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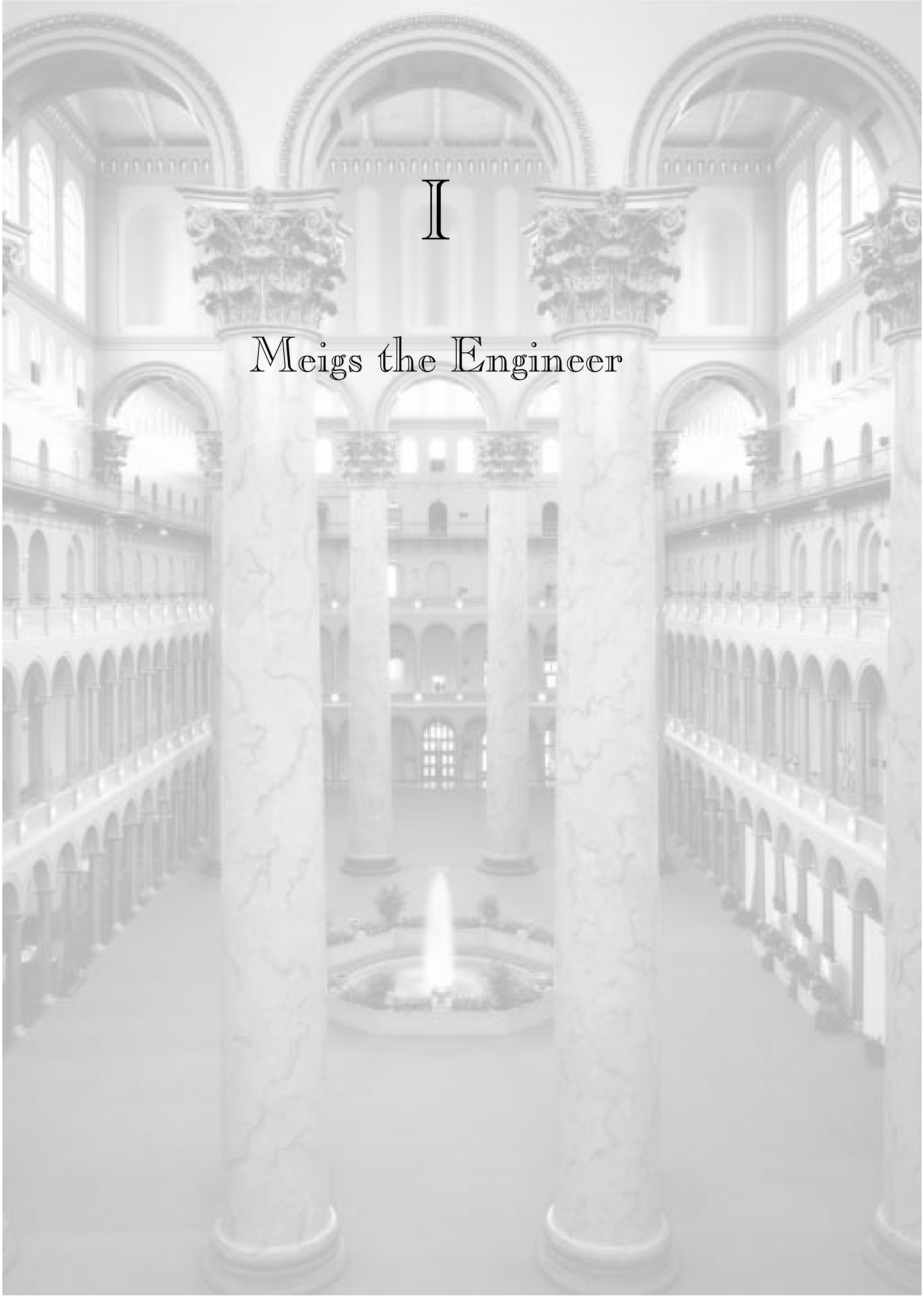
Meigs the Engineer



The Eclectic Engineer

Montgomery C. Meigs and His Engineering Projects

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Monday, January 3, 1859, was unlike any other day for Montgomery C. Meigs. Forty-two years old, a captain in the Army Corps of Engineers, Meigs was in his sixth year as engineer in charge of construction of the new Washington Aqueduct system and the United States Capitol Extension and dome. On this day, a day when all things seemed possible, Meigs united two of his great projects. At 2:30 in the afternoon, Meigs was in the new Senate Chamber in the Capitol's north extension, which he had just completed and for which he was now making final arrangements for the inaugural session the following day. Word arrived by messenger that water flowing through the Washington Aqueduct system, having been released that morning by Meigs himself from a reservoir for the first time, was about to emerge from the fountain on the Capitol grounds. Sen. Jefferson Davis (D-MS), Meigs's longtime mentor, supporter, and friend, took his hand and congratulated him. As the army engineer and several senators watched from the western portico, water burst from the fountain.[1] Later that afternoon, standing on the fountain, Meigs posed for a photograph.[2] Never one for understatement, he majestically described in a letter to his father

[1]Transcript of Montgomery C. Meigs's Journal for January 3, 1859, C628–C629 (hereafter MCM Journal). These journals, located in the Montgomery C. Meigs Papers in the Library of Congress, were written in shorthand and have never been fully transcribed. The existing transcriptions are located in the office of the curator of the Architect of the Capitol's Office, U.S. Capitol, Washington, D.C. A notation such as C628 refers to the transcribed pages as they are identified and arranged in the curator's office.

[2]A copy of the photograph is located in the Montgomery C. Meigs Collection, Engineering Division, National Museum of American History, Smithsonian Institution, Washington, D.C.

how he felt about the moment: "I wish you could see my [jet of water] in the Capitol Park. I look upon it with constant pleasure for it seems to spring rejoicing in the air and proclaiming its arrival for free use of the sick and well, rich and poor, gentle and simple, old and young for generation after generation which will have come to rise up and call me blessed."[3]

Meigs's lofty conception of himself notwithstanding, his engineering work has generally been overshadowed by his legacy as the very effective quartermaster general of the Union army during the Civil War. Yet Meigs was one of the best-trained American engineers of his day, and he left behind monumental works that are landmarks of American public works and civil engineering. This essay will briefly survey Meigs's engineering projects, describe how his career fits into the larger context of nineteenth-century American engineering, and explain why I think Meigs should be remembered for his engineering achievements.

Montgomery Meigs was born in May 1816 to a prominent Philadelphia family. His father was a pioneering obstetrician and his grandfather was a teacher, college president, and eventually the commissioner of the General Land Office of the United States. Historian Russell F. Weigley, who in 1959 wrote the only full-length biography of Meigs, claimed that the family as a rule had a penchant for "cantankerousness" and a "talent for self-righteousness and controversy." Meigs's mother described her son as "high-tempered, unyielding, tyrannical toward his brothers, and very persevering in pursuit of anything he wishes"—and this was when he was only six years old! Many a politician, contractor, and superior officer later would agree with her description.[4]

Meigs entered the University of Pennsylvania at the age of fifteen, but he left before graduating to enter the U.S. Military Academy at West Point in 1832. He graduated in 1836, fifth in a class of forty-nine. When Meigs entered West Point, the academy was the only engineering school in the country, and Meigs wanted to be assigned after graduation to the Army Corps of Engineers. He was first assigned to an artillery unit, but was transferred to the Army Corps of Engineers in 1837. Meigs's first assignment was a survey of the upper Mississippi River with fellow West Pointer Robert E. Lee. For the next ten years, until 1849, he worked on a variety of projects, from improvements in the Delaware River to constructing forts around the Great Lakes (fig. 1). These were the formative years in which Meigs honed his engineering skills. He benefited enormously not only from the variety of projects he was given, but also by serving, in effect apprenticing, under older, more experienced officers.[5]

[3]Russell F. Weigley, *Quartermaster General of the Union Army* (New York, 1959), p. 88.

[4]Henry L. Abbot, "Memoir of Montgomery C. Meigs, 1816–1892," *National Academy of Sciences Biographical Memoirs* 2 (1895):314–15; Weigley, *Quartermaster General,* pp. 17, 24.

[5]Abbot, "Memoir of Montgomery C. Meigs," p. 315; biographical notices in file, "Montgomery C. Meigs," in Division of Engineering, National Museum of American History, Smithsonian Institution.

Fig. 1. Fort Wayne barracks, Detroit, Michigan, designed by Montgomery Meigs, undated but ca. 1850s. *(Courtesy National Archives Still Pictures Branch.)*

In 1849 Meigs was summoned to Washington to work as an assistant to the chief of the Army Corps of Engineers, Gen. Joseph G. Totten. A year later, however, Meigs and his family were stationed at Fort Montgomery by Lake Champlain in New York, where Meigs was given charge of construction. Meigs was finally brought to Washington for good by General Totten in the fall of 1852, with the assignment to survey a route for a public water supply for the city of Washington.

Only a few buildings in Washington in the early 1850s were hooked up to a water system, which at that time was supplied by springs located around the town. However, other cities in the United States, such as Boston, New York, and Philadelphia, were developing extensive public water systems. A fire in the Capitol in 1851 almost destroyed the building because of a lack of access to water and spurred Congress to investigate a more reliable source of water. Meigs worked on his survey for three months, and Congress eventually approved the construction of an aqueduct from Great Falls, Maryland. In March 1853, after Meigs had completed the water supply survey, Secretary of War Jefferson Davis promoted Meigs to captain in the Army Corps of Engineers and assigned him to build the aqueduct. That alone was a challenging assignment, but during the next decade, Meigs also was assigned to be the supervising engineer for the extension of the Capitol wings and the new dome, the extension of the Post Office Building, and repairs on Fort Madison in Maryland.[6]

[6]Weigley, *Quartermaster General,* pp. 60–62; Abbot, "Memoir of Montgomery C. Meigs," pp. 316–17; Harold K. Skramstad, "The Engineer as Architect in Washington: The Contribution of Montgomery C. Meigs," *Records of the Columbia Historical Society* (1969–70):268; U.S. Senate, Exec. Doc. No. 48, 32d Cong., 2d sess. (1853).

Meigs may have been humbled by the challenges awaiting him, but his diary, now in the Library of Congress, reflects more his hope for fame and glory. Meigs had regretted not being able to fight in the Mexican War in the 1840s, but he saw the assignment to the aqueduct as his chance to make a mark. He wrote in his diary that the successful completion of the aqueduct "would connect my name imperishably with a work greater in its beneficial results than all the military glory of the Mexican War." In October 1853 Meigs turned the first shovelful of dirt to officially begin the aqueduct construction. He observed in his diary that night, "Thus quietly and unostentatiously was commenced the great work." But understatement was not Meigs's style, so he added that the aqueduct "is destined I trust for the next thousand years to pour healthful waters into the Capital of our union."[7]

The aqueduct took approximately eleven years to build, with construction occurring in spurts depending on congressional appropriations. Meigs was in charge of the project for most of those eleven years, and he was responsible for almost the entire plan, modeled in part after the Boston Aqueduct built in 1848. The Washington Aqueduct is a circular conduit of brick or rubble masonry, placed mostly underground, approximately nine feet in diameter and eleven miles long, running from Great Falls to a distributing reservoir in Georgetown. Cast-iron pipes carried the water from the reservoir into the city. Except for one small part of Georgetown, all flow of water in the conduit was by gravity, due to the 140-foot difference in elevation between Great Falls and Washington. The system included the Cabin John Bridge, the longest masonry arch bridge in the world until 1903, and the Rock Creek Bridge, only the second iron arch bridge built in the United States.[8]

While Meigs was working on the aqueduct, he also supervised the construction of the new wings on the Capitol and the erection of the new dome (fig. 2). By 1851 Congress realized that the building then in use was too small and lacked adequate heating, ventilation, and acoustics. Congress subsequently appropriated funds for the construction of new wings. The general plans for the Capitol work were devised by the talented Philadelphia architect Thomas U. Walter. Little more than a year into the project, however, Walter came under suspicion of mishandling contracts. He was personally exonerated, but to avoid a scandal, President Franklin Pierce placed the project into the hands of his secretary of war, Jefferson Davis, with the instructions to find a supervising engineer and disbursing agent. General Totten, chief of engineers, turned to Montgomery Meigs. Given the authority to make whatever changes he thought necessary, Meigs involved himself in almost every aspect of the Capitol Extension. He

[7] Weigley, *Quartermaster General,* pp. 48, 68.

[8] Abbot, "Memoir of Montgomery C. Meigs," p. 316; "The Cabin John Bridge," *Engineering,* Apr. 19, 1867, p. 377; United States Army Corps of Engineers, *History of the Washington Aqueduct* (Washington, D.C., 1953), p. 9.

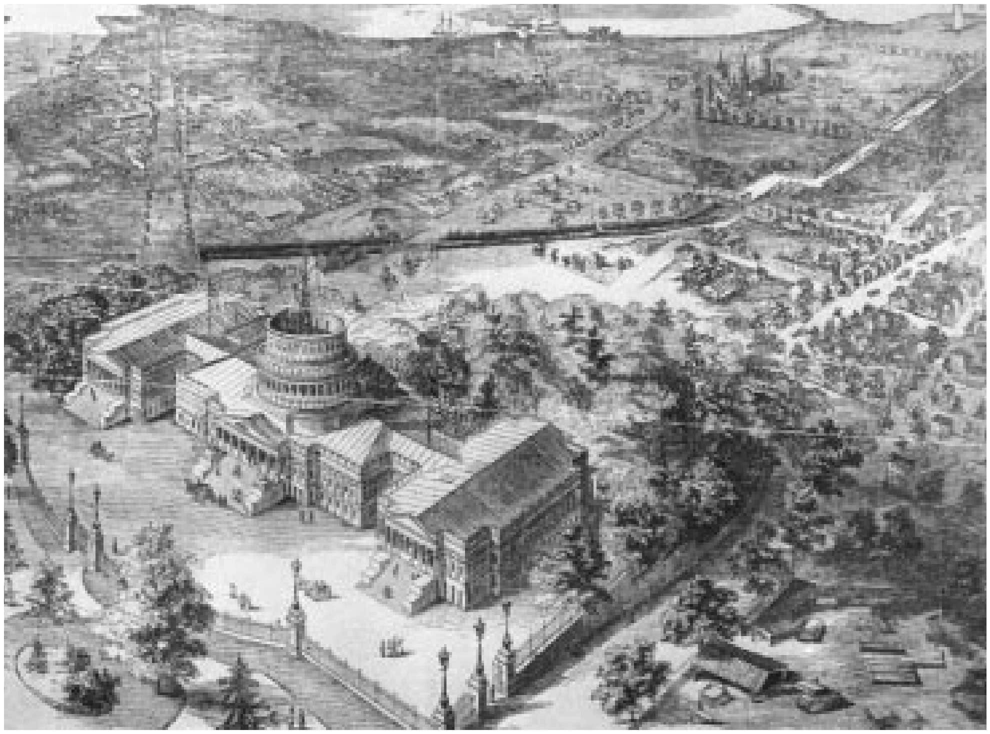

Fig. 2. Aerial perspective of the Capitol, ca. 1861, showing dome under construction. *(Courtesy Office of Architect of the Capitol.)*

directly or indirectly had a hand in design, construction, heating and ventilation, acoustics, lighting, decoration, and furnishing, as well as controlling the administrative and financial management of the entire enterprise. Meigs's experiments in the use of structural iron, in the testing of building materials, in materials handling (especially the derricks for constructing the new dome), and in heating and ventilating systems made lasting contributions in the history of building construction. In addition, while most of the design credit belongs to Walter, Meigs made extremely important contributions in the architectural organization of the Capitol, and he was a surprisingly perceptive and successful art patron of the Capitol's decoration.[9]

Meigs's greatest engineering challenge, however, was the construction of the new dome of the Capitol (fig. 3). The addition of the new wings made the old dome seem out of proportion, and in 1855 Congress approved removing the old dome and building a

[9]Weigley, *Quartermaster General,* pp. 65–66; Russell F. Weigley, "Captain Meigs and the Artists of the Capitol: Federal Patronage of the Arts in the 1850s," *Records of the Columbia Historical Society* (1969–70):285–305; Charles E. Peterson, "Iron in Early American Roofs," *The Smithsonian Journal of History* 3 (1968):41–76; Robert M. Vogel, "Building in the Age of Steam," and Eugene Ferguson, "An Historical Sketch of Central Heating: 1800–1860," in Charles E. Peterson, ed., *Building Early America* (Radnor, Pa., 1976), pp. 127–33, 176–79.

new larger one. The revised dome was Walter's idea, but Meigs and Walter's chief draftsman, Auguste Schoenborn, reworked the architect's plan to make it technologically feasible. The old dome had been constructed of wood, but the new dome was made of cast-iron plates with massive cast-iron ribs and extensive bracing, making the Capitol dome perhaps the largest single mass of cast iron in the world. Walt Whitman, in Washington during the Civil War, described the dome as "a vast eggshell, built of iron & glass, this dome—a beauteous bubble, caught & put in permanent form."[10]

Meigs's final large project was the design and construction of the Pension Building. After the Civil War, a large bureaucracy was needed to administer the pension claims of veterans and widows. In 1882 Congress appropriated money for a building to house such a bureaucracy, provided that it should be erected "under the supervision of General M. C. Meigs." The building, constructed between 1882 and 1887, was the largest brick building in the country when finished. Meigs modeled the building roughly on the Farnese Palace in Rome, which he had seen on one of his European tours. The most important change made by Meigs was to enclose the interior courtyard and make it usable space. His original design called for a large skylit cupola, but the expense forced him to replace the cupola with shedlike monitors. One of the most ornamental details of the building is the three-foot-high frieze depicting marching soldiers that extends around the entire exterior. The Pension Building, like the National Museum, was built to be fire resistant, with brick and iron the main construction elements. Even the interior steps are brick, as are the columns, each of which is composed of fifty-five thousand bricks. Meigs introduced double-glazed windows in the building to insulate and cut down on radiation during the summer, and used large ventilation fans to keep air circulating.[11]

It is interesting to compare Meigs's work on the Pension Building with the Capitol Extension. In the 1850s, Meigs altered Walter's original design of the Capitol Extension, changing the placement of the House and Senate Chambers from the outer walls of the wings to the center. In the original plan for the House of Representatives, for example, Walter placed the main chamber in the western end of the extension, surrounded by outside walls on three sides (fig. 4). Meigs's alteration placed it in the center of the extension; thus, there were no outside windows for either chamber. Meigs

[10]Weigley, *Quartermaster General,* pp. 71–72; Carl Condit, *American Building Art: The Nineteenth Century* (New York, 1960), pp. 64–66; Skramstad, "The Engineer as Architect," p. 272; William C. Allen, *The Dome of the United States Capitol: An Architectural History* (Washington, D.C., 1992); Turpin Bannister, "The Genealogy of the Dome of the United States Capitol," *Journal of the Society of Architectural Historians* 7 (1948):1–31. The Whitman quote is cited in M. Wynn Thomas, *The Lunar Light of Whitman's Poetry* (Cambridge, Mass., 1987), p. 190.

[11]Abbot, "Memoir of Montgomery C. Meigs," p. 324; Skramstad, "The Engineer as Architect," pp. 282–83; Linda B. Lyons, *A Handbook to the Pension Building* (Washington, D.C., 1989).

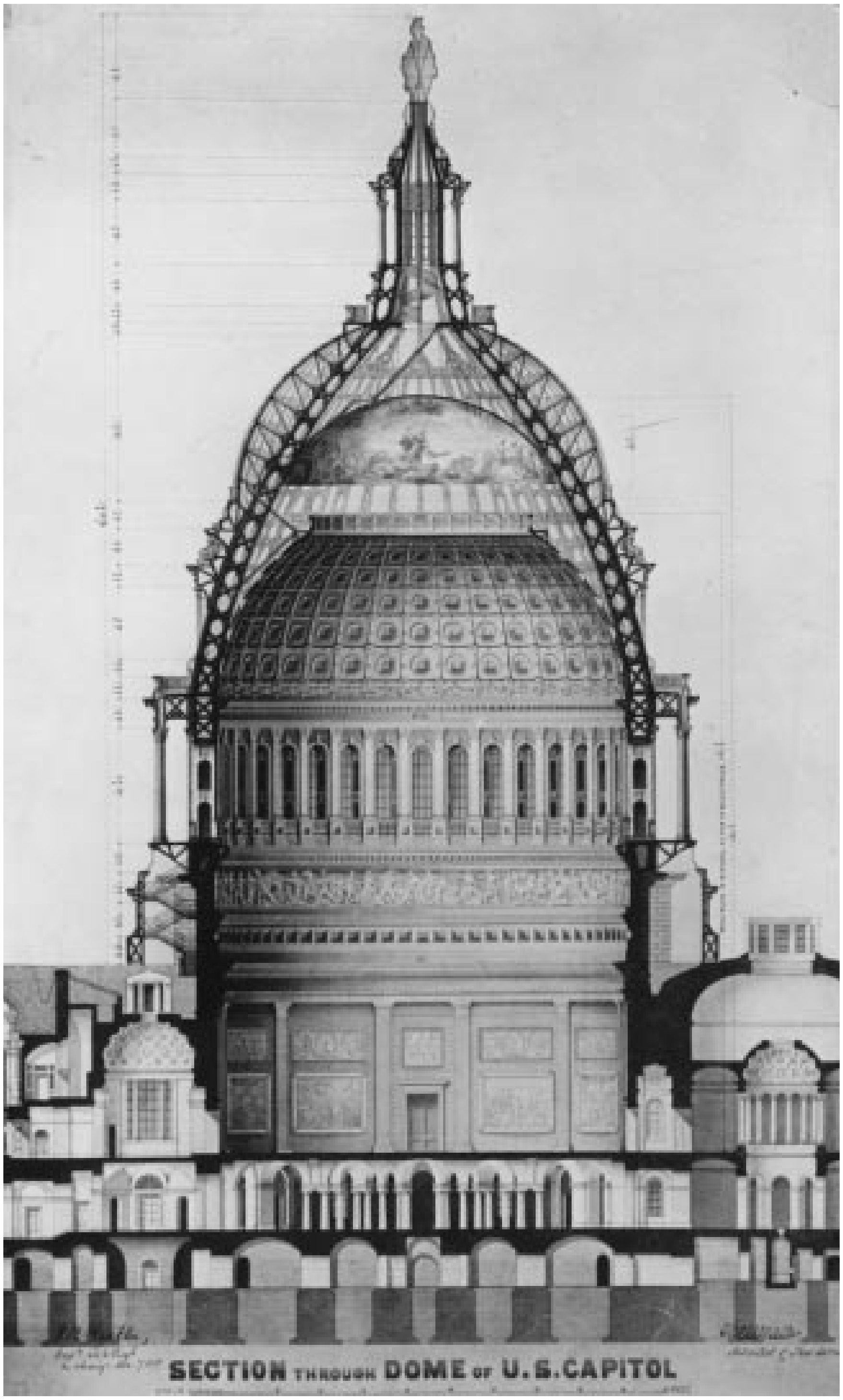

Fig. 3. Section of Capitol dome. *(Courtesy Office of Architect of the Capitol.)*

the engineer felt this afforded a more efficient use of space and, more important, that it would make heating, ventilation, and acoustics easier to control. The historian of technology Eugene Ferguson has lamented this decision, in particular the absence of windows and natural ventilation in the legislative chambers: "Here was an important, perhaps crucial, step in the direction of designing buildings whose internal conditions depend entirely on machines."[12]

Now compare Meigs's design of the Pension Building with that of the Capitol Extension. The design is almost the exact opposite. The primary working space is placed around the perimeter of the building, with natural light available on *both* sides when you consider the skylit courtyard. Each room has natural ventilation as well, for in addition to the windows themselves, three holes were left under each window for airflow. Meigs certainly was influenced by Italian palace architecture in the design of the Pension Building, but after a lifetime of engineering, he also may have come to the realization that engineers simply cannot control everything.

Unfortunately, the Pension Building did not meet with universal approval. Some called it "Meigs's Old Red Barn," and one journal said it looked like either "a colossal machine shop, or a prosperous nut and bolt factory." When told that the building was fireproof, Gen. William Tecumseh Sherman is said to have replied, "What a pity!"[13] Perhaps the most cutting blow, however, came during the Senate's consideration of Meigs's nomination as a regent of the Smithsonian Institution. In the discussions in the Senate in 1885, one senator justified Meigs's selection in part because improvements were soon going to be made in the Smithsonian Building, and "General Meigs is an architect of distinguished reputation." But another senator, while not disagreeing that Meigs should be named a regent, took exception with his architectural ability: "I hope that the resolution will pass . . . but I do not wish it to be understood that I vote for it on the ground stated by the Senator from Texas, that of General Meigs's architectural capacity or ability, for if we take the new Pension Office here as a sample of it, and we undertake in advance to refer that to the judgement and taste of the people of the United States, we shall make a very wide mistake. I shall vote for General Meigs because I think he is a scientist, not because I think he is an architect."[14] Despite the criticism, presidential inaugural balls were held in the Pension Building from 1885 to 1909, and it is still considered one of the great interior spaces in the country.

[12]Ferguson, "An Historical Sketch of Central Heating," p. 179.

[13]Weigley, *Quartermaster General,* p. 359; Lyons, *Handbook to the Pension Building,* p. 58; "Trip Notes—The Architectural and Engineering Works of Montgomery C. Meigs in the Capital City," Society of Architectural Historians, 1986, (in file, "Montgomery C. Meigs," in Engineering Division, National Museum of American History, Smithsonian Institution).

[14]William Jones Rhees, *The Smithsonian Institution: Documents Relative to Its Origin and History, 1835–1899* (Washington, D.C., 1901), p. 972.

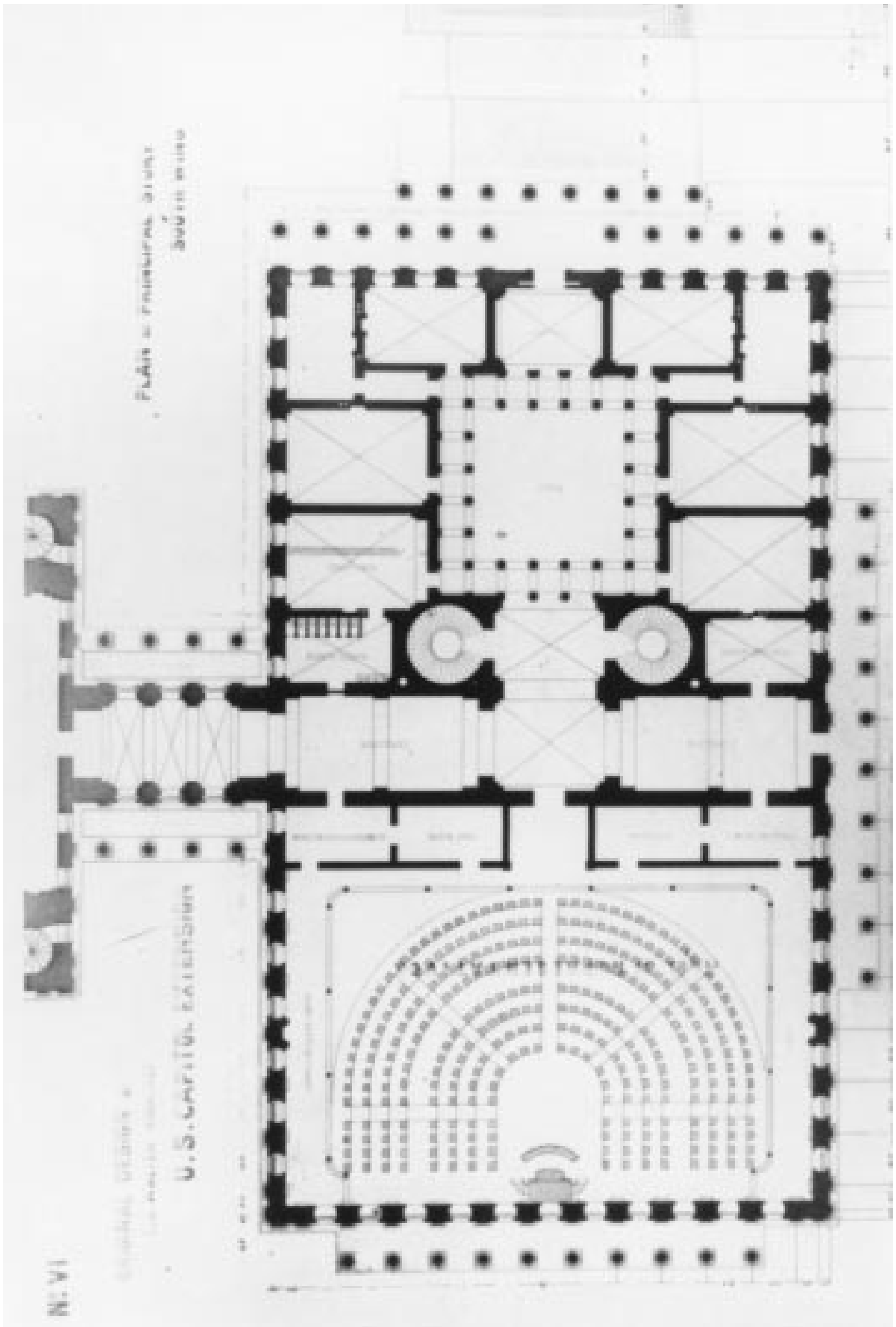

Fig. 4. Thomas U. Walter's original floor plan for the House of Representatives. *(Courtesy Office of Architect of the Capitol.)*

With these projects as evidence, what type of an engineer was Meigs, and what can his career tell us about nineteenth-century American engineering?

Meigs's engineering and architectural structures are noted for their novel, and at times even quirky, features. On the Washington Aqueduct system, for example, Meigs decided to use the conduit itself as a bridge over Rock Creek, dividing the conduit into two cast-iron pipes, each forty-eight inches in diameter. These pipes served as arches, with a two-hundred-foot span, for the roadway carrying Pennsylvania Avenue across Rock Creek.[15] Although relatively unnoticed by Americans, the bridge was featured in leading scientific journals of Europe and was characterized by the French *Annales des Ponts et Chaussées,* the leading technical journal on bridges in the world, as "the most novel enterprise in bridge building of the times."[16]

Meigs's engineering inventiveness is explained in part by his engineering style, meaning his approach to engineering. How was he trained, and how did he go about figuring out engineering solutions? Most antebellum American engineers learned their craft on the job, through observation, word-of-mouth instruction, and trial-and-error practice. Meigs obtained part of his engineering education the same way, but unlike most engineers of his day, Meigs also received advanced training in theory of structures and engineering principles at West Point. The emphasis on theory and advanced mathematics was modeled on the French style of engineering. Even though West Point students received a far less rigorous education than the best-trained French engineering students, and Meigs really only skimmed the surface of engineering theory, this still put him and other West Point graduates far ahead of most other antebellum American engineers.[17] Throughout his career, Meigs read widely in the engineering literature of the day, traveled extensively to see firsthand a variety of engineering structures, and tried to emulate the French model of engineering in his own projects. For example, Meigs used several French engineering theories to construct the Washington Aqueduct system. In designing the Cabin John Bridge, he made extensive use of a theory called "Mery's Method" for determining the bridge's structural characteristics. He at

[15]"Water-Pipe Bridge, Washington Aqueduct," *Engineering,* May 3, 1867, p. 448; William R. Hutton, "The Washington Aqueduct, 1853–1898," *Engineering Record* 40 (1899):193; Abbot, "Memoir of Montgomery C. Meigs," p. 316; *History of the Washington Aqueduct,* pp. 21–22, 24; Condit, *American Building Art,* p. 184; undated biographical notice in Division of Engineering, National Museum of American History, Smithsonian Institution.

[16]"Wizard of the Water," (Washington, D.C.) *Evening Star,* Jan. 16, 1892; Emory L. Kemp, "The Fabric of Historic Bridges," *IA—The Journal of the Society for Industrial Archeology* 15 (1989):7.

[17]Daniel Hovey Calhoun, *The American Civil Engineer: Origins and Conflict* (Cambridge, Mass., 1960), p. 199; Edwin T. Layton, "European Origins of the American Engineering Style of the Nineteenth Century," in Nathan Reingold and Marc Rothenberg, eds., *Scientific Colonialism: A Cross-Cultural Comparison* (Washington, D.C., 1987), pp. 151–66; Eda Kranakis, "Social Determinants of Engineering Practice: A Comparative View of France and America in the Nineteenth Century," *Social Studies of Science* 19 (1989):5–70; Todd Shallat, "Building Waterways, 1802–1861: Science and the United States Army in Early Public Works," *Technology and Culture* 31 (1990):18–50.

times only used the *results* of theoretical work without actually understanding the analysis, which he readily admitted, but his efforts to keep abreast of the most advanced engineering ideas proved invaluable in his design and construction of landmark structures such as Cabin John Bridge and Rock Creek Bridge.[18]

Meigs's ingenuity was in part a product of his natural curiosity and his interest in science. Never one to waste time, Meigs enjoyed working on projects at home during his after work hours. He obtained at least thirteen patents for a variety of inventions, ranging from a roof truss to a hydrant to a file case (fig. 5).[19] In the 1850s he was part of a group of men, including Joseph Henry of the Smithsonian Institution, who called themselves the Saturday Club and met to discuss the latest scientific issues. Meigs maintained a lifelong interest in science; he was elected a member of the American Philosophical Society and the National Academy of Sciences and was selected a regent of the Smithsonian Institution in 1885.[20]

Meigs's ability to "tinker" highlights another theme in nineteenth-century American engineering. Historians of technology have recently begun to de-emphasize American "discoveries" and to focus instead on the notion that America's rapid industrialization in the nineteenth century actually stemmed from the constant day-to-day adaptation, tinkering, and manipulation of existing technology.[21] Meigs, likewise, made at least as much of a contribution to the engineering field as an innovator rather than as an inventor. On the Capitol dome construction, for example, he adapted hoisting technology for the most efficient use of his resources. To erect the new dome, Meigs did not use the common scaffolding, which was cumbersome and time-consuming to build, but instead used derricks and cranes. Through the eye of the old dome, Meigs built a triangular tower with a derrick on top rising above the old dome (fig. 6). The mast and boom were each eighty feet long, giving the derrick a 160-foot diameter. A steam engine placed on the roof of the Capitol provided power to lower parts of the old dome and lift castings up for the new dome.[22] To take another example of Meigs's innovative approach, he relied on heating and ventilation engineers Joseph Nason and Robert Briggs for the basic outlines of the system used in the Capitol Extension, but, according to Briggs, Meigs successfully modified the system with his own improvements.

[18]MCM Journal, Jan. 9, 1856, B13; Feb. 6, 1856, B47; Feb. 9, 1856, B50; Dec. 16, 1856, B365; Dec. 18, 1856, B367; Dec. 25, 1856, B378; Montgomery C. Meigs, Feb. 26, 1856 (pp. 27–28), "Studies and Sketches" Journal, Montgomery C. Meigs Papers, Library of Congress; U.S. Senate, Exec. Doc. No. 48, 32d Cong., 2d sess. (1853), p. 36.

[19]The patent records are on file in the U.S. Patent and Trademark Office, Crystal City, Va.

[20]Weigley, *Quartermaster General,* pp. 67, 74, 354; Abbot, "Memoir of Montgomery C. Meigs," p. 325; Skramstad, "The Engineer as Architect," pp. 267, 278; Julie Link Haifley, *Titian Ramsay Peale, 1799–1885* (Washington, D.C., 1981), p. 26.

[21]See, for example, Judith McGaw, *Early American Technology: Making and Doing Things from the Colonial Era to 1850* (Chapel Hill, N.C., 1994), p. 13; and Patrick M. Malone, "Little Kinks and Devices at Springfield Armory, 1892–1918," *IA—The Journal of the Society for Industrial Archeology* 14 (1988):59–76.

[22]Weigley, *Quartermaster General,* p. 72.

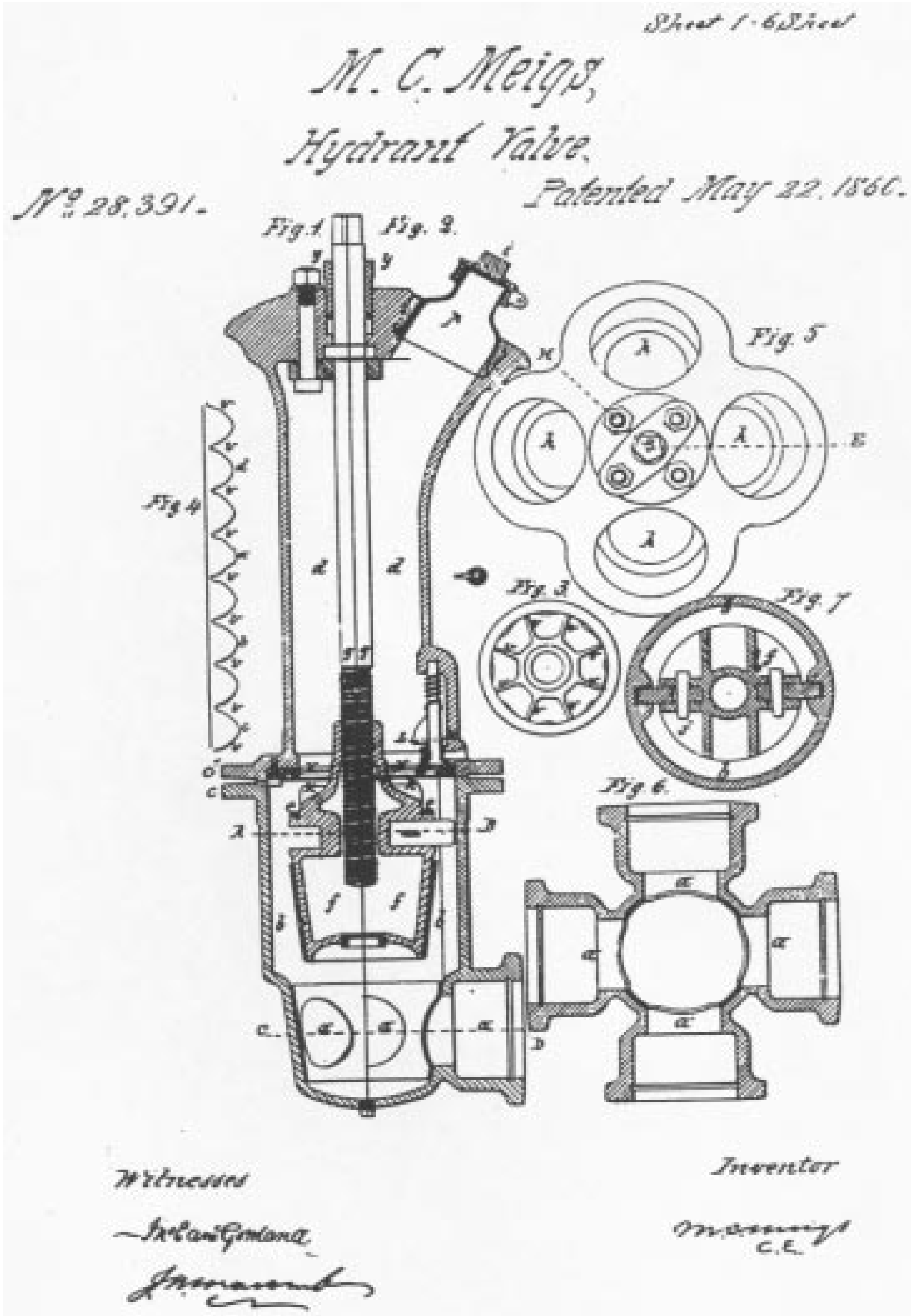

Fig. 5. A drawing of one of Meigs's patents. *(Courtesy Office of Architect of the Capitol.)*

The Capitol, to be sure, had problems with heating and ventilation for years to come, but at the time, the system installed by Meigs was probably the best system obtainable.[23] To summarize these examples, Meigs invented neither the derricks nor the heating and ventilating systems used in the Capitol work, but by adapting them to best fit his requirements, he also advanced the field of engineering in general.

Meigs's training, and his intellect, curiosity, and inventiveness, all contributed to his success as an engineer. But his career also demonstrates that engineers and architects do not work alone, that much of their success is due to assistant engineers, draftsmen, and others who work behind the scenes. Americans love stories of individual achievement, and we particularly revere inventors such as Thomas Edison, Alexander Graham Bell, and Henry Ford. Historians of technology, however, are continually discovering that our inventor heroes heavily relied on assistants and colleagues, and that few inventions were discovered by a lone person working in isolation. Meigs, too, owed much of his success to his assistants.

I am not going to tread too far into the morass that is the infamous Meigs-Walter feud. Meigs could be an overbearing, egotistical, and stubborn engineer who at times claimed credit when he should not have and who refused to appreciate the personal and professional pride of Walter. Walter, however, could be a backstabbing, insecure, conniving, petty architect who did not give enough credit to either Meigs or his own drafting assistants. There was plenty of pettiness to go around for everyone in this feud, but the primary point is that without the engineering, administrative, and political skills of Meigs and the elegant architectural designs of Walter, the Capitol would not have become one of the most admired buildings in America (or else it would have taken another thirty years to have been built).[24]

Giving someone else credit was not one of Meigs's strong points. He felt very deeply, especially before assuming the role of quartermaster general, that his reputation depended on his engineering projects. He constantly referred in his journals to his low pay and to the lack of respect and recognition accorded to government engineers.[25] In addition, particularly during his struggles with Secretary of War John Floyd and architect Thomas U. Walter, Meigs felt he was surrounded by unscrupulous people who wanted to steal the credit that rightfully was his. As a result, to make sure that his

[23]Ferguson, "An Historical Sketch of Central Heating," p. 177; Robert Briggs, *Report on the Ventilation of the Hall of Representatives, and of the South Wing of the Capitol of the United States* (Philadelphia, 1876); Montgomery C. Meigs, "General M. C. Meigs on the Heating and Ventilating of the U.S. Senate Chamber," *The Sanitary Engineer* 9 (1884):431.

[24]For the Meigs-Walter feud, see Allen, *The Dome of the United States Capitol,* pp. 36–41; and Sherrod E. East, "The Banishment of Captain Meigs," *Records of the Columbia Historical Society* (1940):97–143.

[25]See, for example, MCM Journal, Jan. 1, 1856, B2.

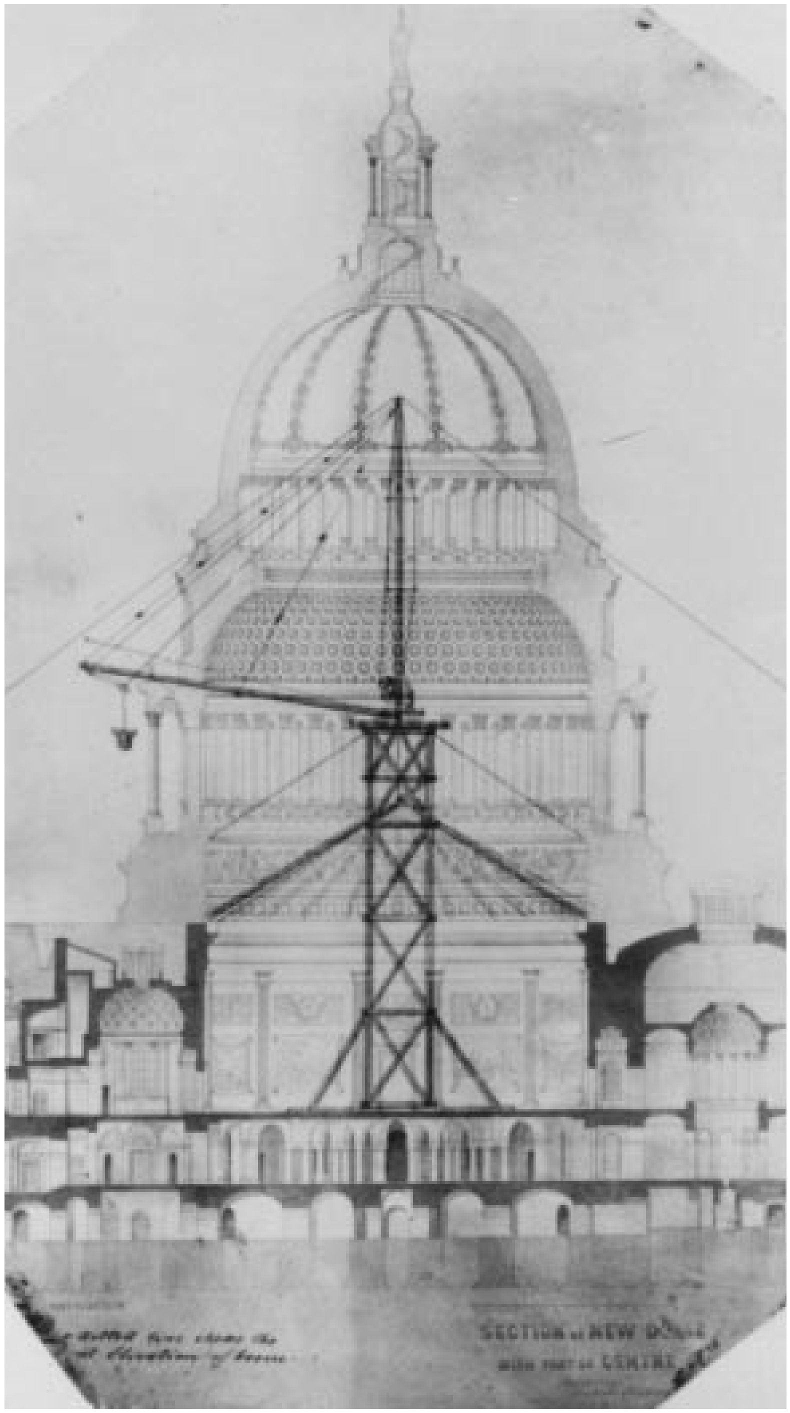

Fig. 6. A section of the Capitol dome showing Meigs's derrick. *(Courtesy Office of Architect of the Capitol.)*

name remained associated with his projects, Meigs literally attached his name to his projects. He had his name inscribed not only on every structure he built, but also on the pipes of the aqueduct system, the iron beams for the Post Office Extension and the Capitol Extension, and on gauges, derricks, hydrants, and most everything else connected with his works. Meigs even had his name inscribed on copper plates that were buried *beneath* the pipes of the aqueduct. Even the canal boat that hauled people and supplies from Georgetown to points along the aqueduct was named the *M. C. Meigs.* To be fair, Meigs did include the names of several of his assistants on some of these inscriptions, but he maintained a proprietary interest.[26]

Meigs should have given his assistants more credit, for they were extremely important to the success of his projects. For example, he employed as one of his assistants on the Washington Aqueduct a young engineer named Alfred Rives (fig. 7). Rives had just returned to the United States in 1855 after studying at the Ecole des Ponts et Chaussées, the premier French engineering school. Meigs recognized the value of Rives's education and soon had the young engineer working on details of the Cabin John Bridge. Rives wrote to his brother in 1856: "In engineering I am getting on swimmingly, I believe, and am engaged at present in showing off my French learning by recalculating and modifying the great bridges of the aqueduct."[27] Rives's contributions to the design and construction of the Cabin John Bridge were immense. It was probably Rives who suggested using Mery's Method to calculate the strains on the bridge, since he had just been taught the procedure.[28] When Rives joined the Confederacy at the start of the Civil War, however, Meigs refused to include his assistant's name on the bridge when it was completed. Years later, controversy arose over credit for the bridge, culminating in 1883 when a magazine writer accused Meigs of deliberately hiding Rives's contribution. Meigs vehemently denied the allegation, and after examining all the records carefully, ample evidence exists to conclude that Meigs did originally design the Cabin John Bridge.[29] Rives, for his part, expressed resentment after the war only that Meigs had not included his name on the bridge.[30] But the point

[26]MCM Journal, Sept. 28, 1854, A250; Sept. 13, 1856, B290; Mar. 23, 1858, C124–C125; Mar. 25, 1858, C127; Mar. 27, 1858, C133; Mar. 30, 1858, C137; Aug. 2, 1858, C412–C413.

[27]Totten to Meigs, Mar. 28, 1855, entry 146, Record Group 77, National Archives and Records Administration, Washington, D.C.; Alfred Rives to William C. Rives, Jr., Jan. 12, 1856, William C. Rives Papers, Library of Congress.

[28]See Rives's student notebooks from the Ecole des Ponts et Chausées in the Rives Papers, University of Virginia, Charlottesville, Va.

[29]Frank D. Y. Carpenter, "Government Engineers," *Lippincott's Magazine* 66 (1883):165–66; Meigs to General H. E. Wright, July 18, 1883, Montgomery C. Meigs Papers, Library of Congress. See also Letter to the Editor, *Lippincott's Magazine,* July 18, 1883. MCM Journal, Feb. 19, 1856, B60 (notations in the margin of the original); MCM, "Studies and Sketches" Journal, preceding entry for Feb. 16, 1856; MCM Journal, Feb. 15, 1856, B55; and Feb. 20, 1856, B60. See also MCM, "Studies and Sketches" Journal, Feb. 20, 1856, p. 24, for another sketch of the bridge.

[30]Alfred Rives to William C. Rives, Jr., Aug. 22, 1865, William C. Rives Papers, Library of Congress.

Fig. 7 Meigs (seated) surrounded by his assistant engineers, including Alfred Rives at far left. *(Courtesy Office of Architect of the Capitol.)*

is, for this Meigs project as well as for others, the completed structures look the way they do today because Meigs was ably assisted by Alfred Rives and other assistants.

But another point arises here as well. Sharing credit may have been a problem for Meigs, but that did not stop him from hiring the best engineering assistants he could find or from finding and consulting the most advanced building experts in the country. From heating and ventilating problems, iron beam fabrication, and acoustical properties of large halls to bridge design, Meigs knew where to find help and how to use it.

Beyond his inventiveness, ingenuity, tinkerer's nature, and ability to find help when he needed it, Meigs's most important attribute as an engineer is summed up in a phrase coined by a historian of technology: heterogeneous engineering.[31] Engineers, for various reasons, have gained a reputation for being rather rigid, by-the-book, unimaginative specialists. However, the most successful engineers, those who display heterogeneous engineering, are often those who are the most flexible, most imaginative, and most able to perform a variety of functions within the scope of a project. Meigs's career is a good example of heterogeneous engineering. An able administrator, shrewd contractor, imaginative inventor and innovator, and a man with artistic sensibilities, Meigs approached his projects from all angles. To further a project, he became proficient in areas not normally associated with engineering, as the following examples attest.

There probably has never been an engineer who exerted more influence over Congress and who was more adept at lobbying Congress than Meigs. Almost from the day he was assigned to the Washington Aqueduct project and the Capitol Extension, Meigs tirelessly informed, cajoled, and lobbied as many members of Congress as he could. He almost weekly corralled some congressman and marched him through the Capitol Extensions or drove him out to the aqueduct work. Perhaps to appeal to their vanity, he even photographed them. Because of his relentless efforts, Meigs enjoyed strong support in Congress and was without question a principal factor in the continued appropriations for his projects in the 1850s.[32]

Meigs used photography for more than just taking congressmen's portraits. He was one of the first engineers to use photography to visually record his projects (fig. 8). Meigs became very interested in photography in the 1850s, and enjoyed experimenting with different processes and taking photographs of his family and his projects. Meigs used photography to enhance his engineering in two ways. He used photography to make multiple images of drawings, as opposed to having drawings copied by hand, which saved enormous amounts of time. These photographs were then given to his assistant engineers and foremen for quick reference. Meigs also used photographs of his works as promotional tools, giving them to members of Congress, for example, to show the progress of his projects. For Meigs, photography and politics were just two of the tools he had at his disposal to further his engineering projects.[33]

Montgomery C. Meigs combined many talents to be an accomplished engineer, and

[31]See John Law, "Technology and Heterogeneous Engineering: The Case of Portuguese Expansion," and Donald MacKenzie, "Missile Accuracy: A Case Study in the Social Processes of Technological Changes," in Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch, eds., *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (Cambridge, Mass., 1987), pp. 111–34, 195–222.

[32]See, for example, MCM Journal, Mar. 10, Mar. 12, Apr. 4, 1856, B140–B143.

[33]Haifley, *Titian Ramsay Peale,* p. 26; Mike Chrimes, *Civil Engineering, 1839–1889: A Photographic History* (Wolfeboro Falls, N.H., 1992), p. 11; MCM Journal, Jan. 2, 1856, B4. See, especially, Meigs's photograph albums in the Montgomery C. Meigs Papers, Library of Congress.

Fig. 8. Photograph of the Capitol dome under construction, with a column lifted to the side. *(Courtesy Office of Architect of the Capitol.)*

his work foreshadowed much that was to occur in the engineering field in later years. Meigs simply could not be constrained by only one type of architectural style or even one occupation. He wanted to be everything—engineer, architect, scientist, artist, art patron, soldier, administrator, and a good family man as well. Meigs, to be frank, displayed many of the annoying habits of the Victorian Age, such as arrogance and an obsession for control, but we should marvel at the success he attained in so many of his endeavors. Civil War historian Bruce Catton wrote in 1952 that Montgomery Meigs was a man who "deserves just a little better of posterity than he seems likely ever to get."[34] Perhaps the essays in this book will improve that record.

[34]Bruce Catton, *Glory Road* (Garden City, N.Y., 1952), p. 96.