replaced by ones [sic] of brick and water proof lime." The "requisite painting and white washing [sic] at the forge and fire place in the same Laboratory" was "to be done without delay."[134]

Included in the Proctor's Papers is a letter from Emmet, most likely to the proctor, outlining repairs that needed to be made in the laboratory and lecture room. The letter is undated,

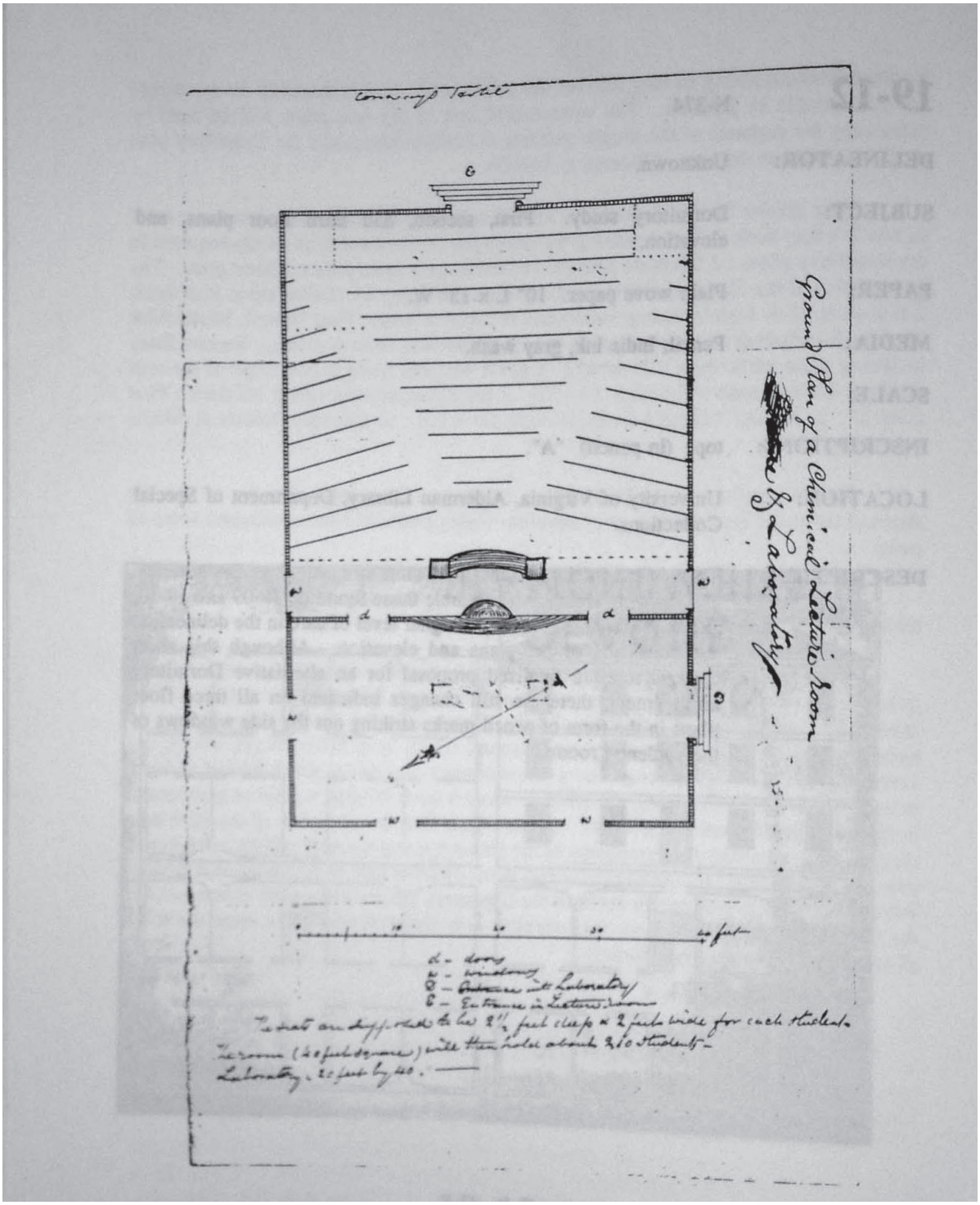


Figure 12. John Emmet's 1827 drawing of the "Ground Plan of a Chemical Lecture room & Laboratory." [Mss. 8553, UVSC. Image taken from Joseph Michael Lasala, Thomas Jefferson's Designs for the University of Virginia, master's thesis, Jan. 1992, School of Architecture, Univ. of Virginia, drawing 19-13.]

but its contents suggest that it was written around 1829-1830 and mentions the cistern: "It is now some weeks since I received the leaden pipe for the cistern in the Laboratory and a much longer time since the man took measure for the cistern itself."[135]

In April 1831 a worker was to be paid $3.00 "for plastering a cistern, &c for Dr. Emmet"; it is not clear whether this work was done in the Rotunda or in Emmet's pavilion.[136] In June 1831 Chiles Brand was paid $1.50 for "Work at Chemical Laboratory."[137] In the summer of 1838, C. M. Brand was paid $1.00 for "repairs to hearth and fire-place"; the location was not given.[138] In 1832 the proctor was directed to cause to have the "cistern in the Chemical laboratory to be compleated."[139] Apparently work on the cistern was still not done a year later, for in July 1833 the Visitors passed a resolution requiring the proctor "to finish the cistern contiguous to the chemical laboratory."[140]

Meanwhile, Emmet had "discovered that a vein of small pieces of white earth or stone ran through the lands of the University, a few feet below the surface, that on examination proved to be the *kaolin* earth, of which the best porcelain is made." Over the years he had conducted "numberless experiments and schemes of rendering it useful" and "converted it into fire-bricks" and "a cement impervious to water"; it was also used "for covering roofs of buildings." In 1845, three years after Emmet's death, it was reported that the "cistern, lined with this same material . . . still remains in the laboratory as a monument of his industry" and "his fertility of invention."[141]

At their July 1833 meeting, the Visitors had directed the proctor "to furnish the Apartment with a stove of proper size to heat it, and with supplies of charcoal requisite for the use of the furnaces, & for the preparation of Chemical Experiments."[142] During the academic year of 1833-1834 a charge of $84.45 was posted for "Stoves and pipes for lecture rooms and laboratory."[143]

CHANGES TO THE CHEMISTRY LECTURE ROOM, 1829-1834

Emmet had relocated the chemistry lecture room to the large west oval room in the basement in 1825. In July 1829 the Visitors agreed that the "pillars in the chemical lecture room" were "to be cased." The "benches in that department" were "to be fixed to a rising platform as in the lecture room of the Professor of Natural Philosophy" on the first floor. [144]

CHEMICAL HEARTH

Emmet's c. 1829-1830 letter mentioned above, most likely to the proctor, outlining repairs that needed to be made in the laboratory, also dealt with what Emmet called "these little and very troublesome jobs" in the lecture room; Emmet wrote that I

> have to request that you will tell the carpenter to call upon me at once. The temporary door for my lecture room is now no longer sufficient as it may be pushed open at pleasure. I am desiring that a proper door should be put up and that the pillars be cased so that there may be one job made of the painting. While the room remains unfinished[,] I am compelled to huddelle [sic] my apparatus together in a very inconvenient manner. The white paint which Mr. Vowels has now on hand, mixed, would I suppose paint the whole room with aspect.[145]

In 1829 and 1830 the university made payments for cabinets, or "presses," for storage of the chemical apparatus, but it is not clear where the cabinets were located, whether in the laboratory or lecture room. In November 1829, for instance, John Vowles was paid $3.00 for "8 Lights & Glazing Case for Dr. Emmet" and $9.60 for "48 lights & Glaz 10 x 12 @ 20c for Laboratory."[146] In July 1830 contractor George W. Spooner was to be paid "$122.74 for presses made for the accommodation of the Chemical apparatus, and for casing with sashes & wire frames two of the windows in the chemical lecture room."[147] In addition, the "fire place in the chemical lecture room" was "to be altered so as to prevent smoking, by the application of a smoke dispenser at the top of the chimney."[148]

The following summer, in July 1831, the Visitors authorized the executive committee, in consultation with Professor Emmet, to "cause a range of cases with glass doors; two panes of glass deep, to be placed on each side of the Door of Entrance to the chemical lecture room, so as to extend from the door to the curved cases at each end of the apartment, and at such elevation on the wall as to exhibit advantageously to the classes the specimens in the collections appertaining to that department." The executive committee was also given the "authority to change the position of the Wood pillars in the chemical lecture room, or to substitute them by pillars of iron."[149]

In 1832 the proctor, "under the direction of the Professor of Chemistry," was "to cause the Chemical lecture room to be white washed" and the "benches in the room to be painted."[150] The same work was carried out the next year; William Kennedy submitted a bill in August 1833 for whitewashing the "Chemical Lecture Room."[151] A year later, in July 1834, the proctor was directed to have "such additions to the Benches" in the chemical lecture room made "as may be necessary for the accommodation" of the class.[152]

HISTORY

PROCURING CHEMICAL APPARATUS AND CHEMICAL PREPARATIONS, 1825-1839

By the fall of 1825 the university had paid $500 for "a chemical apparatus" and had received "some donations of mineral collections," which would be used in the chemistry classes.[153] In one of his notebooks, now in the collection of the University of Virginia, Emmet carefully drew sketches of that apparatus and entitled the drawing "View of apparatus purchased by me at New York from Dr. Greenhow for $275" (see Figure 13).[154] Robert Greenhow had been a classmate of Emmet's at medical school in New York in 1821, and his father was a friend of Jefferson's.[155]

Preserved in the Proctor's Papers at the university is an invoice for $504.00 from Emmet to the university in which he specifically listed a $275.00 charge for the apparatus that he had purchased from Greenhow. A notation on the back of the invoice reads "Dr Emmet'[s] Bill, Apparatus &c, $500," apparently overlooking or rounding off the remaining $4.00 The invoice is not dated, but it seems highly likely that this was the invoice that the Board authorized for payment on October 3, 1825, for the "purchase, and payment of 500.D. for Doctor Emmet's Chemical apparatus and collection of minerals."[156] It would also seem very likely that the items shown in the drawing were in use in Emmet's laboratory and lecture room. In addition, Emmet itemized in the invoice a "Basin Crucible &[c.] from france" ($144.00) and charges for "Repairing electrical machine, glass ware &c, retorts, &c" ($30.00) and Chemical "preparations &c" ($300).[157]

Emmet also supplied other chemical apparatus and minerals. He was paid $300 on April 26, 1825, "in part of chemical apparatus" and another $400 in June 1825 "on account of chemical apparatus and salary."[158] He signed a receipt on May 14, 1825, stating that he had received from the proctor $100 "in part payment for my chemical apparatus."[159] In December 1825 Emmet was paid $138.61 "for chemical preparations."[160] He also collected a small payment of $1.34 for freight in March 1826.[161]

Emmet had left the university during the 1825-1826 winter vacation to be with his family; it had taken him seven days to reach New York, and he had "had a pretty severe jaunt of it." "The stage was filled with students," he complained, and he had been "compelled to ride with the driver all the way to Fredricksburg." Writing from New York in early January 1826, he told Brockenbrough that he had received the funds sent to him and had "paid the Bills of Sadler & Ray Druggists," for chemicals or apparatus, and "upon looking at their account" had found that $30 "more was due to them." "This," Emmet explained," was for

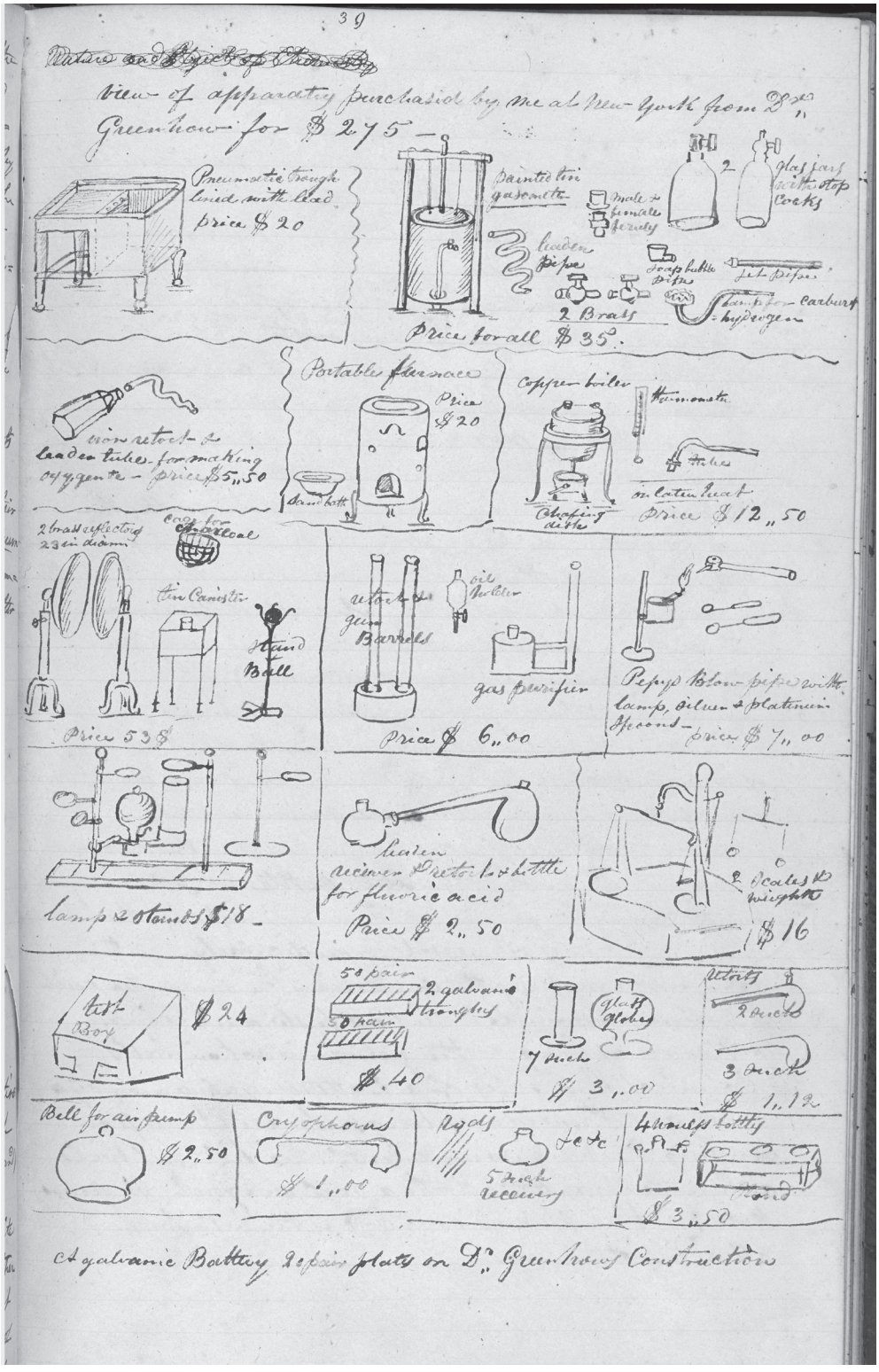


Figure 13. Emmet's sketches of the apparatus purchased from Dr. Greenhow in 1825. [Notebooks of John Patten Emmet, Ledger 3, Mss. 12713-a, UVSC]

chemical preparations which came with my apparatus but which I forgot to charge to the University." Emmet requested that the proctor credit that amount to his account, since the "charge with the Druggists, tho' against me, is a part of the outfit of my Laboratory."[162] Jefferson, in a list of instructions to the proctor, had explained the reimbursement arrangement with Emmet: "Dr. Emmet will provide the chemical substances necessary to be used in a chemical course, their amount to be paid for by the University."[163]

In the summer of 1829 the Visitors agreed to reimburse Emmet for apparatus that he had purchased on the university's behalf for the "Laboratory & Lecture Room" three years earlier: $48.25 for apparatus that he had purchased from Mettayer and a "Safety Lamp" and a "Box of crystal models" that he had purchased from Poole; he was also paid $159.88, plus 7 percent interest, for "the amount of a bill of articles shipped by Sadler Ray & Co. for the use of the University."[164] Emmet's father, based in New York, apparently helped his son settle bills for chemical apparatus for the university from Sadler Ray & Co. in 1829.[165] Some equipment was also purchased from Professor William MacNeven.[166]

The annual report for the university that was submitted on December 6, 1830, indicates that $369.51 had been expended on "Sundries for School of Chemistry," presumably for apparatus or chemicals, nearly triple that spent for teaching natural philosophy and seven times that spent for the medical school.[167] In July 1831 Emmet was to be paid $15 for what appears to read "a refrigerator."[168] The Philadelphia firm of Smith and Hodgson submitted a bill in October 1831 for articles "for the use of the School of Chemistry & Materia Medica"; the bill detailed the chemicals ordered, as well as equipment, which included "Bell Glasses with caps & stop cocks," glass tubes, gray and white "Filtering paper," bladders, tabulated retorts, glass rods, watch glasses, assay jars, apothecary globes, "apparatus for decomposing water," sponges, vial corks, isinglass, and demijohns.[169] Similarly, Smith and Hodgson invoiced the university in November 1832 for various chemicals and a few pieces of equipment, including tubes, elastic bags, vial corks, watch glasses and springs, and retorts.[170]

In July 1834 the Visitors approved having the proctor "procure" and "set up, under the direction of Professor Emmet, a worm, & its necessary fixtures to the distillery in the Chemical Laboratory."[171] A year later a bill was paid for a "stand for still worm."[172] The university continued to procure equipment for the school of chemistry from Smith and Hodgson and from Field and Goss for sundries through 1846.[173] A charge from January 1837 showed that the university had paid Field & Goss for "glass and materials for painting."[174] The firm

of Lewis Feutchtwanger and Co. was paid $110.23 for sundries in February 1837.[175] Barrett and M'Intire was paid for a modest amount of sundries for the school of chemistry in August 1837.[176]

In 1839 Emmet appealed to the university for reimbursement for apparatus that he had personally paid for and had been using in his classes:

> About six or seven years ago, I handed in, for your examination, sundry Accounts or Bills for Chemical Apparatus with a proposition that the University should purchase the latter, for the use of the Chemical Department, at what it cost me (a Sum, I believe, between 4 & 600 dollars.) — I have never received one word of answer upon the Subject!
>
> Since that time many of the Instruments have become seriously damaged and others worn out in the service of the University, so as to make them no longer, perhaps, worth of being recommended.[177]

THE CHEMISTRY CURRICULUM

Chemistry was always considered to be an important part of the curriculum at the university, beginning with the Rockfish Gap report of 1818 on Central College.[178]

The annual *Catalogue of Officers and Students of the University* included a description of the instruction given in each of the schools. The catalogue for 1834-1835, the first to describe the curriculum, included this outline of what Professor Emmet was teaching at that time:

> There are two classes in this school; one of Chemistry, to which there are lectures given twice a week; and the other of Materia Medica and Pharmacy, to which is given a lecture once a week throughout the session.
>
> In the Chemical lectures, all the important applications of the science to the mechanical arts, agriculture and domestic economy are noticed, and when practicable, illustrated by experiment. In the lectures on earths and metals, the appropriate minerals are exhibited and noticed with reference to the sciences of Mineralogy and Geology. At the close of the history of inorganic matter, the atomic theory and the laws of definite proportions are fully explained and exemplified. The latter part of the course is occupied with the chemistry of organic substances; to which are added general views of the connection between Chemistry and the physiology of animals and vegetables.
>
> In the lectures on Materia Medica and Pharmacy, the subjects are treated in the following order: — The operations of Pharmacy, Pharmaceutical preparations, the effect which the combining of different substances has on their medicinal properties,

> the different classifications of the Materia Medica, and lastly, its several articles treated ALPHABETICALLY.
>
> There is attached to this school, a very extensive apparatus and laboratory.[179]

Teaching chemistry at the university was not without risks. An account of Emmet's life published a few years after his death described some of his travails:

> It has been said that natural history imposes severer labour on its votaries than any other science; but, perhaps chemistry may be said to expose hers to the greatest dangers. In prosecuting his researches into the minutest processes of inanimate matter, the chemist is often exposed to injury from the most potent and ungovernable of all elements. Dr. Emmet encountered a full share of these hazards. He met with several accidents, some of which were near proving fatal, and one of them laid him up for eight or nine weeks. On his person he bore the marks of these perils of the laboratory; but they were little heeded by him, and, when adverted to, always afforded him the occasion of some good-humoured pleasantry. His wardrobe paid dearly for the powerful agents with which it was too heedlessly brought into contact, and not unfrequently his attire wore the appearance of the sails of a ship that had just been in action.[180]

The accident that had "laid him up for eight or nine weeks" may have been the 1830 incident where Emmet's laboratory assistant, who was helping him to prepare for a lecture, failed to re-cork a large demijohn filled with sulfuric acid and spilled "part of the contents over Dr. Emmet's shoulders, and getting a portion on his own hands, he threw the demijohn from him so as to break it against the Doctor's body." Emmet's face was spared, "but his body was severely burned and the accident caused him months of suffering."[181]

Thomas Jefferson and John Emmet corresponded at some length about the various aspects of the natural-history curriculum. In April 1826, just months before Jefferson died, he had sent Emmet a detailed, three-page letter about putting more emphasis on botany. "It is time to think of the introduction of the school of Botany into our Institution," Jefferson wrote; he also outlined the curriculum and plans for a botanical garden for the university.[182] Emmet, in his response written the next day, approved of Jefferson's suggestions but also protested that he had "very insignificant pretensions to the character of a practical Botanist" and that his workload was already much too heavy to take on teaching botany:

> I actually have not time to pass a few hours in my garden or engage in any other recreation. This no doubt will diminish after my course of lectures is complete. The labour [sic] required of me at present, is perhaps unknown to you. Yet there is no Professor here, who encounters even 1/3 of it. Preparations to meet my Class requires me to pass 3 or 4

> hours of the morning in actual manual labour, which is rendered doubly inconvenient by the absence of an Assistant. This is absolutely necessary to prevent my becoming useless as an Instructor, for as I have before remarked, I have little else than memory to assist me. I am at present also giving instruction upon 3 of the most useful and only connected branches of my Department. These are Chemistry, Mineralogy, and Geology.[183]

Emmet threatened to resign if he were forced to take on these additional teaching responsibilities.[184]

In his reply to Emmet, dated May 2, 1826, Jefferson noted that the "difficulties" that Emmet had enumerated "must occur at the commencement of every undertaking."[185] Jefferson then explained in detail how Emmet could proportion his 144 annual lectures so that one-third would deal with botany and zoology and two-thirds with chemistry and, to a lesser degree, with mineralogy. Anticipating Emmet's reaction, Jefferson continued: "You will say that 2/3 of a year, or any better estimated partition of it, can give but an inadequate kno[w]ledge of the whole science of Chemistry. But consider that we do not expect schools to turn out their alumni already enthroned on the pinnacles of their respective sciences, but only so far advanced in each as to be able to pursue them by themselves and to become Newtons and Laplaces by energies and perseverances to be continued thro' life."[186] Jefferson advised Emmet to rethink his position:

> your only difficulty appears to be so to proportion the time you can give to the different branches committed to you, as to bring, within the compas[s] of a year, for example, that degree of instruction in each which the year will afford. This may require some experience, and continued efforts at condensation. But, once effected, it will place your mind at ease, and give to our country a result proportioned to the means it furnishes, & which ought, to satisfy, and will satisfy, all reasonable men.[187]

One wonders whether Jefferson's expectations of the level of expertise to be gained by the university's students, as expressed above, had kept him from originally proposing more elaborate chemical facilities than those initially built in the basement of the Rotunda.

Similarly, Jefferson had, while in Paris, advised Thomas Mann Randolph Jr., who was then studying in Edinburgh and would later become his son-in-law, about the next stage of his education:

> At this moment then a second order of preparation is to commence. I shall propose to you that it be extensive, comprehending Astronomy, Natural history, Anatomy, Botany and Chemistry. No inquisitive mind will be content to be ignorant of any one of these branches. But I would advise you to be contented with a course of lectures in most of

> them, without attempting to make yourself completely master of the whole. This is more than any genius, joined to any length of life is equal to. You will find among them some one study to which your mind will more particularly attach itself. This then I would pursue and propose to attain eminence in.[188]

In May 1826 Emmet wrote to Jefferson to defend the rationale behind laboratory fees that Emmet had proposed be paid voluntarily by the chemistry students. If 40 students would pay the $5.00 fee, Emmet explained, then the $200 collected would be sufficient to cover the annual laboratory equipment expenses "upon the plan of practical instruction," although the total might run somewhat higher because the "apparatus will have to be handled by awkward Beginners."[189]

The same letter also provides some background on the facilities for teaching chemistry at that time. Emmet reminded Jefferson that he had "planned the Laboratory for the instruction of the whole class, instead of studying my own convenience." "Verbal instruction alone," he continued, "is altogether inadequate": "the memories of my best students," he wrote, were proving "far too weak tho' sustained by daily examinations." He had been paying for some of the instruction expenses himself, furnishing "both servants and fuel for my lectures." "A laboratory furnished for the first time is expensive and comparatively useless, unless rendered subservient to the whole class, and so anxious am I to have it fitted up for experiments by my pupils, that I would abandon all the advantages of showy class experiments and lectures, to have the means of examining and instructing them with the tests and apparatus in their hands." Emmet had suggested the $5 fee contributions from students because he did not want "to add to the already great expenses of the different Schools"; this concern had "alone induced" him "to remain satisfied, for 2 Sessions, with an exceedingly limited & imperfect chemical apparatus which was purchased for my own use long before my appointment to this Situation, and which scarcely illustrates half my course."[190]

Despite not seeing eye-to-eye on chemistry instruction, Jefferson and Emmet seemed to have held each other in great respect. They corresponded at some length about a candidate to teach fine art at the university, and Jefferson told the proctor that Emmet would be directing the layout of the botanical garden and that he would be responsible for making "enquiries as to Gas lights," which the faculty had recommended over "oil lamps on account of economy and brilliancy."[191]

Emmet eventually prevailed in his efforts to focus his teaching more on chemistry than botany. In the fall of 1826, after Jefferson's death in July, he appealed to the Board of

Visitors to be relieved of his duties related to the botanical garden and to the teaching of botany and rural economy. Accordingly, he was allowed by the Visitors "to suspend, till the further decision of the Visitors, the discharge of his duties as professor of Natural History, in regard to the Botanic Garden, & the subjects of Botany & Rural Economy."[192] In 1827 he was "discharged from the obligation of delivering Lectures on Zoology, Mineralogy & Geology."[193] With all of his duties except chemistry, materia medica, and pharmacy being "dispensed with," his school was renamed the School of Chemistry and Materia Medica, and his title became professor of chemistry and materia medica.[194]

REVERSING THE LOCATIONS OF THE LECTURE ROOM AND THE LABORATORY, 1841

In 1841, as Emmet's health deteriorated, changes were made to the layout of the basement spaces used by the school of chemistry. The Visitors were told that the "lecture room of the professor of Chemistry in the basement story of the Rotunda is not as well adapted for the purposes of a lecture room as the opposite apartment in the same story, now used as a chemical laboratory." The Visitors therefore passed a resolution stating that the proctor "under the directions of the professor of Chemistry be instructed to cause those apartments to be altered in their interior arrangements so that the Eastern apartment be used as a chemical lecture room & the western apartment as a chemical Laboratory."[195] In April 1842 G. W. Spooner was paid $300.00 "on account of changing chemical lecture room."[196] This work may have included bricking up the chemical hearth at the north end of the east room (see Figure 18). If that room was now to be used as a lecture room, having a hearth in that location could interfere with circulation of the students in that space; if it were to be maintained as a professor's or the students' laboratory, its use would interfere with the lectures being given.

Meanwhile, at the same time that other professors were filling in for the ailing Emmet, another chemistry lecture room was being constructed in the anatomical hall, a separate structure that had been designed by Jefferson and was located to the west of Hotel A. An invoice from contractor George W. Spooner, preserved in the Proctor's Papers, provides some details about how the new lecture room in the anatomical hall was constructed; some of its features may have been similar to those in the chemistry lecture room in the basement of the Rotunda.

Spooner billed the university for $320.67 in July 1842 for "Fitting up Chymical [sic] Lecture room in Anatomical Hall" in the space that had been the "Medical lecture room," apparently on the ground floor.[197] He had installed a "Stud Partition framed with Braces" and made a large trapezoidal hood that was "suspended with Irons from the Ceiling over Lecturers [sic] Table." He also furnished "Sheetiron [sic] pipes" and fitted them "into partition, one for the stovepipe to pass through, the other to pass off the vapours." He cut down the "old platforms" for the students' "desks & Benches, did some work on the old risers, and built new desks and benches. He made adjustments to the door and windows and built "2 Large Cases 12 ft wide and 9 ft high, having sash doors hinged."[198] Either for this space in the anatomical hall or for the lecture room in the Rotunda, Spooner made a "large Blackboard to Dr. Rogers' lecture room" and "15 long Spitboxes." He also charged for "taking down hood," but the invoice did not specify where this hood was located.[199]

In June 1842 Spooner made a "Box with lining with lead for Chemical Laboratory."[200] In November 1842 he was paid for "elliptic Shelves & Brackets on Walls of Doctr Roger's Laboratory," which suggests that one of the oval rooms in the Rotunda was still being used as a laboratory.[201] That fall Rogers purchased a few yards of "Green Baize for the Chemical Laboratory," a thick, felt-like cloth typically used on gaming tables, presumably for use on flat surfaces.[202] Years earlier, Emmet also had purchased green baize.[203] In December 1842 Spooner was paid for "windows of Doctr Rogers, Laboratory."[204]

This work was done as other improvements were being made at the Rotunda. Other ground-floor spaces that had been used for the gymnasium were converted to lecture rooms; at least one was to be used for natural philosophy classes. G. W. Spooner held the contract for that work, which was underway in July 1841.[205] The university's apparatus related to natural philosophy, including objects donated by Jefferson, at that time occupied "the two apartments in the first story of the Rotunda"; in July 1841 the Visitors directed that those objects be removed and the spaces "used as additional lecture rooms, under the directions of the faculty."[206] The next summer as they waited for the other Visitors to arrive for their meeting, Thomas Randolph and James Mason "made an inspection of the grounds & buildings of the University, and of its Library & of its various apparatus Philosophical & Chemical."[207]

EMMET'S LATER YEARS AT THE UNIVERSITY

When Emmet had arrived at the university in 1825, he was assigned to Pavilion I. Here he kept a menagerie of wild animals, including a white owl, snakes, and a "friendly" bear, all

of which was disbursed after his marriage to Mary Byrd Tucker in 1829. In 1834 Emmet purchased land on the west edge of the university's grounds along the Staunton Turnpike and built a house for his family on the property, which he called Morea. Here he planted many fruit trees and flowers, including mulberry trees, established a vineyard, built a "brick building for the spinning of silk" from silkworms that he cultivated, and developed colorfast dyes for the silk.[208]

Over the years Emmet published several scientific papers in the *American Journal of Science and the Arts* (commonly called Silliman's Journal), often anonymously, and in other journals, including the *Journal of the Philadelphia College of Pharmacy*, in which he reported in 1834 on "Experiments upon the Solidification of Raw Gypsum."[209] The experiments on which these papers were based most likely were carried out at the chemical laboratory in the Rotunda.

His health failing, Emmet and his wife left for Florida in January 1842. His condition improved as a result of the warmer climate, and he was thought to be "in a fair way of recovery." During his return trip to New York, however, he suffered "a boisterous passage, in a small uncomfortable vessel," which lost its masts and drifted at sea for nearly a month before its passengers were rescued. Emmet lost "more than he had gained in Florida" in terms of his health. He died on August 15, 1842, at age 47, just weeks after landing in New York.[210]

Shortly before his death, Emmet had submitted a claim for payment "for certain Chemical apparatus, purchased by him and appropriated some years since to the use of the University." The Visitors agreed to pay this claim "when the Funds of the University" would permit.[211] After his death, his widow petitioned the Visitors "to purchase for the use of the University certain articles of chemical apparatus which constituted a private collection of her late husband," but her request was denied since the equipment was deemed "not necessary" and since financial restraints precluded the purchase of anything "not called for by the necessities of the Institution.'[212]

William Barton Rogers, the professor of natural philosophy, and two others professors had filled in in the classroom for Emmet during his final illness. Emmet apparently officially held the position of chair of chemistry and materia medica until the time of his death.[213] A memorial tribute noted that

> his lectures were, at once, very well received, and lectures being then a novelty in this part of the country, they were well attended by the public. In common with those on natural philosophy, a large part of the auditory often consisted of ladies. They continued to grow in popularity, by reason of which, together with the subsequent enlargement

> of the medical school, the number of his students gradually rose from thirty-five in the first year, to one hundred and thirty in the twelfth.[214]

The Board of Visitors held a special meeting on September 19, 1842, in order to officially appoint Emmet's successor, Dr. Robert E. Rogers, the younger brother of William B. Rogers, for a term of one year; he was assigned to Pavilion VIII.[215] Robert Rogers was officially appointed professor of chemistry on July 4, 1843.[216]

THE SECOND PROFESSOR OF CHEMISTRY, ROBERT E. ROGERS, 1842-1852

Dr. Robert E. Rogers was a "member of the famous Rogers family," his father and his four older "brothers all becoming distinguished in science." Robert Rogers had studied at the College of William and Mary, where his father taught natural history and chemistry. After a stint as a member of railroad-surveying teams in the North, Robert Rogers studied medicine at the University of Pennsylvania and then worked as a chemist on a survey of the geology of Pennsylvania. His brother William B. Rogers had served as professor of natural philosophy at the University of Virginia beginning in 1836 and would later become the founder of the Massachusetts Institute of Technology.[217]

The first substantive change to the chemistry curriculum appears in the university catalog of 1843-1844, as Robert Rogers took over as Emmet's successor as professor of chemistry:

This subject included in the medical as well as the general academic course, and forming a department of the school of Chemistry and Materia Medica, may be studied separately, or in conjunction with the latter.

> The Lectures, which are delivered twice a week throughout the session, embrace a very full illustration of all the topics of theoretical or practical importance in the science, and in its applications to Mineralogy, Geology, the Chemical Arts, Agriculture and Physiology.
>
> Beginning with an account of the phenomena and laws of Heat, Light and Electricity, Mechanical and Voltaic, the course next takes up the doctrines of chemical reaction, presenting a full and minute view of the principles of definite combination, with their hypothetical expression in the form of the atomic theory, and illustrating these doctrines by numerous experiments and drawings. To this succeeds Pneumatic Chemistry, in which are discussed the preparation, properties and applications of the various gaseous bodies and their compounds.

> This is followed by the detailed account of the metals, their oxides, chlorides, and other compounds, connecting with each metal the chemical history of its important salts. A resume is now given, accompanied by illustrations of the various processes of analysis deduced from the preceding facts.
>
> Organic Chemistry is next taken up, embracing an account of all the more important organic acids, alkaloids and neutral principles, together with a view of the alcoh[o]lic, acetous and putrefactive fermentation; the doctrine Eremacausis and the chemistry of nutrition, growth, respiration, &c. as exhibited in the vegetal and animal enconomy [sic]. In connection with these topics, minute experimental illustrations are given of all the valuable processes for the detection of poisons, and for the counteracting their effects.
>
> Throughout the course, use is continually made of ample diagrams, illustrating the chemical reactions according to the precise method of equivalents now in use, and the bearings of the recent generalizations of Graham, Dumas and Leibig, are particularly referred to.[218]

With the death of Professor Emmet and the appointment of Professor Rogers in 1842, some additional changes were proposed to the chemical lecture room. At their July 1843 meeting the Visitors passed a resolution stating that "with a view to enable the professor of Chemistry more effectually to enforce the regulations of the Lecture room, the Proctor be authorised [sic] and required to have removed the present releif [sic] boards in front of the Benches in the Lecture room so as to make them open & similar to those in the philosophical Lecture room."[219]

At the same 1843 meeting the Visitors turned their attention again to the pillars in the basement: "Resolved that the proctor be required to report to the Board of Visitors at their next meeting, an estimate of the cost of substituting the wood pillars in the Chemical Lecture room and Laboratory by hollow pillars of cast iron of such dimensions as the professor of Chemistry may deem most advisable."[220] A payment of $71.15, made in February 1846 to Wortham and M'Gruder, "for cast iron columns" may have been for such replacements.[221] In May 1847 George W. Spooner was paid $12.00 for "repairing lecture rooms," but the location of the work was not given.[222]

Professor Rogers co-authored several articles for professional journals and in 1846 with his brother James issued a revised edition of a textbook written by Edward Turner entitled *Elements of Chemistry, Including the History of Imponderables and the Inorganic Chemistry of the Late Edward Turner and the Outlines of Organic Chemistry by William Gregory.* Turner had been a popular professor of chemistry at the University of Edinburgh and London University; his textbook,

first published in 1827, had been used throughout Europe and quickly published in an American edition.[223]

A committee of inspection, charged with reviewing the facilities of the university, filed a report on its findings at a meeting of the board of visitors in June 1848. The report indicated that chemistry was still being taught in two spaces—the laboratory and the lecture room:

> Your Committee first proceeded in company with the professor of Chemistry and Materia Medica to examine the Chemical laboratory. They found the Chemical apparatus & agents in neat order, apparently well kept & methodically arranged. On examining the lecture room of the professor, your committee found the Benches & seats used by the Students much defaced, & injured, & not sufficiently ample to accommodate the Students. The professor suggested the necessity of furnishing the additional seats required and repairing the old ones; which suggestion your committee approve & recommend to the Board to be carried out by the proctor under the Inspection of the Executive Committee.[224]

Later in the same meeting the Visitors directed the proctor to "cause the necessary new Benches to be furnished in the lecture room of the professor of Chemistry & to repair the old seats."[225] The inspection committee had secured from the professors of chemistry and natural philosophy lists of their current "apparatus & agents"; the lists were reportedly attached to the committee's list, but they do not appear in the present-day versions of the minutes.[226] In February 1851 Rogers submitted a report to the faculty delineating the "extreme incompleteness of apparatus " for his school, especially what was needed "to illustrate the important subjects of Calorie, Electricity & Galvanism." In addition, "other branches of experimental science" needed equipment. "Almost the only materials with which the Laboratory is supplied," he continued, were "chemical re-agents and the consumable glass ware renewed from year to year." The rest consisted only of "glass vessels, tubes, glass and metal joints and other pieces which the Professor by the aid of corks, files and cement, with great expenditure of time, puts together as occasion requires to be again separated when needed for other purposes."[227] Furthermore, funding for the library had been "insufficient to provide the standard and important works upon the subjects connected with this School."[228]

In the late 1840s the chemistry laboratory and the lecture room were still being occupied exclusively by classes in the School of Chemistry and Materia Medica.[229]

Professor Robert E. Rogers remained at the university until submitting his resignation to the Board of Visitors in September 1852. The Visitors passed a resolution expressing "their high appreciation of his eminent services in the discharge of his duties as Professor, and

their sincere wishes for his future success and happiness." He was succeeded by J. Lawrence Smith, of the University of Louisiana.[230]

Meanwhile, the Visitors expected that the annex to the Rotunda would be completed before their next annual meeting, in 1853, and that it would thus be "desirable in finishing the rooms to adapt them in some particulars to the purposes in which they are to be applied." At their June 1852 meeting the Visitors agreed to assign the "sub basement rooms" in the annex to the School of Chemistry and Materia Medica [231]

PROFESSOR J. LAWRENCE SMITH, 1852-1853

When J. Lawrence Smith took over as professor of chemistry for the 1852-1853 academic year, he inaugurated a "practical laboratory course" and added to the catalog description of the curriculum the statement that the "apparatus connected with this department is calculated for a full experimental demonstration of the different topics embraced in this course."[232] This academic session was probably the last time when the chemistry lectures and demonstrations were held in the basement of the Rotunda.

Professor Smith brought a wealth of experience to his classroom. A native of Charleston, South Carolina, he had studied chemistry at the University of Virginia with Professors John P. Emmet and Robert Rogers, worked as an assistant engineer on the Charleston and Cincinnati Railroad, and then studied medicine at the Medical College of South Carolina and in Europe. While abroad, he also studied chemistry with such greats as Mathieu Joseph Bonaventure Orfila, renowned as the "father of toxology"; Jean-Baptiste-Andre Dumas, the dean of French chemists; and Justus von Liebig, a German chemist known for his work in organic chemistry and for his model laboratory for graduate students at the University of Giessen. Smith assayed gold bullion for three Southern states, explored emery and coal deposits for the Turkish government, invented an inverted microscope, and lectured in New Orleans before arriving in Charlottesville.[233]

MOVING THE SCHOOL OF CHEMISTRY TO NEW FACILITIES IN THE ROTUNDA ANNEX

While the creation of new lecture rooms in the former gymnasium in the early 1840s relieved some pressure on the oval lecture rooms in the Rotunda, within a few years more lecture space was needed. There was also concern that large events held in the library at the top

level of the Rotunda were causing structural problems in the lower stories. In 1850 the Visitors hired architect Robert Mills to design an annex for the Rotunda.

The June 1854 graduation ceremonies were held in the "largest apartment" in the new annex, even though the rest of the building was not entirely complete. Downstairs, though, the "lecture rooms in the basement of the building had been previously prepared for use, and had been occupied by the professors of chemistry and natural philosophy: by the former, soon after the commencement of the session—by the latter, a short time before its close." Thus it would appear that the last use of the chemistry lecture room and the laboratory in the Rotunda would have been in the spring of 1853. The new facility would have separate spaces for lectures and laboratory work.[234]

The annual report for 1853-1854 lauded the facilities for chemistry in the new annex: "It has in the subbasement a chemical lecture room and laboratory, not surpassed, if equaled, in point of extent and convenience, at any other institution in our country." Furthermore, the annex was "connected with the rotunda, so as to bring all the lecture rooms, scientific collections and apparatus in the academical department under a common roof, in graceful and commodious distribution."[235]

Robert Rogers had taught chemistry and materia medica through the 1851-1852 academic session. Smith, his successor, held the post for only one year, from 1852 through June 1853. It would thus seem that Rogers would have been involved in the planning of the new facilities in the annex.[236] Smith, however, was responsible for actually fitting up of the new laboratory and lecture room.[237]

The old benches were renewed and reused in the new lecture room, rather than being replaced with more costly cast-iron benches as originally planned. According to the minutes of the Board of Visitors, the "tables and other arrangements about the lecture rooms are most convenient for the purposes to which they are applied." The tables in the new laboratory were "constructed with reference to the future use of the Laboratory for practical instruction"; the tops, for instance, were "made of thick St. Domingo mahogany, the only kind of wood . . . fitted for tops of laboratory tables." Experiments would be conducted "with perfect ventilation" that allowed for the "escape of all vapors." The improved availability of water was also touted in the minutes: the "supply of the Laboratory with water (an important consideration in view of cleanliness, the first feature of a good laboratory) has been also well accomplished at less expense and with vastly more convenience than by the former plan of digging a well near the Laboratory"; the water was now supplied

from "a cistern back of the Chapel by a leaden pipe & distributed in a fitting manner over the Lecture room and Laboratory."[238] The chemistry facilities were again the pride of the university, much as John Emmet had hoped to achieve a generation earlier.

NOTES

Abbreviations used in endnotes and captions

AR Annual Report, University of Virginia

ASB Arthur S. Brockenbrough

BOV Board of Visitors, University of Virginia

JPE John Patten Emmet

LOC Library of Congress

Min. Minutes

PP Papers of the Proctor of the University of Virginia, UVSC

RHSR John G. Waite Associates, Architects, *The Rotunda, University of Virginia, Historic Structure Report*, 2008

TJ Thomas Jefferson

TJP Thomas Jefferson Papers, UVSC

UVSC University of Virginia Library, Special Collections

1. *Enactments of the University of Virginia, Constituting, Governing and Conducting That Institution* (Charlottesville: C. P. M'Kennie, 1825).

2. As part of the research for this project, I met with leading scholars in London, Oxford, and Cambridge, England, to discuss the chemical hearth at the Rotunda; I am very grateful to all of them for sharing their expertise on the history of chemical hearths and the teaching of chemistry—Frank James and Charlotte New at the Royal Institution; Peter J. T. Morris at the Science Museum in London; Robert G. W. Anderson, former head of the British Museum; and John Perkins, retired dean of arts and humanities at Oxford Brookes University. I am also very grateful to Mary Ellen Bowden, of the Chemical Heritage Foundation in Philadelphia, for providing introductions to these scholars and for making other research suggestions.

3. John Neilson to John Hartwell Cocke, Feb. 22, 1823, TJP. RHRS, 8-9.

4. Cabell to Madison. April 16, 1823, James Madison Papers, LOC.

5. TJ to Thomas Cooper, Aug. 6, 1810, Founders Online, LOC.

6. Cabell to Madison. April 16, 1823, James Madison Papers, LOC.

7. Cabell to Madison. April 16, 1823, James Madison Papers, LOC.

8. Cabell to Madison. April 16, 1823, James Madison Papers, LOC.

9. Cabell to Madison. April 16, 1823, James Madison Papers, LOC.

10. TJ to Madison, April 30, 1823, James Madison Papers, LOC.

11. TJ to Madison, April 30, 1823, James Madison Papers, LOC.

12. TJ to Madison, April 30, 1823, James Madison Papers, LOC.

13. TJ to Madison, April 30, 1823, James Madison Papers, LOC.

14. Madison to Cabell, May 10, 1823, James Madison Papers, Box 2, UVA Special Collections.

15. BOV, Min., Oct. 4, 1824.

16. TJ to Madison, April 30, 1823, Madison Papers, LOC.

17. ASB to TJ, June 6, 1825, TJP.

18. Jon Eklund, "The Incompleate Chymist, Being an Essay on the Eighteenth-Century Chemist in His Laboratory, with a Dictionary of Obsolete Chemical Terms of the Period," *Smithsonian Studies in History and Technology* 33 (1975), 4.

19. Eklund, 6-7, 17.

20. Eklund, 6-7, 17.

21. Eklund, 7.

22. Eklund, 7.

23. BOV, Min., March 29, 1819. TJ was trying to recruit Cooper to teach chemistry and other subjects even earlier, in 1817; TJ to Cooper, Sept. 1, 1817; Cooper to TJ, Oct. 24, 1817, and Dec. 6, 1817; Dec. 7, 1817; Oct. 22, 1819; Dec. 18, 1819; May 3, 1820; TJP, UVa.

24. "Thomas Cooper (1759-1841)," in Penn Biographies, www.archives, upenn.edu/people/1700s/cooper_thos_b1759.html, accessed Dec. 10, 2013. BOV, Min., March 29, 1819; Oct. 4, 1819. Cooper to TJ, Oct. 22, 1819, TJP, UVa. Later in 1819 James Cutbush wrote TJ applying for the post of professor of chemistry; James Cutbush to TJ, Dec. 27, 1819, TJP, UVa., accessed through Founders Early Access, Oct. 14, 2014.

25. Bruce, vol. 2, 14-16. TJ to Francis Walker Gilmer, Nov. 30, 1824; Gilmer to TJ, Dec. 3, 1824; in Richard Beale Davis, ed., *Correspondence of Thomas Jefferson and Francis Walker Gilmer, 1814-1826* (Columbia: Univ. of South Carolina Press, 1946), 120, 123-124. Hugh Miller Spencer, *A History of the School of Chemistry at the University of Virginia, 1825-1943* (Charlottesville: Alumni Association of the University of Virginia, 1983), 10. C. A. Browne, "The History of Chemical Education in America between the Years 1820 and 1870," *Chemical Education in America* 9, no. 4 (April 1932), 709. Franklin Bache was also interested in applying for the post; Franklin Bache to TJ, March 27, 1824, TJP, UVa.

26. Gilmer to TJ, Dec. 3, 1824, in Davis, 123.

27. Gilmer to TJ, Dec. 3, 1824, in Davis, 123.

28. Gilmer to TJ, Dec. 4, 1824, in Davis, 125.

29. Tucker, 5-8. Thomas Addis Emmet, *A Memoir of John Patten Emmet M.D.* (New York: Privately Printed, 1898), 21-22. Wyndham D. Miles and Robert F. Gould, *American Chemists and Chemical Engineers*, vol. 2 (Guilford, Ct.: Gould Books, 1994), 84. Spencer, 11.

30. George Tucker, *Memoir of the Life and Character of John P. Emmet, M.D., Professor of Chemistry and Materia Medica in the University of Virginia* (Philadelphia: C. Sherman, Printer, 1845), 11-12. Emmet, 21. Spencer, 11.

31. Thomas A. Emmet to J. C. Calhoun, Nov. 20, 1824, TJ Papers, LOC. John C. Calhoun to TJ, Nov. 22, 1824, Univ. of South Caroline, accessed through Founders Early Access, Oct. 15, 2014. When Jefferson replied to Calhoun, he told him that Gilmer had secured a professor of chemistry in Europe, perhaps a reference to the desire of Duglison to teach chemistry; however, this did not occur; TJ to Calhoun, Nov. 28, 1824, TJP, LOC, accessed through Founders Early Access, Oct. 15, 2014. It is interesting that Thomas Emmet had approached Calhoun rather than writing Jefferson directly, since Emmet was acquainted with Jefferson; Thomas Emmet to TJ, Oct. 2, 1813; Thomas Emmet to TJ, March 8, 1824, TJ Papers, LOC.

32. TJ to James Madison, Dec. 10, 1824; TJP, LOC. In the same letter Jefferson told Madison that he would explain to John Emmet that since Jefferson was "but 1. or 7. I can engage only for myself. This may prevent his engaging elsewhere."

33. Madison to TJ, Dec. 15, 1824, James Madison Papers, LOC, accessed through Founders Early Access, Oct. 15, 2014. While at the university, Dunglison and Emmet worked together, notably on the analysis of gastric juice in 1833; information kindly provided by Don Eugene Detmer, MD, MA.

34. TJ to JPE, March 6, 1825, electrostatic copy in TJP of original in Huntington Library, San Marino, Calif. BOV, Min., March 4, 1825."

35. JPE to TJ, March 13, 1825, LOC, TJ Papers.

36. John Addis Emmet to TJ, March 28, 1825, LOC, TJ Papers.

37. TJ to Thomas Cooper, April 4, 1825, TJP.

38. TH to JPE, April 8, 1825, electrostatic copy of original in Huntington Library, RG-1/3/3.891, UVSC.

39. TJ to Joseph Coolidge, April 12, 1825, TJP. Jefferson had told Cabell in January 1825 that it would take about $25,000 "more than we have to finish the Rotunda"; TJ to Cabell, Jan. 11, 1825, TJP, LOC.

40. JPE to Jane Emmet, May 6, 1825, in Thomas A. Emmet, *A Memoir of John Patten Emmet M.D.*, 27.

41. JPE to Jane Emmet, May 6, 1825, in Thomas A. Emmet, *A Memoir of John Patten Emmet M.D.*, 27-28. John Emmet was also very concerned about the interior decoration of his pavilion and his own wardrobe, since he expected to be entertaining his fellow professors and visitors to the University.

42. JPE to Jane Emmet, June 15, 1825, in Thomas A. Emmet, *A Memoir of John Patten Emmet M.D.*, 28-29.

43. JPE to TJ, MAY 12, 1825, TJP.

44. Email, John Perkins to Diana S. Waite, July 15, 2014. John Perkins, "Sites of Chemistry in the Eighteenth Century, *Ambix* 60 (May 2013), 95-98.

45. William Howard Adams, ed., *The Eye of Jefferson* (Charlottesville: University Press of Virginia, 1981), 59.

46. TJ to the Rev. James Madison, July 19, 1788, in Douglas L. Wilson and Lucia Stanton, eds., *Jefferson Abroad* (New York: Modern Library, 1999), 257-258.

47. Laura Colaneri of Mount Ida Press has assembled documents relating to these French connections, which further investigation may well show additional connections with the facilities for teaching chemistry at the University of Virginia.

48. TJ to Thomas Cooper, July 10, 1812, quoted in Harold J. Abrahams, "Thomas Jefferson's Library of Applied Chemistry," *Journal of the Elisha Mitchell Scientific Society* 77, no. 2 (Nov. 1961), 267-268; also quoted in part in E. Millicent Sowerby, comp., *Catalogue of the Library of Thomas Jefferson*, vol. 1 (Washington, D.C.: The Library of Congress, 1852), 374.

49. Sowerby, 374-390.

50. Abrahams, 273.

51. Wyndham D. Miles, "William James MacNeven and Early Laboratory Instruction in the United States," *Arbix*, 17, no. 3 (1970), 144.

52. "Front View of a range of Fixed Furnaces, set up by the Professor of Chemistry, Dr. Mac Neven, in the laboratory of the College of Physicians and Surgeons, N. York," *The American Medical and Philosophical Register* 4 (1814), 284-288. Miles, 145. Nathaniel P. Poor, *Retirement Library Catalogue*, p. 5, www.librarything.com, accessed on Jan. 14, 2014. Jefferson knew or at least knew of MacNeven even earlier, for MacNeven had sent him a book on Irish history in 1807; TJ to William J. MacNeven, Aug. 15, 1807, online transcript, Gilder Lehrman Institute, New-York Historical Society, accessed Oct. 15, 2014.

53. "Front View of a range of Fixed Furnaces," 284-288.

54. Abrahams, 273.

55. TJ to William James Macneven, Jan. 12, 1822, online transcript, Gilder Lehrman Collection, New-York Historical Society, accessed Oct. 14, 2014.

56. J. J. V. Tyrrell, *Guides to the Royal Institution of Great Britain: 2, The Site and the Buildings*, www.rigb.org, downloaded Jan. 13, 2014.

57. William Thomas Brande, *A Manual of Chemistry Containing the Principal Facts of the Science, Arranged in the Order in Which They Are Discussed and Illustrated in the Lectures at the Royal Institution of Great Britain* (New York: George Long, 1821), vii-viii.

58. Cooper to TJ, Oct. 24, 1817, TJP, UVa.

59. TJ to John Griscom, Oct. 6, 1823, TJP, LOC.

60. John Griscom to TJ, March 24, 1824, TJP.

61. Unfortunately, archaeological evidence in the area under where such a hearth would have been located appears to have been destroyed when concrete was subsequently laid in that area; telephone conversation with Steve Thompson, Rivanna Archaeological Services, March 10, 2015.

62. This arrangement of the first chemical hearth being located on the east wall of the east oval room was developed during a conversation on March 5, 2015, in Oxford, England, with John Perkins, retired Dean of Arts and Humanities and professor at Oxford Brookes University.

63. Cooper to TJ, Oct. 3, 1818, TJP, UVa.

64. R. Schaer to TJ, March 25, 1819, TJP.

65. Cabell to TJ, Dec. 23, 1822, TJP.

66. Cabell to TJ, March 24, 1823, TJP.

67. TJ to Cabell, Feb. 3, 1824, TJP.

68. TJ to Robert Hare, March 12, [1824]; this letter is known through a transcript of its text contained in a letter from Arthur Pforzheimer to Louise Savage at the Univ. of Va. Library dated April 17, 1944, when the Pforzheimer was offering the letter for sale; MSS 12516, UVSC.

69. TJ to Robert Hare, March 12, [1824]; this letter is known through a transcript of its text contained in a letter from Arthur Pforzheimer to Louise Savage at the Univ. of Va. Library dated April 17, 1944, when Pforzheimer was offering the letter for sale; MSS 12516, UVSC.

70. TJ to Hare, March 12, [1824].

71. Hare to TJ, March 31, 1824, TJP.

72. TJ to Griscom, March 12, 1824, LOC TJP. TJ had contacted John Griscom earlier about supplying a book on university regulations, which Griscom sent to TJ, along with a two-volume account of his travel in Europe; TJ to Griscom, Oct. 6, 1823; Griscom to TJ, Oct. 10, 1823; TJ to Griscom, Oct. 18, 1823; LOC TJP.

73. John Griscom to TJ, March 24, 1824, TJP.

74. [John Griscom], Chemical Apparatus essential to a well furnished Laboratory & Lecture Room, MSS 11904, SC, UVA. This list appears to be in Griscom's hand; assuming that attribution is correct, it would likely be the list that he had enclosed in his March 24, 1824, letter to TJ.

75. John Griscom to TJ, March 24, 1824, TJP.

76. BOV, Min., April 5, 1824.

77. Gilmer to TJ, Dec. 3, 1824, in Davis, ed., 124.

78. John W. Francis, "Historical Sketch of the Origin, Progress, and Present State of the College of Physicians and Surgeons of the University," *American Medical and Philosophical Register*, 4 (1813-1814), 119.

79. JPE to TJ, May 12, 1825, TJP.

80. JPE to TJ, May 12, 1825, TJP.

81. JPE to TJ, May 12, 1825, TJP.

82. JPE to TJ, May 12, 1825, TJP.

83. JPE to TJ, May 12, 1825, TJP.

84. JPE to TJ, May 12, 1825, TJP.

85. JPE to TJ, May 12, 1825, TJP.

86. JPE to TJ, May 12, 1825, TJP.

87. JPE to TJ, May 12, 1825, TJP.

88. JPE to TJ, May 12, 1825, TJP.

89. JPE to TJ, May 12, 1825, TJP.

90. JPE to TJ, May 12, 1825, TJP.

91. TJ to JPE, May 16, 1825, LOC.

92. TJ to JPE, May 16, 1825, LOC.

93. TJ to JPE, May 16, 1825, LOC.

94. TJ to JPE, May 16, 1825, LOC.

95. Browne, 712-713.

96. Georg Lockemann and Ralph E. Oesper, "Fredrich Stormeyer and the History of Chemical Laboratory Instruction," *Journal of Chemical Education* 30 (April 1953), 203. H. G. Good, "On the Early History of Liebig's Laboratory," *Journal of Chemical Education* 13 (Dec. 1936), 557-558. Charles J. Brand, "A Modern Visit to Liebig's Laboratory," *Journal of Chemical Education* 18 (May 1941), 221. Hjalmar Fors, "J. G. Wallerius and the Laboratory of Enlightenment," in E. Baraldi, H. Fors, and A. Houltz, eds., *Taking Place: The Spatial Contexts of Science, Technology, and Business* (Sagamore Beach, Mass.: Science History Publications, 2006), 3-33; Peter J. T. Morris, of the Science Museum in London provided this reference. I am grateful to Morris for sharing the pre-publication manuscript of his book *The Matter Factory: A History of the Chemistry Laboratory* (London: Reaktion Book, forthcoming April 2015).

97. ASB to TJ, June 6, 1825, TJP, ETC.

98. TJ to ASB, June 7, 1825, TJP.

99. TJ to Cooper, April 4, 1825, TJP.

100. JPE to TJ, May 12, 1825, TJP.

101. Conversation with John Perkins, March 5, 2015. It is clear from the aforementioned sources on American laboratories and from conversations with Perkins and other scholars that the alcove hearth alone was not large enough for teaching.

102. JPE, Notebooks of John Patten Emmet, Ledger 3, Mss. 12713-a, UVSC.

103. Invoice, Benjamin Blackford to ASB, Aug. 15, 1825, PP, Box 5, Folder Aug. 15-25, 1825.

104. AR, 1826, 14. It is possible that this charge is related to the Aug. 15, 1825, invoice, but that is difficult to determine since the invoice was drawn up in pounds and the annual report gave amounts in dollars. Blackford also received a second payment, for $62.52, but the nature of the work was not identified. TJ to JPE, May 16, 1825, LOC.

105. Email, Clay Palazzo to Diana Waite, Nov. 11, 2013.

106. For another example of a possible early fume hood, see the floor plan of the chemical laboratory in Uppsala, Sweden, (rebuilt by Torbern Bergman after a fire in 1767) in Hjalmar Fors, "J G. Wallerius and the Laboratory of Enlightenment," in Enrico Baraldi, Hjalmar Fors, and Anders Houltz, eds., *Taking Place, The Spatial Contexts of Science, Technology and Business* (Sagamore Beach, Mass.: Science History Publications/USA, 2006), 23. Peter Morris of the Science Museum in London suggested this source.

107. AR, 1825, 4.

108. BOV, Min., Oct. 2, 1826.

109. AR, 1825, 6.

110. General Faculty, Min., Dec. 2, 1825; March 30, 1826, RG-19/1/1.461, UVSC.

111. JPE to ASB, Oct. 17, 1826, PP, RG-5/3/1.111, Box 6, File 671.

112. General Faculty, Min., Sept. 10, 1827.

113. General Faculty, Min., Jan. 14, 1828.

114. JPE to ASB, Jan. 5, 1826, Harrison, Smith and Tucker Family Papers , MSS 3825-a, Box 2, SC UVA. Emmet's pavilion continued in an "unfinished & dirty state" through the fall of 1827; see JPE, April 20, 1827, and ASB to JPE, Sept. 23, 1827, PP, RG-5/3/1.111, Box 7, File 769, and JPE to ASB, Aug. 9, 1828, Box 7, file 1268.

115. Philip Alexander Bruce, *History of the University of Virginia, 1819-1919, The Lengthened Shadow of One Man*, vol. 2, (New York: Macmillan Co., 1920), 18-19.

116. JPE to ASB, April 12 [1826], PP, RG-5/3/1.111, Box 6, file 609.

117. Joseph Antrim to ASB, Aug. 7, 1826, PP, RG-5/3/1.111, Box 6, File 649.

118. ASB to J. H. Cocke, Aug 8, 1827, TJP, ETC. AR, 1828, 20.

119. AR, 1826, 3-4. The professor of natural philosophy was not happy with his space in the Rotunda; see, for instance, Charles Bonnycastle to Arthur Spicer Brockenbrough, April 10, 1826, TJP, ETC. BOV, Min., Oct. 2, 1826.

120. BOV, Min., July 10, 1827.

121. BOV, Min., July 10, 1828.

122. AR, 1827, 20.

123. AR, 1827, 26. There were other small payments that were identified as being "for Emmett" but were not further identified; these payments were made to—Jesse Lewis, John Kenny, Wilson Cary, Wimer, M. F. Crawford, Mrs. Chapman, J. Rogers. There were addition payments to Crawford for Emmet ($142.17) AR, 1828, 28; also $140 to N. Barksdale for Emmet in March 1828, AR, 1828, 28.

124. Proctor's Ledgers, [Vol. 3], 1826-1832, p. 70.

125. General Faculty, Min., Feb. 4, 1828.

126. BOV, Min., July 10, 1827.

127. BOV, Min., July 10, 1827.

128. JPE, "Ground Plan of a Chemical Lecture room & Laboratory," [1827?], Mss. 8553, UVSC. Joseph Michael Lasala, Thomas Jefferson's Designs for the University of Virginia, master's thesis, Jan. 1992, School of Architecture, Univ. of Virginia, drawing 19-13.

129. Jefferson had donated his "collection of natural and artificial curiosities" to the university, and they were stored initially in the "small oval room on the first floor of the Rotunda"; in the fall of 1828 the Visitors directed that these materials be moved to the "small oval room in the basement story." The space on the second floor was then to be used for the "reception of the Philosophical apparatus, under the superintending care of the Professor of Natural Philosophy"; BOV, Min., Oct. 3, 1826; Oct. 1, 1828.

130. BOV, Min., July 10, 1829. Executive Committee, Min., undated resolution, PP, RG-5/3/1.111, Box 16, File Letters and receipts, N.D.

131. There was trouble with draught of other fireplaces; see *RHSR*, p. 53, note 275.

132. BOV, Min., July 10, 1829.

133. BOV, Min., July 10, 1829.

134. BOV, Min., July 10, 1830.

135. JPE to [ASB], n.d., PP, RG-5/3/1.111, Box 16, File Letters and receipts, N.D.

136. Receipt, Isaac Raphael, May 1, 1831, PP, RG-5/3/1.111, Box 19, File Bills & Accounts, May-Dec. 1831.

137. Receipt, Chiles Brand, June 10, 1831, PP, RG-5/3/1.111, Box 19, File Bills & Accounts, May-Dec. 1831.

138. AR, 1839, p. 12.

139. BOV, Min., July 10, 1832.

140. BOV, Min., July 10, 1833.

141. Tucker, 16. JPE to Jane Emmet, May 6, 1825, in Thomas A. Emmet, *A Memoir of John Patten Emmet M.D.*, 40. Spencer (p. 18) writes that a vein of kaolin ran through his Morea property.

142. BOV, Min., July 10, 1833.

143. AR, 1834, p. 6. Minutes of a meeting of the Board of Visitors in 1835 make clear that the chemical laboratory was located on the "ground floor" of the Rotunda BOV, Min., July 2, 1835. The minutes directed that "the proctor cause the room upon the ground floor of the Rotunda, near the Chemical Laboratory, now occupied by one of the Negroes of the University to be vacated by that occupant; and those rooms after being properly cleansed, to be locked up, or put to other desirable uses."

144. BOV, Min., July 10, 1829. Executive Committee, Min., undated resolution, PP, RG-5/3/1.111, Box 16, File Letters and receipts, N.D. During the recent construction work in the Rotunda, the footings for the columns in both the east and west oval rooms were disovered.

145. JPE to [ASB], n.d., PP, RG-5/3/1.111, Box 16, File Letters and receipts, N.D.

146. Receipt, John Vowels, Nov. 27-30, 1829, PP, RG-5/3/1.111, Box 19, File Bills and Accounts, July-Dec. 1829.

147. BOV, Min., July 10, 1830.

148. BOV, Min., July 10, 1830.

149. BOV, Min., July 10, 1830.

150. BOV, Min, July 10, 1830.

151. BOV, Min., July 10, 1833. Invoice, William Kennedy to University of Virginia, August 1833, PP, RG-5/1/1.111, Box 10, File 1833 Bills and Accounts.

152. BOV, Min., July 15, 1834.

153. Proctor's Ledger, 1819-1825, p. 166, RG-5/3/2.961. AR, 1825, 4. TJ to ASB, July 24, 1825, TJP. Proctor's Ledger, 1819-1825, RG-5/3/2.961.

154. JPE, Notebooks of John Patten Emmet, Ledger 3, Mss. 12713-a, UVSC.

155. Ann Blackman, *Wild Rose: The True Story of a Civil War Spy* (New York: Random House, 2005), 97-98.

156. BOV, Min., Oct. 3, 1825.

157. Invoice, JPE to the [University of Virginia], n.d., PP, Box 16, File N.D. Letters and Receipts.

158. AR, 1825, 16, 18, 30, 34; it is possible that some of these payments were partial payments for his $504.00 invoice. TJ, circular, Aug. 4, 1825, TJP. TJ, A Statement of the Library Fund, Sept. 19, 1825, TJP.

159. Receipt, JPE, May 14, 1825, PP, RG-5/3/1.111, Box 5, File 587, Receipts.

160. AR, 1826, 14.

161. AR, 1826, 18. There were other payments in spring 1826, but it is not clear what they are for.

162. JPE to ASB, Jan. 5, 1826, Harrison, Smith and Tucker Family Papers, MSS 3825-a, Box 2, SC UVA.

163. TJ, Instructions to mr. Brockenbrough, [c. May 1826, calendar number 2324], TJP. TJ to JPE, May 30, 1826, TJP, LOC.

164. BOV, Min., July 10, 1829; the firm name was erroneously spelled Seddlier, May & Co. in the minutes. Receipt, John P. Emmet, July 19, 1829, PP, RG-5/3/1.111, Box 19, File Bills & Accounts, July-Dec. 1829.

165. Receipt, Weeks & Willett, Atty. for Sadler Ray & Co., Sept. 11, 1829, PP, RG-5/3/1.111, Box 19, File Bills & Accounts, July-Dec. 1829. The younger Emmet was also to be reimbursed for costs that he might "be compelled to pay in a suit brought against him on that bill in the State of New York," BOV, Min., July 19, 1829; no further details were given.

166. A bill had been presented by "Dr. McNevin for chemical apparatus purchased of him" at some point before July 10, 1830, BOV, Min., July 10, 1830.

167. AR, 1830, 4.

168. Receipt, G. Harrison, July 18, 1831, PP, RG-5/3/1.111, Box 19, File Bills & Accounts, May-Dec. 1831. The word could be "refrigeratus". Both terms were in use by 1831; *Oxford English Dictionary*, 2nd ed., s.v. "refrigerator."

169. Invoice, Smith & Hodgins, Oct. 29, 1831, PP, RG-5/3/1.111, Box 19, File Bills & Accounts, May-Dec. 1831.

170. Invoice, Smith & Hodgins, [Nov.] 21, 1832, PP, RG-5/3/1.111, Box 10, File 1833 Bills and accounts. For other purchases, see Receipt, Smith and Hodgson, Aug. 19, 1833, Box 10, File 1833 Bills and accounts.

171. BOV, Min., July 15, 1834.

172. AR, 1836, p. 11.

173. AR, 1836, p. 11; 1838, p. 18; 1840, p. 23; 1842, p. 10; 1846, p. 9.

174. AR, 1837, p. 6.

175. AR, 1837, p. 7.

176. AR, 1838, p. 18.

177. JPE to [BOV?], July 4, 1839, PP, RG-5/3/1.111, Box 12, File Correspondence 1839.

178. *Report of the Commissioners Appointed to Fix the Scite of the University of Viriginia* (Richmond: John Warrack, Printer, 1818), 7.

179. *Catalogue*, 1834-1835, p. 15.

180. Tucker, 22-23.

181. Thomas A. Emmet, *A Memoir of John Patten Emmet M.D.*, 38-39.

182. TJ to JPE, April 27, 1826, TJP, LOC.

183. JPE to TJ, April 28, 1826, Papers of Thomas Jefferson, Retirement Series, Huntington Library.

184. JPE to TJ, April 28, 1826, Papers of Thomas Jefferson, Retirement Series, Huntington Library.

185. TJ to JPE, May 2, 1826, TJP, LOC.

186. TJ to JPE, May 2, 1826, TJP, LOC.

187. TJ to JPE, May 2, 1826, TJP, LOC.

188. TJ to Thomas Mann Randolph Jr., Aug. 27, 1786, in Anthony Brandt, ed., *Thomas Jefferson, Travels, Selected Writings, 1784-1789* (Washington, D.C.: National Geographic, 2006), 59.

189. JPE to TJ, May 27, 1826, Papers of Thomas Jefferson, Retirement Series, Huntington Library. The idea of fees further supports the notion that students would be active in the laboratory.

190. JPE to TJ, May 27, 1826, Papers of Thomas Jefferson, Retirement Series, Huntington Library.

191. JPE to TJ, Dec. 25, 1815; TJ to JPE, Jan. 2, 1826; JPE to TJ, Feb. 8, 1826; TJP, LOC. TJ to James Madison, Jan. 2, 1826, TJP, Library of Congress. TJ to John Cocke, May 20, 1826; TJ, Instructions to Mr. Brockenbrough, May 5, 1826, TJP. JPE to TJ, May 13, 1826, Papers of Thomas Jefferson, Retirement Series, Huntington Library.

192. John P. Emmet to [BOV], Oct. 1, 1826, Mss. 11923, UVSC. BOV, Min., Oct. 2, 1826.

193. BOV, Min., July 10, 1827.

194. BOV, Min., July 10, 1827.

195. BOV, Min., July 1, 1841.

196. AR, 1842, 10.

197. Invoice, George W. Spooner to Univ. of Virginia, Dec. 1, 1841, PP, RG-5/3/1.111, Box 14, File 1842 Bills, accounts and receipts.

198. Invoice, George W. Spooner to University of Virginia, Feb. 7, 1842, PP, Box 14, File 1842 Bills, accounts and receipts.

199 . Invoice, George W. Spooner to University of Virginia, July 29, 1842, PP, Box 14, File 1842 Correspondence.

200. Invoice, George W. Spooner to University of Virginia, June 5, 1842, PP, Box 14, File 1841 Bills and accounts.

201. Invoice, George W. Spooner to Univ. of Virginia, July 29, 1842, PP, Box 14, File 1842 Correspondence.

202. Invoice to Dr. Rogers, Oct. 8, 1842, PP, Box 14, File 1842 Bills, accounts and receipts.

203. John Emmet receipt, PP, RG-5/3/1.111, Box 6.

204. George W. Spooner, PP, Box 14, File 1842 Correspondence.

205. AR, 1842, 9. Joseph Simms was paid $57.63 for "stoves for lecture rooms," but their location was not identified, so they may have been used in the new lecture rooms; ibid.

206. BOV, Min., July 1, 1841.

207. BOV, Min., July 1, 1842.

208. JPE to Jane Emmet, May 6, 1825, in Thomas A. Emmet, *A Memoir of John Patten Emmet M.D.*, 40. Miles and Gould, vol. 2, 85. "John Patten Emmet," in Harry Clemons, *Notes on the Professors for Whom the University of Virginia Halls and Residence Houses Are Named*, http://xtf.lib.virginia.edu (accessed Sept. 23, 2013).

209. John P. Emmet, "Experiments upon the Solidification of Raw Gypsum," *Journal of the Philadelphia College of Pharmacy* 5 (Jan. 1834), 48-52.

210. Tucker, 21. Miles and Gould, vol. 2, 85. Spencer, 19.

211. BOV, Min., July 1, 1842.

212. BOV, Min., July 4, 1843.

213. Miles, 84-85. Tucker 21. An extra $100 was allocated for the "purchase of Chemical apparatus & agents" in July 1842; BOV, Min., July 1, 1842.

214. Tucker, 12. An 1825 list indicates that Emmet had 34 chemistry students, not 35; JPE, Note books of John Patten Emmet, 1825-1841, Mss. 12713, UVSC.

215. BOV, Min., Sept. 19, 1842.

216. BOV, Min., July 4, 1843.

217. Browne, 710. For more on the Rogers family, see Edgar Fahs Smith, "James Blythe Rogers, Chemist, 1802-1852," *Journal of Chemical Education* 20 (June 1943), 287-291; Edgar F. Smith, *Chemistry in America, Chapters from the History of the Science of the United States* (New York and London: D. Appleton and Co., 1914), 235-241.

218. *Catalogue*, 1843-1844, p. 15-16.

219. BOV, Min., July 4, 1843.

220. BOV, Min., July 4, 1843.

221. AR, 1846, p. 9.

222. AR, 1846, p. 14.

223. Gemmill and Jones, 46. "Edward Turner," www.chem.ucl.ad.uk/resources/history/people/turner.html (accessed Oct. 8, 2014).

224. BOV, Min., June 25, 1848.

225. BOV, Min., June 25, 1848.

226. BOV, Min., June 25, 1848.

227. Gemmill and Jones, 44.

228. Gemmell and Jones, 45.

229. BOV, Min., Oct. 17, 1849.

230. BOV, Min., Sept. 1, 1852.

231. BOV, Min., June 25, 1852.

232. John Staige Davis, "History of the Medical Department of the University of Virginia," *Alumni Bulletin of the University of Virginia*, Series 3, 7 (1914), 307. *Catalogue*, 1852-1853, p. 21.

233. Gemmell and Jones, 51-52.

234. AR, 1854, p. 9.

235. AR, 1854, p. 10.

236. *Catalogue*, 1841-1842 through 1854-1855.

237. Gemmell and Jones, 52.

238. BOV, Min., June 25, 1853.

HISTORY

EVOLUTION OF CHEMISTRY LABORATORY AND LECTURE SPACE WITHIN THE ROTUNDA

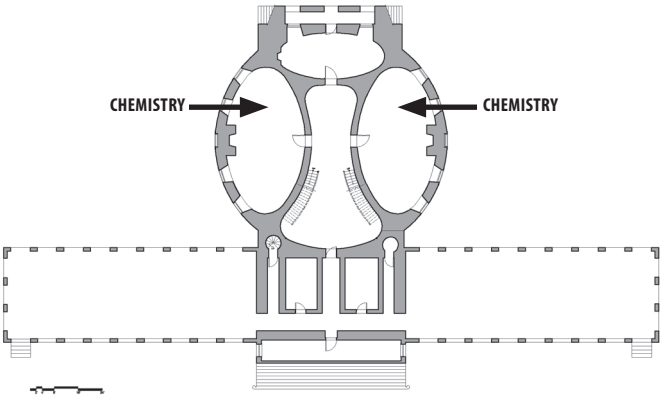


Figure 14. April 1823: Thomas Jefferson states that both large basement rooms are to be used for chemistry. [TJ to Madison, April 30, 1823, James Madison Papers, LOC]

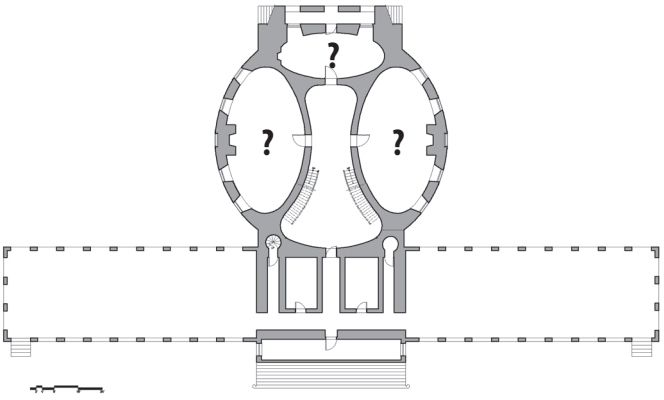


Figure 15. October 1824: Board of Visitors designates one basement room for chemical laboratory. Space not identified further. [BOV, Min., Oct. 4, 1824]

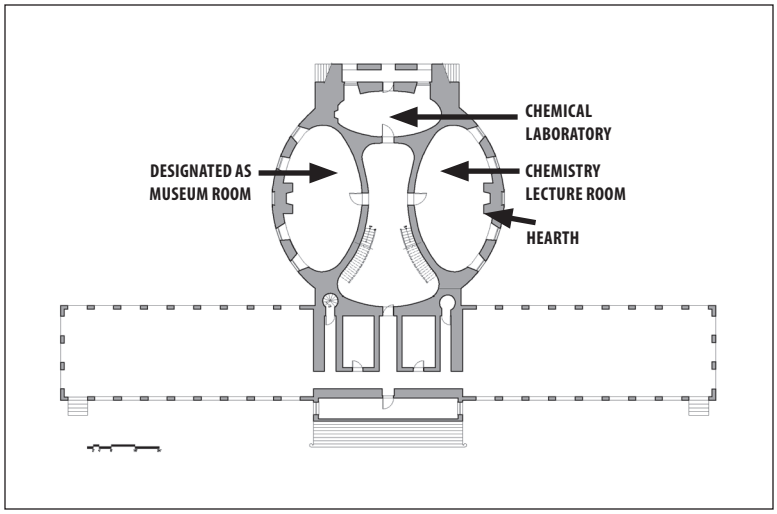


Figure 16. April 1825: J.P. Emmet arrives at the university to begin teaching, finds rudimentary facilities; in May, he sends drawing of new facility to Jefferson. Jefferson, in turn, draws plan of how Emmet's desired features could be incorporated into existing spaces (drawing not located). [JPE to TJ, May 12, 1825; TJ to JPE, May 16, 1825; TJP]

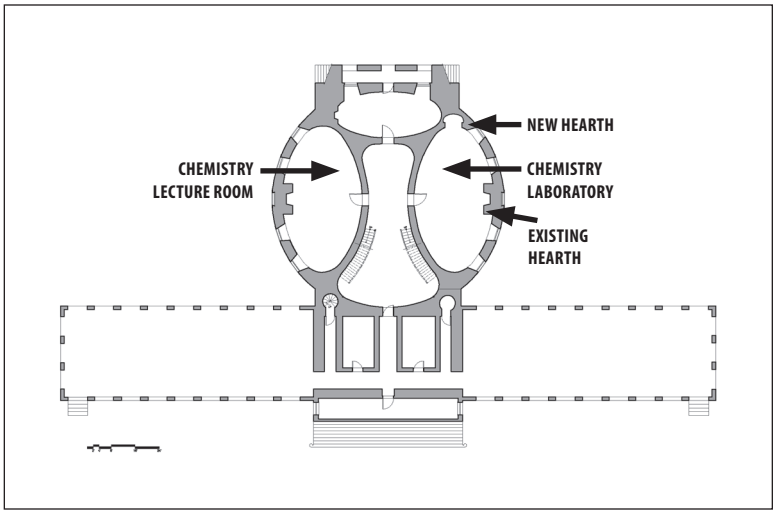


Figure 17. Summer-Fall 1825: Emmet constructs what may have been a supplemental hearth in laboratory space, and moves lecture room to west oval room, after Jefferson finally gives him permission to use the two large oval rooms and equip them as he sees fit. Use of small oval room at this time not clear. [TJ to Arthur S. Brockenbrough, June 7, 1825, TJP]

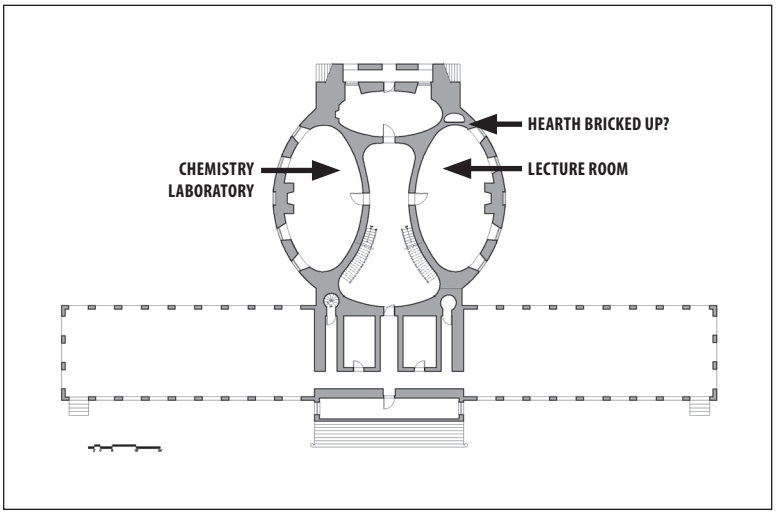


Figure 18. 1841: Positions of lecture room and laboratory switched; supplemental hearth may have been bricked up at this time. [BOV, Min., July 1, 1841; and AR, 1842, 10.]

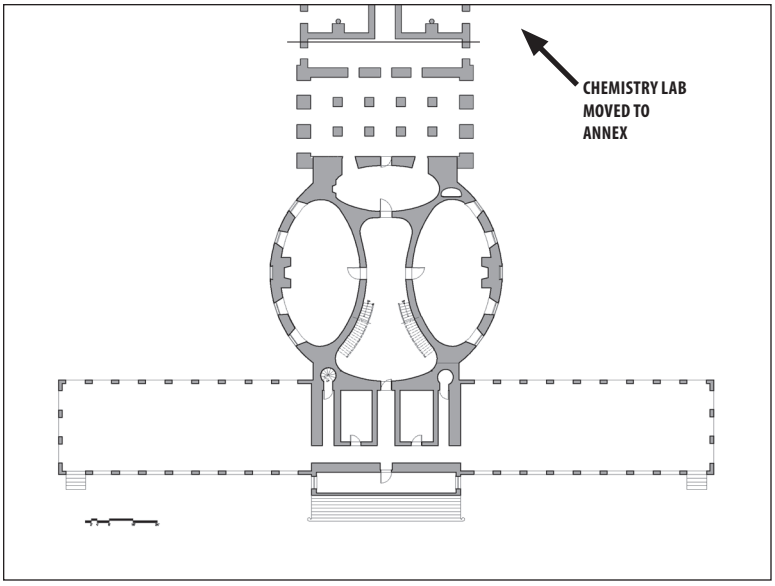


Figure 19. 1854: By 1854, the chemical laboratories and lecture rooms were relocated to the ground floor of the new Rotunda annex. [AR, 1854, 9.]

CHEMICAL HEARTH

Figure 20. The chemical hearth at the north end of the Lower East Oval Room in the restored Rotunda, 2016. [JGWA]

THE ROTUNDA
CHEMICAL HEARTH
INVESTIGATION & DESCRIPTION

DISCOVERY

On February 28, 2013, two architects from John G. Waite Associates, Architects were surveying the Rotunda in the course of preparing schematic design documents for the restoration of the building. Speculation about the impact of the 1897 McKim, Mead and White work on wall thickness of the lower floors of the building led them to look at the exposed brickwork of the two small "chemical ovens" located at the north end of the Lower East Oval Room. These small niches had been discovered during the 1976 renovation work. Small doors had been placed in the finished wall to allow viewing of the two small brick-lined chambers. In the course of examining the niches in 2013 it was discovered that the upper surface of the two chambers were made of cut stone similar to the stone used in the exterior water table of the building. These cut stone elements were approximately 4–1/2" thick, with a 10–1/2" square opening aligned with the brick chambers. These openings led to a large cavity above.

This previously unknown space appeared to be at least partially finished with painted plaster. It was immediately clear that the small niches previously thought to be the extent of the "chemical ovens" were actually just a small part of a larger, more elaborate feature of the building.

A series of small probes were conducted to reveal the full extent of the chemical hearth. Circa 1976 plaster was removed from the brick wall at the north end of the Lower East Oval Room, revealing an arched opening infilled with brick. A probe through the infilled brick wall was gradually increased in size to allow full access to the space. A second probe was made through the floor of the closet located directly above the hearth. The stone water table at the exterior face of the wall adjacent to the chemical hearth was removed to reveal air ducts set into the masonry wall construction (see Figures 39-42). Additional probes investigated the corresponding niches at the north and south ends of the lower west oval room. These crescent shaped niches appear at the north and south ends of the lower east

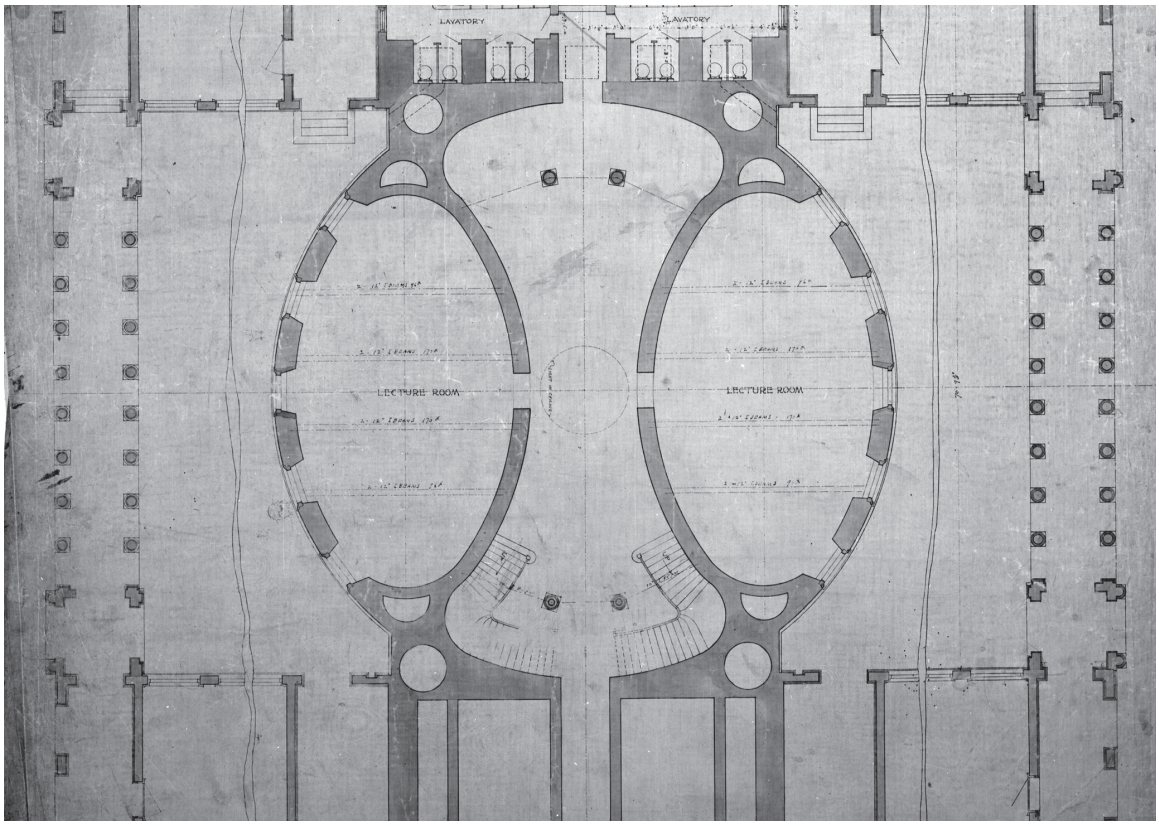


Figure 21. Detail from McKim, Mead & White ground-floor plan, April 9, 1896. [University Archives, UVSC]

and west oval rooms in the circa 1895 McDonald Brothers Architects drawings following the 1895 fire. They appear again in the 1896 McKim, Mead and White Architects restoration drawings on the basement plan (see Figure 21).

DESCRIPTION

The chemical hearth occupies a semi-circular niche at the north end of the Lower East Oval Room. The niche is approximately 5'–10" wide and 5'–2" deep. The jambs of the opening are formed by two shallow piers. The upper extent of the niche is defined by a shallow brick arch. The single rowlock arch has been interrupted and partially replaced with both clay and concrete bricks. The lowest four bricks of the arch remain on either side. The surface

of the exposed bricks suggest that the entire opening, including piers and arch, were once covered by a layer of plaster finish. The ceiling of the niche is a flat surface constructed of red Guastavino tile (see Figure 49).[1] The floor of the niche is loose clay brick laid in a herringbone pattern set on a sand bed. The floor is approximately 7–3/4" above the current floor level of the east oval room, and may represent the historic floor level of the larger oval room (see Figure 44).

Projecting from the walls of the niche are five distinct work stations constructed of brick with a thin plaster finish. The workstations are roughly symmetrical about the north-south centerline of the niche and oval room (see Figures 31 and 32).

The outermost stations are an irregular shape in plan and are built against the piers that form the jambs of the niche. These stations are topped by a cut stone slab approximately 4–1/2" thick that forms a small work surface. An approximately 10–1/2" square hole in the slab is oriented 45 degrees from the face of the pier. The outermost points of the opening touch the faces of the piers. The northern edges of the stone slabs are angled in plan. The facing edges of the slab are rounded. The southern edges of the slabs appear to have been chipped away to align with the shape of the oval room. These edges likely projected into the oval room by a few inches. This modification was probably done when the hearth was initially abandoned and the opening filled in. Below the stone slab at each station is a small brick chamber located directly below the square openings and presumed to be a firebox. Access to the firebox is through a horizontal opening that aligns with the slab opening. Inside the firebox are several cast-iron bars. The loose bars are square in section with slightly larger square ends, oriented 45 degrees from the bars (see Figure 10). These bars sit on a narrow brick ledge on either side of the firebox to form a simple grate. At the rear of the firebox below the grate is an approximately 3" x 6" opening that leads to a brick-lined duct. At the east station this duct travels horizontally to the east, then up vertically approximately 2'–0", then horizontally again through the exterior wall to an opening at the stone water table (see Figure 37). At the west station this duct travels down approximately 1'–6", then east under the floor to join up with the vertical duct of the east station. At the rear of each firebox is an opening approximately 3" x 6" just below the stone slab. The opening leads to a vertical brick flue located within each pier. A small slit is located on the face of the pier above the work station. The slit is approximately 9" wide and 1/8" tall. This slit aligns with and connects to the vertical flue. This slit may have been intended to be a type of simple damper, utilizing a piece of thin sheet metal. The sheet metal damper could be inserted or withdrawn from the flue to control the draft (see Figure 46).

CHEMICAL HEARTH

Between the outer stations and the center station are two intermediate stations. These stations are much simpler in construction compared to the outer stations. The work surface appears to have been exposed brick laid on top of a plastered brick chamber. Some of the bricks are missing, but they appear to have extended across the width of the station and slightly overlapped the outer stations. An approximately 8" square opening in the work surface extends down to the floor level. An approximately 7" x 7" opening at the floor level connects to this chamber. At the northwest station a small cast-iron grate was found in place approximately 3" below the work surface (see Figures 47 and 48). At the northeast station a brick duct at the top of the chamber extends horizontally to the northeast and nearly straight out to the opening in the water table. At the northwest station a similar duct connects to a vertical duct that extends down to a horizontal duct under the floor that then connects to another vertical duct and finally up to the water table vent. There are no vertical exhaust flues connected to the intermediate stations.

The center station is slightly offset from the centerline of the niche towards the east. The center station also has a cut stone slab, set lower than the adjacent work surfaces. The exposed front edge of the slab is convex in plan and projects slightly into the center of the niche. The plain plastered wall below follows this curve. The stone slab has a small round depression carved into the top. Above the slab is an approximately 1'–3" wide by 1'–3" deep by 1'–6" tall chamber. The sides and back of the chamber are brick. The opening of the chamber has been partially filled in with brick. This infill has an approximately 6" diameter hole, that appears to have been retrofitted for a later flue pipe (see Figure 42).[2] The top of the chamber is constructed of corbeled brick that forms a small tapered hood to the chamber. The front of the hood rests on a small flat iron bar. The hood transitions into a pier that extends up to the ceiling. The flue within extends beyond into the chamber above. There does not appear to be any provision for a damper for this flue. An approximately 1" diameter sheet metal tube is set within the west wall of the chamber and connects to the interior of the chamber. This tube appears to be constructed of tin-plated iron; it may have been part of a bellows system to aerate charcoal in the depressed stone slab of the chamber (see Figure 50).

The brick ducts below the floor appear to have been laid directly on the brick wall footings that extend across the width of the niche. There appears to be at least one iron plate under the west intermediate station, perhaps used to support the brick construction above, or perhaps to provide a cover for an air passage beneath the floor, but its full extent and purpose are unknown.

INVESTIGATION & DESCRIPTION

The Guastavino tile ceiling of the niche separates the lower portion of the hearth from a small chamber beneath the closet floor above. From within the upper chamber the three piers formed by the three flues and the curved wall of the niche can be seen. The plaster finish of the curved wall continues up to a point nearly level with the existing second finished floor level of the second floor. This may indicate that there was initially no floor here, and that the cavity above the hearth continued to a flue or outlet above. The two outer piers flanking the chemical hearth appear to have been connected by three distinct arches springing from three distinct elevations. The successive, stepped arches form a hood above the hearth (see Figure 27). The lowest portions of the outer arch are visible from below. The lowest portions of the upper two arches can be seen from above.

The three successive arches at the opening of the niche and lack of clear evidence for a floor above suggest that the ceiling may have actually stepped up to form a kind of fume hood over the entire niche to draw out dangerous vapors and smoke. This hood could have joined up with the three other flues and continued up through the building to a chimney at the roof level.

The probes at the corresponding niches at each end of the west oval room indicate that these spaces are part of the original construction of the building and were simply leftover spaces resulting from the unusual geometry of the building. The two west niches were completely full of debris that was deposited in several distinct layers, and it is clear that these spaces were never occupied. From top to bottom the layers are:

1. Circa 1976 floor construction.
2. Circa 1976 construction debris.
3. Circa 1897 Guastavino tile laid over debris.
4. Circa 1897 construction debris.
5. Circa 1895 fire debris.
6. Circa 1825 construction debris.
7. Circa 1825 brick foundation.

By comparing the construction method of the west niches with that of the chemical hearth, it is clear that the chemical hearth was inserted into an existing niche after the building was at least partially complete, rather than integrated into the building during the initial construction.

CHEMICAL HEARTH

The niche at the south end of the east oval room was disturbed during the 1976 reconstruction work. This area will again be disturbed to create a new vestibule for an elevator during the current phase of renovation work.

On the east elevation of the Rotunda drum the bottom of the water table stone adjacent to the chemical hearth was roughly chipped out to create an air passage. This passage splits into four brick ducts that connect to the four outer and intermediate work stations of the chemical hearth.

FUNCTION

The two outer stations appear to be built with the same features and to function in a substantially similar way to each other. These stations are composed of the following components:

1. A firebox with cast-iron bars forming a grate.
2. A duct to draw in fresh air.
3. An opening, perhaps with an iron door, to tend the fire.
4. A flue to exhaust smoke.
5. A damper to control the draft of the flue.
6. An opening in the stone counter slab.

The opening in the stone counter slab may have been fitted with one or more devices to transfer the heat of the fire to the materials in the experiment. These could include an open grate, a flat iron plate, a metal box containing sand or water, or perhaps an earthenware vessel.

The two intermediate stations appear to be built with the same features and to function in a substantially similar way to each other. These stations are composed of the following components:

1. A firebox or chamber.
2. A duct to draw in fresh air.
3. An opening at the floor level.
4. A cast-iron metal grate.

INVESTIGATION & DESCRIPTION

It is not clear how these stations were used. They may have been used for much smaller fires with lower heat and less smoke; charcoal may have been placed on the grates.

The center station is composed of the following components:

1. Firebox with depressed stone slab.
2. Bellows tube.
3. Smoke hood and flue.

It is likely that a bellows was connected to the metal tube and was used to create a hotter fire.

NOTES

1. The Guastavino tile is a remnant of the tile vaulting installed during the McKim, Mead & White restoration to support the main floor. The tile was removed in 2015 to re-establish the cavity of the hood above the chemical hearth.

2. The brick infill was removed in 2015 to re-establish the original chamber of the center station (see Figure 20).

CHEMICAL HEARTH

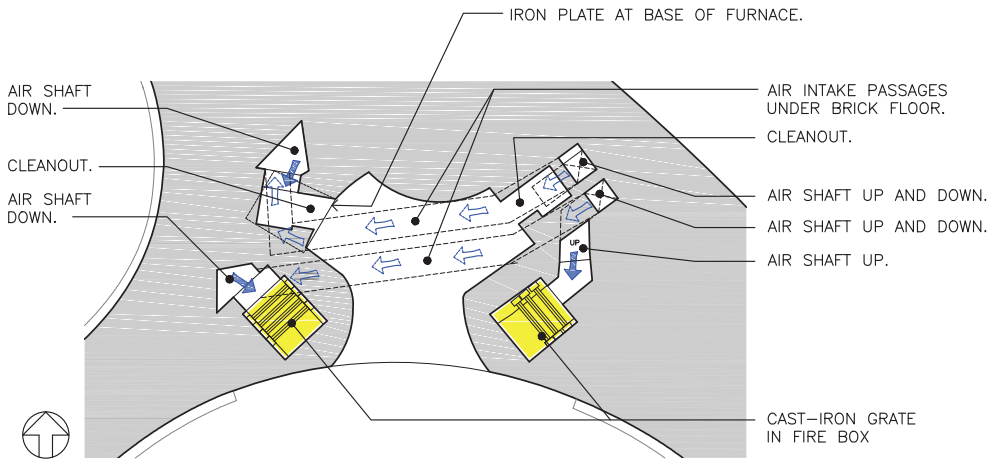


Figure 22. Chemical Hearth Lower Plan. [JGWA]

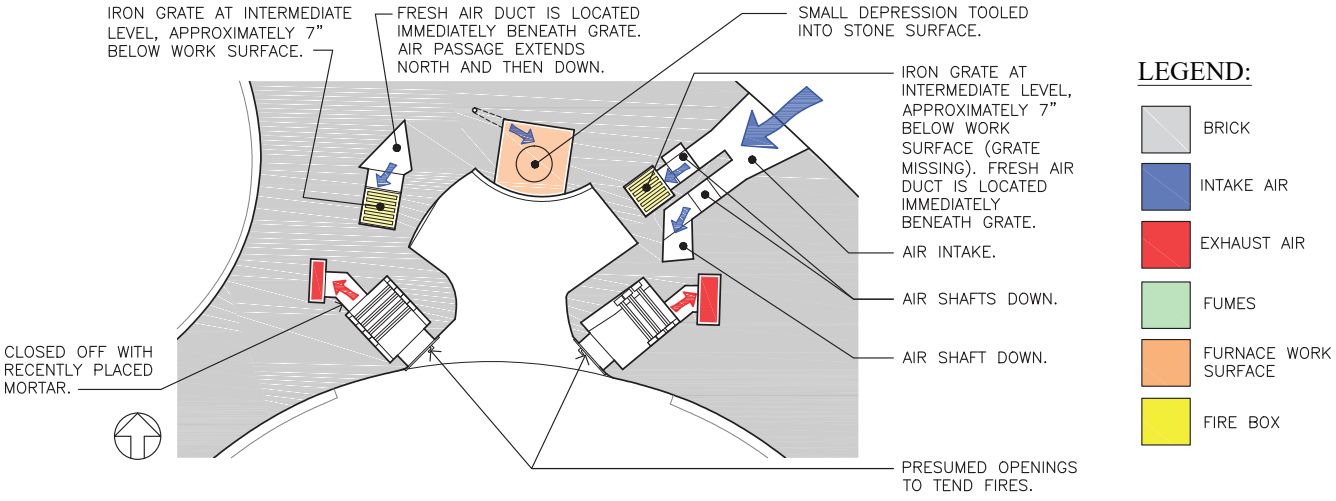


Figure 23. Chemical Hearth Middle Plan. [JGWA]

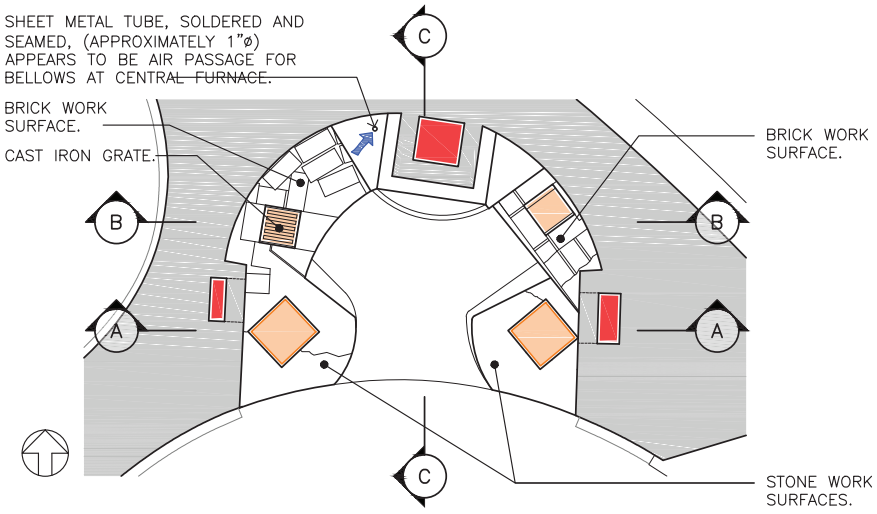


Figure 24. Chemical Hearth Counter Plan. [JGWA]

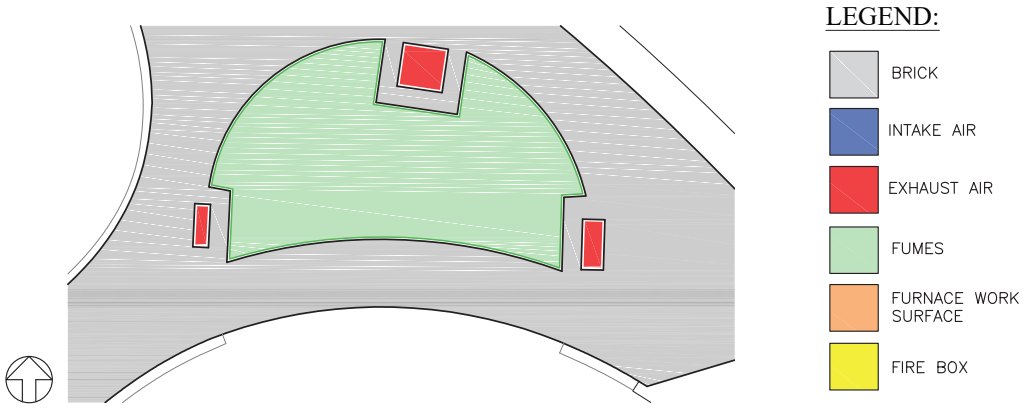


Figure 25. Chemical Hearth Upper Plan. [JGWA]

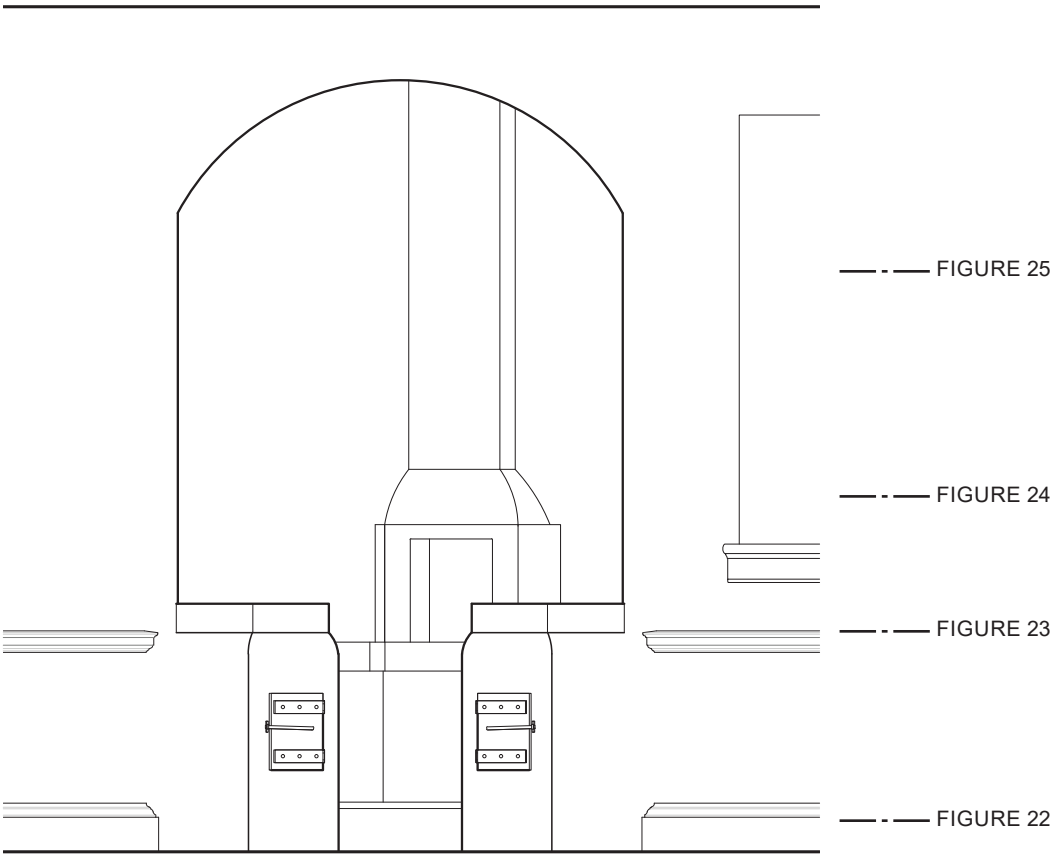


Figure 26. Conjectural north elevation of the chemical hearth. [JGWA]

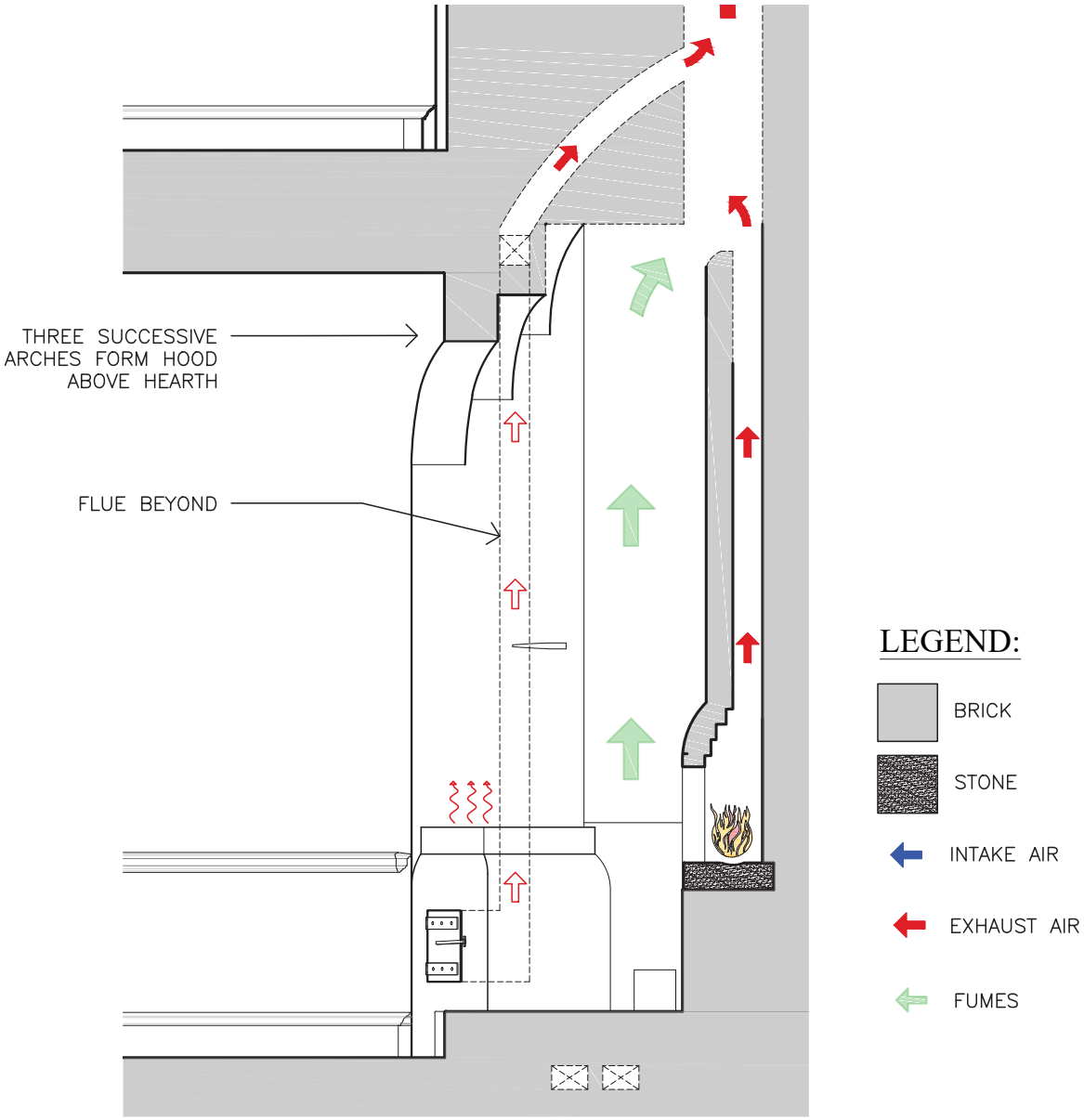


Figure 27. Section C-C through chemical hearth, looking west (see Figure 24). [JGWA]

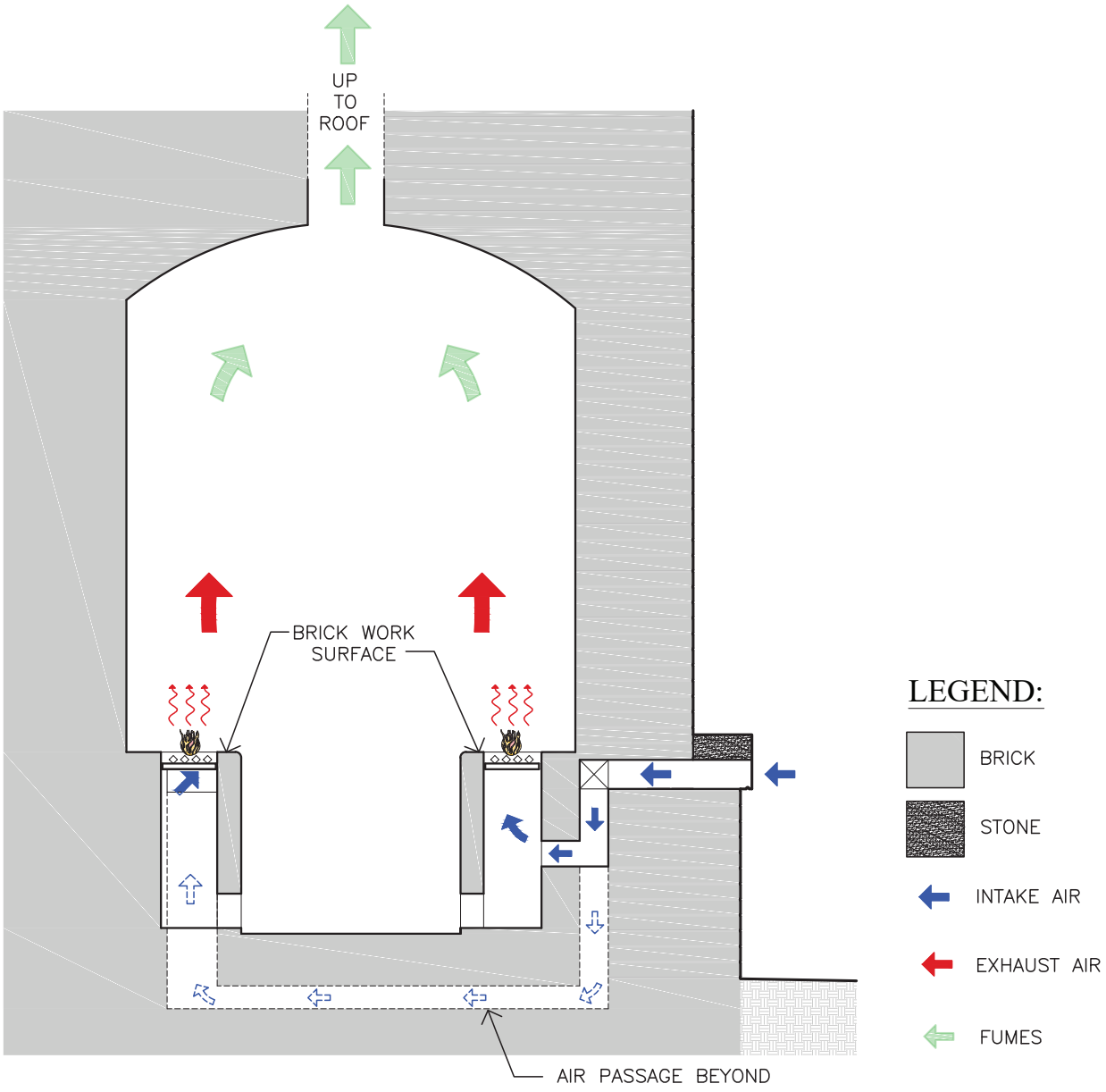


Figure 28. Section B-B at back furnaces, looking north (see Figure 24). [JGWA]

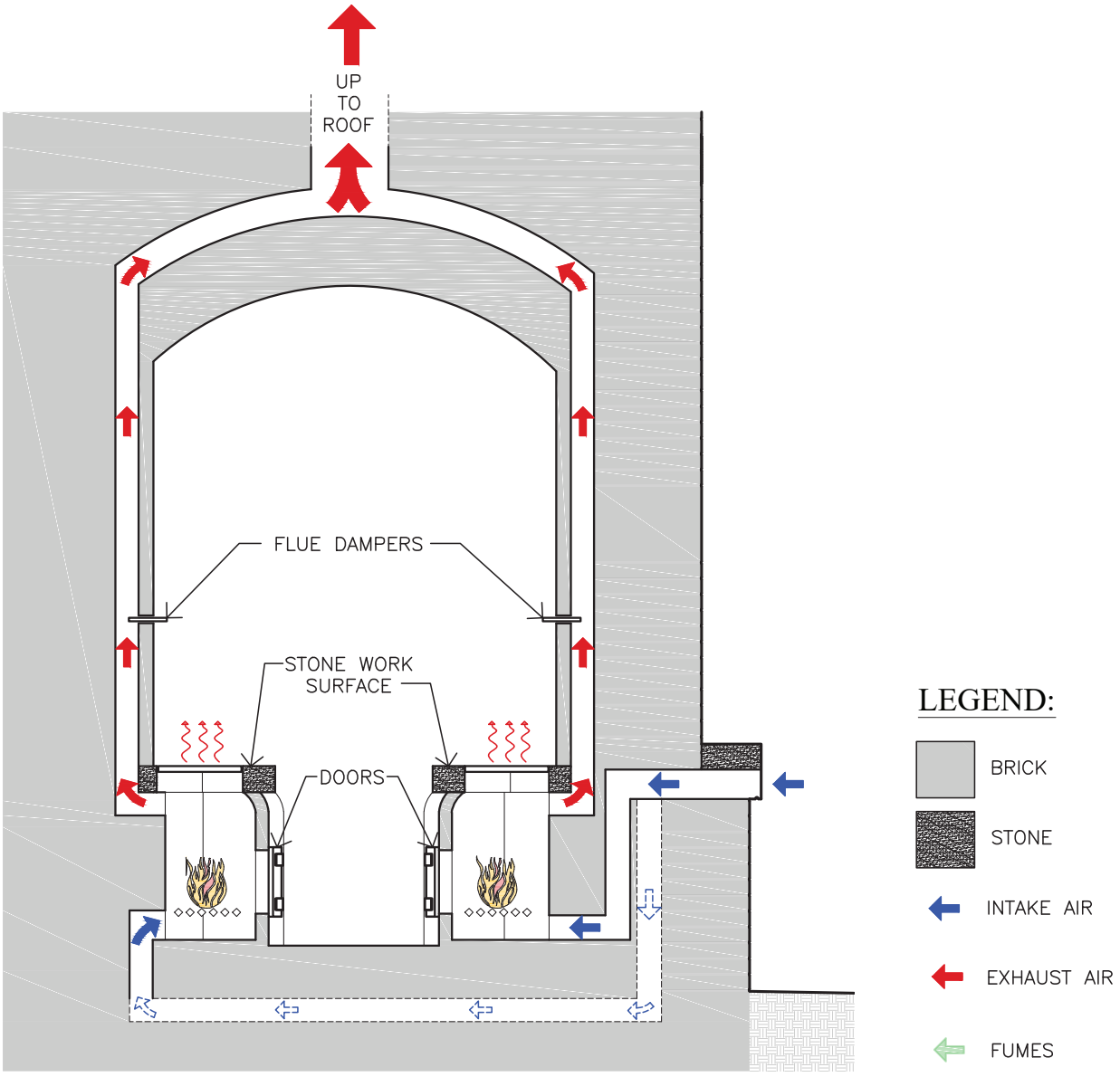


Figure 29. Section A-A at front furnaces, looking north (see Figure 24). [JGWA]

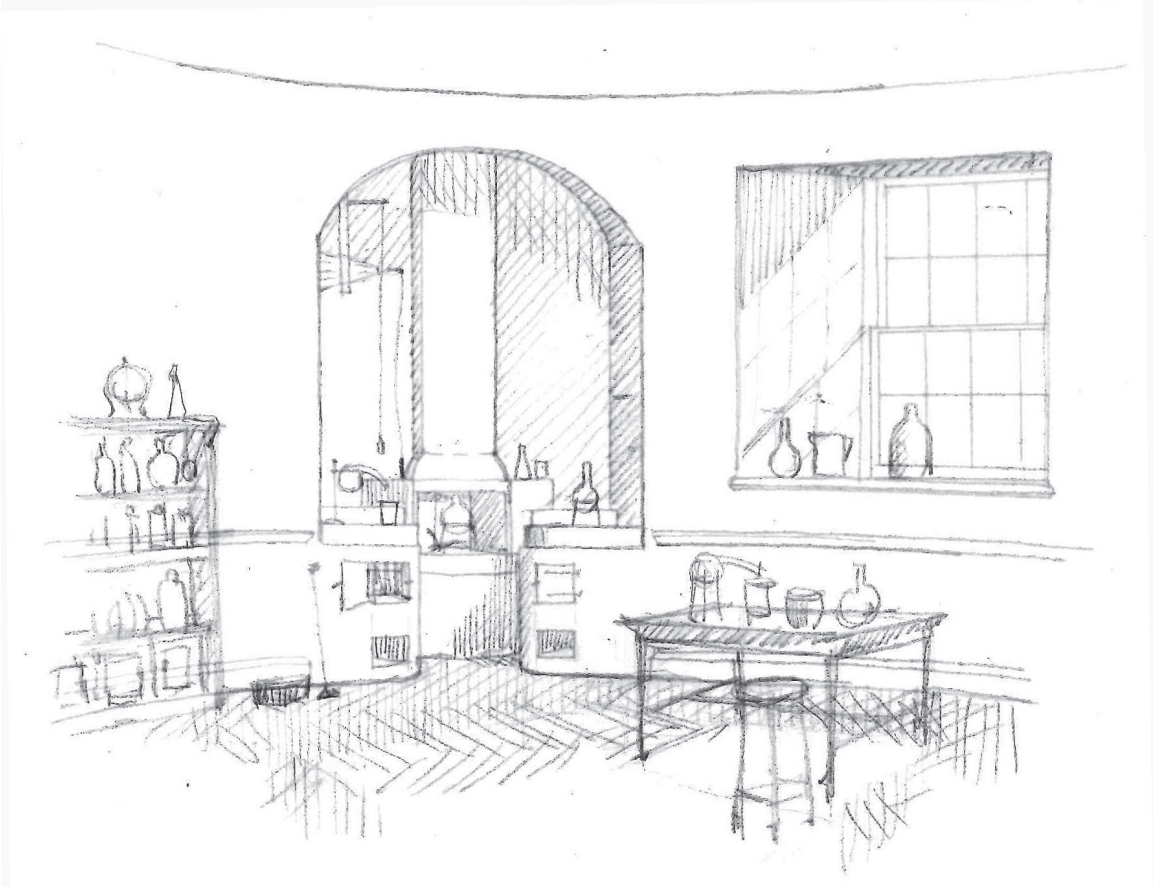


Figure 30. Conjectural sketch of the chemical hearth at the north end of the Lower East Oval Room, with Emmet's apparatus. [JGWA].

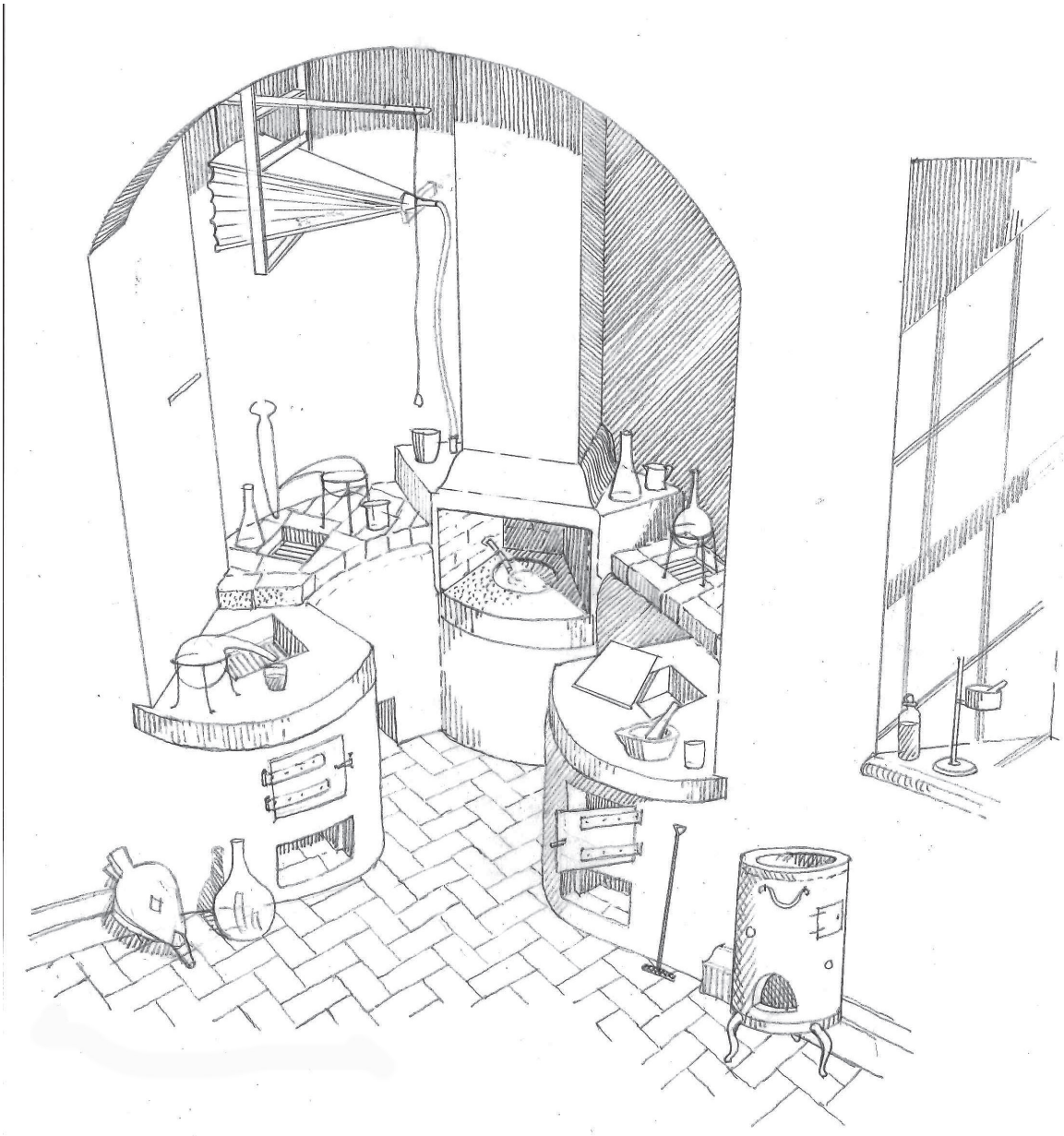


Figure 31. Conjectural sketch of the chemical hearth with Emmet's apparatus. [JGWA]

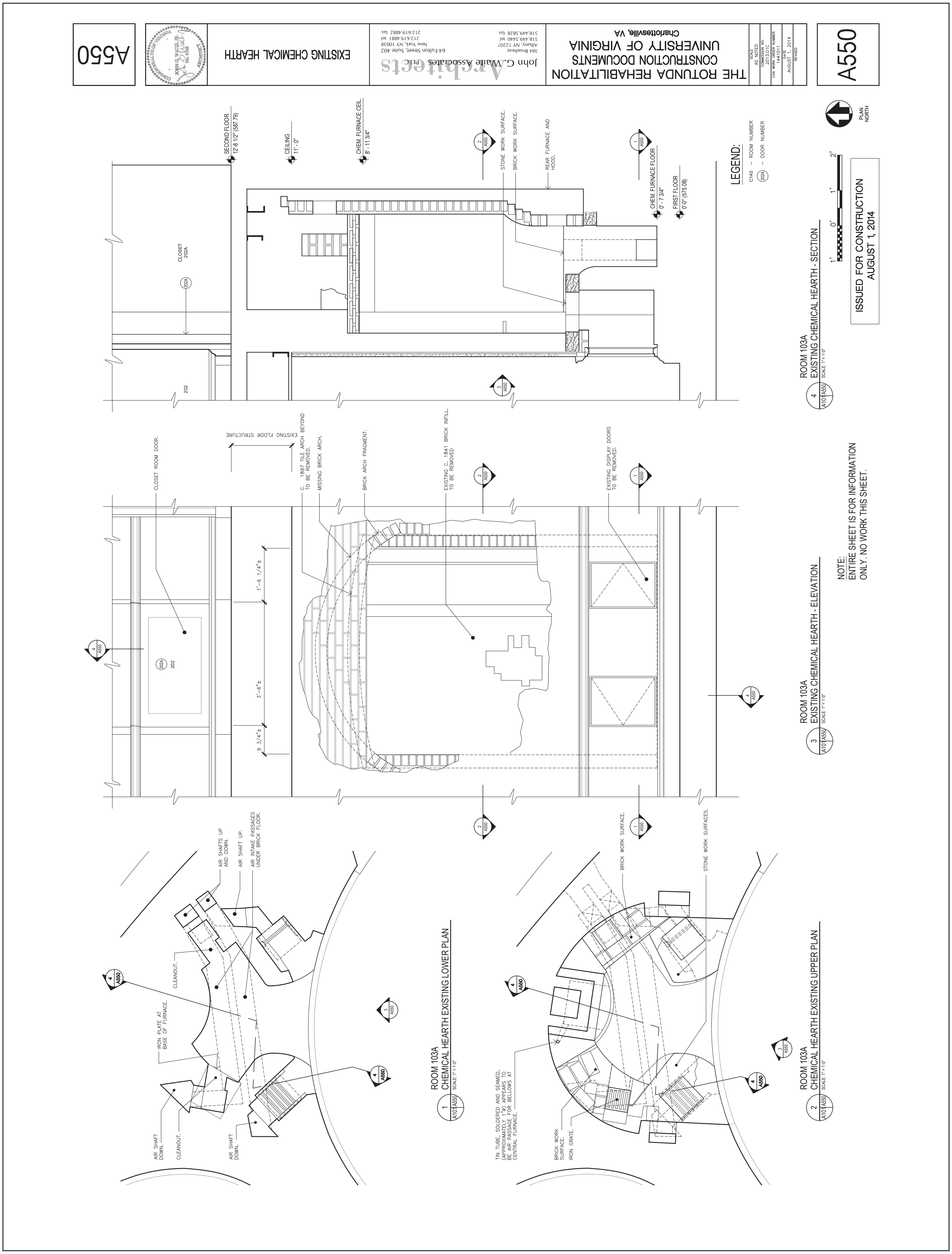


Figure 32. Existing conditions at the chemical hearth, from the August 1, 2014 construction documents for the Rotunda rehabilitation. [JGWA]

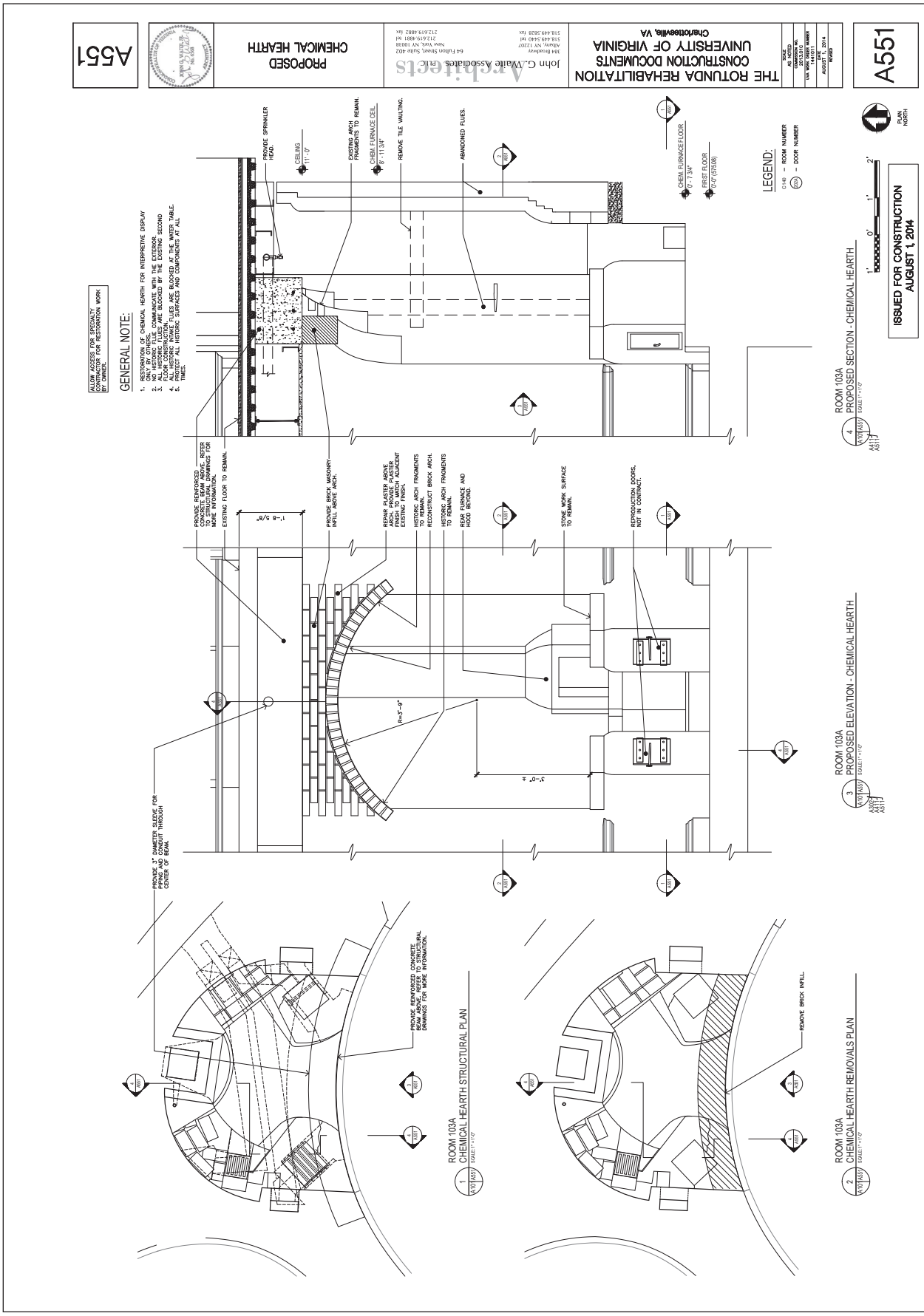


Figure 33. Proposed treatment of the chemical hearth, from the August 1, 2014 construction documents for the Rotunda rehabilitation. [JGWA]

Figure 34. East elevation of the Rotunda after the 1895 fire. Note column in east oval room (in the upper photograph) and the exposed vents in the water table (lower photograph). [RG-30/1/10.011, UVSC]

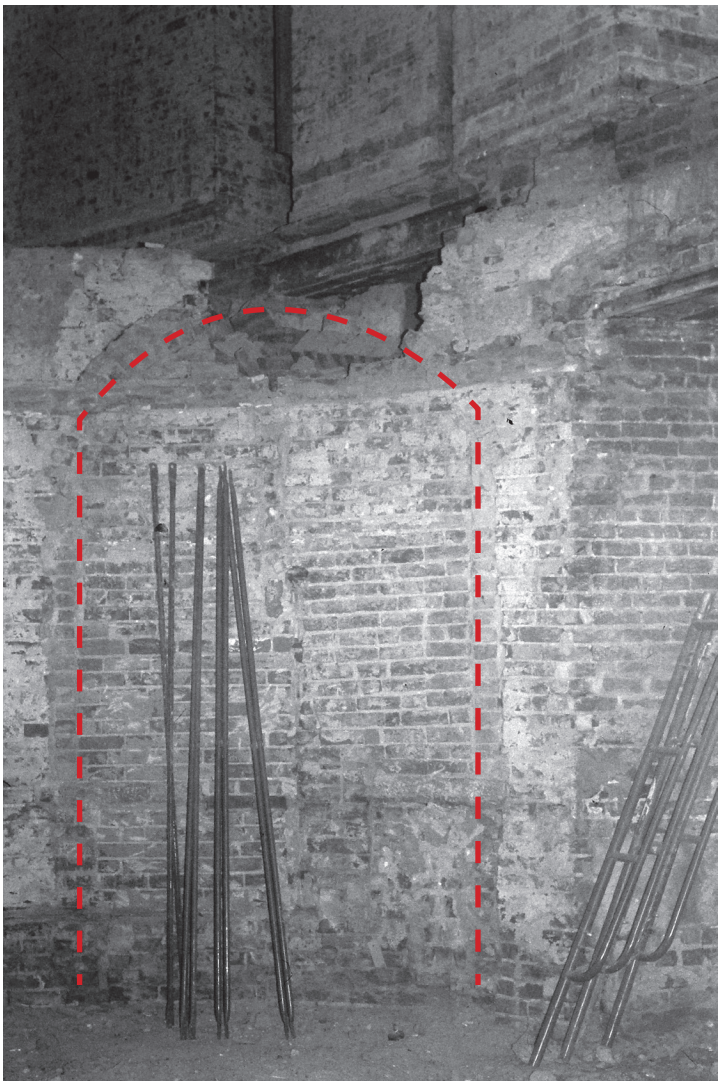


Figure 35. View of the north wall of Lower East Oval Room during 1976 reconstruction. The dotted line indicates the location of the opening for the chemical hearth. [UVSC]

Figure 36. View up through one of the fire boxes discovered in the 1976 work, showing a glimpse of the large cavity above, partially finished in plaster. [JGWA, 2013]

Figure 37. The stone water table on the east facade of the Rotunda drum, adjacent to the chemical hearth, was removed to reveal the fresh air intake for the chemical hearth at the north end of the east oval room. The lower edge of the stone water table, seen in the upper photograph, was chipped out to accommodate the fresh air intake. [JGWA, 2012-2013]

Figure 38. The stone water table on the east facade of the Rotunda drum. The water table at the center window, behind the chimney mass, was removed to investigate possible air duct locations. A cutout in the stone water table, seen in the upper photograph, filled with mortar and brick, may have been the location of a fresh air intake for the main hearth on the east wall of the Lower East Oval Room.[JGWA 2012-2013]

Figure 39. (Above) Early probe, removing plaster from the north end wall of the Lower East Oval Room.

(Left) View of the probe after it was enlarged. [JGWA 2013]

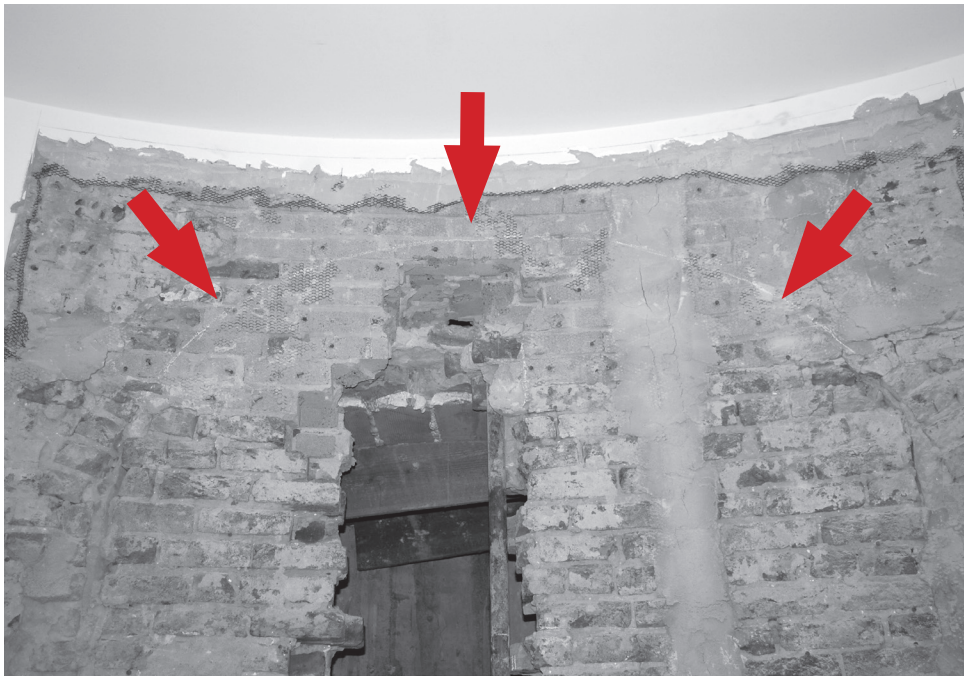


Figure 40. Chalk line outlining the historic arched opening at the chemical hearth. [JGWA, 2013]

Figure 41. View down through the probe to the undisturbed condition of the hearth. [JGWA, 2013]

Figure 42. Overall views of west side (above), center (upper right), and east side (right) of the hearth. [JGWA, 2014]

Figure 43. East stations. [JGWA, 2014]

Figure 44. Hearth floor. [JGWA, 2014]

Figure 45. West stations (above left and left); and looking down into the west station fresh air duct (above right). [JGWA, 2014]

Figure 46. (Left) West pier with slit for damper control of the flue beyond. [JGWA, 2014]

Figure 47. (Below) West intermediate station with cast-iron grate. [JGWA, 2014]

Figure 48. West intermediate cast-iron station grate (upper image) and iron plate (lower image). [JGWA, 2014].

Figure 49. Center flue and circa 1897 Guastavino tile ceiling (above) and view up through center flue (left). [JGWA, 2014]

Figure 50. Detail of tinplate pipe located immediately west of the center station. This pipe is believed to have been part of a bellows system. [JGWA, 2014]

Figure 51. East intermediate station with shelf (upper image); and looking down through the station (lower image). [JGWA, 2014]

Figure 52. West station counter. A fragment of the brick infill wall construction that concealed the chemical hearth can be seen bearing on the stone counter top. [JGWA, 2014]

Figure 53. The plaster wall finish of the chemical hearth appears to continue above the second floor level. [JGWA, 2013]

RECOMMENDATIONS

THE ROTUNDA

CHEMICAL HEARTH

RECOMMENDATIONS

PRESERVATION AND STABILIZATION

While it may be tempting to restore the chemical hearth and its surviving furnaces to a specific period in time, a substantial amount of conjecture would be involved, and it is likely that some degree of the surviving physical evidence would be altered or destroyed. The challenge will be to preserve the appearance and perception of the two hundred year archaeological discovery, while simultaneously stabilizing the fragile physical artifact and making it available for interpretation.

A curatorial approach should be taken with the painted plaster finish, the brick and stone masonry, the tinplate piping and the cast-iron grates and bars. These materials will need to be cleaned, and portions of the historic plaster may need to be stabilized where it has lost bond with the masonry.

The infill brick should be removed from the modified opening of the central furnace to reveal the original hood construction of the station.

The original arched brick opening for the chemical hearth alcove has been compromised. At the time of the 1970s interior reconstruction the damaged arch was not rebuilt; however, the masonry wall construction at the north end of the Lower East Oval was repaired with concrete brick. The infill brick should be removed from the alcove opening, taking care to preserve the original brick arch construction. Missing portions of the successive, stepped brick arches should be reconstructed to frame the opening of the alcove for the chemical hearth.

CHEMICAL HEARTH

INTERPRETATION

Decisions must be made with regard to interpretation of the hearth and its individual elements, and with regard to the context of the larger laboratory and lecture hall. There are several interpretative approaches that may be considered. The most extensive would be a reinterpretation of the Lower East Oval as a nineteenth century laboratory space with laboratory equipment and furniture, fuel for fires, intermediate structural columns, and tiered seating. There would be some degree of conjecture involved in this approach; however, John Emmet's drawings of apparatus, the archaeological confirmation of two column foundations, and the survival of the chemical hearth at the north end of the space provide substantial evidence for the recreation of the larger laboratory. This information can be supplemented with the documentation of other nineteenth century American and European chemistry laboratories.

Modifications made during the 1898 restoration and during the 1970s reconstruction of the building interior have obstructed or destroyed evidence that may have remained from a chemical hearth or fireplace on the east wall of the room. If serious consideration is given to an interpretation of the larger laboratory, additional probes at the modified chimney mass on the east wall should be undertaken; although, it appears that much of the evidence was destroyed following the fire of 1895 when the existing chimney mass was largely removed for the installation of a central window on the east elevation of the room.

In the scenario outlined above, the surviving hearth at the north end of the room would become a highlighted feature of the larger laboratory.

An alternative approach to interpretation could involve stabilization and presentation of the surviving chemical hearth at the north end of the Lower East Oval in combination with exhibits that illustrate nineteenth century chemistry education and laboratory apparatus. The exhibits could provide digital or model representation of the laboratory and lecture spaces within the larger building. This approach isolates the chemical hearth at the north end of the Lower East Oval, but it leaves the remainder of the room available for other purposes.

The services of a museum exhibit designer, in consultation with a preservation architect, should be sought for an appropriate presentation of the hearth. This work should incorporate the design of an unobtrusive lighting system that will sufficiently illuminate the hearth for interpretation. Care must be taken not to sacrifice the surviving materials.

RECOMMENDATIONS

A more drastic approach to interpretation could follow the example of the Caves at Lascaux in southwestern France. These caves with Paleolithic paintings were discovered in 1940 and opened to the public in 1948. By 1955 visible damage to the paintings was being attributed to carbon dioxide, heat, humidity and other contaminants associated with more than 1200 visitors a day. The caves were closed to the public in 1963 to preserve the art, and a replica of a portion of the caves, known as Lascaux II, was opened to the public in 1983. In a similar way, the hearth within the Rotunda could be accurately recorded, and a recreation could be erected at a remote location. Any conjecture necessary for a complete interpretive exhibit would have no adverse impact on the original hearth. Furthermore, the existing hearth could more easily be preserved in a closed environment, with access limited to academic investigation. Alternatively, a recreation in model or digital form could be made available to visitors.

ACCESS

Providing interpretive access to the historic chemical hearth, while restricting physical access, is problematic. Visitor access within the alcove of the hearth will lead to unnecessary wear. If the hearth is exposed to public visitation, the best possible solution for the long term preservation of the artifact will be the erection of an unobtrusive physical barrier that enables visitors to see, but not touch, the hearth. A glass knee wall with an interpretive rail positioned beyond the alcove opening should allow sufficient access for interpretation while restricting contact with the historic materials.

The final solution should make provision for the curatorial access that will be necessary for long term cleaning and conservation needs.

ADDITIONAL RESEARCH AND INVESTIGATION

As part of the interpretive process, additional research is recommended to better understand chemistry education at UVA and the operational aspects of a nineteenth century chemistry laboratory. Specific recommendations for research and investigation are provided below.

1. Locate more information about how Jefferson developed his ideas for constructing the chemical hearth in the basement of the Rotunda:

- Search the papers of Joseph Cabell, a member of the Board of Visitors, who had earlier investigated universities in Europe and had a special interest in chemistry.
- Search the papers of architect B. H. Latrobe for references to the chemical hearth in Davidge Hall at the University of Maryland and for any correspondence with Jefferson related to chemistry.
- Search collections of papers of other chemists with whom Jefferson corresponded, including Thomas Cooper, William J. MacNeven, Franklin Bache, and others.
- Investigate Jefferson's association with the American Philosophical Society.
- Investigate further Jefferson's role in the establishment of the French academy of the sciences and fine arts in Richmond, Virginia, in the 1780s.
- Investigate Jefferson's connections with eminent chemists and private chemical laboratories during his years in Paris, including Benjamin Franklin's science connections and experiences that may have helped or influenced Jefferson.
- Investigate contemporary chemical laboratories at other American colleges and universities, including the following: Dickinson College, University of Pennsylvania, University of Maryland, College of William and Mary, Harvard University, Yale University, Rutgers University, University of South Carolina, and the U.S. Military Academy at West Point.
- Review digital collections of Jefferson papers online as they are updated.

2. Investigate the possibility that Jefferson's drawing for John Emmet, of the chemistry laboratory and lecture room, still survives:

- Contact scholars and archives.
- Identify and locate Emmet family descendants to see if there are additional papers of John Emmet available.

3. Gather additional information on how Professor John P. Emmet set up and utilized the chemical hearth:

RECOMMENDATIONS

- Locate information on where and how Emmet gave lectures in Charleston, South Carolina, immediately before his appointment to the faculty at the University of Virginia.
- Search faculty minutes, including those for the early 1840s when the locations of the laboratory and lecture hall were to be reversed.
- Study notebooks of Emmet's students and his course of lectures, including students in the medical school, to see if students were doing their own experiments. Investigate whether any of his students became famous scientists and published accounts of their student experiments.
- Collect the remainder of Emmet's published scientific papers to see what features of the chemical hearth he was using.
- Investigate the papers of Robley Dunglison, who taught medicine at the University of Virginia while Emmet was teaching chemistry (Dunglison had wanted to teach chemistry as well).
- Obtain information on how the possible changing sizes of chemistry classes and the possible expansion of the chemistry curriculum may have affected the arrangement of the chemistry facilities.
- Search for any possible photographs of the former lecture room and laboratory after the chemistry facilities were moved to the annex of the Rotunda.

4. Determine whether the other professors who taught chemistry in the basement of the Rotunda produced any descriptions of the laboratory and lecture rooms before they were moved to the new annex of the Rotunda:

- Review the papers of brothers William Barton Rogers and Robert E. Rogers and their father, Patrick Kerr Rogers, who taught at the College of William and Mary.
- Review the papers of J. Lawrence Smith.
- Investigate the decision to construct a second chemical laboratory in the anatomical theater building for clues about the original laboratory and lecture hall.

5. Additional probes of the building may yield more physical information. Selective removal of the 1970s concrete block at the east chimney mass in the Lower East Oval may expose flues and air passages used for a larger chemical hearth; however, significant construction modifications in this area could have destroyed any remaining evidence.

6. Video inspection of the air passages within the north hearth may help us to better understand the mechanics of the surviving furnaces.

7. The removal of the 1970s wood paneled reveal in the north door opening of the Lower North Oval may confirm the existence of a single window or door in the space that Emmet described as oppressively hot, suffering from "want of room & light".

THE IMPORTANCE OF THE CHEMICAL HEARTH

The circa 1825 chemical hearth in the Rotunda at the University of Virginia is one of the last, if not the last, surviving, unmodified hearths used for chemistry education in nineteenth century America. The nature of chemistry education requires that facilities constantly change to address the shifting needs of experimentation and advances in the field. Generally, laboratory facilities are renovated or removed when they become functionally obsolescent. The existing facility has survived because the alcove housing the hearth was bricked over and forgotten. The chemical hearth in the Rotunda has been preserved as a time capsule. It survived half a century of building modifications, a catastrophic fire, a major turn-of-the-century building restoration, and an extensive late twentieth century building renovation. The chemical hearth is an extremely rare and culturally significant artifact that has provided an even greater appreciation of Jefferson's contributions to education.

THE ROTUNDA
CHEMICAL HEARTH
APPENDIX A

Conservation Treatment Report for Plaster Stabilization
within the Chemical Hearth
at the Rotunda
University Of Virginia Charlottesville, VA

Conservation Solutions, Inc.
Forestville, Maryland

CONSERVATION TREATMENT REPORT
for
ADDITIONAL PLASTER STABILIZATION
within the
CHEMICAL HEARTH
at the
ROTUNDA
UNIVERSITY OF VIRGINIA
CHARLOTTESVILLE, VA

Prepared for:
Mark Kutney, Architectural Conservator
University of Virginia
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Charlottesville, VA

Prepared by:
Caitlin Smith, Conservator & Project Manager

Date:
December 1, 2015

INTRODUCTION
At the request of the University of Virginia, Conservation Solutions, Inc. (CSI) performed additional in situ stabilization of fragile plaster surfaces within the 19th-century chemical hearth within the historic Rotunda on the UVa campus. An initial site visit and investigation was performed on May 1, 2014; the first treatment was performed May 20-22, 2014. The additional treatment described in this report occurred on November 23-24, 2015.

SCOPE OF WORK
The goal of the first intervention was to stabilize vulnerable plaster surfaces within the chemical hearth while the Rotunda undergoes major structural stabilization. The intention was to provide sufficient stabilization against potentially damaging vibrations associated with the renovation, specifically underpinning of the foundation.

The goal of this intervention was to provide additional stabilization to potentially vulnerable plaster surfaces within the chemical hearth while work occurs within it. In addition to the previously treated areas, CSI treated the area above the Guastavino ceiling vault. The scope of work included injecting adhesives behind the plaster surfaces and applying a facing to the renders just adjacent to the ceiling to help stabilize these during the future removal of the ceiling.

At the conclusion of construction, a dedicated and more comprehensive conservation/restoration treatment can be performed. The selected treatment was intended to be as non-invasive as possible and to provide the least amount of interference with whatever conservation/restoration plans are developed in the future.

MOBILIZATION
CSI mobilized tools, equipment, and personnel to the site. All equipment was stored on site; at the end of each day, materials were collected out of view behind a plywood barrier wall and the spaces were relocked where applicable.

Before work began in the area above the ceiling vault, UVa staff removed the pier within the space. Both spaces, the hearth on the first floor and the area above, were lightly vacuumed before CSI staff arrived.

DRY CLEANING
Before starting the treatment, the surfaces and floor of the hearth were gently vacuumed again by CSI staff to remove loose dust and debris from the space. Only "dry" methods were used to clean the chemical hearth, including clean cotton rags and soft bristle brushes.

ADHESIVE STABILIZATION
The primary method of stabilization was re-adhesion of the plaster to the brick substrate. Plaster surfaces were gently sounded to identify voids and hollows under the surface. Once loose and delaminating areas were identified, they were selectively injected with a high-viscosity adhesive to reestablish a bond between the plaster and the brick. The

intention was not to fill the entire cavity at this time, but to restore adhesion locally until a more comprehensive campaign can be undertaken in the future.

The adhesive utilized was a 20% solution of Paraloid B-72. B-72 is a methyl methacrylate/ethyl acrylate copolymer, a general purpose thermoplastic acrylic resin widely used in conservation. The B-72 was dissolved in acetone and bulked with microballoons and Cabosil (silica thickener/adhesive filler) as necessary. Conservators avoided water-based adhesives for their potential side effects, such as unwanted saturation of the plaster/limewash and also to prevent migration of the adhesive and unwanted staining of the surface. To the greatest extent possible, the adhesive was injected via existing cracks and in openings between the plaster and the brick.

TEMPORARY PROTECTION
In addition to adhesive stabilization, the conservation team applied a facing consisting of layers of Japan paper and cheese cloth bonded in a 20% solution of B-72 in acetone. The facings were installed above and below the Guastavino ceiling, adjacent to the joint. Approximately 6-inches in either direction were faced in this manner. The facings are intended to provide additional stabilization to the renders that will be directly affected during the removal of the ceiling. The facings should help resist breakage and will hold onto fragments that may break and/or detach during the removal work.

DE-MOBILIZATION
At the completion of work, all material, equipment, and work-related debris was removed from the site.

Any future detached plaster found in the spaces should be considered a new loss.

FUTURE MONITORING
CSI recommends that a trained University employee and/or conservator enter the space approximately once a month while heavy construction is occurring. They should look for major changes in the space, such as the accumulation of new debris on the floor.

If new debris is found, we recommend that the material be collected in an archival quality box and labeled as to the specific area in which it was collected. Large pieces of salvaged plaster could potentially be re-used at a later date during the more comprehensive restoration.

If a significant amount of plaster continues to detach (>10% of the total surface area) it is likely that a mechanical repair may be necessary, typically achieved by countersinking a fastener with a large washer into the plaster surface and anchoring it to the substrate. Please note that each major crack or loss may need to be addressed on a case-by-case basis.

Adequate protection should be installed and maintained while any work occurs within the spaces. When the Guastavino ceiling is removed, a hand grout saw should be used

to cut at the joint and isolate the render from the ceiling before its removal. The ceiling should be cut away close to the render, but no less than 3-inches, and removed. Dust should be contained as much as possible during this work and adequate plywood protection should be in place. The remaining masonry should then be carefully excavated by hand. By cutting out the center of the sandwich and pressing the top and bottom together, if possible, before removing. Avoid lateral pressure on adjacent materials during removal.

Figure 1: Additional B72 injections to the hearth plaster.

Figure 2: Adhering tissue paper to plaster with B72 solution.

Figure 3: Adhering cheese cloth to tissue paper with B72 solution.

Figure 4: View of completed facing application below the Guastavino ceiling tiles.

Figure 5: Applying tissue paper with B72 solution, space above ceiling.

Figure 6: Applying cheese cloth to tissue paper with B72 solution, space above ceiling.

Figure 7: Injecting B72 solution between plaster and brick, space above ceiling.

Figure 8: Plaster above ceiling after adhesive injections and application of facing.