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# The Elevator, the Iron Skeleton Frame, and the Early Skyscrapers: Part 1

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**Abstract**

The evolution in the use of the elevator and the iron frame to build ever-taller buildings that would eventually be called "skyscrapers" is still somewhat shrouded in the mist of history. This two-part paper is an attempt to document the significant persons and events in that evolution, showing that these had a greater continuity than that previously recorded. In this first part, I discuss how the exploitation of the elevator in the design of buildings allowed "skyscrapers" to be built taller than the five-six story limit imposed by stairways, so that their owners could include more and more rental square footage needed to offset the increasing cost of Manhattan real estate. The use of iron framing for the interior framing in these taller buildings would reduce the amount of square footage lost to construction, thereby also increasing the rental return from the building. By the start of the Great Depression of the 1870s in 1873, New York architects had erected two ten-storied skyscrapers.

**Keywords:** Iron Framing, Elevator, Skyscraper, Masonry Curtain Wall, James Bogardus, Daniel Badger, George B. Post, Elisha Otis, Otis Tufts

## 1. Introduction

### 1.1. Early British Developments in Iron Framing

In July 1832 Great Britain's famous engineer Richard Trevithick (among his "firsts" was the first steam railroad locomotive) announced his plan to erect a 1000' tall tower (Fig. 1) to commemorate the passage of Parliament's Reform Act of 1832. The conical tower had a diameter of 100' at the base that tapered in response to the moment diagram of a cantilever, to a 12' diameter at the top that supported a 50' diameter observation platform. The tower was to be made with 10' tall, curved 2" thick cast iron plates that were cast with interior flanges on all four sides. These allowed the plates to be bolted to one another, with a sheet of lead placed between them to account for surface deformations. The panels were also cast with a 6' diameter circle in the center to reduce the weight of the panel as well as the wind load on the structure. The entire iron exterior was to have been gilded with gold leaf, so imagine this great, golden spike glistening in the morning sun.

There were no stairs provided in the tower as access to the top was achieved by a piston that ran inside a 10' diameter cylinder located at the center of the tower. The piston could accommodate a maximum of 25 passengers, who would be whisked up the cylinder at the exhilarating rate of three feet per second by compressed air supplied by a steam engine. By slowly releasing a pressure valve, the piston would be allowed to float at the same rate gently back to the ground. King William IV gave his official approval on March 1, 1833, but unfortunately, Trevithick was at the end of his life and died, as did the first credible attempt to build a 1000' iron tower less than two months

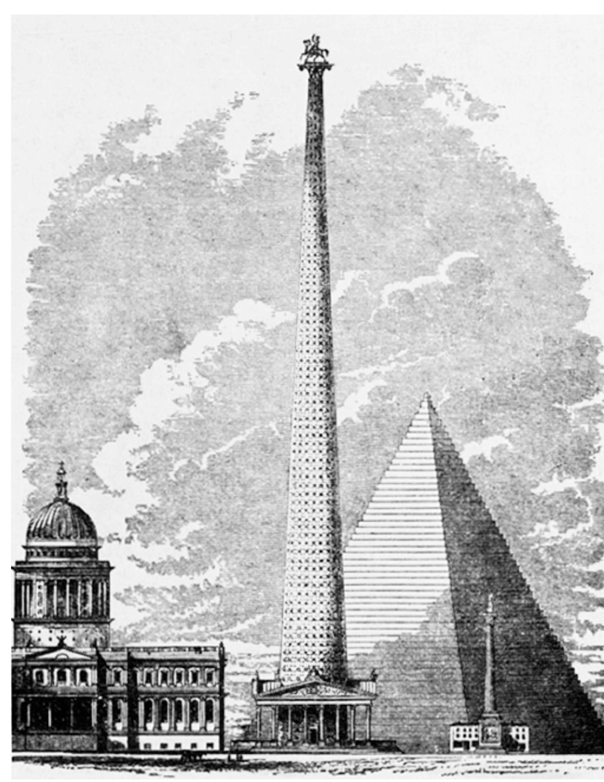

**Figure 1.** Richard Trevithick, Proposed 1000' Reform Act Tower, London, 1833.(Jenkins, *JASH*, December 1957.)

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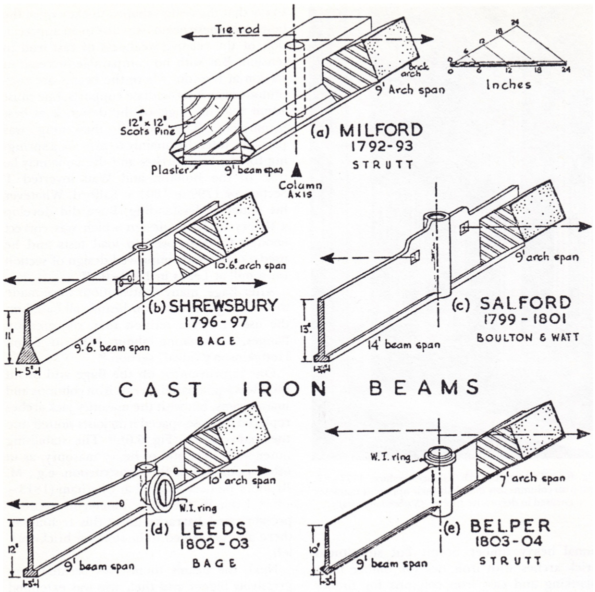


**Figure 2.** Cast Iron Inverted Y- and T-shaped Cross Sections. (Peterson, Charles E. (ed.). *Building Early America*, Radnor: Chilton, 1976.)

later. (Jenkins, 1957).

The first significant British iron structure had been erected in 1778, over 50 years earlier. The cast iron bridge erected by Abraham Darby III at Coalbrookdale had a span of 100' span that was already 2/3's of the way to equaling the record span held for over 1600 years by the concrete dome of the Roman Pantheon. By 1800, the British were erecting six-storied factories with interior cast iron skeleton framing (Fig. 2) that were stabilized with a loadbearing masonry exterior. The British would continue to evolve a system of multistoried iron skeleton framing for the next 30 years.

### 2.1. James Bogardus Refines the American Iron Frame

It would take American builders almost 50 years to catch up with the headstart that the British enjoyed in the early development of iron framing. It is thought that the 1845 fire in New York City convinced American James Bogardus to build a new factory with a "fireproof" cast iron multistory exterior, and thereby, change the course of American architecture. Bogardus was a very successful mechanic and inventor, having established his reputation in the U.S. and Europe by patenting an eccentric grinding mill that was used by businesses (from paint and ink, to sugar and spices) during the 1830s and early 1840s. In 1840 he had traveled to Italy and while studying the architectural monuments had conceived of emulating them in modern times with the use of cast iron. In 1847, his mill business was so successful that he planned to erect a factory of his own design in New York City. Historian Margot Gayle has documented that during the first half of 1847 he had worked on the details necessary to fabricate an exterior for his building that would be made completely of cast iron that would envelope and protect the building's conventionally framed interior of masonry and wood from the heat of a burning building nearby. In essence, he had turned the British system of using a traditional masonry exterior to protect an iron interior inside out. (Gayle, 1998).

As he had no prior experience with cast iron buildings, he actually improved upon the typical friction and slip connections of earlier iron construction by developing a new, bolted connection to join the pieces together into a rigid framework, thereby overcoming one of the major limitations of this type of construction in the past. His system (Fig. 3) consisted conceptually of only three pieces: columns that were half-round with flanges on all four sides to permit bolting to other pieces, beams that were C-shaped in section so that they could be bolted to the

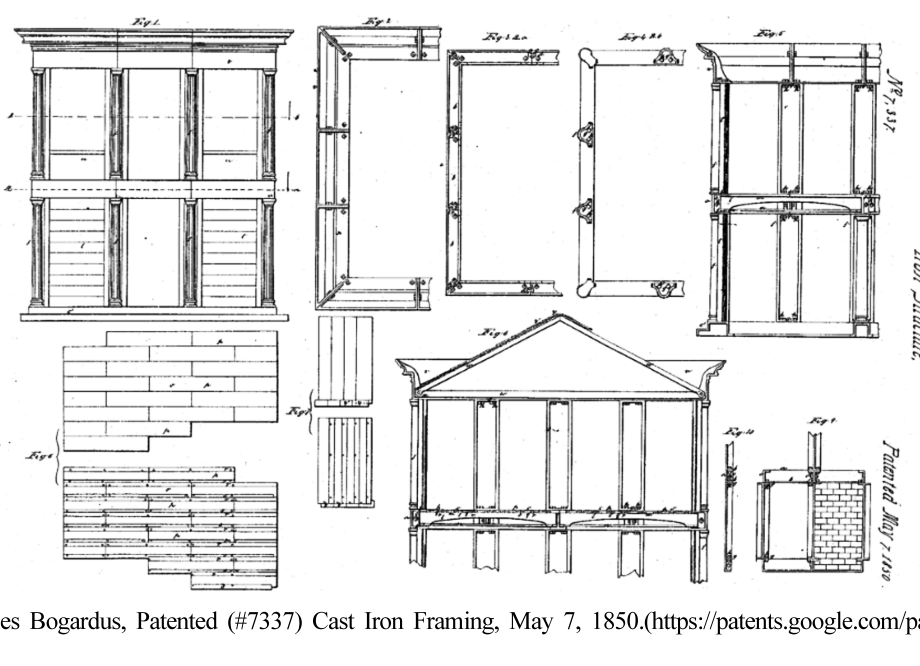


**Figure 3.** James Bogardus, Patented (#7337) Cast Iron Framing, May 7, 1850.(https://patents.google.com/patent/US7337A/en.)

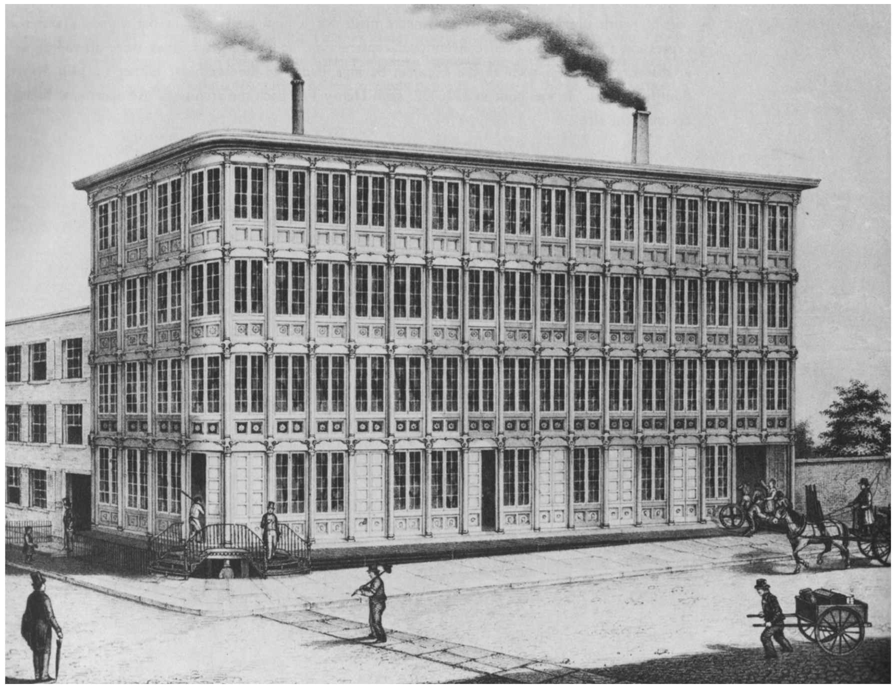

**Figure 4.** James Bogardus, Eccentric Mill Factory with Cast-Iron Front, New York, 1847.(Bogardus, *Cast Iron Buildings.*)

columns from the interior, and an infill panel that enclosed the lower portion of a bay, upon which could be set the sill of a window frame. The joints between these pieces, where water could easily penetrate, were to be covered with a cast iron ornamental piece of any style desired by the owner, that would be bolted to the overall frame. Bogardus' mill factory (Fig. 4) was, therefore, planned to be not only the first multistory, all cast iron front proposed for New York, but also the first American multistory building that incorporated only skeletal iron framing and glass in its exterior. Over the next decade, Bogardus would continue to evolve his system into one that could support not only the exterior but also the entire interior of a building, and having done so, deserves to be known to history as the "father of the American iron skeleton frame."

Bogardus' plan caught the attention of a New York businessman, Edgar H. Laing, a coal merchant and real estate developer, who asked Bogardus to produce a building for the northwest corner of Washington and Murray Streets. The corner site permitted Bogardus to create not just an iron facade, but what would appear to be a complete, iron building. The Laing Stores that Bogardus completed by May 1849 consisted of an elevation that had a frontage of 132' that turned the corner at the intersection. The facade comprised of four stories of Bogardus' iron system, in 21 identical bays. What seemed to impress people most was the speed of its construction for in just over two months, the entire cast iron front and the interior timber structure was erected and occupied. Bogardus had articulated the Laing Building's volume with a horizontal accent by detailing the floor spandrels as a continuous line that interrupted the vertical pilasters. However, depending on how the pieces were detailed, a designer could impart either a vertical emphasis to his façade by projecting the pilasters in front of the spandrel beams, or just as easily any romantic historic style depending upon the design of the mold. The decision was simply a matter of the personal taste of the owner or the architect.

The intervening year between the start of his factory and the completion of the Laing Stores, had apparently given Bogardus time to reconsider one important aspect of the construction of his factory. The promotional brochures that he published after his factory's completion stated that instead of using timber for its interior structure, like he had done in the Laing Stores, Bogardus had decided to erect a complete iron building: the exterior walls, as well as the interior columns, beams, floors, and roof, were reported to have been constructed completely in cast iron. If we are to believe the pamphlet, and there is no reason to doubt the veracity of Bogardus' claim based on what is known of his personality and business practices, then his factory can be considered to be the first multistory building in the U.S. to have been completely iron skeletally-framed, in the interior and on the exterior.

### 2.2. The Harper Brothers' Building

Bogardus' best-known building during this period arguably was the Harper Brothers publishing building. The Harper Brothers publishing factory in New York was destroyed in a spectacular fire on December 10, 1853. This had created a keen interest in the Harpers' not only to quickly rebuild, but also to erect a fireproof building. (Condit, 1960). Both qualities were readily available in cast iron, so the Harpers had turned to Bogardus in early


**Figure 5.** James Bogardus, Harper and Brothers Publishing Building, New York, 1854.(Silver, Nathan. Lost New York, New York: Houghton Mifflin, 1967.)

1854 to engineer the new building. The Harpers designed the building (Fig. 5) by themselves, incorporating a number of ideas with the goal of making it as fireproof as possible. First, they wanted to isolate all of the equipment that had any explosive potential from the rest of the building, so they divided the building into two parts, placing an exterior courtyard between them, in which was located the boilers, steam engines, coal storage, as well as the shipping dock. The two-part, or binuclear plan comprised of two buildings: the front or Pearl Street building contained all of the non-production offices, management, accounting, etc., while all the production spaces and equipment (printing presses and binders) were located in the rear building that fronted on Cliff Street. The design called for five stories above ground, with two in the basement.

Second, the Harpers also decided to eliminate all openings in every floor (stairways, mechanical runs, hoistways) so that there was no possibility that a fire on one floor could spread to the floor above. A circular iron stairway was located outside of the buildings, in the courtyard. Iron walkways were used to link each floor with the stairway, and across the courtyard to the opposite building. Adjacent to the stairway was a steam-powered freight hoist that was also connected to the buildings via the walkways.

Third, the entire interior structure was to be as fireproof as possible, meaning the use of "fireproof" cast iron columns and beams. The structure for the five stories above ground that Bogardus supplied consisted of cast iron columns on a 15' center-to-center grid that supported composite girders of cast iron upper chords and webs that were reinforced with wrought-iron tie rods as bottom chords (Fig. 6). The Harpers' Building was the second building in the U. S. to incorporate Peter Cooper's recently perfected rolled wrought iron beams that were spaced at 5' intervals on the top flange of the girders, connected to a seat that was cast with the upper flange. The floor between the beams was supported by brick jack arches leveled with a bed of concrete. (Condit, 1960 and Gayle, 1998).

### 2.3. Daniel Badger and the Haughwout Building: Elisha Otis' Safety Lifter

Bogardus quickly faced competition from other iron contractors, especially from Daniel D. Badger, originally a Boston iron contractor. Badger's expanding company was incorporated in 1856 as the Architectural Iron Works of New York, and undoubtedly his best-known building is the five-story E.V. Haughwout & Co. Building at Broadway and Broome Street, designed in 1857 by architect John P. Gaynor. This building is also famous as having been the first building designed (not retrofitted) to incorporate an Otis safety elevator. The credit for the development of the modern passenger elevator is usually shared between Elisha Graves Otis of Yonkers, N.Y., and Otis Tufts from Boston. Elisha Otis had eventually secured a patent on January 15, 1861, for a safety brake for the passenger elevator. A variety of lifting mechanisms had been used for some time in warehouses and hotels prior to Otis' invention, but the weak point in these had always been the breaking of the rope used to raise/lower them. Otis had developed a brake consisting of a leaf spring that was physically connected to the tension of the lifting rope. If the rope broke, the loss of tension would activate the spring which would release a catch mechanism that would push lugs into a series of "teeth" that had been attached to the rails

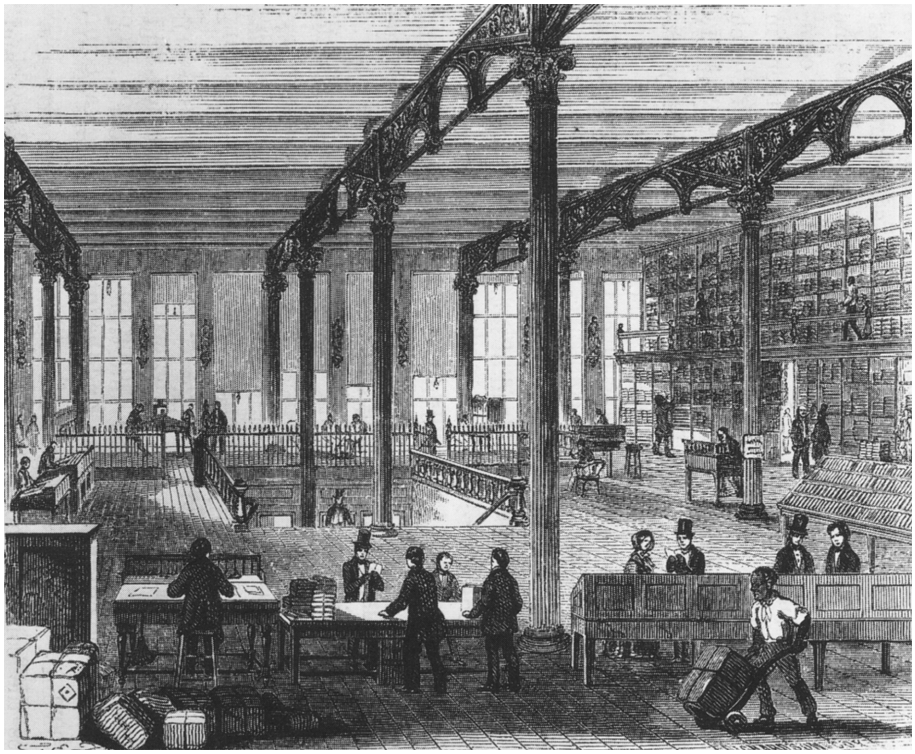

**Figure 6.** James Borgardus, Harper Brothers Building. View of interior of second floor, showing the iron structure. Cast iron columns support iron composite girders, that support wrought iron girders, from which spring brick jack arches. (Gayle, Margot and Carol Gayle. *Cast-Iron Architecture in America: The Significance of James Bogardus*. New York: Norton, 1998.)

of the car, thereby swiftly stopping the car's freefall. The first public exhibit of his new "safety lifter" took place in the summer of 1854, during the second year of the New York World's Fair, and three years later he installed one of his elevators in the Haughwout Building. (Gray, 2002)

### 2.4. Otis Tufts' Parallel Efforts in the Development of the Elevator

Meanwhile, two year later, Otis Tufts installed an elevator of his design in New York's Fifth Avenue Hotel at the corner of Fifth Avenue and 23rd Street, designed in 1856 by Griffin Thomas. Historian Lee Gray has documented Tufts' contribution to the development of the elevator with this installation. (Gray, 2002). Freight lifts and hoists in factories had been in since the start of the decade, but these were limited to moving freight and materials, not people (on purpose). While Otis had been the first to fabricate and install an elevator in a building in the Haughwout Building two years earlier, Tufts' was the first elevator primarily designed to carry people. The car was circular in plan and raised/lowered by a steam-powered helical shaft that extended the entire height of the elevator shaft that was located at the back of the car. Tufts had modelled his elevator on a railroad car that included a bench that lined the perimeter of the car. The success of Tufts' elevator quickly made it a requirement for the city's better hotels to have such a device. The continued demand for these in hotels allowed inventors, including but not limited to, the sons of Elisha Otis who died in 1861, Norton and Charles Otis who formed N.P. Otis and Brother, to refine this technology so that it would be sufficiently mature to be incorporated into office buildings by the end of the 1860s. (Gray, 2002)

### 2.5. Bogardus Invents the Masonry Curtain Wall: The McCullough Shot Tower

As Bogardus had developed a system of cast iron columns, beams, and infill spandrel panels to replace the traditional masonry bearing wall structure that had been used in the construction of buildings since the ancient Egyptians, it was not that difficult for him to eventually replace the iron spandrel panel of his system with a panel of bricks and invent the modern masonry curtain wall. He did this in 1855 in the McCullough Shot Tower in New York (Fig. 7). Lead shot at this time was made by pouring molten lead through a sieve located at the top of a tall masonry tower. As the drops of lead descended, gravity would shape them into spheres before they hit a tub of water at the ground, in which they were cooled before being removed. The great height of such a masonry tower also dictated that the base of the tower would consist of thick walls leaving little usable room at the ground.

However, the site in the midst of a former landfill simply did not have the necessary soil bearing capacity to support the huge weight of a traditional tall masonry tower, a problem to which Bogardus responded by erecting

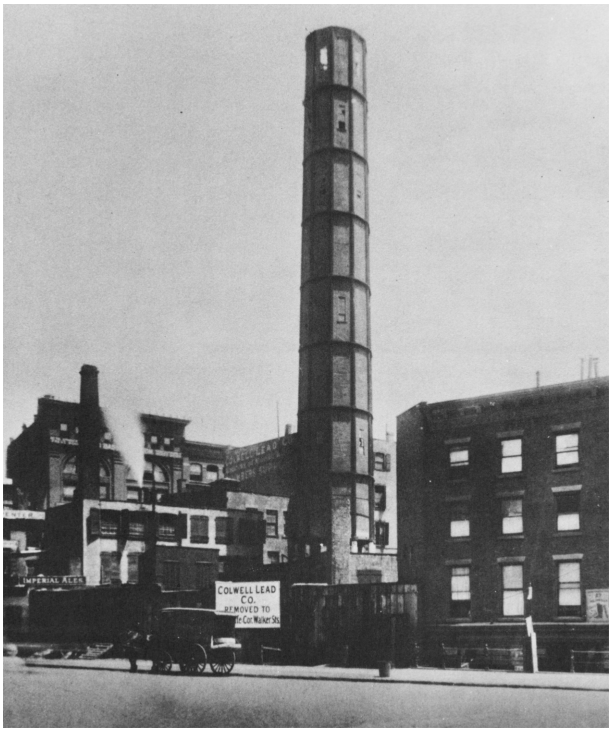


**Figure 7.** James Bogardus, McCullough Shot Tower, New York, 1855.(Silver, Lost New York.)

a lightweight, eight-sided skeletal iron framework of ten stories to a height of 175'. The columns were inclined towards the center, the diameter at the base starting at 24' and correspondingly diminishing to only 12' at its top. From the view of architectural history, he significantly chose not to use the cast iron plates that he had used in his lighthouses to enclose their exterior, but instead reverted to the architecturally more traditional, and less expensive brick to clothe the structure. Twelve-inch thick brick infill panels were constructed on the beams at each level, thus the iron frame supported its own masonry enclosure for the first time in history. This not only significantly reduced the weight of the tower but also allowed the ground floor to be entirely free of any enclosure, facilitating the movement of the plant's workers. (Bannister, 1957).

Therefore, the tower not only was an early (perhaps the first) example of the relationship between poor soil conditions and the use iron skeletal framing as a technique to reduce the weight of a building to within the capacity of the ground, but was also the first multi-story structure with an exterior iron skeletal frame that supported its masonry enclosure. What would later be called by historians as "skyscraper" or "Chicago construction," had been invented and first constructed by Bogardus in New York in 1855.

### 2.6. Bogardus Erects the Santa Catalina Warehouse

The detailing with which he supported the brick on the iron frame of these towers manifested a subtle, but very significant semantic and conceptual difference from embedding an iron member within a masonry element, a technique the French had first developed with great success and was now being employed by their architects at this time to structurally reinforce masonry enclosures. Historian Margot Gayle was the first to note the difference between these two techniques in the first building that Bogardus erected that used his new, masonry curtain wall. In 1858 he was given the commission by the Santa Catalina Company to design and erect a sugar warehouse in Havana, Cuba. This would be the largest building he would construct, two-stories high with a plan that measured 400' wide by 600' long. There were no masonry bearing walls in the entire structure, therefore, it was entirely framed with an iron frame composed of cast iron columns and composite girders (Fig. 8) with cast iron top flanges and a bottom tie rod of wrought iron, very similar to the girders he had used only four years earlier in the Harper's Building. As is easily seen in the few existing photographs of the building's construction (Fig. 9), the building's exterior enclosure consisted of brick panels that were constructed on the iron beams.(Gayle, 1998)

### 2.7. Badger Erects the Seven-story U.S. Warehousing Elevator

Daniel Badger would take this idea to its next logical step in 1860 and employ the iron skeleton frame with the brick curtain wall in a multistory building in a grain elevator for the U.S. Warehousing Company, located on South Brooklyn's Atlantic Dock (Fig. 10). The seven-story (two were attics) elevator was framed both in the interior and its exterior completely in iron. Much of the exterior iron frame was enclosed with brick infill panels.

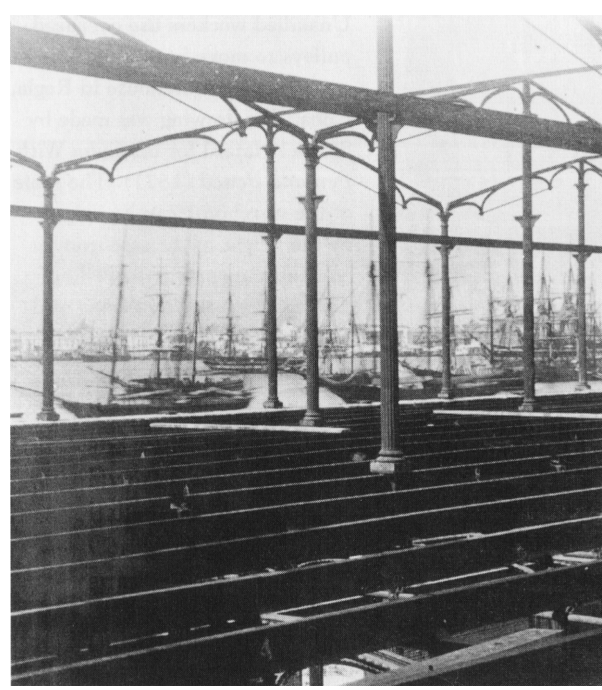

**Figure 8.** James Bogardus, Santa Catalina Warehouse, Havana, 1858.(Gayle, *Bogardus.*)

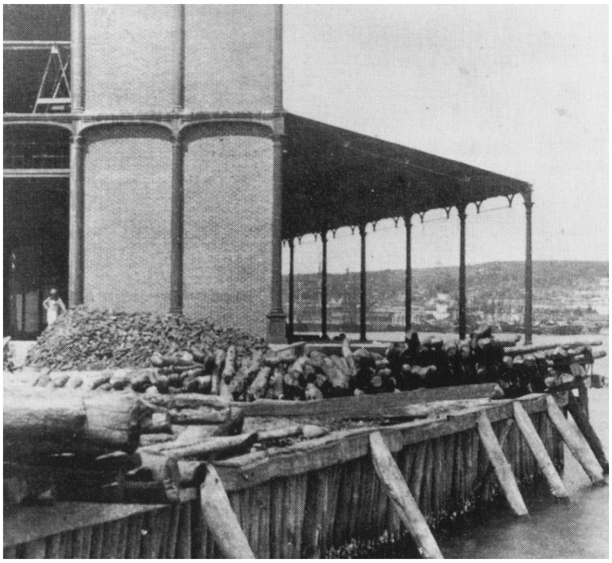

**Figure 9.** James Bogardus, Santa Catalina Warehouse, Havana, 1858.(Gayle, *Bogardus.*)

In 1862, Badger was contracted to build a similar grain elevator for the Pennsylvania Railroad on Washington Street in Philadelphia. (Badger, 1856). Historians have tended to discount the importance of Bogardus and his two shot towers in the history of the skyscraper. However, when seen in context with both his Havana warehouse, and Badger's two large, grain elevators, it is an indisputable fact that New York City had given origin to the American multistory iron skeleton frame, and that Bogardus and Badger had also shown how to enclose the voids of the exterior iron framing with curtains of glass and/or masonry. With the addition of Otis' safety elevator, all the construction parts necessary for the birth of the skyscraper seemingly were in place in New York City by the start of the Civil War. The only piece missing was the fact that there was no demand prior to the Civil War for such a tall building.

### 2.8. The All-iron Framed A.T. Stewart Department Store

The closest that an antebellum building came to approaching the size of that of a future skyscraper was A.T. Stewart's new cast iron-fronted department store (Fig. 11) at Broadway and Fourth Avenue, between 9th and 10th Streets, that opened in Nov. 1862. It was designed by John Kellum in 1859 and fabricated by John B. Cornell. Costing $2,750,000 and with eight floors, each having over 2.5 acres of floor area, it was easiest the largest department store in the world (including Paris) for the next decade. Its size allowed Stewart to have at least 19 separate departments, giving substance to the argument that it, and not Paris' *Bon Marché* whose construction did not begin until 1869, was the first true "department store." The footprint of the site was so large that a central atrium was required to bring daylight into its interior. This opened through all of the floors that were accessed by double staircases. The atrium was topped by a glass skylighted dome, and together with the cast iron columnular structure, created a vast, open interior "open plan" that

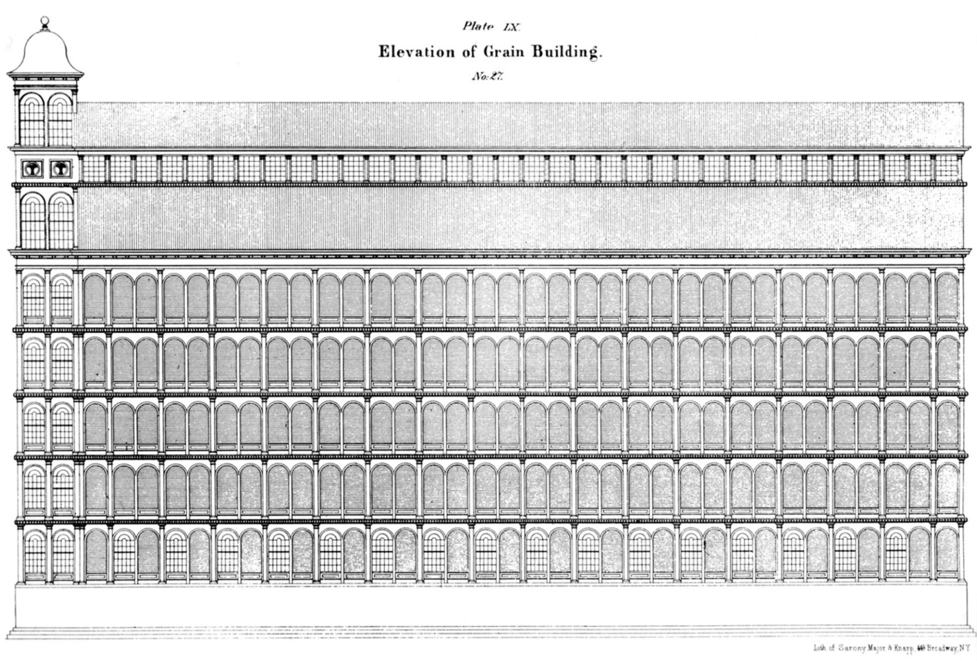


**Figure 10.** George H. Johnson and Daniel Badger, Grain Storage Building, New York and Philadelphia, 1860 and 1862. Elevation showing the cast iron front with brick infill panels. In New York as late as 1865, this type of building was called a Grain Storage Building as opposed to the Chicago term, Grain Elevator.(Badger, Daniel D. *Illustrations of Cast Iron Architecture*. New York, 1856.)

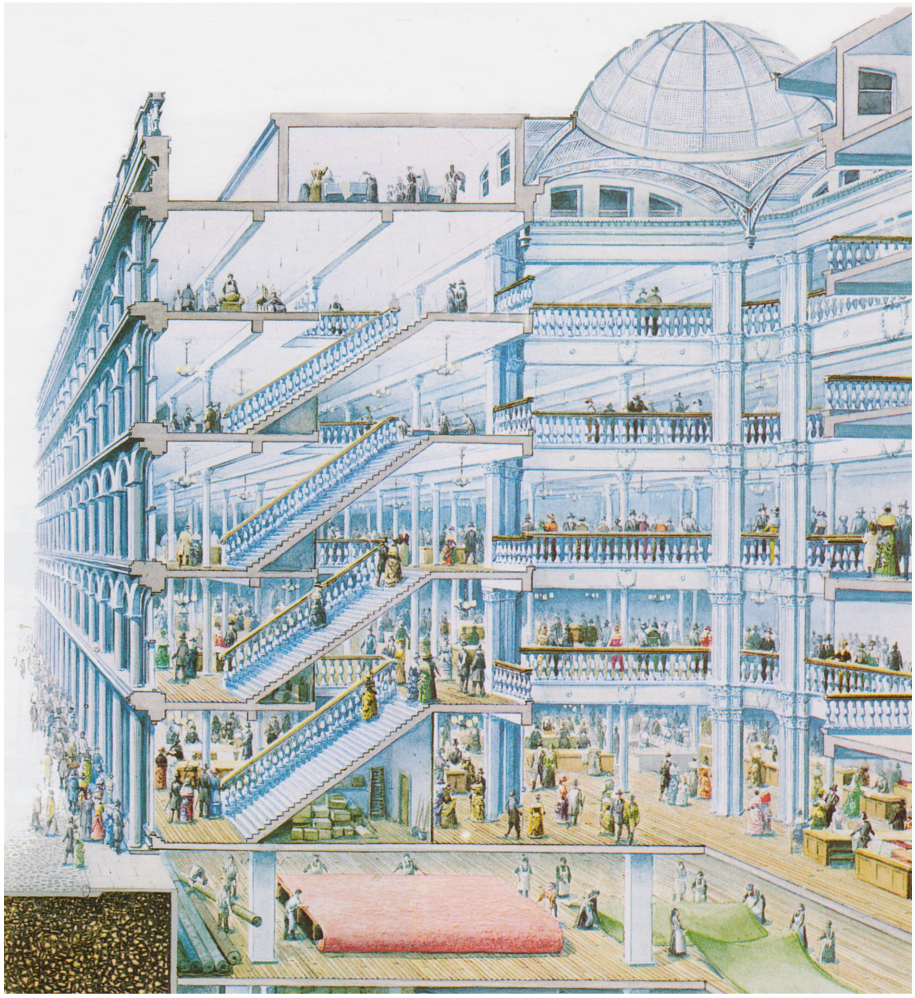

**Figure 11.** John Kellum and John B. Cornell, A.T. Stewart's Cast Iron Department Store. Sectional Perspective at the Atrium.(Homberger, Eric. *The Historical Atlas of New York City*. New York: Henry Holt, 1994.)

was filled with continuous organ music. Stewart's iron building was gutted by fire on July 14, 1956, revealing that the vast majority of the building was indeed skeleton-framed solely in iron in the interior as well as at the exterior. This construction was, by no means, unique when the building was originally erected, for as I have shown, the technique had evolved in the 1850's through the efforts of Bogardus and Badger prior to the start of the Civil War.

### 3.1. The First Proposed Skyscrapers: Eleven-story Apartment Buildings in Paris

You may think that the U.S. is where the skyscraper was first proposed but as Napoléon III was successfully remaking Paris into a model for the city of the future, it should come as no surprise that the first documented proposal to build tall, urban buildings (skyscrapers) was the product of the Second Empire while the U.S. was still in the throes of the Civil War. By 1865, the population of Paris was exploding (the city's population had nearly doubled during the Second Empire) as people flooded into the city from the rural countryside in search of work. If one assumed that the Second Empire would simply continue on its path of "social order" and prosperity into the last decades of the nineteenth century, the ballooning population of Paris would eventually have to be housed vertically, a task the autocratic regime of the Second Empire in charge of rebuilding Paris, could have easily decreed and financed. Remarkably, in 1865 Henri-Jules Borie, an engineer and social philosopher had proposed not just an individual tower but had designed an entire utopian urban complex (Fig. 12), similar in scale and functional organization to what the Emperor was erecting at Les Halles. This comprised of not one or two, but twenty-five 11-story towers and two 11-story four-block long courtyard monster blocks.

Marrying the new technology of the passenger elevator to the by then well-understood iron skeleton frame, Borie had designed his *Aérodômes*, the first skyscraper, not as a multistoried office building as will be the case in the U.S., but as a multistoried apartment building. Borie's towers respected the city's 20-meter height limit, by

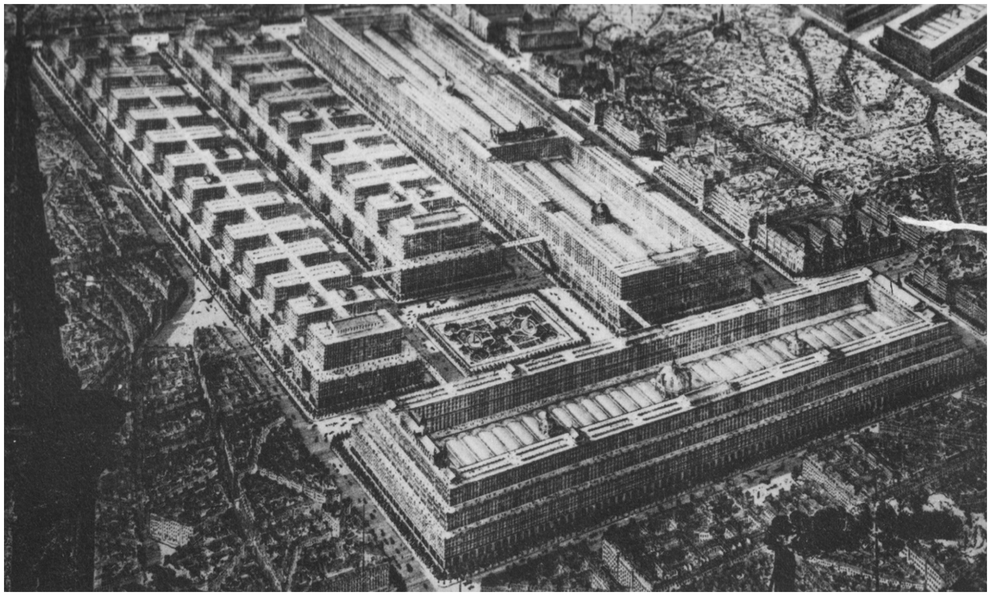

**Figure 12.** Henri-Jules Borie, Aérodômes, Paris, 1865.(Wolf, Peter, "Urban Redevelopment 19th Century Style: Older, Bolder Ideas for Today," *Design Quarterly*, 85, 1972, pp. 3-17.)

carrying up the first five floors to the cornice limit (Fig. 13), and then placing a shallower, 6-story residential tower on top of the lower tower, thereby creating a stepback at the city's constant cornice height. This not only would reduce the size of the buildings' shadows but also created a pleasant promenade around the towers' setbacks that provided great views to the city below. The towers were linked to adjacent buildings with glass-covered skybridges.

The towers were supported by iron skeleton frames that were stiffened against wind loads with portal bracing, a system of very stiff (or rigid) connections between the beams and the columns that imparted a rigidity to the structure that enabled it to resist wind loads (similar to how diagonal bracing works, without the physical obstruction of the diagonal lines crossing at head height). (Wolf, 1972). This would have been completely unnecessary if the buildings had been constructed with traditional masonry bearing walls. Engineer Armand Moisant would employ these exact connections in the Menier Chocolate Factory (Fig. 14), designed in 1871 by architect Jules Saulnier in Noisiel, France. Nonetheless, Napoléon III's defeat at the hands of Prussia's Chancellor Otto von

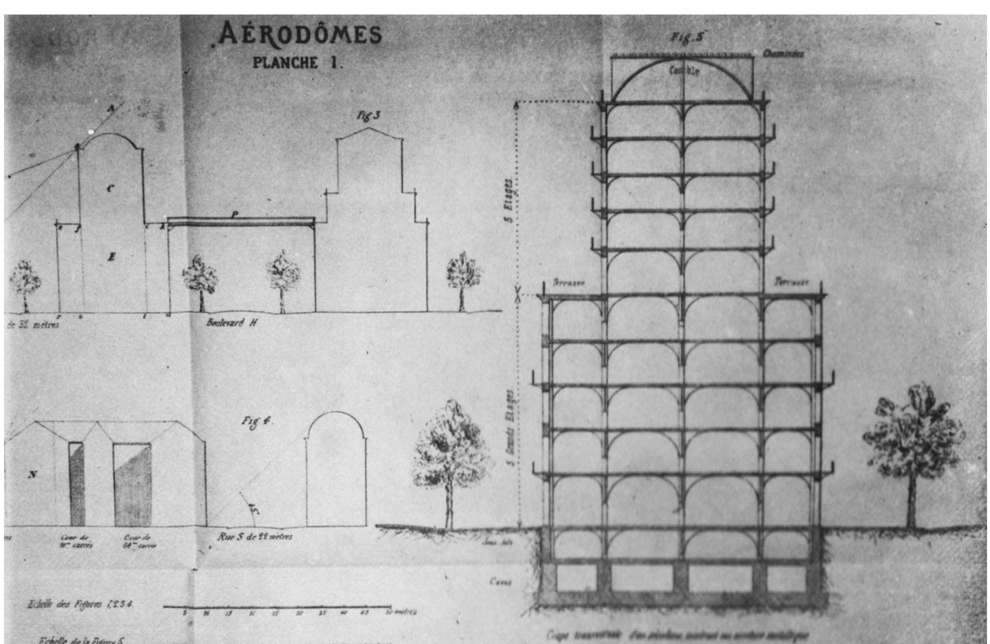


**Figure 13.** Henri-Jules Borie, Aérodômes. Section.(Peter Wolf, *Design Quarterly.*)

**Figure 14.** Jules Saulnier and Armand Moisant, Menier Chocolate Factory, Noisel, 1869. Interior showing iron structure with portal bracing.(Unknown source.)

Bismarck in the Franco-Prussian War ended any chance that Paris might see the birth of the skyscraper.

### 4.1. The First Constructed Skyscraper: Henry Hyde and the Equitable Building

Two years later in 1867, the same year that Borie published a second, more detailed design, New York architect George Post designed the first building that many historians credit as having been the first constructed skyscraper, the Equitable Life Assurance Building (Fig. 15). It is important to note and to emphasize the difference at this moment between the socio-economic climate of France and that of the U.S.: *while the Parisians were proposing to build tall apartment buildings, Americans would erect tall office buildings.*

Quite simply, the end of the American Civil War had unleashed a demand for office space that had been pent up since the Panic of 1857. While the railroad (and its accompanying telegraph) had brought fundamental changes in how business, indeed how almost everything was conducted, it was the scale of the war that had profoundly impacted the nature of American business in that it tended to centralize decision-making and production, forcing smaller companies to grow or consolidate. The post-war era saw the birth of the modern American corporation that not only required larger buildings as well as regional offices to house its operations, but also had the capital resources to invest in the erection of these larger buildings. One example was the Equitable Life Assurance Company in New York. It was organized in 1859 with $100,000 in capital, and when the company moved into its newly completed building in 1870, its assets were listed to be over $11 million.

**Figure 15.** George Post, Equitable Building, New York, 1867. Image has been altered by removing the Mansard roof that was added later to the warehouse at the right. (Weisman, Winston, "Commercial Palaces of New York 1845-75," *Art Bulletin*, 34, 4, December 1954.)

Following the end of the Civil War, Equitable's indefatigable and single-minded founder, Henry Baldwin Hyde began to plan the erection a new building to house its growing operation, for which he had managed to secure the southeast corner of Broadway and Cedar. In October 1867 eight local architects were invited to submit drawings in a competition for the design of the planned building. The committee chose Gillman & Kendall's design of a building that contained seven floors above a raised basement. Seven floors in a commercial building at this time should raise some eyebrows, as the typical limit of floors in such a building, even in Paris at this time, was usually five, or if it was pushed, six. One is also struck by the exaggerated height of the Equitable's first floor that would only add more stairs to climb for those going to the upper floors. The extra height in the Equitable Building could only have been feasible with the use of an elevator. Although elevators had been incorporated into New York buildings prior to the Civil War, apparently no one prior to Hyde had yet to realize that individual stories, let alone entire buildings could be made taller with the use of an elevator without any physical inconvenience in reaching the upper stories.

Another result of the post-war increased demand for office space was the steep increase in the price of Manhattan real estate, upon which to build this office space. The decision to include an elevator was made by Hyde so that an extra floor of rental space could be included that would help to pay for the increased price of land in downtown Manhattan. While this was the initial reason for the inclusion of the extra floors, one must also think that Hyde also foresaw the continued growth of his company, with an eventual increase in the need for more office space. An elevator would also permit the floor-to-floor heights in the building to be increased. therefore, not only would more window area be available for daylighting, but the higher ceiling also allowed the light to penetrate farther back into the interior of the building, meaning that a greater percentage of the lot's square footage could be utilized as rentable space on each floor.

When one looks at all of the original design submissions, it appears that Equitable had laid out a strict floor layout in the program. One of the interior requirements in the competition program was the inclusion of a two-story banking hall (Fig. 16) that was to be located in the least desirable, i.e., lowest rentable, area: in the middle of the building at the second floor. As we have seen in other buildings, this would require an overhead skylight to provide sufficient daylight. The basement and first floor (or *entresol*) that had the best pedestrian access, was to be reserved for higher foot-traffic functions. Above the two-story banking hall, where it was hoped that the elevator would make the space more desirable (i.e., higher rent), there were to be three floors of rental offices, intended for professionals such as lawyers. (Landau and Condit, 1996)

### 4.2. George Post Uses Iron Framing in the Interior

The interior structure of the initial design reflected contemporary New York fireproof concerns and practices as it was originally planned to be entirely of masonry. Evidently, this proved to be prohibitively expensive, for

**Figure 16.** George Post, Equitable Building. Banking Hall as it appeared in 1889.(Landau, Sarah B., and Carl Condit. *The Rise of the New York Skyscraper*, 1865-1913. New Haven: Yale University Press, 1996.)

Equitable had later hired 30-year old George B. Post, a young engineer/architect who had also submitted a competition entry, as a consultant to revise the structure back to within Hyde's cost guidelines. By substituting the proposed construction with Bogardus' antebellum system of iron columns and beams, brick floor arches, and lightweight brick partitions, he succeeded in reducing the cost of the interior construction by almost half of the original estimate. (Landau and Condit, 1996). There was no conceptual difference between the Equitable's interior structure and that of the Harper's Building, constructed almost twenty years earlier. Had the fact that the Harper's Building had been apparently successfully "fireproof" for this long period been the decisive factor in choosing to replicate it?

The first historian to appreciate Hyde's actions that resulted in a building taller than was customary at the time was Winston Weisman in 1953. Weisman argued that the elevator had been used by Hyde for the first time to purposefully increase the height of the building, and therefore, the Equitable Building should be considered to be the first "skyscraper," an assertion with which I wholeheartedly agree. (Weisman, 1953).

### 4.3. Post's Encore: The Western Union Building

The elevator also unleashed Manhattan real estate prices from its stairway-imposed limitation. The Western Union Telegraph Company, whose corporate experience during the Civil War was comparable to that of Equitable's, had moved to New York in 1866 and was planning to erect a new building at the northwest corner of Broadway and Dey to house its growing operations. Obviously inspired by the success of Hyde's experiment with the elevator in Equitable's new building, they invited its architects, Arthur Gillman and George Post to each submit designs in a competition for their new building. Equitable had proven the financial wisdom of including rental offices in a project like this to initially generate income to offset the cost of the land in the short run, and eventually to provide space in which to expand operations as a business grew in the long run. Western Union, therefore, had increased the number of rental floors to four.

Planned to house all of their telegraphic operations, the program was technically far more complex than was the Equitable's, which may have steered the committee in August 1872 to choose Post's (due to his engineering background) design (Fig. 17), that was essentially an extruded version of the Equitable that had a height of approximately 180', fifty feet higher than the Equitable. (Landau and Condit, 1996). A gratuitous 50' clock tower with a steep, octagonal roof grew out of the roof's main pavilion, bringing the total height of the layered pile to 230,' making its height second in the city only to that of the 281' steeple of Trinity Church. The skyscraper had begun to grow up.

Post located the space dedicated to the telegraph operators at the top of the building apparently for two reasons. First, as the telegraph wires were hung in the air from poles, it would be easier to bring the wires into the building at a higher level, without any potential conflict with the traffic in the street. Second, locating this huge space on the top floor meant that it could be virtually free of columns and walls, as there was no need to extend the building's interior structure into this space because it could be spanned with deep iron king-post trusses that clear-spanned the building's 65' width between the exterior walls. These were tall enough so that Post used the bottom chords of the truss to support a ninth floor for an employee dining room. He also managed to insert a tenth floor at mid-height of the trusses for living quarters for the building's engineer and the kitchen for the dining room below. (Landau and Condit, 1996) He increased the ceiling height of this space (Fig. 18) to 23,' not only to make it feel even more open and airy, but also to make the perimeter windows taller so that more light could penetrate deeper into the space.

The company's public business operations were logically located on the ground floor, leaving the five floors between

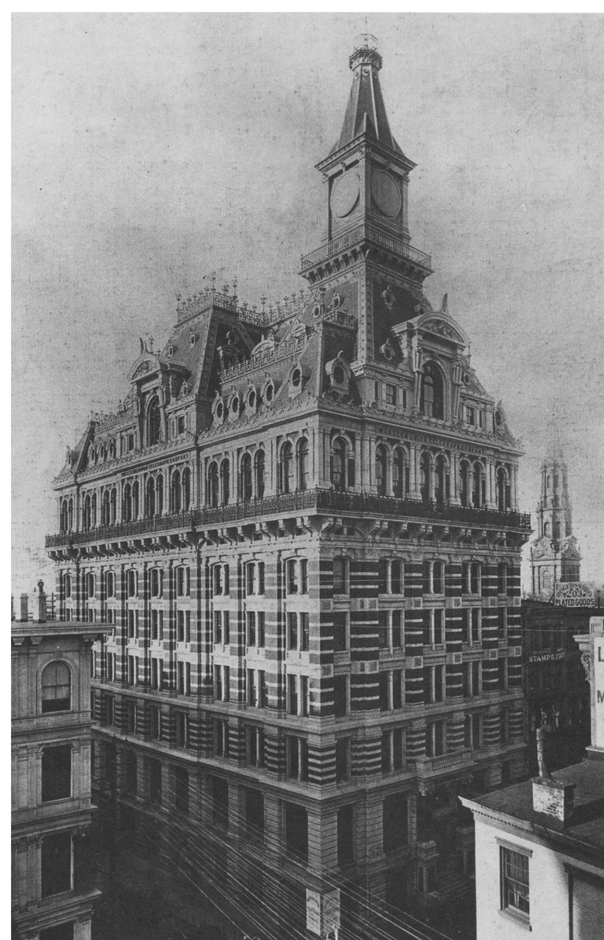

**Figure 17.** George B. Post, Western Union Telegraph Building, New York, 1872.(Silver, *Lost New York.*)

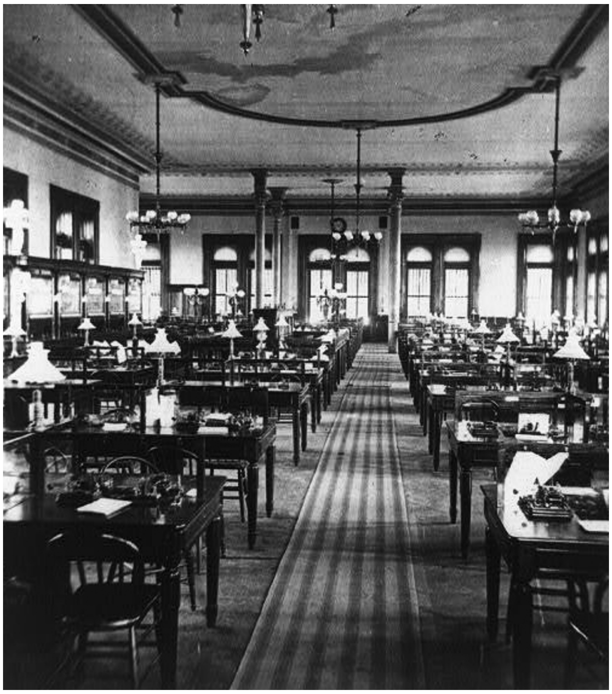

**Figure 18.** George B. Post, Western Union Telegraph Building, New York, 1872.(http://memory.loc.gov/service/pnp/cph/3b20000/3b26000/3b26000/3b26096r.jpg.)

one and seven available for rental offices. The company needed one floor for its executives and management, so it chose the least desirable/rentable floor, the one in the middle of this layer, the fourth. Floors two and three were closest to the street, and floors five and six were the highest above the street. Post incorporated four elevators in the building: two for its managers and the tenants in the rental floors, that ran only from floors one to six, one located on the north end of the building for the company's employees that ran to the top floor, and a small freight elevator that served all of the floors. (Landau and Condit, 1996)

As the building was designed after the Chicago fire, the company had prohibited the use of any structural iron in the building's exterior. Nonetheless, Post once again employed an iron structural system similar to that he had designed in the Equitable Building that comprised a cage of cast iron columns with wrought iron beams and joists, that supported a floor structure of brick jack arches leveled with a bed of concrete. The decision to use exposed, unprotected cast iron columns following the experience of the Chicago fire, however, is somewhat surprising at this time, yet it is understandable given the operative theory at this time that a building's interior was protected if the building's exterior was completely fireproofed. (Wight, 1878 and Randall, 1999).

### 4.4. Richard Morris Hunt and the *New York Tribune* Building

Only a few months after Post had won the commission for the Western Union Building, Richard Morris Hunt won the competition in early 1873 to design a new building for the *New York Tribune* on Nassau and Spruce Streets, fronting Printing House Square. The *Tribune*, owned and edited by Horace Greeley, was the nation's leading Republican newspaper, but Greeley had become so disenchanted with Pres. Grant that he eventually resigned in order to run against him in the 1872 election. Fortunately, Greeley had groomed his replacement, Whitelaw Reid, who not only took over the newspaper, but bought it outright upon Greeley's death some three weeks after the election. Reid, similar to Equitable's Henry Hyde, was of the next generation coming into power after the Civil War who were not afraid of the latest technology. (Gray, 2002). As such, he wanted the tallest building in the city to proclaim the newspaper's position in the country's politics and decided to do Western Union one better: he wanted a taller building with five floors of rental offices.

Hunt's final design (Fig. 19) comprised of a granite base, a 3:2:1 sequence for the middle three layers, a Second Empire mansard roof, and a tower that extended 30' taller than the Western Union's to a total height of 260.' The awkwardness of the exterior was only compounded by Hunt's final detailing of the tower that instead of being designed as a continuous vertical element from the ground, the tower was detailed to bulge out from the fourth floor on corbels, that only amplified the top-heaviness of the building (and spoke of the influence of French theoretician Viollet-le-Duc's latest publication in which such corbelled projections were prominently displayed.) In response to questions about the unresolved quality of the building's final appearance, Hunt pointed his finger at the newness of the tall building type: "the exigencies of the case demanded a new style of architecture - a style which was at once an outgrowth of the country and the demands of the time."

Similar to the Western Union Building, the *Tribune* building's vertical organization was also determined by function. In the case of a newspaper, the type composers needed as much daylight as possible, meaning they were always located on the top floor to take advantage of skylights. Meanwhile, the printing presses were dependent on steam power, meaning the presses were always located in the basement, that also minimized the structural impact of the machines' deadloads and vibrations. The composers would set the lead type in a metal box and then send the finished box to the basement via a freight hoist. Again, following Post's lead, the composing room in the top floor allowed Hunt to take advantage of the roof's clearspan trusses to open the space as much as possible. The paper's editorial staff occupied the ninth floor, directly under the composing room. The paper's public contact offices were located on the ground floor, with floors two through eight leased as private offices. Two elevators were thought to be sufficient, although these were now placed side-to-side with a metal-framed stair wrapping around the back and

**Figure 19.** Richard Morris Hunt, *New York Tribune* Building, New York, 1873.(https://www.nyc-architecture.com/GON/GON021.htm)

side of the elevators, forming an early elevator core. (Gray, 2002). Reid was interested in saving money so the elevators ran in open metal cages as well, borrowing daylight from the windows next to the stairway. This saved money in that the gaslights for the elevators did not need to be lit during the day.

### 4.5. Hunt Returns to All-masonry Construction: The Effect of the 1872 Boston Fire

Compared to the standard construction employed by Post in the Western Union that varied little from all-iron construction that dated back to the Harper's Building, the structure that Hunt employed in the *Tribune* Building was simply medieval. As Hunt was commissioned after the Great Boston Fire of November 9, 1872, the fire seems to me to have been the reason for such a retrograde structure for Hunt to have employed. (While the Chicago fire occurred the year before Boston's fire, everyone expected "the largest wood city in the world" to eventually be destroyed by a fire. Boston had always been considered to be one of America's better built cities, and this fire had grabbed the attention of owners and architects alike.) The entire structure relied on masonry bearing walls; there were no iron columns used in any part of the building. Given the additional story in the *Tribune* Building and the nature of the weight of some of the equipment in the composing room, one would expect that the thickness of the walls in the *Tribune* would have been even greater than those in the Western Union Building. The piers in the ground floor started at 5' 2" thick, and gradually decreased in size by 4" per floor until they were *only* 3' 2" in the top floor. Ironically, the tallest skyscraper erected prior to the Great Depression of 1873-79 used little, if any iron in its structure, but one does not have to do the math to understand that walls of 62" of solid masonry, especially in the premier rent location of the ground floor, could not continue to grow much larger and still be economically feasible. (Wight, 1892 and Weisman, 1953).

## Conclusion

The construction technique of multistoried iron framing evolved principally in New York City during the 1850s through the efforts of James Bogardus and Daniel Badger. During this period, Elisha Otis and Otis Tufts developed and perfected the elevator. Henry B. Hyde, Vice-President of Equitable Life Assurance realized that the elevator could be used to build buildings that not only contained more floors than the traditional limit of five-six that had been imposed by stairs that could help offset the increasing price of Manhattan real estate, but also had higher floor-to-floor heights that increased the amount of daylight and allowed it to penetrate deeper into the building, allowing more of a site's surface area to be used as rentable floor space. By the start of the Great Depression of the 1870s in 1873, George Post and Richard Morris Hunt had each designed a ten-storied skyscraper.

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