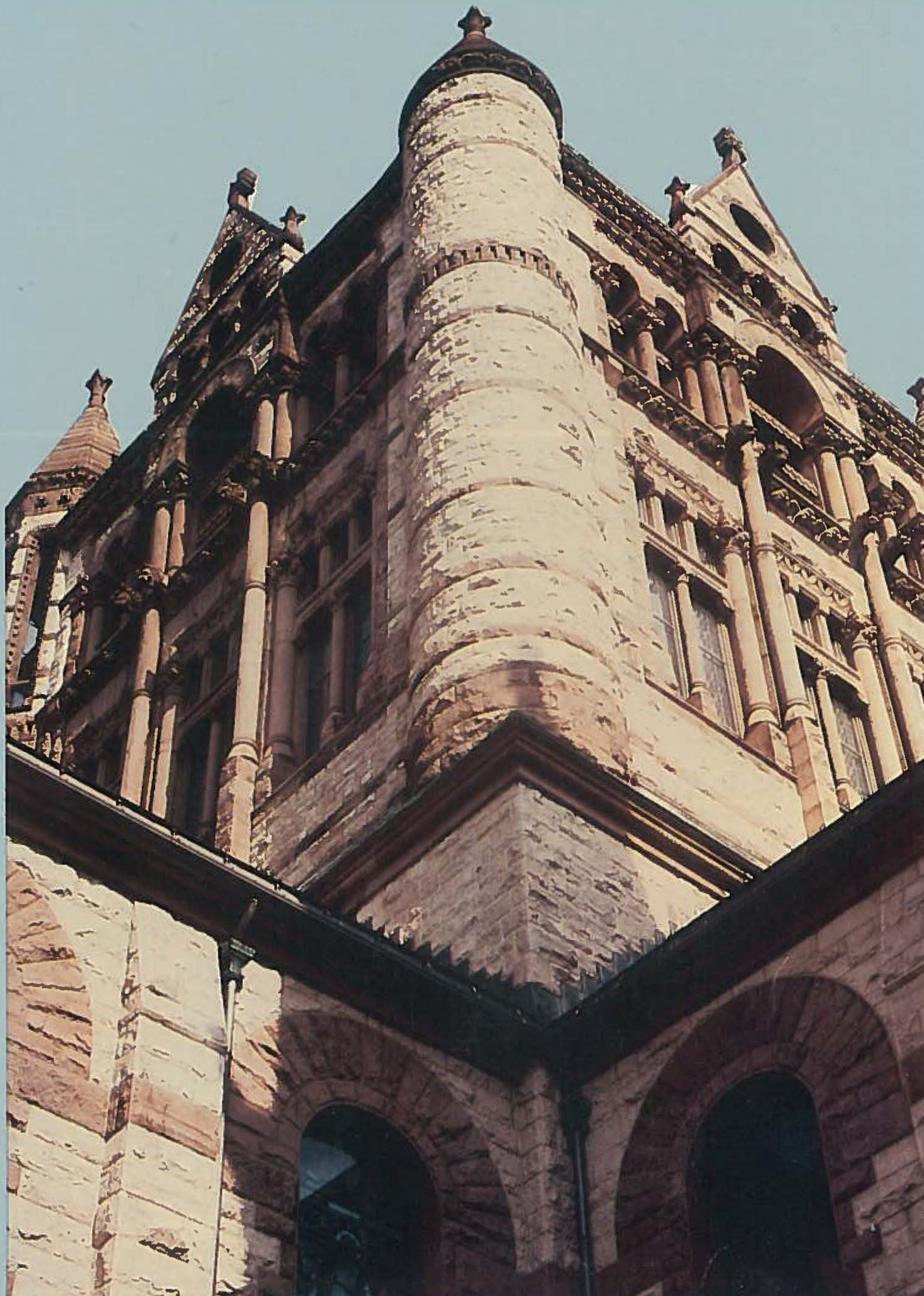
# American Public Architecture

## European Roots and Native Expressions





Papers in Art History from The Pennsylvania State University

Volume V

# American Public Architecture
## European Roots and Native Expressions

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and
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# Contents

# Preface

Public architecture in the United States can be broadly defined. It clearly includes structures built by and for the people, such as a city hall or a public library. However, most buildings within the public realm are not publicly owned, but are built to serve the public, as exemplified by a department store or a bank. Other prominent buildings, such as churches and those on university campuses, are used by a defined sector of the population. There is also the public face of urban architecture, which contributes to one's perception of a city, such as we see in the monumental institutions of Washington, D.C., or the skyscrapers of Chicago. The nature of a city's public architecture is likewise shaped by its public spaces, from park cemeteries to grand boulevards like Chicago's North Michigan Avenue. Architecture which serves the public also includes those practical necessities that make a city function, such as its waterworks.

In this volume a second general theme is explored: European roots and native expressions. European antecedents for many American public buildings have existed since the establishment of the colonies. American architects have often sought for their buildings a sense of legitimacy and sophistication by following the stylistic lead of European architecture and the conventions of its building types. Juxtaposed against this European influence are the necessity and longing for native expressions: for buildings that are distinctly American. Often this wish for native expression parallels a desire to define a modern architecture.

"American Public Architecture: European Roots and Native Expressions" is a very broad topic. This volume certainly does not aspire to completeness; many important building types, periods and issues are not addressed here. Nonetheless, we present a collection of ten papers that is a sampling of the breadth of the topic. Some papers share similar sub-themes, such as defining America's sacred buildings and precincts in relation to European precedence (the papers of William H. Pierson, Jr., and Gunther Barth), the relationship of modernism and history (Mary N. Woods, Arnold Lewis, and Narciso G. Menocal), coming to terms with the skyscraper city of Chicago (Lewis, Menocal, and John W. Stamper), urbanism and the early twentieth century (Stamper and Stephen Tobriner), the infrastructure of our cities, particularly relative to the distribution of water (Tobriner and John S. Garner), and the changing nature of monumental architecture in the early twentieth century (Richard Guy Wilson and myself).

This volume of the *Papers in Art History from The Pennsylvania State University* represents the fifth such compilation. The origin of each volume is an annual lecture series at Penn State, sponsored by the Department of Art History and the Institute for the Arts and Humanistic Studies. Each series addresses a chosen theme in the history of art. Seven of the papers in this volume were first presented in the lecture series of 1986–1987. The authors have had the opportunity to revise and enhance their contributions before publication. Since the conclusion of the lecture series, three new papers of relevance had been added to broaden the volume's perspective.

Our sincere gratitude is extended to Mary Louise and Jack Krumrine, whose generous support has made this series of *Papers in Art History* a tangible reality. Stanley Weintraub, Director, and William Allison, former Associate Director, of the Institute for the Arts and Humanistic Studies have provided continuing support that has been the keystone of this enterprise. We are equally thankful to James Moeser, Dean of the College of Arts and Architecture, whose constant encouragement and support were essential for the realization of this volume.

Linda Wheeland and Deana Bryan cheerfully and expertly executed the enormous amount of typing involved in this project. Our graduate assistant for the *Papers*, Charles Fox, has been a great help in innumerable ways.

Hellmut Hager, Head of the Department of Art History, initiated this series of volumes, and it is to the high level of his vision, standards, and excellence in scholarship that we aspire. My final thanks are to Susan Munshower, my coeditor and managing editor for all the *Papers*, whose unquestionable skill in this role and admirable command of the complicated mechanics of creating a publication have produced what we hope is a valuable contribution to the field of American architectural history.

Craig Zabel

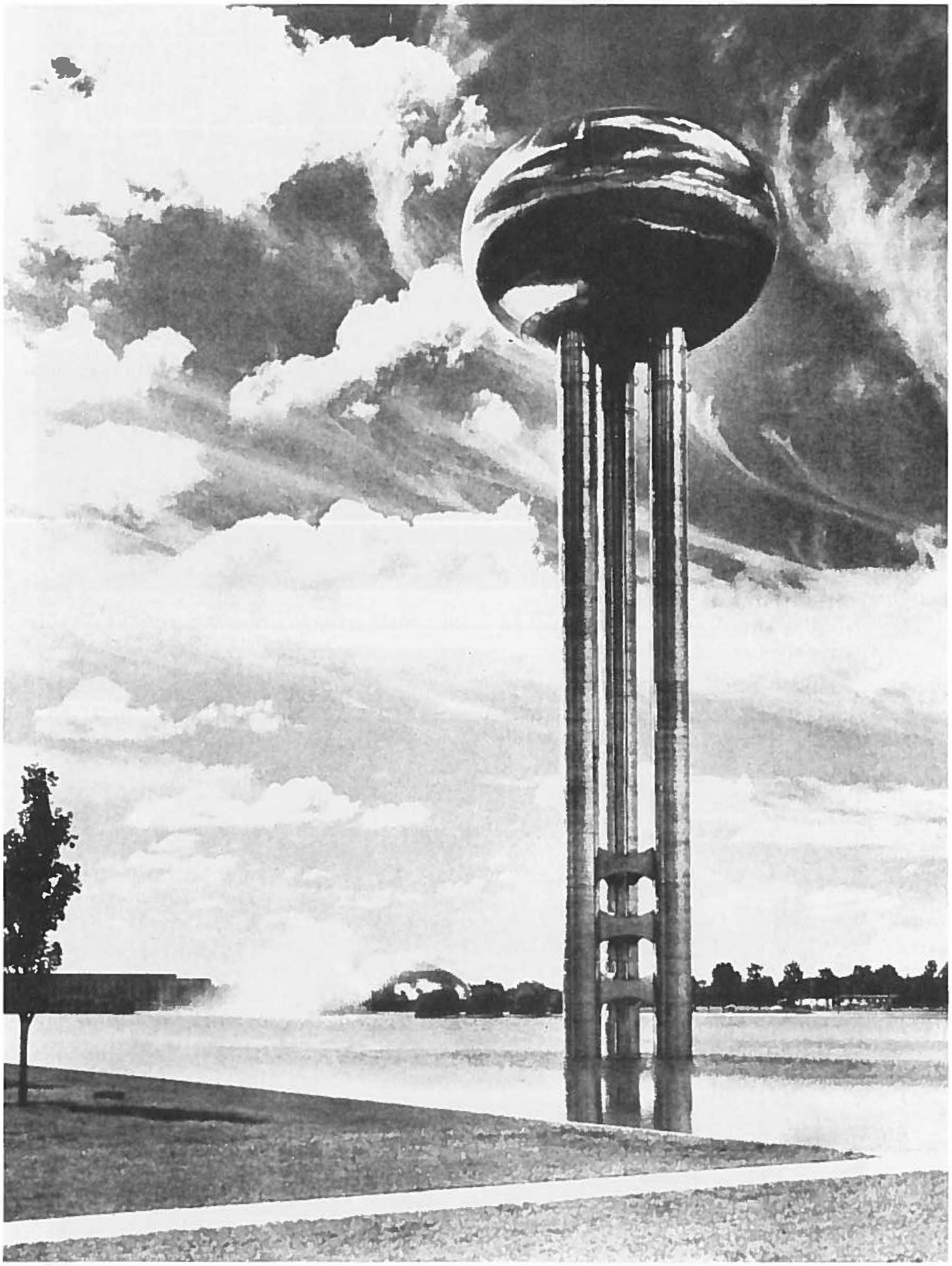

Fig. 8–17 Eero Saarinen, Watersphere, General Motors Technical Center, Warren, Michigan, 1948–1955. Photo by Ezra Stoller, ca. 1956. Ricker Architecture Library Photograph Collection, University of Illinois at Urbana.

# Tanks and Towers: Waterworks in America

# 8

In the history of American public architecture structures of a utilitarian nature have generally been overlooked. Buildings of a commercial or residential type usually are chosen to illustrate technical advances and representations of style. Occasionally, an industrial building is cited as an exception to the rule. But such structures as water towers, bridges, dams, derricks, and grain elevators, to name the more prominent, often escape consideration. Not that they are unimportant; they simply do not fit as well as other building types into what is traditionally classified as architecture. They represent feats of engineering, not examples of design. That such structures did receive the attention of some outstanding American architects should not be forgotten. To consider one of these structural types will suffice to emphasize its importance in the history of urban development.

Water towers figure prominently in the horizon of most cities, and they dominate the skyline of smaller towns: even when painted silver or blue, their silhouettes and long shadows are inescapable. Those single column spheroidal towers, occasionally given facial expressions to smile down upon us, evolved from earlier, far more primitive structures. In their day, however, the first towers were no less awesome.

Standpipes and water towers were largely introduced to both Europe and America in the nineteenth century, though the systematic distribution of water has evolved since antiquity. Frontinus, who left a detailed account of Rome's water supply in the first century A.D. in his treatise, *De Aquis*, mastered the technique of distributing water for both public and private use.[1] By gravity flow, the water was borne by nine aqueducts—remnants of which remain—from outlying streams. It descended into the city and was distributed from strategic points. Frontinus describes how a portion of the waters from the Julian aqueduct flowed into an elevated tank on the Caelian Hill. Such a large masonry tank or cistern (*castellum*) was apparently buttressed or placed against the aqueduct as an integral part of its construction. Frontinus lists 247 such tanks, which assured supply to the private houses of the wealthy. The ruin of a Roman tank in Chester, England, indicates the size and construction of these elevated reservoirs. According to Frontinus, the architect Vitruvius invented a device for metering the water used. Unfortunately, the empirical knowledge gained from such technical feats was lost after the fall of the Empire.[2]

Not until the eighteenth century were there cities that rivaled the population of ancient Rome and its problems of water supply. Experimentation during the "Age of Reason" rekindled the imagination of artists, architects, and engineers who were fascinated by the problems of handling huge volumes of water. The need to drain water from mines in Cornwall and Wales led to the development of pumps and engines. Towards the end of the eighteenth century, the English engineer, John Smeaton, erected machinery in Kent on the Ravensbourne River to supply water to the towns of Deptford and Greenwich. London, the largest city of the period, relied on private companies to supply its water until the middle of the nineteenth century. Reservoirs with settling basins and filtering beds were required because of the pollution attending the rivers Lea, New, and Thames.[3]

Stream driven pumps, though used elsewhere, were not used in London until after 1800. Diderot's *Encyclopédie* (1751) contains illustrations of several contrivances for pumping and delivering water to reservoirs (Fig. 8–1). Suggestions for elevating columns of water were proposed even earlier in Poleni's *Castellis per quae derivatur Fluviorum Aquae* (1718).[4] For the most part, these pumps were operated by waterwheels, though Diderot's "Moulin à Eau" would have been driven by wind, and was similar in type to the windmills first employed in the Netherlands to drain the polders.[5]

In America, the rapid, post-colonial growth of the Mid-Atlantic cities posed new problems with regard to water supply. Though most cities were situated near rivers and lakes, where supplies of fresh water were bountiful, their inhabitants preferred the convenience of shallow wells. As a result, they also suffered the ravages of typhus, typhoid, and diptheria, when their wells became polluted.

Philadelphia, America's largest city on the eve of the Revolution, with a population of 24,000, was especially hard hit by recurring plagues caused by contaminated drinking water. Neither resident nor visitor was spared. Thomas Jefferson, for example, suffered a mild case of dysentery while drafting the Declaration of Independence.[6] Benjamin Franklin, Philadelphia's *éminence gris*, left a bequest in his will for the purpose of improving the city's water supply.[7]

Although nearby Bethlehem, Pennsylvania, may have introduced the first "water supply system" in America in 1754–1761, where water was carried from a settling reservoir in pipes, designed by Hans Christopher Christiansen, Philadelphia gave us the first truly modern system in which pumps and an elevated tank were employed. The genius behind the Philadelphia Waterworks was Benjamin Henry Latrobe (1764–1820), the celebrated architect and engineer.[8] Latrobe arrived in Philadelphia in 1798, married into a prominent family, and landed two important commissions, one to design the Bank of Pennsylvania, and the other to design the Waterworks. He submitted drawings for the latter in December of that year. In the summer of 1799, during a yellow fever epidemic, attributed in part to open wells and cisterns, work commenced. A canal and tunnel were excavated from the Schuylkill River, from which a basin had been dredged. The water was then raised by pump more than one hundred feet above the level of the river and conducted through a brick-masonry tunnel by gravity flow to Market Square in the center of the city. There, a small subterranean basin was dug, on top of which was placed the "Centre-Square Engine House" (Figs. 8–2 and 8–3). In addition to housing a second steam pump, this Ledoux-inspired Greek Revival style structure contained two elevated water tanks, the first in America.[9] Although the building was constructed of marble, the interior tanks were wooden. Collectively, they held 30,000 gallons of water to provide a sufficient head of pressure for the distribution of nearly three million gallons per day. The distribution network was also wooden: some six miles of white pine pipe had been laid by the time the pumps were put into operation in 1801, and not until 1818 were cast-iron pipes substituted.[10]

Latrobe may have derived his ideas from John Smeaton with whom he had apprenticed in England. Smeaton's works on the Ravensbourne River were greatly admired. However, Smeaton's pumps were driven by waterwheel and not by steam. Philadelphia could have obtained its water from the Wissahickon Creek by aqueduct and canal, as had been suggested by Franklin. But Latrobe was eager to employ the new technology of his day, and thus conceived a more sophisticated system of water delivery. Because of restrictions on the export of British technology, Latrobe turned to native mechanics to fashion pumps and engines. Nicholas Roosevelt of New Jersey produced the original machinery, which would have appeared crude by British standards. The boiler for the steam engine, some of the shafting, counterweights, and lever beam were constructed of wood. Despite the leaky equipment, fuel costs, and labor-intensive maintenance, the Philadelphia Waterworks was a huge success.[11]

Demand soon over-reached the capabilities of the delivery system, and the works were expanded in 1812 with a reservoir placed at the summit of Fairmont Hill above the Schuylkill River. The reservoir safe-guarded the water supply and avoided interruptions in service whenever the pumps broke down. In time, the original equipment was replaced, but the technology was not abandoned. Engines were used to ensure supply and adequate pressure, and the Philadelphia Waterworks became a model for cities like Cleveland, Cincinnati, Louisville, and Chicago.[12]

Water towers were used as small reservoirs to place gravity pressure on distribution pipes, delivering water to hydrants. They also provided an important secondary function. They counterbalanced the pressure on water pumps. As pumps became larger and more sophisticated, the pressure under which they operated needed to be equalized. Huge machines, usually designed on the Cornish principle, with cylinders of several feet in diameter and plungers with a stroke of ten or more feet could be damaged if permitted to operate without an adequate load. In instances, delicate balancing was required. When Philadelphia expanded its water delivery system to the northwest portion of the city, beginning in the 1840s, it excavated another reservoir fed by several pumps. Because of demand, yet an additional pumping engine was acquired in 1854; and shortly thereafter a "standpipe" was erected "which relieved the shock upon the pump, and enabled the engine to be worked with safety."[13]

A standpipe is a column of water supported by at least as great a volume of water at its base as at its top. In design, a standpipe is less efficient than an elevated tank because its ground pressure is less. Greater pressure will be exerted on a main below a tank elevated fifty feet than by a column of water distributed in height between one and fifty feet. However, it was reasoned that the foundations of such structures could be made more stable if their weight was uniformly distributed. In fact, this was not the case, and standpipes frequently failed at the foundations because of their concentrated hydraulic loads.[14] But this was not understood in the mid-nineteenth century. Moreover, the difficulty and expense of designing structures to support elevated tanks posed an even greater challenge.

The standpipe of the West Philadelphia Waterworks was a picturesque affair, a novelty because of its prominence. It was erected by the engineers, Birkinbine and Trotter, and stood 137 feet high (Fig. 8–4). A stair wrapped around the pipe, leading to an observation platform. Its octagonal base was masonry and it was intended to carry a statue of George Washington on its cap. But the sculpture was never set in place, and, apparently, a spire was substituted. Its iron tank tapered in diameter from six feet at bottom to three and half feet at top, and this produced another problem. In sub-freezing weather the pumps were put out of commission because the upper part of the pipe became frozen.[15]

Notwithstanding their functional deficiencies, there was something elegant about these early standpipes, owing to their slender profiles, seeming to appear as obelisks, classical columns, and medieval watch towers. Those erected in Louisville in 1858, Chicago in 1869, and Roxbury, Massachusetts in 1870 still remain, though the pumps they augmented have long-since been abandoned (Figs. 8–5 through 8–7).[16]

Water towers, or elevated tanks, did not appear in number until after 1870, despite Latrobe's early design of the Market Centre Engine House. Tanks of large diameter, as opposed to small-diameter standpipes, required thicker walls and stronger foundations. The manufacture of tanks was hampered by the small size of available metal plate. Rolled sections of boiler plate could not be produced in sizes larger than several feet square. Special shapes had to be wrought. Since cast iron was poor in tensile strength, and Bessemer steel was not available until the last decades of the century, the fabrication of metal tanks was delayed.

In Germany, where structural iron was readily available, a water tower had been completed in 1859 for the city of Altona, a suburb of Hamburg on the Elbe River. An impressive brick masonry structure carried a metal tank supported by arches (Fig. 8–8). A door and windows penetrated the lower portion of the tower, while the upper part concealed the tank. Its engineer, William Lindley, designed the building in such a way that its masonry walls supported a wrought-iron roof and left the tank entirely freestanding. Though the tank itself was of large diameter, 42 feet, it was quite shallow and capable of holding only 9,920 gallons. The tank was cast-iron and thus its capacity was reduced. Though a handsome structure, it had a limited capacity for such a large investment.[17] The same applies to a water tower in Wallasey, England, a suburb of Liverpool. Designed by Robert Rawlinson, ca. 1876, its strange proportions gave it the appearance of a high-rise Venetian *palazzo* or Sienese *torre* (Fig. 8–10). Only the attic portion of the 90-foot square-based structure contains the tank.[18]

If metal plate was expensive and difficult to fabricate, wood was cheap and readily available in America. Barrel making,the cooper's art, had been practiced since antiquity, and wooden casks are depicted in the relief carving of Trajan's Column. Liquids and other perishables were shipped to America in casks large and small. Small wooden tanks served as cisterns to catch rain water for domestic use. By the second half of the nineteenth century, they became commonplace. Stockmen used them to water their cattle and railroads used them as supply tanks for steam engines. The same principles were employed in their manufacture, regardless of their size. Wooden staves of pine or fir were held together by wrought-iron hoops. When filled, the staves expanded to make the vessel watertight.

The problem came with making large tanks to hold tens of thousands of gallons (Fig. 8–9). The staves had to be several inches thick, typically two and three-quarter inches by six inches in cross-section; and unlike the cooper's hoop which formed a perfect circle, strap iron for large tanks required draw bolts. Though fluid mechanics was understood by engineers, inconsistencies in materials and workmanship were impossible to calculate. A further complication was the placement of wooden tanks on towers. Because the bottom of the tank was flat, it required uniform support, such as provided by heavy timber trestles or wrought-iron I beams. Usually, the larger tanks were supported around the perimeter by masonry towers. These varied in height depending on the pressure desired. Within the tower were additional supports, such as wood or metal columns to help distribute the load. A cylinder or head pipe that carried the water from the tank to the mains and the service pipe that filled the tank were also enclosed by the tower to protect them from freezing.

Among the more interesting early water towers in America was the one designed by Jenney, Schermerhorn and Bogart at Riverside, Illinois in 1870 (Fig. 8–11).[19] William Le Baron Jenney built his home in this Chicago suburb that had been laid out the preceding year from the plans of Olmsted and Vaux. Educated in Paris as an engineer, Jenney later designed Chicago's first skyscraper.[20] The design of a masonry tower to carry a wooden tank was a task he was well equipped to perform. Moreover, because of the romantic image projected by Olmsted, the architect set about to create a compatible design—a tower that would complement its rustic surroundings, including a pump house and depot as part of the ensemble. From a limestone base, the tower ascended in courses of buff-colored brick. Lancet windows with corbeled arches above were more decorative than functional. Wooden brackets near the top supported an observation platform that was partially enclosed by an ornate wooden railing, and the whole was capped by a wooden conical roof. Though the tower represented a handsome feature within this picturesque suburb, its wooden tank twice had to be replaced, and in 1913 caught fire. Another architect, W. D. Mann, inserted a metal tank and increased the height of the tower to 74 feet. A steel roof replaced the wooden one.[21]

For a suburb or small town, a water tower sufficed for a reservoir. It provided sufficient pressure to operate the pumps and to pressurize the mains, and it contained adequate reserves for places of limited population. An 1887 masonry tower in Paxton, Illinois, is a case in point (Figs. 8–12 and 8–13).

Paxton was a railroad town that had been laid out in the 1850s. Supposedly, it was named for the designer of the 1851 Crystal Palace in London, Sir Joseph Paxton, who, like many of his countrymen, invested in American railroads.[22] The town of Paxton lay on the prairie with neither hill nor lake to relieve its flat landscape. Its water derived from deep wells. But if the town was to thrive and attract industry, it needed a water supply system. By the 1880s, Paxton's population had grown to several thousand and was expected to double by the turn of the century. Though a reservoir would have been desirable, the expense for earth moving and embankments would have exceeded the town's budget. Moreover, there were no naturally elevated sites on which to place a reservoir. Given the alternative, the mayor and city council accepted a bid from Fairbanks, Morse, and Co. of Chicago to build a water tower.[23]

The structure stood 100 feet to the top of its wooden tank. The lower 80 feet comprised an octagonal brick tower whose walls measured two and one half feet thick at the base and gradually tapered to the top. Inside the tower stood four wooden columns, each one foot square, to help support the bottom of the tank. The masonry walls and columns rested on a poured concrete foundation six feet thick. They supported a large tank of 60,000 gallons capacity, which served the town of Paxton until the 1940s. Though the tank has been removed, the masonry tower remains as a testament to the town's pioneering efforts. The quality of brick work, the simplicity of the tower's design, and its majestic proportions qualified it for the National Register of Historic Places in 1985, nearly 100 years after its construction.[24]

Imposing as some of these structures were, they could also be spectacular, especially when their wooden tanks burst. When one collapsed, its impact was like a freight train falling from the air. In an account titled "Another One Gone," a Stewartstown, Pennsylvania bystander remarked:

> The 45,000 gallons of water, weighing 180 tons, fell a distance of 75 feet, making a hole three feet deep and about 20 feet wide in the ground where it struck. The ensuing splash caused water and mud to deluge the bathroom on the second floor of the home of the Rev. William Leishman, 200 feet away.[25]

The calamity occurred because two wrought-iron bands holding the staves of the tank snapped. Wooden tanks were subject to bursting, rotting, and, when struck by lightning, catching fire.[26] Even when new, there were risks involved. A tank 24 feet in diameter and 20 feet high perched on a 100-foot tower in Newport, Arkansas, burst in 1887 when filled for the first time. The accident resulted from attempts to tighten its hoops to stem its leaking. In addition to loss of life, the tower, pump house, and a nearby dwelling were wrecked.[27]

Replacing wooden tanks with metal ones offered no guarantee against failure. However, the performance of a metal tank was more predictable. Cast and wrought iron had been employed in standpipes since the 1850s, though in small-diameter sections. Unless encased by masonry and insulated against freezing, metal standpipes were put out of operation by cold weather. Ice formed on the inside of the pipe and became attached to the wall. When the ice thawed, it would detach and float to the top, rather like a small iceberg. For tall, narrow standpipes, this could be disastrous. The dynamic force caused by the released ice would rend the side of the pipe and cause its collapse. In Erie, Pennsylvania, an 1868 standpipe with a diameter of five feet and a height of 220 feet, dislodged a cylinder of ice that projected twenty feet into the air, knocking the cap off the tower as well as an observation platform that had been occupied only hours before.[28] Ice also formed on the sides of wooden tanks, where expansion caused leaking. However, tanks of larger diameter did not freeze solid and were rarely put out of service.

Towards the end of the nineteenth century, rolled sheet steel of heavy guage could be produced in large curved panels of six to ten feet on a side. When the panels were riveted together and properly caulked, a water-tight tank was produced. Metal tanks began to replace those of wood, which in most instances stood on masonry towers.

A breakthrough occurred in 1893, however, which would change forever the appearance and performance of water towers. An engineer by the name of Horace Horton, who in 1889 founded the Chicago Bridge and Iron Company, patented a design for a metal tank with a hemispherical bottom.[29] The design concentrated pressure on a return pipe leading to the mains below, and permitted a light-weight open structure to support the tank. Four braced-steel legs were attached to a girdle on the sides of the tank where the hemisphere connected. A safe, stable, easily erected, and relatively inexpensive structure resulted. In 1894, the first such water tower was constructed in Ft. Dodge, Iowa. It measured 116 feet to the top of its tank and held 104,000 gallons (Fig. 8–14).[30]

Horton's design won grudging acceptance. At first, cities were reluctant to invest in such a radical design. Skeptics waited to see whether the tower would stand or fall. The following year, the Chicago Bridge and Iron Works (CB&I) sold another 100,000 gallon water tower in Paris, Illinois, as orders began to trickle in. E. G. Ladd, a company salesman, sold the second tower and received seven additional orders in 1896. By 1899, the number of commissions had risen to twenty-two; and by 1914, when CB&I printed the first issue of its trade journal, *The Water Tower*, it had erected over 2,000 water towers, located in every state of the union, and throughout South America, Cuba, the Philippines, China, and France.[31]

Steel water towers of the type first designed by Horton became ubiquitous. Though other companies purchased his patent rights and built towers of similar design, CB&I pioneered in their manufacture and marketing.

It was a sales ploy to offer a city the free demoliton of its original masonry tower and wooden tank in return for a new commission. *The Water Tower* held photo contests in which cash awards were posted for images of failing tanks and towers. These were used to convince water commissioners how unsafe their equipment was in order to secure a replacement.[32] As a result of CB&I's sales strategy and escalating insurance premiums, the old-fashioned masonry clad standpipes and water towers of the nineteenth century all but disappeared. Their distinctive silhouettes and park-like settings also disappeared. Designed as works of civic art, they were intended to complement the Victorian architecture of surrounding neighborhoods. But the progressive era with its emphasis on the "city rational" accepted larger more austere structures which no longer disguised their function.

In 1930, CB&I sponsored a water tower design competition open to architects, engineers, and draftsmen. Over 150 entries were submitted and three thousand dollars in prizes awarded. The designs were published the following year in a volume similar to one produced by the Chicago *Tribune* for its 1922 skyscraper competition, and the results were nearly as fascinating.[33] The winning entry captured the essence of the streamlined moderne (Fg. 8–15). Its designer, Eugene Voita, may have been influenced by the popular industrial designer, Norman Bel Geddes. A stainless steel tank supported by three legs placed second (Fig. 8–16). This entry was reminiscent of the Russian Constructivist architecture of the Vesnin brothers. In a far more graceful design, the architect Eero Saarinen used a similar approach to structure and material in his water tower for the General Motors Technical Center in Warren, Michigan, conceived in 1948 and completed in 1955.[34]

Saarinen's design remains today the most interesting and appealing of water towers (Fig. 8–17; see page 206). Waterspheres, the name given to single-column supported spheroids, had appeared as early as 1928.[35] But Saarinen did not want a ball on a column; what he wanted was a perfect ellipse in elevation supported by three columns. His ellipsoid was to be 46 feet in diameter with columns of five feet diameter, the whole to be clad in stainless steel. The tank would hold 250,000 gallons at a height of 137 feet, 10 inches.

To design such a monumental tower was one thing, to fabricate it was quite another. The Chicago Bridge and Iron Works received the architect's drawings and set about to produce the components. The task was at least as daunting as the one Latrobe handed over to Frederick Graff, his young assistant, who helped supervise construction of the Philadelphia Waterworks. The skin of the tower was carbon steel clad with stainless steel. To protect the bright exterior surface during handling and assembly, it was covered with plastic and paper. Hooks and slings were rubber coated to protect the components when being moved. Unfortunately, when the plates were welded together (welding had taken the place of riveting tanks during the 1930s), the heat from the inside discolored the stainless because of its wrapping. Therefore, the protective covering had to be pulled away from all seams and then replaced once the connections had cooled.[36] After the tower was completed, its surface was buffed by hand—to shimmer in the sky like a drop of water held in tension and magnified a million times its natural size.

Water towers, so much an urban fixture, are the products of design, both by architects and engineers. Their form evolved with advances in hydraulic theory, new materials, and industrial procedures. The principle on which they function within a city's waterworks has changed little, however, since the days of Latrobe. Pumping machinery has become more sophisticated, and is now operated by electricity instead of steam, though the water is still drawn from rivers, lakes, and wells. The supply of water is pure, and public hygiene has replaced our fear of tainted wells and cisterns. Moreover, such reserves guard against the spread of fire. Today, we take for granted the convenience of opening a tap. Because of the water tower, there is sufficient pressure to fulfill our expectations.

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## Notes

A useful starting place for the study of water towers is Donald H. Dyal's *The Architecture of Water Towers: A Bibliography* (Vance Bibliographies, A-869, 1982, 4 pp.). As the author mentions, his list is incomplete, and the need remains for a larger study of the subject. Just published is Bernd and Hilla Becher's *Water Towers* (Cambridge: MIT Press, 1988). Although short on text, it contains over 200 illustrations.

1 See Clemens Herschel, ed., *The Two Books on The Water Supply of the City of Rome of Sextus Julius Frontinus* (New York: Longmans, Green, and Co., 1913).

2 "These waters, going underground at the elevation of the Viminal Hill, flow up to the Viminal Gate. There they again see the light of day. But first, a portion of Julia [aqueduct] is distributed to the delivery tanks of the Caelian Hill, having been diverted at Spes Vetus ['prius tamen pars Iuliae ad Spem ueterem excepta castellis Caelii montis diffunditur.']." *Ibid.*, pp. 21, 23, 59.

3 *Reports of the late John Smeaton, F.R.S., made on various occasions, in the course of his employment as A Civil Engineer*, Vol. 2 (London: M. Taylor, 1837), p. 90, plate V; and Zerah Colburn and William H. Maw, *The Waterworks of London* (London: E. & F. N. Spon, 1867), p. 64.

4 See Joannis Poleni, *Castellis per quae derivatur Fluviorum Aquae* (Patavii, 1718).

5 *Dictionnaire des Sciences, Planches 5, Recueil de Planches sur les Sciences* ... (Paris: Briasson, 1767), p. 937.

6 Howard P. Chudacoff, *The Evolution of American Urban Society* (Englewood Cliffs, New Jersey: Prentice-Hall, 1981), pp. 4, 41–42; and Dumas Malone, *Jefferson the Virginian* (Boston: Little, Brown, & Co., 1948), p. 180.

7 John Bigelow, ed., *The Works of Benjamin Franklin, Vol. X* (New York, G. P. Putman's, 1888), pp. 222–223.

8 J. N. Hazlehurst, *Towers and Tanks for Waterworks* (New York: John Wiley, 1901), p. 5. See Talbot Hamlin, *Benjamin Henry Latrobe* (New York: Oxford University Press, 1955), pp. 159–167.

9 *History of the Works, and Annual Report of the Chief Engineer of the Water Department of the City of Philadelphia* (Philadelphia: C. E. Chichester, 1860), pp. 10–12.

10 John C. Van Horne and Lee W. Formwalt, eds., *The Correspondence and Miscellaneous Papers of Benjamin Henry Latrobe* (New Haven: Yale University Press, 1984), pp. 170–173.

11 *History of the Works ... of the City of Philadelphia*, pp. 9–10.

12 *Ibid.*, p. 25.

13 *Ibid.*, p. 30.

14 See William D. Pence, *Stand-pipe Accidents and Failures* (New York: Engineering News Publishing Co., 1895).

15 Susan Oyama of The Library Company of Philadelphia has brought to my attention a stereograph of the standpipe taken by Birkenbine in 1857 that indicates a spire. George B. Tatum, *Penn's Great Town* (Philadelphia: University of Pennsylvania Press, 1961), p. 181; and *History of the Works ... of the City of Philadelphia*, pp. 30, 34.

16 As regards the Chicago Water Tower, designed by W. W. Boyington in the Crenelated Mode of the Gothic Revival Style, the present 1869 structure was preceded on its site by an earlier standpipe, a two-foot diameter metal pipe encased by a brick tower that was square in plan and 136 feet in height, constructed in 1854. Because of poor soil conditions caused by a high water table, it leaned like the Tower of Pisa. Pence, *Standpipe Accidents and Failures*, p. 106. See also *A Century of Progress in Water Works* (Chicago: Department of Public Works, 1933), pp. 13–15.

17 Colburn and Maw, *The Waterworks of London*, pp. 131–132.

18 William Humber, *A Comprehensive Treatise on the Water Supply of Cities and Towns* (Chicago: Geo. H. Frost, 1879), p. 110.

19 Walter L. Creese, *The Crowning of the American Landscape* (Princeton: Princeton University Press, 1985), p. 229.

20 This attribution has long been contested, though not convincingly disproved. For a recent disputation see Gerald R. Larson and Roula Mouroudellis Geraniotis, "Toward a Better Understanding of the Evolution of the Iron Skeleton Frame in Chicago," *Journal of the Society of Architectural Historians* 46 (March, 1987), pp. 39–48. See also Carl W. Condit, *The Chicago School of Architecture: A History of Commercial and Public Building in the Chicago Area, 1875–1925* (Chicago: University of Chicago Press, 1964), pp. 79–94.

21 "Esthetic Design of Water Towers," *The Water Tower* I (July, 1915), p. 3.

22 E. A. Gardner, *History of Ford County, Illinois* (Chicago: S. J. Clark Publishers, 1908), p. 88. Sir Joseph Paxton also knew something of water storage. When the Crystal Palace was moved to Syndenham in 1854, two standpipes were erected, one on each side of the entry pavilion.

23 *Paxton Daily Record*, July 14, 1887.

24 *Paxton Daily Record*, August 4; September 8; December 22, 1887.

25 "Another One Gone," *The Water Tower* IV (February, 1918), p. 8.

26 "Remarks on Advantages of Steel Tanks," *The Water Tower* III (January, 1917), pp. 2–6.

27 Pence, *Stand-pipe Accidents and Failures*, p. 22.

28 *Ibid.*, p. 108.

29 Writing about this patent, Horton's son declared: "He [Horace E. Horton] brought out these two essential elements which made the steel tank commerical with not over a half hour's study. The more I think of this one thing, the more remarkable it seems." An early history of the works and description of first elevated tank appears in "Founder of the Chicago Bridge and Iron Works," *The Water Tower* I (October, 1914), pp. 2–5.

30 "Special Issue," *The Water Tower* XXXVIII (July, 1952), p. 5.

31 "History of Employees," *The Water Tower* I (December, 1914), p. 5.

32 See *The Water Tower* IV (October, 1917).

33 See *Elevated Tank Designs: Sponsored by the Chicago Bridge & Iron Works* (Chicago: CBIW, 1931).

34 Aline B. Saarinen, ed., *Eero Saarinen on his Work* (New Haven: Yale University Press, 1968), pp. 30, 32.

35 "Watersphere," *The Water Tower* XXVIII (January, 1942), p. 4.

36 "Stainless Clad Tank Designed to Blend with General Motors Technical Center," *The Water Tower* XLI (May, 1955), pp. 4–5.

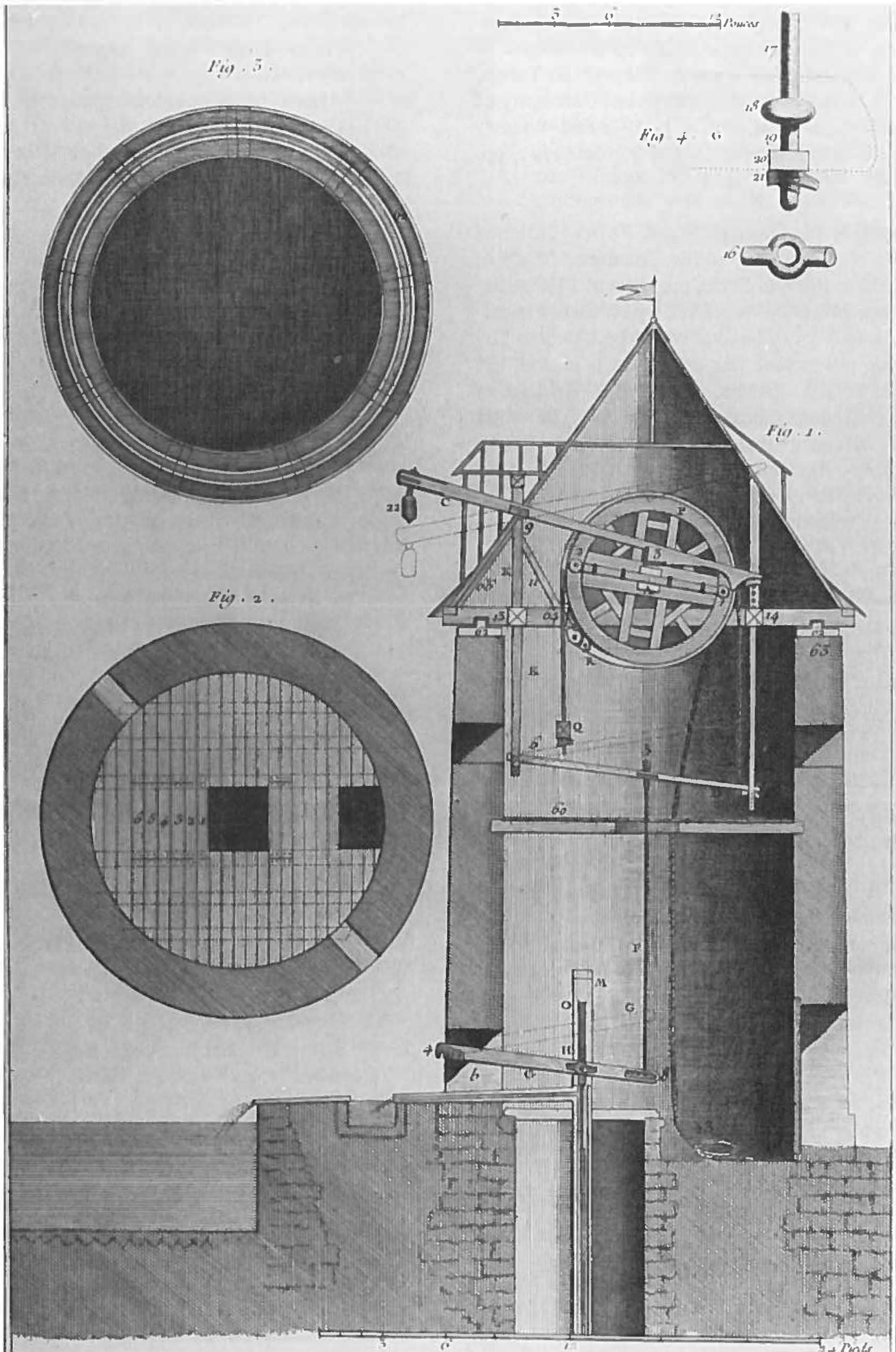


Fig. 8–1 "Moulin à Eau" from *Dictionnaire des Sciences*, Plans and Section, planches 5, plate 3, 1767. University of Illinois at Urbana Rare Book Collection.

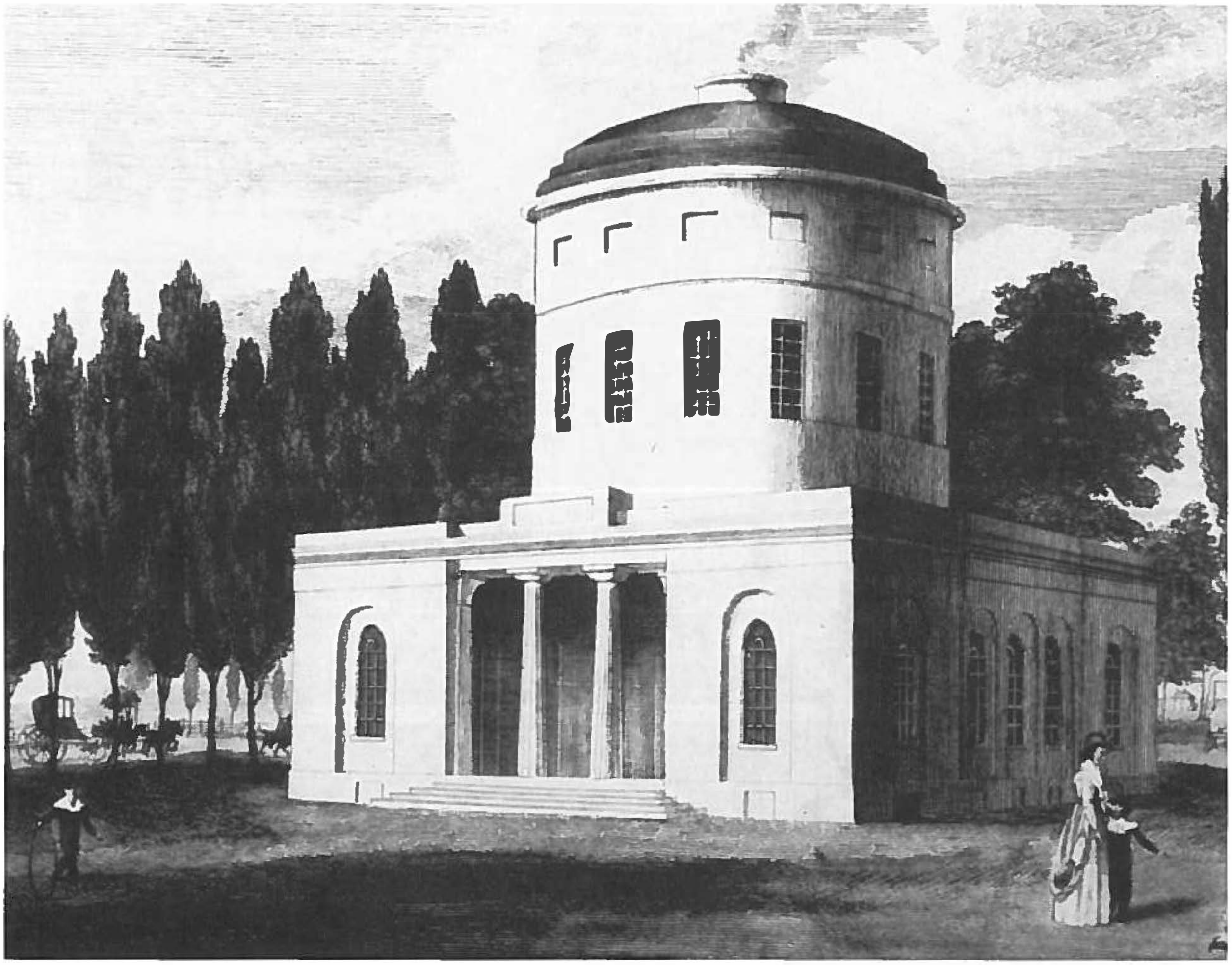

Fig. 8–2 Benjamin Henry Latrobe, Centre-Square Engine House, Philadelphia, 1801. Razed, 1828. Photo: Ricker Architecture Library Photograph Collection, University of Illinois at Urbana.

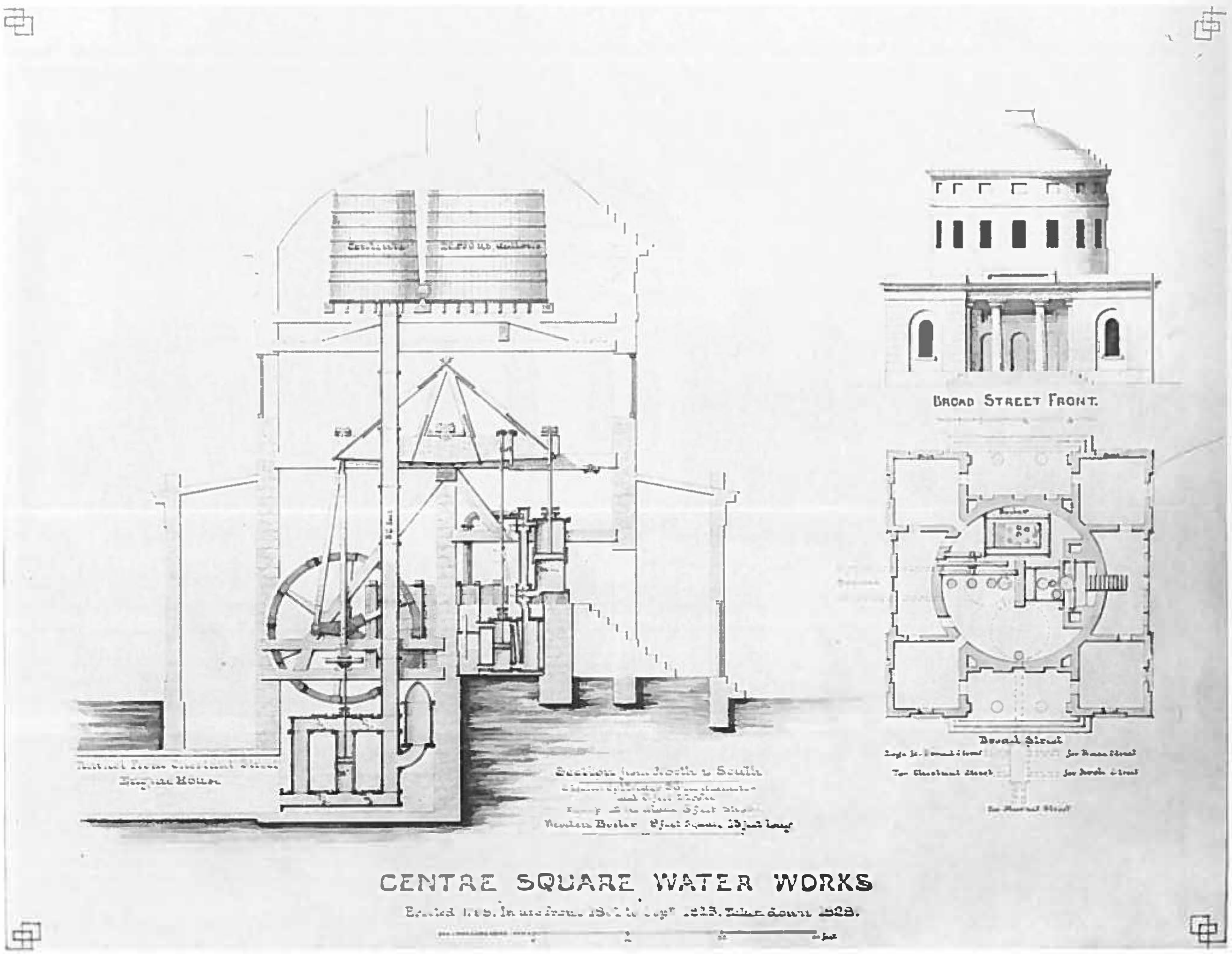


Fig. 8–3 Centre-Square Engine House, section, elevation and plan, drawn by Frederick Graff, ca. 1828. Photo courtesy of The Historical Society of Pennsylvania.

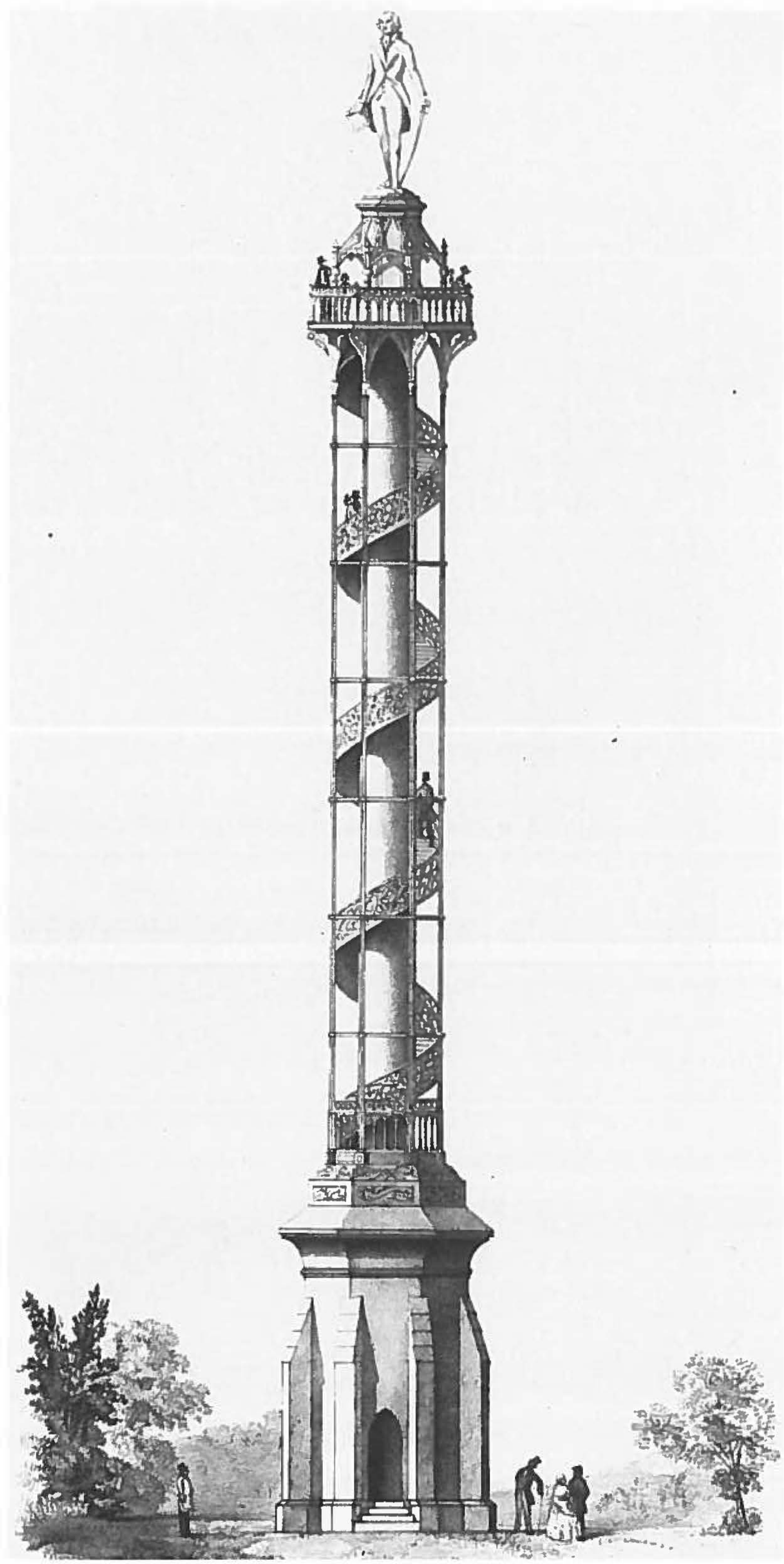

Fig. 8–4 Birkinbine and Trotter, Standpipe of the West Philadelphia Waterworks, Philadelphia, ca. 1854–1855. Razed, ca. 1870. A spire was substituted for the statue of George Washington. Photo courtesy of the Library Company of Philadelphia.

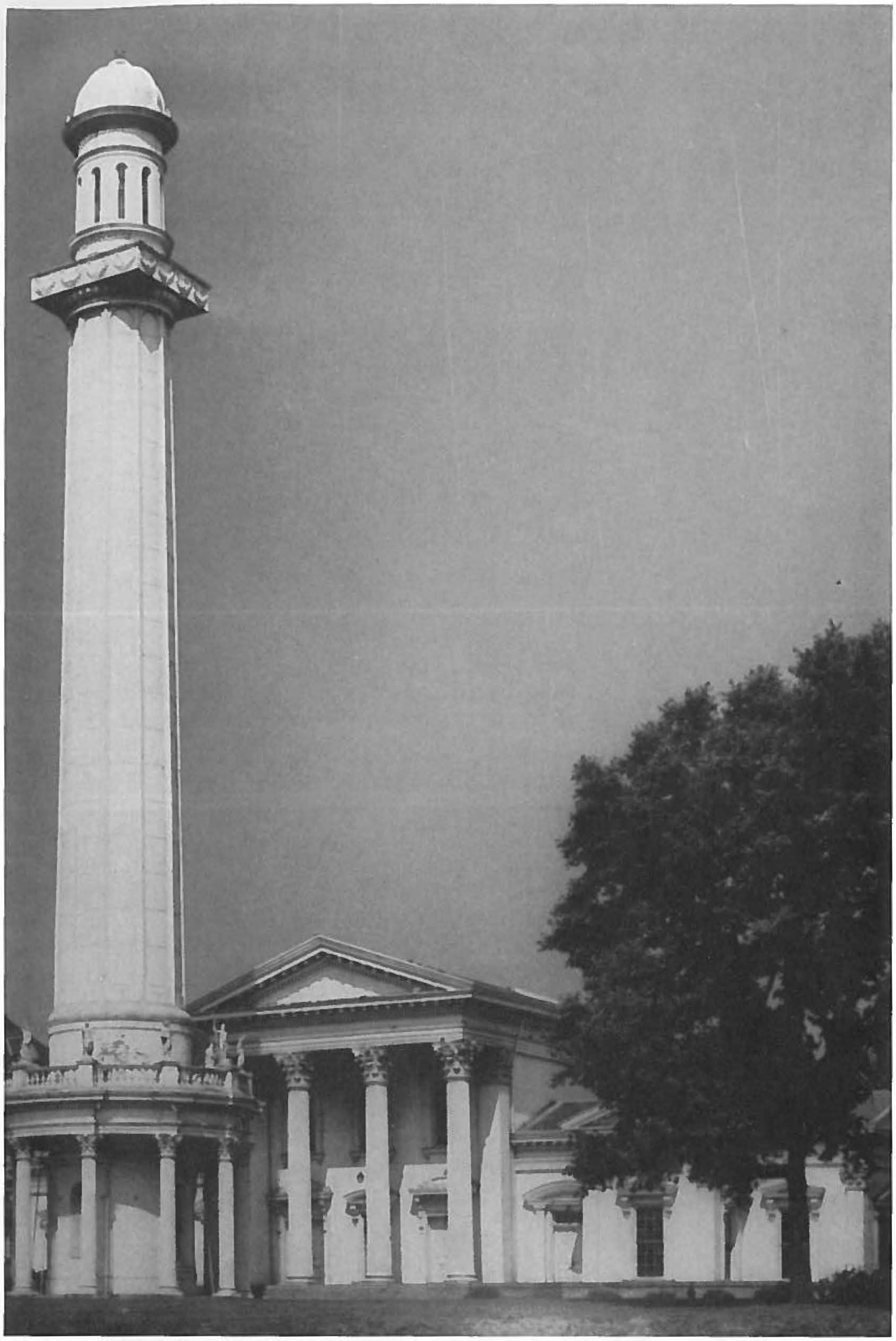

Fig. 8–5 Theodore R. Scowden and H. P. Hahn, Louisville Waterworks, 1858. Photo by Wayne Andrews, 1954. Ricker Architecture Library Photograph Collection, University of Illinois at Urbana.

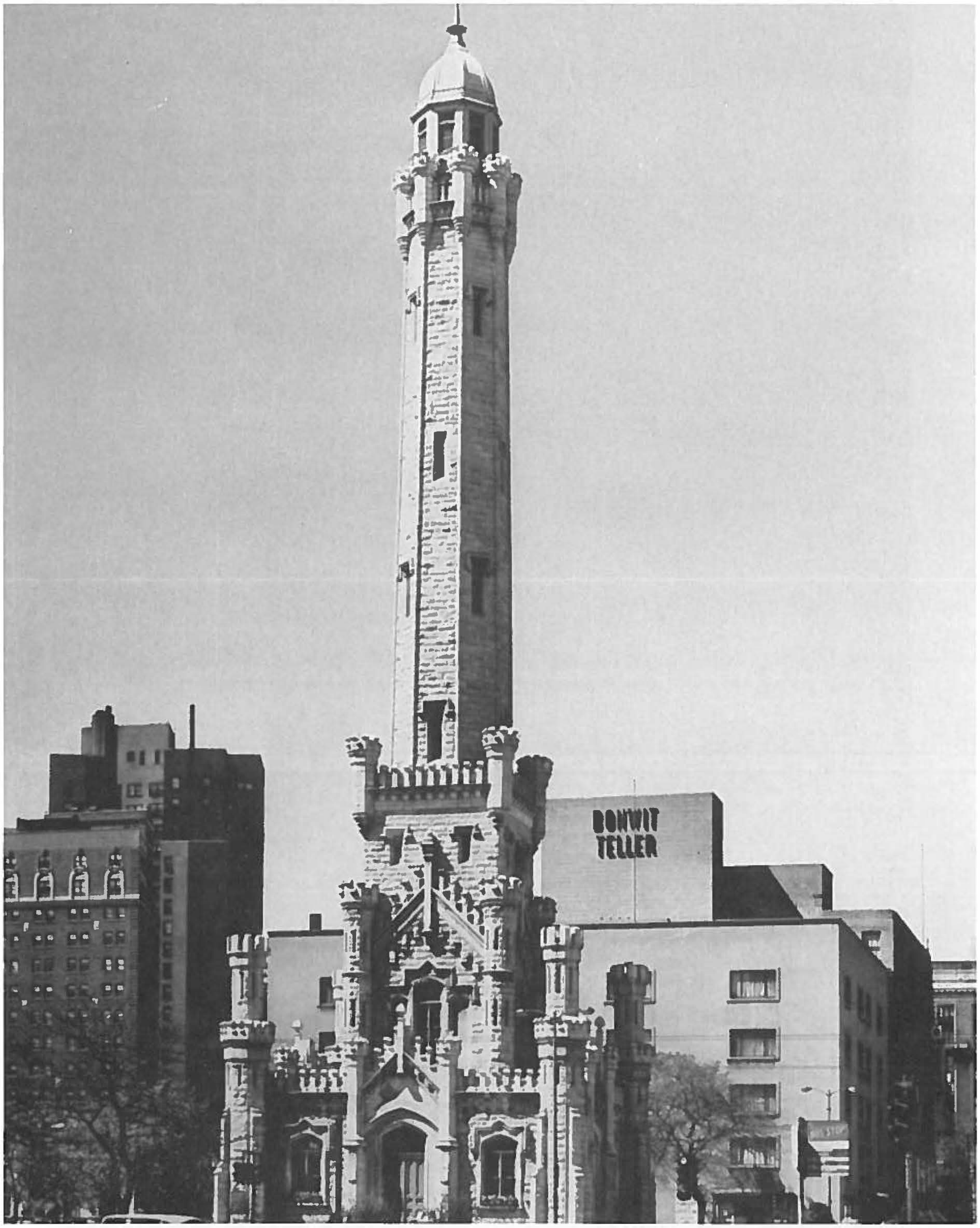


Fig. 8–6 W. W. Boyington, Chicago Waterworks, 1869. Photo: Ricker Architecture Library Photograph Collection, University of Illinois at Urbana.

Fig. 8–7 Standish and Woodbury, Roxbury Standpipe, 1870. Photo from *History of the Boston Waterworks, 1868–1876.*

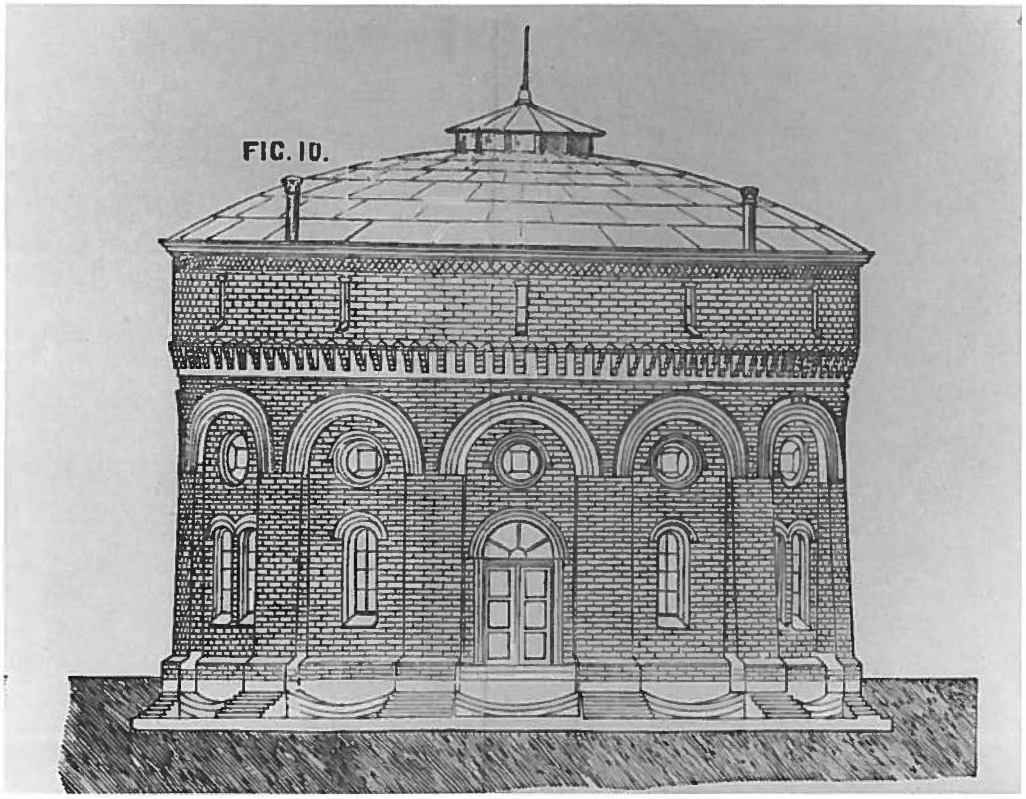


Fig. 8–8 William Lindley, Water Tower, Altona, Germany, 1859. Photo from Colburn and Maw, *The Waterworks of London*.

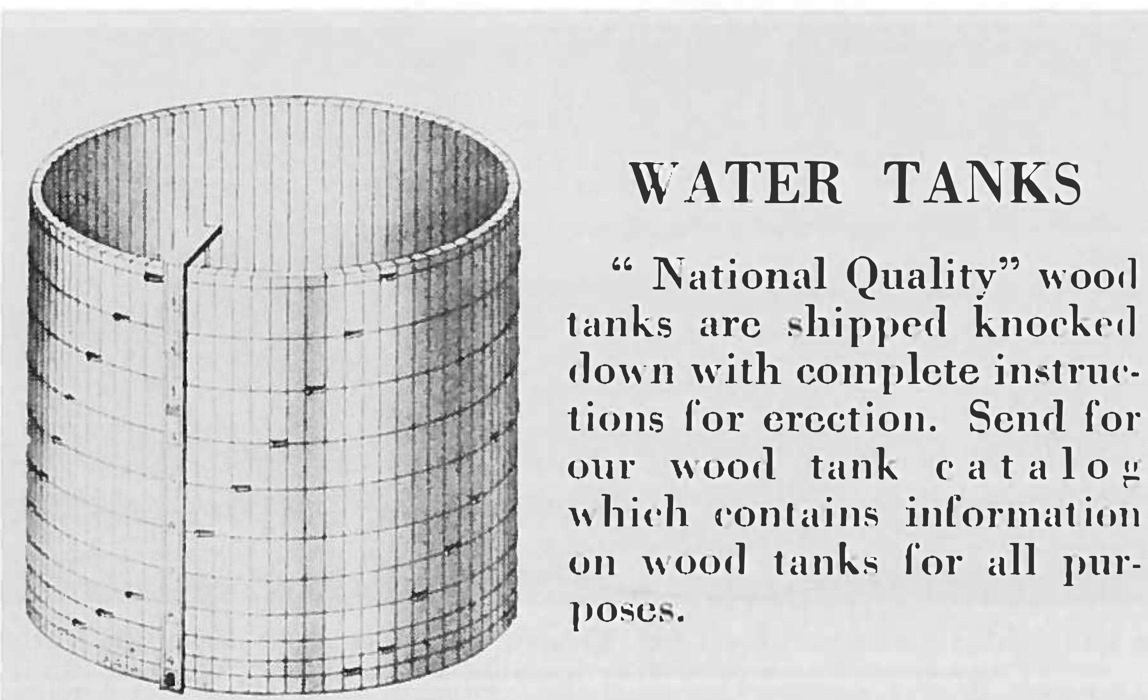


Fig. 8–9 Wooden tank advertisement for the National Tank and Pipe Company of Portland, Oregon, 1905. A ten thousand gallon tank sold for $195. Photo from *Wood Pipe Handbook*.

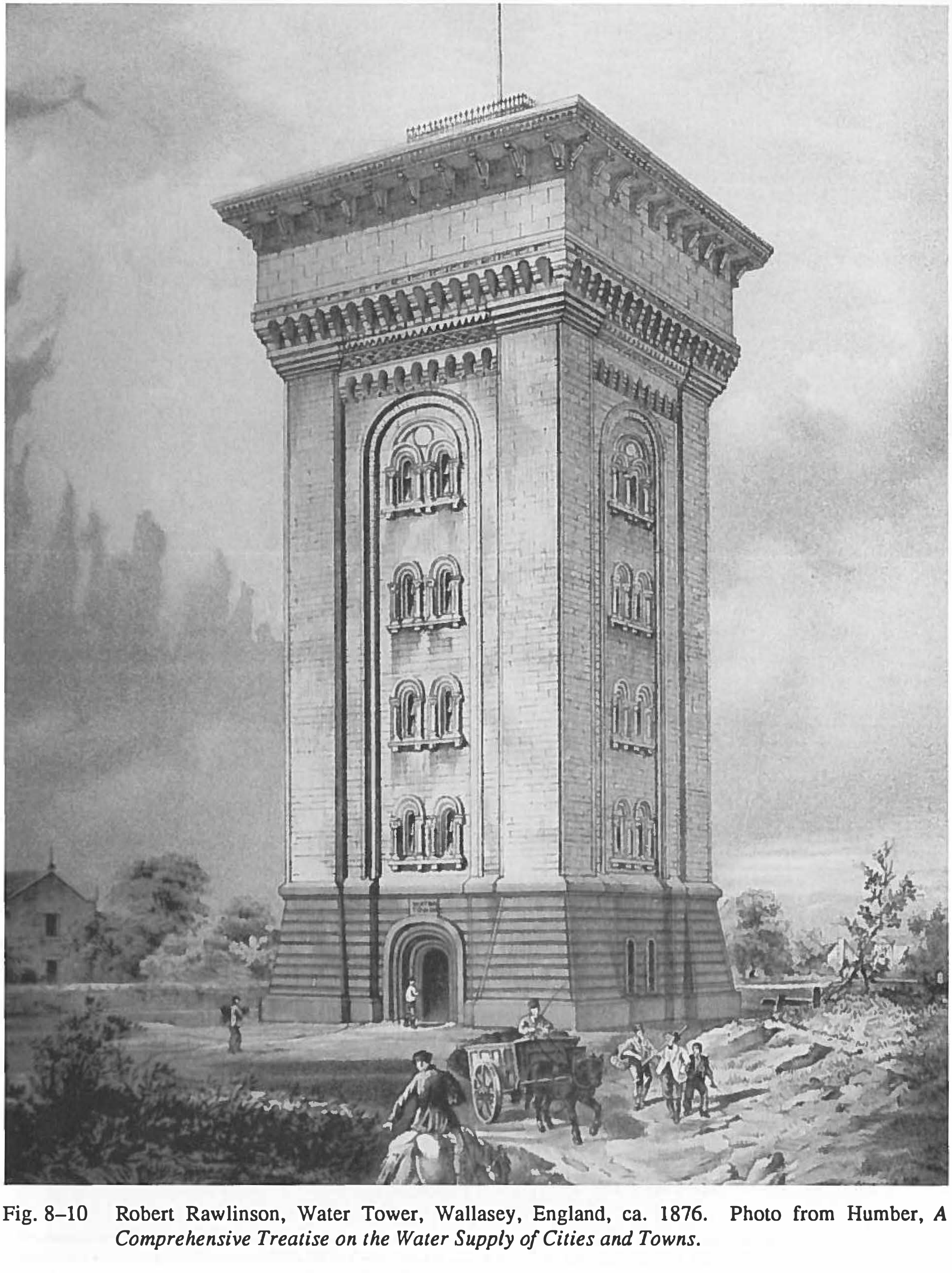

Fig. 8–10 Robert Rawlinson, Water Tower, Wallasey, England, ca. 1876. Photo from Humber, *A Comprehensive Treatise on the Water Supply of Cities and Towns.*

Fig. 8–11 William Le Baron Jenney, Water Tower and Pumphouse, Riverside, Illinois, 1870. Photo from *The Water Tower*, Vol. I (July, 1915).


Fig. 8-12 Fairbanks, Morse, and Co.,water tower with wooden tank, Paxton, Illinois, 1887. Photo courtesy of the Ford County (Illinois) Historical Society.

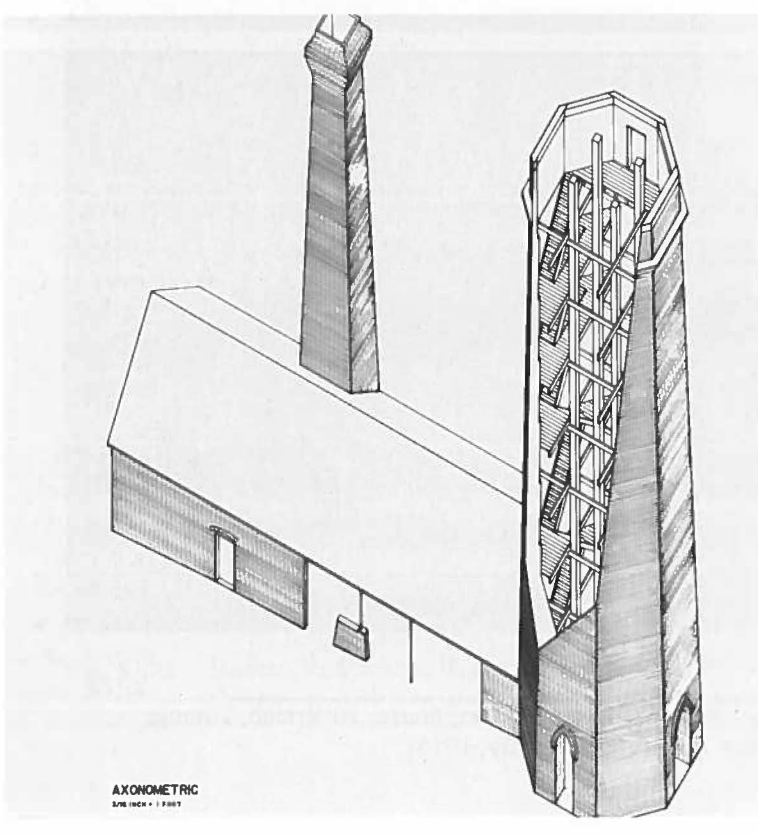


Fig. 8-13 Axonometric drawing of the Paxton Water Tower, showing cutaway of masonry wall and internal wood columns used to support the wooden tank. HABS drawing by Richard Hanpeter, University of Illinois at Urbana, 1981.

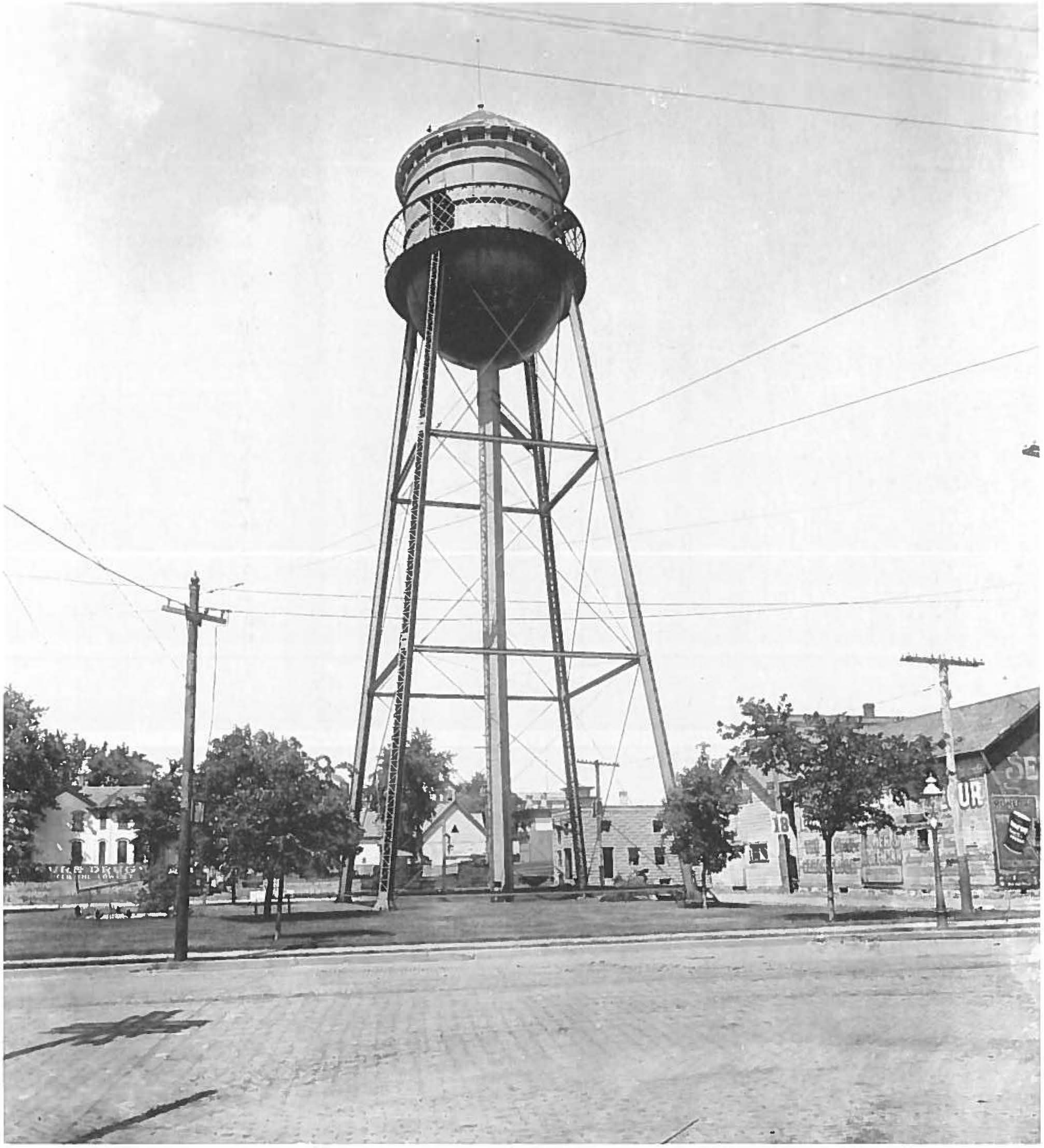

Fig. 8–14 First steel water tower manufactured by the Chicago Bridge and Iron Works, designed by Horace Horton and erected at Ft. Dodge, Iowa, in 1894. Photo courtesy of CBI Industries.

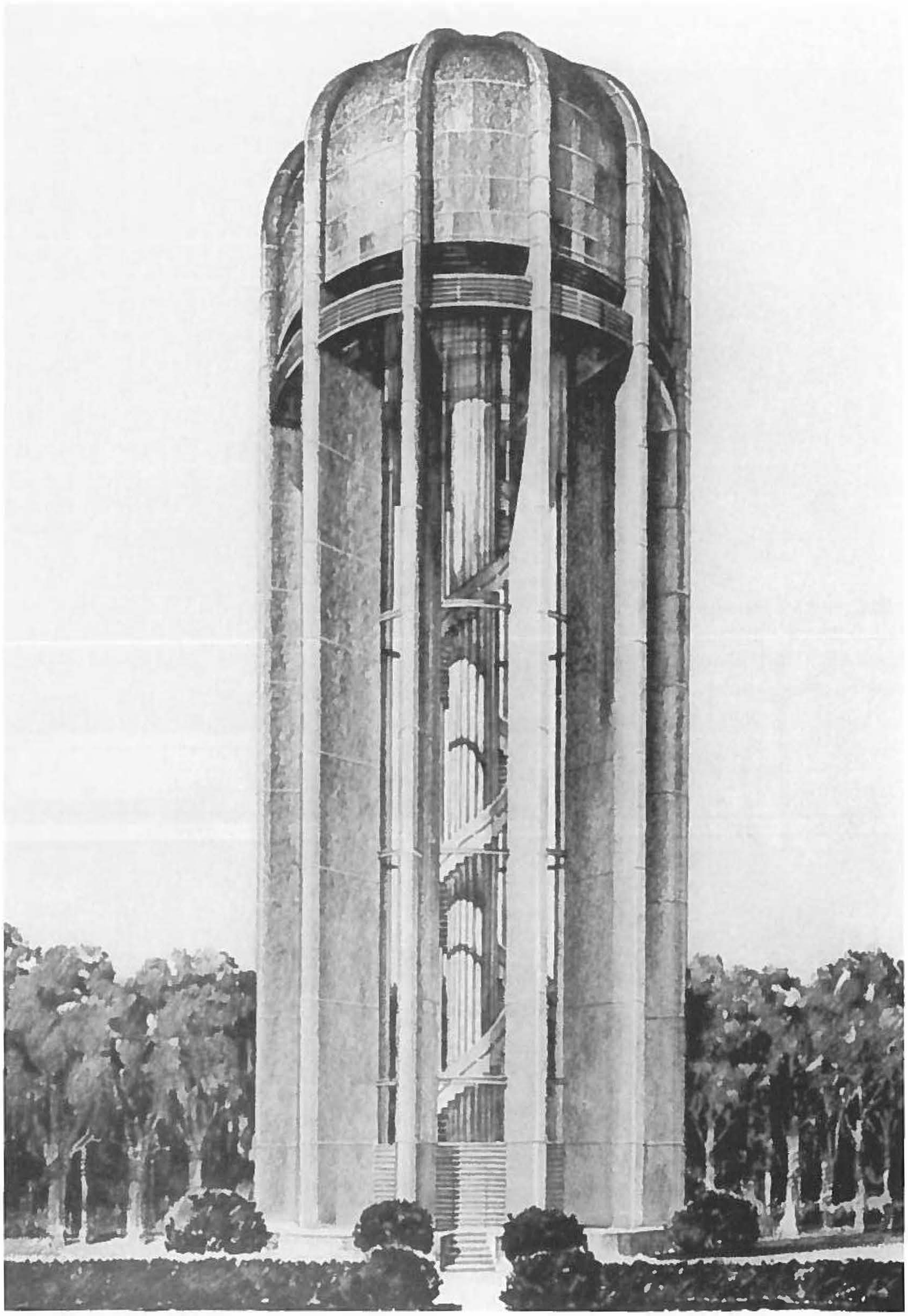

Fig. 8–15 Winning design by Eugene Voita of a competition sponsored by the Chicago Bridge and Iron Works, 1930. Photo from *Elevated Tank Designs.*

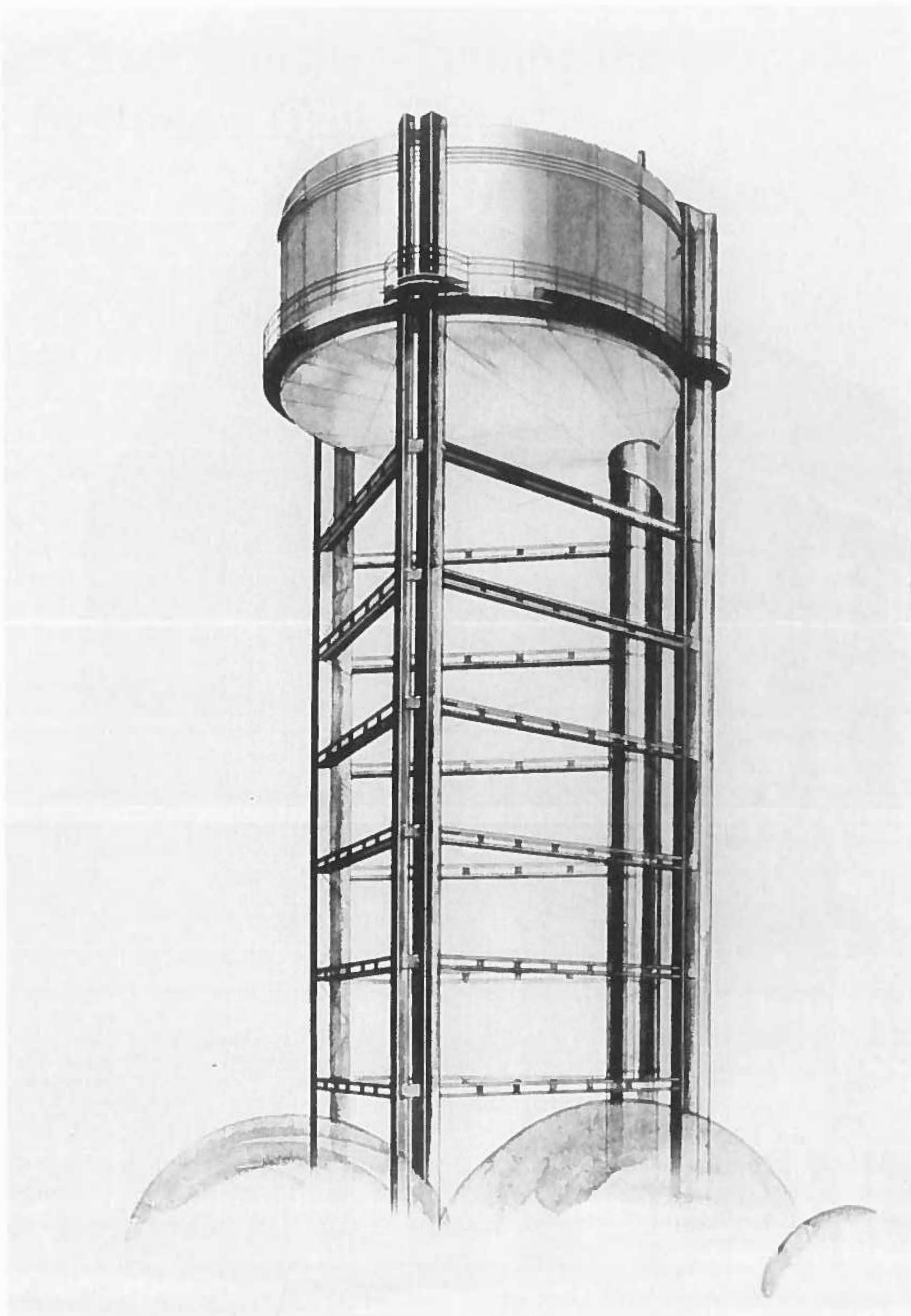

Fig. 8–16 Second Place by Chapman and Coldman of a competition sponsored by the Chicago Bridge and Iron Works, 1930. Photo from *Elevated Tank Designs*.