PDHonline Course M541 (12 PDH)

Going Up! Going Down! A History of the Otis Elevator Company

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Going Up!
Going Down!

A History of the Otis Elevator Company

Table of Contents

Part 1

Looking Back

The Art of the Elevator

“The history of the Otis Elevator Company is the history of the development of the elevator art. Since 1852, when Elisha Graves Otis invented and demonstrated the first elevator ‘safety’ - a device to prevent an elevator from falling if the hoisting rope broke - the name Otis has been associated with virtually every important development contributing to the usefulness and safety of elevators…”

RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators* (1940)

<u>Left</u>: *Elisha Graves. Otis*

Elisha Graves Otis **was born in 1811 on a farm in Halifax, VT. As a young man, he tried his hand at several careers – all with limited success. In 1852, his luck changed when his employer;** ***Bedstead Manufacturing Company,*** **asked him to design a freight elevator. Determined to overcome a fatal hazard in lift design (unsolved since its earliest days), Otis invented a safety brake that would suspend the platform safely within the shaft if a lifting rope broke suddenly. Thus was the world's first "Safety Elevator" born.**

"…new and excellent platform elevator, by Mr. Otis, of Yonkers, N.Y…It is worked by steam power, and operates like some of the elevators in cotton factories. It has a plain platform, which runs up and down on guides…It is self-acting, safe, and convenient."

Scientific American, **June 10th 1854**

RE: there was, however, no mention of the safety device or its spectacular demonstration given

In the main *Exhibition Hall*, Otis constructed a complete safety elevator equipped with guide rails, ratchets, spring, platform and hoisting machinery. Otis had the hoist fully loaded with freight. As a crowd gathered, he climbed on board and ordered the platform raised to full height. The hoisting rope was cut with an axe. The crowd gasped. But before the platform could fall, the safety spring locked the lift in place as Otis reassured the startled crowd with the cry "All safe, gentlemen. All safe."

"…who, as he rides up and down the platform occasionally cuts the rope by which it is supported…"

***New York Daily Tribune,* May 30th 1854**

RE: despite its significance to arch-itectural and engineering history, Elisha Otis' dramatic demonstration of his "Safety Elevator" went nearly completely un-noticed by the public-at-large, mainly due to the indiff-erence of the press of the day. This despite the fact that the *Crystal Palace Exhibition* of 1853-54 (held in NYC) was widely covered by popular newspapers and magazines. Otis' ap-paratus was to be found in the "Machine Arcade," along with a whal-ing harpoon and a cigar rolling machine.

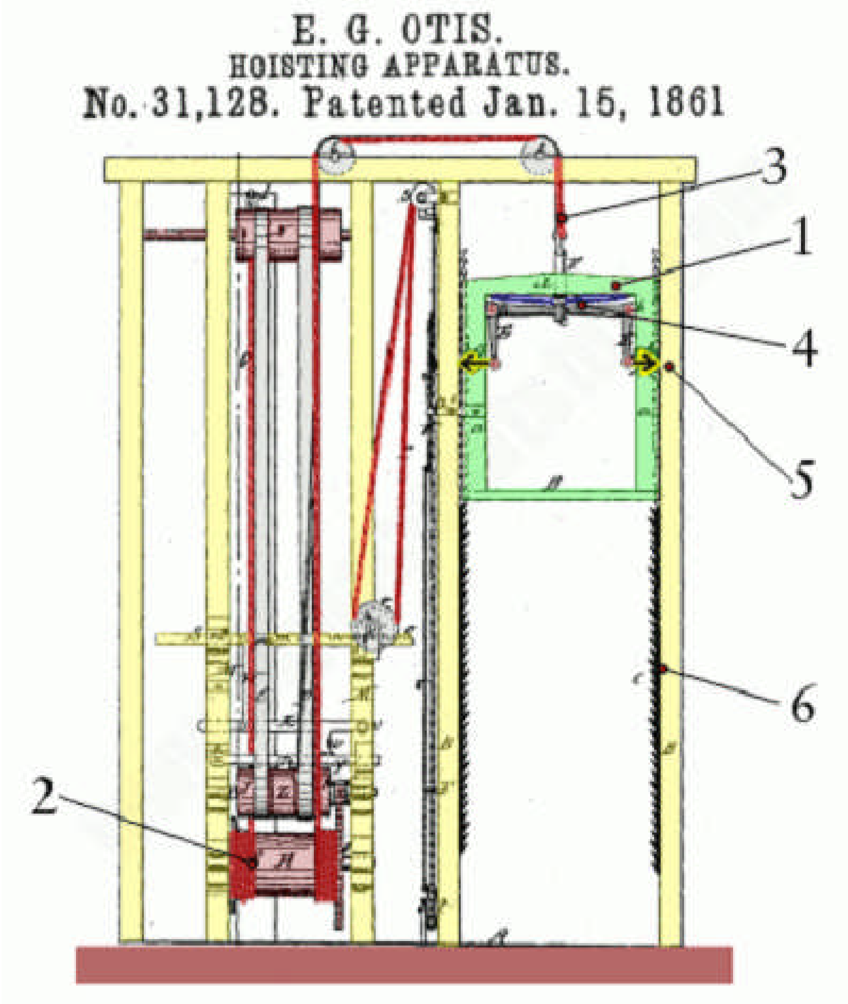
The World's Word for Elevator Safety

"…The first elevator safety was exhibited by Elisha Graves Otis at the Crystal Palace Exposition in New York City in 1853, and from that day to this Otis has continued to be 'The World's Word for Elevator Safety,' as well as the source of innumerable improvements and inventions which have marked the development of the elevator from the first crude belt-driven freight hoist to the miracle of speed, smoothness and efficiency typified by the modern gearless elevator with Otis Peak-Period Control…"

RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators* (1940)*. E.G. Otis* invented the *Safety Elevator* for his employer – a bedding manufacturer, in 1852 (he was the factory's "Master Mechanic"). Realizing the interest it generated, he began manufacturing them himself. In 1853, he sold three Safety Elevators for $300 each, then sales slumped. No more were sold in 1853 or early 1854. He decided to promote his invention by demonstrating its novelty at the *Crystal Palace Exhibition* in NYC in May 1854. Sales got a boost and he sold seven more in 1854 and fifteen in 1855.

"…A model of engineering simplicity, the safety device consisted of a used wagon spring that was attached to both the top of the hoist platform and the overhead lifting cable. Under ordinary circumstances, the spring was kept in place by the pull of the platform's weight on the lifting cable. If the cable broke, however, this pressure was suddenly released, causing the big spring to snap open in a jaw-like motion. When this occurred, both ends of the spring would engage the saw-toothed ratchet-bar beams that Otis had installed on either side of the elevator shaft, thereby bringing the falling hoist platform to a complete stop…"

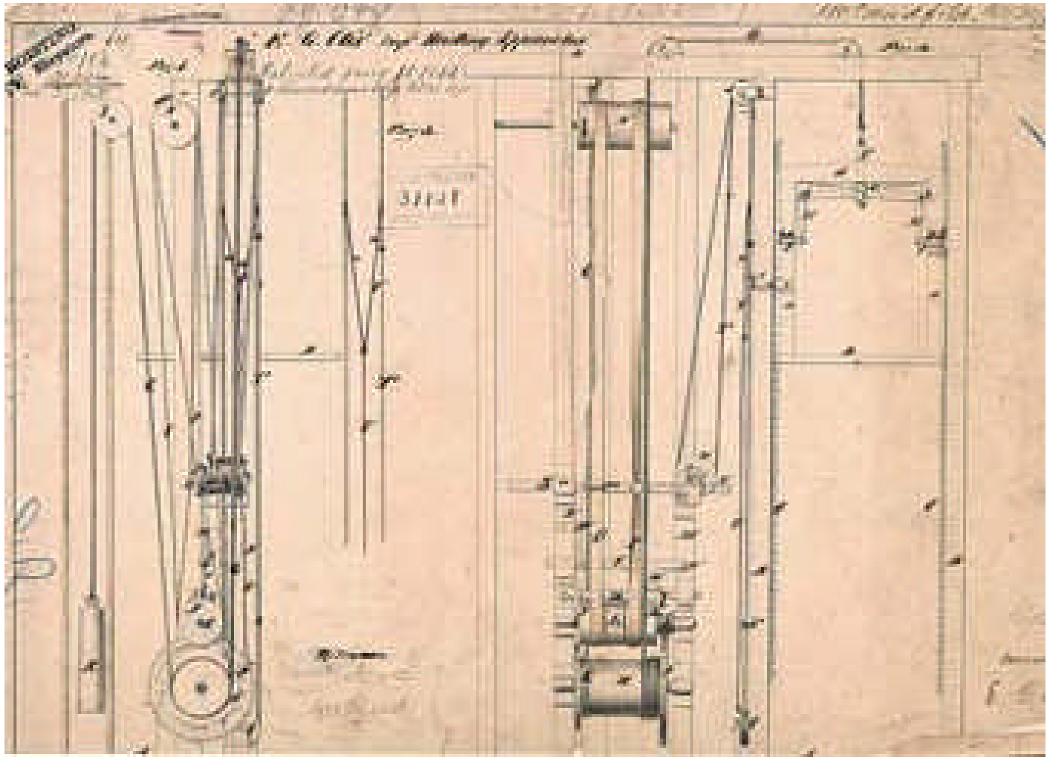
RE: excerpt from *Entrepreneurs: The Men and Women Behind Famous Brand Names and How They Made It*

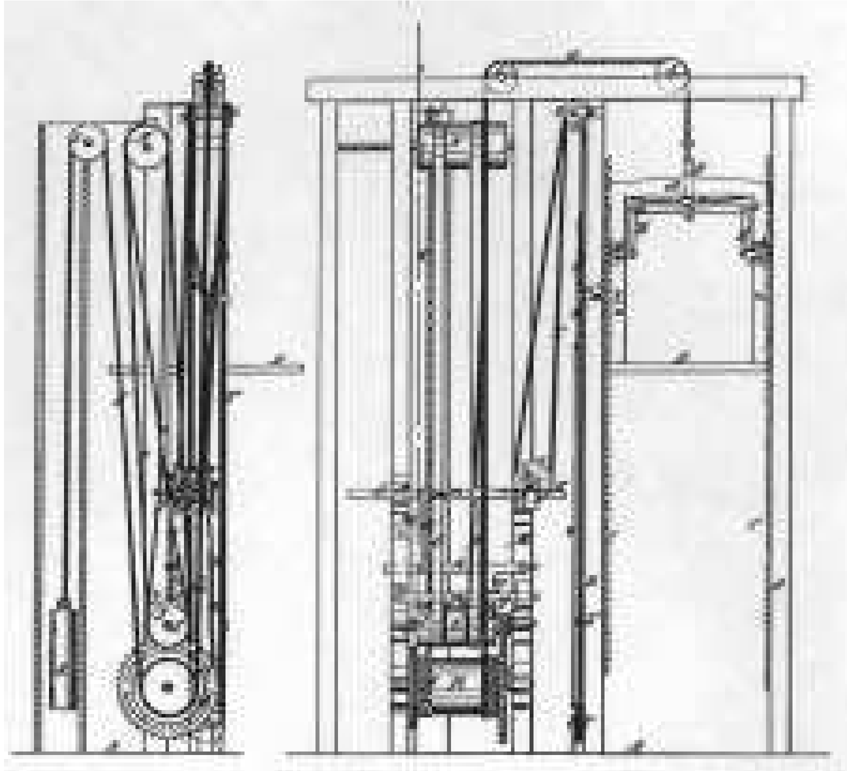


"Having the pawls and the teeth of the racks hook formed, essentially as shown, so that the weight of the plat-form will, in case of the breaking of the rope, cause the pawls and teeth to lock together and prevent the contingency of a separation of the same."

E.G. Otis*, Inventor of the *Safety Elevator

<u>Left</u>: caption: "The elevator compartment (1, green) is raised and lowered by a hoist and pulley system (2) and a moving count-erweight (not visible). The cable that does all the lifting (3, red) wraps around several pulleys and the main winding drum which was raised and lowered by hand. At the top of the elevator car, there was a simple mech-anism made up of spring-loaded arms and pivots (4). If the main cable (3) broke, the springs push out two sturdy bars called 'pawls' (5) so they lock into vertical racks of upward-pointing teeth (6) on either side. This ratchet-like device clamps the elevator safely in place."

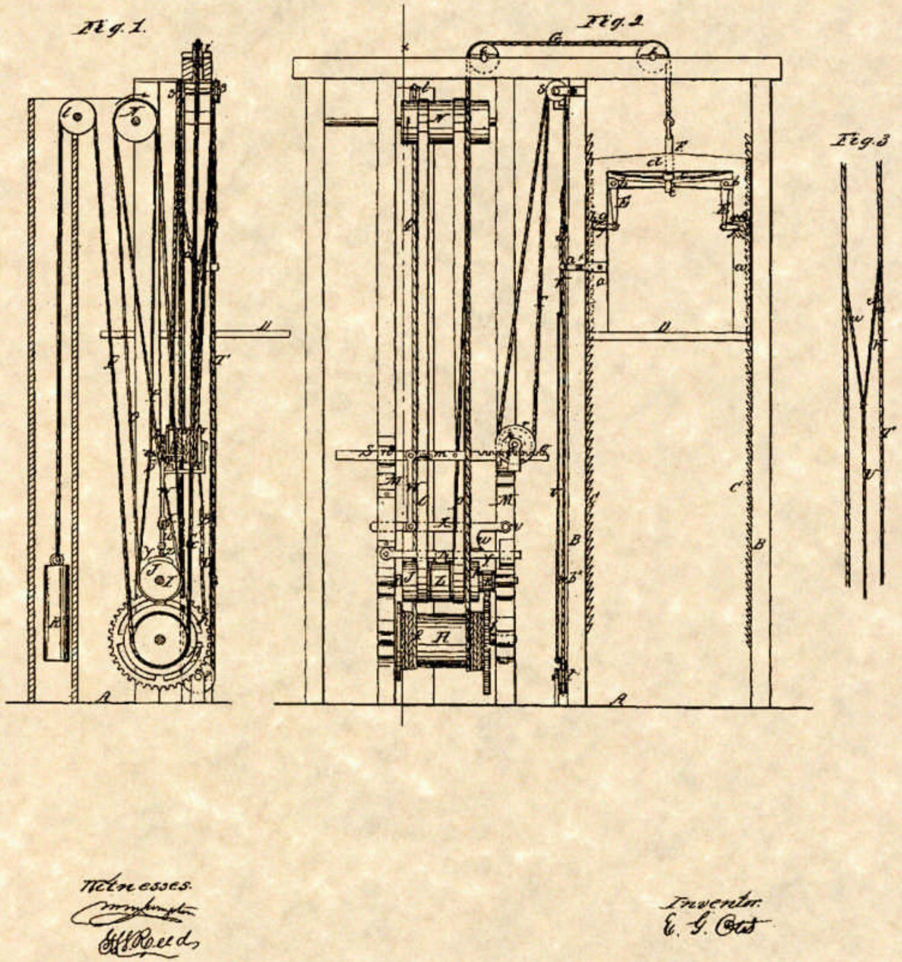




<u>Above L&R</u>: E.G. Otis' *U.S. Patent* drawings (Patent No. 31,128) for an "Improved Hoisting Apparatus," dated January 15th 1861. Claimed as original were an automatic safety device (the same as originally demonstrated at the *Crystal Palace Exhibition*), shipper ropes, a combined belt-shipper and brake mechanism and a counter-poise weight (shown in the drawings).

E. G. OTIS.
HOISTING APPARATUS.

Patented Jan. 15, 1861.



United States Patent Office.

E. G. OTIS, OF YONKERS, NEW YORK.

IMPROVEMENT IN HOISTING APPARATUS.

Specification forming part of Letters Patent dated January 15, 1861.

To all whom it may concern:

Be it known that I, E. G. OTIS, of Yonkers, in the county of Westchester and State of New York, have invented a new and Improved Hoisting Apparatus; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the annexed drawings, making a part of this specification, in which—

Figure 1 is a vertical section of my invention, taken in the line *x x*, Fig. 2; Fig. 2, a front view of the same; Fig. 3, a detached side view of the stop mechanism.

Similar letters of reference indicate corresponding parts in the several figures.

The object of this invention is to obtain a hoisting apparatus which may have its weight or load stopped at any desired point and a brake automatically and simultaneously applied with the stopping of the load or weight.

The invention also has for its object the sustaining of the load or weight in case of the breaking of the lifting-rope in such a way as to insure a certain effectual action or operation of the load-sustaining mechanism.

To enable those skilled in the art to fully understand and construct my invention, I will proceed to describe it.

A represents a base or platform, to which two uprights B B are secured, said uprights having each a rack C at its inner side. These racks C have teeth of hook form, or the teeth may be described as having an inclination upward, as shown clearly in Fig. 2.

Between the uprights B B a platform D is placed, the platform being secured to two uprights *a a*, which are grooved vertically to receive the racks C C. To each upright *a* a bent lever E is attached by a fulcrum-pin *b*, and the inner ends of the levers E E overlap each other and are fitted in an eye *c* at the lower end of a vertical bar F, which passes loosely through a rail or bar *d*, that connects the upper ends of the uprights *a a*. To the lower end of the bar F a spring *e* is attached, said spring having a tendency to keep the pawls *f*, which are attached to the lower ends of the levers E E, in gear with the racks C C. This will be fully understood by referring to Fig. 2, in which it will be seen that the pawls *f* are connected to the ends of the levers E by pivots, and have springs *g* attached, which springs have a tendency to keep the pawls pressed down into or between the teeth of the racks C. The pawls, it will be seen, fit or work in mortises *h* in the uprights *a a*. To the upper end of the bar F there is a rope G attached. This rope G passes over pulleys *i i*, and extending down is attached to a drum H, which is connected by gearing *j k* to a shaft I, having two idle-pulleys J K upon it and a working-pulley L between them.

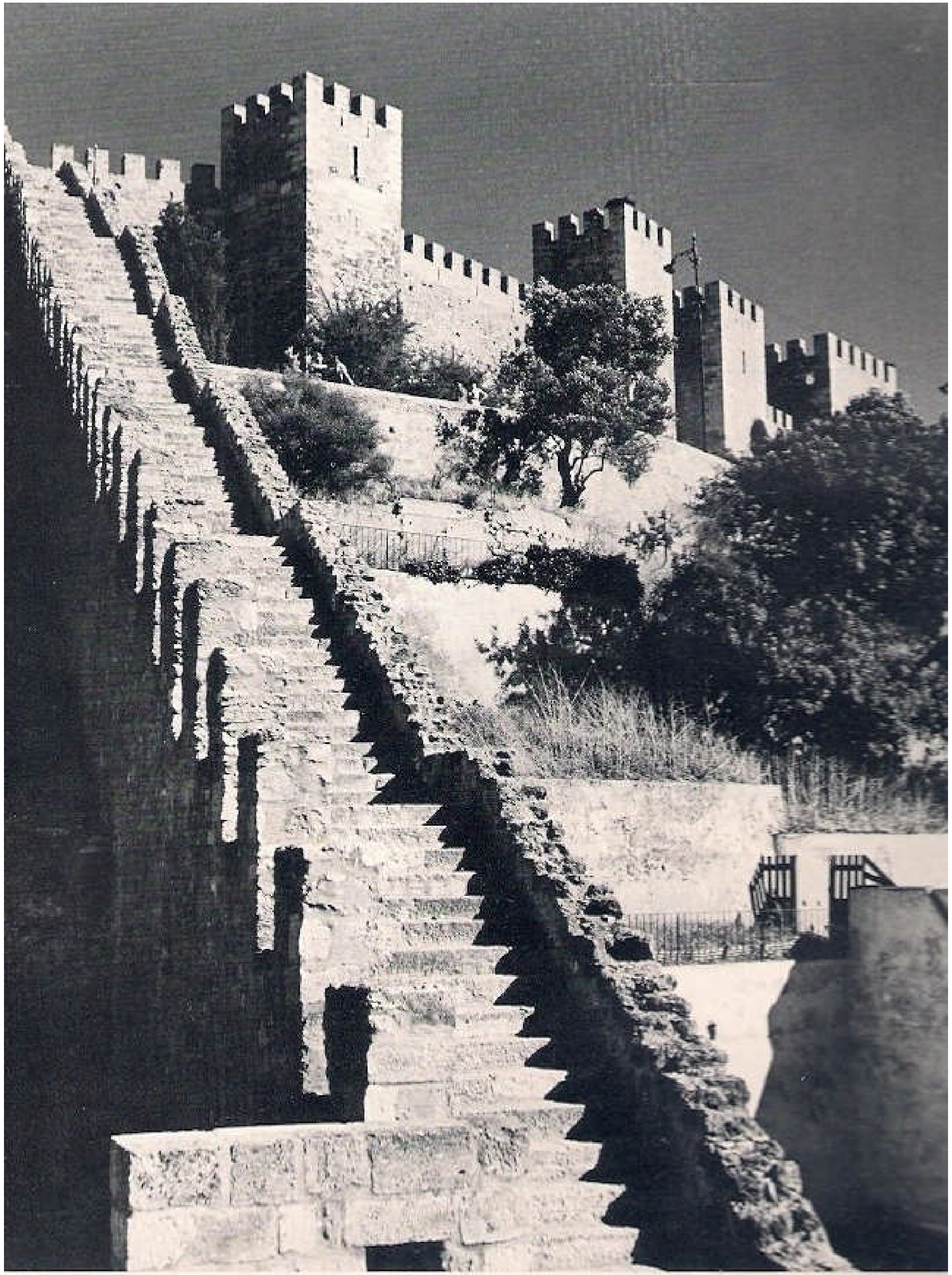
The drum H and shaft I have their bearings attached to suitable uprights M M, and between these uprights there is placed a drum N, around which and the idle-pulleys J K belts O P pass, one of which P is a cross-belt. To the drum H a rope Q is attached. This rope winds on drum H in a contrary direction to the rope G, which is connected with the platform D. The rope Q passes upward over a pulley *l* and has a weight R attached to it, said weight serving as a counterpoise for the platform D.

The belts O P pass through eyes *m*, attached to the slide S, which forms a belt-shipper. This slide is fitted in suitable guides *n n* and has a rack *o* at one end, into which a pinion *p* gears. The pinion *p* is on a shaft *q*, which has a drum *r* placed on it, around which a rope T passes, said rope being secured to the drum *r* and wound around it in opposite directions. The rope T also passes over pulleys *s s* and down around a pulley *t* near the base A. To the portion of the rope T between the pulleys *s s* and *t* a rope U is attached by a branched end V, each part *u* of which is attached to a side of the rope T, as shown clearly in Fig. 3.

To the slide or belt-shipper S there is attached an arm W, the lower end of which is attached by a pivot to a bar X. This bar X is attached by a pivot *v* to one of the uprights M, and the bar X is provided with a pendent projection *w*, which bears on a bar Y, one end of which is attached by a pivot to one of the uprights M and the opposite end fitted in a guide *a'* on one of the uprights. To the bar Y at about its center a shoe Z is attached, which, when the bar Y is pressed downward, bears upon the working-pulley L.

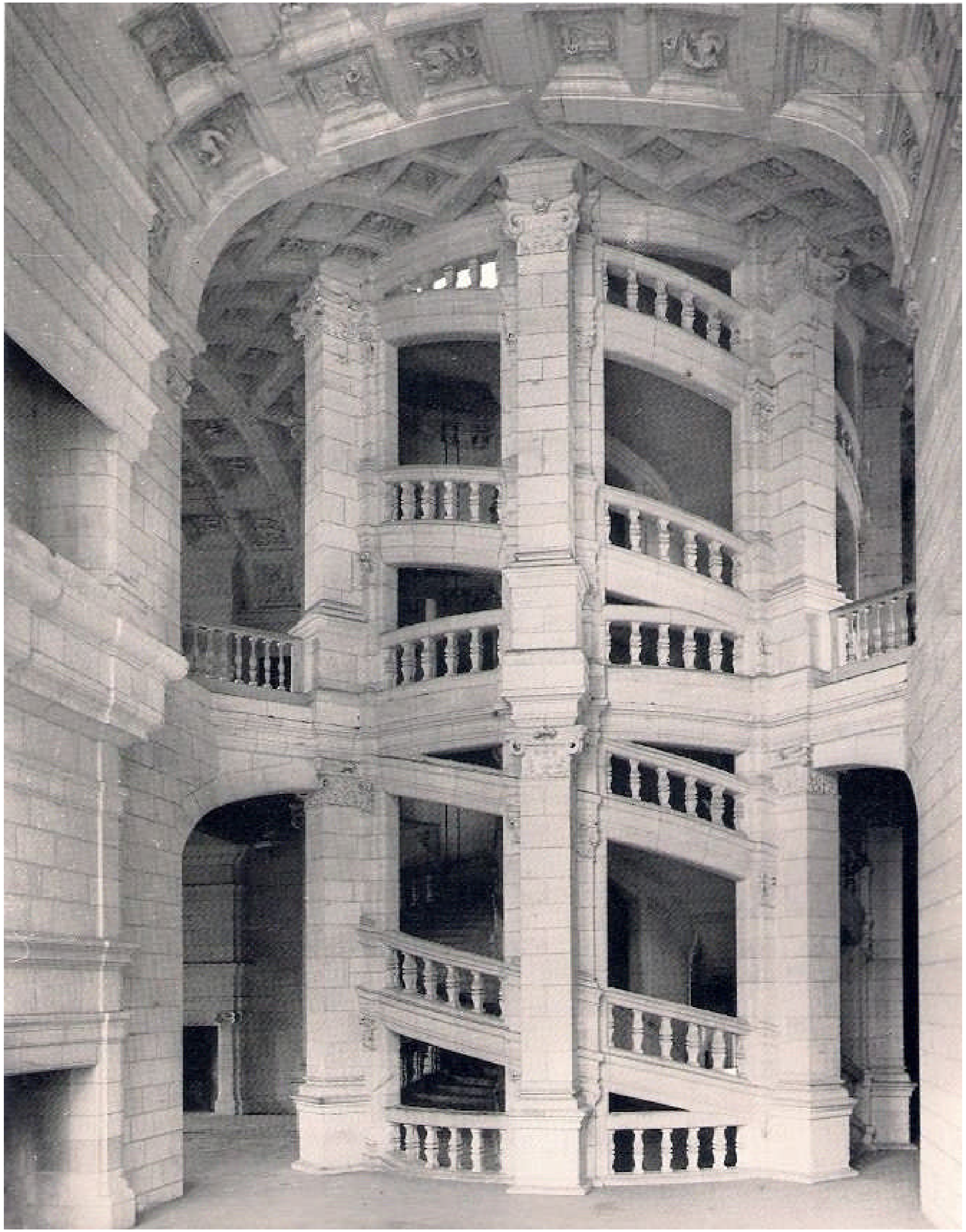
The operation, which will be readily seen, is as follows: When the drum N is turned in the direction of the arrow and the belt P on the working-pulley L, the rope G will be wound on the drum H and the platform D

As Old as Civilization



The need for vertical transportation is as old as civilization itself. Starting with crude stairs and raw muscle power, mankind has employed many ingenious forms of lifting using human, animal and water power to raise a load. Lifting devices relied on these basic forms of power right up to the dawn of the *Industrial Revolution.*

Left: caption: "Stairs at the Chateau St. George, Lisbon, Portugal"



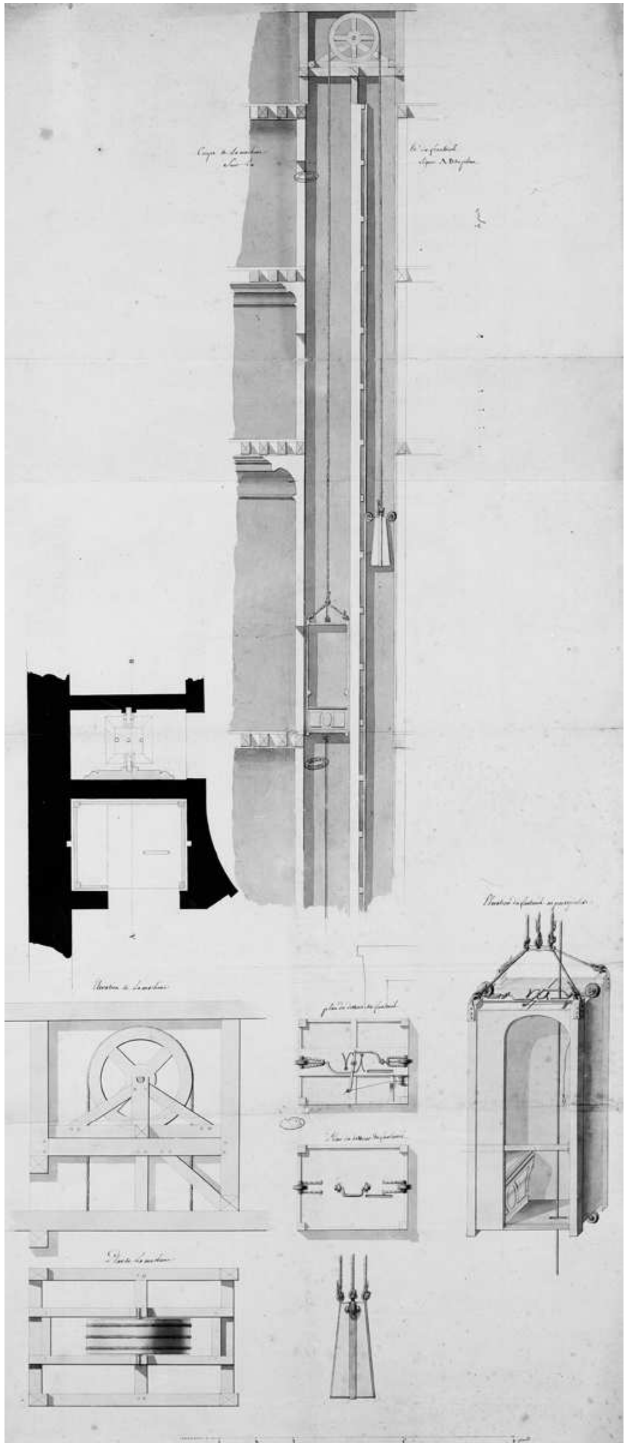
<u>Left</u>: caption: “The Great Staircase in Chambord, France”

In ancient Greece, *Archimedes* developed an improved lifting device operated by ropes and pulleys, in which the hoisting ropes were coiled around a winding drum by a capstan and levers. By A.D. 80, gladiators and wild animals rode crude elevators up to the arena level of the *Roman Coliseum*. Medieval records contain numerous drawings of hoists lifting men and supplies. Among the most famous is the hoist at the monastery of *St. Barlaam* in Greece (top). The monastery stood on a pinnacle approximately 250-feet above the ground. Its hoist, which employed a basket or cargo net (bottom) was the only means up or down.

The earliest known reference to an elevator is in the works of the Roman architect *Vitruvius*, who reported that *Archimedes* (287 BC–212 BC) built his first elevator in around 236 B.C. Some sources from later historical periods mention elevators as cabs on a hemp rope powered by hand or by animals. It's believed that elevators of this type were installed in the *Sinai Monastery* of Egypt. In 1000 AD, the *Book of Secrets* (by *al-Muradi*) described the use of an elevator-like lifting device (in order to raise a large battering ram to destroy a fortress in Islamic Spain).

<u>Left</u>: caption: "Elevator design by the German engineer Konrad Kyeser (1405)"

The Flying Chair



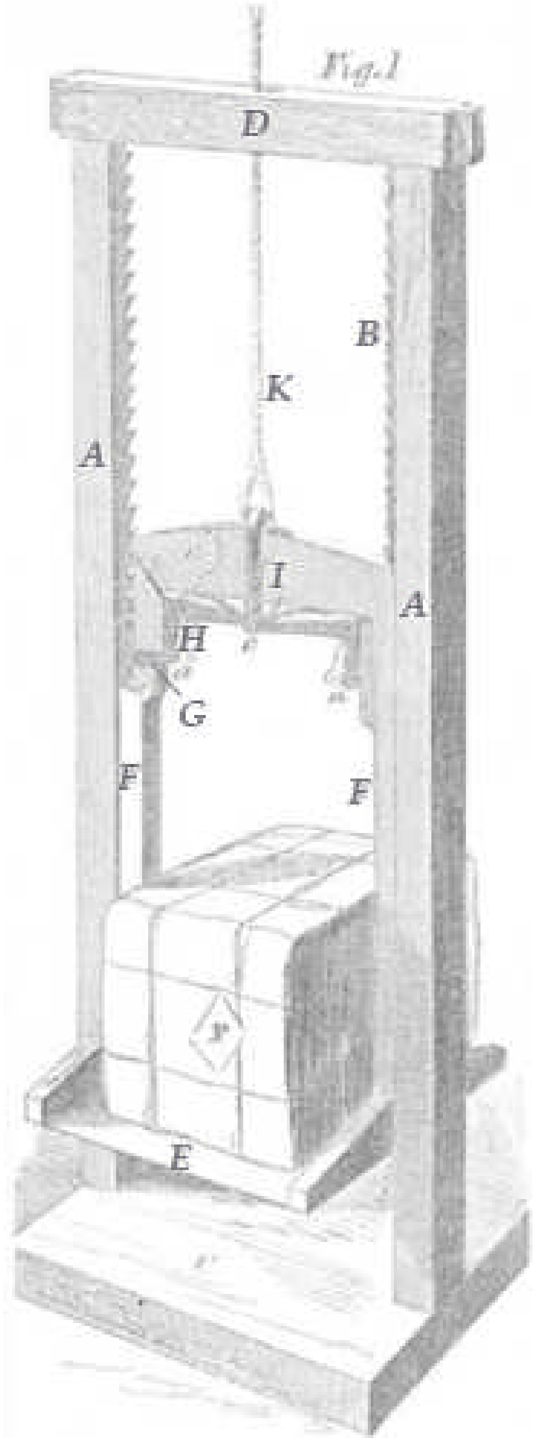
By the 18th Century, machine power was being applied to the development of the lift. *Louis XV* of France had a "Flying chair" - an ancestor of the lift, built for *Madame de Chateauroux*. The King's mistress used the device to reach her apartments on the palace's third floor. Later, another favorite of the King; *Madame de Pompadour*, also used it. *Count de Villayer* developed the chair in the 18th Century and Louis XV later commissioned this adaptation from *Blaise-Henri Arnoult* (his talented machinist) who also worked on the *Versailles Royal Opera*. The Flying Chair's occupant operated the device by tugging on a cord in the car that was connected to a system of pulleys and counterweights. This *Flying Chair*, the only one known at the *Chateau de Versailles*, shows how technical knowledge helped improve the comfort of everyday life. It also recalls the "Flying Tables" Louis XV had installed in his chateau at Choisy and planned for Trianon. They went up and down to and from the kitchens located directly beneath the dining room, allowing the king to enjoy a private meal without his servants' intrusive presence.

<u>Left</u>: caption: "Cross-sections and plans of the mechanism designed by Blaise-Henri Arnoult, Agence des Batiments du roi. 1743."

By 1833, a system using reciprocating rods raised and lowered miners in Germany's *Harz Mountains*. A belt-driven elevator called the "Teagle" was installed in an English factory in 1835. The first hydraulic industrial lift powered by water pressure appeared in 1846. As machinery and engineering improved, other powered lifting devices quickly followed. Despite these advances, one problem continued to trouble the elevator as it had since ancient times. There was no effective way to prevent the hoist from plummeting to earth if the lifting cable parted. This ever-present danger made elevators a risky proposition. In 1852, *Elisha Graves Otis* was working as a Master Mechanic at the *Bedstead Manufacturing Company* in Yonkers, NY. He was given the assignment to design a freight elevator to move the company's products. Otis was well aware of the inherent problem of cable failure and sought a solution that would eliminate the hazard.

Flash of Genius

Otis realized that some sort of safety brake was required. The brake had to function automatically the instant the cable broke if it were to save lives and property. Otis experimented by placing a wagon spring above the hoist platform. He then attached a ratchet bar to the guide rails on each side of the hoistway. The lifting rope was fastened to the wagon spring in such a way that the weight of the hoist platform exerted just enough tension on the spring to keep it from touching the ratchet bars. However, if the cable snapped the tension would be released from the spring and it would immediately engage the ratchets, preventing the platform from falling.



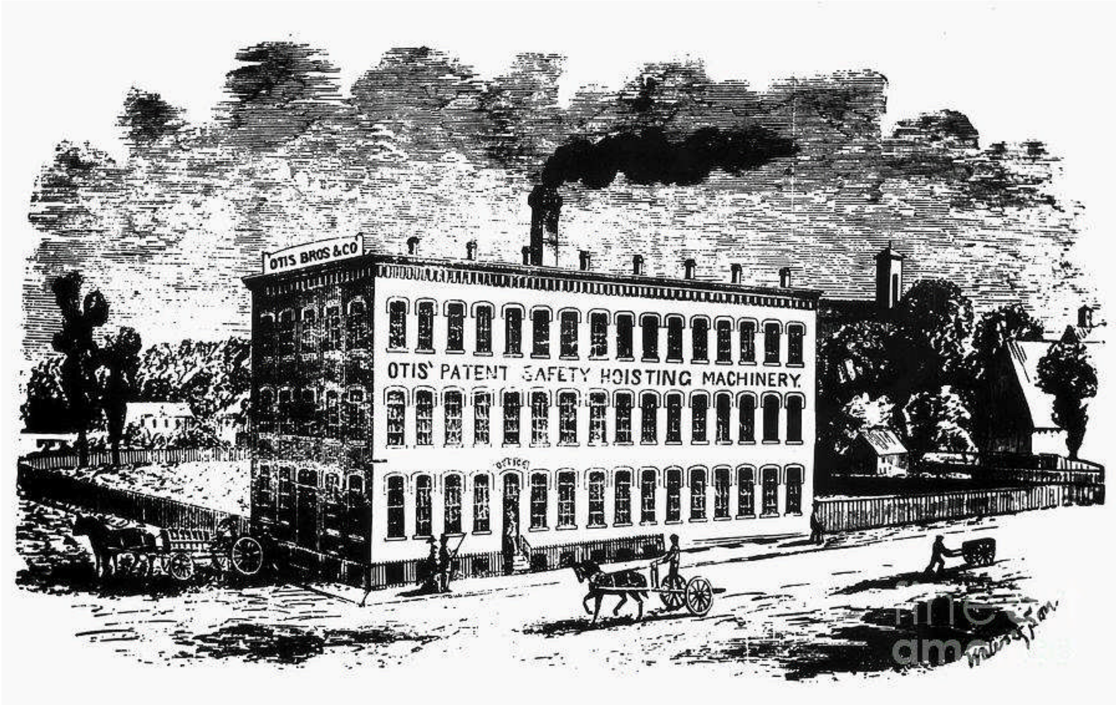
"…when power is applied to the lifting rope (K), the rope pulls on a vertical rod (I), which in turn pulls on right-angled levers (H), thereby pulling two pawls (G) away from the racks (B) secured to the inner sides of the vertical posts (A). This system prevents the pawls from bearing against the racks during the upward movement of the frame (F) and platform (E), and much friction is obviated thereby. When the pull on the rope stops, the pawls automatically catch into the racks again. By design, the pawls are also kept free from the racks during the elevator's normal downward passage. If the rope should break, or be loosened from the driving shaft, or disconnected from the motive power accidentally, the platform will be sustained, and no injury or accident can possibly occur, as the platform is prevented from falling…"

***Scientific American*, November 25th 1854**

Left: diagram of E.G. Otis' "Safety Elevator"

In the meantime, financial problems had forced the *Bedstead Manufacturing Company* to close its doors. Otis was about to head west to take part in the *Gold Rush* when an unsolicited order for two of his "safety hoisters" arrived from a furniture manufacturer in NYC. It seems two of its employees had been killed when a hoist rope had broken. The company wanted to prevent further tragedies. On September 20th 1853, Otis opened his own shop in part of the bankrupt Bedstead plant. In order to promote his new venture, Otis decided to stage a dramatic demonstration of his new safety elevator at the *Crystal Palace Exposition* in NYC for promotional purposes.

An Industry is Born



"Otis' Life-Saving Steam Elevators are so constructed that if the rope breaks the platform cannot fall. Twelve men killed in this city (Yonkers, N.Y.) within four years with the old-kind, and not one killed or hurt with Otis' Excelsior Elevators."

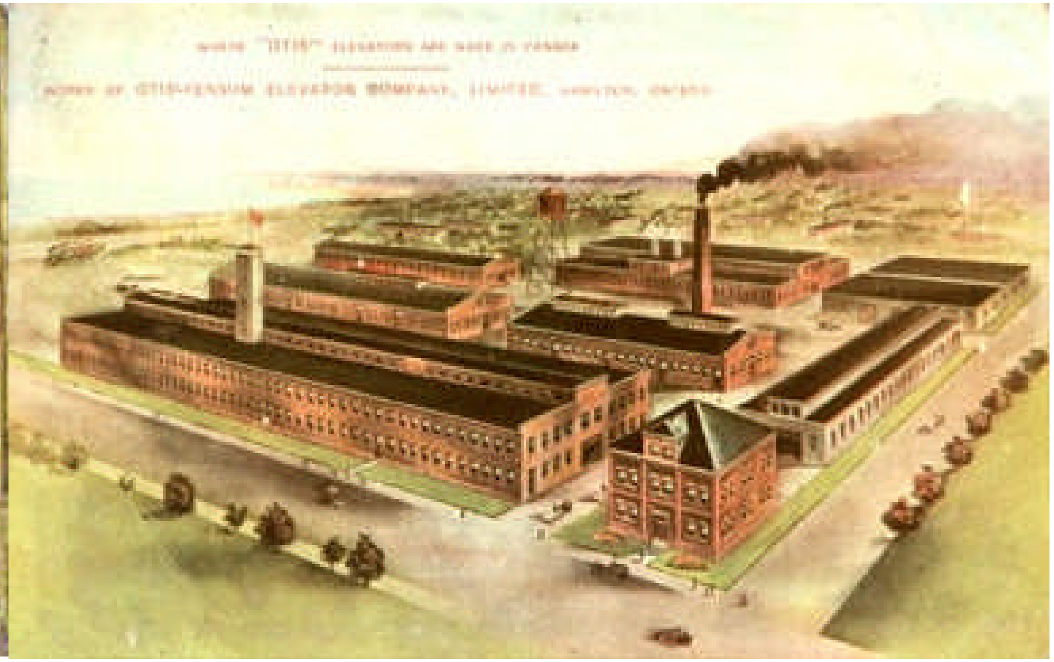
RE: excerpt from E.G. Otis' business card (ca. 1853). By today's standards, the *Otis Patent Safety Hoisting Machinery Company* (above) had modest beginnings. Otis' account book (dated December 3rd 1853) showed a total inventory of $122.71 with two line items accounting for $97.96 (a second-hand lathe and iron, steel and other materials). A desk and workbench were valued at $22.00 Two oil cans were assessed at $1.50 and an account book and paper were listed at $1.25. The business address in Yonkers was listed as 307 Broadway, 3rd floor, with office hours listed as 1 to 2 p.m.

Elevators were available for sale in the 1850s, but not all businesses were convinced they needed one. So, in 1854, inventor *E.G. Otis* penned the first advertisement to sell his: "Improved Platform Elevator." Delivery would not be a problem, the ad promised. Elevator units were: "constantly on hand" or could be: "furnished to order on short notice." The new machine, the: "safest and best" anywhere, was suitable for mills, factories, warehouses, hotels, hospitals, bookbinderies or sugarhouses, among others. It could be powered by steam or water or even by hand. A model capable of lifting five-hundred pounds could be installed for $350: "in complete running order" or up to 8K-pounds for $750. At the time, Otis' company was called *Union Elevator Works*, reflecting his belief that the Union must survive the coming *Civil War*.

"…The great elevator industry of the Otis Elevator Company was founded in the year 1854, over half a century ago, by Mr. E.G. Otis. Starting in a small shop at Yonkers, N.Y., the business has since grown and expanded, and the original factory has developed into a great industrial establish-ment…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

<u>Above</u>: caption: "Factory, Otis Elevator Co. – Company of Wide Awakes assem-bled in celebration of the election of Lincoln." On September 20th 1853, *E.G. Otis* made his first elevator sale. The buyer was *Benjamin Newhouse*, who wanted the elevator for his furniture factory in NYC. The price of the elevator was $300, but Otis - a captain in an artillery company in Yonkers, N.Y., accepted a cannon and its carriage (valued at $58.65) as partial payment. Later the same day, Otis sold a similar elevator to *Searles & Williams,* also of NYC.



A St. John's, Newfoundland, baker named *N. Robert Vail* decided he needed help moving heavy ingredients and finished goods in his mill and bakery. He turned to the Otis who, in 1862, provided Vail a "No. 2 Machine," complete with elaborate handwritten specifications and schematics. Vail required a hoist capable of lifting 1K-pounds and painted "chrome yellow" (for some obscure reason). Vail's *No. 2 Machine* became the first elevator Otis sold outside the United States. In 1905, Otis' Canadian subsidiary merged with the *Fensom Elevator Company* of Toronto, Ontario, becoming the *Otis-Fensom Elevator Company* (the "Fensom" name was dropped in the 1940s).

<u>Left</u>: caption: "Otis-Fensom Elevator Company Nameplate"

<u>Right</u>: caption: "Works of the Otis-Fensom Elevator Company, Ltd,, Hamilton, Ontario"

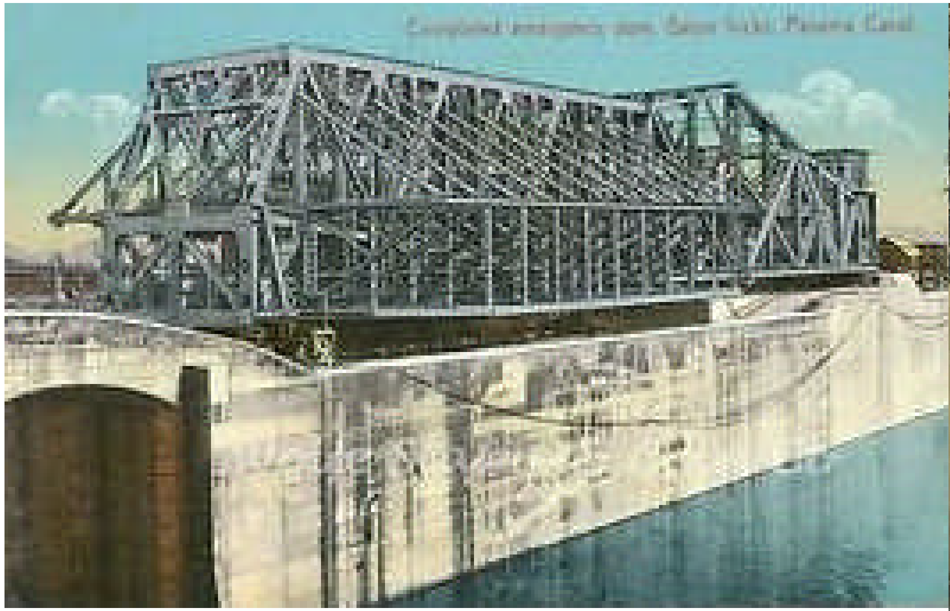
Otis incorporated in Canada in August 1902 and began work on a factory in the industrial city of Hamilton, Ontario. Automatic machinery was used in the 12K-square-foot state-of-the-art factory, which included a test tower with two shafts. The eight buildings in the complex were erected in such a way that all parts; from raw materials to finished equipment, went through a straight course without unnecessary waste and/or handling.

<u>Above</u>: caption: “Otis Elevator came to Hamilton in 1902”

Otis did business in European countries as early as 1873. In February 1884, Otis established sales offices in London and Paris by purchasing the *American Elevator Company*. Some of the early sales provided elevators for the *Eiffel Tower*, *London Underground Railroad*, *Glasgow Harbor Tunnel*, *The Kremlin*, *Balmoral Castle*, *Hungarian Royal Palace* and offices and apartments throughout Europe. Otis began installing elevators and escalators in Mexico in 1883. A duplex cleat-type escalator was installed in 1915 in a bar called "Salon Rojo" in Mexico City. By the end of the 19th Century, Otis was doing business around the world. Otis began European production in 1910 (in Bezons, near Paris) and opened a plant in Berlin, Germany, in 1912. The company also had sub-sidiaries in England and Belgium; agents in Austria-Hungary, Holland, Russia and Spain and a branch office in Scotland.

The first electric elevator in Panama City, Republic of Panama (in fact, the first in the country), was the Otis *No. O-H Electric Elevator* with a 500-pound load capacity and a speed of 110 feet-per-minute (fpm). It was installed in the studio of photographer *Carlos Endara* in 1913 (left). The single push-button elevator operated on a three-phase, 60-cycle, 220-volt circuit. It was, at the time, considered the "most modern type" because it was equipped with a safety device that: "acts automatically in case of an accident." In 1914, the *Panama Canal* was completed making Panama a crossroads of world commerce. Today, Panama City boasts a proud "Skyscraper Skyline" (right) with many Otis installations. Endara's studio was restored and is now a museum and local landmark (left).

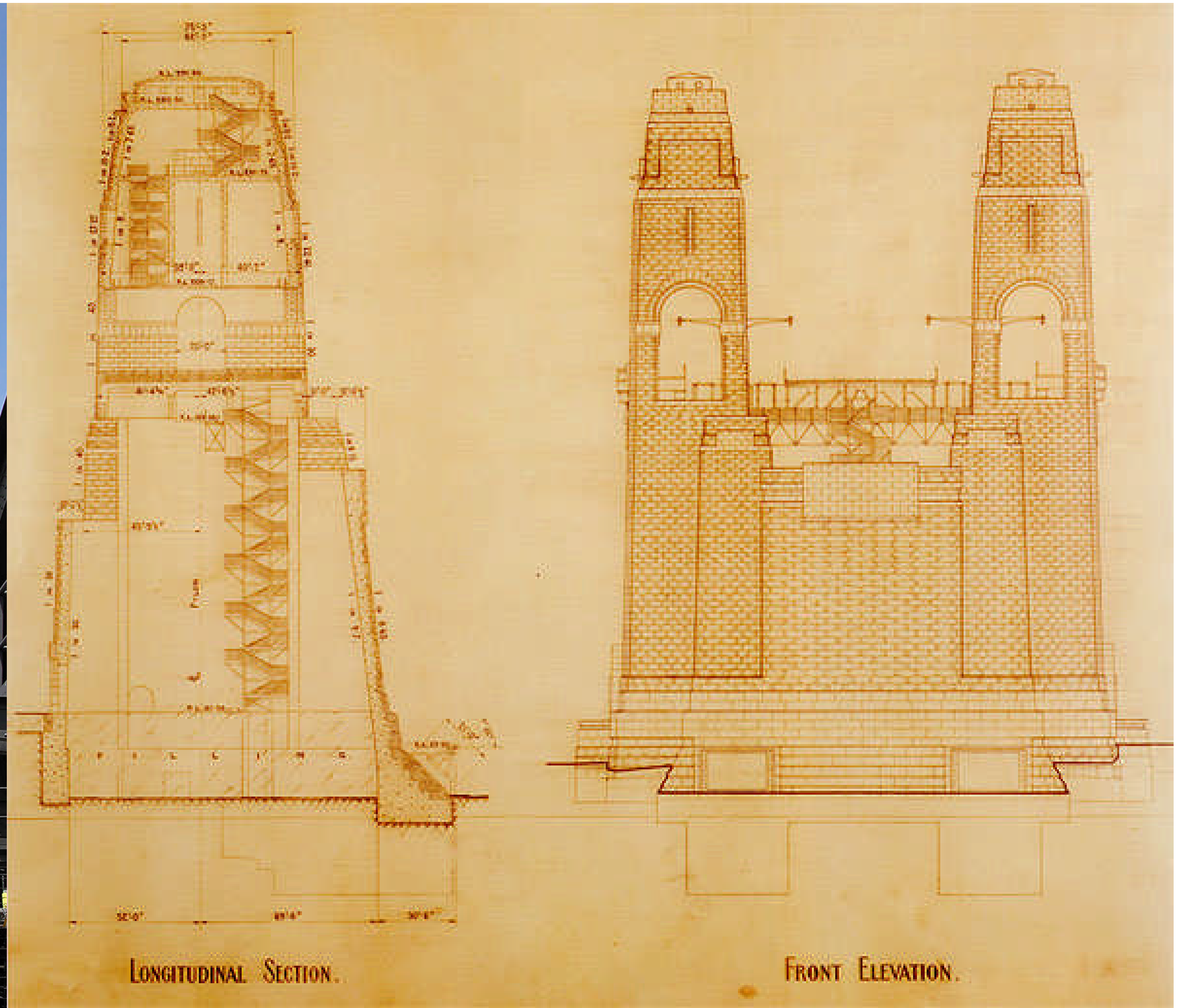
<u>Above</u>: Otis' first installation of an electric elevator unit in Korea occurred in 1914 for the new *Chosun Hotel* in the capital, Seoul.



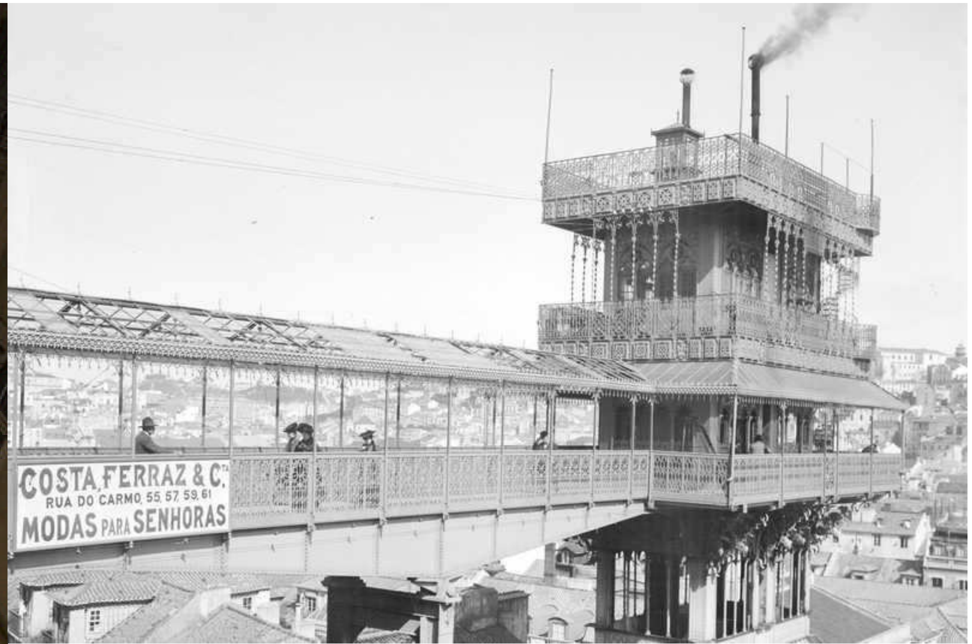
In 1915, the *U.S. Government* commissioned Otis to build gate-hoisting machines for the emergency dams at the *Panama Canal*. The miter-lock gates could be damaged and/or fail causing large volumes of water to escape rendering the canal inoperative for weeks or months. To prevent this potential disaster, *Emergency Swing Dams* (left) would be swung into position while the Otis gate-hoisting machines lowered and locked the emergency gates into position (right).

<u>Left</u>: caption: 'Completed Emergency Dam, Gatun Lock, Panama Canal"

<u>Right</u>: caption: "Emergency Dam swung across lock, ready to drop girders"



The *Sydney Harbor Bridge*, which opened in 1932, was/is one of Australia's great engineering accomplishments. Otis, which at the time operated in Australia under the name "Waygood-Otis," was associated with its construction, installing an elevator in the *South East Pylon*. The unit continues in operation, serving the look-out and museum located inside the pylon (above & left).



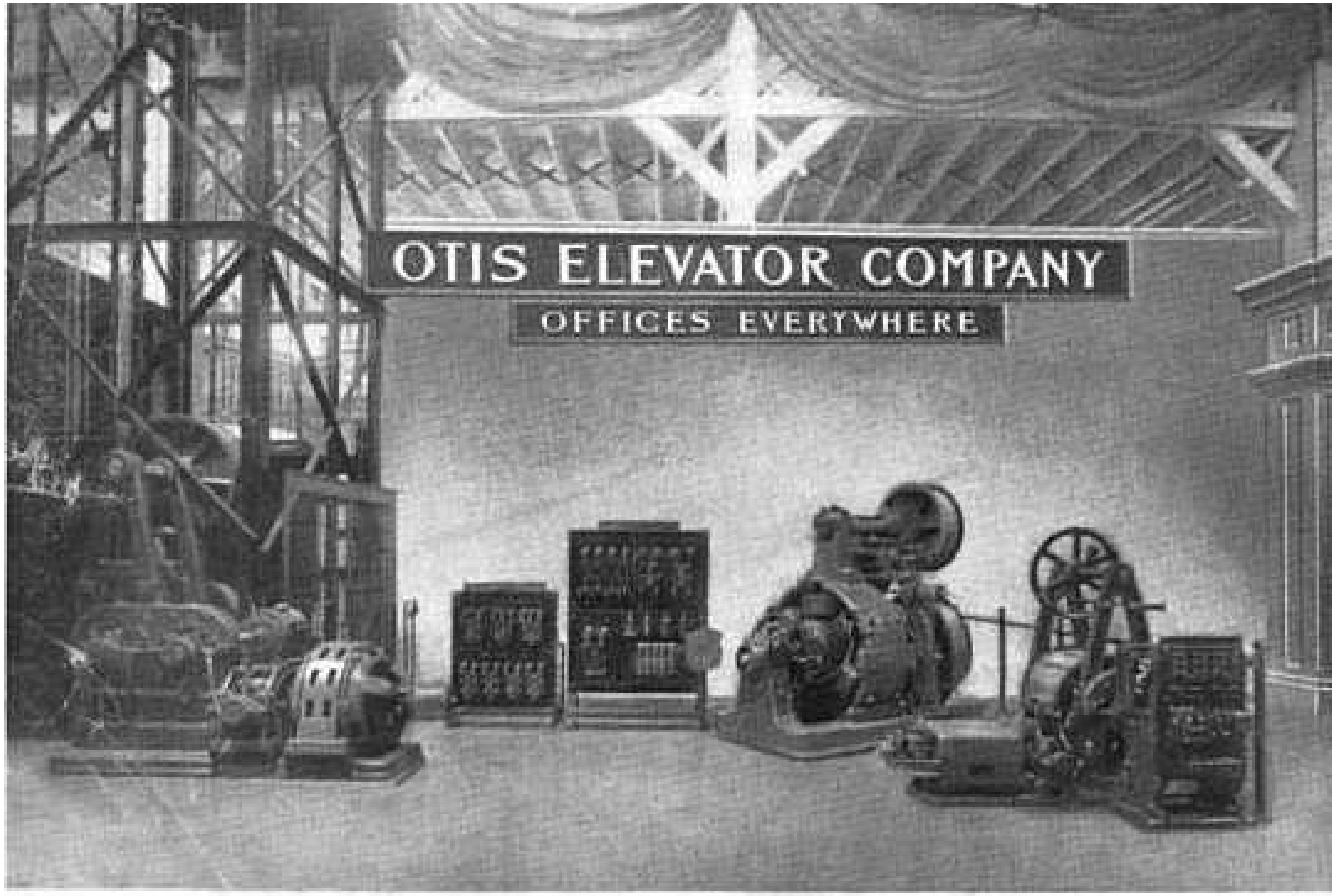
The oldest surviving 20th Century Otis elevator is the *Elevador de Santa Justa* (a/k/a "Santa Justa Lift") constructed in Lisbon, Portugal, in 1901 (left). Still in operation, it has a two functions:

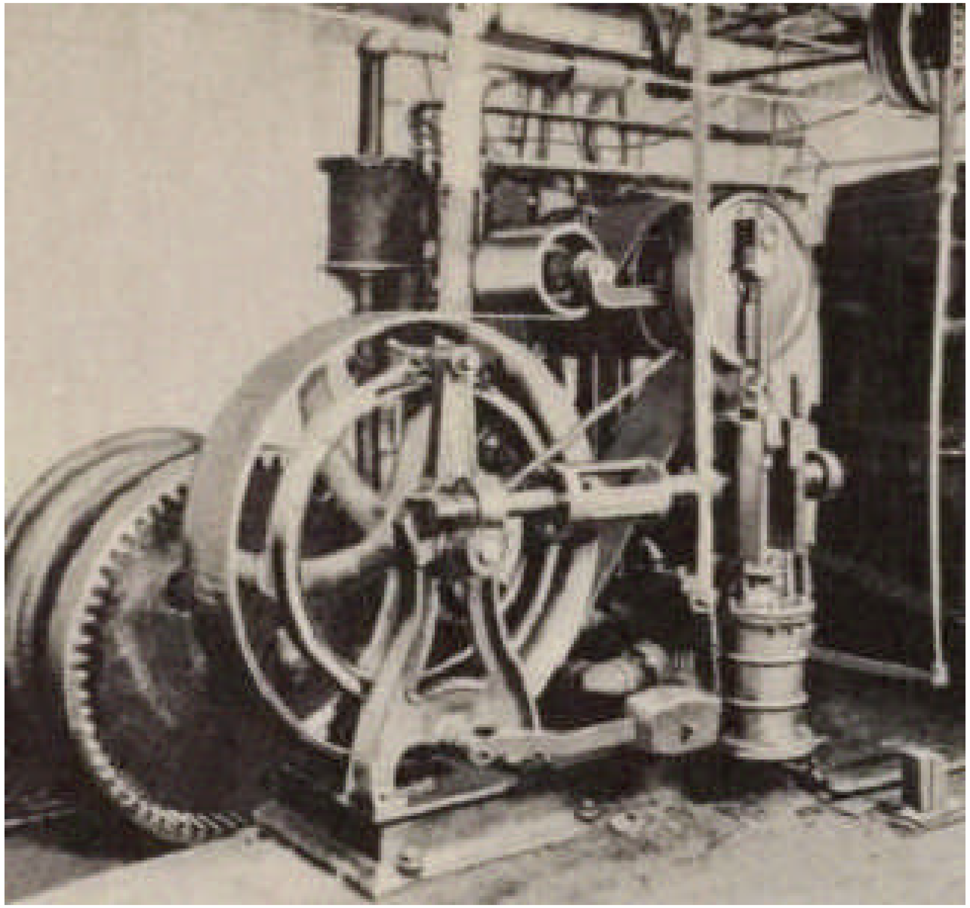
- **Permit tourists a panoramic view of the city and the *Tagus Estuary***
- **Link two levels of the city**

<u>Above</u>: caption: "Photo of the Santa Justa Lift, as it appeared prior to a 1907 conversion to Electric power"

"…The pre-eminence of the Otis Elevator Company in all fields of vertical transportation is evidenced by the fact that throughout its history it has continued to be the largest elevator company in the world. The Company now has three manufacturing plants and 170 offices in the United States alone. It employs over 12,000 people, and in 1938 installed Otis elevators in fifty-one different countries. In addition Otis and its Associated Companies have 185 offices in all other parts of the world, with manufacturing plants in Canada, England, France, Belgium, Germany, Italy, Australia and Japan, and also assembly plants in Rio de Janeiro and Buenos Aires…"

RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators*


OTIS ELEVATOR COMPANY
OFFICES EVERYWHERE



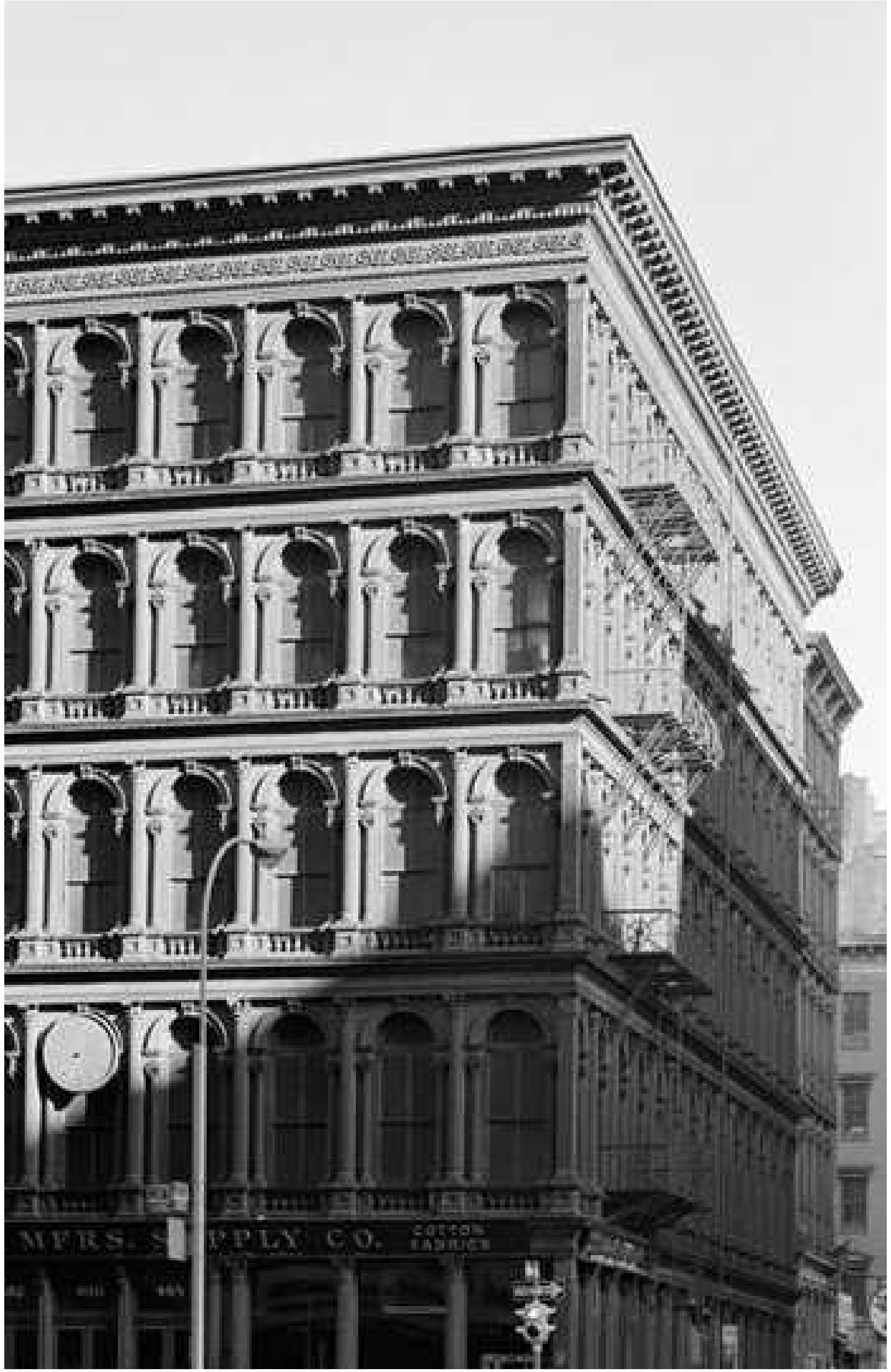
"…It has been the Otis policy not only to continue to improve all existing equipment to the highest practicable degree of perfection, but to seek constantly to develop new and better elevator equipment of a type previously unknown. To this end, the Otis Elevator Company has for more than forty years maintained the largest elevator engineering organization in the world, and has made available to the public the product of its extensive research and invention…"

RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators*

Left: caption: "Steam Elevator Machine"

"…In the long list of notable Otis achievements which have marked the advancement of the elevator industry, the following are of particular interest and historical significance…"

RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators*



"…In 1857 the first known passenger elevator was in-stalled by Elisha Graves Otis in the store of E.V. Haughwout and Company, Broadway & Broome Street, New York City. This elevator was of the belt-driven type, and marked the beginning of an era in which elevators have made possible buildings of constantly incr-easing height…"

RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators*

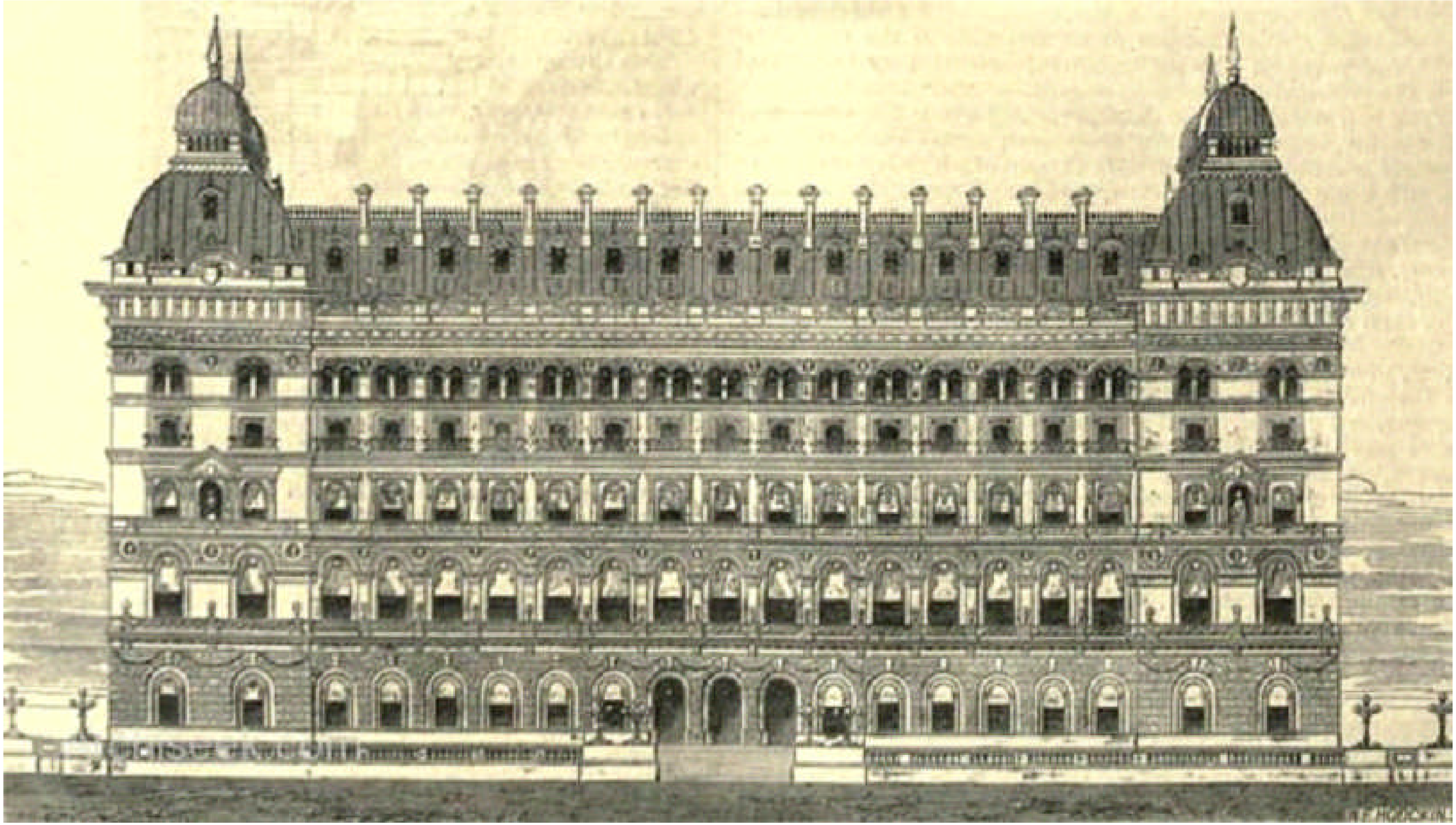
Left: caption: "On March 23, 1857, the first commercial elevator was installed in the E.V. Haughwout Building. The original Otis elevator is still in operation today."

<u>Left</u>: in 1857, E.G. Otis installed an elevator in the *H.V. Haughwout and Company* - a fashionable department store selling cut glass, silverware, china and chandeliers. Although the store was only five stories tall (similar to other NYC buildings at the time), the owners hoped the novelty of an elevator would bring in customers (it did).

<u>Right</u>: caption: "Ground Floor – Elevator Front - E.V. Haughwout & Company Building, 488-492 Broadway, New York, New York County, NY"

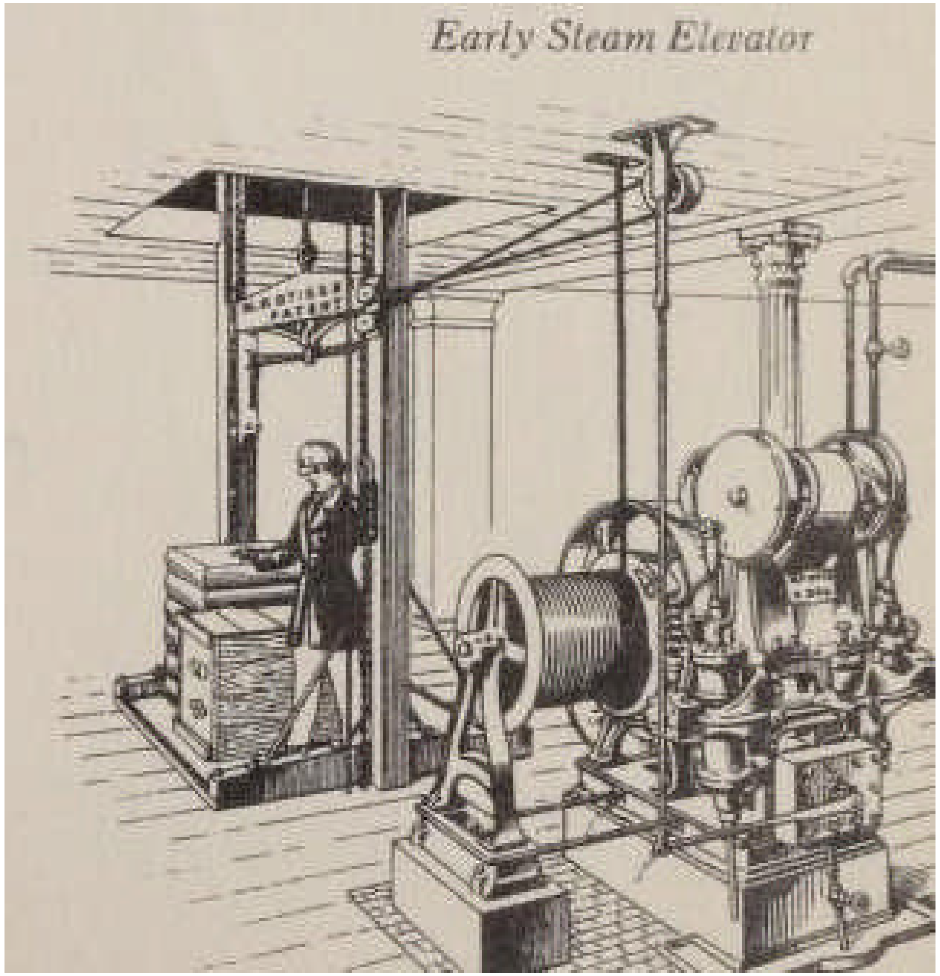

The price of the *E.V. Haughwout* elevator (above L&R) was $300. The cab rose at a speed of 40 fpm. As elevator safety and efficiency improved, there were two-thousand Otis elevators in service by the 1870s, making high floors in buildings more desirable.

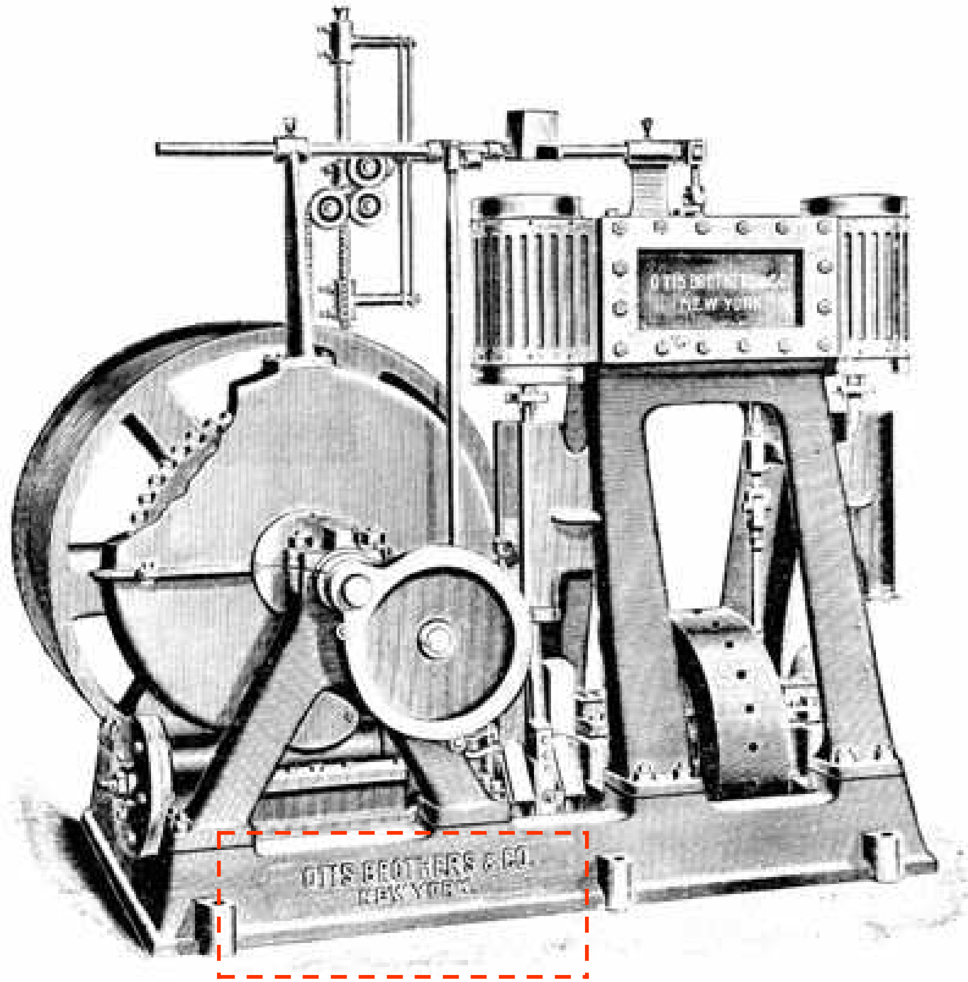
The Ascending Room



<u>Above</u>: London's *Grosvenor Hotel* opened at *Victoria Station* in 1861 and was the first hotel in London to install elevators for the convenience of guests as well as for handling their luggage. Elevators were initially known as: "The Ascending Room." However, the word "Lift" and/or "elevator" was in general use by the 1860s.

In 1861, Otis provided to *Horace Claflin* - one of the most prominent dry goods merchants of the day, steam-powered hoist equipment for his prosperous business on lower Broadway in NYC. It was to be Otis' first service contract. The contract was written in longhand by *Charles Otis*, son of founder *E.G. Otis*. The simply-worded contract offered to: "assume the entire charge and responsibility for the care of the hoisting equipment and to give it my frequent personal examination." All for $780 per annum.

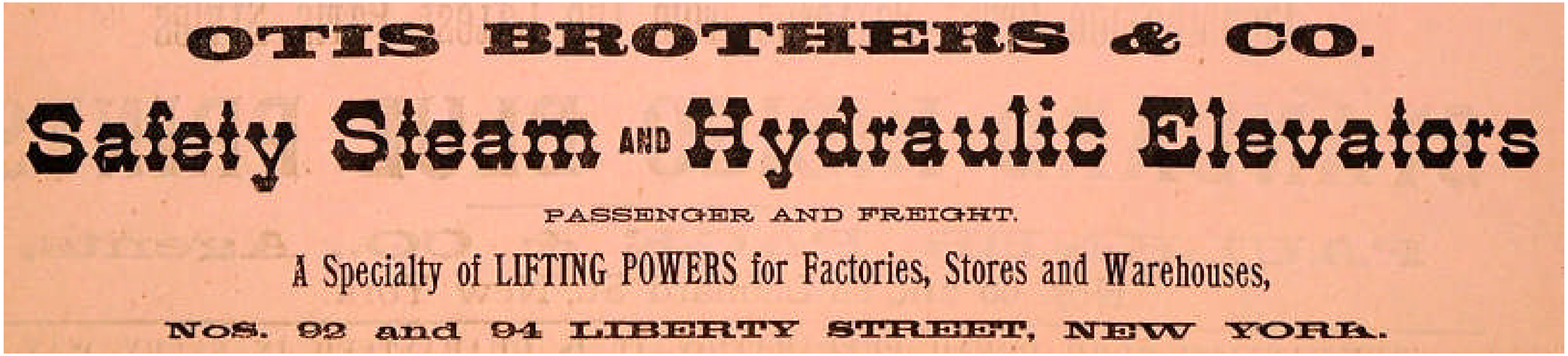




<u>Above L&R</u>: the first Otis steam elevators were installed in 1859 and were popular for more than thirty years. Much like a conventional windlass used on steamships, the cable system provided the necessary guidance. However, it did not require trained supervision. Although easy to maintain and reliable, steam elevators were slow and cumbersome.

"…After the death of Elisha Graves Otis in 1861, his sons, Norton P. Otis and Charles R. Otis, continued the business under the name of N.P. Otis and Brother and, in 1865, built a new elevator factory in Yonkers, New York, and adopted the name Otis Brothers and Company. During this period they invented and developed a screw-type belt machine and a stationary-cylinder steam engine which represented a marked improvement over the elevator equipment previously available…"

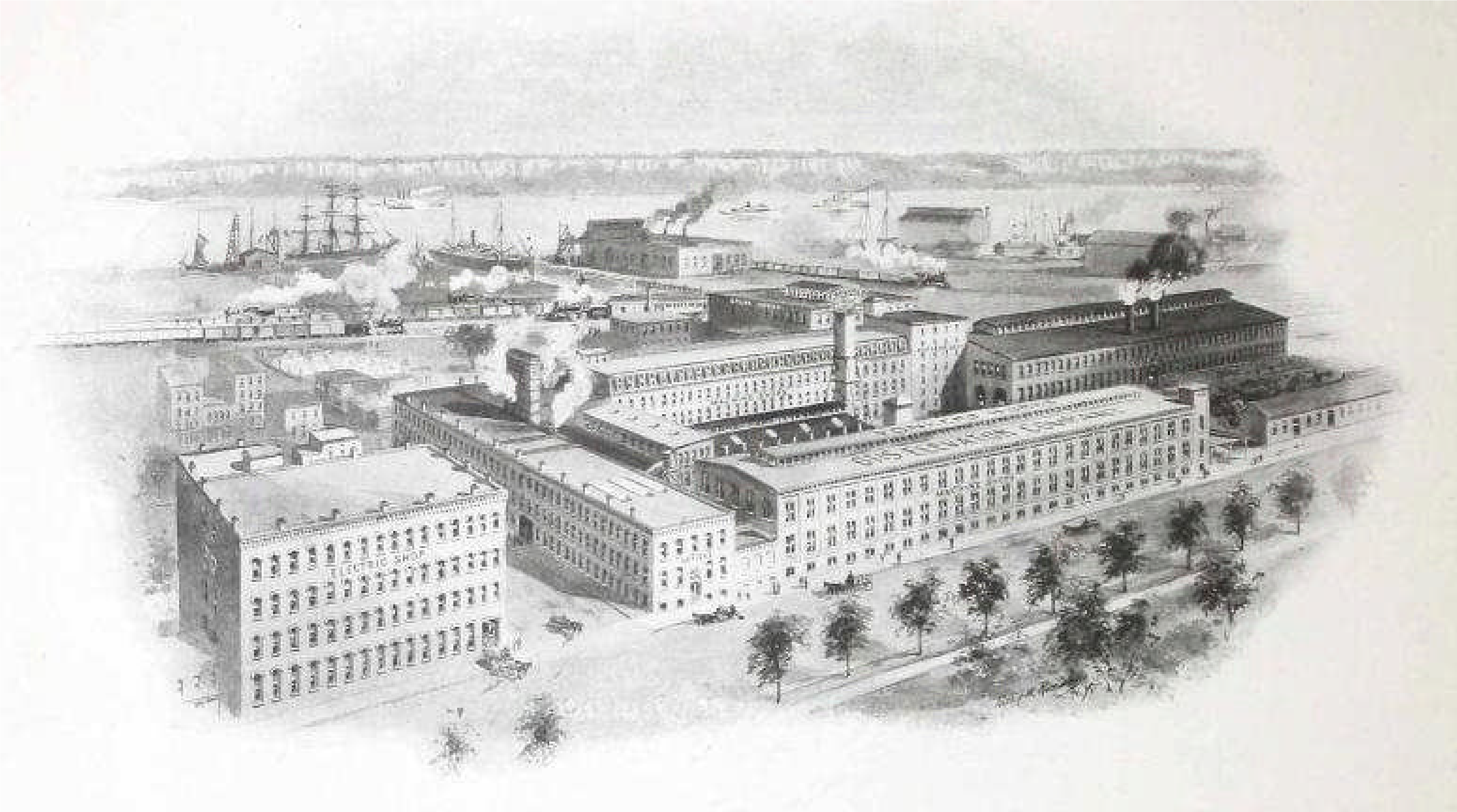
RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators. E.G Otis* died during the diphtheria epidemic of 1861, leaving the business to his two sons: *Charles* and *Norton*, who would build it into a multi-million dollar industrial empire.



The *E.G. Otis Company* was renamed *N.P. Otis & Brother Company* upon the death of founder *Elisha Graves Otis* in 1861. *Charles R. Otis*, one of two sons of Elisha Otis, was named president and his other son; *Norton P. Otis*, was named treasurer. The firm of *Otis Brothers & Company* was incorporated on November 8th 1867, with a capitalization of $225K. A year later, a new factory building was completed in Yonkers, N.Y., at a cost of $13,000. By 1868, the Otis Brothers had developed a steam passenger elevator with an elaborate car and a half dozen safety devices in addition to the original invention. As the safety and efficiency of the early elevators continued to improve, space in buildings' upper floors became more desirable, reversing a long-standing trend in commercial and residential leasing. By 1870, Otis Brothers & Co. had revenues in excess of $1 million. A few of years later, there were no less than two-thousand Otis elevators in use.

<u>Above</u>: caption: "1883 Otis Bros. ad – Safety Steam & Hydraulic Elevators"


OTIS, BROTHERS & CO.
Sole Manufacturers of
OTIS' PATENT LIFE AND LABOR SAVING
HOISTING MACHINERY
MANUFACTORY AT YONKERS, N. Y.
Office Hours, From 12 to 2 o'clock.
OFFICE, 307-9 BROADWAY, N. Y. CITY.
For the use of Stores, Hotels, Commission Houses, Storage Warehouses, Sugar Refineries, Packing Houses, Livery Stables, Factories, Bakeries, Mills, Shipping, Docks, Mines, &c.
A great variety of SUPERIOR HOISTING MACHINERY, adapted to every class of business and power, constantly on hand, and in process of manufacture.
Union Hoisting Engine.
Union Hoisting Engine.
DEALERS in all kinds of Machinery required in the application of Steam for Hoisting Purposes.
STEAM BOILERS, STEAM PUMPS, STEAM & WATER GUAGES, STEAM & WATER PIPES, DAMPER REGULATORS, SHAFTING, IRON CASTINGS, PULLIES, &C.
WIRE ROPE,
Of the best quality, manufactured expressly for Hoisting, constantly on hand, and supplied to Order.
OTIS BROTHERS NEW YORK
Automatic Safety Drum.
Lifting Power—screw combination.
Lifting Power—gear combination.
DESCRIPTIVE CIRCULARS
Metropolitan Hoisting Engine.
Relief Hoisting Engine.
Universal Hoisting Machine.



Otis Elevator Company Works at Yonkers, N. Y.

"…the business has since grown and expanded, and the original factory has developed into a great industrial establishment illustrated above. …"

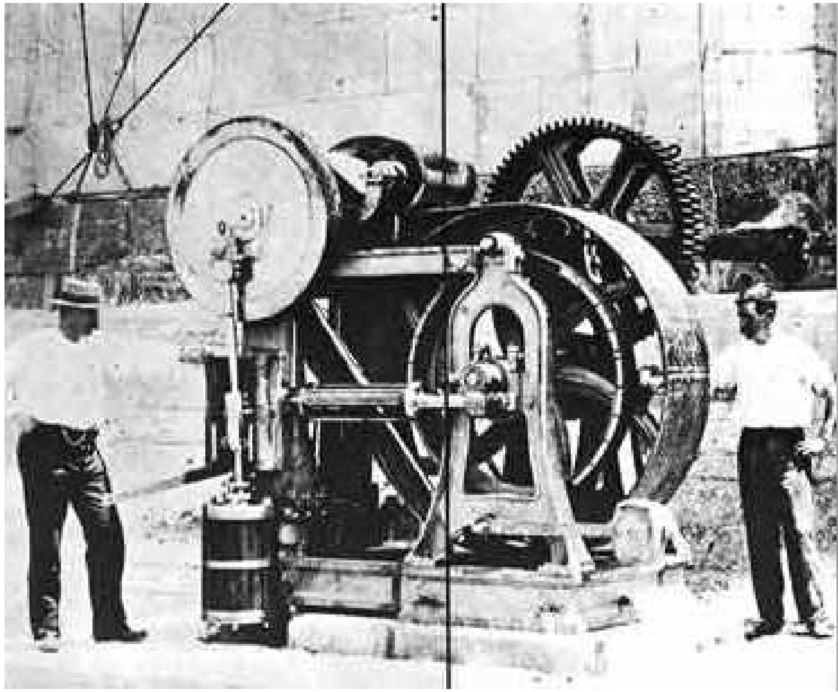
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

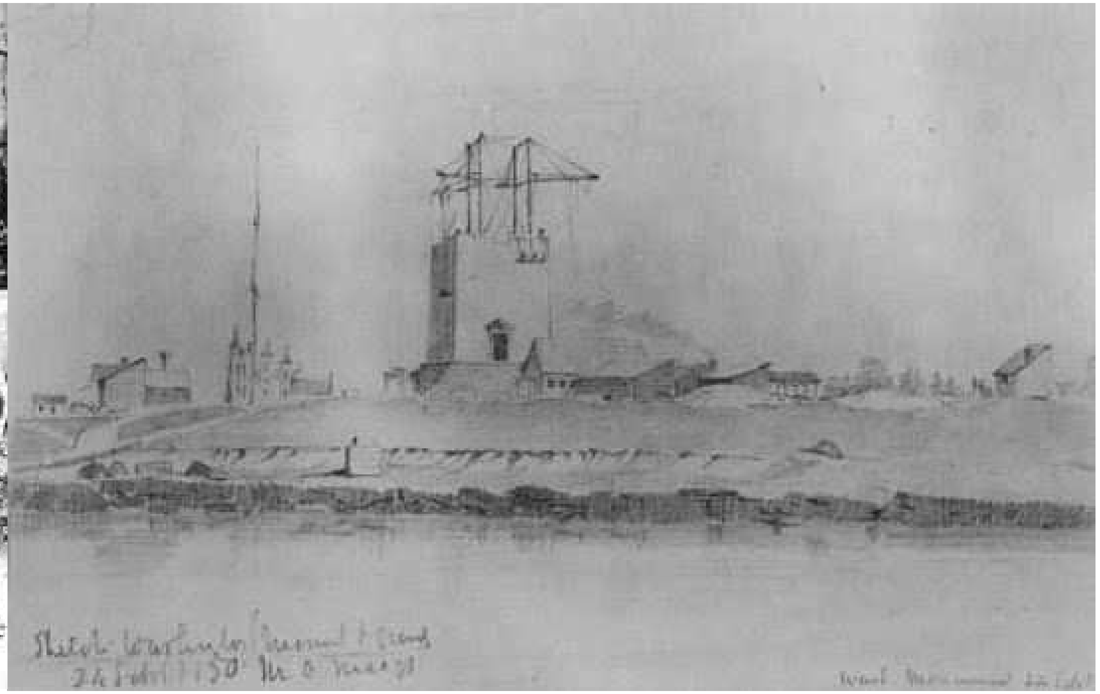
In 1870, an "Otis Metropolitan Steam Safety Elevator" was installed at the *Lord & Taylor* department store at Broadway and 20th Street in NYC (left). In its January 11th 1873, edition, *Leslie's Illustrated Weekly* said the Otis elevator carried ten-thousand people up and down to the fifth floor in three days (an overly-optimistic estimate). A second steam passenger elevator was installed in the store in 1874.

Also in 1870, *Otis Brothers* installed two elevators in the *Maxwell House Hotel* in Nashville, TN - one for passengers and one for baggage. By 1892, a Nashville wholesale grocer was supplying the hotel with a coffee blend so popular the innkeeper would serve no other brand. It became known as “Maxwell House Coffee.”

Left: caption: “Maxwell House Hotel, ca. 1925”

<u>Left</u>: an *Otis Brothers & Company* advertisement (ca. 1876). The company's products were on display at the *Centennial Exhibition* held in Philadelphia in 1876 where they won "First Prize" for their "Safety Steam and Hydraulic Elevators."





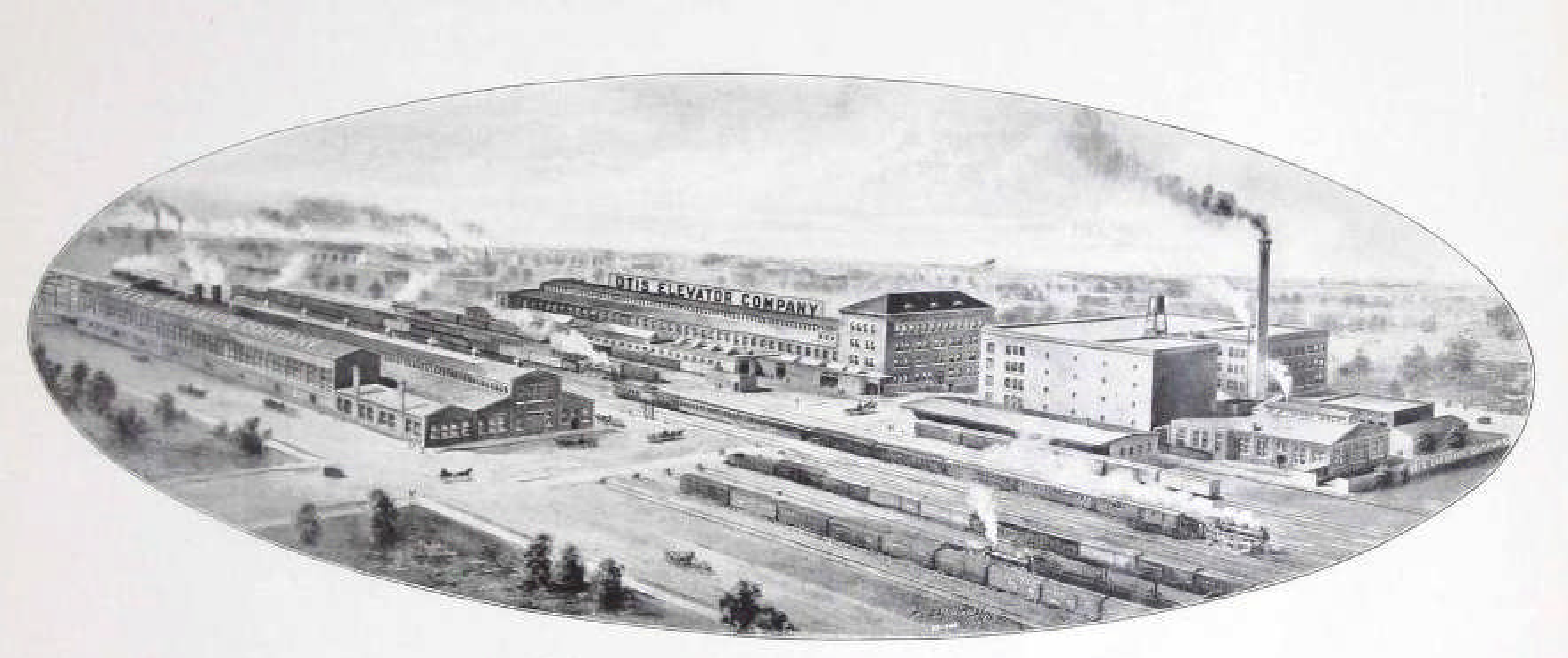
An Otis elevator was part of the *Washington Monument* in Washington, D.C. In mid-1879, the U.S. Engineer's office in Philadelphia had requested bids for a steam-driven, drum-winding elevator that could be used in the construction phase and later be converted to passenger service. The duty was specified to be six-tons at fifty-fpm. Four companies submitted proposals and, at the end of the year, the Engineers selected Otis Brothers' bid of $18,350. The company commenced work April 1st 1880 and three-and-a-half months later, their machine (left), operating on eighty-pounds of steam pressure, had been tested on the jobsite and accepted. Thereafter, iron columns were pushed upward in each corner to a height above the outer walls which would allow the car (suspended from the overhead work's large pulleys) to bring stone to the tower's four faces (right).

A year after the capstone was placed, Otis quoted the sum of $2,740 for converting the work elevator to passenger service. The bid included additional safety devices and the installation of a cab with cane seat settees and an oil stove. An operator was hired at the annual salary of $900 and groups of thirty visitors began making the twelve-minute trip to the summit. During the first year, daily operation carried almost 110K persons. A few years later, perforated wooden seats replaced the cane, and an electric annunciator was installed in the car by which signals could be received from the engine room as well as the top and bottom landings.

Left: present-day Washington Monument elevator. The modern electric elevator can make the trip to the top in seventy seconds

Around the turn of the century, Otis made getting to the top of the *Statue of Liberty* (on *Bedloe's Island* in *New York Harbor*) a little easier. Otis installed a double screw drum-type machine with a rise of 105-feet 8-inches and a lifting cap-acity of 3K pounds (at a speed of 350 fpm).

<u>Left</u>: caption: "The elevator inside the pedestal of the Statue of Liberty"



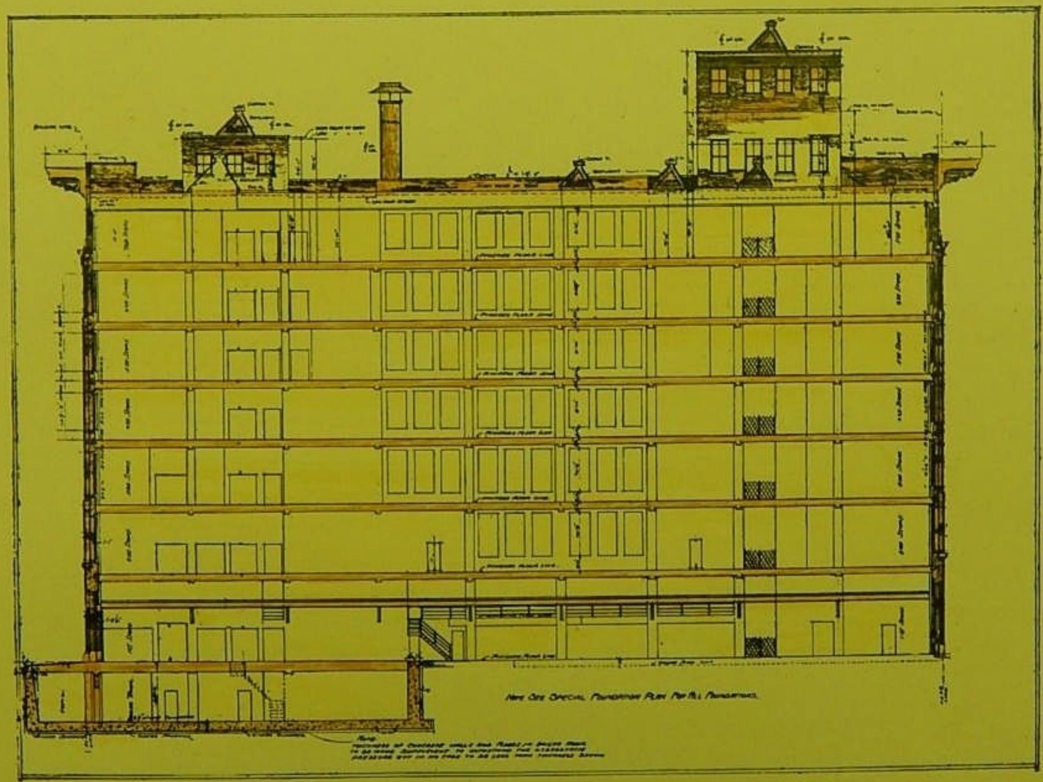
Otis Elevator Company Works at Chicago, Ill.

"…With the development of the business, it has from time to time become necessary to build factories in other cities and in other countries, and, in some instances, to acquire existing establishments devoted to this branch of manufacturing. With each increase of facilities it has been possible to further improve the product…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

<u>Left</u>: caption: “Above - The Yonkers Works of the Otis Elevator Company. Other factories are located at Harrison, N.J., Buffalo. N.Y., and Quincy, Ill. Below - The Otis Building, New York. In this Building are located the General Offices and the Service Warehouse.” (ca. 1916)

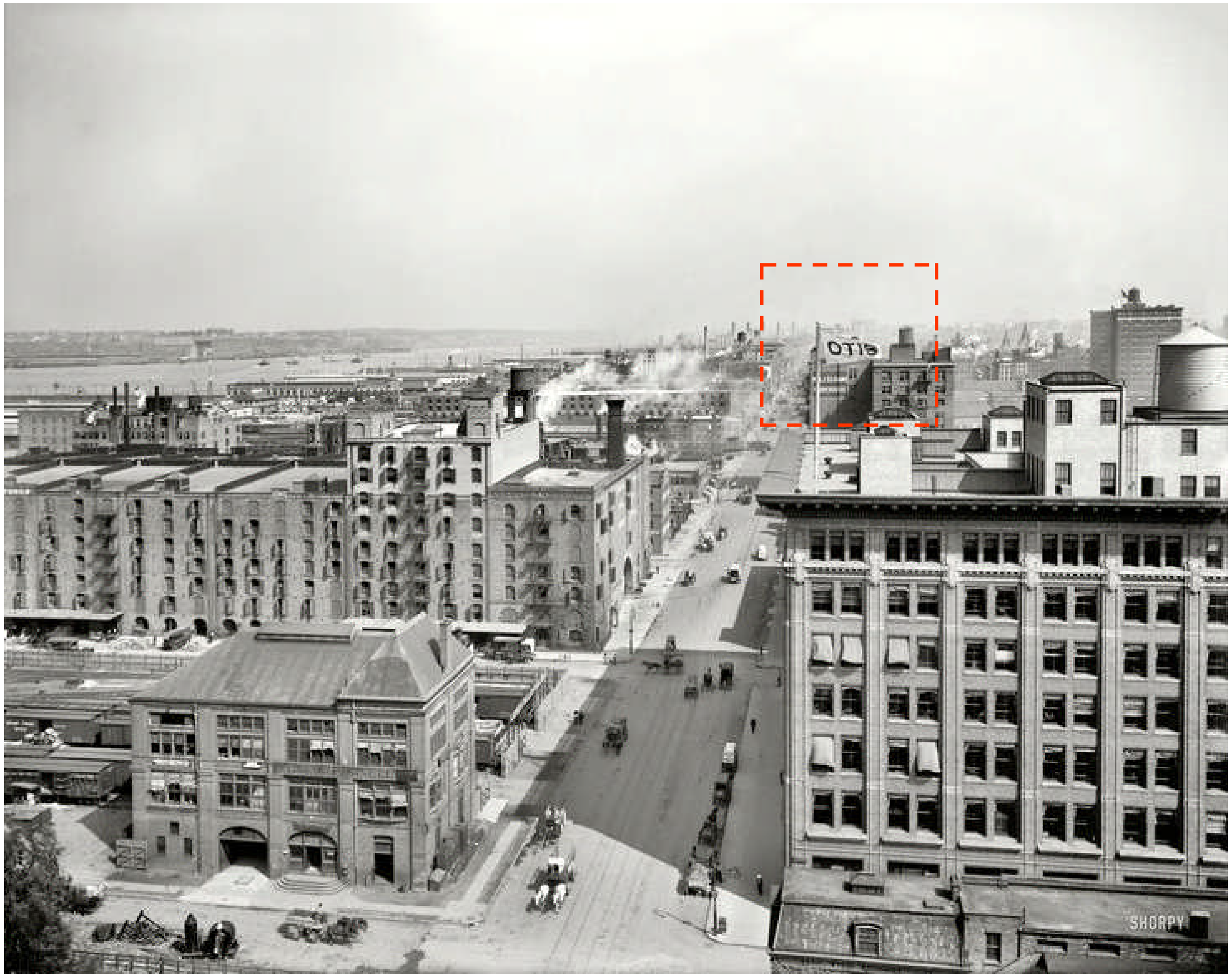

Otis Elevator Building
Otis Elevator Company
Begs to Announce the Removal of all its Offices and Departments to its New Building
Eleventh Avenue and Twenty-sixth Street
New York

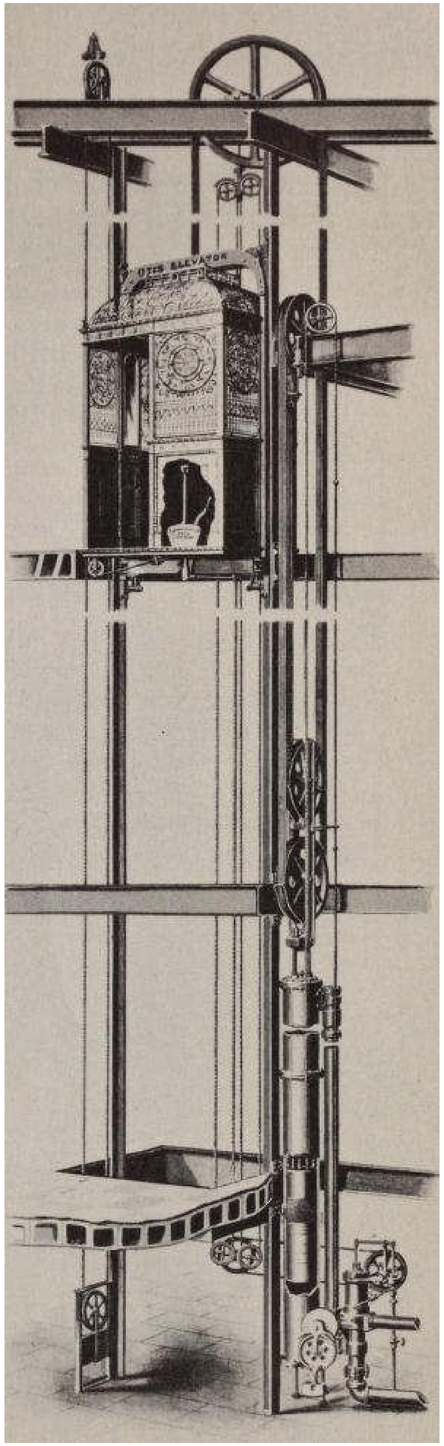


BUILDING FOR OTIS ELEVATOR COMPANY

ELEVENTH AVENUE, 26TH AND 27TH STREETS, NEW YORK

MESSRS. CLINTON & RUSSELL, ARCHITECTS


OTIS
SHORPY

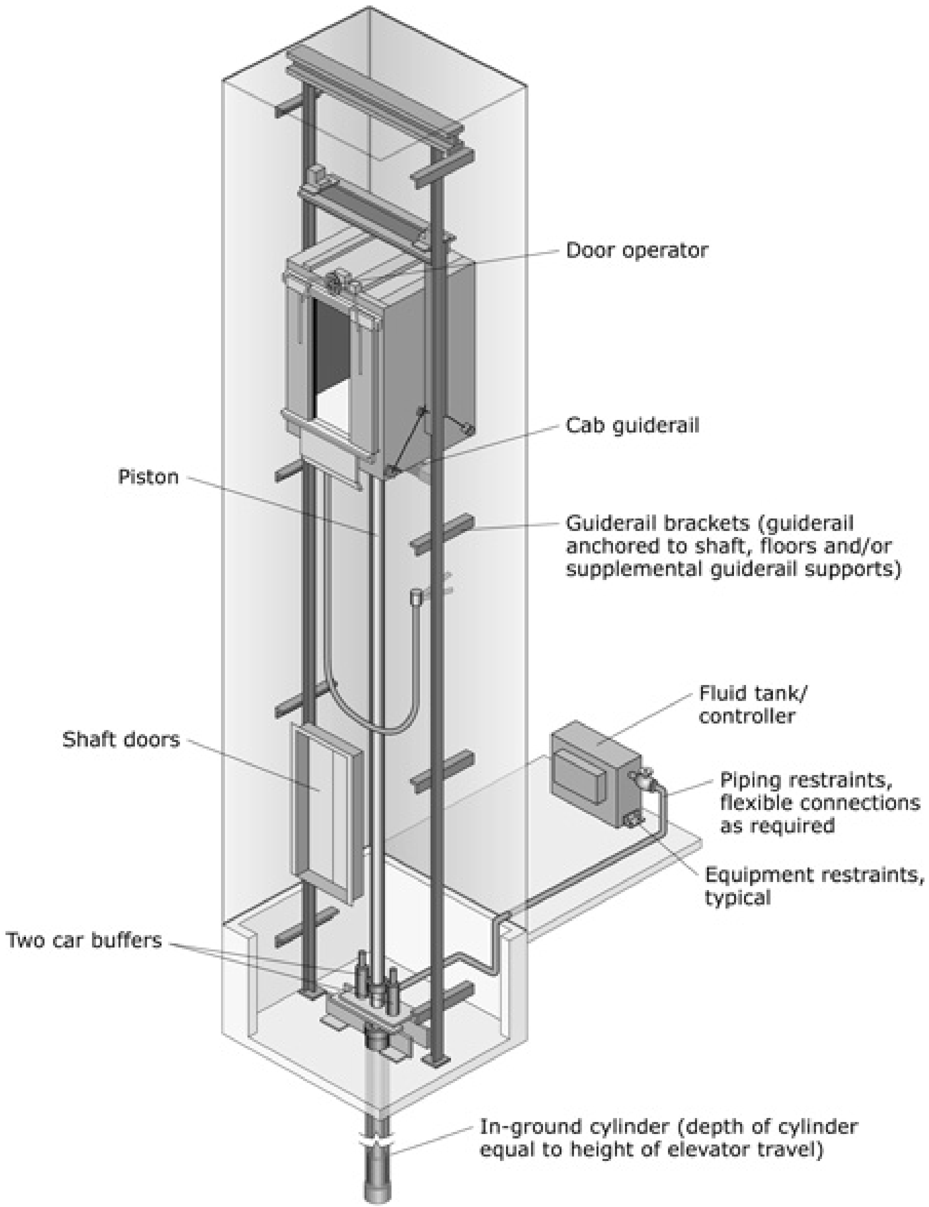


"…1872 marked the advent of a radically different type of elevator capable of much higher speeds than ever before. It was invented by C.W. Baldwin, who joined the Otis organization and assisted in the development of this new equipment. This geared hydraulic elevator consisted of a cylinder and piston mounted vertically in the elevator hoistway adjacent to the elevator car and was arranged to raise and lower the car through the medium of multiple sheaves and iron ropes. The water pressure was supplied by steam-driven pumps and the system of tanks - with the necessary piping - required considerable space in the basement of the building served. However, the vertical geared hydraulic elevator - and the horizontal geared hydraulic elevator, a modification also developed by Otis Brothers and Company, made available a car speed of 600 feet per minute, and furnished a tremendous impetus to the erection of higher buildings than had theretofore been commercially practicable. For many years geared hydraulic elevators continued adequate in speed, capacity and rise but much still remained to be accomplished to reduce space requirements and cost of installation and operation, and to increase safety and ease of operation…"

RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators*

Left: caption: "Vertical Geared Hydraulic Elevator"

In the early 1870s, hydraulic elevators; which relied on water pressure rather than steam, were introduced. They were more economical to install, safe and inexpensive to run since they could be hooked-up to municipal water mains instead of steam plants. The car was connected to the top of a piston, which moved up and down in a cylinder. A hydraulic valve controlled movement. *Otis Brothers* installed the company's first hydraulic elevator in 1878 at 155 Broadway in NYC. The unit was capable of reaching a height of 111-feet and operated from 59 to 78 fpm.



Nowadays, *Hydraulic Elevators* are used extensively in buildings up to five or six stories high. These elevators - which can operate at speeds up to 150 fpm - do not use the large overhead hoisting machinery the way geared and gearless systems do. Instead, a typical hydraulic elevator is powered by a piston that travels inside a cylinder. An electric motor pumps oil into the cylinder to move the piston. The piston smoothly lifts the elevator cab. Electrical valves control the release of the oil for a gentle descent.

<u>Left</u>: caption: "With holed hydraulic systems, the elevator car is mounted on a piston that travels inside a cylinder. The cylinder extends into the ground to a depth equal to the height the elevator will rise. As hydraulic fluid is pumped into the cylinder through a valve, the car rises. As the fluid returns to the reservoir, the car descends."

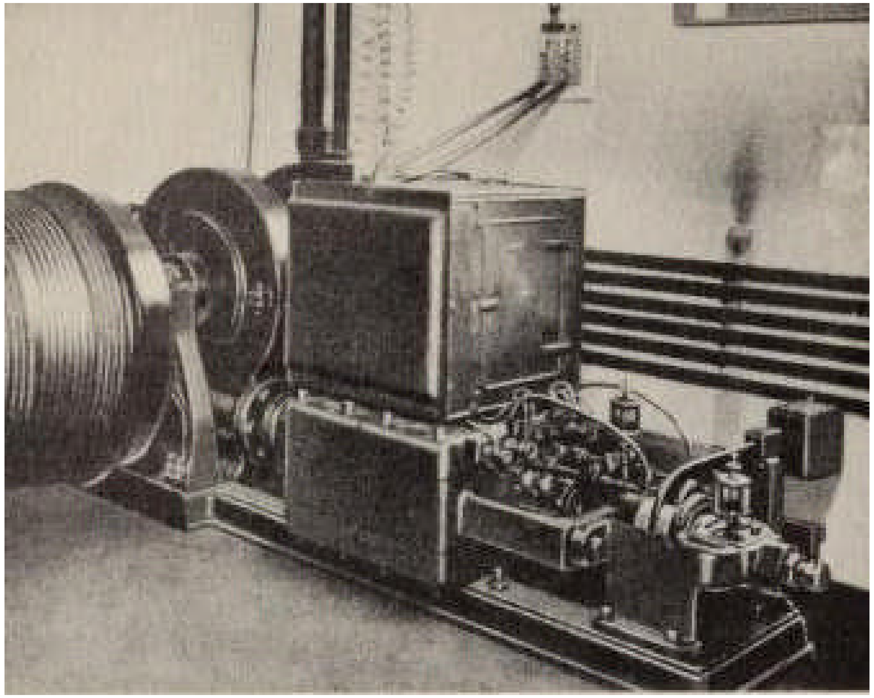
"…In 1878 a speed governor, invented by Charles R. Otis, contributed immensely to the safety of elevators by providing a practical and reliable device for stopping the elevator safely in the event of excessive downward speed from any cause. Prior to that time, elevator safety devices had been operative only in the event of broken hoist ropes. The speed governors used today employ the same basic principle embodied in the governor invented by Charles R. Otis more than sixty years ago…"

RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators*

"…The first two successful electric elevators were installed in 1889 by Otis Brothers and Company in the Demarest Building, 33rd Street and Fifth Avenue, New York City, where they continued in service until the building was torn down thirty years later. These elevators were operated by worm-geared drum machines with direct-current motors, and were similar to those used for limited rise and for speeds up to 400 feet per minute for the next twenty years. With this type of elevator, the height of travel was limited by the width and size of the drum, and the speed by the limitation of the worm gearing. Hydraulic elevators therefore continued to be used for a number of years for high-speed, high-rise installat-ions…"

RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators*

RE: in 1889, *Otis Brothers* installed the first electric elevator machine in the *Demarest Building* at 335 Fifth Avenue in NYC. Two machines were installed: one passenger elevator (with a capacity of 1,500 pounds that traveled at a speed of 100 fpm) and one freight elevator (with a capacity of 2,500 pounds that also traveled at a speed of 100 fpm). The total rise (distance) the elevators traveled was 69-feet.

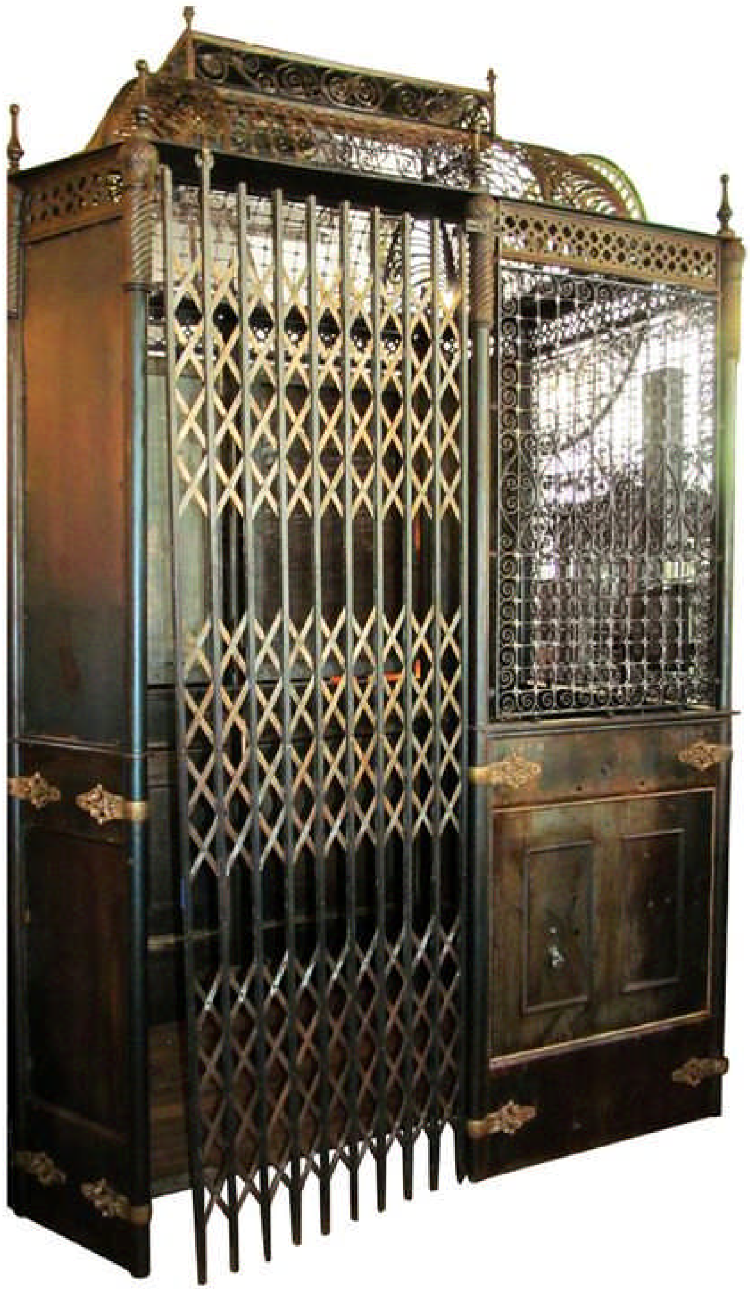


"From Eickemeyer's point of view an elevator was simply a vertical streetcar, starting and stopping at floors rather than at trolley stops."

***Ronald R. Kline*, Author**

RE: *Rudolf Eickemeyer* contributed greatly to the development of the electric elevator. When the *Otis Brothers* installed an elevator in the *Demarest Building* in NYC, it was powered by two Eickemeyer motors, comprising the first electric elevator and the second direct-connected electric elevator in the U.S. (the first direct-connected electric elevator had been installed in Baltimore in 1887)

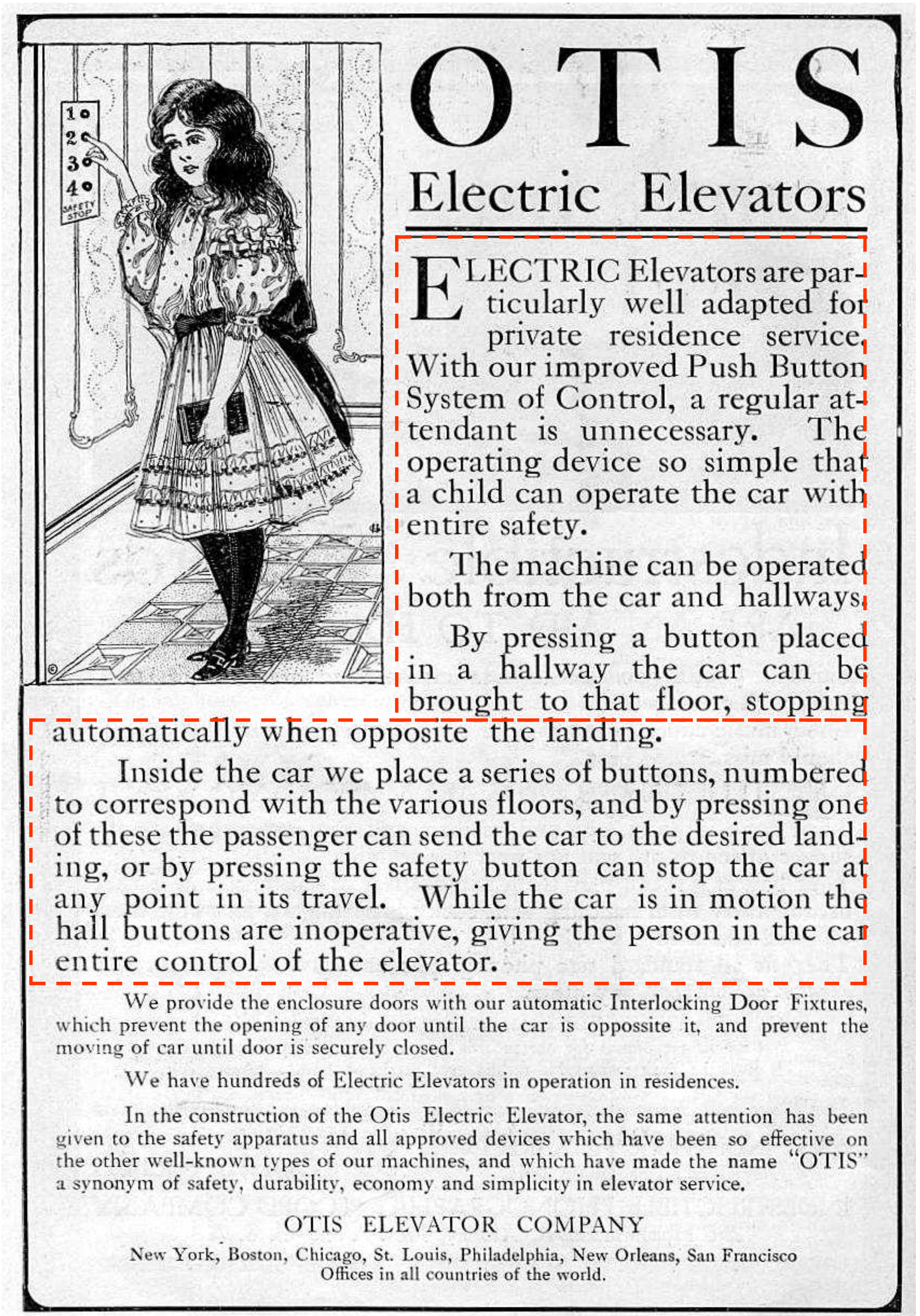
<u>Above</u>: caption: "First Electric Elevator Machine"



"…1892 witnessed the first automatic or push-button controlled elevator - limited at that time to slow-speed elevators of the type installed in residences and small apartment houses…"

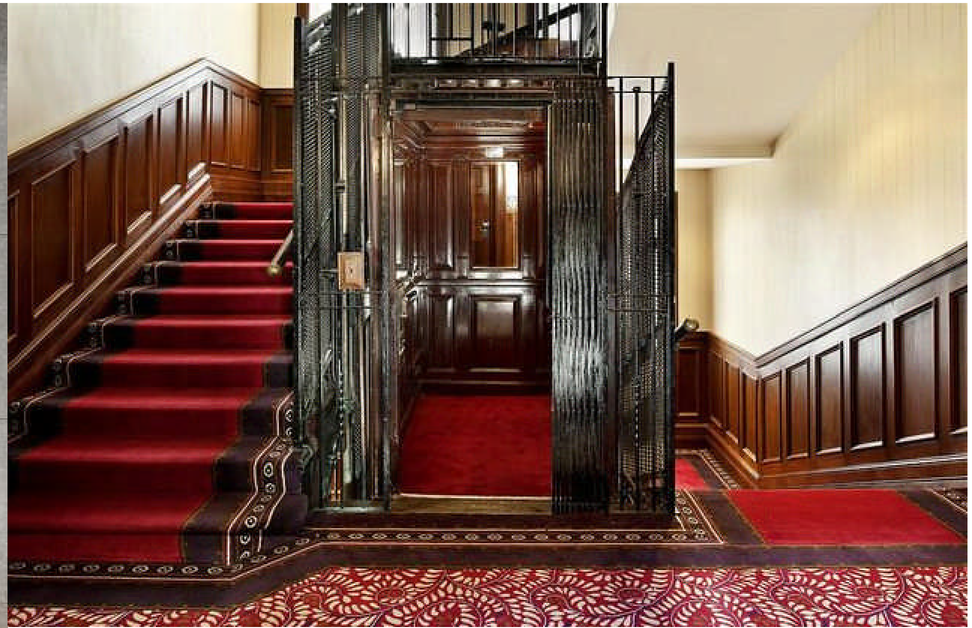
RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators*

Left: caption: "Otis 'Birdcage' Elevator with Finials and Scissor Doors (ca. 1890s)" The first "Safety Elevators" were freight elevators, with open platforms that made it easy to get the materials on and off. However, as elevators began to be used for passengers, the cabs had to be somewhat enclosed for safety. The marriage of enclosure and Victorian taste produced the style known as the "Birdcage" cab.



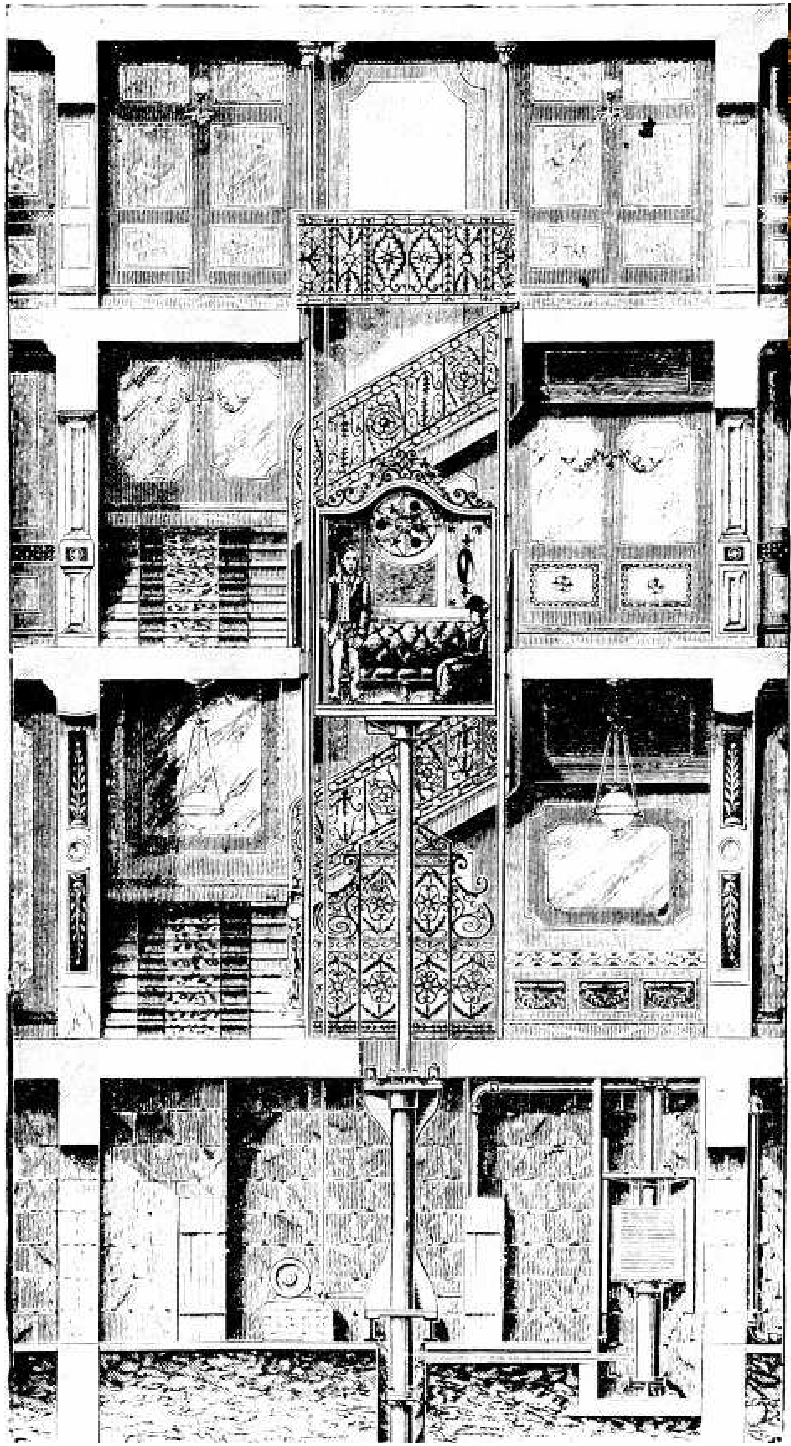
Left: caption: "Electric Elevators are particularly well adapted for private residence service. With our improved Push Button System of Command, a regular attendant is unnecessary. The operating device so simple a child can operate the car with entire safety. The machine can be operated both from the car and hallways. By pressing a button placed in a hallway the car can be brought to that floor, stopping automatically when opposite the landing. Inside the car we place a series of buttons, numbered to correspond with the various floors, and by pressing one of these the passenger can send the car to the desired landing, or by pressing the safety button can stop the car at any point in its travel. While the car is in motion the hall buttons are inoperative, giving the person in the car entire control of the elevator."

RE: OEC. ad (ca. 1908)



Though a rudimentary elevator helped transport *Louis XV* of France's mistress into his boudoir, Otis was the first elevator company to transport royal families vertically in several countries. Otis elevators arrived at *Nicolavaski Palace* (at *The* Kremlin, Moscow) in the 1890s; the *Royal Castle* (in Budapest, Hungary) in 1900; *Buckingham Palace* (in England) in 1901 and the *Maharaja of Mysore's Palace* (in India) in 1904.

<u>Above</u>: caption: "The Astor Hotel, Tianjin"
<u>Left</u>: caption: "Otis Elevator with Etched Glass Doors, Biltmore Hotel"



"…In 1898 the Otis Elevator Company was incorporated, and in that year contributed materially to the development of high-speed, high-rise direct-plunger elevators which offered high speed and smooth operation but were necessarily expensive to install because of the fact that the cylinder had to be sunk in the ground a distance slightly in excess of the travel of the elevator. A large number of elevators of this type were installed throughout the country - some of which served buildings thirty stories high…"

RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators*

Left: caption: "English direct plunger hydraulic elevator (ca.1895)"


Otis
Elevators
Hydraulic
Electric
Steam or
Belted
Passenger
or Freight
for every
Service
Every
Method
of
Control
The name OTIS in connection with an
elevator is a guarantee of excellence
Otis Elevator Company
New York Office
17 Battery Place
Branch Offices throughout
the country
Lillibridge, N. Y.-1300.

Look, Moving Stairs!

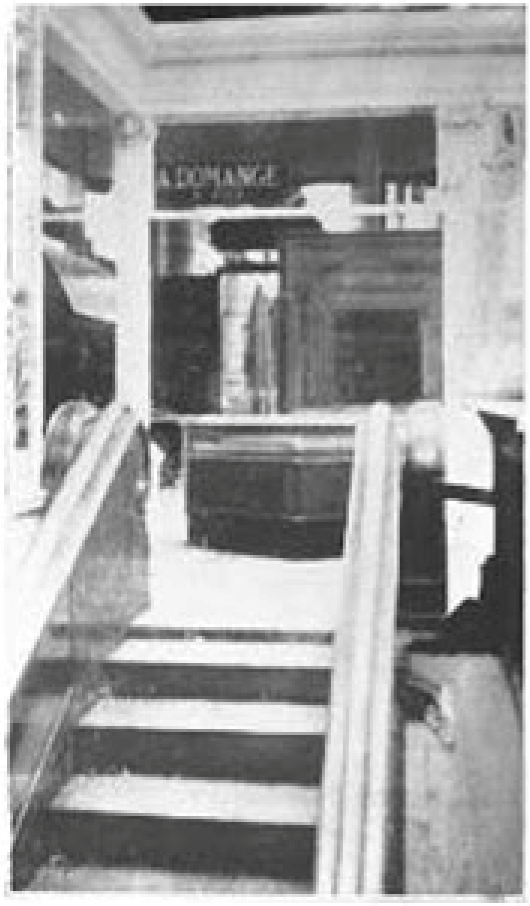
"…In 1900 a new and unique type of vertical transportation was made available by the Otis Elevator Company in the form of the first Escalator. It was of the flat-step type and, after being exhibited at the Paris Exposition, was installed in a department store in Philadelphia where it is still in operation…"

RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators*

<u>Left</u>: caption: "First Escalator – Paris World's Fair, 1900"

"…The Otis Escalator - an ingenious device, is a moving stairway which is well adapted to all kinds of service where great numbers of people are to be elevated from one level to another within a limited time. It has been demonstrated that one of these Escalators in actual use can readily lift from seven to ten thousand people per hour. It is so constructed that the hand rail travels with the stairs, so that its action is as simple for the person using it as standing upon an ordinary stairway. The device is the result of many years' experiment, and may be seen in its perfected form in operation at the Paris Exposition."

RE: excerpt from *Otis Elevator Company* brochure (ca. 1900)



<u>Above</u>: three images of the "Escalator" at the 1900 *Paris Exposition*. The photo at left shows it under construction (most of the lower level portion was hidden under the flooring). The middle photo shows the installation completed and the photo at right shows the top landing. Otis' escalator made steps for the first time and was awarded the first-prize for its innovative design. After the exhibition closed, it was dismantled, shipped back to the U.S. and reinstalled at *Gimbel's Department Store* in Philadelphia in 1901. It remained in service there for almost forty years.

“When the directors of the Old Merchants National Bank and Trust Company, of Battle Creek, Michigan, first contemplated the erection of a new structure to house their banking operations they were confronted with this situation: The building site was located in the center of the business section, where the ground floor of a building affords highly desirable quarters for stores. If the banking equipment were installed on the ground floor, it would occupy space of high rental value. On the other hand, if the banking equipment were placed above the level of the street, bank patrons would be inconvenienced. The directors laid this problem before their architects, who, in turn, submitted it to Otis Elevator Company. As a solution, Otis proposed that the banking equipment be placed on the second floor and that escalators connect this floor with a wide and roomy passageway leading directly to the street. Thus could the convenience of bank patrons be quite satisfactorily fulfilled. Thus could the comfort of both patrons and employees because of better light and ventilation, more freedom from dirt and noise. Thus also could the street floor, with its windows of high visibility, be offered for rent to merchants. And the building would really get the benefit of two ground floors. Into the unusual and complicated traffic problems of many concerns have Otis engineers delved. The one related above is a typical example. The solution to this one has become quite popular and other banking concerns are now planning to make use of it. from these analyses of building transportation problems, Otis has gathered a great deal of first-hand knowledge. The benefit of this experience is available to any concern desiring it. A complete study of traffic conditions will be made and a comprehensive report submitted. There is no cost or obligation. All you need do is ask for a traffic analysis at the Otis office. Otis Elevator Company…offices in all principal cities.”

RE: excerpt from a ca. 1920s *Otis Elevator Company* ad entitled: “How a Modern Building Got Two Main Floors”


OTIS

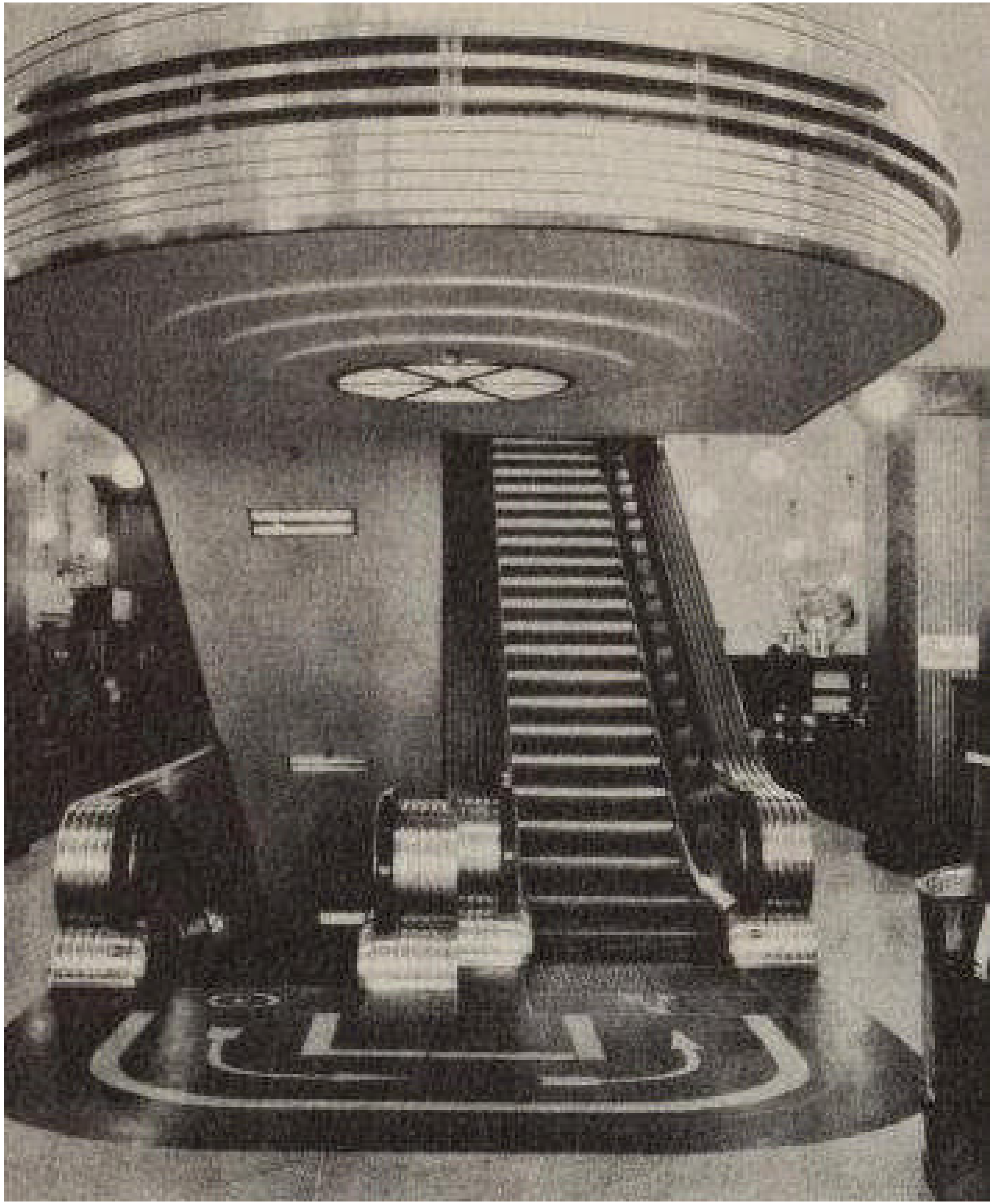
Coming of Age

"Paris, 1900…'Look, moving stairs!' At that time, the Escalator or 'moving stairs' was quite an innovation. It had just been introduced by Otis Elevator Company and was making its debut at the Paris Exposition. Way back, since some early form of man had hacked his footing up a cliff, steps had served as a means of getting upward. Never before had a staircase supplied the locomotion to carry someone upward. In the 36 years since the Paris Exposition, The Escalator has traveled a long way. Its value was first recognized as a traffic-distributing medium in department stores where it has carried literally millions of shoppers. More recently its service has been enlisted at a wide variety of strategic traffic points: Street to second-floor bank; subway to street; first-floor to basement or cafeteria in various types of structures; in theaters, railway stations and public buildings. In these 36 years, the Escalator has also come a long way in design and construction. Following its progress, you can almost measure the progress of a concern that gas devoted its undivided attention toward perfecting vertical transportation facilities. You will find Escalators giving good service today that have been running for many years, showing honest engineering and construction. And you will observe in today's Escalator installations, gracefully flowing lines and an intelligent use of modern alloys and metals, indicating a spirit of progress in design, as well as in workmanship and engineering knowledge."

RE: excerpt from a 1936 Otis ad

Above: caption: "Interior and exterior balustrading of The Emporium Escalators is of a sand-blasted glass, coral tinted in some places. It is illuminated from within, and nickel-bronze metal is used for accent." (from a 1936 Otis ad)

Left: caption: "Otis Escalator installation in the International Building, Rockefeller Center, New York City" (from a 1936 Otis ad)



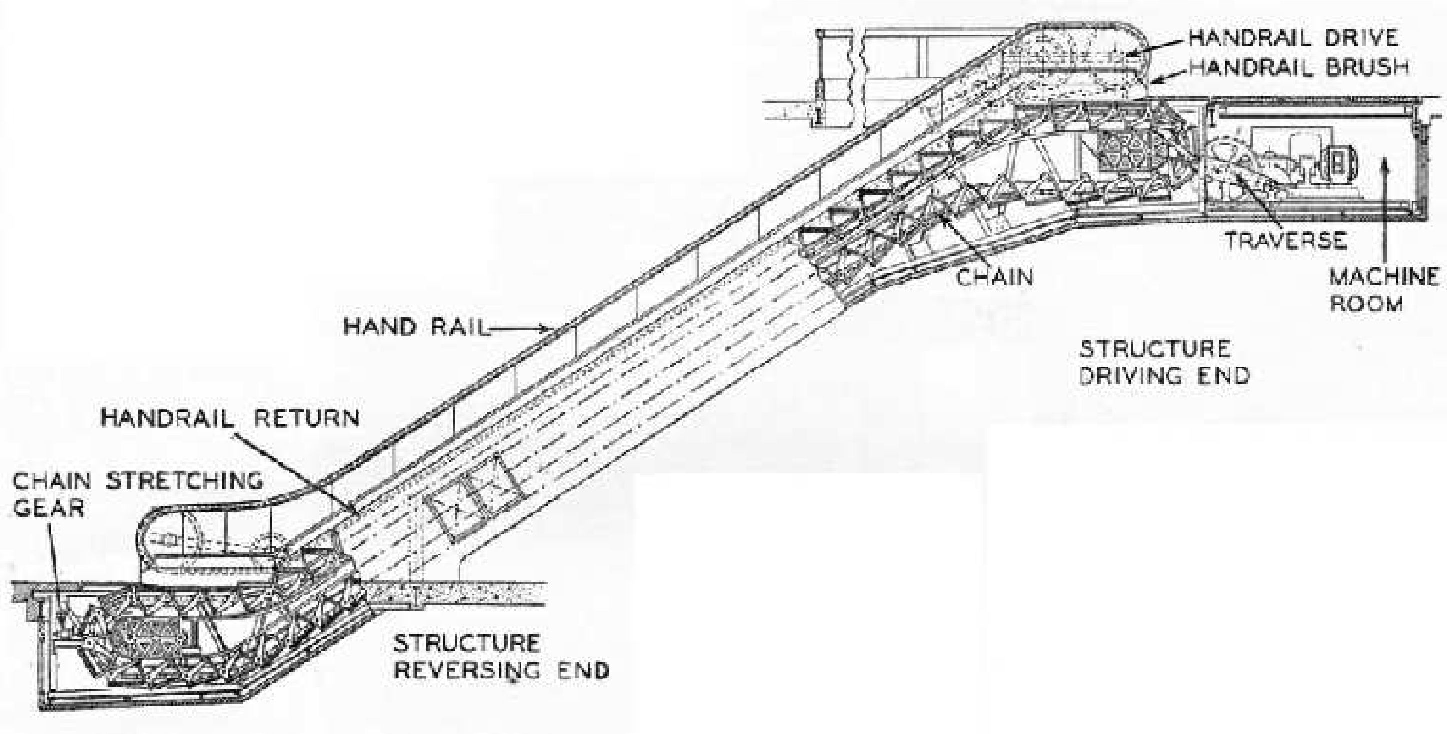
"…The utility of Escalators in transporting large crowds led to the installation of hundreds of Otis Escalators throughout the world in department stores, subways, elevated railway and railroad stations. Continued improvement in design and appearance has greatly widened the field of application, and today the Otis Escalator with its paneled or streamlined nickel-silver balustrading and stainless-steel risers is widely used in the highest class department and specialty stores as well as in banks, restaurants, showrooms, and office buildings…"

RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators*

Left: caption: "Escalator with Nickel-Silver Balustrading"

<u>Left</u>: caption: "Few years ago, the Escalator polished up its manners (less noise – smoother action), put on a new dress of gleaming metal in the latest streamline fashion, and went out in quest of new jobs. It found those jobs where Escalators had never been before. People whom these Escalators served quickly realized here was something that made their comings and goings easier. Sensing that the Escalator could be installed in many places where stair climbing was a daily burden, they began to demand Escalator installations. The press, mirror of public interests, has recently printed the news about installations in progress and installations that are contemplated. The Otis Escalator, today, has an enthusiastic following. Still numerous, however, are the places where an Escalator can be installed for the common good. In some of these, it will solve traffic congestion problems. In others, it will coax traffic flow off the beaten path and be a boon to some one's business. In still others, it will enroll enough public good-will to pay its own way." (1937 Otis ad)

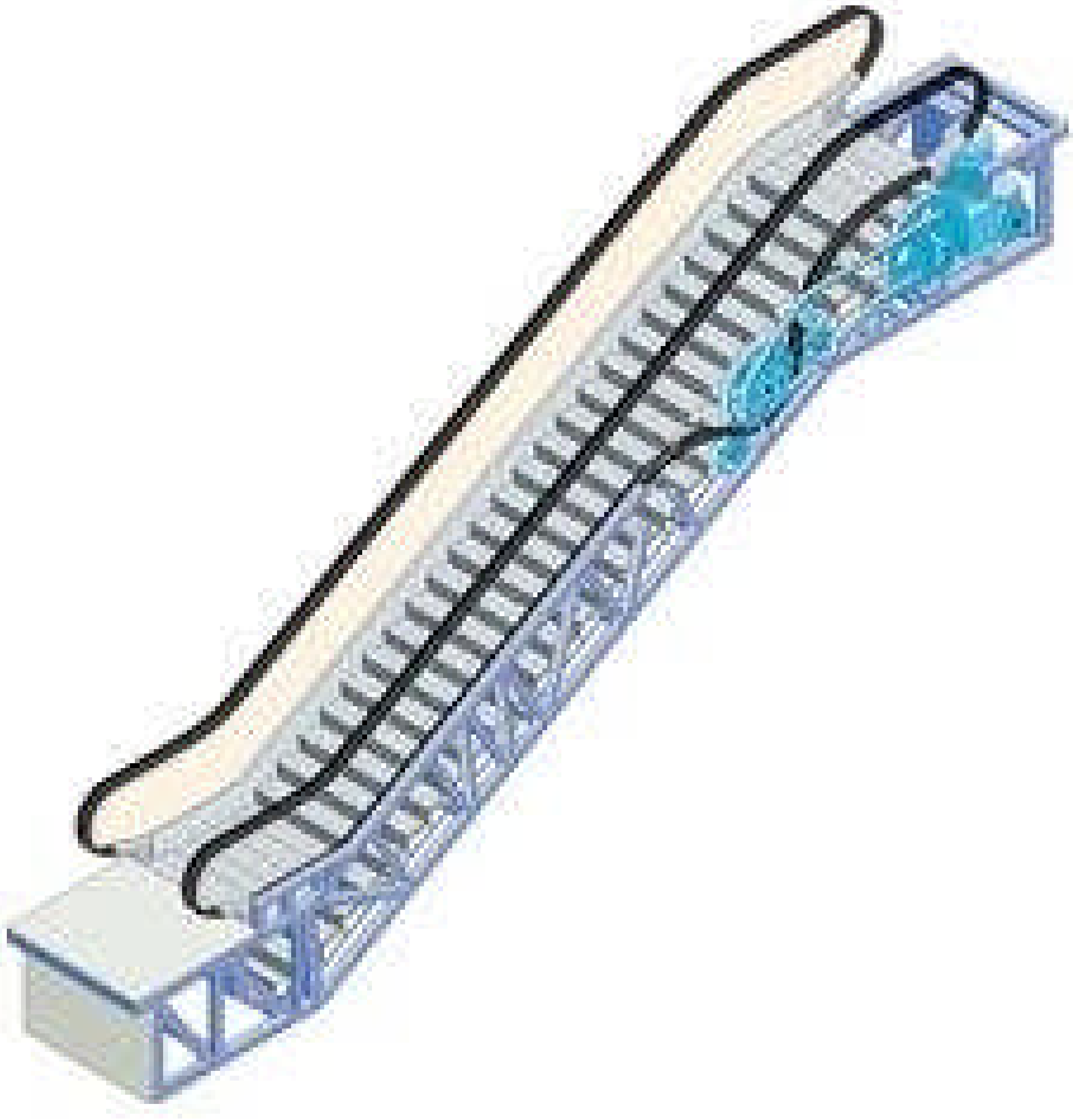
<u>Photo</u>: caption: "One of the modern Otis Escalators recently installed in Stern Brothers, New York City"



"An escalator can never break, it can only become stairs. There would never be an 'Escalator temporarily out of order' sign, only an 'Escalator temporarily stairs. Sorry for the convenience.'"

***Mitch Hedberg,* Comedian**

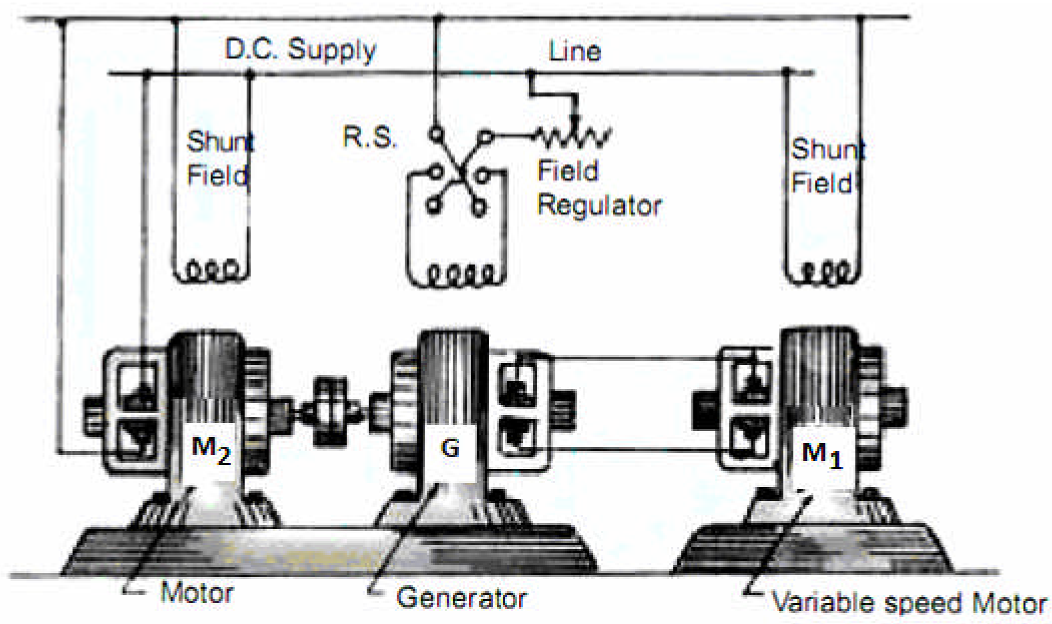
<u>Above</u>: caption: "Sectional View of an Escalator, showing the way in which the treads are arranged as a continuous chain, the formation of which is changed by the guide rails running beneath the stairway. The driving apparatus is housed in a machine room below the floor near the top of the escalator."




OTIS
ESCALATOR

"…The Otis Elevator Company was the first to employ the Ward Leonard principle of control in connection with elevators, and in 1895 installed the first elevators using this type of operation. This same principle, now known as Unit Multi Voltage, still furnishes the smoothest type of control so far obtainable…"

RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators*



WARD LEONARD SYSTEM OF SPEED CONTROL

<u>Above</u>: caption: "The speed of motor M1 is to be controlled which is powered by the generator G. The shunt field of the motor M1 is connected across the DC supply lines. Now, generator G is driven by the motor M2. The speed of the motor M2 is constant. When the output voltage of the generator is fed to the motor M1 then the motor starts to rotate. When the output voltage of the generator varies then the speed of the motor also varies. Now controlling the output voltage of the generator the speed of motor can also be controlled. For this purpose of controlling the output voltage, a field regulator is connected across the generator with the DC supply lines to control the field excitation. The direction of rotation of the motor M1 can be reversed by excitation current of the generator and it can be done with the help of the reversing switch R.S. But the motor-generator set must run in the same direction. This Ward Leonard method of speed control system is used where a very wide and very sensitive speed control is of a DC motor in both the direction of rotation is required. This speed control system is mainly used in colliery winders, cranes, electric excavators, mine hoists, elevators, steel rolling mills and paper machines etc."

The Breakthrough

"…One of the most important contributions to the elevator art was the development by the Otis Elevator Company in 1902 of the gearless traction electric machine - the first commercial installation of which was in the Majestic Theatre Building in Chicago, and is still operating satisfactorily. As the name indicates, this machine has no gears and the driving sheave is mounted directly on the armature shaft. A gearless traction machine can be used for any rise and, depending on size, is capable of any desirable speed. With the advent of the gearless machine, the limitations of available methods of control furnished the principal limitation on practical elevator speed as it was found that even skilled operators could not secure accurate landings with variable loads with a speed in excess of 600 feet per minute…"

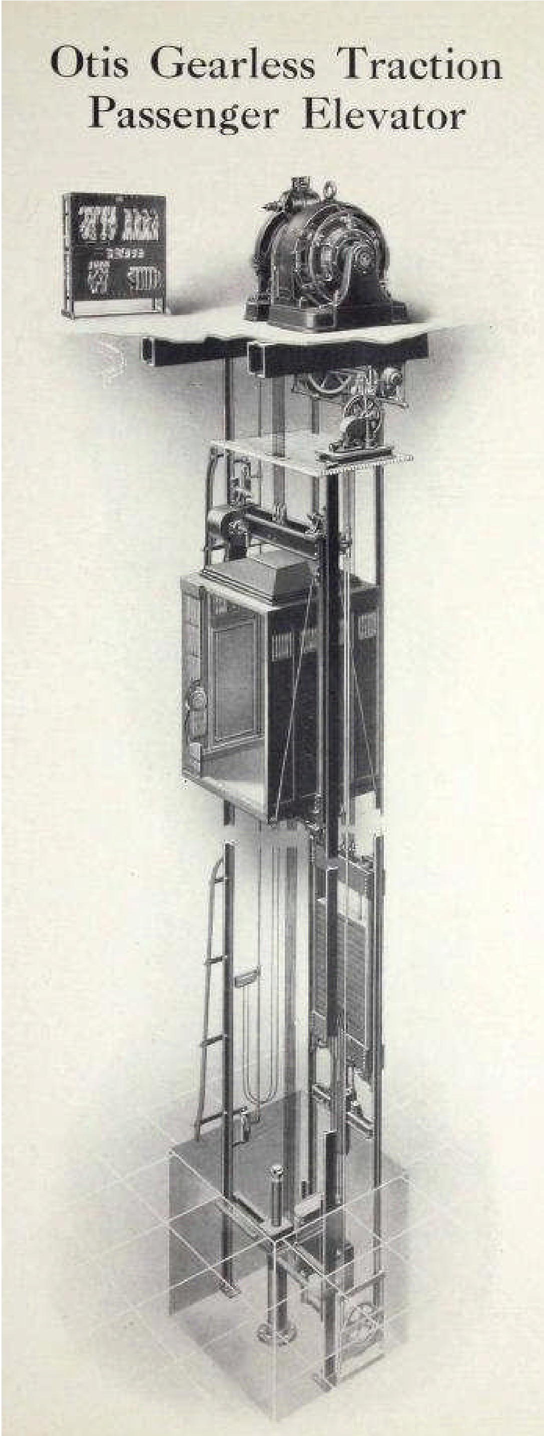
RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators*

<u>Left</u>: caption: "Majestic Building and Theatre, Chicago"

Skyscrapers never would have been possible without the *Gearless Electric Traction Elevator* (which overcame the 300-foot limit of its predecessors; hydraulic piston and/or winding drum-type elevators). Its simple design resembles a pulley lowering a bucket into a well. The machine used a counterweight, an electric controller and a grooved sheave over which the elevator's ropes looped. One end of the rope attached to the elevator cab and the other to the counterweight. The same basic design is used today. In 1903, Otis introduced the design that would become the standard in the elevator industry. The Gearless Electric Traction Elevator could be employed in buildings of any height and operated at much higher speeds than steam-powered elevators. This design has proven so durable that even today, when a building is modernized (while the elevator control system is replaced with the most up-to-date electronics), it is rarely necessary to replace a well maintained gearless machine. These elevators typically operate at speeds greater than 500 fpm.

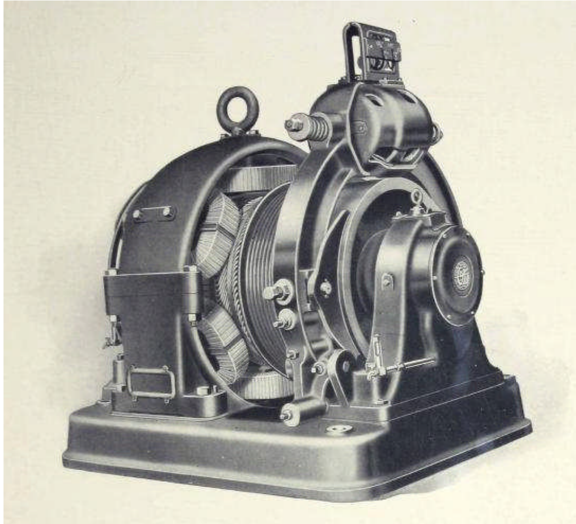
Otis delivered the first Gearless Electric Traction Elevator/s in 1903 to NYC's *Beaver Building* and Chicago's *Majestic Building*. The Beaver Building machines used a complicated roping arrangement that was never used again. The Majestic Building machines used just one set of ropes. However, Otis can't take total credit for the Gearless Traction Elevator. A German engineer worked on the concept as early as 1877 and an Austrian named *Anton Freissler* experimented with the concept in the late 1890s (Otis later merged with Austria's *Freissler Company*, becoming first "Freissler-Otis" and, later, "Otis-Austria"). It would be Otis that brought this revolutionary elevator machinery into widespread use.

<u>Left</u>: caption: "Beaver Building, Wall, Beaver and Pearl Streets"



"…The Otis Gearless Traction Machine consists of traction driving sheave, extremely slow speed motor, and electric brake. In order to maintain proper alignment, all parts are mounted on a heavy continuous cast iron bed plate, provided with stiffening ribs. Direct drive is obtained from the armature of the main motor through a traction driving sheave, eliminating all intermediate gear reduction between the motor and the car. The traction driving sheave of large diameter is made of the best grade of semi-steel, is accurately turned, and provided with grooves of special design to maintain continually con-stant traction and with minimum wear on the hoisting ropes. The sheave is mounted directly on, and securely bolted to, the armature spider, which is integral with the armature shaft. The characteristics of the machine, in conjunction with the system of drive, produce except-ionally high efficiency, absence of vibration, minimum wear, and economy of operation. An inherent safety feature of the traction drive is the reduction of the tractive effort upon the bottoming of the car or counterweight, which eliminates the possibility of either of these being drawn into the overhead work…"

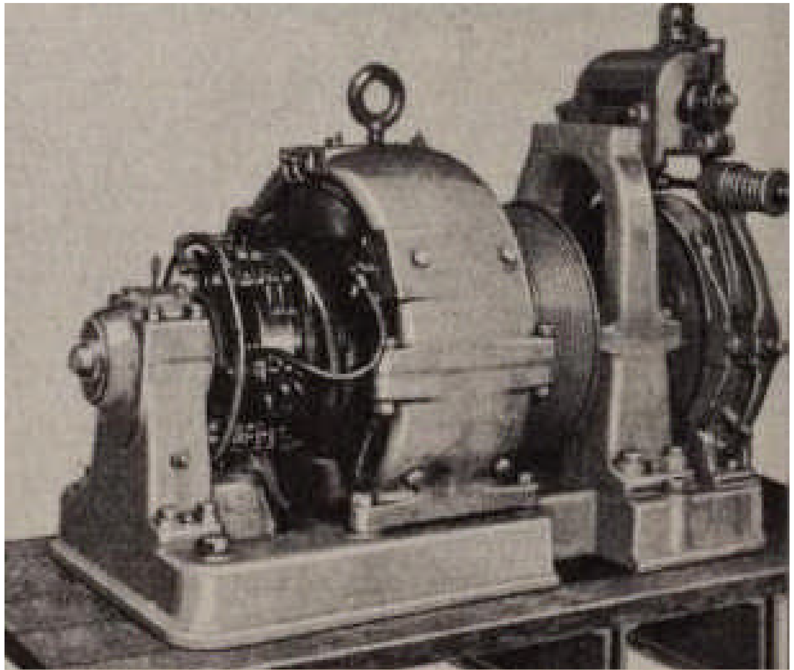
RE: excerpt from *Otis Elevator Company: The World's Word for Elevator Safety* (ca. 1922)

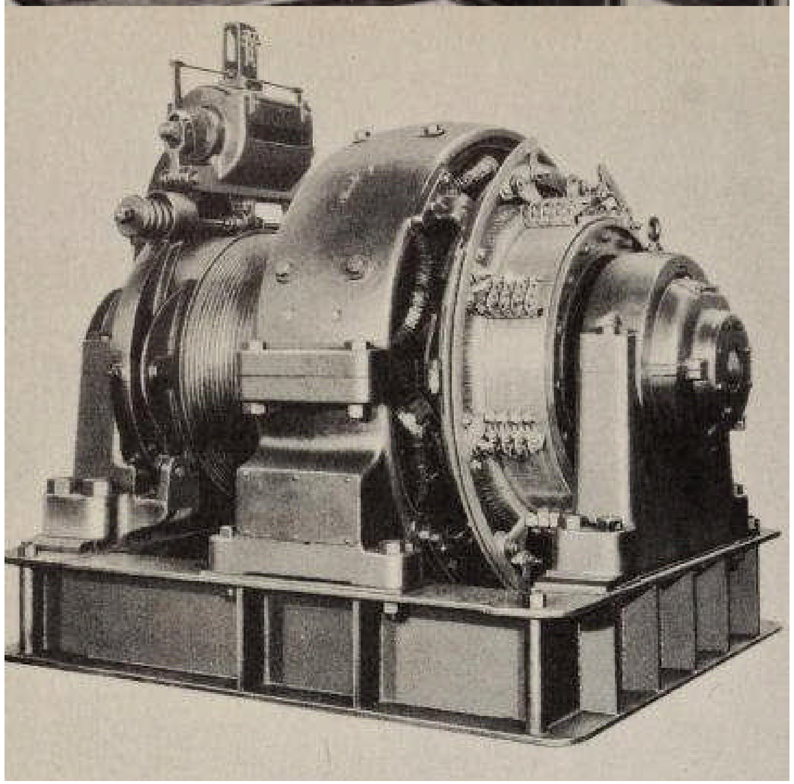


"…All bearings are amply proportioned, provided with large bearing surfaces, and equipped with suitable means for proper lubrication. The bearings are of the self-aligning type, with babbitted linings, provided with dust covers and with chains for automatic lubrication. A spring-actuated, electrically released brake of a powerful type is provided to hold the car securely with maximum load. The brake wheel is mounted on, and bolted directly to, the armature spider. Swivel brake shoes are applied to the brake wheel simultaneously, and with equal pressure, by means of a pair of powerful helical springs. The brake magnet is designed for quick release, and is arranged with adjustable, automatically controlled, magnetic retardation, for the purpose of obtaining smooth and gradual application of the brake shoes. All exposed cast surfaces are filled and rubbed down, and have uniform semi-gloss rubber finish. The entire equipment is finished in a neat and distinctive manner…"

RE: excerpt from *Otis Elevator Company: The World's Word for Elevator Safety* (ca. 1922)

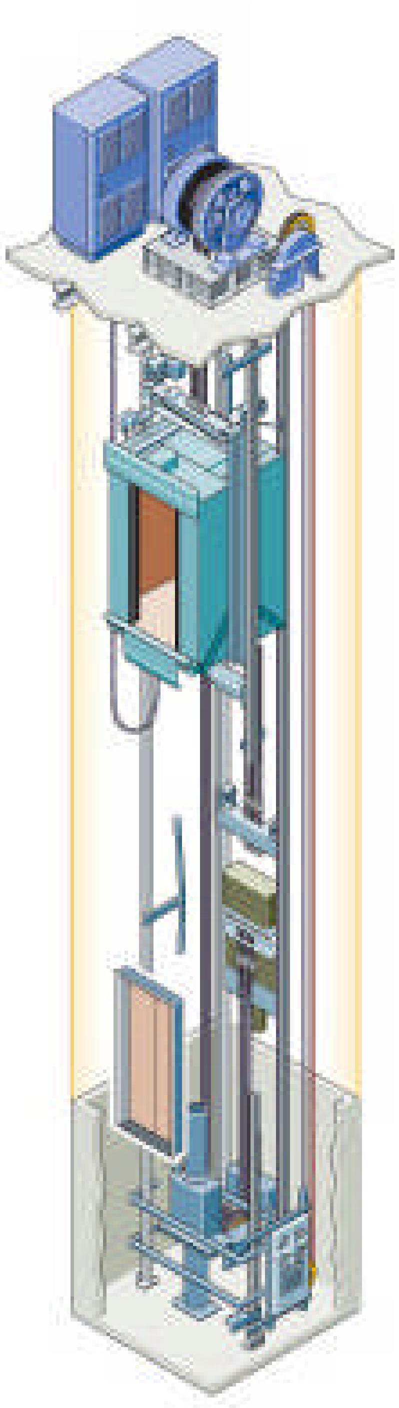
Above: caption: "Otis Gearless Traction Machine"



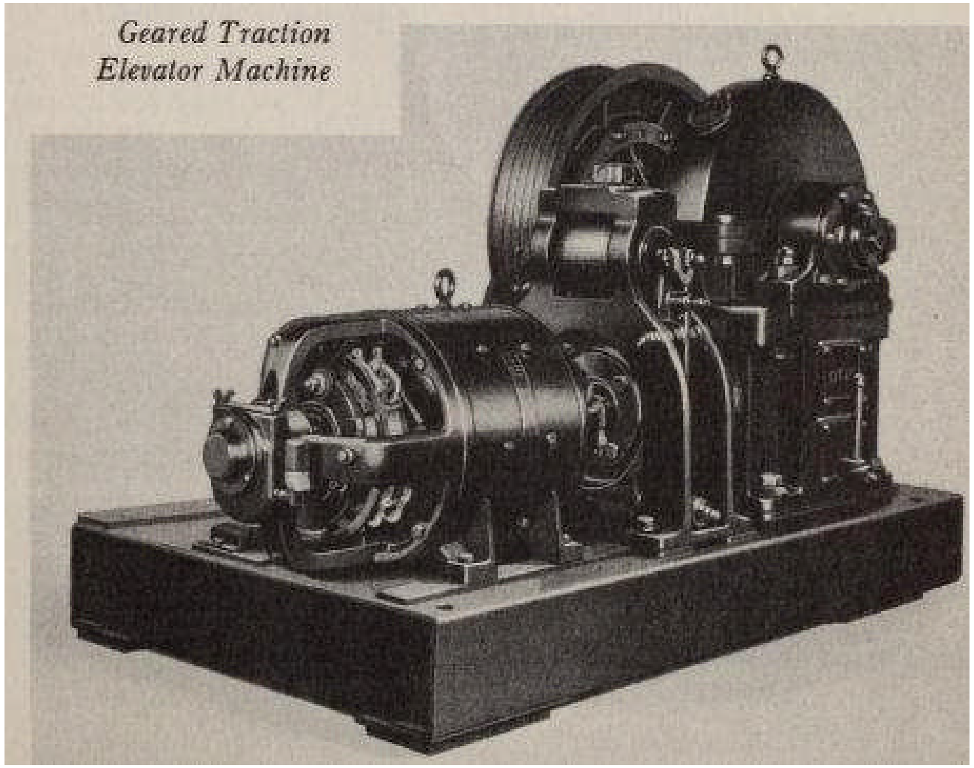


<u>Top</u>: caption: "First Gearless Electric Machine"

<u>Bottom</u>: caption: "Gearless Traction Electric Elevator Machine." The gearless electric traction elevator uses a slow-speed motor directly connected to the driving sheave, thus eliminating the need for motor speed reduction gearing. The result was a machine of great simplicity. The relatively few parts and the compactness of the gearless elevator make it the ideal drive for high-speed service. Smooth, steady motion of the car is assured under all conditions. It is primarily used for the high-speed service required in tall buildings.



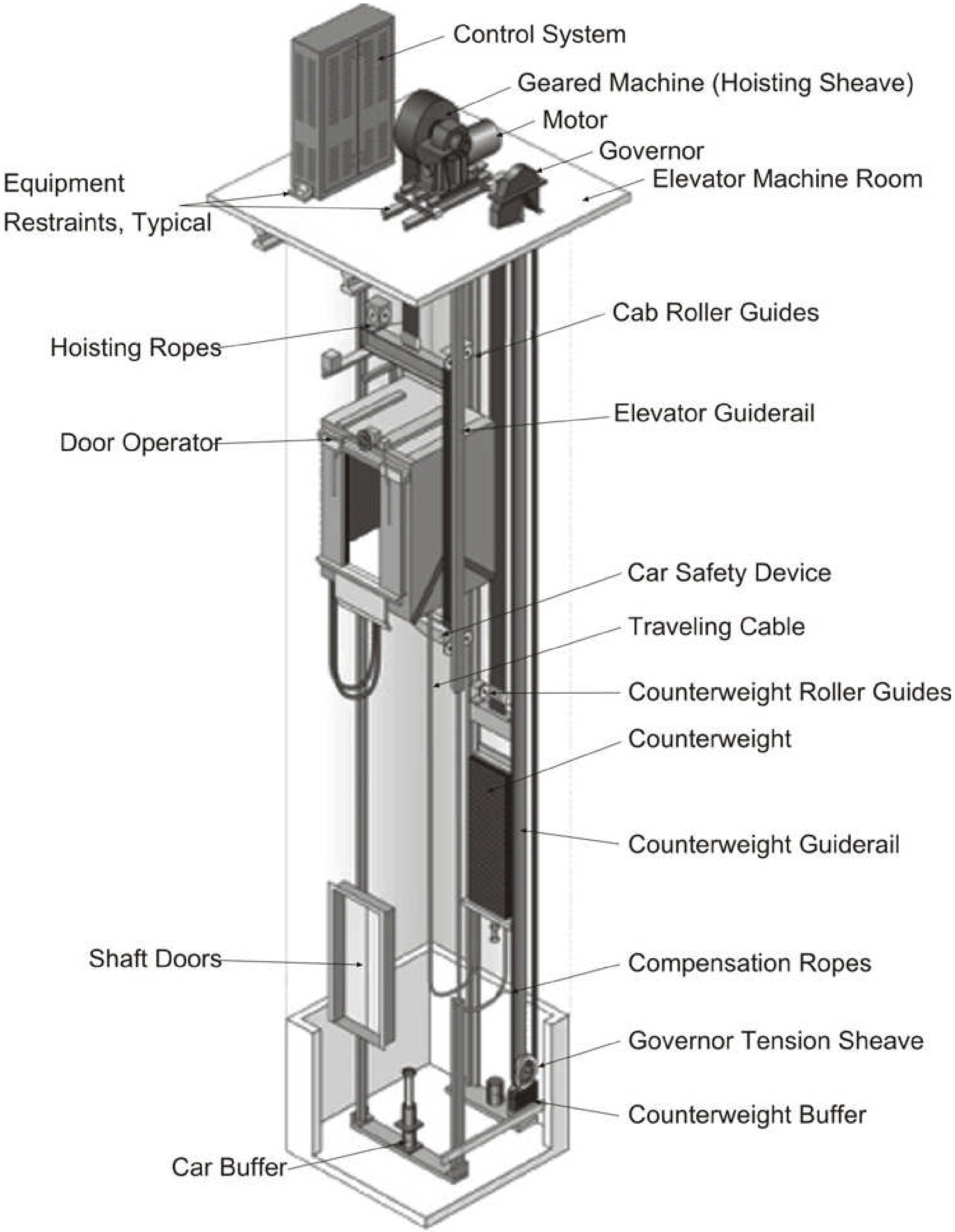
In a gearless traction machine (left), six to eight lengths of wire cable (known as “hoisting ropes”), are attached to the top of the elevator and wrapped around the drive sheave in special grooves. The other end/s of the cables are attached to a counterweight that moves up and down in the hoistway on its own guiderails. The combined weight of the elevator car and the counterweight presses the cables into the grooves on the drive sheave, providing the necessary traction as the sheave turns. To reduce the load on the motor, the counter-weight is calculated to match the weight of the car and a half-load of passengers. As the car rises, the counterweight descends, balancing the load. This reduces energy consumption because the motor is required to lift no more than the weight of half a car load at any time The grooved sheave in this traditional gearless system is quite large, from 2 to 4-feet in diameter. The electric motor that runs it must be powerful enough to turn this large drive sheave at 50–200 rpm in order to move the elevator at the proper rate. Safety is provided by a governing device that engages the car’s brakes should the elevator begin to fall. A powerful clamp clutches the steel governor cable which activates two safety clamps located beneath the car. Moveable steel jaws wedge themselves against the guiderails until sufficient force is exerted to bring the car to a smooth stop.



"…In 1908 the Otis Elevator Company successfully applied to geared elevators the traction principle embodied in the gear-less traction elevator and, in so doing, added immeasurably to the utility and safety of geared elevators. In 1911 the traction principle was adapted to single wrap roping on geared elevators…"

RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators*

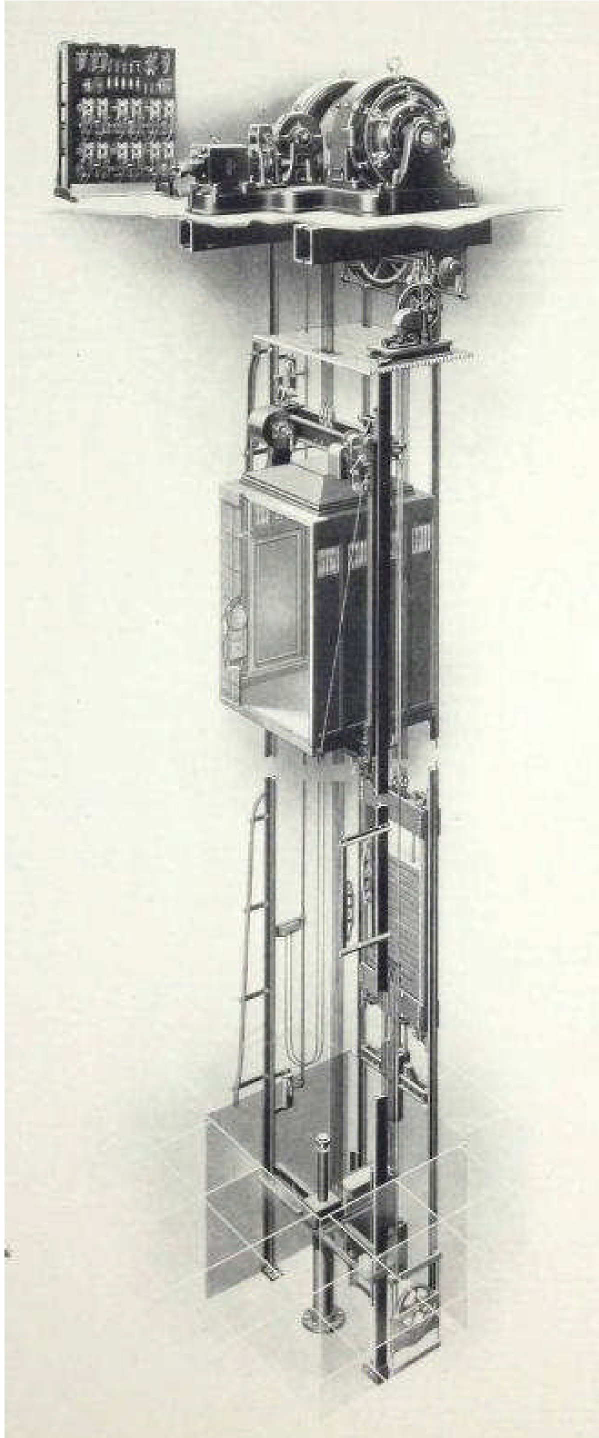
Above: caption: "Geared Traction Elevator Machine"



As the name implies, in a *Geared Traction Elevator* (left) the electric motor in this design drives a worm-and-gear type reduction unit, which turns the hoisting sheave. While the lift rates are slower than in a typical gearless elevator, the gear reduction offers the advantage of requiring a less powerful motor to turn the sheave. These elevators typically operate at speeds from 125 to 500 fpm and carry loads of up to 30K pounds. An electrically controlled brake between the motor and the reduction unit stops the elevator, holding the car at the desired floor level.

Two factors contributed to the demise of the elevator cab style known as the “Birdcage” (left). As the speed of elevators increased dramatically (with the introduction of the *Gear-less Electric Traction Elevator*), a fully enclosed cab became essential for passenger safety. At about the same time (ca. 1910), tastes began to change in decorative styles as well. Even so, the durability and beauty of Birdcages has led to their continued use in some historic structures (i.e. the *Biltmore Estate* in Asheville, North Carolina)

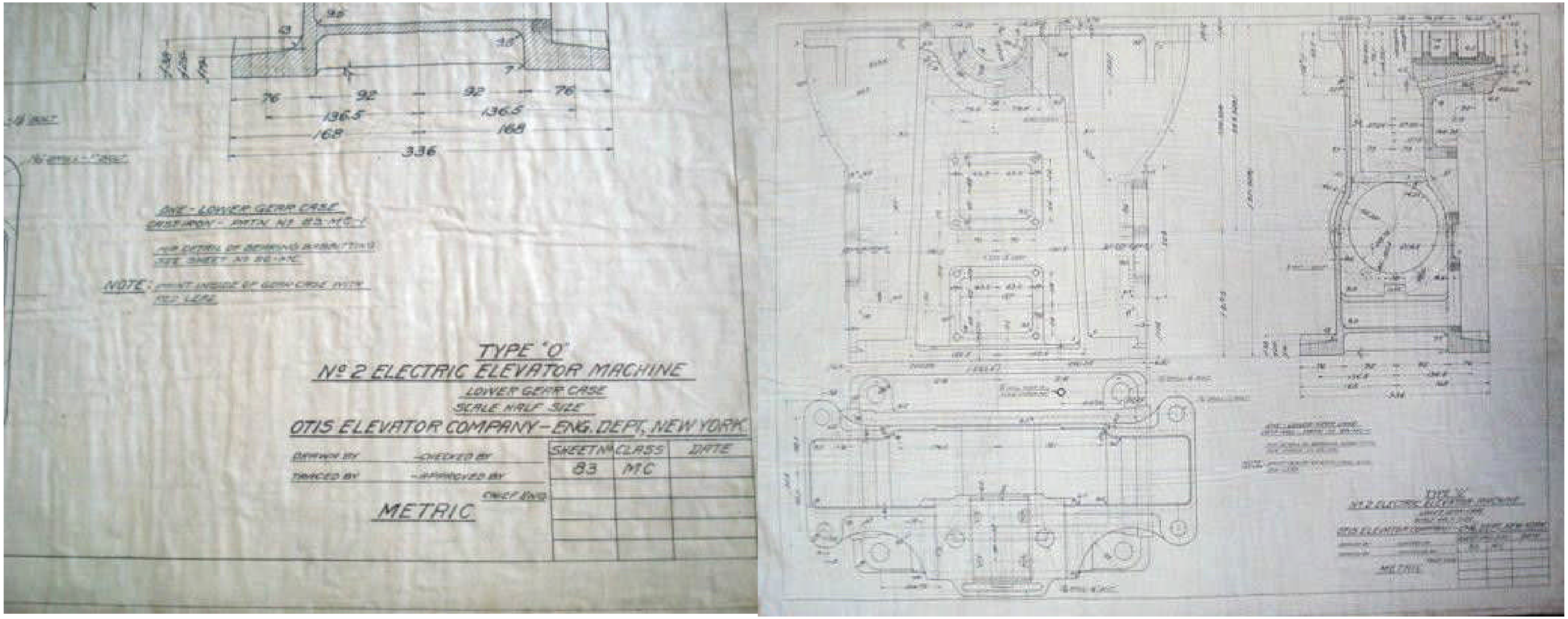
Micro-Drive



"…In 1915 the effective speed of elevators was still further increased through the invention and development by the Otis Elevator Company of Micro-Drive - an ingenious arrangement for automatically bringing the car platform level with the landing and maintaining this level regardless of stretch of cables or change in load. Self-leveling contributed materially to safety by reducing the stumbling hazard, and speeded up elevator service by facilitating a prompt and accurate landing…"

RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators*

Left: caption: "Otis Gearless Traction Micro-Drive Passenger Elevator (Multi-Voltage Control)"

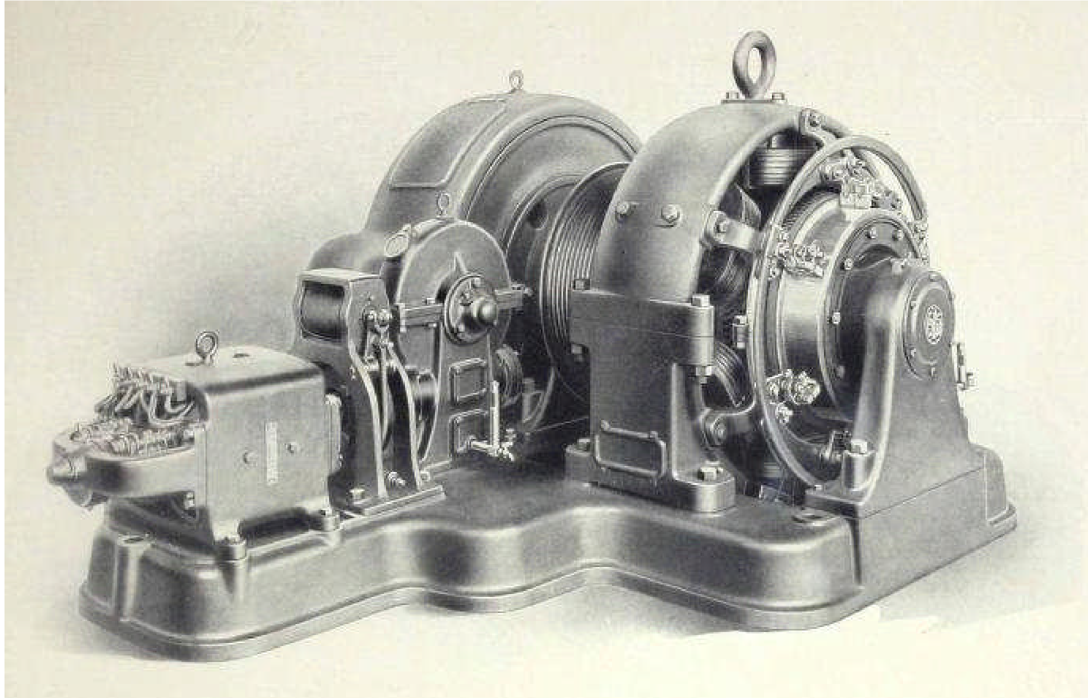


As passengers step on and off an elevator, the load constantly changes, making it difficult to keep the platform level with the floor. Otis solved this problem in 1915 with a self-leveling device called "Micro-drive." First developed for lifts in naval vessels, Otis introduced it as a safety device in passenger elevators. It also saved time and improved the ride quality for passengers as the leveling operation was automatic.

<u>Above L&R</u>: caption: "Lower Gear Case Details – 'O' Electric Machine" (ca. 1916)

"…The Otis Gearless Traction Micro-Drive Machine consists of traction driving sheave, extremely slow speed main motor, self-leveling Micro-Drive motor, main and leveling electric brakes and auxiliary worm and gear for leveling operation. In order to maintain proper alignment, all parts are mounted on a heavy continuous cast iron bed plate, provided with stiffening ribs. Direct drive is obtained from the armature of the main motor through a traction driving sheave, eliminating all intermediate gear reduction between the motor and the car. The traction driving sheave of large diameter, is made of the best grade of semi-steel, is accurately turned and provided with grooves of special design to continually maintain constant traction and with minimum wear on the hoisting ropes. The sheave is mounted directly on, and securely bolted to, the armature spider which is integral with the armature shaft…"

RE: excerpt from *Otis Elevator Company: The World's Word for Elevator Safety* (ca. 1922)



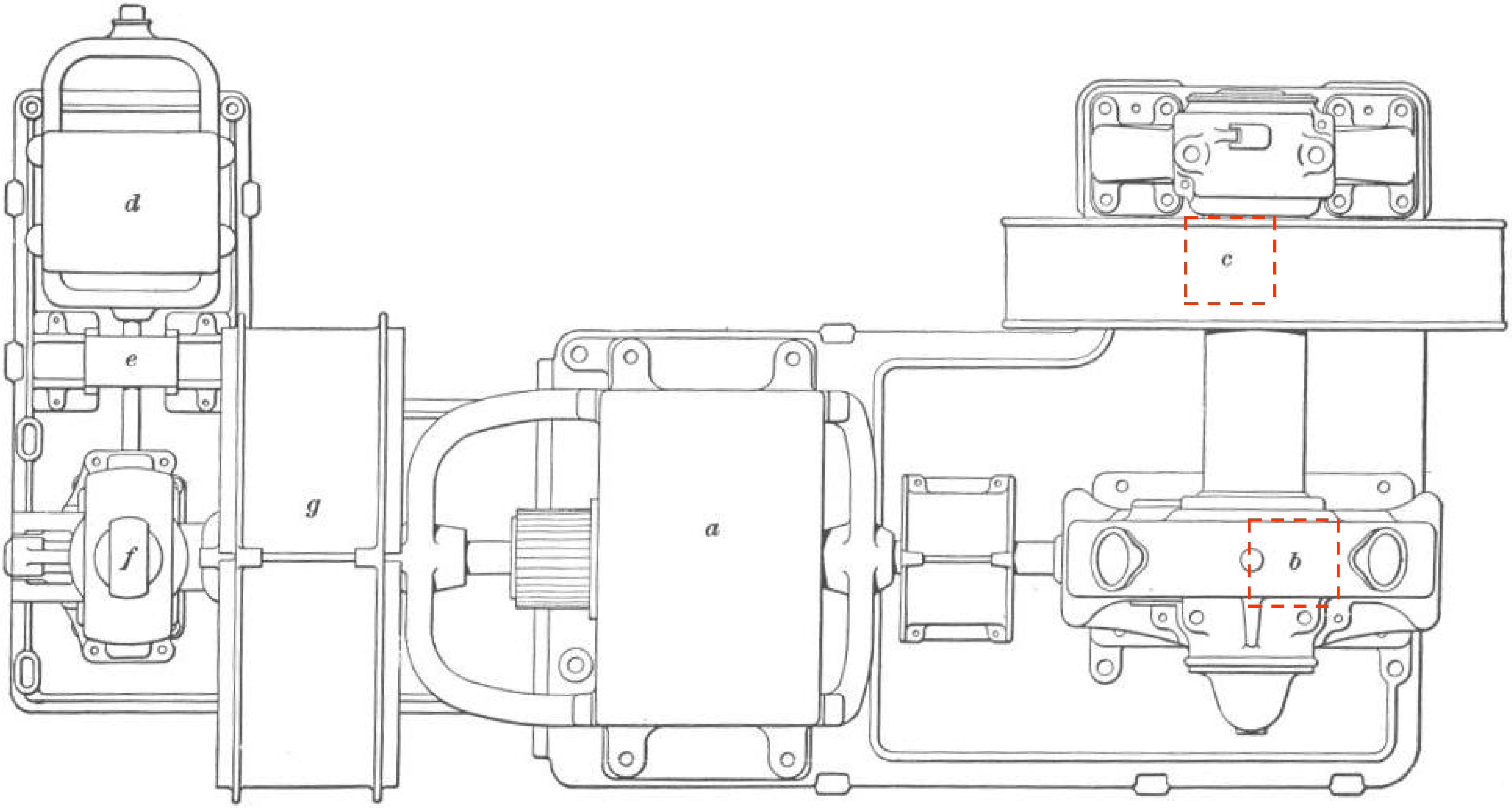
"…The characteristics of the machine, in conjunction with the system of drive, produces exceptionally high efficiency, absence of vibration, minimum wear and economy of operation. An inherent Safety Feature of the Traction Drive is the reduction of the tractive effort upon the bottoming of the car or counterweight, which eliminates the possibility of either of these being drawn into the overhead work…"

RE: excerpt from *Otis Elevator Company: The World's Word for Elevator Safety* (ca. 1922)

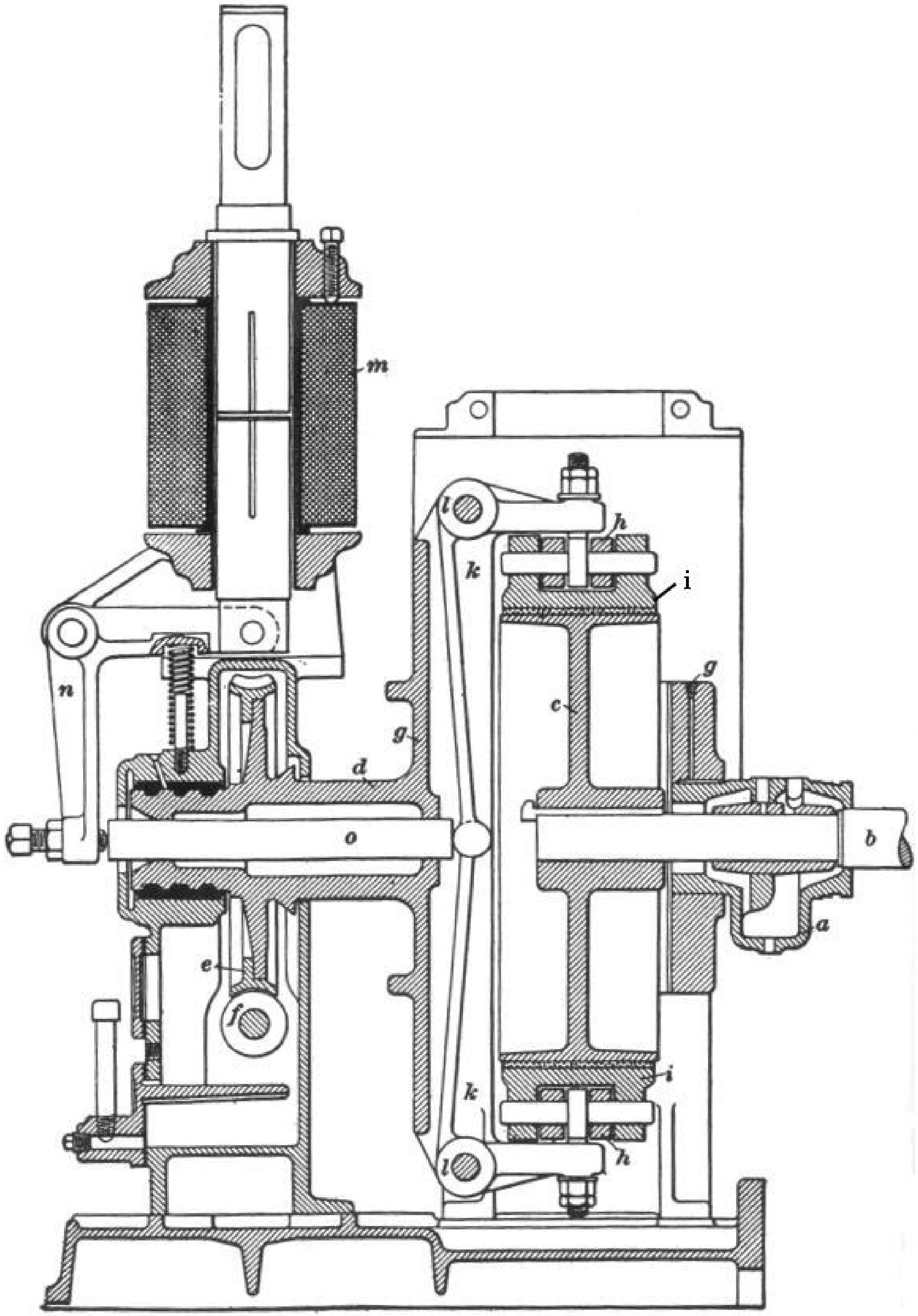
<u>Above</u>: caption: "Otis Gearless Traction Micro-Drive Machine"

"…All bearings are amply proportioned, provided with large bearing surfaces, and with suitable means for proper lubrication. The main bearings are of the self-aligning type, with babbitted linings, provided with dust covers, and with chains for automatic lubrication. The leveling motor bearings are self-aligning, with bronze bushings. Spring actuated, electrically released brakes of a powerful type are provided to hold the car securely with maximum load. The main brake wheel is mounted on, and bolted directly to, the armature spider. Swivel brake shoes are applied to the brake wheel simultaneously, and with equal pressure by means of a pair of powerful helical springs. The main brake magnet is designed for quick release, and is arranged with adjustable, automatically controlled, magnetic retardation, for the purpose of obtaining smooth and gradual application of the brake shoes. All exposed cast surfaces are filled and rubbed down, and have uniform semi-gloss rubber finish. The entire equipment is finished in a neat and distinctive manner…"

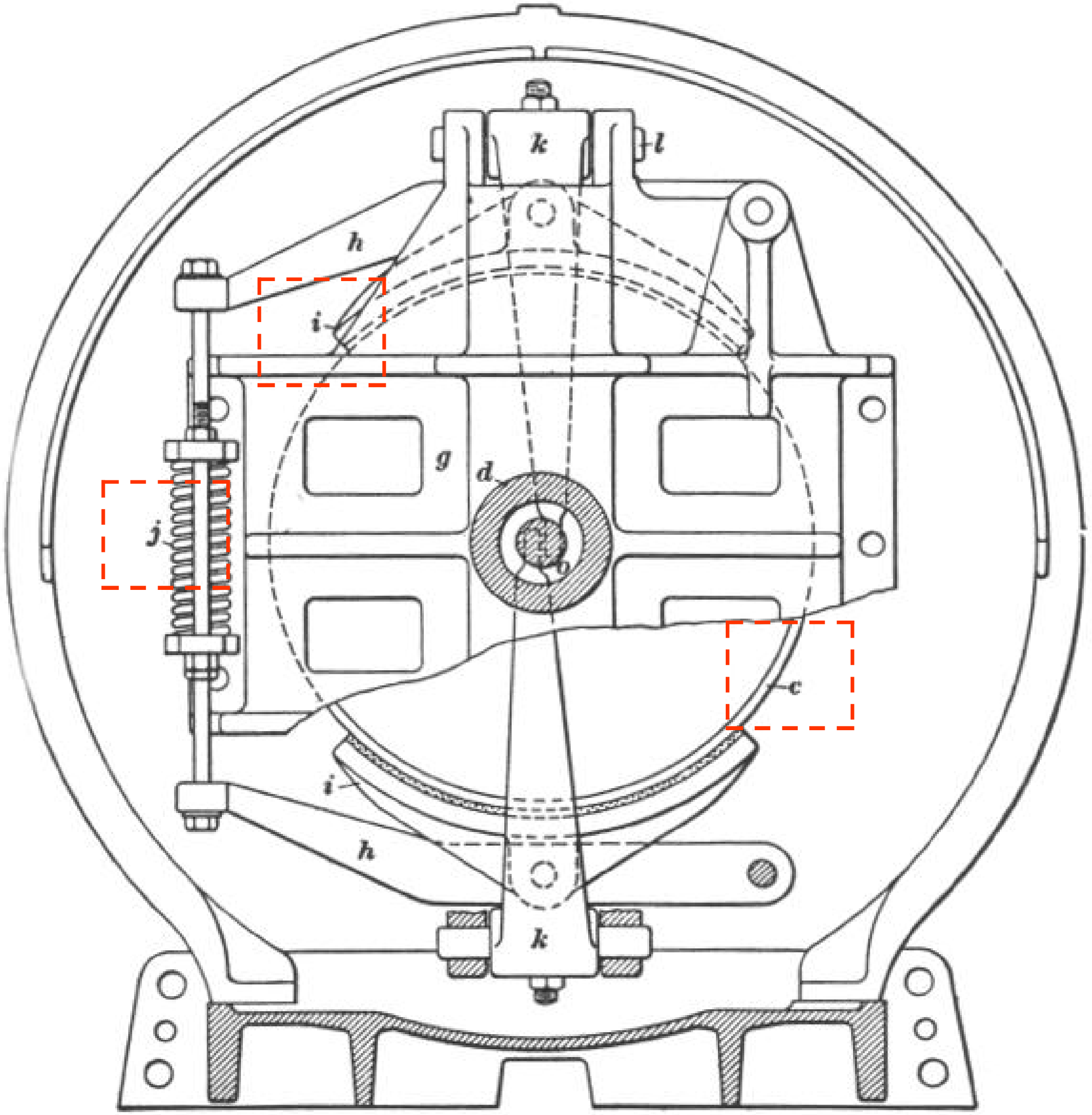
RE: excerpt from *Otis Elevator Company: The World's Word for Elevator Safety* (ca. 1922)



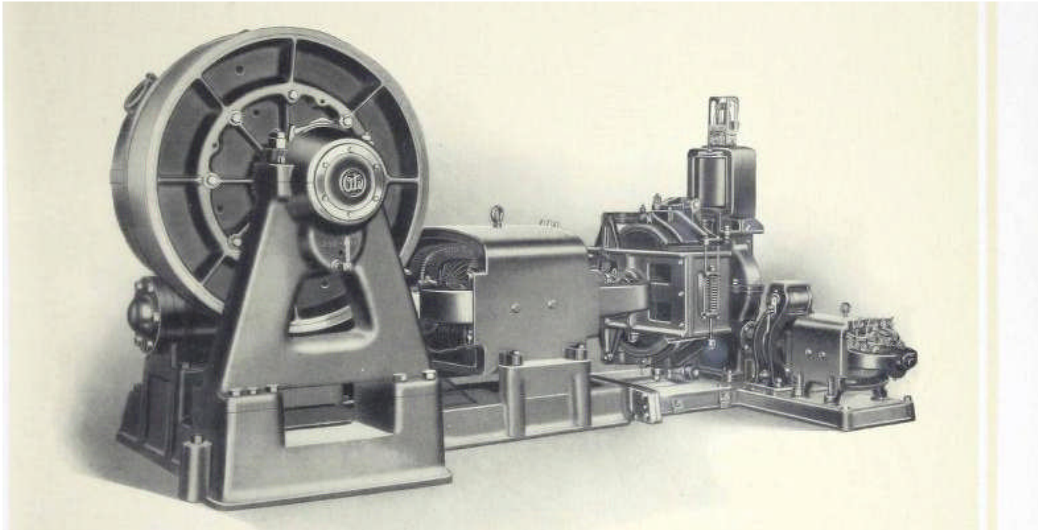
<u>Above</u>: caption: "Microdrive Machine Drawing (Plan). Brake pulley (c) is connected to the main machine motor shaft (b) and is the inter-face between the two machines"



<u>Left</u>: caption: "Microdrive Machine Drawing (Section). The auxiliary machine is released from the main machine as follows: When the brake coil (m) is energized, brake lever (n) rotates counter-clock-wise and slides shaft (o) to the right. Shaft (o) passes through the sheave shaft (d) on the aux-iliary machine. Shaft (o) presses against two bell-cranks (k) which pivot at point (l) causing the brake shoes (i) to lift off the brake pulley (c). If brake shoes (i) are applied to the brake pulley (c) and the auxiliary machine is energized - the entire brake assembly rotates and moves the main machine at leveling speed."



<u>Above</u>: caption: "Microdrive Machine Drawing (Section). Spring (j) is used to adjust the brake shoe (i) tension against the brake pulley (c)."



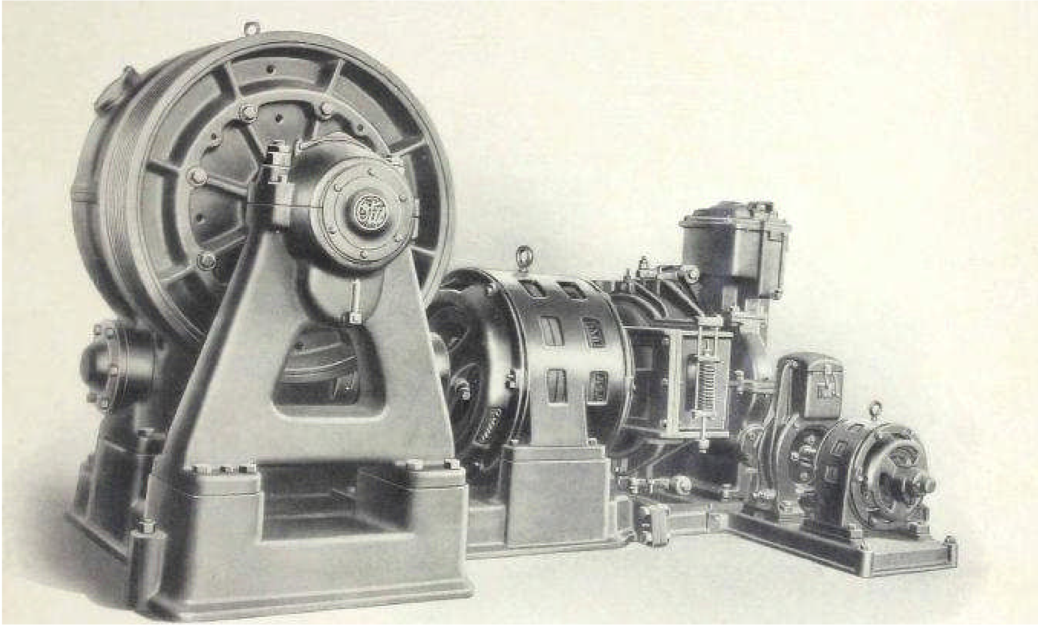
"…The Otis Single Wrap Traction Micro-Drive Machine consists of a traction driving sheave, main drive, self-leveling micro-drive, main and self-leveling motors, electric brakes and gearing. The entire machine is designed as a complete unit, and is mounted on a heavy, reinforced cast iron bed plate to maintain all parts in proper alignment. The traction driving sheave is made of semi-steel, the ropes passing around the sheave in machined grooves specially designed to obtain proper traction, and with minimum wear on the hoisting ropes. The sheave is mounted between bearings on a solid steel shaft and is driven directly from the worm gear through a spider, which is securely bolted to both the worm gear and sheave, thereby relieving the shaft of torsional stresses…"

RE: excerpt from *Otis Elevator Company: The World's Word for Elevator Safety* (ca. 1922)

Above: caption: "Otis Single Wrap Traction Micro-Drive Machine – Direct Current"

“…The worm gears are made of a special grade of phosphor bronze, accurately machined with hobbed teeth, designed to produce smoothness of operation, eliminate vibration, and give highest possible efficiency. The worms are cut from solid, high carbon steel forgings integral with worm shafts, and are accurately cut and machined. The thrusts in both directions are taken up by special Otis designed, ball thrust bearings of the self-aligning type. The worms, gears and thrusts run in oil, in oil tight housings, which are made of cast iron strongly built to withstand the severe stresses to which they are subjected, and to maintain perfect alignment of the worms and gears. Babbitted bearings of ample size are provided for the shaft and are equipped with suitable means for lubrication. The machine is provided with a main and a micro-drive electric brake, each of which is provided with a pair of powerful spring-actuated, electrically released brake shoes. The shoes of each brake are applied simultaneously, and exert equal pressure upon both sides of the brake pulley. The main brake is of the revolving type, but during normal operation is in a fixed position with the micro-drive disconnected. During leveling operation the main brake revolves and automatically acts as a connection between the main and micro-drive. The micro-drive brake is effective during leveling operation…”

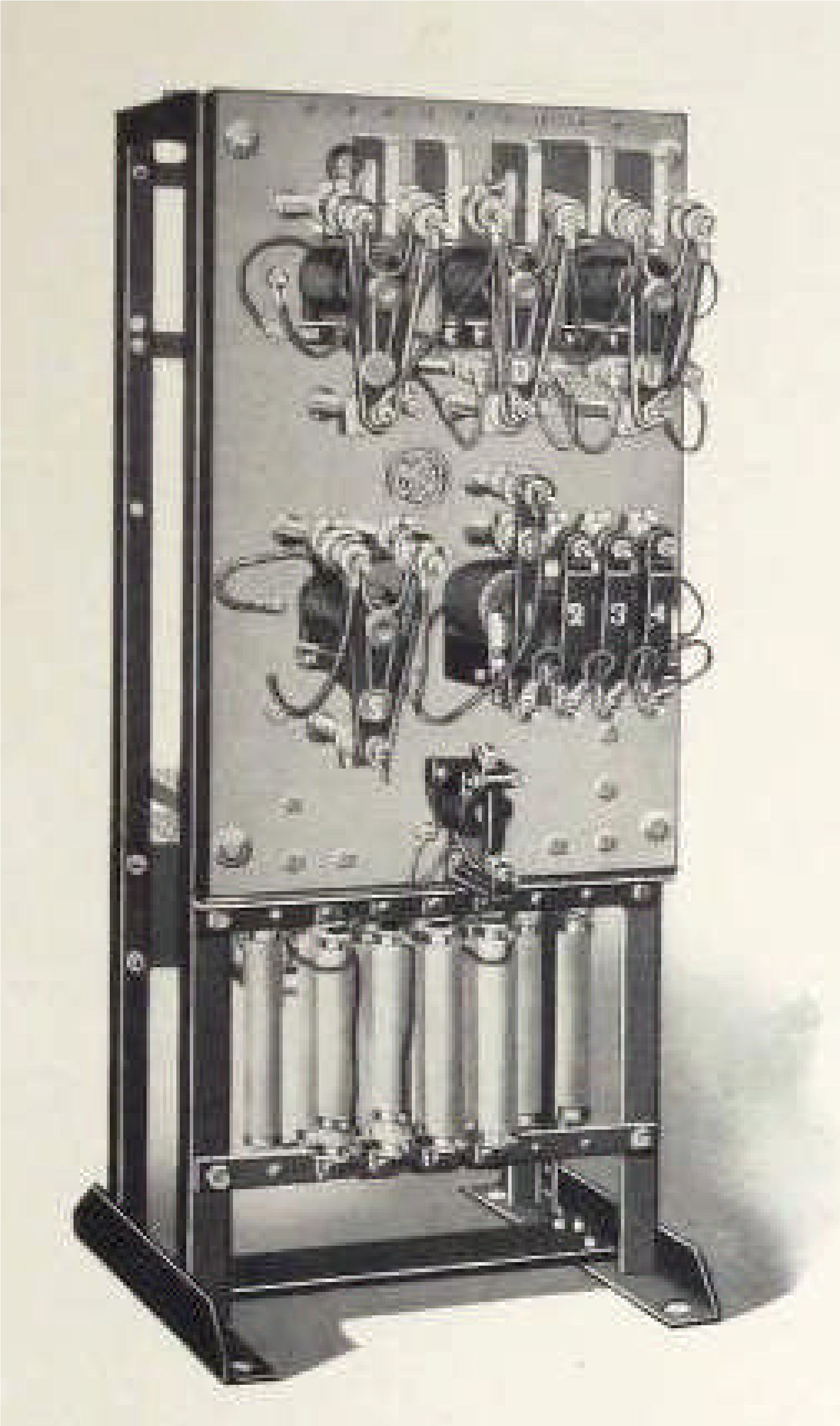
RE: excerpt from *Otis Elevator Company: The World’s Word for Elevator Safety* (ca. 1922)



"…The application of the main and micro-drive brakes is automatically governed by the operation of the controller. Either brake will hold the car securely with maximum load, and are so arranged that they will be automatically applied when the car is brought to rest, or upon failure of current from any cause. The machine, motors, electric brakes, and controllers are Otis designed and manufactured in Otis factories. The entire machine is designed to meet the exacting requirements of self-leveling operation and is constructed as a complete unit. The design of the machine produces the highest possible efficiency and smoothness of operation, without any appreciable vibration or undue noise. All parts are proportioned for strength, rigidity and wear, and are made inter-changeable for ready replace-ment…"

RE: excerpt from: *Otis Elevator Company: The World's Word for Elevator Safety* (ca. 1922)

<u>Above</u>: caption: "Otis Single Wrap Traction Micro-Drive Machine – Alternating Current"



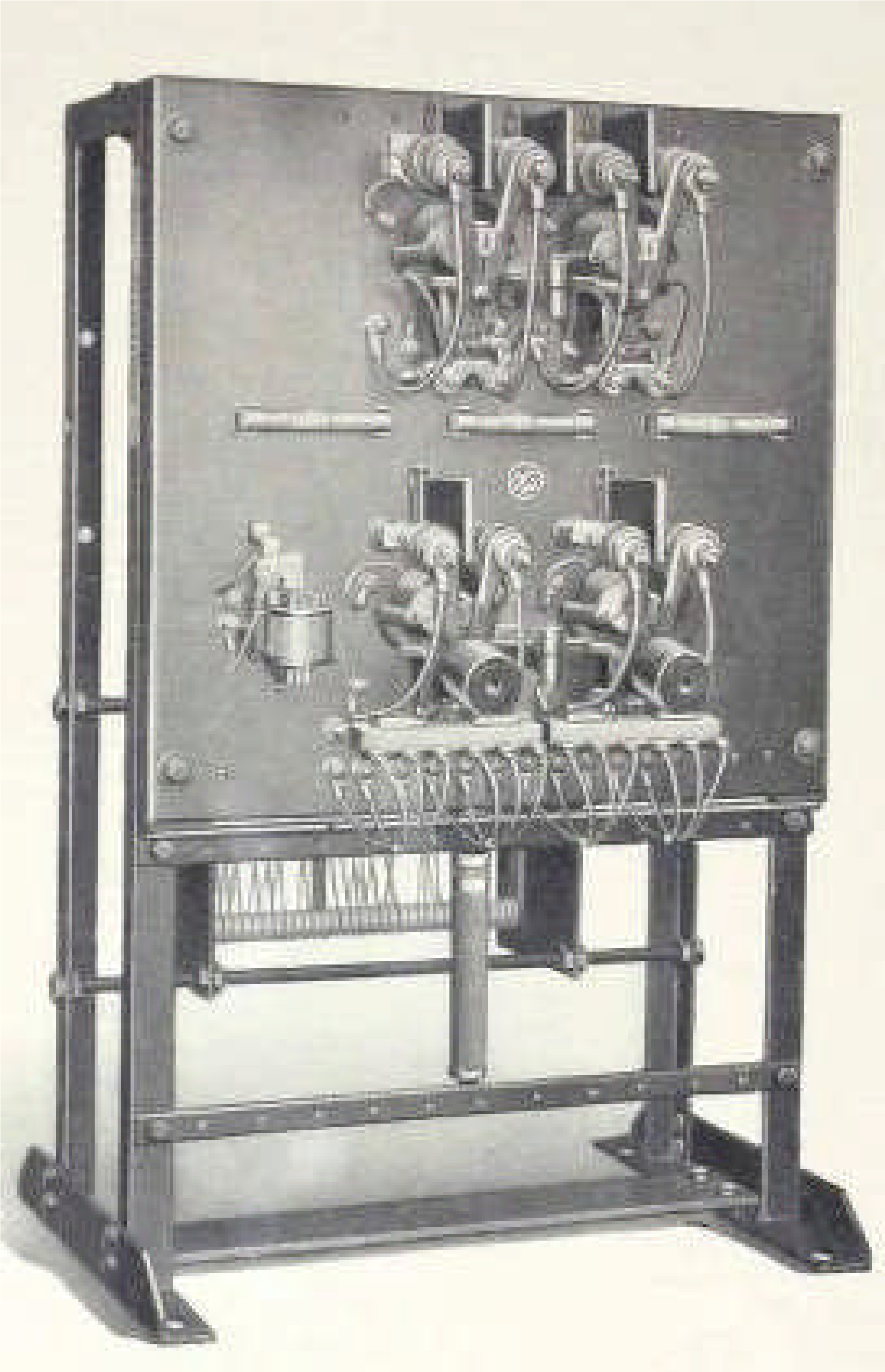
"…Otis Micro-Drive Controllers are Otis designed and manufactured in Otis factories. This Controller is of the Full Magnetic Micro-Drive Type, operated through the leveling switch on the car, and is used in connection with the main controller on Otis Single Wrap Traction Micro-Drive elevator machines. When the car arrives within the leveling zone above or below the floor landing at which the car is to stop, the main motor and controller are automatically cut out of service, and the self-leveling motor and controller automatically operate the machine, through the leveling switch, until the car is exactly at the floor level. This is accomplished by means of the leveling switch on the car which engages the up or down leveling cam in the hatchway. The position of the leveling switch in relation to the up and down leveling cam governs the direction of travel of the car while leveling…"

RE: excerpt from *Otis Elevator Company: The World's Word for Elevator Safety* (ca. 1922)

<u>Left</u>: caption: "Otis Micro-Drive Direct Current Controller"

"…When the leveling switch reaches the neutral position, the power is cut off, the brakes applied, and the car is brought to rest level with the floor landing. The leveling operation is entirely independent of the operator and is accomplished automatically by the car itself when within the leveling zone. After the car has been leveled, the position of the car platform will he automatically maintained regardless of any change in load on the platform, or stretch of ropes. The change from main drive to micro-drive operation is accomplished smoothly, even if the leveling operation requires a reversal in the direction of car travel when leveling to the floor landing. This controller is designed to prevent damage to the leveling motor from overload or excess current, and to prevent the admission of more current than is necessary to perform the specified duty of the elevator. Smooth and correct acceleration of the leveling motor is automatically obtained. The controller employs electro-magnets through-out, thereby eliminating the use of all rheostats, sliding contacts, or other easily deranged devices. Protective fuses are provided for operating circuits…"

RE: excerpt from *Otis Elevator Company: The World's Word for Elevator Safety* (ca. 1922)



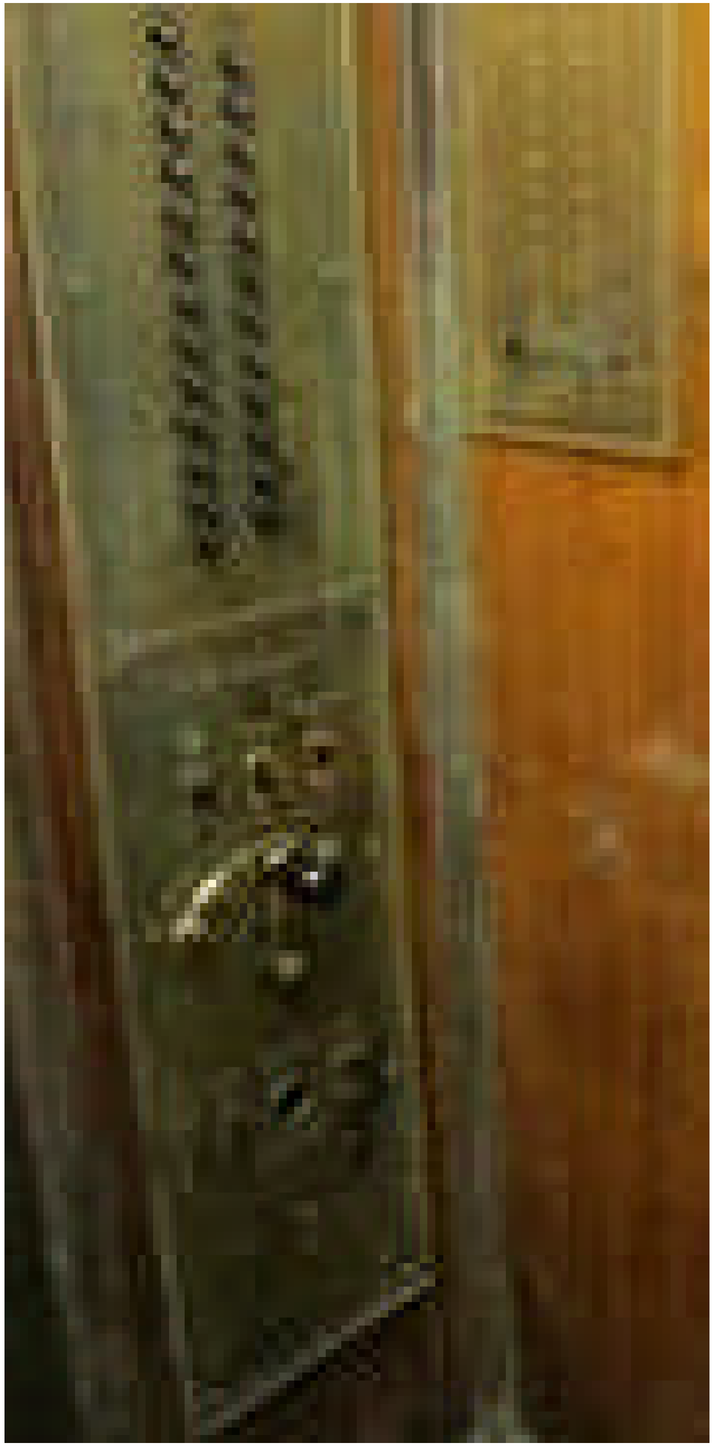
"…The various electrical safety devices which operate in connection with the main controller are also operative through this controller during the leveling operation. The Controller is made up of selected slate panels, free of metallic veins, mounted on heavy angle iron frame and thoroughly insulated. Suitable resistance is mounted on rear of controller, arranged for proper ventilation. All magnet coils are thoroughly impregnated by a special process. All switches have copper to carbon contacts of ample size, backed with cushion springs to maintain proper contact. Connections to switches and resistance are placed on the rear of controller panel to provide easy access. All parts are easily removable for replacement and can be readily adjusted…"

RE: excerpt from: *Otis Elevator Company: The World's Word for Elevator Safety* (ca. 1922)

Left: caption: "Otis Micro-Drive Alternating Current Controller"


OTIS ELEVATOR CONTROLLER

A No-Brainer



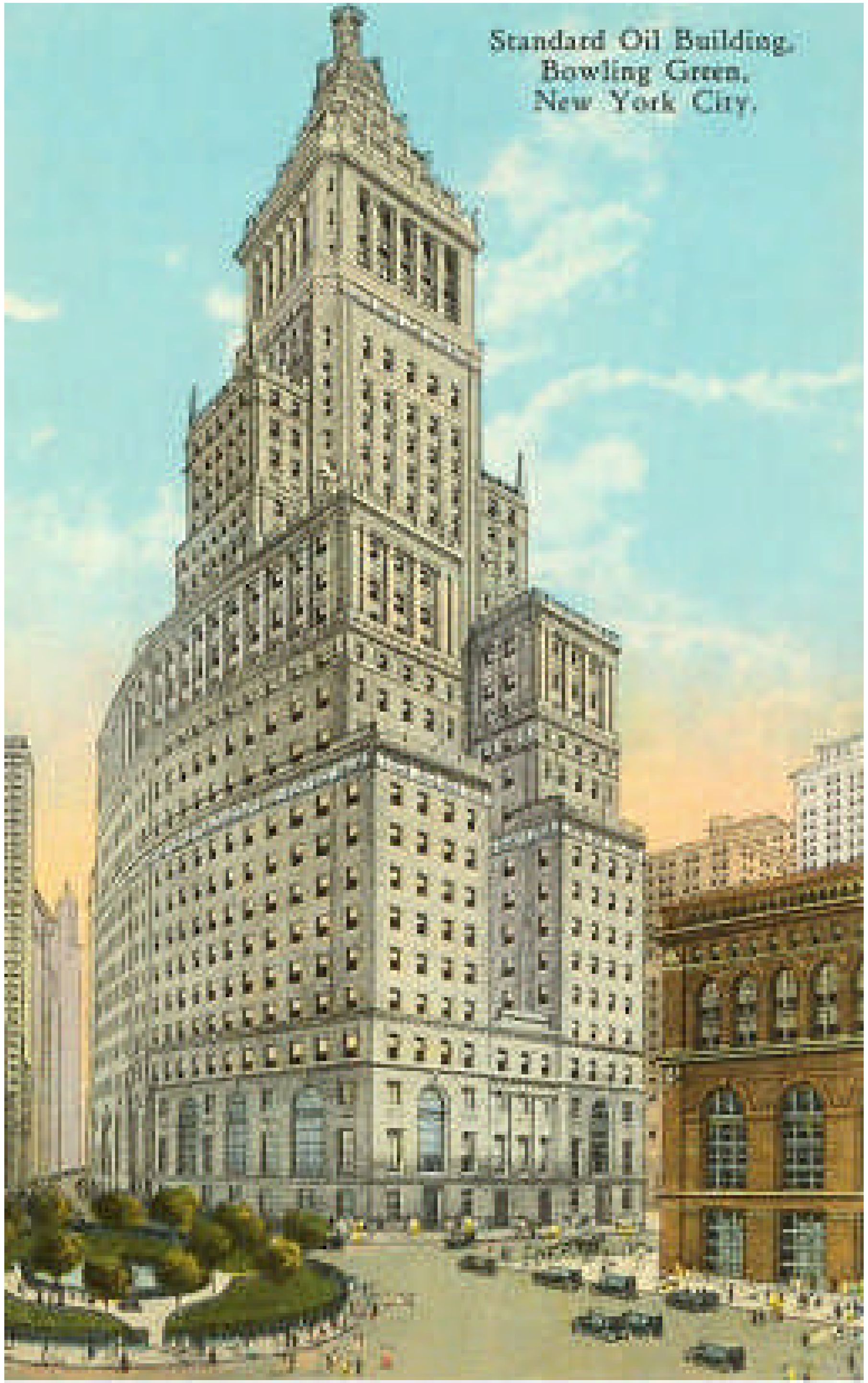
"…There remained to be overcome, however, the inherent limitations of human operators. At speeds in excess of 600 feet per minute the demand imposed on operators for split second reactions to blurred floor numbers, flashing signals and requests from passengers proved to be greater than that with which the most skilled operator could comply. This apparently insuperable obstacle was completely overcome by the Otis Elevator Company by a series of inventions beginning about 1920, which resulted in the development of Signal-Control…"

RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators*

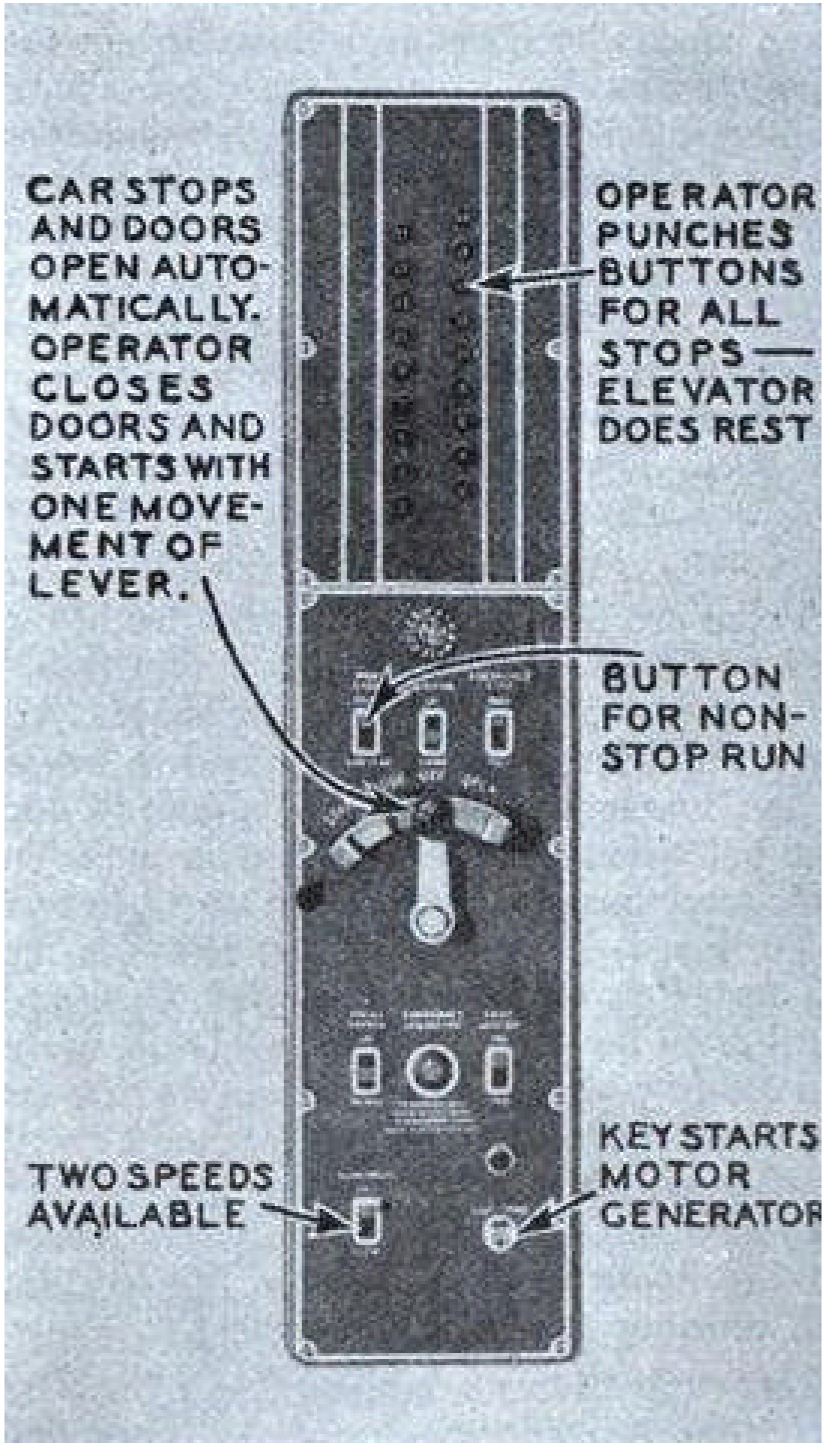
Left: Otis *Signal Control* manual car station and annunciator panel (ca. 1920s)

"…Elevators have developed in the last few years to where they are not only almost human, but in some cases are even better than human operators could be. It was human faults that produced the modern signal control system in which the operator punches buttons before he starts for all the floors where passengers wish to alight, and from there on has nothing to do but close the doors and start the car. It stops and the doors open automatically, and it not only stops for the passengers who want off, but automatically stops to pick up those who want on. The signal system owes its being largely to the fact that human operators could not think fast enough and make their muscles respond quick enough to catch signals and stop a car moving at 700 feet a minute…"

Modern Mechanics and Invention, **April 1931**



Judging when to slow the cab was easy enough for an operator when speeds were between 300 to 400 fpm. But when speeds increased to over 700 fpm, this became too difficult. The logical step was to automate the control system. In 1924, Otis installed its first *Signal Control System* in the new *Standard Oil Building* in NYC (left). The system automatically controlled acceleration, speed between floors and deceleration as the car approached the landing.



Signal Control completely relieves the operator of all duties except that of pressing buttons to register the destinations of passengers and closing the door and starting the car. The ability of the operator is no longer a limiting factor in determining the attainable or desirable speed of an elevator. As a matter of fact, one of the factors limiting car speed is the rate of change of atmospheric pressure to which passengers can comfortably adjust themselves…"

RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators*

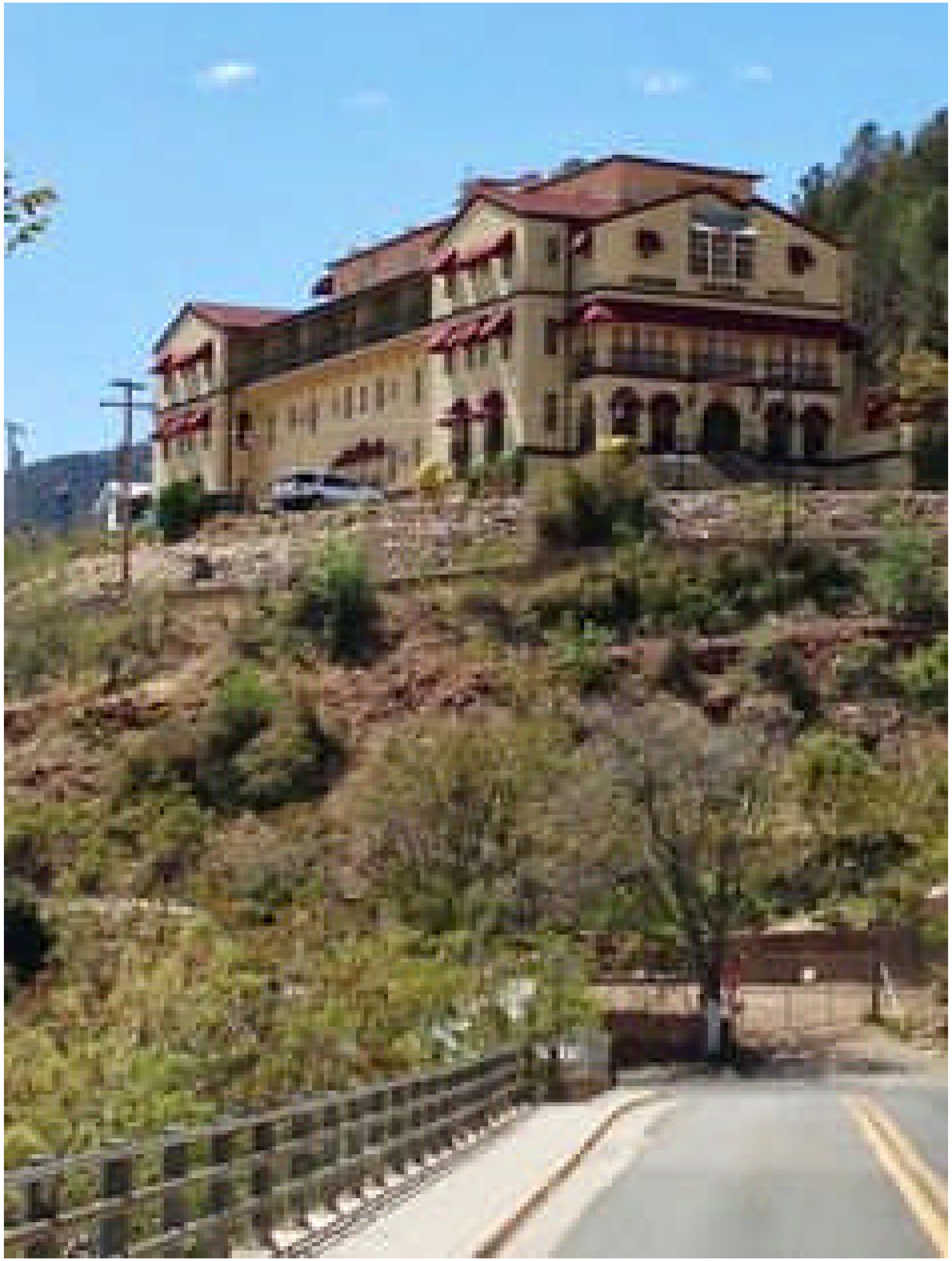
Left: caption: "Operator's panel in a Signal Control elevator. Everything except starting the car is automatic."

"…With the multi-volt gearless car and the signal system the operator has very little to do, beyond seeing that passengers get off and on safely. Instead of the old fashioned worm gear drive of the hoisting drum, the drum is built right on the armature shaft of the motor. Regardless of the type of electric current available, the hoisting motor gets its power from its own motor generator set, and therein lies its secret, for the voltage can be varied at will. When the operator in the car, or a waiting passenger at a floor, presses the signal button, a selector sets up the necessary contacts on a panel at the head of the shaft. Attached to the elevator car is a steel tape, running over a driving gear which in turn is belted to a screw moving the cross-head of the selector - virtually a small elevator. As the car travels up and down the shaft the cross head moves correspondingly, and establishes the contacts which slow down, stop and start the car. As the car approaches a stop the controller cuts out the driving current and cuts in the micro-drive, which, sending a reduced voltage through the driving motor, brings the car to a smooth stop exactly at the floor level…"

***Modern Mechanics and Invention,* April 1931**

<u>Above</u>: the *Otis Elevator Company Building* in San Francisco was built from 1923-1924 to designs by Otis' architectural office in Yonkers, NY. The building was used for elevator assembly and the manufacture of the selector mechanism of Otis' *Signal Control* system. A railroad spur led into the Grant Avenue side of the building. With smaller buildings of similar design in Los Angeles and Portland, the San Francisco office serviced the entire west coast plus Nevada, Arizona, Alaska and Hawaii. During the *Great Depression*, when construction activity was minimal, the San Francisco office was transformed into a service and maintenance facility exclusively. Otis remained in the building until 1969. After that, an intermediary floor was added and the industrial interior was converted into modern office space.

Self-Service



<u>Left</u>: one of the first Otis "self-service" elevators (an elevator not requiring an operator) was installed in the *Jerome Grand Hotel* in Arizona's *Verde Valley* (northwest of Phoenix) in October 1926. It is the oldest original self-service elevator in Arizona and one of the oldest in the U.S. The hotel sits atop a hill overlooking the town and the valley. It was originally a hospital, one of the most modern for its time.

"…To serve buildings where it is desirable for passengers themselves to operate the cars, Otis developed a form of automatic operation by means of buttons, and known as Collective-Control. This type of control is extensively used in apartment houses, hospitals and small hotels…"

RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators*

Miss Manhattan Goes Finger-Tipping

1 ***Miss Manhattan steps up and presses the button of an Otis Finger-Tip Control elevator. She is asking the elevator – not the elevator operator – to call for her.***

2 ***Here in this 'electrical brain,' Miss Manhattan's Finger-Tip message is received and registered. Here the elevator gets a definite order to pick up a passenger.***

3 ***The very first elevator going in her direction stops for her. It can't forget, can't dilly-dally on the way, can't pass her floor by mistake and then drift back.***

4 ***The doors open automatically, as if by an unseen hand. When Miss Manhattan is in the car, the doors close quietly and the elevator immediately is on its way.***

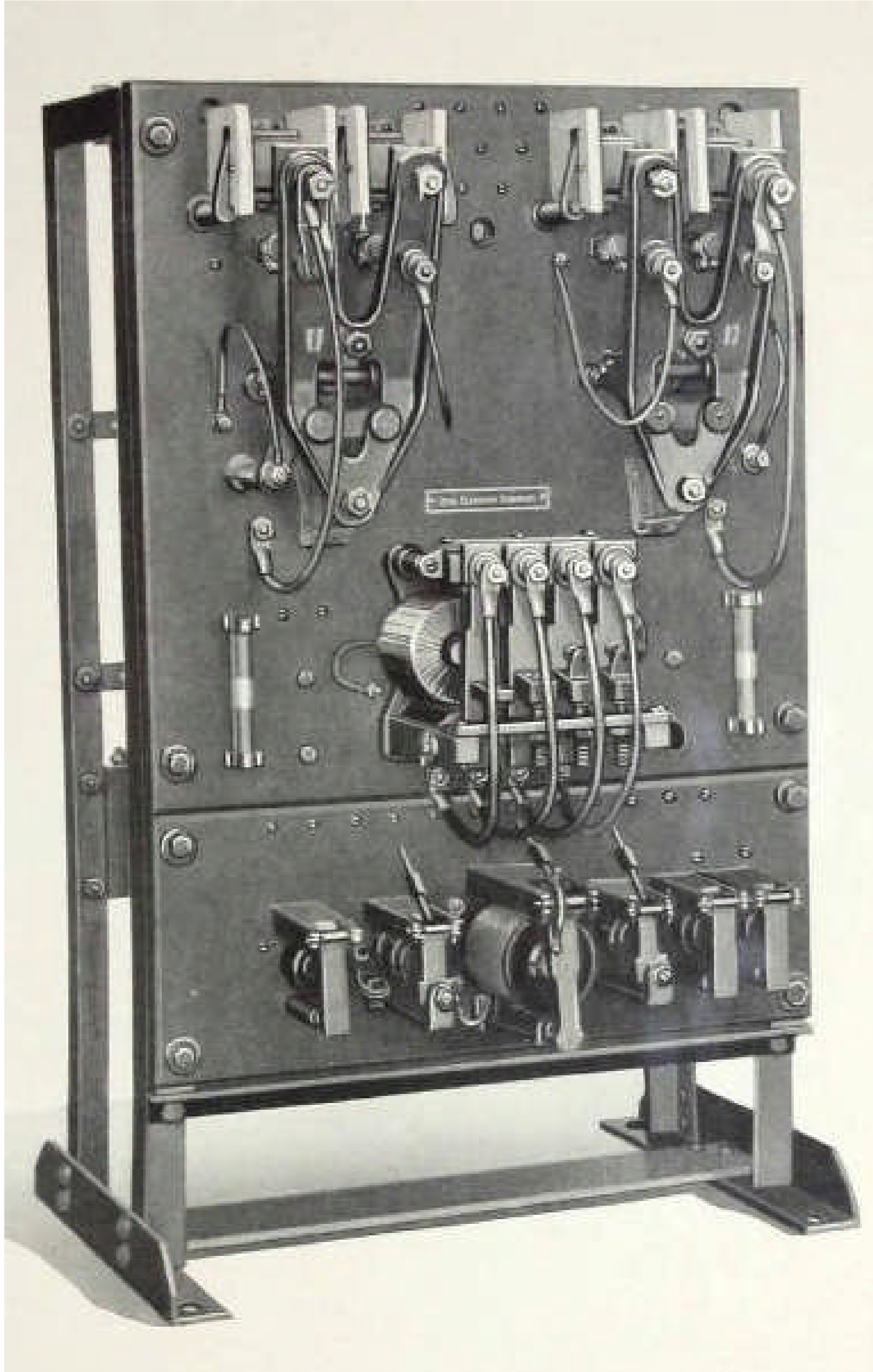
5 ***The operator presses a button for her floor (or Miss Manhattan does in a passenger-operated elevator) and the car stops automatically. There is little chance of error or lost time because the very minimum of human attention is required to give Miss Manhattan Finger-Tip Control elevator service.***

<u>Left</u>: caption: "Little things can make a big difference in our daily lives. A ride in an elevator is a little thing – yet it can jangle nerves. Or it can be an almost unnoticeable (and not at all unpleasant) moment. The difference is almost invariably a difference in quality of service. It isn't necessarily the age of the elevator that counts for poor service. The basic machinery of an elevator a dozen or more years old is usually sound. It is control mechanism, more than anything else, that frequently makes an elevator a service cripple. An elevator modernized to Finger-Tip Control gives *modern* service. Where can (and should) Finger-Tip Control be installed? Almost everywhere. Is it practical (and economical) in modernization of medium-speed machines? Yes. Where is more detailed information available on the subject? At any Otis office."

(1937 Otis ad)

"…Otis automatic interlocking door fixtures are provided on the enclosure doors at all landings, to prevent the movement of the car unless all doors are closed and locked, and also to prevent the opening of any door excepting the one to which the car has been sent or called, and then only when the car has stopped at that landing. This is obtained by means of an automatic electric door selective unlocking device with a retiring cam on the car, which engages only the door at the landing to which the car has been sent. An Electric Contact is provided to be used in connection with the collapsing gate in the car and connected in the operating circuit in such a manner as to prevent the movement of the car while this gate is open. Automatic non-interference protection is provided, so that when the car is in use, pressure on a button at any outside landing will not call the car until the car has reached its designated landing and the landing door has been opened and closed. Correct and smooth acceleration is attained automatically by cutting out starting resistance in steps as the motor accelerates to full speed, with corresponding reduction in starting current. This controller is designed to prevent damage to the motor from overloads or excess current and prevent admission of more current than is necessary to perform the specified duty of the elevator. Dynamic braking effect is automatically obtained in stopping. The controller employs electro-magnets throughout, thereby eliminating the use of all rheostats, sliding contacts or other easily deranged devices…"

RE: excerpt from *Otis Elevator Company: The World's Word for Elevator Safety* (ca. 1922)



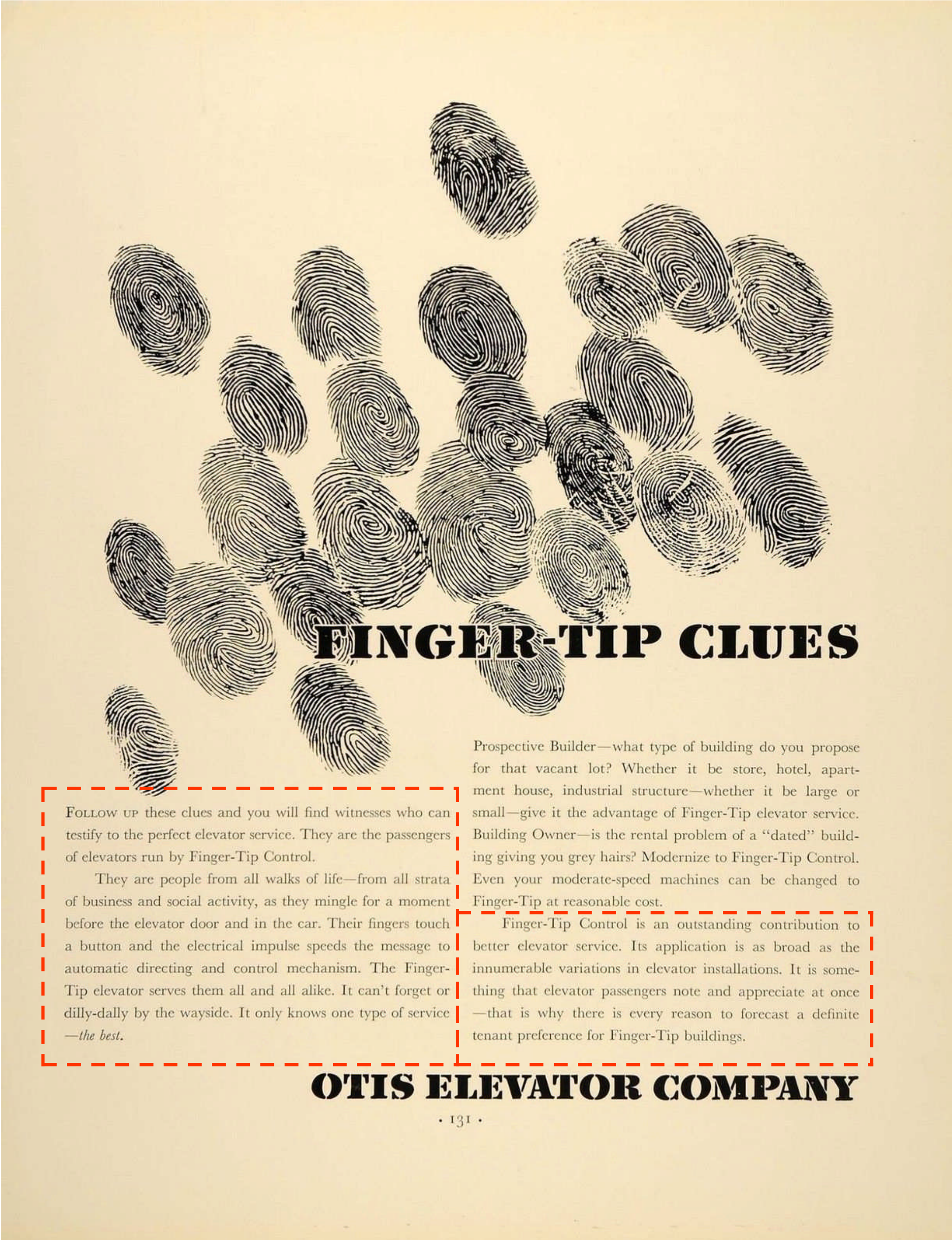
"…This Controller is of the Full Automatic Type, operated by means of push buttons, and used with moderate speed elevators equipped with OTIS Direct Current Motors. Push Buttons are provided with this controller, located at each landing, the momentary pressing of which brings the car opposite the landing at which the button is pressed, unless the elevator is in use, in which case all landing buttons are inoperative. Operation from the car is obtained by means of a series of push buttons, numbered to correspond to the various landings. The momentary pressing of one of these buttons will send the car to the designated floor, where it will automatically come to rest. In addition, there is a safety or cop button, the momentary pressing of which will stop the car…"

RE: excerpt from *Otis Elevator Company: The World's Word for Elevator Safety* (ca. 1922)

<u>Left</u>: caption: "Otis Push Button Controller – Direct Current"

"…Additional electrical safety devices as provided with this type of controller consist of hatchway limit switches, and a switch which is actuated by the car safety device. All these safety devices are so arranged that they automatically cut off all power, apply the brake and bring the elevator to rest. Protective fuses are provided for operating circuits. The Controller is made up of selected slate panels, free of metallic veins, mounted on heavy angle iron frame and thoroughly insulated. Suitable resistance is mounted on rear of controller, arranged for proper ventilation. All switches have copper to carbon contacts of ample size, backed with cushion springs to maintain proper contact. The switches that make or break the main circuit are provided with powerful magnetic blowouts to prevent destructive arcing Connections to switches and resistance are placed on the rear of controller panel to provide easy access. All parts are easily removable for replacement and can be readily adjusted…"

RE: excerpt from *Otis Elevator Company: The World's Word for Elevator Safety* (ca. 1922)



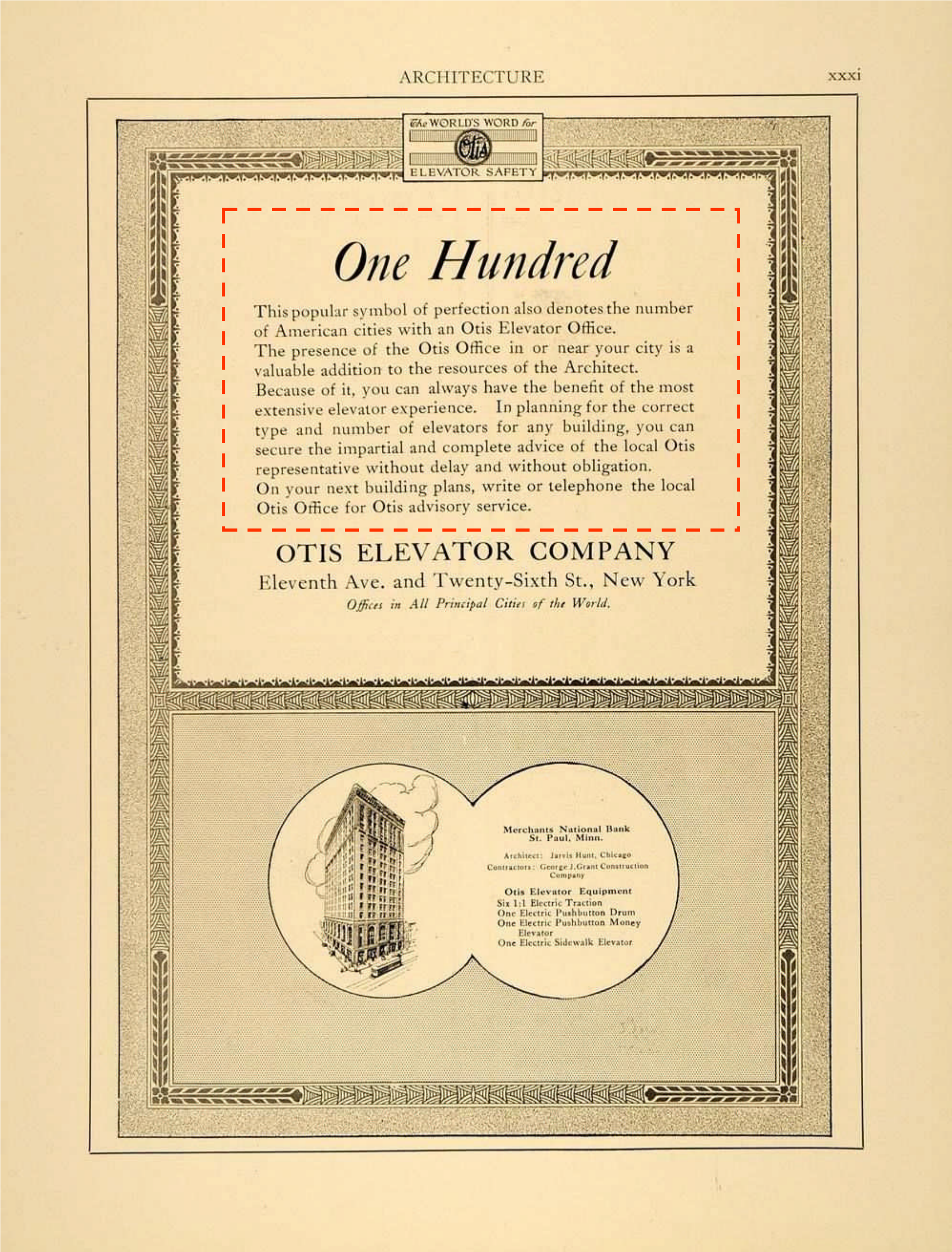
<u>Left</u>: caption: "Follow up these clues and you will find witnesses who can testify to the perfect elevator service. They are the passengers of elevators run by Finger-Tip Control. They are people from all walks of life – from all strata of business and social activity, as they mingle for a moment before the elevator door and in the car. Their fingers touch a button and the electrical impulse speeds the message to automatic directing and control mechanism. The Finger-Tip elevator serves them all and all alike. It can't forget or dilly-dally by the wayside. It only knows one type of service - *the best*...Finger-Tip Control is an outstanding contribution to better elevator service. Its application is as broad as the innumerable variations in elevator installations. It is something that elevator passengers note and appreciate at once – that is why there is every reason to forecast a definite tenant preference for Finger-Tip buildings."

RE: excerpts from 1937 Otis ad


INSTRUCTIONS
TO OPERATE ELEVATOR:
Press firmly for a moment the "UP" or "DOWN" button, as desired.
When elevator arrives, gate on car will open automatically, and you may open door and enter. If you do not open door in a few seconds, car may leave to answer other calls.
OTIS ELEVATOR COMPANY
UP
DOWN

Proper Care & Systematic Attention

Otis began offering regular elevator inspection service by the mid-1880s, gradually broadening the scope of the service until, on April 1st 1921 (in Springfield, Illinois), Otis made its first official contractual arrangement to take complete care of a customer's elevators for a flat monthly fee and to maintain them in their original operating condition. The relationship between elevator user and manufacturer has matured and today, Otis provides a worldwide maintenance service.



<u>Left</u>: caption: "*One Hundred*. This popular symbol of perfection also denotes the number of American cities with an Otis Elevator Office. The presence of an Otis Office in or near your city is a valuable addition to the resources of the Architect. Because of it, you can always have the benefit of the most extensive elevator experience. In planning for the contract type and number of elevators for any building, you can secure the impartial and complete advice of the local Otis representative without delay and without obligation. Write or telephone the local Otis Office for advice."

(1915 Otis ad)

"…The supremacy of Otis Elevators - in design, in manufacture and in operating qualities - has been for many years, and is today, universally acknowledged. Considered from the standpoint of elevator apparatus generally, Otis Elevators are conceded to need the least amount of mechanical attention. But like any piece of good machinery, they do need proper care and systematic attention if they are to be kept up to their highest operating efficiency…"

RE: excerpt from *Better Elevator Service* (ca. 1916)

"…With the development of the Otis elevator it soon became apparent that proper service facilities were necessary if the elevators were to be maintained at the point of highest efficiency. This resulted in the establishment of service facilities in all of the branch offices, consisting of a stock of necessary replacement parts and special tools to perform service work in the most efficient manner. Supervisors and skilled mechanics were also made available to render service night or day. This service has been developed to a point where thousands of owners place their elevators completely in Otis' care for a reasonable fixed monthly sum under an Otis Maintenance Contract. This contract provides for frequent examinations at regular intervals and the replacement of all worn parts, thus assuring the owners of maximum safety and the same performance at all times that was built into the original equipment…"

RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators*

<u>Left</u>: caption: *"He's a great horse. Has the pedigree of a winner. All that. But if he could be interviewed, he'd probably say he it is the daily cure he gets which keeps him in winning condition.* There are many things to which this rule of intelligent care applies. One of them is surely the elevator on which you are a frequent passenger. Depending a great deal on the way it is handled, this elevator can either be a convenient and trustworthy mode of transportation or a daily annoyance. And because good elevator service is important to you, we think you will be interested in knowing about Otis Elevator Maintenance. We want to say this of Otis Maintenance: it is a nationwide service under the managership of men who know elevators. It is an extension of that responsibility which has for years been put into the manufacture of an Otis elevator itself. It is a service that puts safety and comfort of passengers first…"

(1933 Otis ad)

"…There are now over one hundred and sixty Otis service offices located in the United States alone, each office carrying in stock all necessary elevator accessories, supplies and parts, ready for immediate shipment. At these offices one or more factory-trained experts are stationed - men who are thoroughly familiar with elevator construction and operation; and continuous telephone service is maintained in order that these Service men may be reached promptly, at any hour of the day or night, or on Sundays and Holidays. Service can be arranged for with these offices at nominal rates under standard contracts as follows:

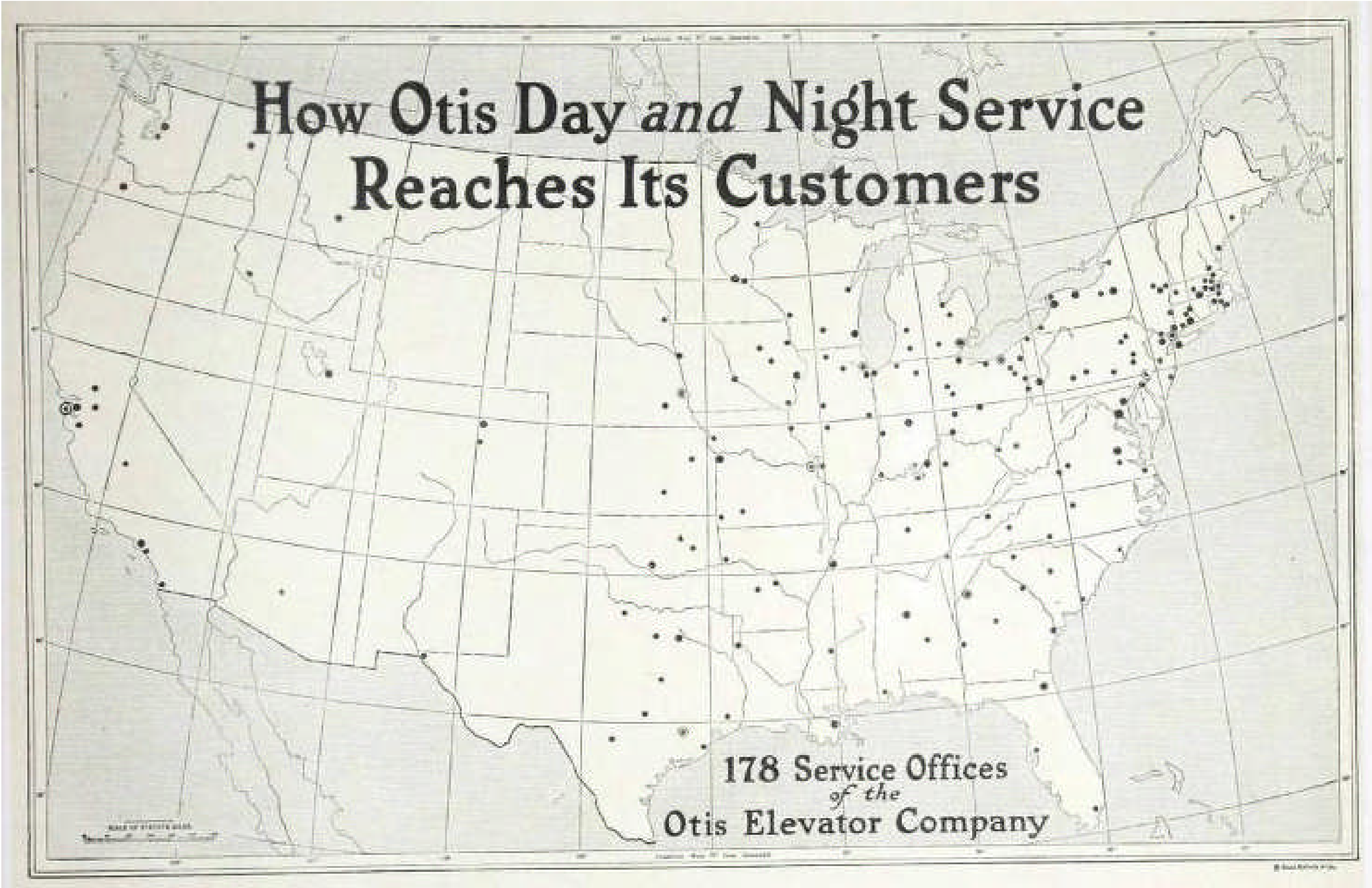
WEEKLY SERVICE WITH PARTS, OILS AND GREASES

This service to consist of a weekly examination of the elevator, excepting signal devices, including oiling and cleaning machine, motor and controller; greasing or oiling bearings and guides; necessary minor adjustments; call back service during regular working hours of regular working days; and furnishing the following specified supplies: All carbon and copper contacts, contact insulations and contact springs, motor brushes, copper braids, oils, greases, rope preservative and cotton waste.

WEEKLY SERVICE

This service to consist of a weekly examination of the elevator, excepting signal devices, including oiling and cleaning machine, motor and controller; greasing or oiling bearings and guides; necessary minor adjustments; and call back service during regular working hours of regular working days…"

RE: excerpt from *Otis Elevator Company: The World's Word for Elevator Safety* (ca. 1922)


How Otis Day and Night Service
Reaches Its Customers
178 Service Offices
of the
Otis Elevator Company


BILLIARDS
POOL
POOL
OTIS ELEVATOR COMPANY
OTIS
ELEVATOR COMPANY
DAY AND NIGHT SERVICE
OTIS
ELEVATOR COMPANY

By the Same Reasoning


One step up!

Your elevators should provide one easy step to any floor. If they give good service, they help rent building space and put a premium on upper floors. But if they give poor and ragged service, they help empty a building and send it on its way to the mortgagee.

An Otis Elevator is built to give years and years of good service. Only one thing is needed to insure this service—good maintenance.

How can you be sure of proper maintenance? Where is it available? Ordinary reasoning would suggest that the manufacturer of a machine knows best how to take care of it. By the same reasoning, Otis Maintenance is the *proper maintenance* for an Otis Elevator.

Otis Elevator Maintenance (a complete service that covers everything from regular examination to replacement of worn parts) is available at an economical, flat monthly rate. *For complete details, telephone your local Otis office.*

CONSULT YOUR ARCHITECT

Call him in at least once a year to discuss ways and means of *keeping* your building attractive to tenants.

OTIS ELEVATOR COMPANY

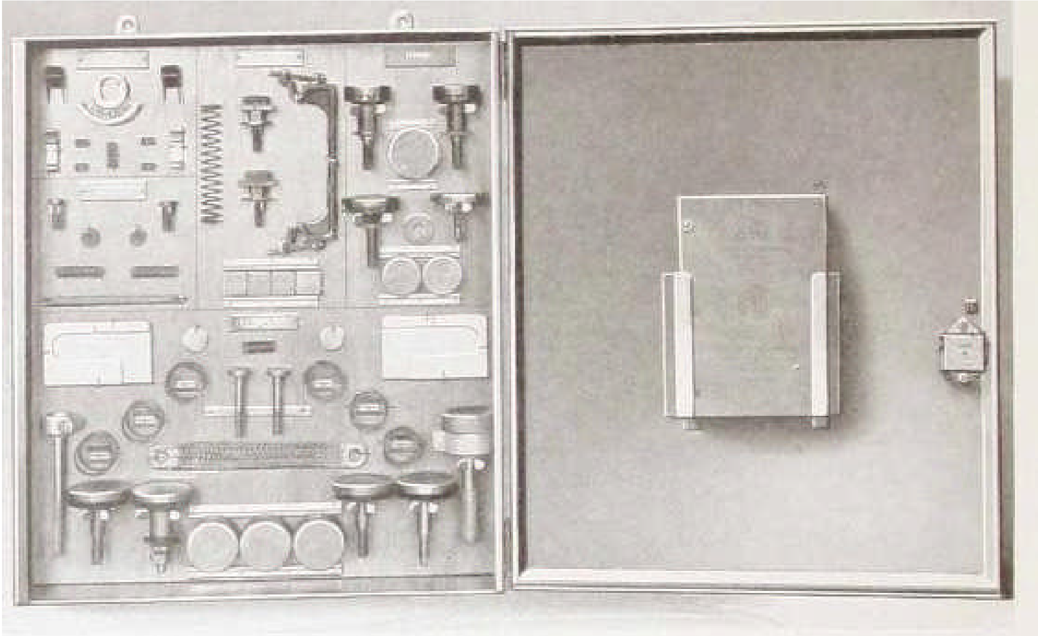
• 141 •

<u>Left</u>: caption: "Your elevators should provide one easy step to any floor. If they give good service, they help rent building space and put a premium on upper floors. But if they give poor and ragged service, they help empty a building and send it on its way to the mortgagee. An Otis Elevator is built to give years and years of good service. Only one thing is needed to insure this service – good maintenance. How can you be sure of proper maintenance? Where is it available? Ordinary reasoning would suggest that the manufacturer of a machine knows best how to take care of it. By the same reasoning, Otis Maintenance is the *proper maintenance* for an Otis Elevator. Otis Elevator Maintenance (a complete service that covers everything from regular examination to replacement of worn parts) is available at an economical, flat monthly rate."

(1935 Otis ad)

"…As a means of identification and to eliminate any possibility of impostors gaining unauthorized entrance to buildings under our name, we have supplied our examiners with badges as shown at left…"

RE: excerpt from *Otis Elevator Company: The World's Word for Elevator Safety* (ca. 1922)



"…The Otis Controller Parts Cabinet has been devised to facilitate and quicken repair service in the event of unexpected breakdowns or worn parts on the elevator controller. It is a compact, shallow box, strongly made of reel and contains all essential emergency wearing parts of the type of Controller furnished with the elevator machine installed. It is generally hung on the wall of the motor or engine room, so that the engineer in charge, by referring to the descriptive catalogue that goes in the cabinet, can quickly determine the part needed to replace the worn mechanism on the controller and locate instantly that part in the Cabinet…"

RE: excerpt from *Better Elevator Service* (ca. 1916)

<u>Above</u>: caption: "An Otis Controller Parts Cabinet"

DIRECT CURRENT

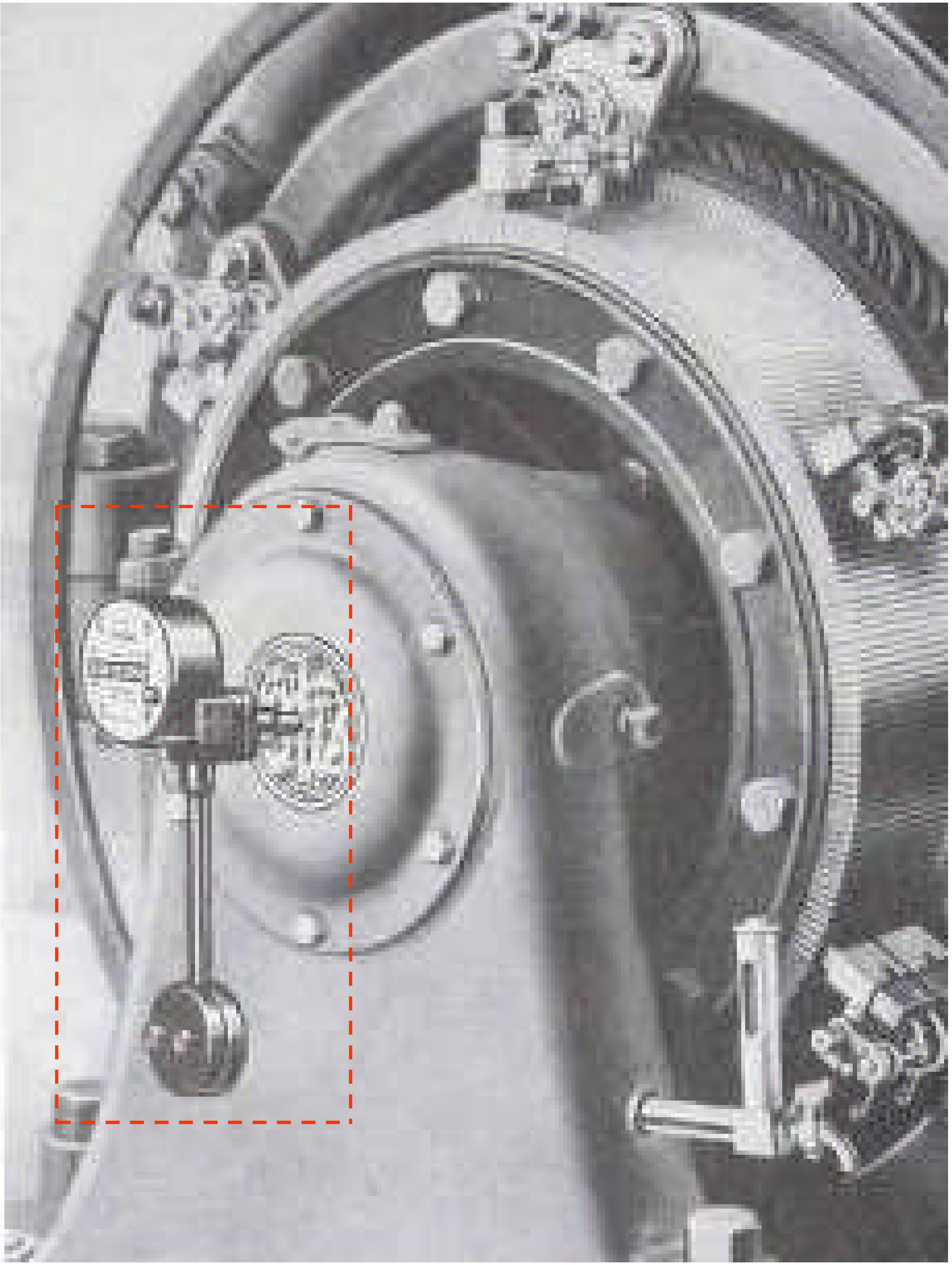
2 DD Controller	3 FD Controller
HB "	6 F "
AP "	6 FD "
HKS "	MFL 4 B "
3 F "	MFL 4 C "

ALTERNATING CURRENT

2 DA Controller	2 VAS Controller
3 DA "	OVB "
2 E-AC "	2 SAS "
2 VR "	1-1/2 SS "
2 VS "	2 SS "

"…Duplicate parts should be ordered at once to replace the parts removed, so that the Cabinet is at all times complete and ready for other renewals. With one of these Cabinets in the engine room, minor changes of parts can be made immediately and without impairment of the elevator service. These Cabinets are now being furnished for practically all the standard types of Otis Controllers. Many of them are listed above. Any of the Otis Service offices can supply the Cabinet required for your elevator controller…"

RE: excerpt from *Better Elevator Service* (ca. 1916)

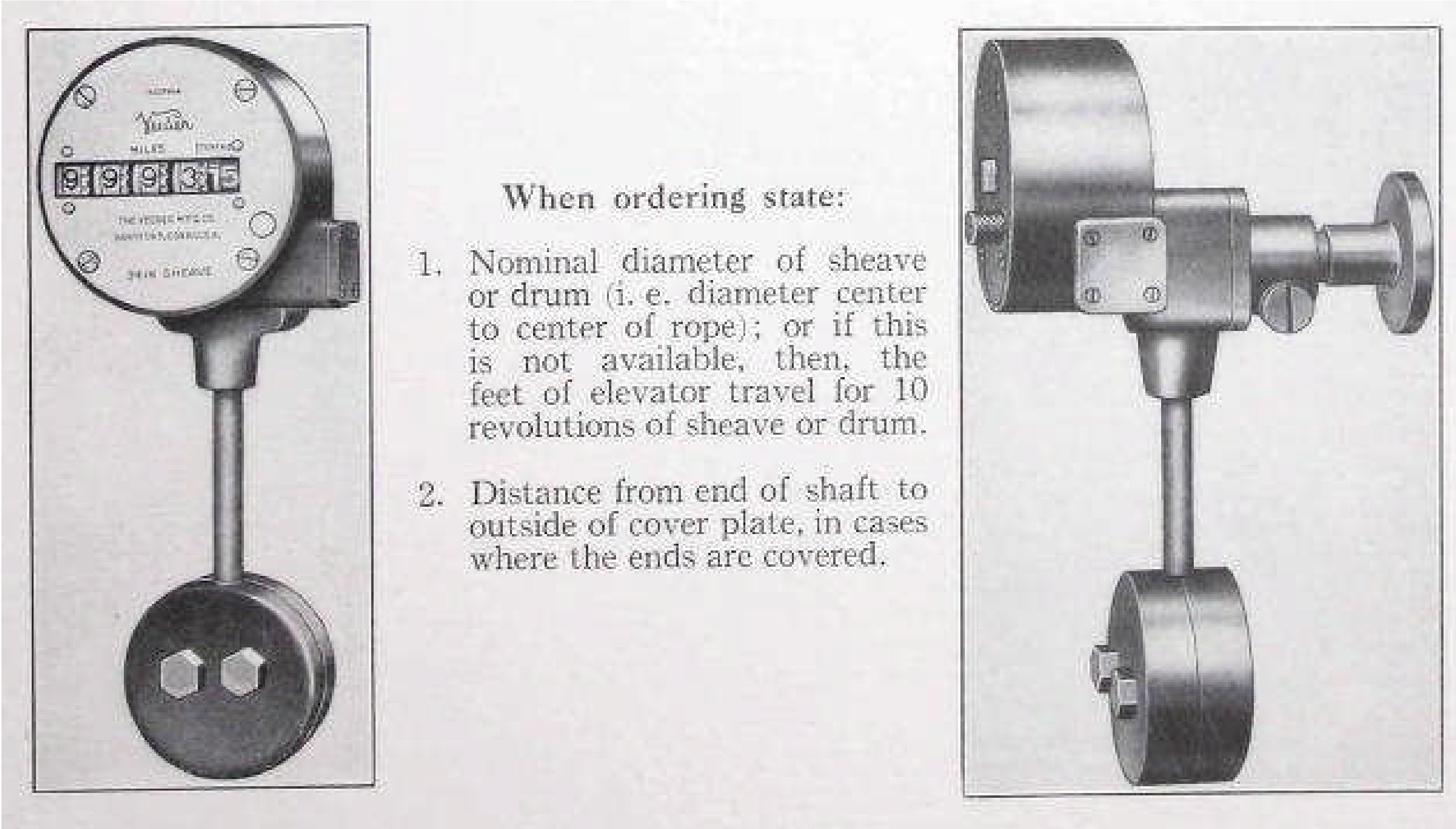


"…The Veeder Elevator Mileage Recorder is used for the purpose of determining the mileage, and consequently the cost per mile, of elevator operation, also the length of life and mileage of the elevator ropes. The record is made continuously, whether the elevator travels 'up' or 'down'…"

RE: excerpt from *Otis Elevator Company: The World's Word for Elevator Safety* (ca. 1922)

"…The cost per mile may be easily determined by dividing the operating cost by the mileage. With the data thus obtained, suggestions may be made for reducing the current consumption and maintenance. Since this Recorder will show at all times the mileage of the elevator and the approximate life of the elevator ropes, its use will enable operators to anticipate the time when replacements will be needed and to plan advantageously for their installation. Such knowledge will obviate costly shut-downs and will maintain maximum elevator service…"

RE: excerpt from *Otis Elevator Company: The World's Word for Elevator Safety* (ca. 1922)


When ordering state:

1. Nominal diameter of sheave or drum (i. e. diameter center to center of rope); or if this is not available, then, the feet of elevator travel for 10 revolutions of sheave or drum.

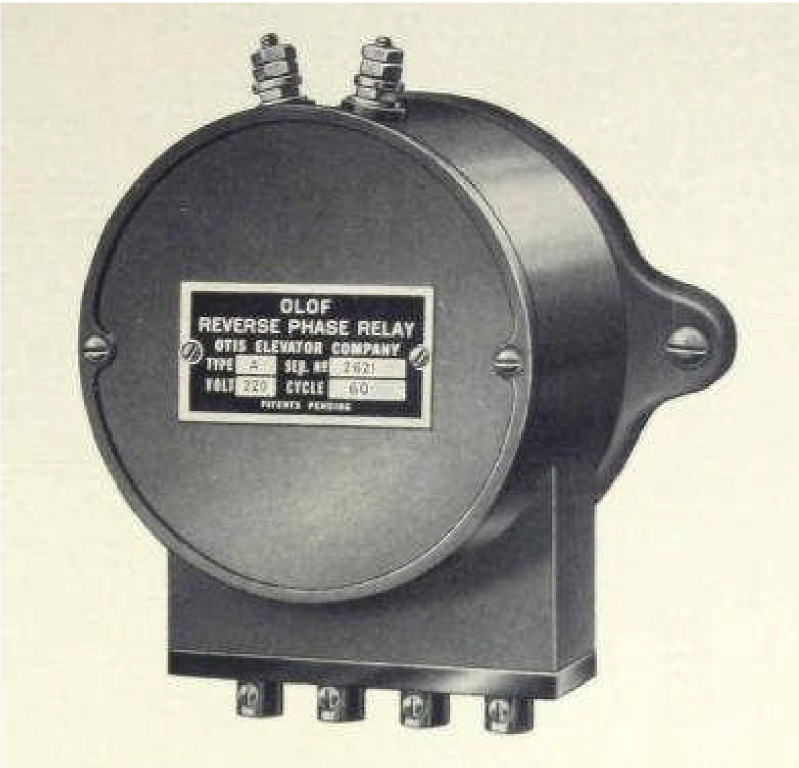
2. Distance from end of shaft to outside of cover plate, in cases where the ends are covered.

"…The Recorder may be readily attached to the shaft of the driving sheave or drum, whether the end of the shaft is exposed or covered. The instrument is direct reading, no constants being necessary. The two piece driving stud makes it easy to attach the Recorder. The flanged part is detachable for use as a template in locating the three ¼-inch tapped holes on the end of the shaft to which it is to be attached. A pin projects from the center of the flange for first centering the flange on the shaft. For shafts having covered ends, a one inch diameter hole should be drilled in the cover plate…"

RE: excerpt from *Otis Elevator Company: The World's Word for Elevator Safety* (ca. 1922)

“…The <u>Otis Reverse Phase Relay</u> is designed to protect elevator motors against Phase Reversal, Low Voltage, and Phase Failure. Phase Reversal causes the motor to rotate in the opposite direction to that intended by the operator, and is produced when the supply lines to the motor are inter-changed, either in the power house or by line men when make repairs. Low Voltage may cause the motor to stall and possibly burn out when lifting heavy loads. It may also cause increased speed when lowering heavy loads or when raising light loads, and is produced in the power house or by over-loads on the supply lines. Phase Failure, which is produced by open circuits, increases the amount of current passing into the motor and is liable to burn it out…”

RE: excerpt from *Otis Elevator Company: The World’s Word for Elevator Safety* (ca. 1922)



"…The principle of operation of the Otis Reverse Phase Relay is that of an induction motor, the metal disc acting as a rotor. The relay contact is opened or closed by motion of the disc, and is kept closed by the operating coils as long as the different phases maintain their proper relation. Should Phase Reversal occur, the rotor of the relay will turn in the opposite direction, thereby opening the relay contacts, which in turn cut off all current supply to the motor…"

RE: excerpt from *Otis Elevator Company: The World's Word for Elevator Safety* (ca. 1922)

Left: Otis *Reverse Phase Relay*

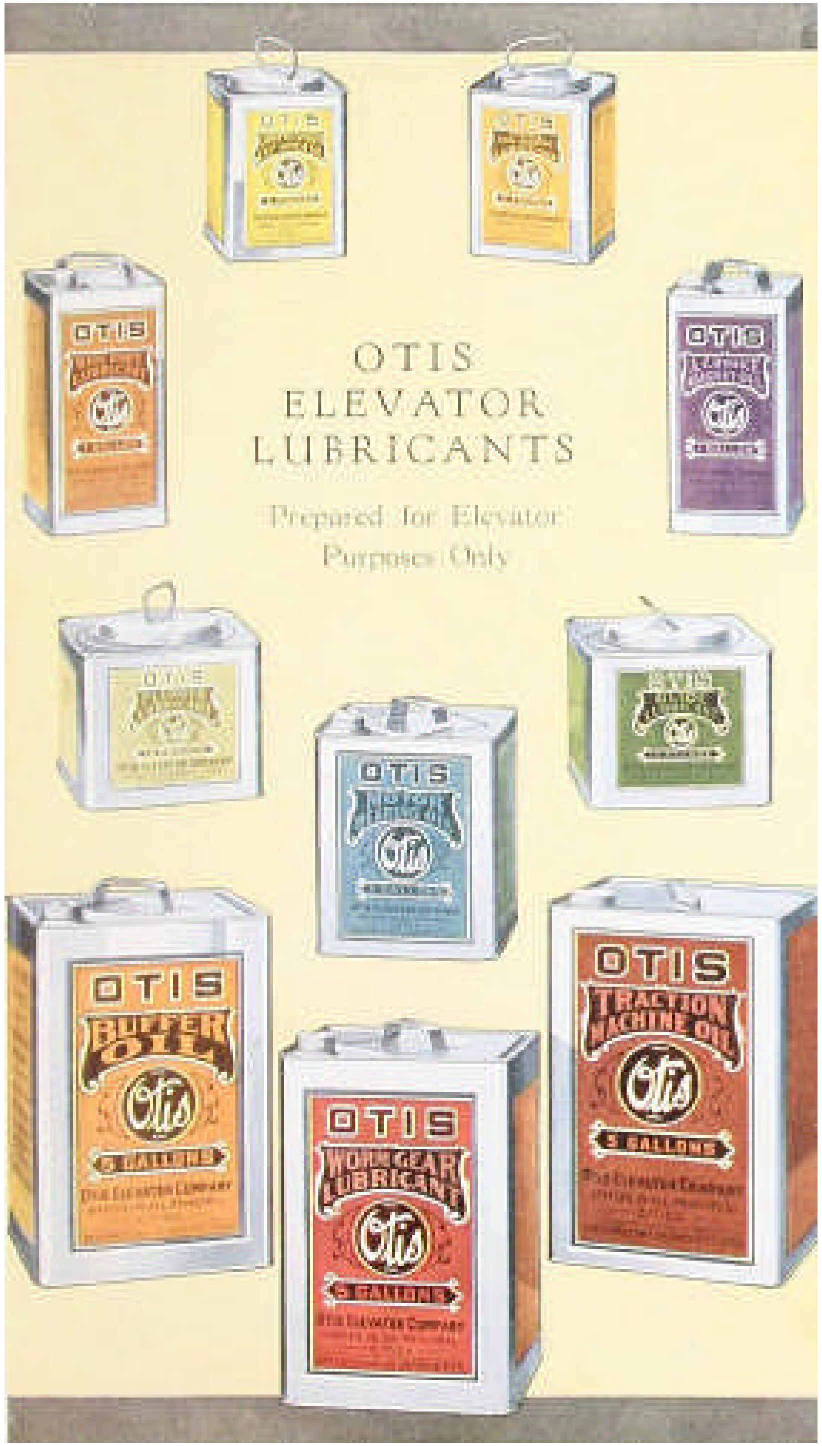
"…Should Low Voltage occur, the torque of the relay will be reduce so that it will be unable to keep the contacts in a closed position. They will then open and cut off all current supply to the motor. Should Phase Failure occur while the motor is not running, the relay loses all torque and cannot keep the contacts in a closed position; they will then open and cut off all current supply to the motor. Should Phase Failure occur after the motor is started, the relay contacts remain closed, allowing the elevator to travel to its designated floor (Otis motors have sufficient torque when running on single phase to complete the trip of the elevator without damage to the motor). Phase Failure, however, must be remedied before the elevator can again be started. The Otis Reverse Phase Relay is of compact design, enclosed in a neat dust-proof metal case, and is easily mounted. It has only a few parts all which are of substantial construction and designed to maintain their adjustment The Relay is designed for constant service and low power consumption, and consumes only about 6 watts per phase…"

RE: excerpt from *Otis Elevator Company: The World's Word for Elevator Safety* (ca. 1922)

Lubrication

"…Every Building Owner, Manager and Engineer is vitally interested in the economical maintenance and proper operation of his elevators. A good many, however, fail to appreciate thoroughly the importance of proper lubrication and its direct bearing upon the operating efficiency of the elevators. Elevators need special lubrication and special lubricants. While most users do not buy inferior or cheap oils, they frequently obtain oils which are not of the correct constituents for use as applied. Otis Lubricants are produced with the one idea of sup-plying high grade lubricants, strictly for elevator apparatus - each lubricant compounded for a particular purpose…"

RE: excerpt from *Better Elevator Service* (ca. 1916)



"…There are eleven of these lubricants. They were adopted only after a careful study of what was required and analyses of tests covering a period of years. Long practical experience has proven that these lubricants can be recommended, without reservation, for the exclusive use of elevator operators or owners. A full supply is carried in stock at each Otis Service Office. The illustration shows the Otis lubricant cans in full color. The can containing each particular lubricant is easily recognizable by the color of its label and this has proved an added convenience in the handling of Otis lubricants…"

RE: excerpt from *Better Elevator Service* (ca. 1916)

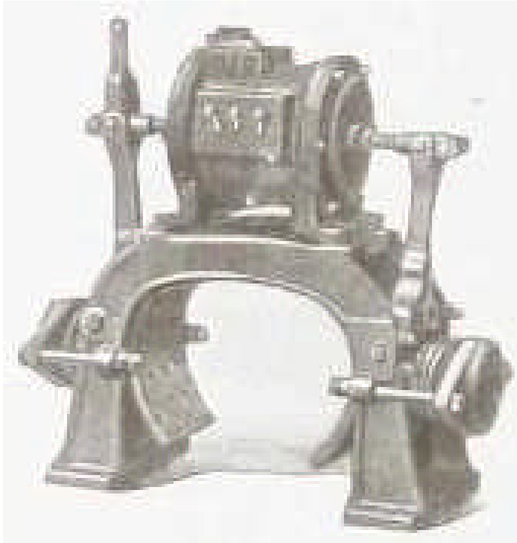
"…Open the main line switch when preparing to clean, oil or adjust any part of the machinery. Keep all parts of the machinery scrupulously clean. A pair of hand-bellows should be used to clean all parts of the apparatus that cannot be conveniently reached. All other parts must be wiped clean…All of the safety devices on the car frame and car should be examined at frequent intervals and all working parts kept clean, well lubricated, and free from rust*… *When ordering parts for any part of the elevator, mention the number of the machine as stamped on the Motor Name Plate. Also give Part Number and Name...Wearing parts are carried in stock for immediate shipment…"

RE: excerpt from *Better Elevator Service* (ca. 1916)

"…The motor bearings have automatic feed rings, which should always turn freely and the oil chamber must be kept sufficiently full of oil to insure the oil rings dipping into it. Use only Otis Motor Bearing Oil for these Bearings…"

RE: excerpt from *Better Elevator Service* (ca. 1916)

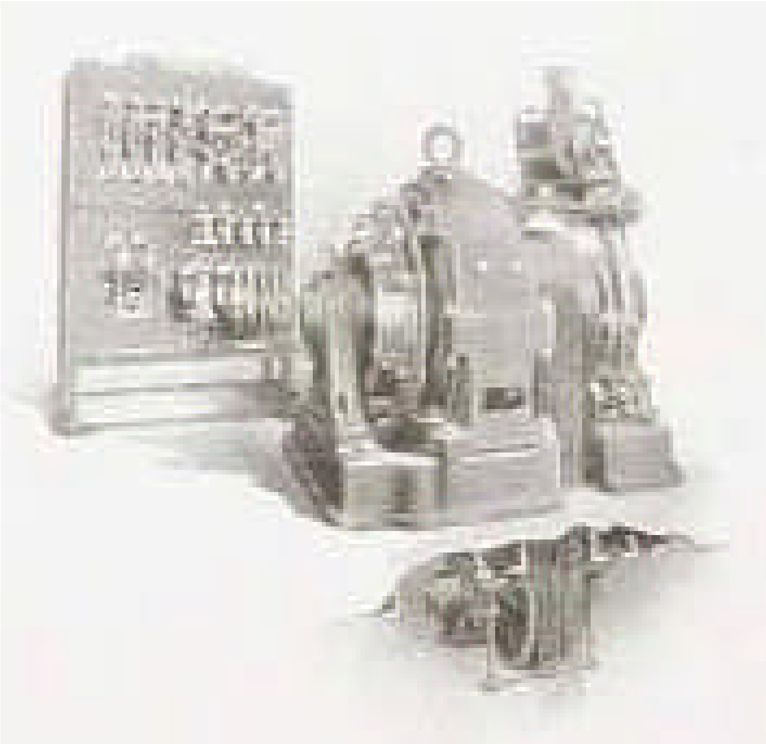
Left: caption: "Ball Bearing Lubricant. A non-corrosive compound free from acid and of a consistency to properly and thoroughly lubricate either slow or high speed ball bearings. Supplied in five pound cans only. "



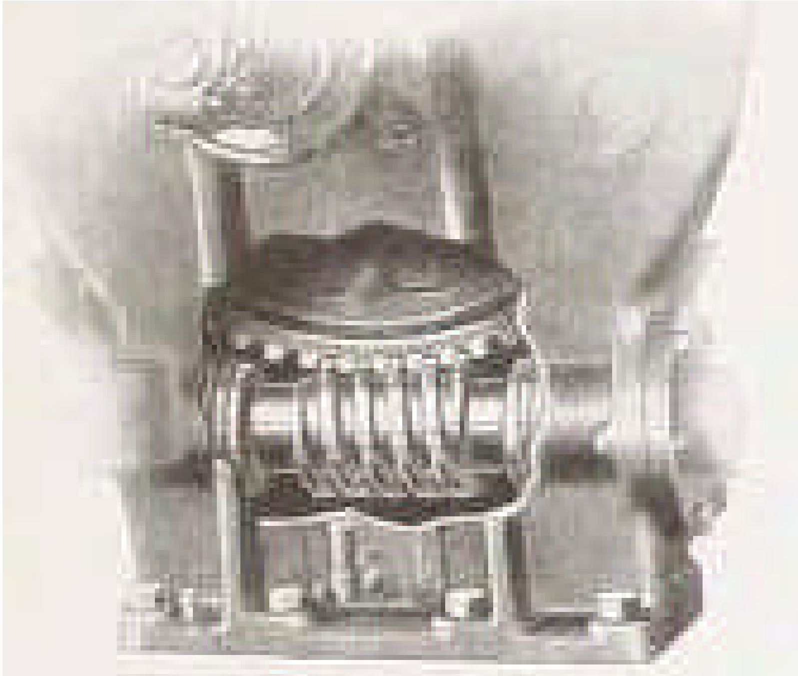
"…The oiling of Alternating Current Machines is the same as noted for Direct Current Machines excepting the Brake. This brake being housed in an oil tight housing, is flooded with oil. It is very important that the brake magnet case be kept well filled with oil. In view of the design and requirements of this brake, it is important to use only Otis Brake Magnet Oil in this Housing, otherwise the plunger will become gummed, and stick, and retard the operation of the brake magnet, tending to burn out the brake coil or magnet…"

RE: excerpt from *Better Elevator Service* (ca. 1916)

<u>Above</u>: caption: "A.C. Brake Magnet Oil. This oil (used in connection with alternating current brake magnets) is for dissipating the heat generated in the brake magnet coil. It is extremely important that this oil be used, as the brake is designed for its use and other oils will gum and stick the core of the magnet, or in other ways vary the speed of the brake plunger. Some cases have been called to our attention where the use of other oils has been the cause of the brake's refusing to release with the current on. with consequent burning out of the motor coils. This oil has superior insulating qualities as well as being free from acid and, therefore non-corrosive. Supplied in one gallon and two gallon cans."



Left: caption: “Traction Bearing Oil. This oil is used for lubricating the bearings of the gearless traction machines, where solid bearings have been furnished. The regular motor bearing oil should not be used for this purpose, as it has been found to be entirely too light. Supplied in two and five gallon cans.”



"…Always keep the gear case filled to top of worm-shaft. The stand pipe on the side of the gear case should be used to determine if sufficient oil is used. To remove the sediment and grit from gear case, drain oil at least twice a year and wash the housing with kerosene oil. Always refill the housing with fresh oil. Use only Worm Gear Lubricant for the Worm and Gear…The worm shaft bearings are automatically oiled from the gear case, and the oil should be allowed to drip slowly through the worm shaft gland to insure perfect lubrication of this bearing. Use drip pan to catch this oil. The worm shaft stuffing box must be kept packed with soft square braided flax packing. The gland adjusting nuts must be tightened evenly to prevent binding of the worm shaft…"

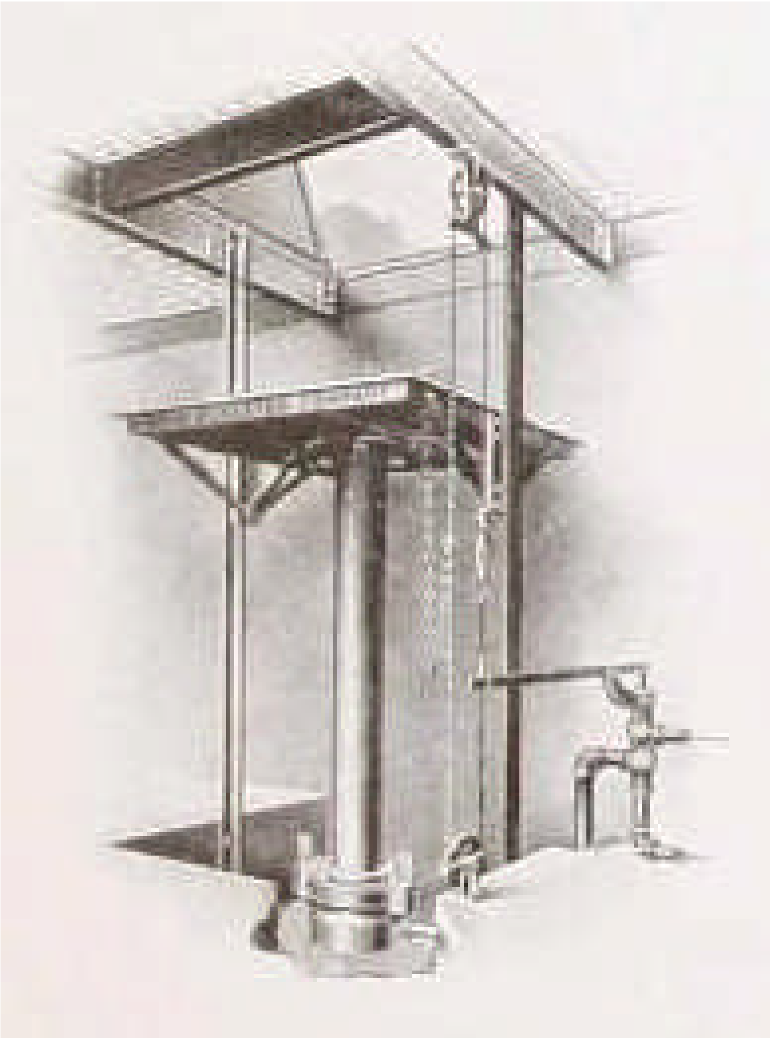
RE: excerpt from *Better Elevator Service* (ca. 1916)

Above: caption: "Worm Gear Lubricant. This oil has been found to give the best results for worm gear lubrication. It consists of high grade vegetable castor oil mixed with a mineral cylinder stock. This compounding process is a matter of experiment with most oil retailers and it was only after tests covering a period of several years that Otis Worm Gear Lubricant was developed to a point of proper consistency and quality. Supplied in two gallon and five gallon cans."

"…Oil sparingly the pins and moving parts of the different switches with Otis Motor Bearing Oil…"

RE: excerpt from *Better Elevator Service* (ca. 1916)

<u>Left</u>: caption: "Motor Bearing Oil. An excellent quality of high speed bearing oil. It is used for motor bearings and for small working parts where a light oil is required. This oil will not gum or stick nor will the heat developed in high speed bearings thicken the oil to make it useless. Supplied in one and two gallon cans."



<u>Left</u>: caption: “Plunger Lubricant. A white grease which has been found very satisfactory for lubricating plungers and the cylinders of horiz-ontal hydraulic elevators. Graphite plunger grease is sometimes used but this is not necessary unless the surfaces have become scored or rough. Supplied in five and ten pound cans.”

"…Both wood and steel guides are used for guiding the car and counterweights. Some Engineers have preferred to install automatic lubricators which automatically feed oil on the guides. However, where lubricators are not used, we would recommend the use of Otis Guide Grease for this purpose…"

RE: excerpt from *Better Elevator Service* (ca. 1916)

Left: caption: "Guide Lubricant. Particularly desirable for both wood and steel guides, when automatic lubricators are not used. It is less apt to dry or gum than the average lubricant and will not run on the guides. Supplied in five, ten and twenty-five pound cans."

"… Lubricate the drum or sheave shaft bearings every day…Keep the compression grease cups on the vibrator sheaves of drum machines filled and sufficiently compressed to feed the lubricant. This also applies to sheave bearing boxes of the drum type machines. Use only Otis Compression Cup Grease for this purpose…"

RE: excerpt from *Better Elevator Service* (ca. 1916)

Left: caption: "Compression Cup Grease. A lubricant that is particularly suited for lubricating sheaves and all bearings where grease cups are furnished. It is free from acid and will not harden in the cups. Supplied in two, five and ten pound cans."

"…The secondary sheave bearing of the worm geared traction machines should be given the same care and attention as the motor bearings; the oiling chains should turn freely and the bearings properly supplied with oil. The governor bearings and gears must be lubricated frequently. The governor pawl bearings should be kept well oiled and should always be perfectly free, so that the pawls will fall against the governor rope when the latch is raised. Keep all pins and moving parts well oiled. Keep the compression grease cups on the vibrator sheaves of drum machines filled and sufficiently compressed to feed the lubricant. Use only Otis Compression Cup Grease for this purpose…"

RE: excerpt from *Better Elevator Service* (ca. 1916)

"…Examine the oil buffers under the car and counterweight of traction machines frequently, and be sure that they are filled with oil to height of the pet cock. As these buffers are designed to operate with oil of a certain consistency, it is very necessary to use Otis Buffer Oil for proper operation of the buffers…"

RE: excerpt from *Better Elevator Service* (ca. 1916)

<u>Left</u>: caption: "Buffer Oil. This oil has been selected after being found entirely suitable for the purpose. The graduated parts of Otis Buffers have been proportioned for the use of this oil and their successful operation depends upon the circulation of oil through the oil chambers. It is very essential that buffers be occasionally inspected to ascertain if they are filled with oil, otherwise rust or corrosion affect the operation of the plunger. Supplied in two gallon and five gallon cans."

"…The cables on all types of elevators are subjected to varied strains and unusual wear and the lubrication of cables has been a problem not easily solved. Cables on all types of elevator machines should be lubricated to obtain the greatest possible service. Use only Otis Wire Rope Lubricant for this purpose…"

RE: excerpt from *Better Elevator Service* (ca. 1916)

Above: caption: "Wire Rope Lubricant. A compound especially manufactured for this company and which has been found particularly satisfactory for lubricating and preserving wire ropes. This compound distributes itself throughout the rope and lubricates each individual wire, it also penetrates the core of the rope and serves to prevent moisture from collecting at the core and rusting the internal wires. Only carefully selected oils are used, oils that will neither drip nor gum. Supplied in one gallon cans or barrel and half-barrel lots."

"…Hydraulic Lubricant is a specially compounded soluble oil, being free from acid or other injurious alkali. Will not corrode linings or wearing parts and will materially prolong the life of cup leathers or packings. To obtain best results, one gallon of this lubricant is used to every one thousand gallons of water. After first charge this proportion can be increased as demands warrant. One charge will lubricate the water for a period of from four to six months, depending upon the service required of the elevators. Supplied in five gallon cans, half barrels and barrels…"

RE: excerpt from *Better Elevator Service* (ca. 1916)

This Commuter

Her suburb is the upper floor of a city building. She has chosen convenience of location in preference to roomier surroundings. Still she is a commuter — a commuter by elevator. Every day she and her family use this conveyance that travels up and down. And good elevator service is as important to her as good train service is to the suburbanite.

Good elevator service is vital to satisfaction of tenants and elevator maintenance is something not to be passed over lightly by the building owner or manager. What is good maintenance? Who has the equipment and knowledge to supply this type of elevator care?

Good maintenance should not just keep the elevators running but should keep them running perfectly as well. Should insure comfort and safety and complete passenger confidence. Should see to it that the elevators are always in as good condition mechanically as when they were first installed.

The manufacturer should be able to best provide this type of care. He built the elevator and installed it — he knows all about it from stem to stern. He has facilities and knowledge at his command that are not available to an isolated maintenance service, no matter how conscientious that organization or man. And this is why Otis Elevator Company organized its own nation-wide Maintenance Service some years ago. A service that is as dependable as an Otis elevator itself.

This Otis Maintenance Service is available at a reasonable, fixed monthly rate. And we invite you to ask your local Otis office to inspect your elevators and explain Otis Maintenance in relation to your own building. No obligation whatever.

OTIS ELEVATOR COMPANY

<u>Left</u>: caption: "…Good elevator service is vital to satisfaction of tenants and elevator maintenance is something not to be passed over lightly by the building owner or manager. What is good maintenance? Who has the equipment and knowledge to supply this type of elevator care? Good maintenance should not just keep the elevator running but should keep them running perfectly as well…The manufacturer should be able to best provide this type of care. He built the elevator and installed it - he knows all about it for stem to stern. He has facilities and knowledge at his command that are not available to an isolated maintenance service, no matter how conscientious that organization or man. And this is why Otis Elevator Company organized its own nation-wide Maintenance Service some years ago…"
(1934 Otis ad)

Otis' annual reports began commenting on the performance of maintenance in 1932; the year the value of service bookings first outstripped the value of escalator and elevator sales combined. The company continued to earn more from its Service Department than from new sales until 1946.

<u>Left</u>: Otis advertisement (ca. 1946). In 1938, Otis opened a service office for maintaining and servicing elevators in the area between 59th Street and 125th Street in NYC. The new office was at 1999 Broadway.

"There is no other maintenance service like Otis Maintenance - anywhere. It can be obtained by phoning your local Otis office."

RE: excerpt from a 1947 Otis advertisement. In 1936, Otis published a book entitled: *The Maintaineer*. It codified service practices and launched a sales initiative for service contracts that boomed in the 1940s.

The Success of the Building Served

"…Otis developments, extending over a period of eighty-seven years, have created and are continuing to maintain a line of elevator equipment specifically designed to fulfill all the requirements of vertical transportation so far encountered. However, a high standard of elevator service depends, not only upon the use of well designed and carefully manufactured equipment, but upon the number, location, capacity and speed of the elevators specified, and upon the type of control, accessories and method of operation. Upon the correct determination of each of these variable factors depend the adequacy and quality of the elevator service, and, in many instances, the utility and commercial success of the building served…"

RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators*

"…Otis engineering experie-nce and facilities are avail-able to architects, engineers and building owners without obligation for the purpose of recommending the proper eq-uipment for conditions com-monly encountered or for pro-viding the solution to any pro-blem of vertical transportat-ion, however unusual…"

RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators*

Part 2

Reach for the Sky

How High?

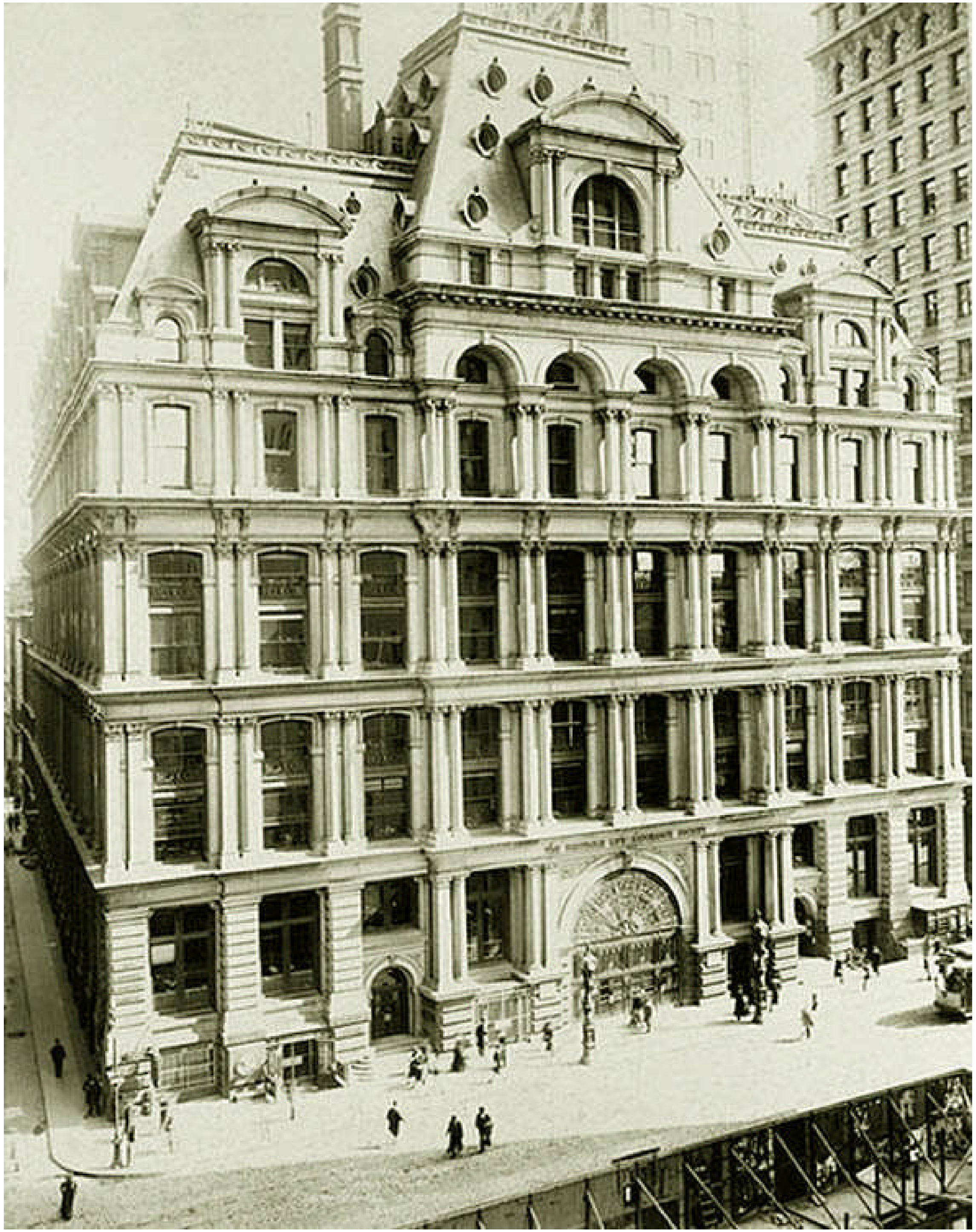
"…Never had there been such splendor in the great city, for the victorious war had brought plenty in its train, and the merchants had flocked thither from the South and West with their households to taste of all the luscious feasts and witness the lavish entertainments prepared - and buy for their women furs against the next winter and bags of golden mesh and varicolored slippers of silk and silver and rose satin and cloth of gold…"

RE: excerpt from F. Scott Fitzgerald's *May Day*

<u>Left</u>: caption: "Audacious engineers are filling our popular publications with descriptions of the cities of the future. We have all seen their prophetic pictures: tiers of gigantic buildings rising one hundred, two hundred, three hundred stories above four or five levels of street. All the ingenuity of these prophets is required to explain away, even theoretically, certain problems of construction. *IF* this material can be made to bear so much strain; *IF* means can be devised to ensure a solid foundation – *IF*, *IF*. One important detail, however, is always taken for granted. 'There will be express elevators,' they say, 'from the various street levels to the hundredth and two hundredth floor.' *THERE WILL BE! We find no 'if'* in connection with the elevators. For all builders have come to expect a perfect solution of every interior transportation problem, no matter how audacious. As the cities of the future are being planned, the OTIS COMPANY expects that dependable vertical transportation will continue to be taken for granted by architects, engineers, and the public."

"…When elevators and steel or iron girders and frames were only architectural dreams, owners of land could find no way to erect buildings which would yield a profitable rent. Rock foundations were not sought by boring to any great depth in those days, and very thick and costly walls were built to support even five- and six-story buildings. But when these were built, tenants would not climb more than one or two flights of stairs and pay a fair rental…"

RE: excerpt from *The Master Builders: A Record of the Construction of the World's Highest Commercial Structure* (1913)



"…But in 1859 the elevator was patented, and after some years of experimenting it was adopted in the first Equitable Building at 120 Broadway in 1870. Real estate men laughed at the innovation and prophesied empty offices above the second floor, but they were all wrong. The elevator was a success from the start and all the offices had tenants very quickly…."

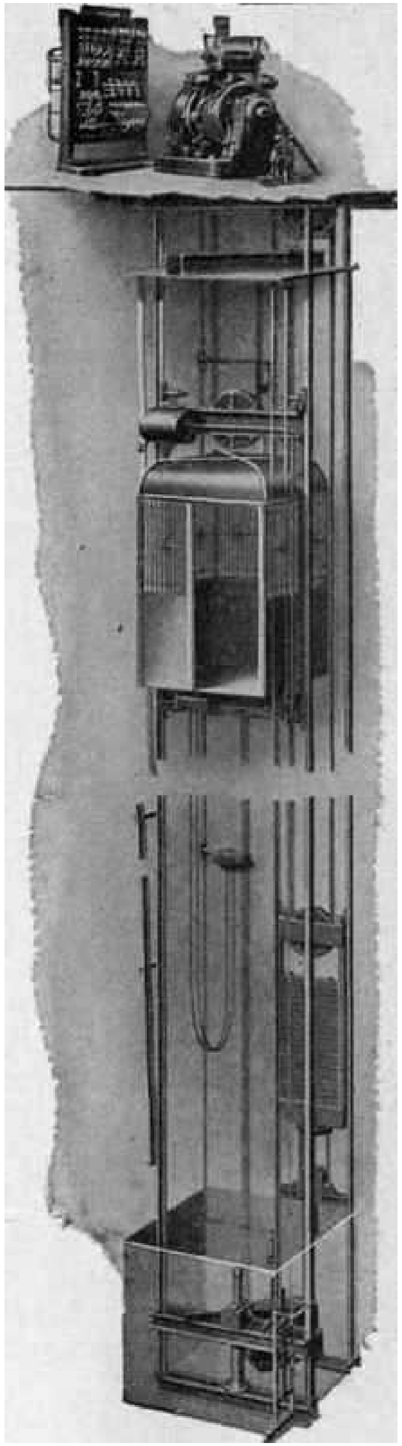
RE: excerpt from *The Master Builders: A Record of the Construction of the World's Highest Commercial Structure* (1913)

<u>Left</u>: the *Equitable Life Assurance Building* (ca. 1890)

"Elevators became an essential part of office building construction. This new means of vertical transportation brought about a complete reversal of building operations and rental policies. The lower floors were no longer as desirable as they were in non-elevator buildings because the demand now shifted to the upper stories which were removed from the noise and dust of the street. The upper floors actually commanded higher rents."

***William T. Hogan*, Author (ca. 1900)**

RE: with the advent of high-speed elevator service, the lower floors of buildings would no longer be as desirable as the higher floors thanks to the *Gearless Electric Traction Elevator*



In the 1880s, *Otis Brothers & Co*mpany, established electric power as the paradigm in elevator design. Along with the cage frame, the electrical elevator lead directly to the birth of the *Skyscraper*, but acceptance of the electrified elevator came slowly. Electricity was a new technology and a source of both fear and wonderment. Electricity was a mysterious, unseen force that moved through slender wires. It could magically light a room or street - but it could also kill. Fear of electrical energy was bad enough, but anxieties were increased significantly when coupled with the thought of being suspended in an elevator twenty or more stories above the ground. Considerable progress was needed before electricity could be used and accepted in elevators. It took several decades to move from Siemens' demonstration elevator to one that could move people swiftly and safely in tall buildings. The first electric elevators were geared thus, they were very slow making high floors less desirable.

Left: caption: "A Complete Installation of a 2:1 Electric Geared Traction Passenger Elevator, Showing Machine and Controller at Top of Hatchway"

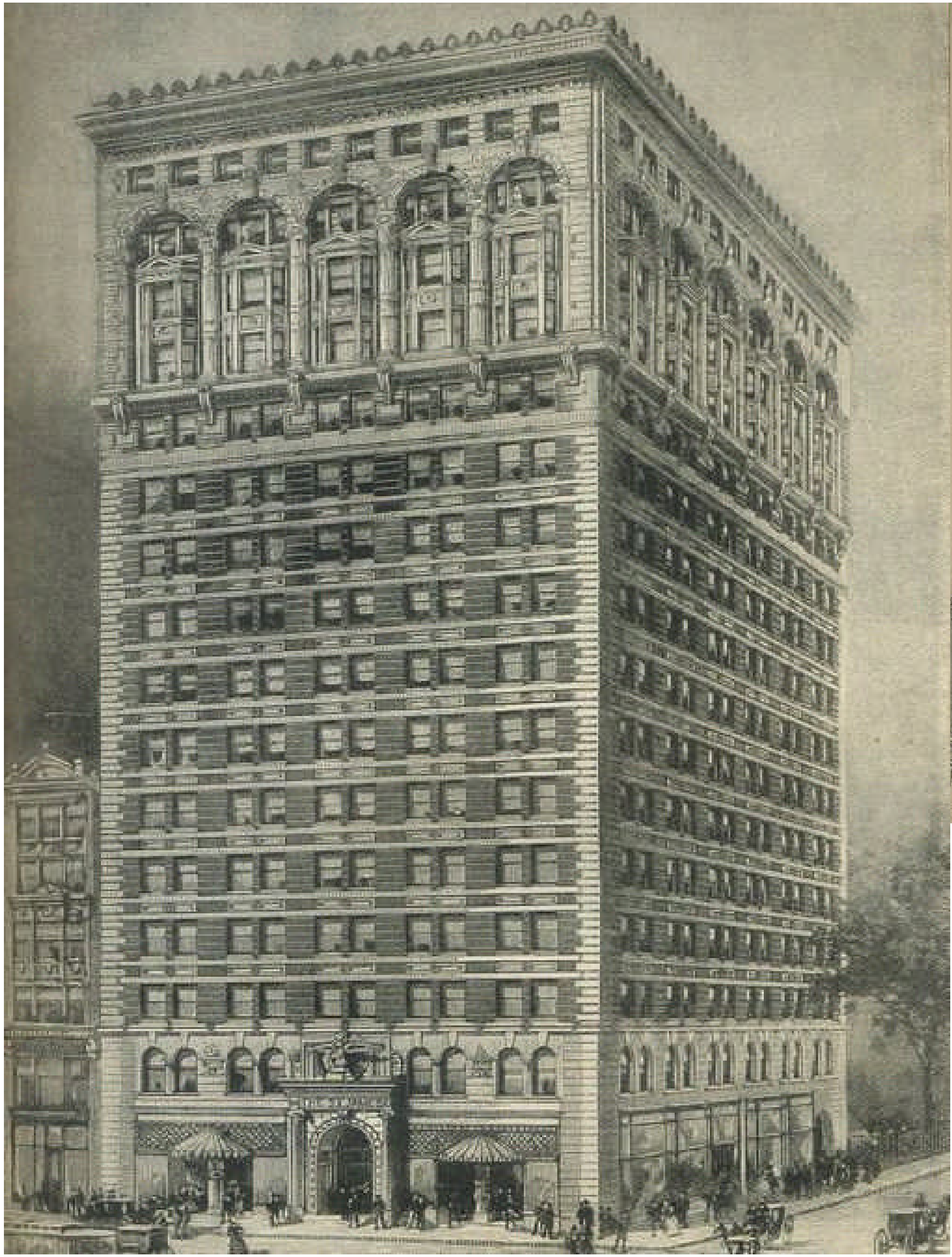
"Elevator service to the upper floors of the very high buildings has proved insufficient, so that the present practice has settled down to the erection of buildings of 200 to 250 feet in height, containing fifteen to eighteen stories"

***R.P. Bolton*, Author (ca. 1900)**

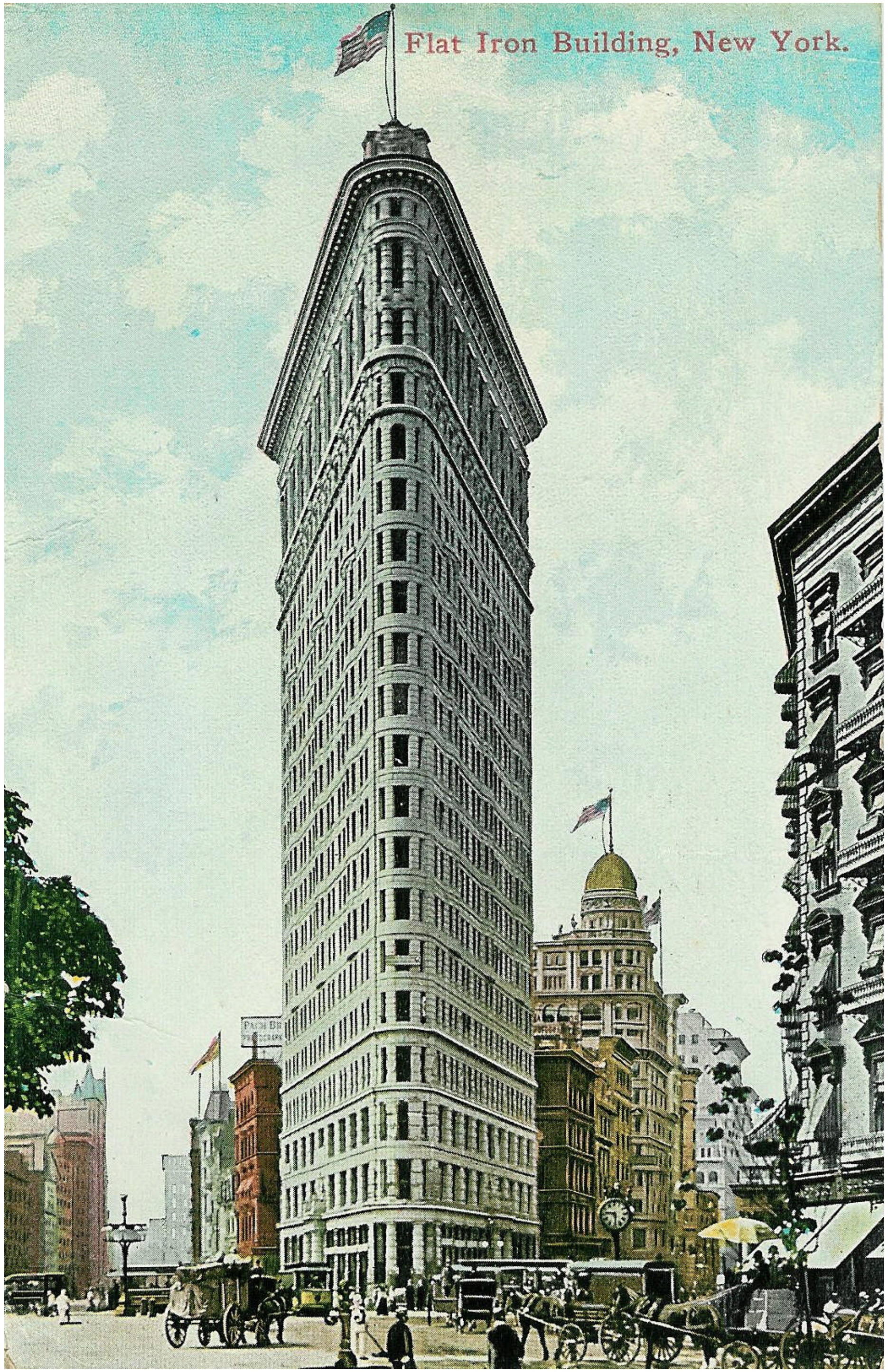
Above: caption: "The Sky Line of New York – The Skyscrapers at the South End of Manhattan Island." The photograph, along with fifteen other illustrations of NYC's landmark skyscrapers, appeared in the March 1898 issue of *Munsey's* magazine. The article was entitled: "The Tall Buildings of New York." It talked about early skyscrapers at a time in which there was great wonder at the rapid progression from ten-story sky-scrapers to those of twenty to thirty stories in height.

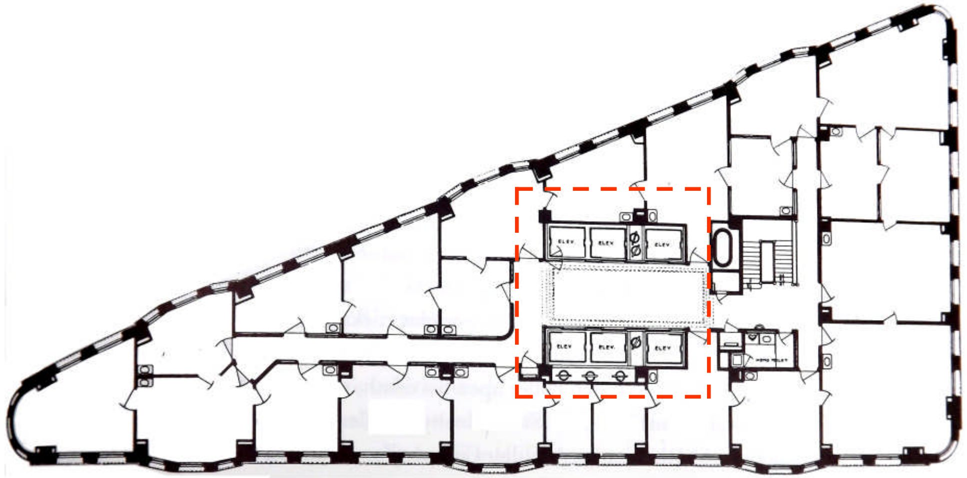
<u>Above</u>: caption: "The Waldorf-Astoria Hotel, 34th Street and Fifth Avenue"
<u>Left</u>: caption: "The American Surety Company's Building, Pine Street and Broadway"

<u>Above</u>: caption: “The Metropolitan Life Insurance Company's Building, Madison Square”
<u>Left</u>: caption: “The New York Life Insurance Company’s Building, 346-348 Broadway”

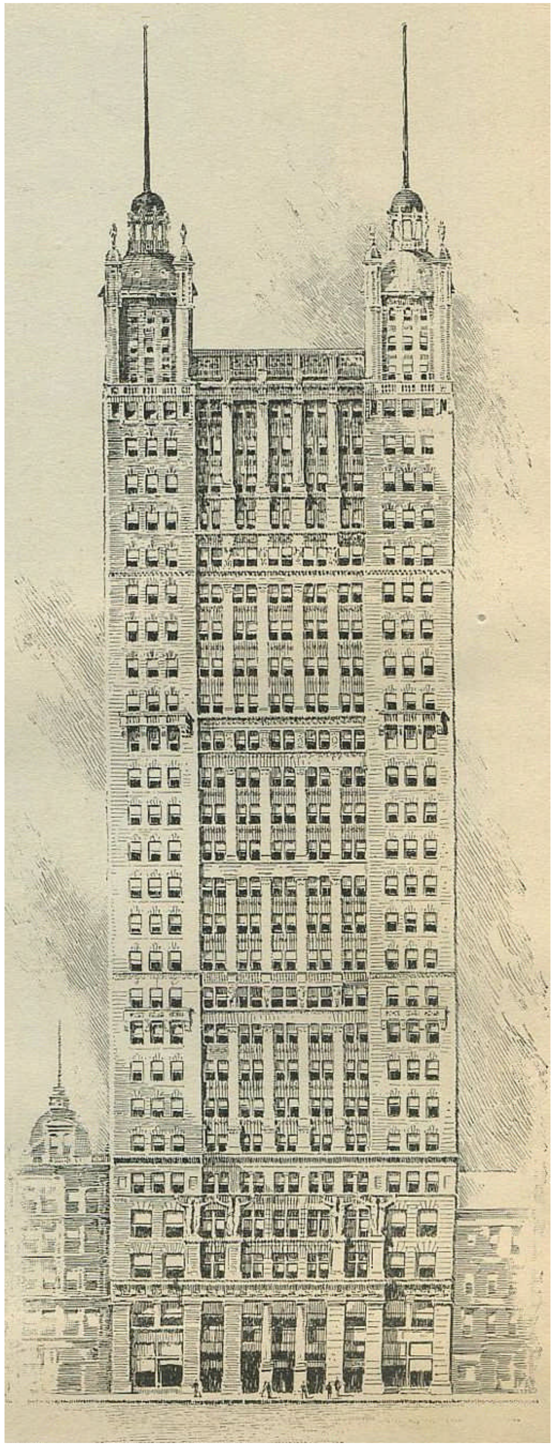


<u>Above</u>: caption: “The Empire Building, Rector Street and Broadway”
<u>Left</u>: caption: “The St. James Building, 26th Street and Bro-adway





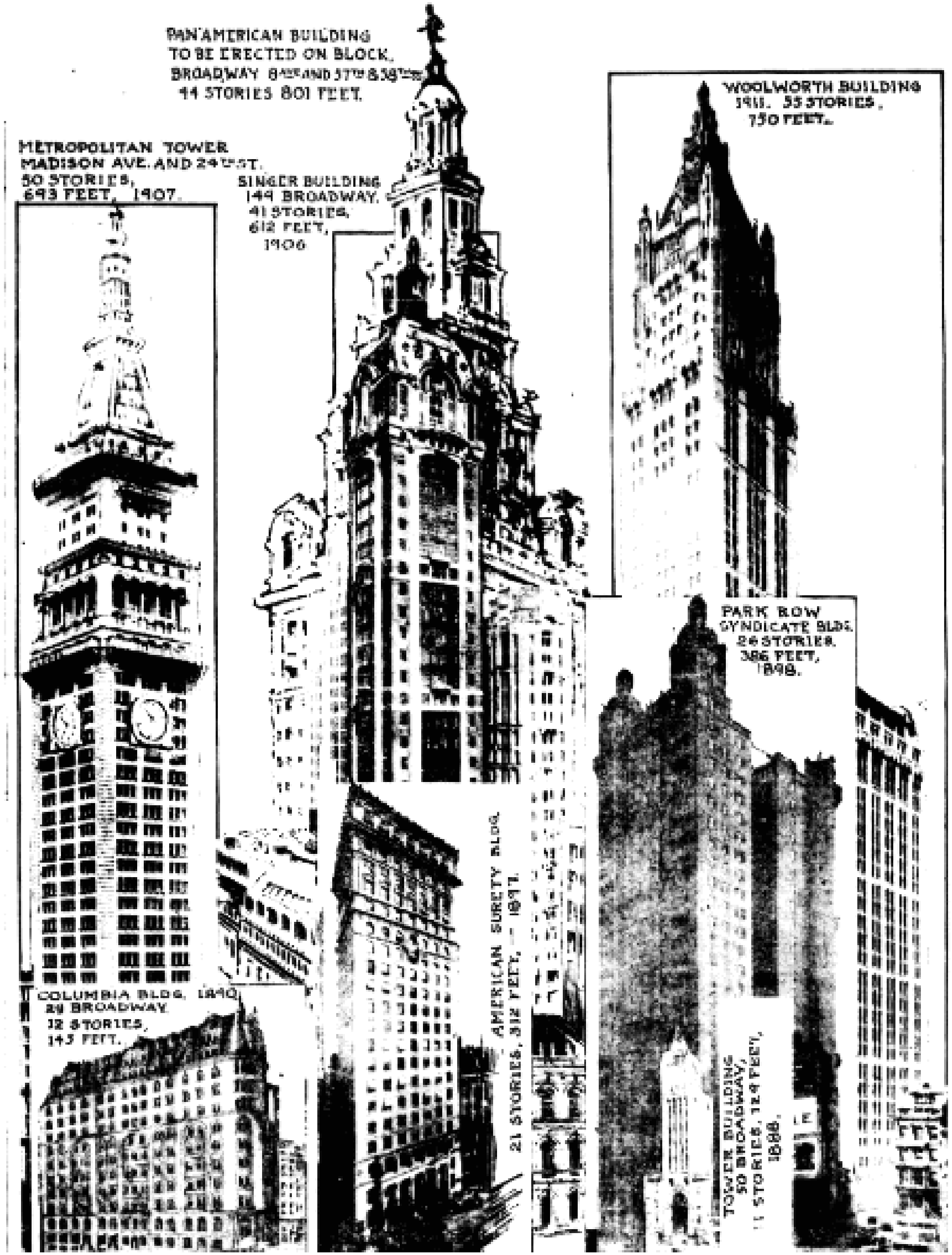
Among the Otis-equipped early skyscrapers in NYC was the *Flatiron Building* (left). Also known as the *Fuller Building*, the 20-story Flatiron Building was completed in 1902. The original elevator equipment consisted of six Otis vertical cylinder hydraulic elevators (highlighted, in typical floor plan above) with a speed of 600 fpm.



"…To a very large extent the success of the modern high office building as a paying investment must depend upon its elevator service. Every floor must be readily acc-essible and must be reached in the shortest possible time. During business hours time is too valuable to be wasted in waiting long for an elevator, or in spending ten, or even five, minutes in reaching a floor which should be reached in as many seconds…"

RE: excerpt from *The Master Builders: A Record of the Construction of the World's Highest Commercial Structure* (1913)

Left: caption: "The Ivins Syndicate Building, 13-21 Park Row" (a.k.a. "Park Row Building," 1899)



"…It is only forty-three years since the installation of the first elevator in a New York City office building, and about a quarter of a century since the first steel skeleton was erected to be enveloped in stone or terra cotta…"

RE: excerpt from *The Master Builders: A Record of the Construction of the World's Highest Commercial Structure* (1913)

Left: illustration accompanying an article appearing in *The Sun* dated January 4th 1914 entitled: "City's First Skyscraper Now Being Razed While New Giant 800 Feet High Is Planned"

“There is no legal limit to the height of buildings now, and so far as I can see, there is no need for any such limit. Just so long as builders comply with all the regulations of the de-partments controlling the size and depth of the found-ations they can go on raising their structures in the air until they more than double their present height. The 100-story building I believe to be not only possible, but practicable. Certainly on all grounds of safety there will not be any objection to a structure of that height. To prophesy for the future a little, it seems to me that the era of tall buildings has just begun. Tall as the forty-six-story building to be built by the Metropolitan Life Insurance Company may seem at present, I am positive we shall often see it equaled, beaten and perhaps actually doubled in size.”

***Edward S. Murphy*, NYC Superintendent of Buildings (ca. 1907)**

The World Magazine

How Far Can New York Climb Into the Sky?

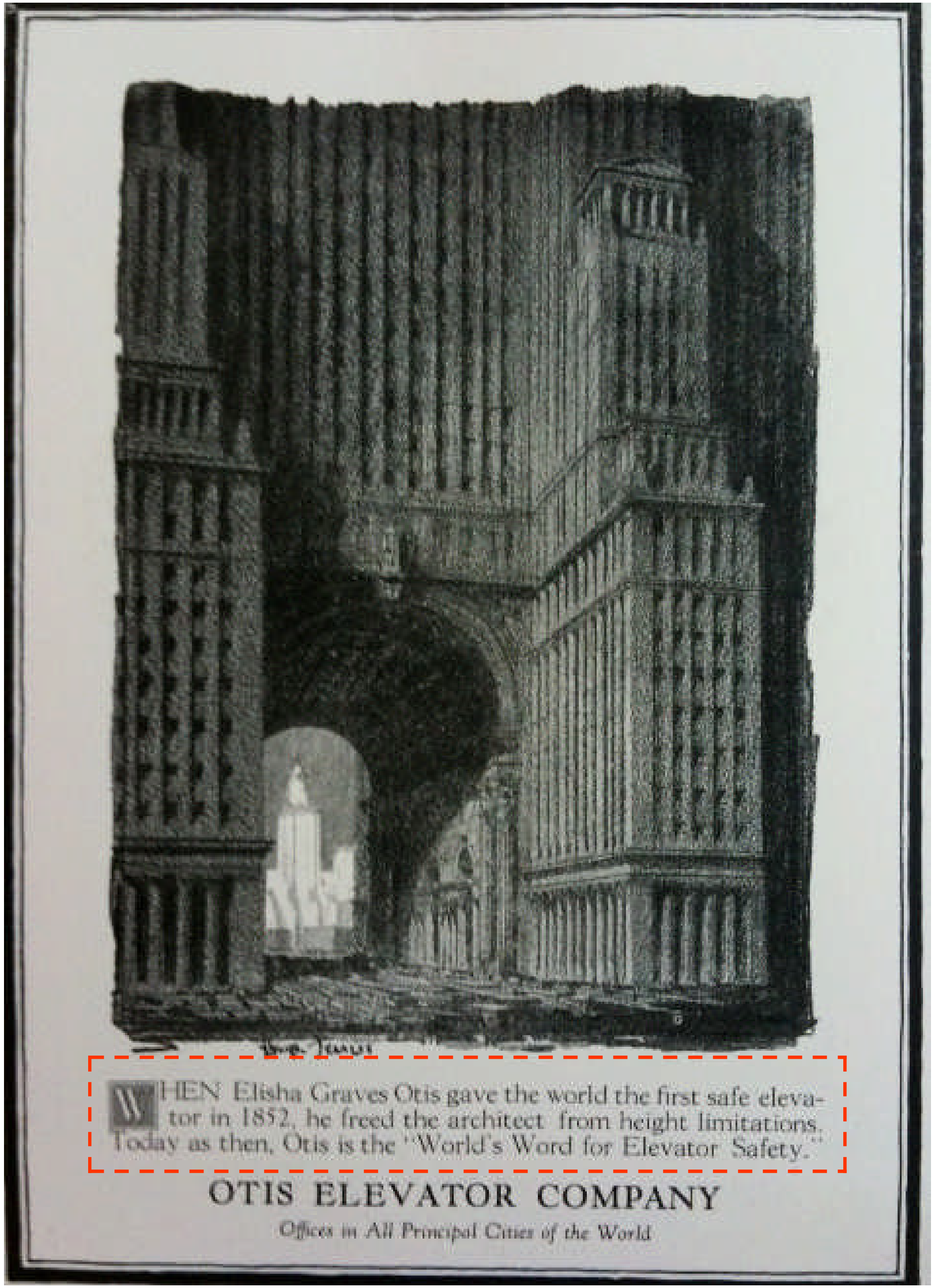
THE FORTY-SIX STORIES for the NEWEST SKYSCRAPER WILL BE WITHIN FOUR STORIES of the LIMIT, DECLARES ARCHITECT HOPPIN, but the NEW YORK BUILDING SUPERINTENDENT Says ONE HUNDRED STORIES ARE POSSIBLE.

The popular interest in skyscrapers can be seen in the illustration published on the cover of the *Sunday World Magazine* on January 20th 1907 (left) in an article entitled: "How Far Can New York Climb into the Sky?," which pictures an assembly of the city's tall towers (at the time) packed into the space surrounding *Trinity Church* on lower Broadway at Wall Street. A key in the corner identifies the structures, including the newspaper's own headquarters; the *Pulitzer Building* (a/k/a "World Building" – highlighted, with dome - at far right) which was the world's tallest office building from 1890 until the completion of the *Park Row Building* in 1899.

The great breakthrough came in 1902, when the *Otis Elevator Co*mpany, after a costly R&D effort, pioneered the first *Gearless Electric Traction Elevator*. First installed in a NYC building in 1904, the innovation was an ingenious combination of electrical and mechanical sub-systems. Almost overnight, this new electric elevator rendered the geared electric and the faster hydraulic elevator obsolete for tall buildings, opening up a whole new world of possibilities for architects and the skyscraper form. From 1906 to 1912, several buildings forty-six stories and taller were built in NYC including: the *Singer Building* (1908), the *Metropolitan Life Tower* (1909) and the *Woolworth Building* (1913). In fact, the first telephone was installed in one of the Otis elevators built for the Singer Building (left). Eventually, all sixteen elevators had telephones linked to all forty-two floors. The addition of electro-mechanical and, later, electronic-switching devices, enabled gearless traction electric technology to make even taller buildings like the *Chrysler* (1930) and *Empire State Building/s* (1931) possible.


THE INDICATOR

In July 1908, the first edition of *The Indicator* (“Published for Employees of the Otis Elevator Company”) was published (1911 edition, at left). The artist for the masthead (highlighted) used part of an elevator enclosure. According to the publication, the dial in the masthead indicated: “the extreme height (fortieth floor) to which elevators have been carried at the new Singer Building.”



The *Otis Elevator Company* (and other large elevator manufacturers in the U.S.) were able to establish offices in many of the major cities of Europe and compete very successfully with local firms. This in spite of higher costs for shipping. Continued elevator improvement was an essential factor in the rapid increase of building heights. However, considering the situation in European cities (where buildings of over ten-stories were, and still are, rare) points to the fact that European cities did not develop in the same manner which characterized urban growth in American cities. The American tendency to confine commercial activity in a small area resulted in excessive land values, which drove buildings skyward. Therefore, the elevator industry in America had to keep pace with the development of tall buildings in a way their European rivals never had to.

Left: caption: "When Elisha Graves Otis gave the world the first safe elevator in 1852, he freed the architect from height limitations. Today as then, Otis is the 'World's Word for Elevator Safety'"

Top Floor, Please

“…Then they were in an elevator bound skyward.
‘What floor, please?’ said the elevator man.
‘Any floor,’ said Mr. In.
‘Top floor,’ said Mr. Out.
‘This is the top floor,’ said the elevator man.
‘Have another floor put on,’ said Mr. Out.
‘Higher,’ said Mr. In.
‘Heaven,’ said Mr. Out…”

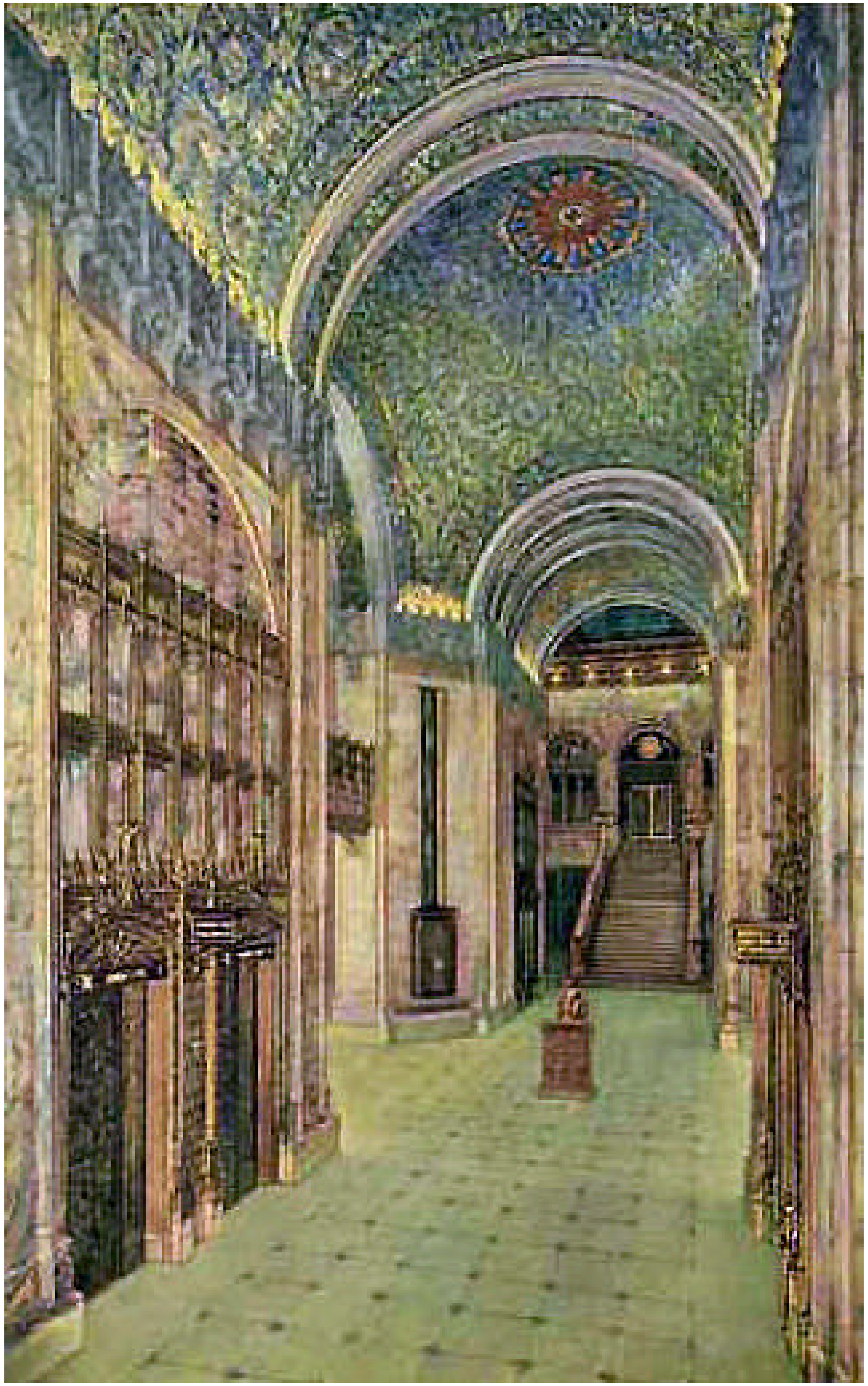
RE: excerpt from F. Scott Fitzgerald’s *May Day*

The Question of Elevators

"…Perhaps the most difficult problem in a structure as tall as the Woolworth Building is the question of elevators. The Building's success depends largely upon the adequacy, safety and regularity of the elevator service. The architectural design of the Building, together with the peculiarities and difficulties of its structural steelwork, to a very great extent govern the number, arrangement and grouping of elevators. This important feature has been carefully studied, and as a result, 29 high-speed electric traction elevators afford excellent service throughout the 24 hours of each day, every day in the year, Sundays and holidays included…"

RE: excerpt from *The Cathedral of Commerce* (1918). *Frank W. Woolworth* had heard of several elevator disasters in other tall buildings thus, he instinctively understood the real concerns of potential tenants and determined to have the world's safest elevators built for his new *Woolworth Building* (left).

Safety, Reliability, Speed & Simplicity



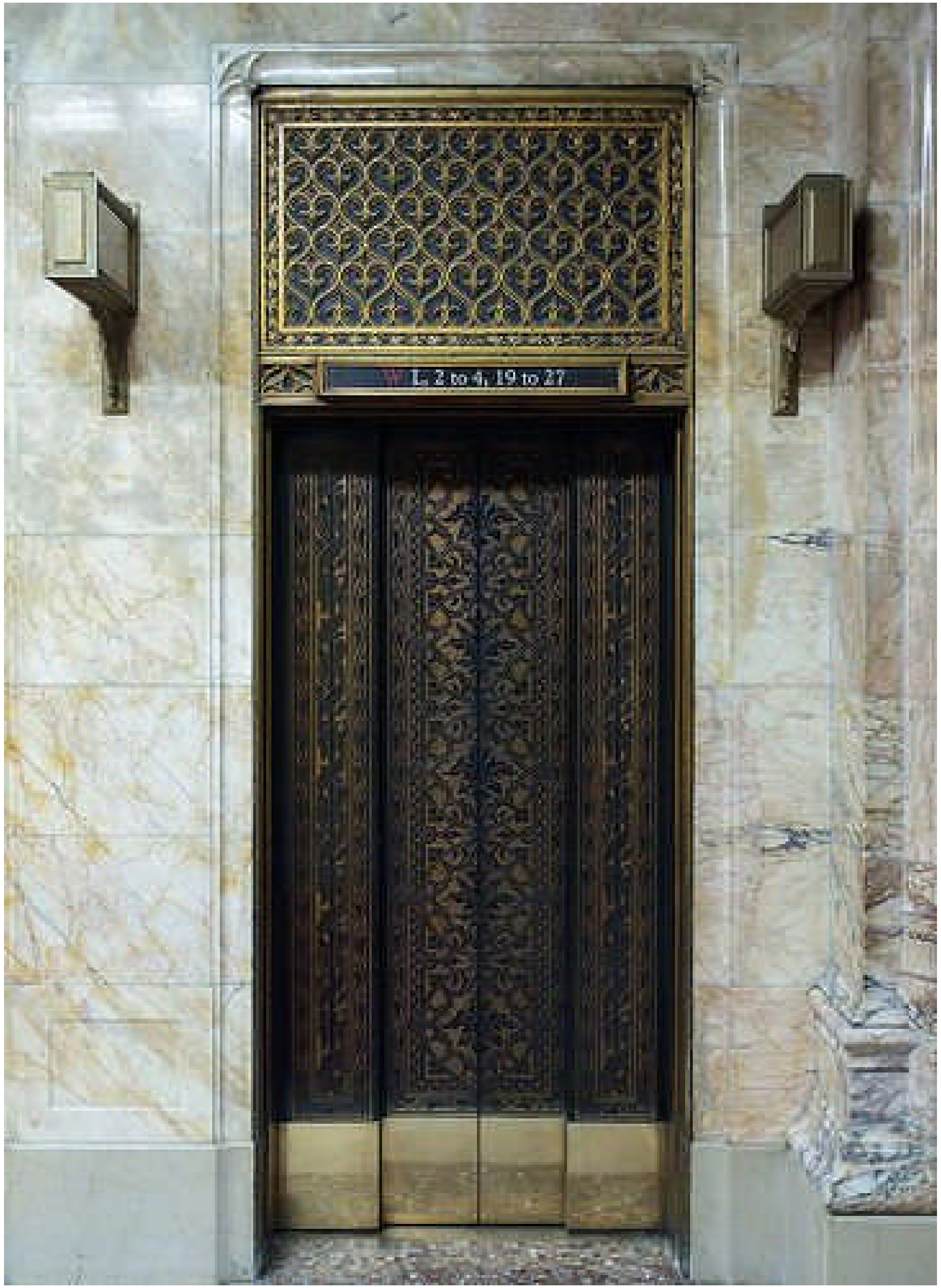
"…It was considered fitting that a building of such architectural excellence and completeness as the Woolworth should be provided with the most modern transportation facilities. With a view to selecting the best, all the different elevator systems in use were carefully investigated and tested, having in mind the extraordinary height of this building, as well as the many floors to be served. As a result of this investigation, in which safety, reliability, speed and simplicity were paramount to every other consideration, the contract for the entire equipment was awarded to the Otis Elevator Company of New York…"

RE: excerpt from *The Master Builders: A Record of the Construction of the World's Highest Commercial Structure* (1913)

<u>Left</u>: postcard view of the Woolworth Building's ornate lobby

“When we installed our elevators in the Woolworth Building we were met by a problem which, while not entirely new, we were forced to solve in a different way. It is only in this building that elevators run uninterruptedly for fifty stories and more, so that the matter of safety had to be attended to with special care; we arranged the shafts in a manner to allow a car to drop from the top floor without danger to the passengers; ordinary doors could not withstand the pressure generated at the bottom by such a drop, so the thickness of the enclosure doors, as well as the height of the air-cushions, were increased; the increase in weight of the doors was such that it became unpractical to work them by hand and we installed an automatic system. The air-cushions cover a fifth of the shaft, and are so safe that recently, when a test was made at the Empire Building, a car containing a basket of eggs was allowed to drop twenty floors and when it was checked in its downward flight by the air cushions, it was found that not an egg had been injured. The elevator system in the Woolworth is unique, not from the number of elevators – there are only twenty-nine – but from the fact that in a building of that height the rapidity of transportation becomes of the utmost importance. It is the fastest service in the world; the cars easily attain a speed of seven hundred feet per minute, and they are all controlled from one central station; the dispatcher, by means of miniature lamps on a position indicator, can read the exact location of all the cars, whether stationary or in motion.”

***Otis Elevator Company* (ca. 1915)**

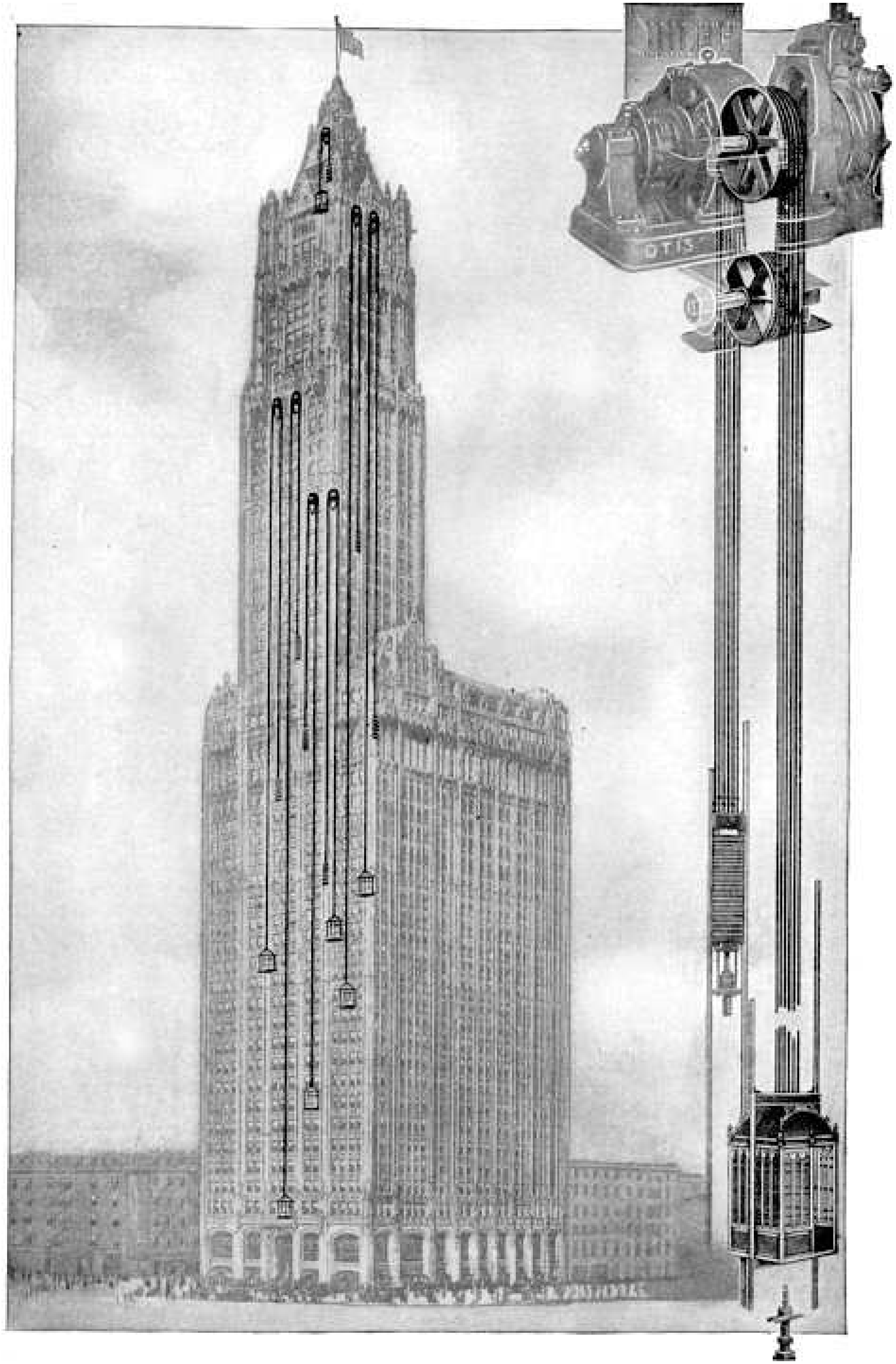


"…These elevators travel on a headway of twenty-five to thirty-five seconds during business hours, which means that a car is available to carry passengers up or down from any floor about every half-minute, and this service is faithfully maintained. In order to get tenants, their employees and clients to and from the offices with the least possible delay, many of the elevators are operated at a speed greater than that maintained in any other building, yet they travel so smoothly and noiselessly that their movements are scarcely observed…"

RE: excerpt from *The Cathedral of Commerce* (1918)

"…The elevator equipment, which is the most important part of the mechanical equipment of the building, consists of twenty-nine Otis Electric Elevators. Of these, twenty-seven are for the use of the public, seven serving the tower, and twenty the main building. In addition, there is an automatic push-button elevator for the private use of the Irving National Bank, and an ash lift which runs from the sub-basement to the sidewalk…"

RE: excerpt from *The Master Builders: A Record of the Construction of the World's Highest Commercial Structure* (1913)

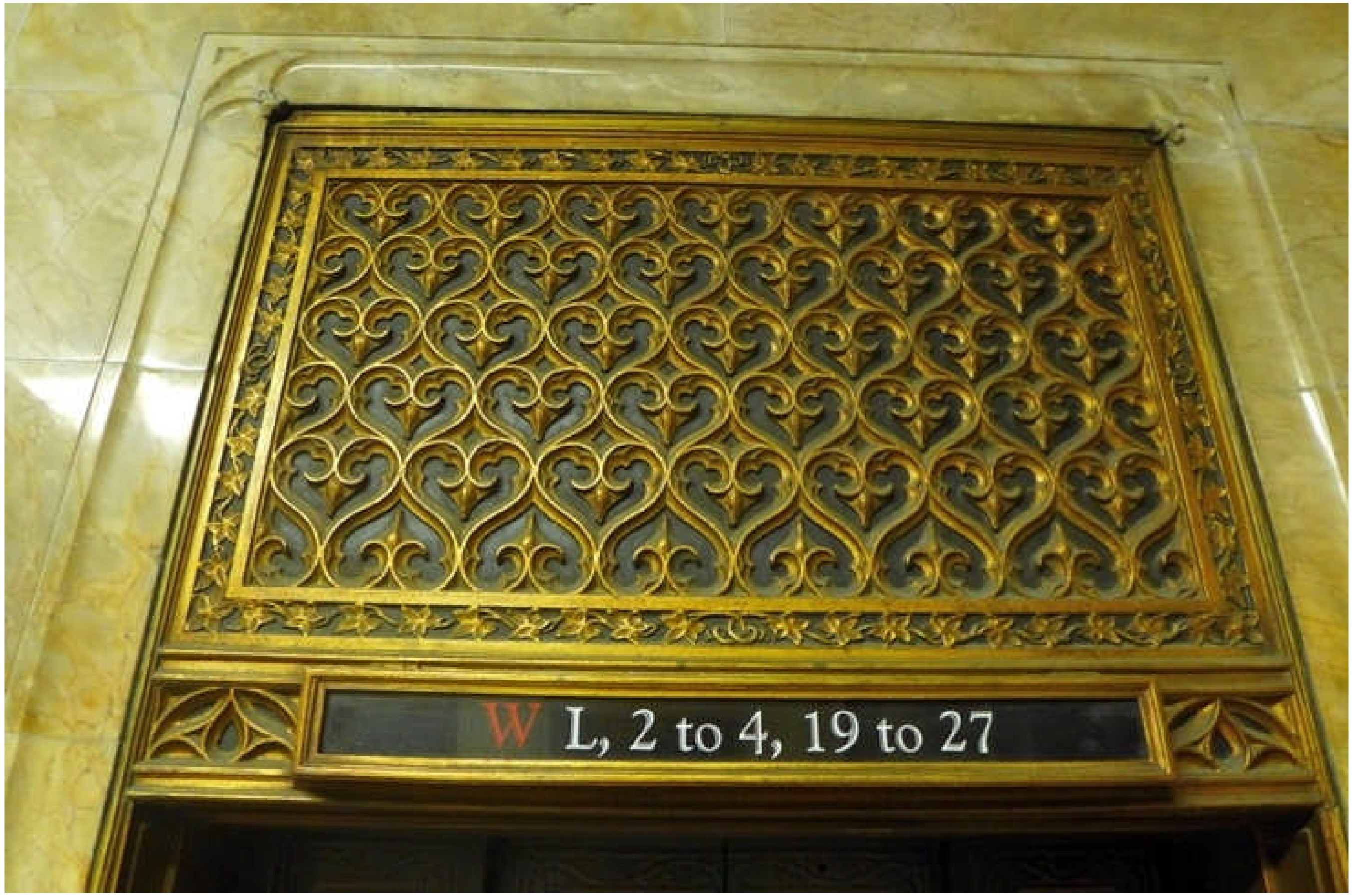


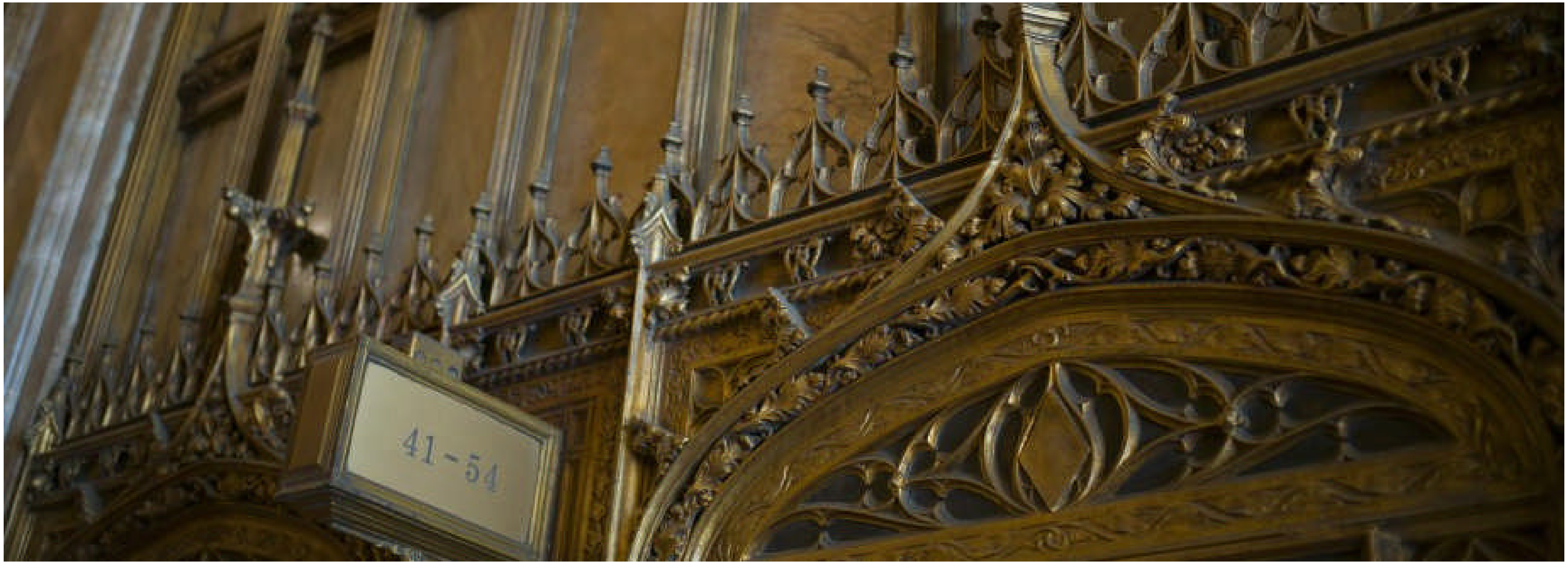
<u>Left</u>: caption: “Woolworth Building, New York City. This building, the tallest in the world, is equipped with 16 Otis Gearless Traction Elevators. Two of the elevators run from the first to the fifty-first floor with actual travels of 679 feet 9½ inches and 679 feet 10¼ inches respectively. There is also a shuttle elevator which runs from the fifty-first to the fifty-fourth floor. Total height of building from curb to base of flag staff, 785 feet.”

"…In the main part of the building, two of the elevators rise from the sub-basement to the twenty-seventh floor, twelve from the basement to the twenty-seventh floor, and four from the first floor to the twelfth floor. All are passenger elevators, with a maximum capacity of 3,000 pounds, and are designed to operate at a speed of 600 feet per minute with a load of 2,500 pounds. The other two main building elevators are combined passenger and freight machines which rise from the basement to the twenty-eighth floor, operating at a speed of 550 feet per minute with a load of 4,000 pounds. These also have an additional capacity of 6,000 pounds for lifting safes and other loads…"

RE: excerpt from *The Master Builders: A Record of the Construction of the World's Highest Commercial Structure* (1913)

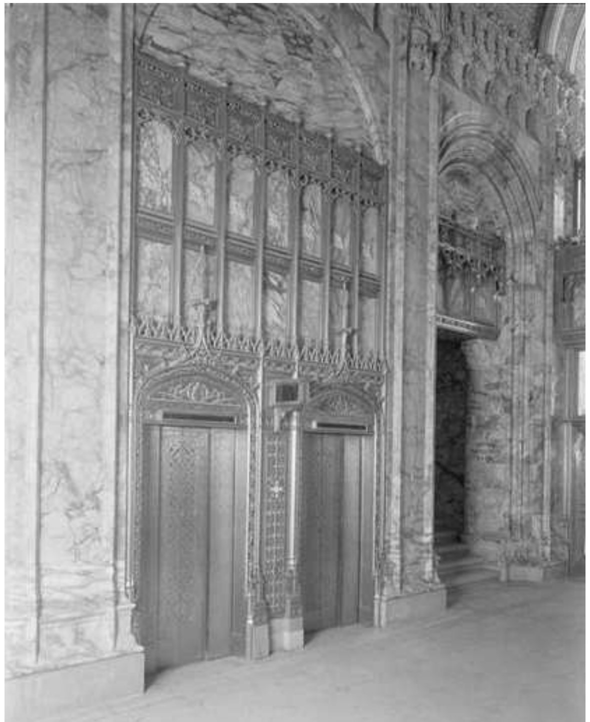
<u>Left</u>: Elevator Bank in Elevator Corridor – Woolworth Building Lobby


W L, 2 to 4, 19 to 27



"…Of the seven elevators in the tower, two run to the fifty-third floor, two to the forty-seventh floor and two to the fortieth floor. These six elevators have a maximum capacity of 3,000 pounds, and are designed to operate at a speed of 700 feet per minute with a load of 2,500 pounds – the fastest service given by any electric passenger elevators in the world. One of the elevators which serves the fifty-fourth floor has an additional capacity of 6,000 pounds for lifting safes or other heavy loads. The seventh tower elevator is a shuttle, which carries passengers from the fifty-third floor to the observation station of the tower and runs at a speed of 200 feet per minute with a load of 1,500 pounds…The two elevators serving the fifty-third floor travel to a height of 670 feet 6 inches, which is the highest travel by any single passenger elevator in existence…"

RE: excerpt from *The Master Builders: A Record of the Construction of the World's Highest Commercial Structure* (1913)

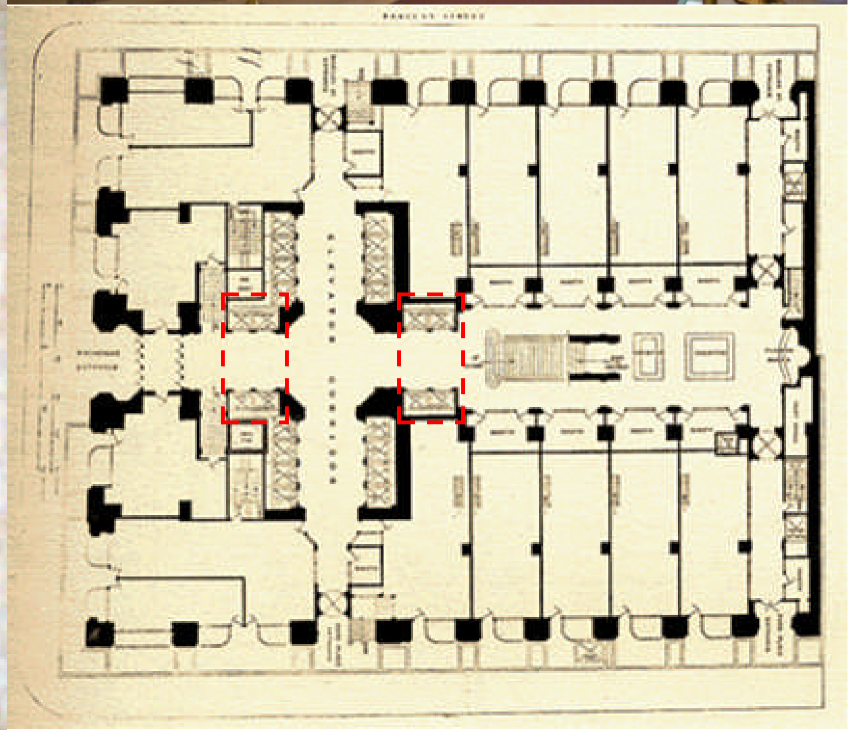


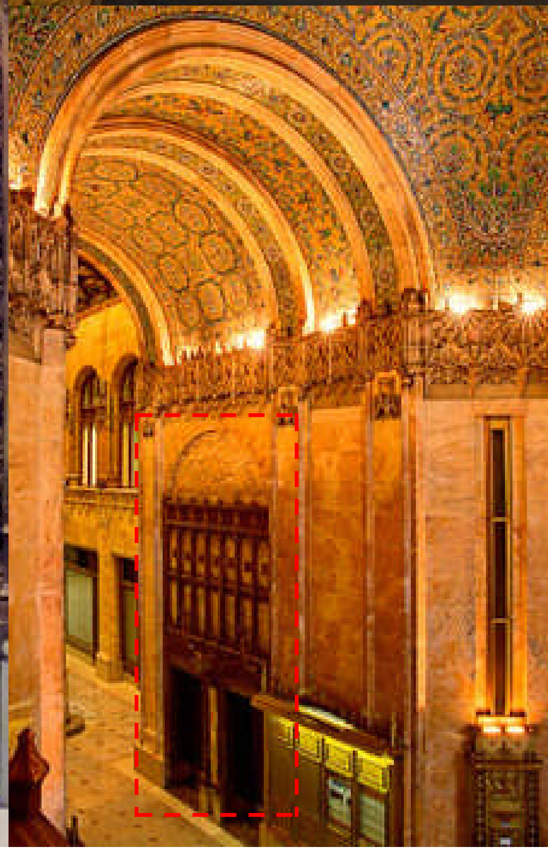
"…The two elevators, which operate from the ground to the fifty-fourth floor rise 700 feet in one minute, and these are the highest-rise and fastest-traveling elevators in the world. Although elevator service is provided in the Eiffel Tower, Paris, to a height of nearly 1,000 feet, three cars must be used to reach the top, the highest rise of a single one being about 450 feet…"

RE: excerpt from *The Cathedral of Commerce* (1918)

<u>Top</u>: caption: "Woolworth Building. Detail of grilles in Entrance Hall."

<u>Bottom</u>: caption: "One of the Elevators to the Observation Gallery (Highest-Rise Elevators in the World)"





<u>Above & Left</u>: Arcade Elevator/s – Details (ornate tracery was executed by *Tiffany & Co.*)

Safety First…

"…'Safety first' was the motto of the builders of this great structure, and in particular did this apply to the elevators. During the last few years accidents resulting in personal injury, due to faulty elevator mechanism, have been very rare. Nevertheless, every precaution was taken to make the Woolworth elevators absolutely safe. They were equipped with the most improved mechanical safety devices. All the shafts, too, were equipped with air cushions, which have been proved time and time again to be absolutely reliable. Not long ago, when severe tests were made, a car was allowed to fall from the twentieth story of the Empire Building in New York, and a basket of eggs which it contained was entirely uninjured when the car was checked in its downward flight by the air cushions…"

RE: excerpt from *The Master Builders: A Record of the Construction of the World's Highest Commercial Structure* (1913)

"…On account of the complex elevator problem and the high speed at which service is maintained, together with the fact that nearly 30,000 people daily travel upon these elevators (more than 9,000,000 a year), particular attention was given to the matter of safety devices. The more important of these are the under-car safety operated by a governor placed over-head; oil buffers placed under each car and counterweight; retarding and latching device at the top of each shaftway; limit switches at the bottom and top of travel; speed governor and potential switches operated by governor; switch attached to safety plank on the under-car safety; emergency wheel and safety switch inside the car itself. Besides these, the gearless traction elevator has the great inherent safety feature because, if either the car or counterweight over-travels, the tractive force is lost, owing to the weight of the car or counterweight being removed from the hoisting cables. There are also many electrical safety devices which form a part of the controlling equipment safeguarding the operation of these elevators…"

RE: excerpt from *The Cathedral of Commerce* (1918)

"…Two additional features of great importance among the safety devices are the emergency exit doors and the interlocking devices on the shaftway doors. The emergency exit doors are so constructed that, in the event of an elevator being accidentally held between floors, passengers may be transferred to an adjoining elevator and carried safely to their destinations without delay or confusion. The interlocking device on the shaftway doors effectively overcomes one of the common causes of elevator accidents, namely, those which occur as passengers enter or alight from elevators. These accidents may usually be charged to the carelessness of the operator in opening the shaftway door before the elevator reaches a full stop or starting the elevator before the door is fully closed. In this Building, elevators cannot be so operated because the interlocking device absolutely prevents an elevator from moving until the shaftway doors are fully closed…"

RE: excerpt from *The Cathedral of Commerce* (1918)

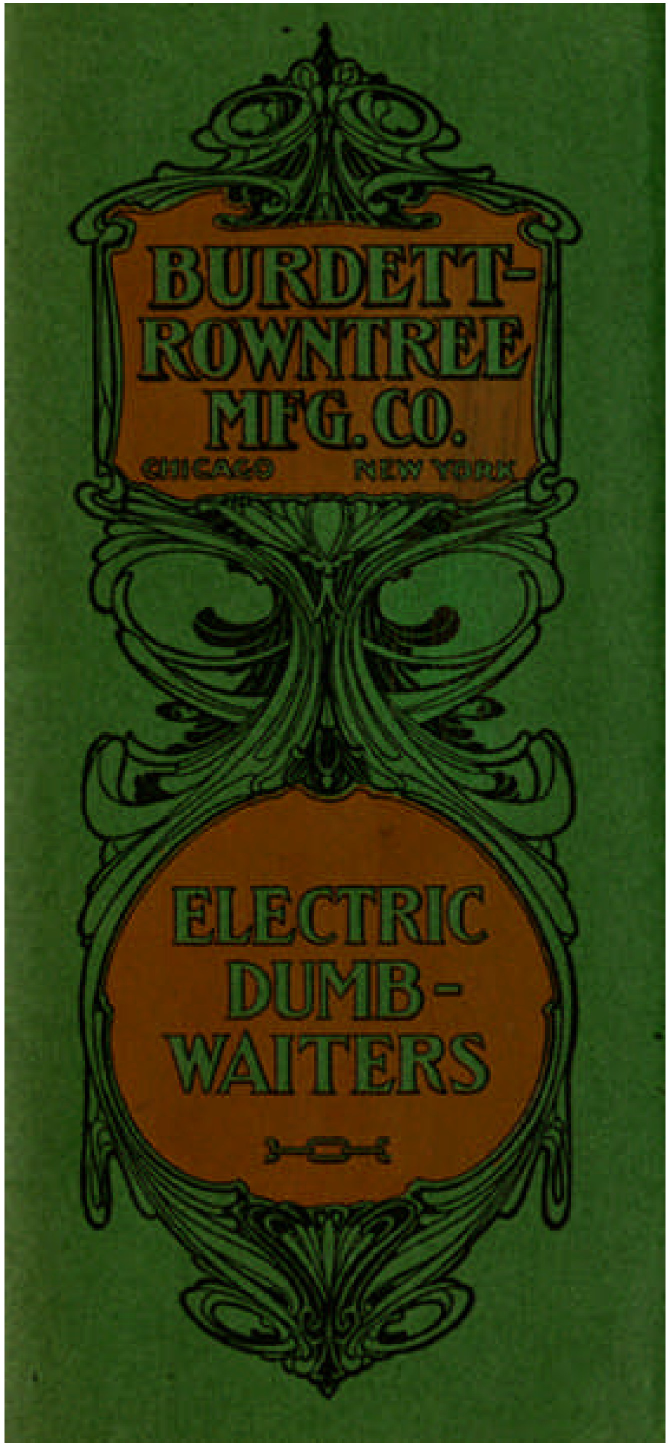
"…All the elevators are equipped with a complete system of safety devices, and including air cushions which will bring the cars gradually to rest at the bottom of the hatchways, in case of a drop even from the top of the shaft…"

RE: excerpt from *The Master Builders: A Record of the Construction of the World's Highest Commercial Structure* (1913)

"…Besides the regular safety devices enumerated above, Mr. Woolworth ordered air cushions for all elevators. These consist of a heavy steel structure enclosing each elevator shaft separately with reinforced concrete placed between I-beams. In addition, the interior of the shafts is lined with heavy steel plates, and as a car enters the air-cushion zone and approaches the bottom of travel the air pressure underneath increases. Therefore if all safety devices fail to operate and the car dropped, the air would be so rapidly compressed that it would not have time to escape through the automatic valves or through the clearance space around the elevator; hence, the speed of the latter would be retarded and the car brought gradually to rest at the base of its shaftway without injury or shock to passengers within…"

RE: excerpt from *The Cathedral of Commerce* (1918)

<u>Left</u>: caption: "Woolworth Building, air cushion Nos.15, 16, 17 and 18"



"…As this was the first time that air cushions were to be used on elevators traveling fifty or more stories, every precaution was naturally taken to make them perfect. The air cushion being approximately one-fifth of the height of the shaft, it meant that the enclosure doors on the lower eleven floors of the high rise elevators would have to be heavy enough to withstand the air pressure developed in case the car fell from the top. As manual operation of these doors was out of the question on account of the weight, the architect asked the Burdett-Rowntree Manufacturing Company to solve the problem, believing that their broad experience in equipping all types and weights of sliding and lifting elevator doors with pneumatic operating devices would guarantee the successful solution…"

RE: excerpt from "The Master Builders"

<u>Top Left</u>: caption: "Woolworth Building, air cushions from center south (10/05/1912)"

<u>Top Right</u>: caption: "Woolworth Building, air cushions Nos. 3, 4 and 5 (11/08/1912)

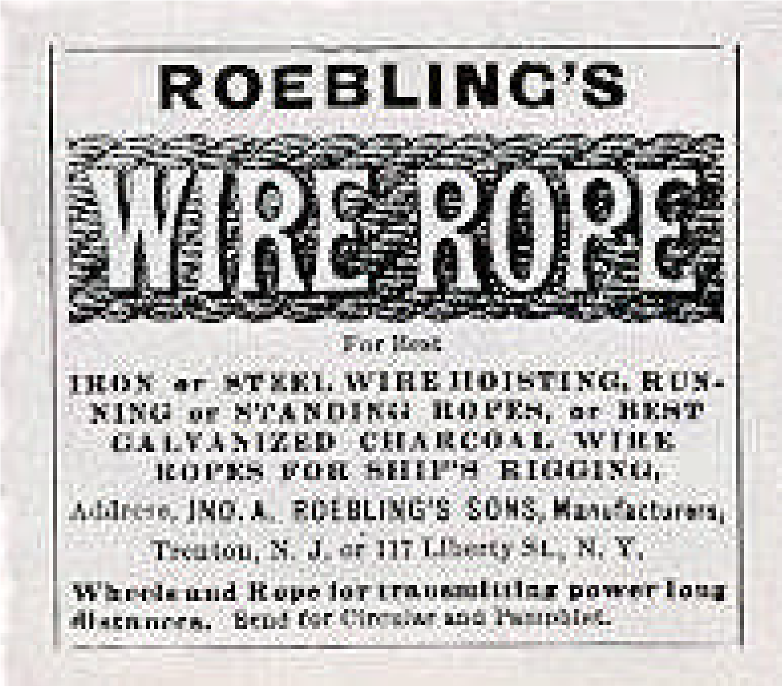
<u>Left</u>: caption: "Woolworth Building, air cushion Nos. 14, 15 and 16 (11/08/1912)"

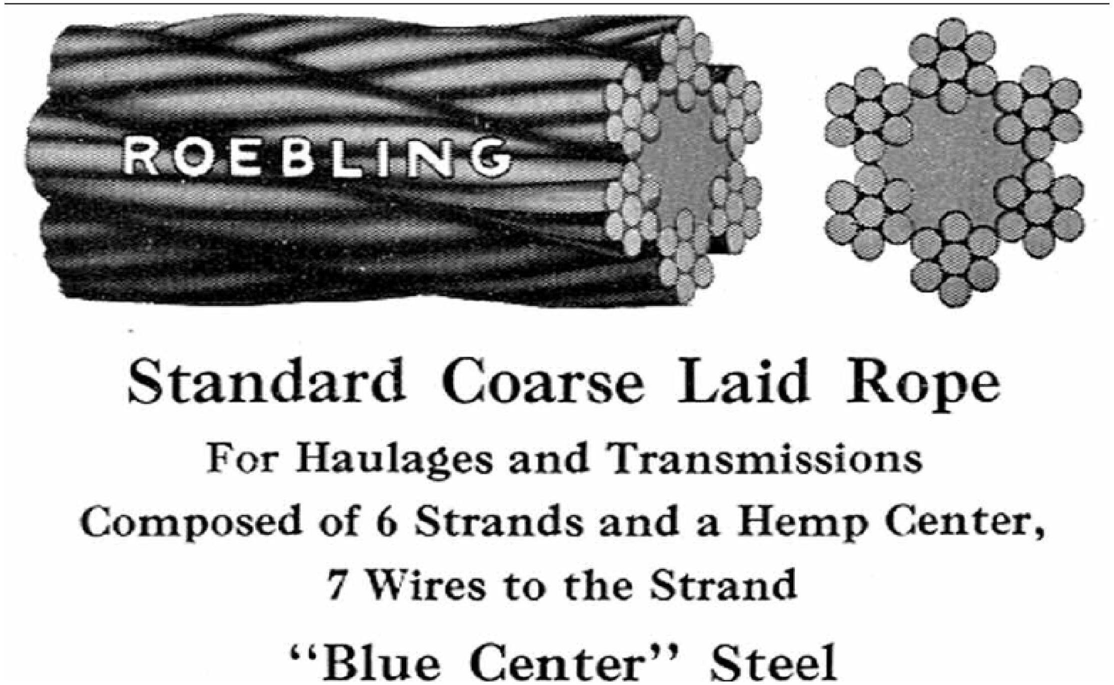
"…To determine the utility of the air cushions, a test was made by loading an elevator with 7,000 pounds of material and dropping it from the forty-fifth floor with all safety devices and cables removed. When this elevator reached bottom, its load was unharmed; the vibration being so slight that even a glass of water, which it carried, remained intact…"

RE: excerpt from *The Cathedral of Commerce* (1918)

"…Tests were made and a special pneumatic device manufactured, and the satisfactory manner in which all the one hundred and twenty-four air cushion doors are operating is evidence of good reasoning in selecting the Burdett-Rowntree manufacturing Company for this part of the work, To reduce the cost of maintenance of the operating devices so far as possible, this company installed an automatic lubricating system whereby all the devices are lubricated through the medium of the air from one point. The Architect desired that the Burdett-Rowntree Manufacturing Company should assume the responsibility for as much as possible of the working of the air cushion doors, and therefore, in addition to the pneumatic door operating devices, they manufactured and installed the special door hangers and adjustable interlock switches and hung all of the air cushion doors…"

RE: excerpt from *The Master Builders: A Record of the Construction of the World's Highest Commercial Structure* (1913)





"…Daily inspections are made by the Building's maintenance force, not only of this apparatus but of everything else affecting the safety, comfort and welfare of tenants and the general public. To show the extreme caution of these inspectors, a remarkable test was made in the plant of John A. Roebling's Sons Co. with a set of six hoisting cables condemned and taken from an elevator after three years of active service. The one most worn of these cables was placed upon a powerful testing machine to determine the weight it would sustain before pulling apart. It broke only after assuming a burden of 16,600 pounds; hence the total carrying strength of the six condemned cables was at least 99,600 pounds. As the maximum weight of an elevator and its passengers is about 6,000 pounds, it will be seen that these cables were, by actual test, still strong enough to safely handle sixteen times the maximum weight of a loaded elevator…"

RE: excerpt from *The Cathedral of Commerce* (1918)

<u>Left</u>: designed by ***Charles G. Roebling*** **(1849-1918), engineer and president of *John A. Roebling's Sons* (1876 to 1918), this was the largest wire-rope closing machine of its day. The machine, built in 1893, twisted six strands around a central core rope. These seven combined in the machine's forming die to produce a finished wire-rope, a process known as closing. The machine was built to produce 1.5-inch rope for cable rail-ways (80-tons could be loaded at a single spinning providing 30K-feet of unspliced cable). The demand for ever longer cable-car ropes led to its design. It was a vertical machine, standing 64-feet high, requiring the machine and building to be built as a unit. Such wire-rope would be used for a myriad of industrial activities, including the elevator cables serving the** ***Woolworth Building*****.**

…and *Always*

"…'Safety first' and <u>always</u> is the watchword in the operation of this vertical railway system. While the cars travel at great speed, the maintenance is so closely watched and cared for that they move along almost unnoticed – no quivering, no vibration, no sound whatever, absolute smoothness and safety…"

RE: excerpt from *The Cathedral of Commerce* (1918). With more and more tall buildings being built and elevator speeds ever increasing, in 1920 Otis joined with others in the industry to establish an American code of safety standards for the construction, operation and maintenance of elevators, dumbwaiters and escalators. The code was approved by the *Council of The American Society of Mechanical Engineers* in January 1921. The following year, Otis called a meeting at Yonkers, NY, of the major elevator companies to plan for testing, implementing and revising the code. The document produced in 1920 was the basis for what became *American National Standards Institute* (ANSI) *Code 17.1*, which guides safe elevator and escalator practices in the U.S., even to the present day.

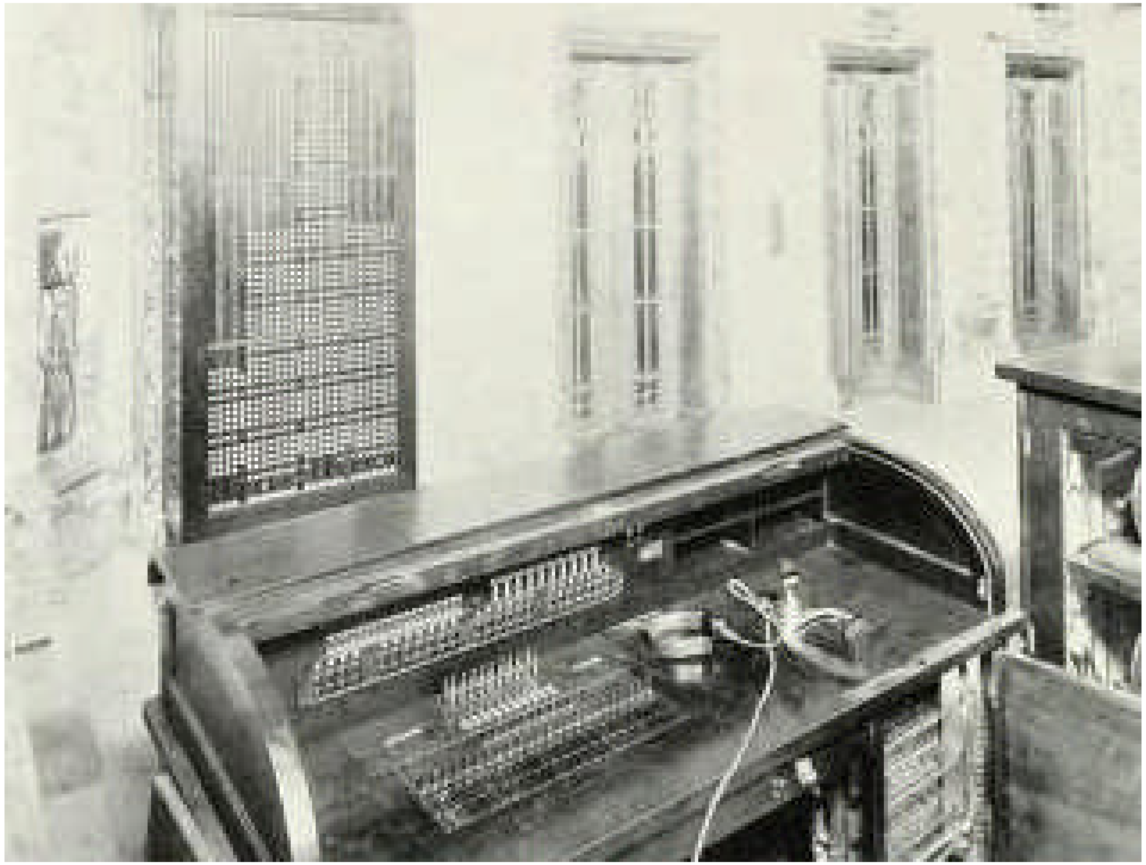
The Best Elevator Service Possible

“…Owing to the arrangement of the elevators, the severe service to which they are subjected, and the variations in the height of travel, it was necessary to provide special means of controlling the operators and the movement of the elevators themselves. A Dispatcher System was therefore devised and used in this Building for the first time. This system consists of a dispatch board and a signal board with electric flashlights to indicate the movement and location of every elevator. The dispatcher absolutely controls the elevators and is prepared, by means of telephonic communication, to pass instructions to the operators when necessary, regardless of whether the elevators are in motion or at rest, so as to correct immediately any irregularities in the service. Incidentally, the telephone in each elevator, while primarily a part of an interior system designed to bring about the greatest efficiency in operating, is also connected with the great Bell telephone system directly through the Telephone Company’s central office, so that one may communicate by telephone with any part of the United States from a moving elevator in the Woolworth Building…Eighteen hundred telephones are in service throughout the Building, a greater number than is used in a city of 30,000 inhabitants. The average daily traffic is 29,000 calls, totaling 8,700,000 messages per year…”

RE: excerpt from *The Cathedral of Commerce* (1918)

"…Automatic starting signals are placed at the terminal landings and a buzzer signal is fixed in each car. In order that the dispatcher may communicate with the operator, telephones have been provided. These are so arranged that they may be operated from either end of the line, or from the dispatching room only. The telephone instrument in the car is provided with a loud-speaking transmitter which magnifies the voice tones and enables the operator to receive telephoned instruction while the car is in operation…"

RE: excerpt from *The Master Builders: A Record of the Construction of the World's Highest Commercial Structure* (1913)



"…The dispatcher is located in an isolated room, and by means of a position indicator is able to follow the progress of each elevator in the building. These indicators consist of a series of miniature lamps corresponding to the different floors served by each elevator, and as a car reaches a floor the fact is known to the dispatcher by the lighting of the corresponding lamp…"

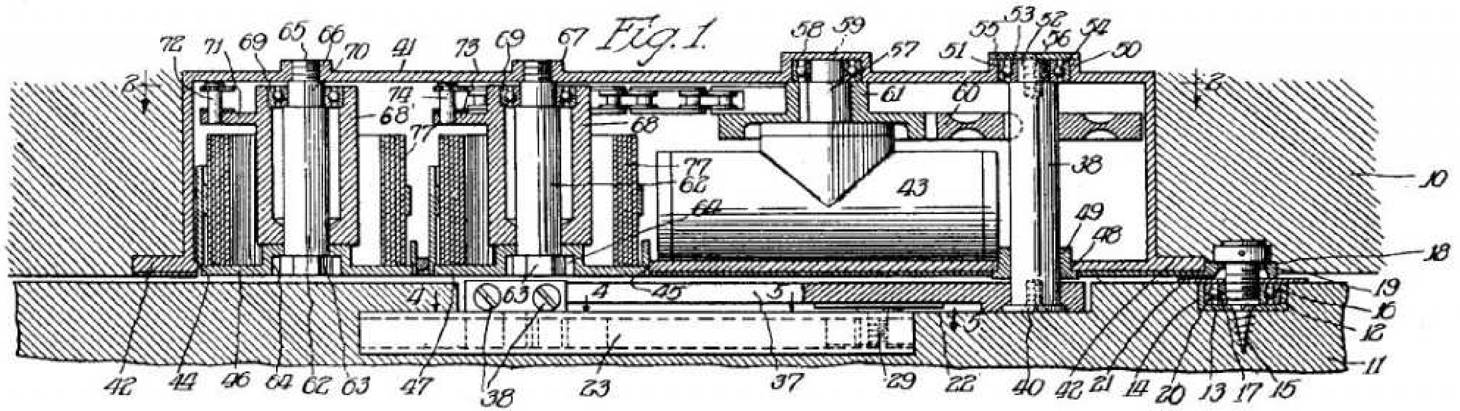
RE: excerpt from *The Master Builders: A Record of the Construction of the World's Highest Commercial Structure* (1913)

<u>Above</u>: caption: "Dispatcher System"

"…The public signals consist of the Armstrong Full Flash Type, having the up and down lamps at each floor. In addition to these, for each group of elevators, there is an electric sign to indicate the character of the service, whether express or local, and the floors which are being served. These signs are operated electrically and can be controlled and changed from the dispatcher's station…"

RE: excerpt from *The Master Builders: A Record of the Construction of the World's Highest Commercial Structure* (1913)

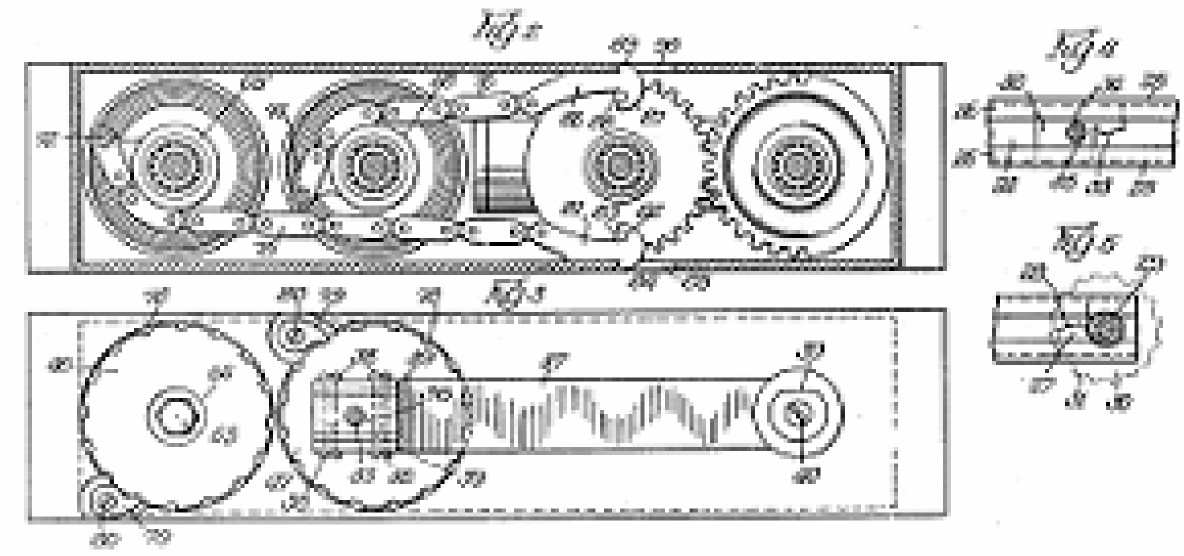
<u>Left</u>: caption: "Up-Down Indicator"



"…The large number of high-speed elevators in the Woolworth Building, while a fundamental necessity, by no means solve in themselves the problems involved, and they fall short of the duty demanded of them but for the elaborate system of elevator signals and auxiliary devices provided after careful study and experiment by the architect, consulting engineers and contractor. The results attained are perfect elevator service, controlled from one central station instead of through several starters stationed at different points on the ground floor, efficient and economical operation of the elevators through the system of signals and signs whereby false stops are eliminated and delay in waiting for passengers at the floors is avoided; absolute safety to passengers ensured, whether entering or leaving the elevators, through the installation of the Norton device, which automatically closes and locks the doors and prevents all movement of the car until the door is closed. The signals and various devices through which these results are accomplished may be mentioned briefly, as follows…"

RE: excerpt from *The Master Builders: A Record of the Construction of the World's Highest Commercial Structure* (1913)

<u>Above</u>: caption: "L.C. Norton – Door Closing and Checking Device"



"…The records of the liability companies show that eighty-five per cent of all accidents to the public in connection with elevator service are what they classify as 'door accidents,' or those due to unlocked doors or which occur while the passengers are attempting to board or leave the elevators. The elevators in the Woolworth Building are equipped with the Norton Elevator Door Closer, a device that absolutely prevents the possibility of accidents of the class cited. With this device the door is opened manually by the operator in the usual manner; when released, it closes automatically, without noise and locks. By an electric switch arrangement the controlling circuit of the elevator is broken while the door is open, and all motion of the car is automatically and positively prevented until the door is closed. Carelessness or confusion on the operator's part is thus rendered harmless to the safety of the passenger…"

RE: excerpt from *The Master Builders: A Record of the Construction of the World's Highest Commercial Structure* (1913)

<u>Above</u>: caption: "L.C. Norton – Door Closing and Checking Device"

"…The passenger elevators, twenty-four in number, are equipped throughout with the Armstrong Flashlight Signal System, embracing the usual 'Up Down' lanterns at the floors, through which the waiting passenger is directed promptly to the first approaching car. 'Up Down' push buttons at the floors, whereby the operator is given timely signal to stop, and which signal is automatically carried to the next car in the event of his inability to stop by reason of a 'full car' or other cause. Signals of special design are provided for two high-rise cars for night service. Directional signs are also provided, designating the travel of the elevators and showing plainly to the public their travel in respect to express or local service. The elevators are also equipped with illuminated 'thresholds,' a valuable factor of safety inasmuch as the passenger is enabled to see clearly where he is stepping when entering the car and is not liable to stumble…"

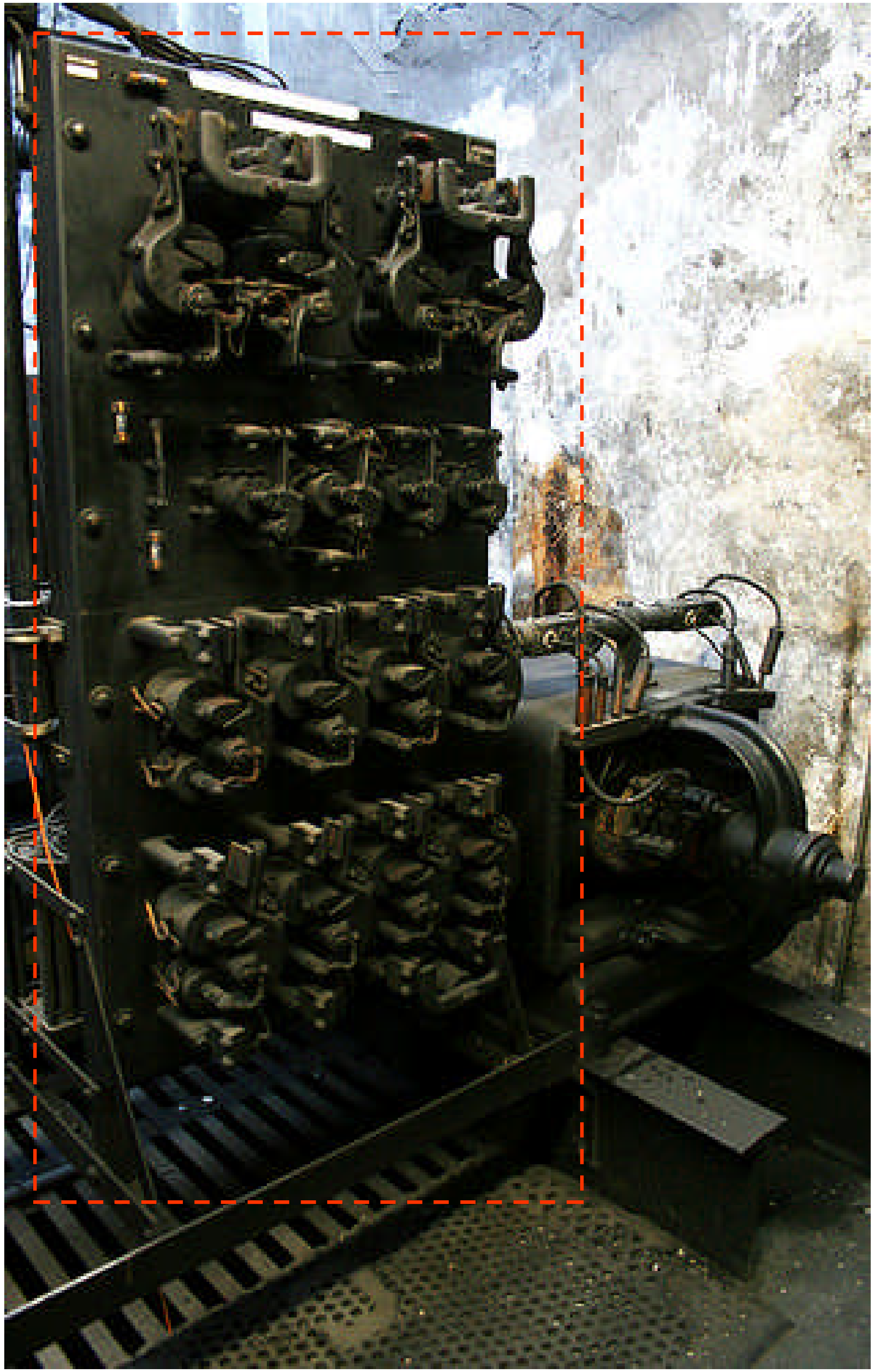
RE: excerpt from *The Master Builders: A Record of the Construction of the World's Highest Commercial Structure* (1913)

Left: caption: "Original (ca. 1911) ornamental cast bronze gothic style elevator cab floor indicator push button plaque or backplate"


Y L, 10, 12, 17, 18

"…All the elevators are controlled, as has been mentioned, from one central station. This dispatcher's station is located on the main floor balcony and is provided with a Position Indicator Lamp Board showing by miniature lamps the exact position of all the cars; a telephone system extending to all the cars and establishing communication between the dispatcher and operators at all times and regardless of the position of the car; motor-driven Automatic Timing Devices, ringing bells and buzzers at the top and bottom of the elevator hatchways for starting the cars at predetermined intervals; motor generators, storage batteries, and equipment complete in every detail for the control of all the cars by one dispatcher…"

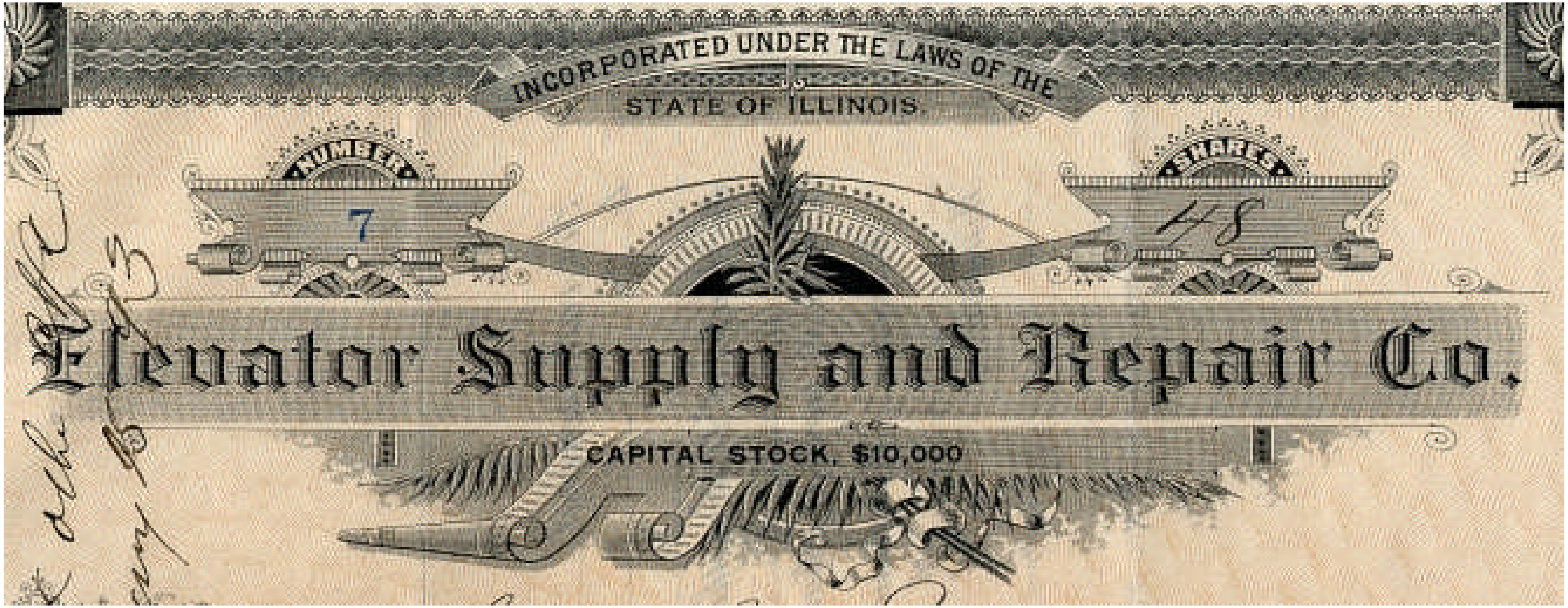
RE: excerpt from *The Master Builders: A Record of the Construction of the World's Highest Commercial Structure* (1913)



"…In providing means for automatically starting the cars from either terminus and of transferring the signal to the next approaching car when the car originally signaled does not stop, and means whereby the dispatcher and his operators are in full communication at all times, the greatest source of delay in elevator service has been overcome…"

RE: excerpt from *The Master Builders: A Record of the Construction of the World's Highest Commercial Structure* (1913)

<u>Left</u>: close-up of the elevator control panel for a *Gearless Electric Traction Elevator* (similar to that of the *Woolworth Building*)



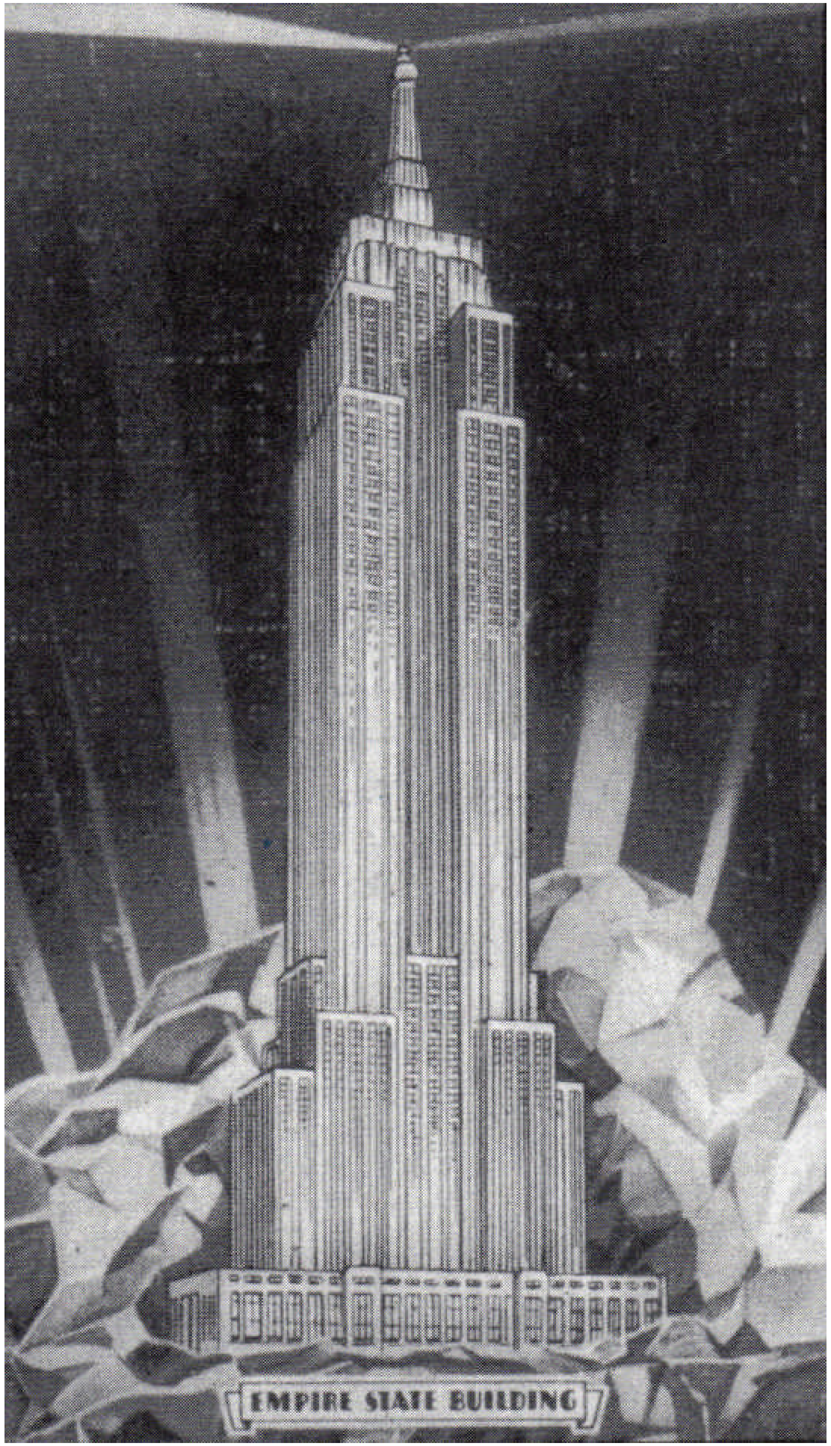
"…Nothing has been spared to make this the most complete elevator installation in the world, and to give to the public and the tenants of the building the best elevator service possible…The elevator signals and auxiliary devices herein described were furnished and installed by the Elevator Supply & Repair Company, of New York and Chicago…"

RE: excerpt from *The Master Builders: A Record of the Construction of the World's Highest Commercial Structure* (1913)

<u>Left</u>: caption: "The achievement of this Company in perfecting the highest type of elevators has gained for its product recognition as the standard of excellence throughout the civilized world - for Quality, Safety, Efficiency, and Permanancy. Otis Elevators are the ONE thing that has made possible the construction of the Titanic structures of stone and steel that everywhere today dot the marts of trade and industry - the ONE thing that has heightened the 'sky line' – and marvelously increased the land values of the world's greatest cities, immuring to them unlimited development, concentration, and prosperity."

(1913 Otis ad)

Monarch of the Sky



The eighty-five story *Empire State Building* opened in NYC in May 1931 on the site of the original *Waldorf-Astoria Hotel,* immediately surpassing (by 202-feet) the nearby *Chrysler Building* thus earning for itself the title: “Tallest Man-Made Structure in the World.” There were sixty-seven Otis elevators in the building, of which fifty-eight were Otis *Signal Control* type with *Unit Multi-Voltage Control* and *Micro-Leveling*. Each of the main passenger elevators was equipped with an Otis *High-Speed Electric Door Operator*. This control automatically opened the hatchway and car doors as the car was stopping at a floor. The doors on the freight and tower elevators and the night-service openings of the main passenger elevators were equipped with Otis *Manually-Opened Door Closers*. At the time of its installation, Otis *Freight Elevator No. 1*, with a rise of 986-feet, had the greatest travel of any of the elevators. This elevator served a total of eighty-one floor openings.

"…Otis Signal Control made available elevator speeds up to 1,400 feet per minute, and made commercially practicable such monumental structures as the Empire State Building, New York, which towers 1,248 feet above Fifth Avenue and is equipped with 58 Otis Signal-Control Elevators…"

RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators*

Left: one of several commemorative *Duralumin* medallions in the lobby of the ESB (for the various trades involved in the construction of the building)

STEEL

HEATING

Robot Elevators to Serve 85,000 in Greatest Building

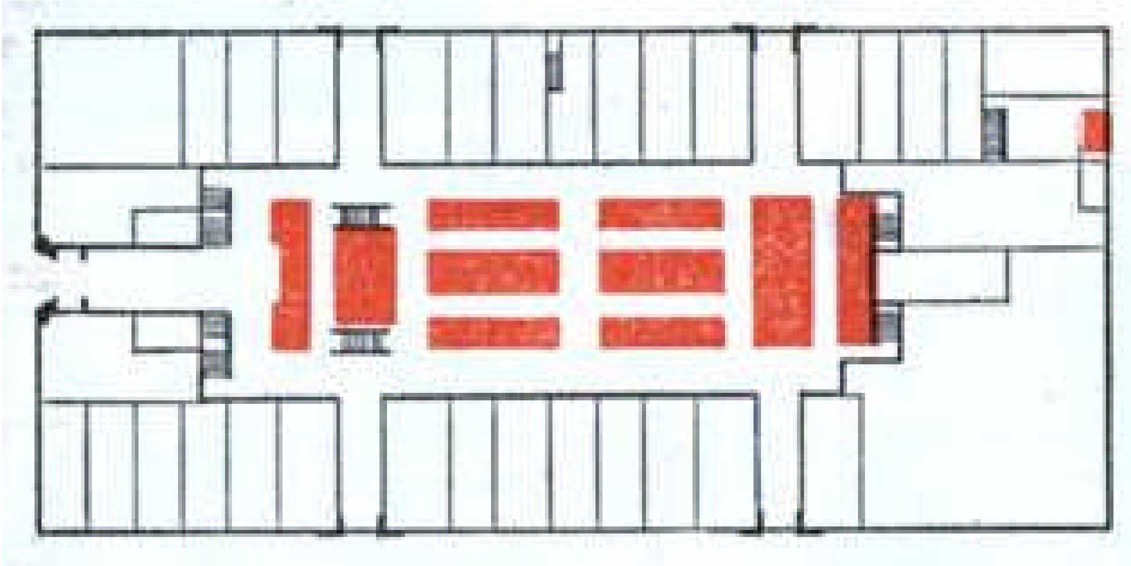
By KENNETH M. SWEZEY

"When in a few weeks the doors of New York City's Empire State Building are opened to admit the public, fifty-eight electrical robot elevators will be standing at attention, awaiting merely the push of buttons to begin the distribution of a daily population almost equal to the combined population of the famous summer resorts Newport, R.I., and Atlantic City, N.J. Governed by complex electrical brains, through miles of copper-wire nerves, this fleet of automatic elevators is expected to handle an unprecedented traffic with a smoothness, swiftness, and safety that could not be approached under ordinary control…"

Popular Science, **April 1931**

“…Curiously enough the elevator, a comparatively modern invention, is the only limiting factor on how high a building may go. Solve the elevator question and 100 or even 200 story buildings are quite possible. The trouble is to get an elevator system that will be fast enough to move the traffic and will not take up so much valuable space as not to leave enough rentable area to earn a respectable income on the investment…”

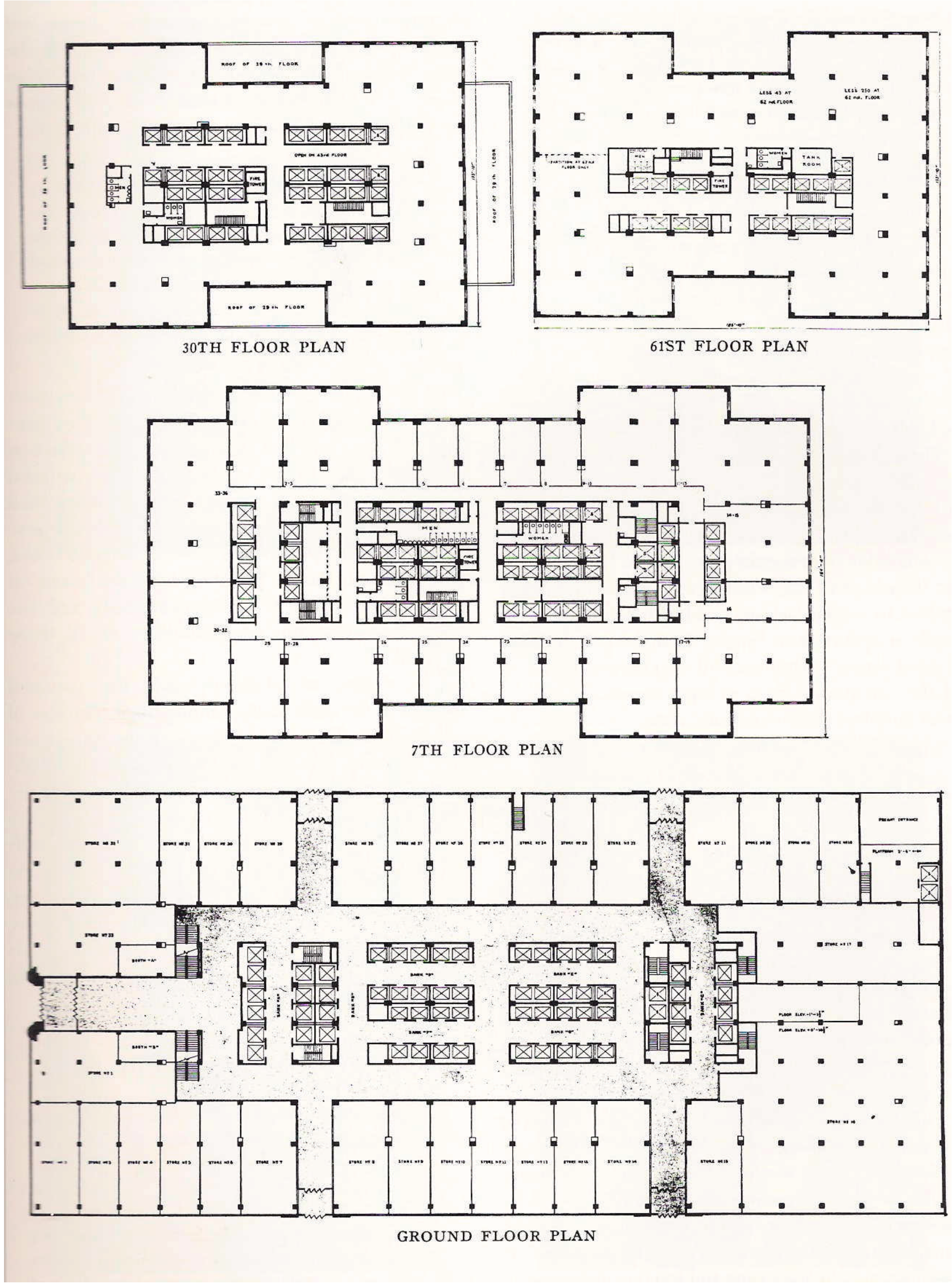
***Modern Mechanics and Invention,* April 1931**



"…If you want some idea of how much space the elevators of a modern skyscraper take up, look at the ground plan of the Empire State, the 1,243-foot super-skyscraper rising under the guidance of former governor Al Smith. The huge pile has a frontage of 197 feet 5 inches on Fifth avenue and 424 feet 9½ inches on 33rd and 34th streets, occupying the entire block between them. But virtually one-fourth of all that ground area is taken up by the elevator banks and their hallways. Of course, as the building ascends, the shorter shafts, locals and lower express banks, come to an end, but the building set-backs also reduce the available renting area in more than equal proportion…"

Modern Mechanics and Invention, **April 1931**

<u>Above</u>: caption: "Ground floor plan of the world's tallest building, revealing how the banks of sixty-six separate elevator shafts consume more than one-fourth of all the available floor space"



"So that the additional rentals, even though proportionately less, may be applied to increase the returns on the total investment, including construction and ground costs"

***William Lamb*, ESB Architect**

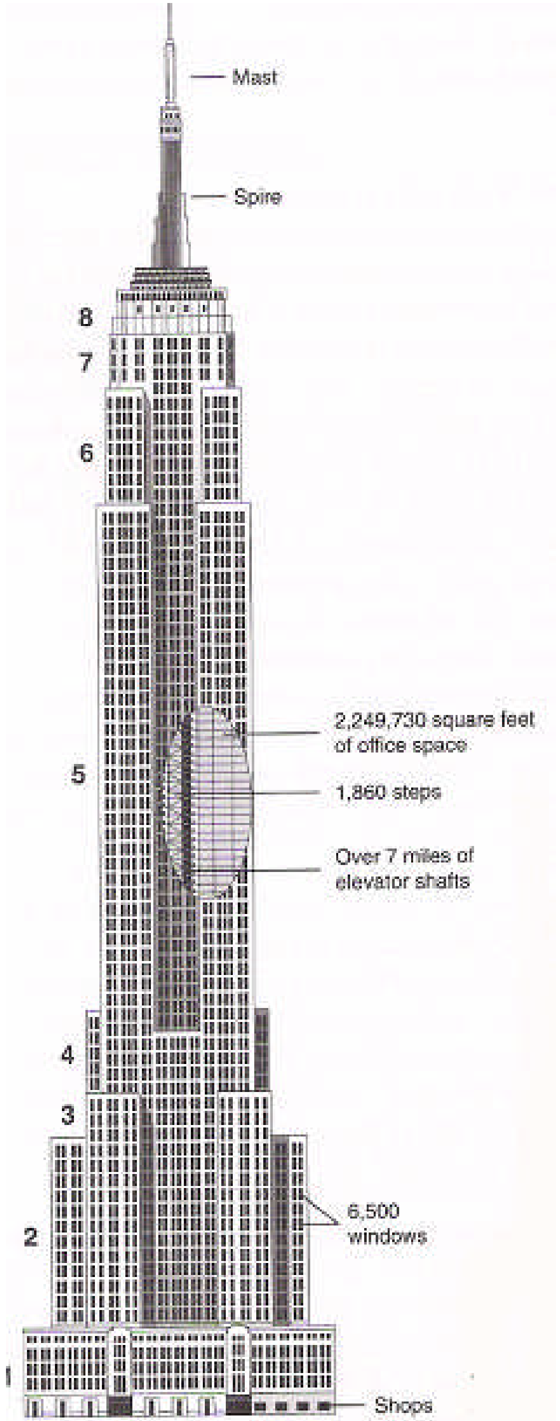
RE: taking advantage in the design of the large plot to provide additional elevator shafts allowing the building to go higher thus providing more rentable space

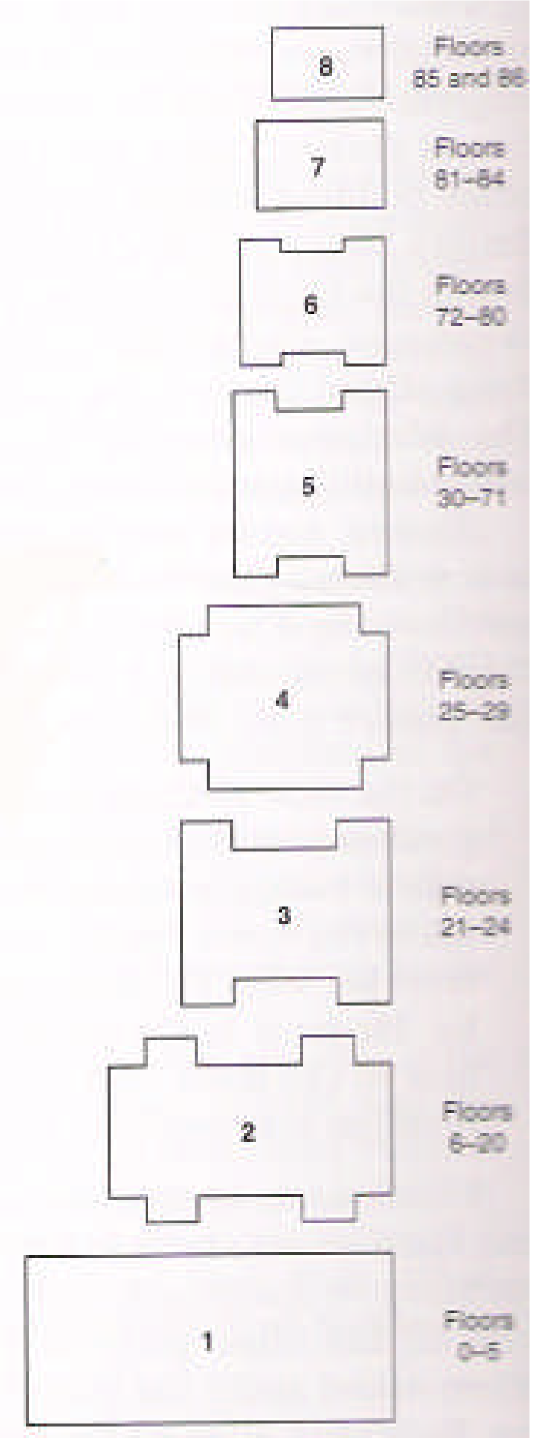
<u>Left (Bottom to top)</u>:

- **Ground Floor Plan**
- **7th Floor Plan**
- **30th Floor Plan (left)**
- **61st Floor Plan (right)**

"…Not only would it be necessary to transport this army of 85,000 persons to the desired parts of the building and down again, but all the floors would have to be served with nearly equal speed and comfort. If the value of office space is not to decrease with height, the eightieth floor will have to be as nearly accessible as the tenth or the twentieth. Besides, there loomed the highly concentrated traffic of rush hours. Figures gave evidence that in the minutes between 5 and 5:30 P.M., for instance, about 15,000 persons would have to be brought to the ground floor…"

Popular Science, **April 1931**





"The logic of the plan was very simple. A certain amount of space in the center, arran-ged as compactly as possible, contains the vertical circulat-ion, mail chutes, toilets, shafts and corridors. Surrounding this is a perimeter of office space twenty-eight feet deep. The sizes of the floors dim-inish as the elevators decre-ase in number. In essence there is a pyramid of non-rentable space surrounded by a greater pyramid of rentable space, a principle modified of course by practical consid-eration of cost and elevator operation."

***William Lamb*, ESB Architect**

RE: excerpt from *The Architectural Forum*, 1931

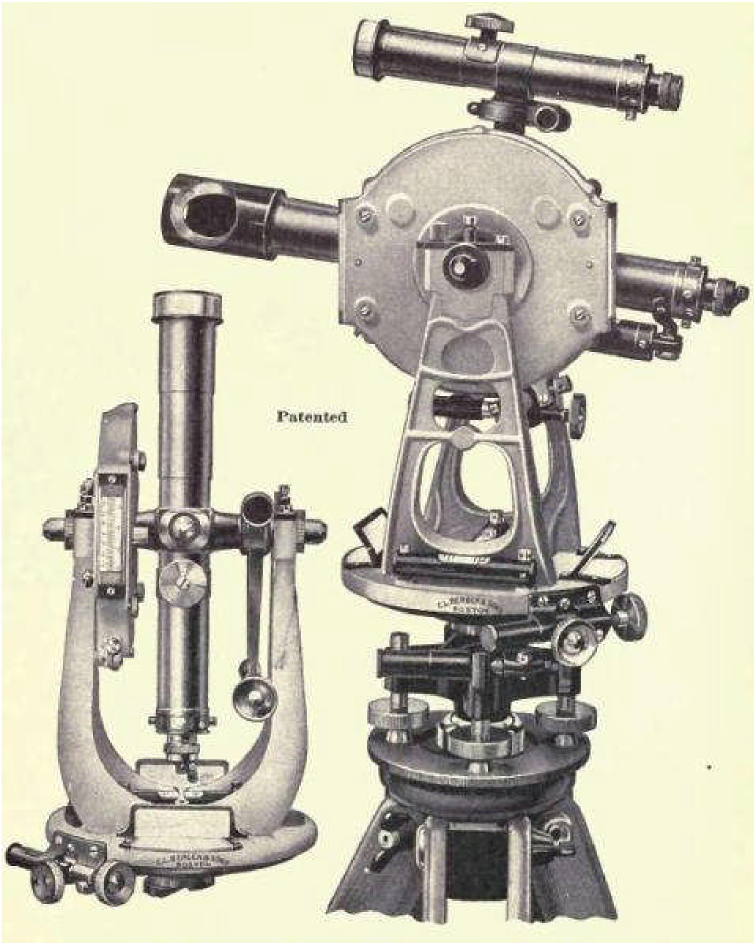
“We must keep in mind that the eighty-five stories of the building surmounted by a mooring mast tower, rises to a total height of 1,252 feet above the street level. Commensurate with this unprecedented height, the cubical contents of the building is nearly 36,000,000 cu. ft. Planning the elevator service for a building of these proportions is a special problem necessitating a thorough study of the requirements by competent engineers. Adequate elevator service must be provided to all floors, since the rental value of a floor depends largely upon the character of the elevator service which is provided. With a building of this height, the problem of securing the necessary elevator service with the least possible encroachment on the net rental area is especially important. Its solution in this case was the selection of high-speed elevators having the most efficient and time-saving method of operation obtainable. This permitted the specifying of the fewest number of elevators for the maximum service required.”

Starrett Brothers & Eken, **ESB General Contractor**

"…Engineers and architects worked together over the problem, leaving no detail out of consideration. It was finally decided that fifty-eight elevators with automatic starting, stopping, leveling, and door opening and closing devices could most efficiently handle the bulk of the work. Nine additional elevators, with varying degrees of self-operation, were decided upon for operation in the top seven stories, the tower, and for freight service. The entire elevator installation, including such related work as the preparation of hatchways, cost about $4,000,000…"

***Popular Science,* April 1931**

RE: the ESB, including its eighty-five stories (plus the 200-foot mooring mast) rose to an overall height of 1,252-feet above street level and contained nearly thirty-six million cubic-feet. Since the value of rentable space in such a tall structure is dependent to a large extent on proper elevator service, providing suitable vertical transportation was critical. The key to success was high-speed elevator service. There would be fifty-eight passenger elevators, two tower elevators, one mooring mast elevator and six freight elevators (sixty-seven elevators total). General Contractor *Starrett Brothers & Eken* chose the *Otis Elevator Company* for the $2.9 million contract to design, manufacture and install the elevator service in the ESB. At that time, elevator technology could extend only to the eightieth floor; passengers had to switch cars to go to the observation deck on the 86th floor. In all, the the ESB has sixty-eight elevators spread across seven banks. While most elevators service the first eighty floors, two go to the 86th floor and one more goes to the 102nd.

"…For the permanent elevator installation, a number of innovations were necessary. Because eleven of the cars were to rise higher than any previously installed, larger hoisting motors had to be designed and built. Ordinarily plumb lines are sufficiently accurate to align the rails that guide the cars and counterweights. However, fearing that air currents might deflect the lines in some of the tremendous shafts of the Empire State Building, the rails were aligned by sighting through mine transits – surveyors' instruments adapted my mining engineers for determining the straightness of mine shafts. A larger construction crew was required than on probably any earlier installation. Through one period over three-hundred elevator men were working simul-taneously…"

Popular Science, **April 1931**

Left: caption: "Wet Mining Transit w/Auxiliary Scope"

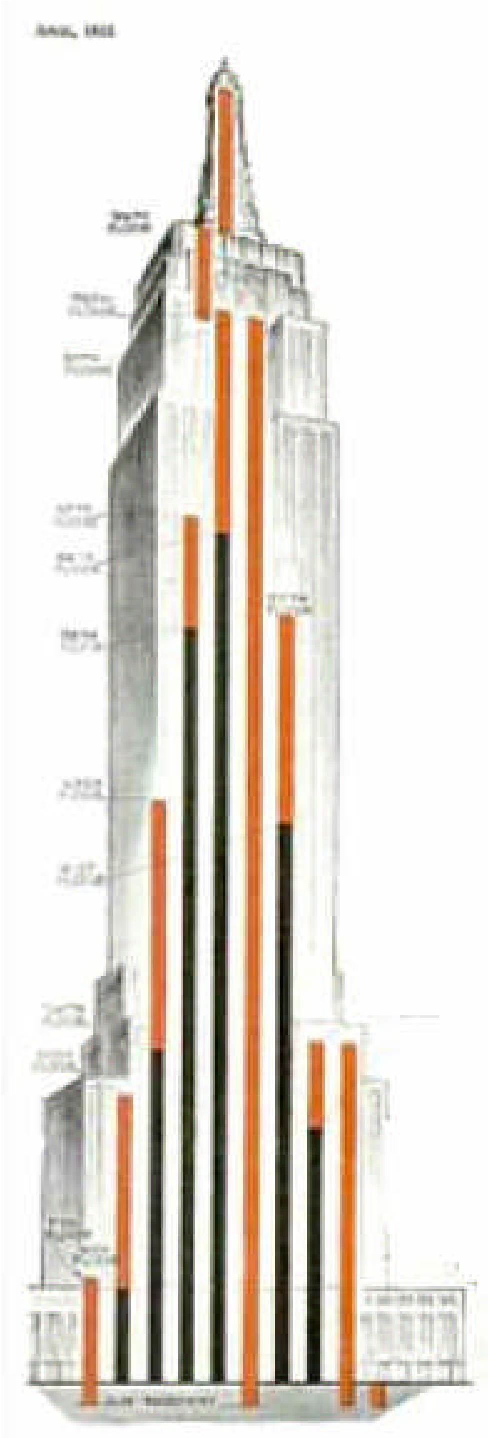
“…Elevator counterbalances are heavier than the car, by about forty per cent of the maximum load the car may carry. As a result an empty car is lighter than the counterbalance, and a heavily loaded one is heavier, and so each tries to run faster than the governor speed, the empty one when going up and the loaded one when coming down. When that happens the driving motor becomes a generator, and actually puts current back into the line, while the enormous resistance of the field acts as a brake and maintains an even speed, just as regeneration is used to brake heavy trains on the electrified mountain divisions of the Milwaukee Road, where air brakes are never necessary to keep the train speed constant while going down hill…”

***Modern Mechanics and Invention,* April 1931**

"…For many years the Otis Elevator Company, which has the contract for the present installation, has been developing what it calls 'signal-control' elevators. These machines were originally developed for slow-speed, operator-less, foolproof service in apartment houses. When tall building made high-speed elevator operation essential, the necessity for automatic control became clear at once and development took a new direction. The first signal-control elevators in New York City were installed in the Standard Oil Building about six years ago. Since that time many improvements have been made. The installation in use in the Chrysler Building, and the still greater one soon to be in operation in the Empire State Building, represent the most advanced systems of vertical transportation in the world…"

***Popular Science,* April 1931**

<u>Left</u>: caption: "The Chrysler Building (1930)"



"…We can best get an idea of automatic elevator magic by taking an imaginary ride. For an example let us enter the Empire State Building with the purpose of ascending to the seventy-ninth floor, seven stories below the top. We do not have to search long among the elevator corridors for the correct bank, which is indicated by an electric sign that announces 66th to 80th FLOORS. A light above one of the cars indicates that this is the next one to leave. We step in. In a jiffy a jewel flashes on the attendant's control panel. He gives a slight throw to a lever. The doors of the shaftway and of the car silently and swiftly close, and the car automatically be-gins it smooth and fast leap skyward…"

Popular Science, **April 1931**

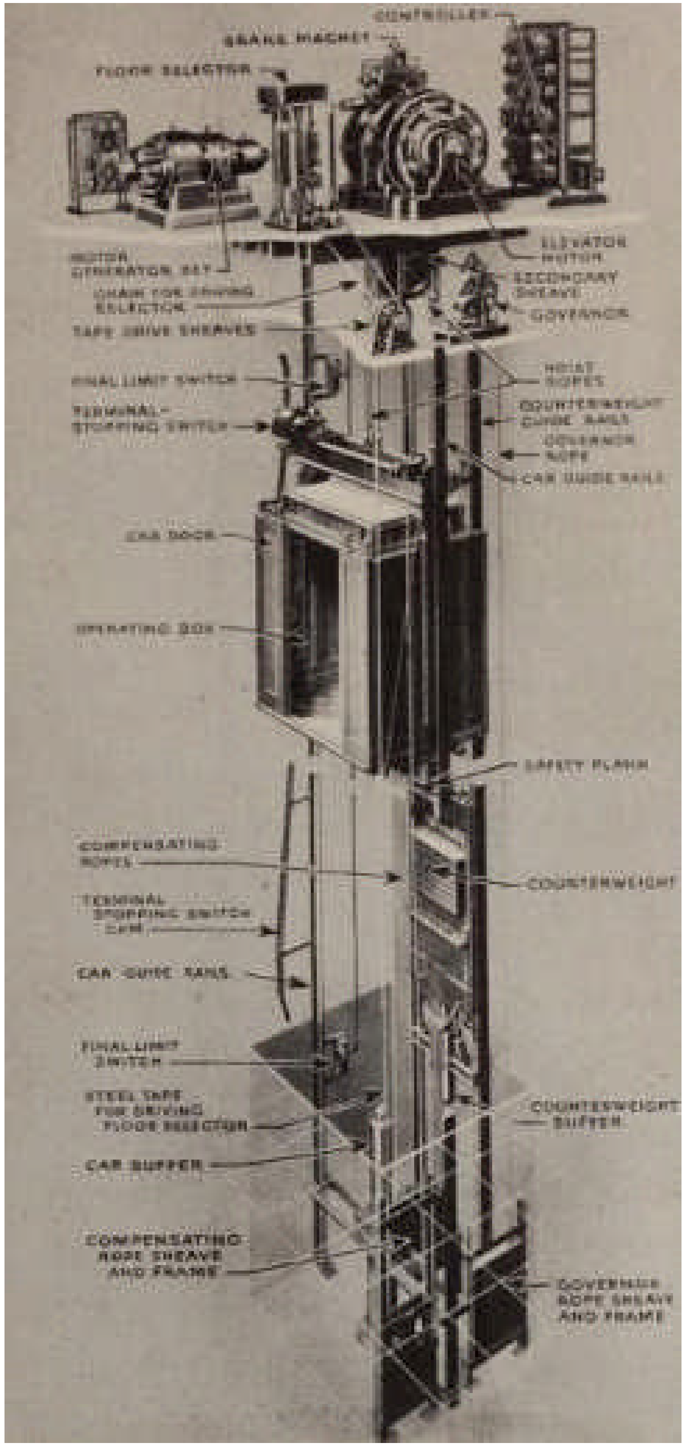
Left: caption: "Red lines in drawing indicate banks of local elevators, black are the express banks"

"…'SIXTY-EIGHT,' 'seventy,' 'seventy-nine,' the passengers announce their floors to the attendant, who merely presses a button on the control panel for each number called. He need worry no more. Once the door is closed the car is under the care of invisible supervisors – cams. cables, governors, generators, motors brakes, switches, rheostats, relays that are quicker, more sensitive, and more positive in action, than he. The car continues to speed upward for about a minute (this time will later be cut almost in half), then suddenly numbers begin to flash on a panel above the door, 66, 67. Almost imperceptibly, the speed of the car is retarded…"

Popular Science, **April 1931**

"…As 68 flashes, it stops, the doors automatically glide open, and we discover that the car has leveled itself perfectly with the landing. There has been no under- or overshooting of the mark, no breath-taking acceleration or retardation, no wrestling with the doors. A gang of electromechanical geniuses, hidden about the car, in the shaftway, and in the motor room have done away with all that. After two of the passengers have stepped out, the attendant again gives a slight throw to the lever, which initiates the closing of the doors, and the car proceeds. For every button that has been pressed, the elevator automatically makes the same sort of gentle, swift, and accurate stop. Not only does it stop in response to buttons on the operator's panel, but to buttons pressed by passengers waiting at hall landings, in which case the stop is made entirely without the attendant's knowledge. To economize to the utmost in waiting time, only the car that will actually stop to take on a passenger will flash a light in the hall. Ordinarily, the first car traveling past the landing in the direction desired must automatically stop; but when a car is full, the attendant, by throwing a switch on his control board, may relay all calls to the next available car…"

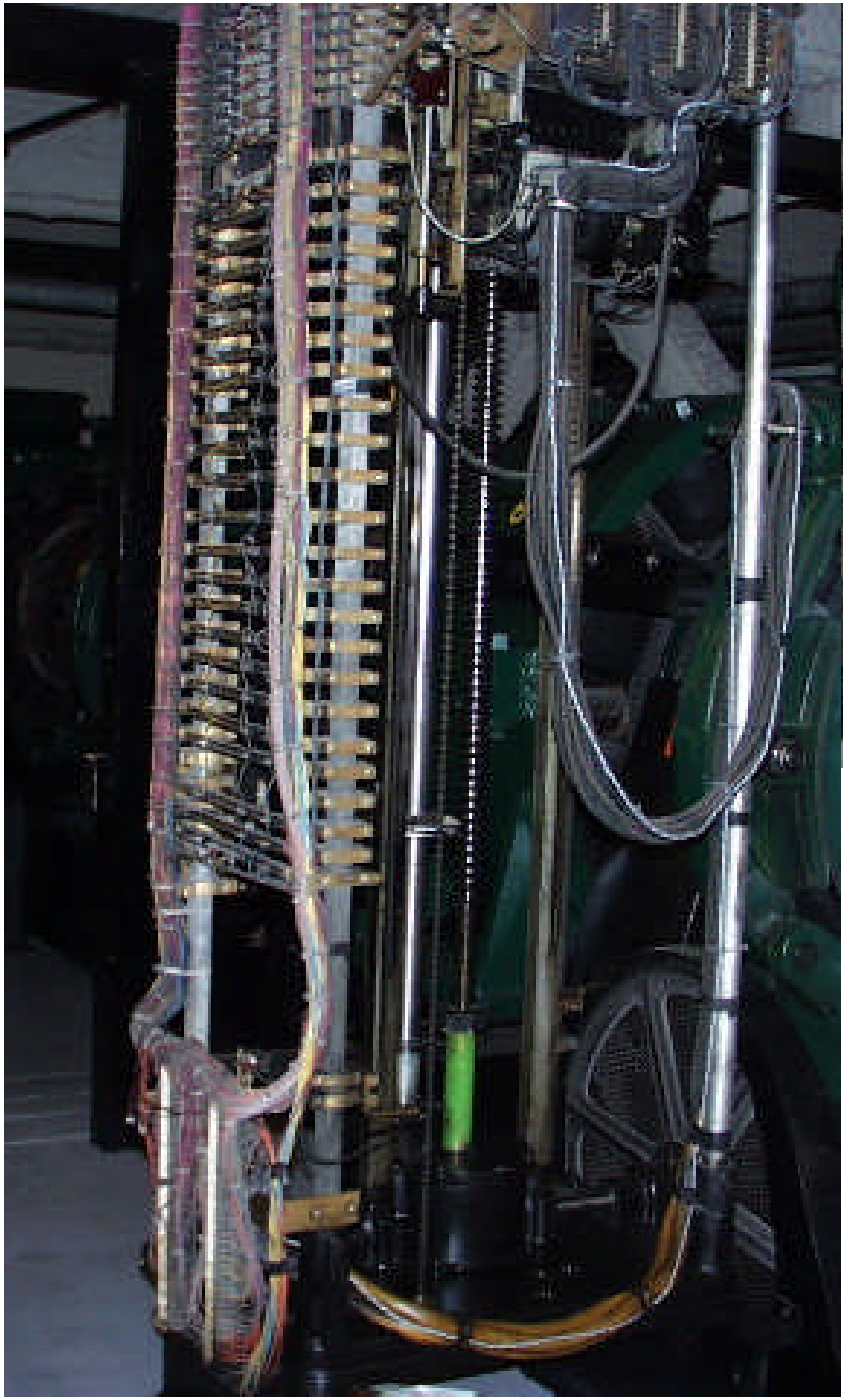
***Popular Science,* April 1931**

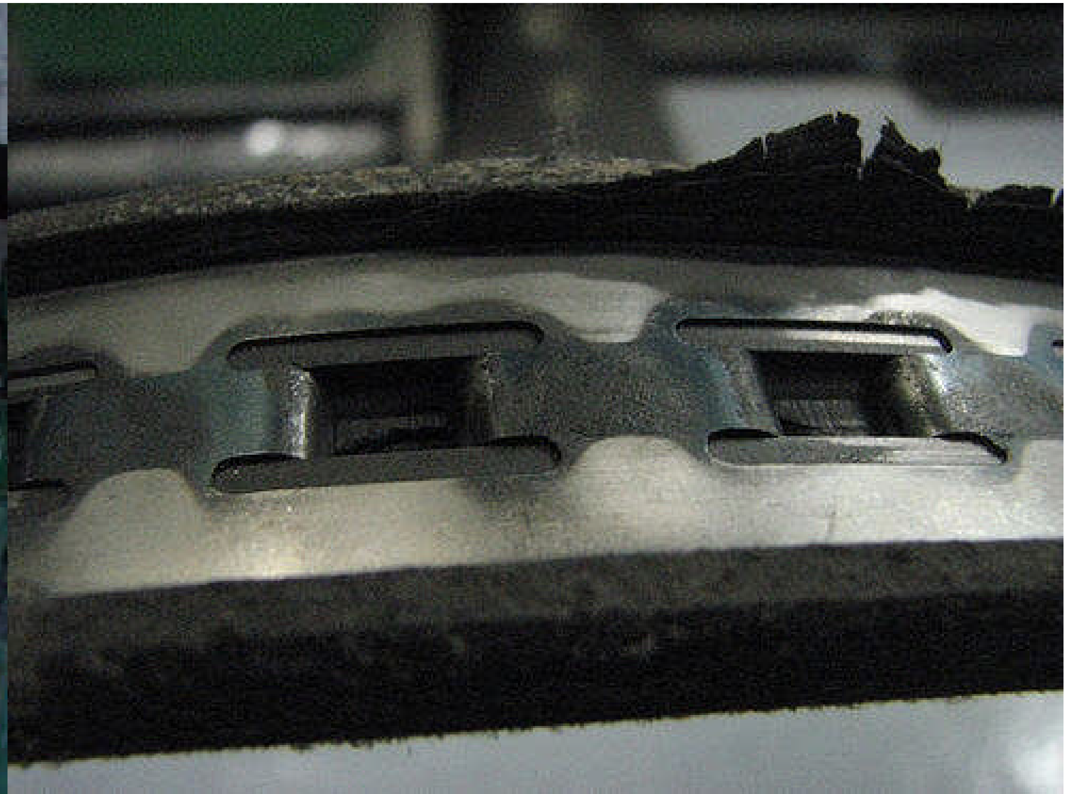


"…The controlling and operating equipment is by no means simple. To interconnect all the electrical circuits required by the elevators in this one building, nearly 8,000,000 feet of rubber-covered wire were necessary – more than enough to reach from Boston to Kansas City. In addition there are thirty-six miles of conduit. The length of the hoisting ropes, compensating ropes, and governor ropes exceeds 120 miles. Accelerating, slowing down, leveling and stopping of a car is accomplished chiefly through the assistance of what is known as a 'selector.' This device, located in the motor room directly above each shaftway, has a sliding member that is run up and down past groups of contacts – in a small way following exactly the position of the elevator in the shaft – by a steel tape attached to the car…"

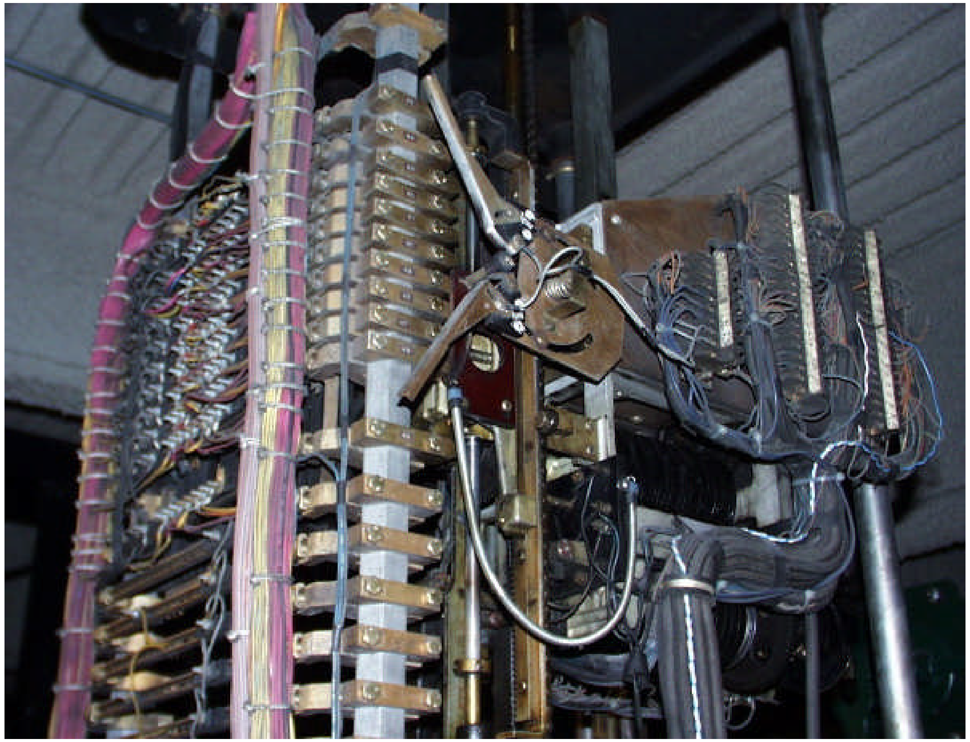
Popular Science, **April 1931**

Left: caption: "Typical arrangement of Otis Signal-Control Gearless Traction Passenger Elevator"





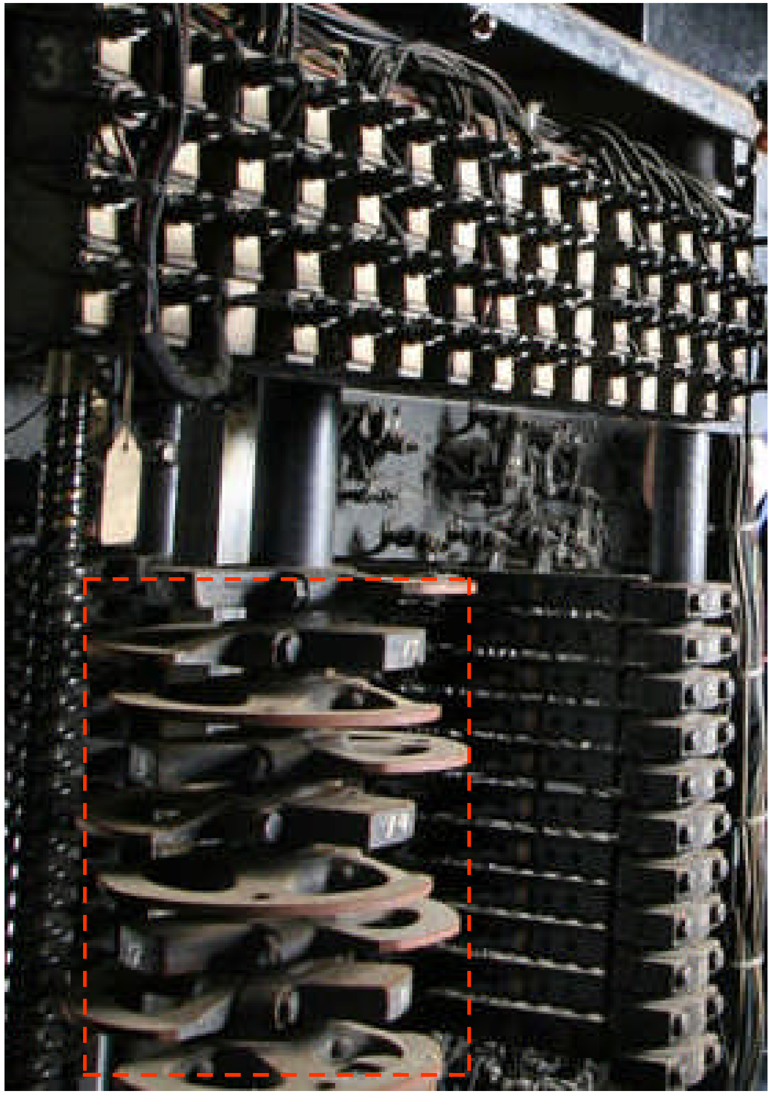
<u>Above</u>: caption: "Otis Selector Tape"
<u>Left</u>: caption: "Otis Selector for Gearless Traction Machine"



"…If, by the pressing of a stopping button, the contacts of a certain group are made active, when the sliding member of the selector touches that group the circuits will be automatically manipulated to properly level and stop the car. The doors, which are opened and closed by an electric motor, are actuated simultaneously..."

Popular Science, **April 1931**

Left: close-up of an Otis *Selector*



"…Not only was it necessary to provide electrical and mechanical devices to attend to the normal operation of the elevators, but devices to attend also to their safety. So much attention has been given to the question of safety that the chances of meeting with an accident in an elevator in this new installation are four or five times smaller than the chances of an accident in your automobile…"

Popular Science, **April 1931**

Left: Otis *Selector* in rear and *Leveling Cams* (a.k.a. "Pie Plates") in foreground (highlighted)

Getting Emotional

“Before the Empire State Building opened, it was inconceivable for someone to get into a box that automatically opened and closed and didn’t need to be driven by a human being. It required a very large machine at the top of the building. The developers back then took a risk building something that high because they couldn’t be sure the elevator technology could transport people efficiently. The elevator could take someone to the 80th floor in fifty seconds. We have an emotional attachment to this building.”

***Randy Wilcox*, President - *Otis North and South America* (ca. 2011)**

RE: a critical part of Otis’ history is tied to NYC and the *Empire State Building*, allowing it to be built to its great height. The ESB was one of the first buildings to showcase Otis’ groundbreaking *Signal Control* technology. The first elevator system to operate without an “elevator man,” *Signal Control* was introduced in 1924 in NYC’s *Standard Oil Building* in lower Manhattan. It allowed passengers to press a button for their desired floor and allowed doors to self-close.

Extraordinarily Safe (?)

"…elevators are extraordinarily safe - far safer than cars, to say nothing of other forms of vertical transport…An average of twenty-six people die in (or on) elevators in the United States every year, but most of these are people being paid to work on them. That may still seem like a lot, until you consider that that many die in automobiles every five hours. In New York City, home to fifty-eight thousand elevators, there are eleven billion elevator trips a year - thirty million every day - and yet hardly more than two dozen passengers get banged up enough to seek medical attention…Still, elevator lore has its share of horrors: strandings, manglings, fires, drownings, decapitations…"

***The New Yorker*, April 2008**

"…'What if a cable should break?' someone asks. The answer may be surprising. The safety of the car would not be interfered with. The cables are frequently inspected, and there are six cable to support each car, though the cars in the two highest banks of the Empire State Building have <u>eight</u> cables. Should flaws pass undetected, and one, two, three, four, or even five cables break, the car would not drop, as one cable is sufficient to carry the whole load! Of course an attendant will not continue to run a car with even one cable broken. The passengers would be left off at the nearest landing, and the elevator would not be put into service again until the cable had been replaced…"

***Popular Science,* April 1931**

"…Modern elevators are provided with so many safety features that accidents are virtually impossible. A single cable is sufficient to support the load, yet six are commonly used, not so much for safety as to give more traction on the hoisting drum. A ball governor fixes the limiting speed, and in event of accident would trip a clutch, releasing dogs and shoes which would press against the guide rails and bring the car to a stop. In the pit at the bottom of the shaft an oil piston buffer provides additional safety, and the counter-balance also is fitted with a buffer. The stops at the ends, or terminals of the elevator 'line' are operated by curved cam rails attached to the guides. The cams move a lever which trips the switches and brings the car to a stop. That's just added insurance against failure of the selector, and then to guard against failure of the cam lever there's a final limiting switch which cuts out all current and stops everything…"

***Modern Mechanics and Invention,* April 1931**

A Gruesome Death

"…The elevator industry likes to insist that, short of airplane rammings, most accidents are the result of human error, of passengers or workers doing things they should not. Trying to run in through closing doors is asking for trouble; so is climbing up into an elevator car, or down out of one, when it is stuck between floors, or letting a piece of equipment get lodged in the brake, as happened to a service elevator at 5 Times Square, in Manhattan, four years ago, causing the counterweight to plummet (the counterweight, which aids an elevator's rise and slows its descent, is typically forty per cent heavier than an empty car) and the elevator to shoot up, at sixty miles an hour, into the beams at the top of the shaft, killing the attendant inside. Loading up an empty elevator car with discarded Christmas trees, pressing the button for the top floor, then throwing in a match, so that by the time the car reaches the top it is ablaze with heat so intense that the alloy (called 'babbitt') connecting the cables to the car melts, and the car, a fireball now, plunges into the pit: this practice, apparently popular in New York City housing projects, is inadvisable…"

***The New Yorker*, April 2008**

"An out-of-control freight elevator zoomed up to the top of the Ernst & Young Building in Times Square yesterday and crashed into the roof, killing a security guard inside, fire officials said. A malfunction in the elevator's counterweight braking system sent the car racing to the 37th floor, officials said. 'It seems to be a freak, somewhat unusual accident,' said one source close to the investigation. Two people in another elevator were trapped inside when the power was shut off, but firefighters found them unharmed. The incident at 5 Times Square, a new office tower at Seventh Ave., rattled workers who heard the monstrous boom about 4:45 p.m…"

***NY Daily News,* August 13th 2004**

(MORRISTOWN, NJ, 8/13/04) – Schindler Elevator Corporation extends its deepest sympathy to the family and friends of Carl DeClercq, who was killed in a tragic elevator accident on Thursday, August 12, 2004 at the 5 Times Square office building in New York City.

Schindler, the elevator manufacturer and maintenance company for 5 Times Square, has dispatched experts to the scene to work closely with the building owner and authorities to help determine what happened. The initial inspection has confirmed that the elevator in question has not been issued any citations and did not experience any cable breakage. However, it would be premature to speculate about the cause of the accident or provide further comments at this time.

As a leading manufacturer of elevators and escalators since 1874, Schindler is committed to the safety of its equipment and passengers. The company has given this matter top priority and is dedicated to determining the cause of the accident.

RE: Schindler Elevator's press release regarding the fatal accident involving one of its elevators at *5 Times Square*

" A go-getter at one of the city's top advertising agencies died a gruesome death Wednesday moments after she did what millions of New Yorkers do countless times each day - step inside an elevator. On her way to her job at Young & Rubicam, Suzanne Hart marched across the tiled lobby of the landmark 285 Madison Ave. building and stepped into an elevator around 10 a.m., joining a man and a woman inside. She was barely inside the compartment - the doors hadn't even closed - when it suddenly shot up 20 feet or so to just below the second floor. In an instant, Hart, 41, who still had one foot out, was pulled up the shaft where she became wedged between the elevator and the wall - and had the life crushed out of her…"

***NY Daily News*, December 14th 2011**

<u>Above</u>: caption: "The body of advertising director Suzanne Hart is wheeled out of her Madison Ave. office building"

"…A vertical-transportation axiom states that if an elevator is in trouble the safest place to be is inside the elevator. This holds even if the elevator is not in trouble. Elevator surfing - riding on top of the cab, for kicks - is dangerous. This is why the escape hatch is always locked. By law, it's bolted shut, from the outside. It's there so that emergency personnel can get in, not so passengers can get out…"

***The New Yorker*, April 2008**

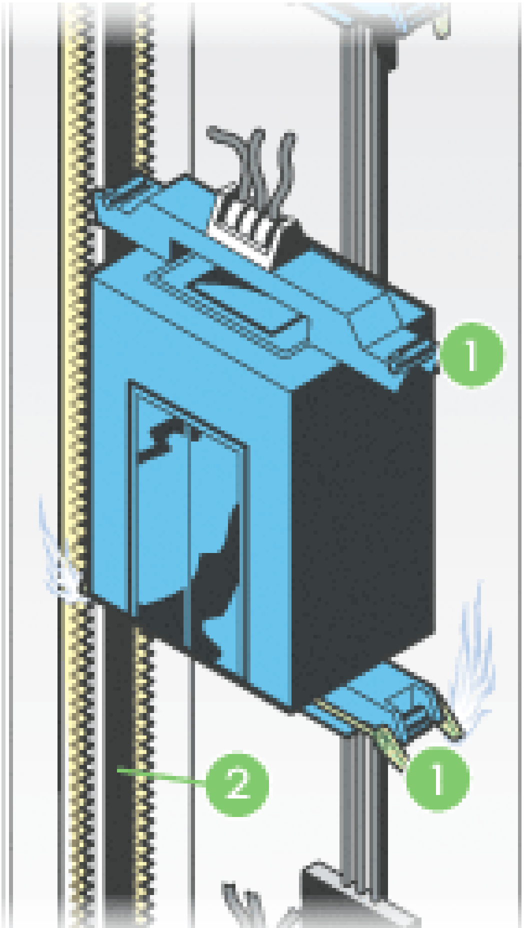
Dead’s Dead

“…To the age-old half-serious question of whether a passenger barrelling earthward in a runaway elevator should jump in the air just before impact, Pulling responded, as vertical-transportation professionals ceaselessly must, that you can’t jump up fast enough to counteract the rate of descent. ‘And how are you supposed to know when to jump?’ he said. As for an alternative strategy - lie flat on the floor? - he shrugged: ‘Dead’s dead.’…”

***The New Yorker*, April 2008**

"…Traction elevators - the ones hanging from ropes, as opposed to dumbwaiters, or mining elevators, or those lifted by hydraulic pumps - are typically borne aloft by six or eight hoist cables, each of which, according to the national elevator-safety code (and the code determines all), is capable on its own of supporting the full load of the elevator plus twenty-five per cent more weight. Another line, the governor cable, is connected to a device that detects if the elevator car is descending at a rate twenty-five per cent faster than its maximum designed speed. If that happens, the device trips the safeties, bronze shoes that run along vertical rails in the shaft. These brakes are designed to stop the car quickly, but not so abruptly as to cause injury. They work. This is why free falling, at least, is so rare…"

***The New Yorker*, April 2008**



1. If the cables snap, the elevator's **safeties** would kick in. **Safeties** are braking systems on the elevator.

2. Some safeties clamp the **steel rails** running up and down the elevator shaft, while others drive a wedge into the notches in the **rails**.

Worst Case Scenario

"…Ask a vertical-transportation-industry professional to recall an episode of an elevator in free fall - the cab plummeting in the shaftway, frayed rope ends trailing in the dark - and he will say that he can think of only one. That would be the Empire State Building incident of 1945, in which a B-25 bomber pilot made a wrong turn in the fog and crashed into the seventy-ninth floor, snapping the hoist and safety cables of two elevators. Both of them plunged to the bottom of the shaft. One of them fell from the seventy-fifth floor with a woman aboard - an elevator operator (the operator of the other one had stepped out for a cigarette). By the time the car crashed into the buffer in the pit (a hydraulic truncheon designed to be a cushion of last resort), a thousand feet of cable had piled up beneath it, serving as a kind of spring. A pillow of air pressure, as the speeding car compressed the air in the shaft, may have helped ease the impact as well. Still, the landing was not soft. The car's walls buckled, and steel debris tore up through the floor. It was the woman's good fortune to be cowering in a corner when the car hit. She was severely injured but alive…"

***The New Yorker*, April 2008**

"Horror stricken occupants of the building, alarmed by the roar of engines, ran to the windows just in time to see the plane loom out of the gray mists that swathed the upper floors of the world's tallest building…It crashed with a terrifying impact along the north wall of the building"

***New York Times* – Sunday, July 29th 1945**

RE: the Saturday morning, July 28th 1945 head-on crash of a USAAF B-25 Mitchell bomber into the ESB

, JULY 29, 1945.

BOMBER HITS EMPIRE STATE BUILDING, SETTING IT AFIRE AT THE 79TH FLOOR; 13 DEAD, 26 HURT; WIDE AREA ROCKED

WHERE BOMBER CRASHED INTO EMPIRE STATE BUILDING

B-25 CRASHES IN FO

Hole 18 by 20 Feet To Through North Wal by Terrific Impact

BLAZING 'GAS' SCATTE

Flames Put Out in 40- Fight—2 Women Sur Fall in Elevator

By FRANK ADA

A twin-engined B- bomber, lost in a Mi crashed into the Em Building at a point 91 the street level at 9:4

“Holy Smokes!”

***Henry Hering*, Sculptor**

RE: his only comment when returning from a round of golf to view the damage to his Penthouse-Studio at 10 West 33rd Street. One engine, part of the fuselage and a landing gear tore through internal office walls, two fire walls, across a stairway, through another office and out the south face of the 78th floor. It all came crashing through his roof destroying most of his life’s work in the fire that ensued. His twenty-two foot model for *Pro Patria* – which stood in the *Indiana War Memorial* and was the largest bronze statue of its kind at that time, was also destroyed that faithful day.

Lucky to be Alive

B-25 CRASHES IN FOG

Hole 18 by 20 Feet Torn Through North Wall by Terrific Impact

BLAZING 'GAS' SCATTERED

Flames Put Out in 40-Minute Fight—2 Women Survive Fall in Elevator

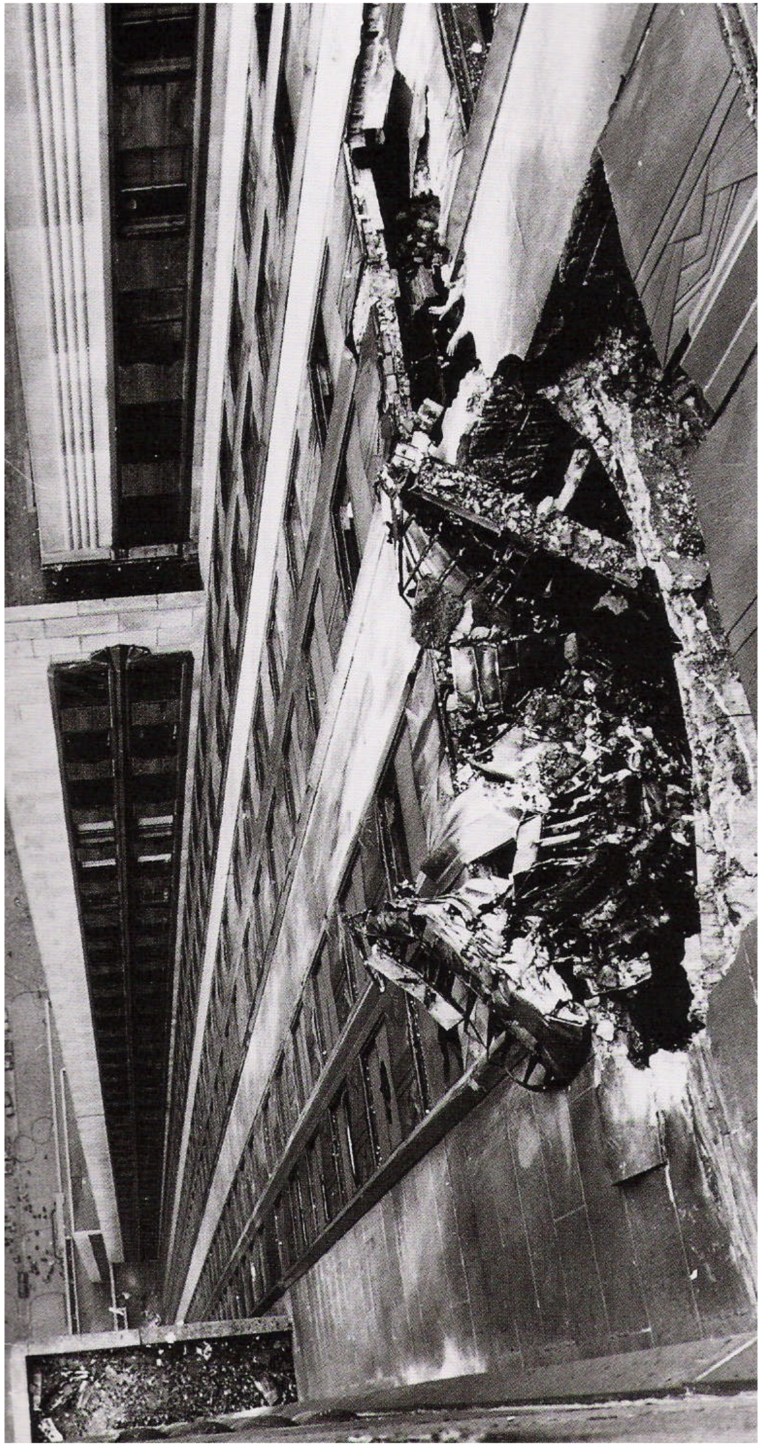
"Thank heaven, the Navy's here"

RE: comment from one of two female elevator operators when there appeared a *Coast Guard* corpsman to their aid and rescue. Witnessing the crash, he commandeered from the *Walgreen's* drug store (on the 33rd Street side of the ESB) medical supplies and proceeded to the sub-basement where the elevator in shaft six had come to rest after the cable snapped as a result of one engine passing through the shaft and landing atop the car. Though injured, both survived their harrowing ordeal.

"…According to Otis representatives and safety experts, an elevator freefall is as unlikely to happen as finding life on other planets. The last and only time it happened, (except in a movie of course), was in New York City on July 28, 1945. That day, Betty Lou Oliver was working her shift as an elevator operator at the Empire State Building. Older New Yorkers will remember - a B-25 bomber crashed into the north side of the skyscraper. Oliver was on the 79th floor and was badly burned. Rescuers decided to lower her in an elevator. The cables, though, were damaged in the collision. They snapped. Oliver plummeted seventy-five stories to the basement. Miraculously, she survived because the cables tangled up, preventing her from crashing to the floor…"

***NY Daily News*, December 2nd 2011**

Left: caption: "Betty Lou Oliver walks again with her nurse at Bellevue Hospital"

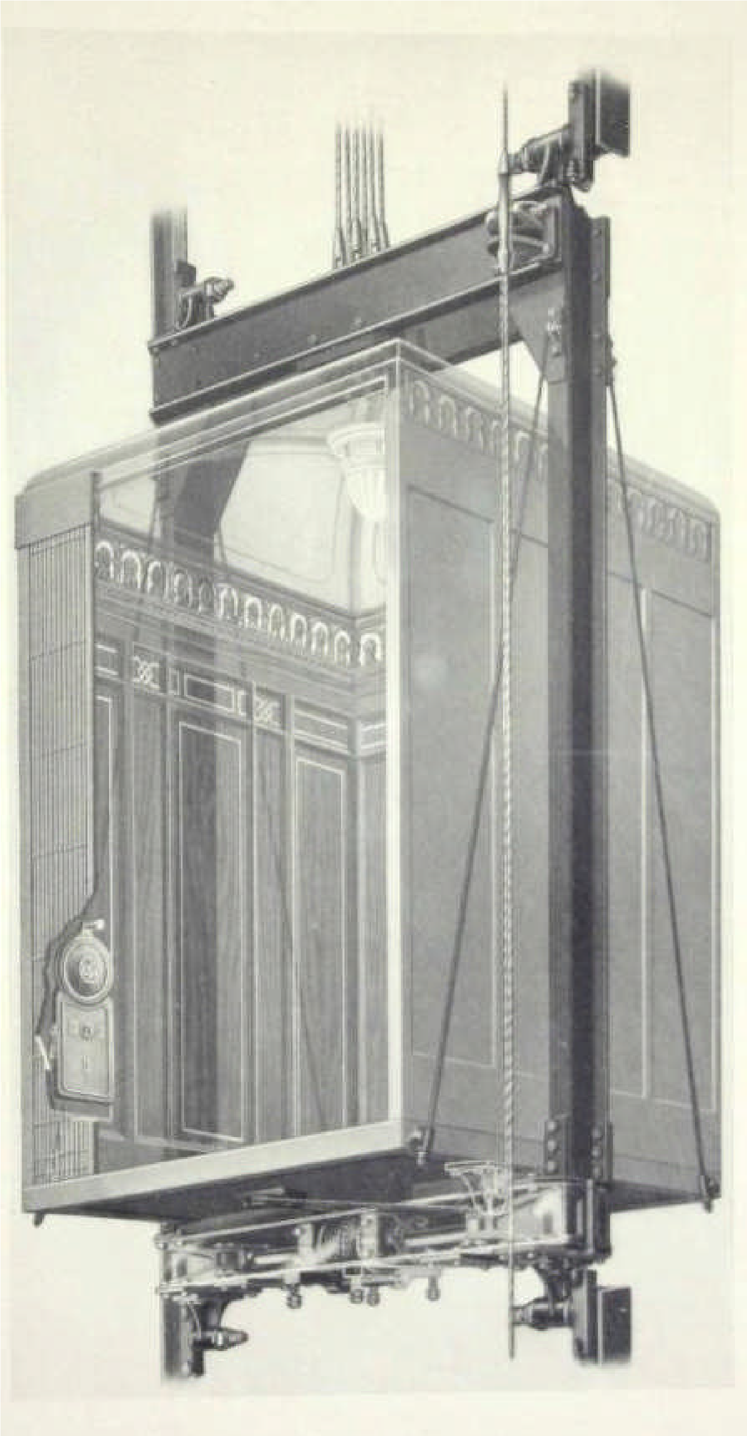


"There must be many tenants of the ESB who, like us, wish to pay tribute to the engineering perfection which enabled this magnificent building to withstand the assault of the bomber…The grand building stood staunch and firm. This almost human steadfastness on the part of the structure itself was further impressed on me when later I returned to my office. There was the same stillness of any Saturday afternoon…no hint of the chaos not so many floors above and of the wreckage of the two elevators in the basement below."

Francis G. Guilford **– ESB tenant**

RE: she was in her office on the 34th floor at the time of the crash

Car Safety Frame



"…The <u>Car Safety Frame</u> is made of structural steel securely bolted and riveted together, to which the hoisting ropes are attached by means of self adjusting hitches, which provide means for equalizing the strain on the ropes and relieving them of undue twisting strains. Spring adjusting, self-aligning guide shoes an mounted on the car-frame to secure smooth running. The car platform is strongly built with a steel frame, securely braced to the safety frame, and having a selected well seasoned wood door, fireproofed on the under side with sheet metal and the upper surface finished with tile or other floor covering. An Otis <u>Car Safety Device</u> of the most efficient type is mounted underneath the car platform on the safety frame, and is operated by means of an Otis <u>Centrifugal Speed Governor</u> at the top of the hatchway…"

RE: excerpt from *Otis Elevator Company: The World's Word for Elevator Safety* (ca. 1922)

"…In case of emergency, due to parting of the ropes, the governor will be tripped, and grip the governor rope, which in turn actuates a drum mounted in the safety frame. The revolving of this drum operates right and left hand screws, which force wedges between the guide clamps, causing heavy steel safety jaws to gradually grip the guide rails and bring the car to a smooth and gradual stop. Prior to the operation of the safety device, the governor will cause all power to be cut off from the motor, the brake will be applied and the machine stopped…"

RE: excerpt from *Otis Elevator Company: The World's Word for Elevator Safety* (ca. 1922)

"...<u>COUNTERBALANCE</u>: The elevator is to be suitably counterbalanced for smooth and economical operation. The counterweight consists of heavy cast iron sections, contained in a structural steel frame provided with adjustable guide shoes. The weights are properly secured by means of tie rods.

<u>GUIDE RAILS</u>: The car and counterweight are guided by steel tees, which are securely fastened to the framing of the hatchway. The guides are of special heavy section, with planed surfaces, and having the ends tongued and grooved to form matched joints, thereby providing perfect alignment and smooth running.

<u>OIL CUSHION TERMINAL BUFFERS</u>: Otis Oil Cushion Buffers are provided as a means of bringing the car and counterweight to a gradual and positive stop at the extreme limits of travel beyond the terminal landings, should the car for any reason run by the final limit switches. The operation of either buffer causes a displacement of oil from one chamber of the buffer to another, through graduated openings, carefully calculated, and designed to obtain a uniform rate of retardation of car or counterweight and produce a gradual and positive stop. The Buffers automatically reset for further action when the car resumes operation…"

RE: excerpt from *Otis Elevator Company: The World's Word for Elevator Safety* (ca. 1922)

The Need for Speed

"…There are fifty-eight passenger cars in the various express and local banks at the ground level, and two cars in the tower shafts. All the ground level cars are designed to travel at the maximum speed now allowed – 700 feet per minute – but provision is made in their mechanism to speed up when and if the law is changed. If that happens the ten traveling express to the 66th floor and local from there to the 80th level will move at 1,200 feet per minute. Eighteen serving the floors between 24 and 43 and 41 and 57 will be speeded up to 1,000 feet per minute, and another eighteen to 800 feet. Only four locals, serving floors from the first to the seventh, will continue at the 700 foot speed…"

***Modern Mechanics and Invention,* April 1931**

Summary of Elevators

Passenger Elevators	Duty		
Bank A, 4-Local	4000 lbs.	@ 700 F.P.M.	
" B, 10-Express	4000 "	" 700 "	(arranged for future)
" C, 8-Express	3500 "	" 700 "	speed of 800 F.P.M.)
" D, 10-Express	3500 "	" 700 "	(arranged for future
" E, 8-Express	3500 "	" 700 "	speed of 1000 F.P.M)
" F, 8-Express	3500 "	" 700 "	(arranged for future
" G, 10-Express	3500 "	" 700 "	speed of 1200 F.P.M.)
(Total 58)			
2 Tower Elevators	3000 lbs.	" 500 F.P.M.	
1 Mooring Mast Elev.	2000 "	" 500 F.P.M.	

Freight Elevators	Duty	
No.1.	3500 lbs.	@ 700 F.P.M.
2.	3500 "	@ 700 F.P.M.
3 and 4,	3500 "	@ 700 F.P.M.
5 and 6,	5000 "	@ 250 F.P.M.

Floors Served	Rise	Operation	Platform Sizes (clear)
Sub-Basement -7th, incl.	123'1"	Signal Control	6'6"x6'11½"
Ground, 6th-20th, "	238'1"	" "	6'6"x6'11½"
Ground, 18th-25th, "	300'7"		6'6"x6'3½"
Ground, 24th-43d, "	514'1"		7'2" x 5'5"
Ground, 41st-57th, "	682'1"		7'2" x 5'5"
Ground, 56th-67th, "	799'7"		7'2" x 5'5"
Ground, 66th-80th, "	951'0"		7'2" x 5'5"
79th-86th incl.	103'3"	(Car switch UMV -)	7'0" x 5'5¾"
85th-GG Level, incl.	183'10½"	(with Micro-Leveling)	6'0" x 5'0"

Floors Served	Rise	Operation	Platform sizes (clear)
Sub-bsmnt.,Bsmnt.2nd-80th inc.	986'	(Car Switch UMV)	6'11¼ x 5'6"
" " " 2nd-57th incl.	716'7"	(with Micro-)	7'2" x 5'6"
" " " 2nd-25th incl.	335'	(Leveling)	6'6" x6'1"
Sub-bsmnt. Bsmnt.Ground	36'2"	Car switch resistance	6'11¼x6'1¾"

"…The present law in New York City limits the speed of elevators to 700 feet a minute. Certain that this law will soon be changed, eighteen of the Empire State elevators are arr-anged for a future speed of 800 feet a minute, eighteen for 1,000 feet. And eight-een more for 1,200 feet. The latter are the fastest passenger el-evators ever made…"

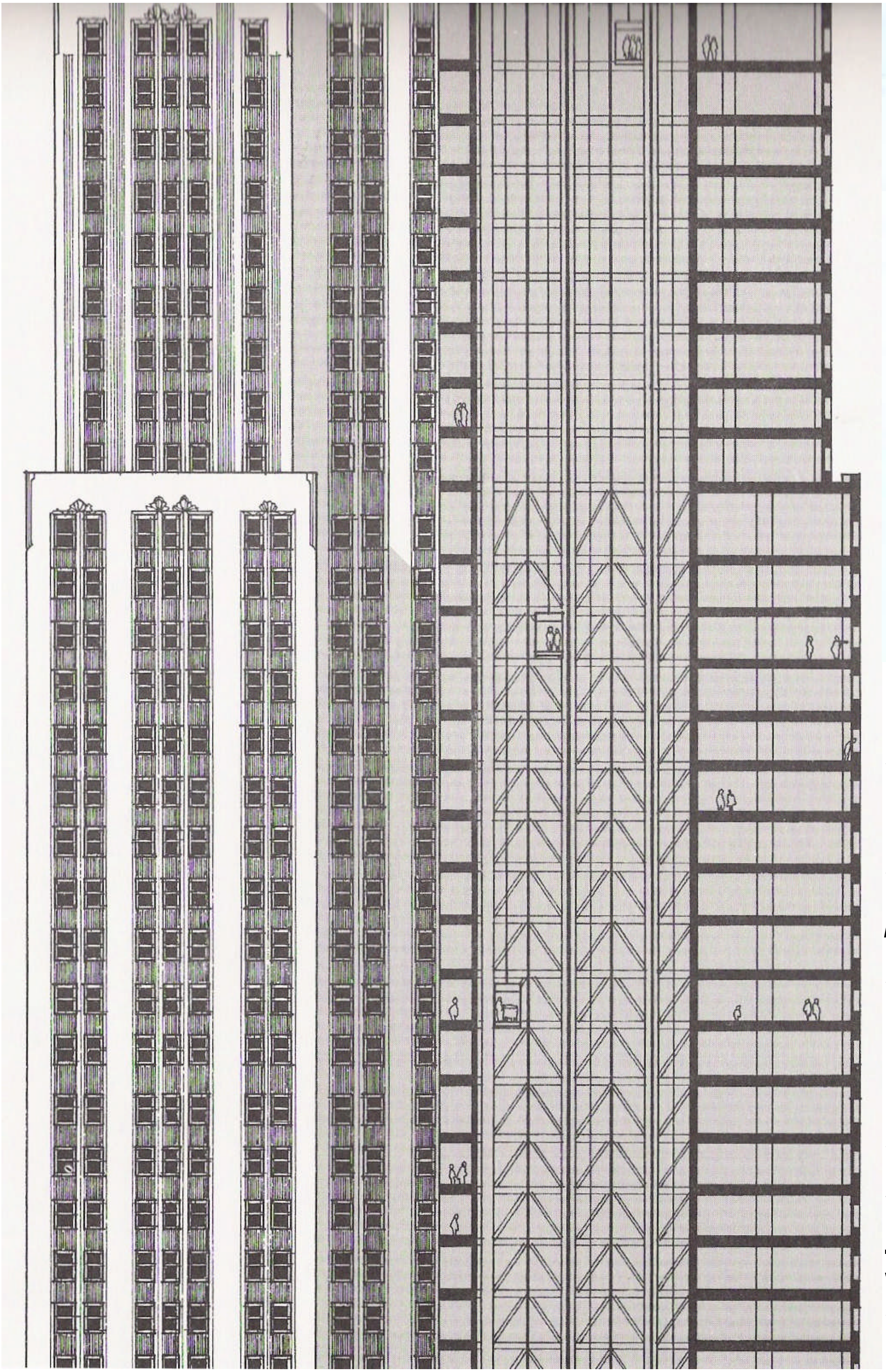
***Popular Science,* April 1931**

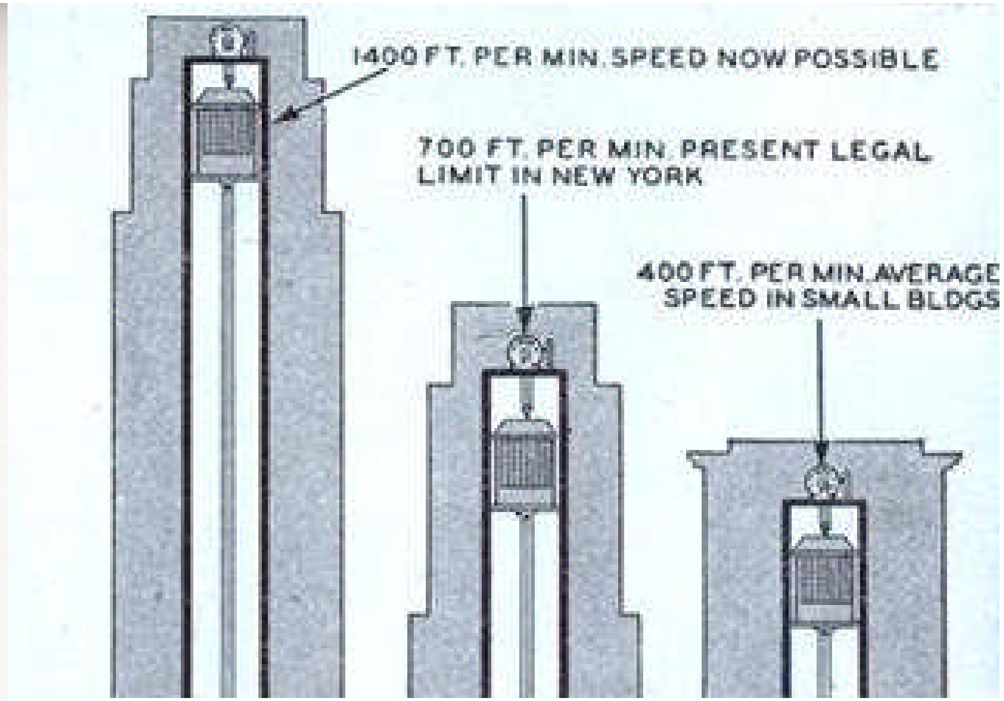
<u>Left</u>: "Summary of Elevators"

"…The code restricted the speed of elevators to 700 fpm. For the giants among skyscrapers, that was too slow - the code had to be revised to allow elevators to travel as fast as 1,200 fpm. For the first six weeks after the building opened, the elevators operated at the slower rate. By the second week of June, however, under the new elevator rules adopted by the Board of Standards & Appeals, elevators could whisk their passengers upward at a rate of 1,200-fpm…"

***John Tauranac*, Author**

<u>Left</u>: caption: "This elevator in the LaSalle-Walker building in Chicago is the fastest in the world. It is capable of 1,000 fpm"

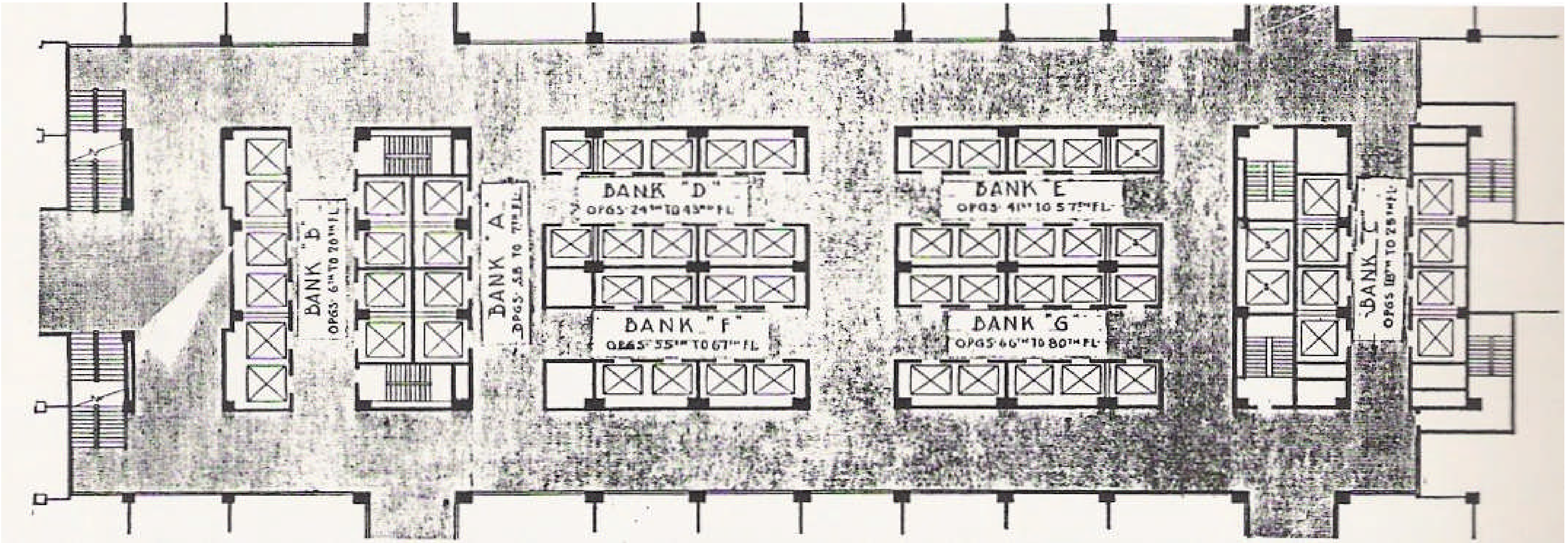




"…According to Otis engineers, the speed limit with modern equipment is not determined by factors of safety but by the normal distance between stops. In a department store, where stops must be made at every floor, 500 feet a minute would be more sensible than 1,200; but where a clear jump of nearly 800 feet must be made the lower speed is ridiculous…"

Popular Science, **April 1931**

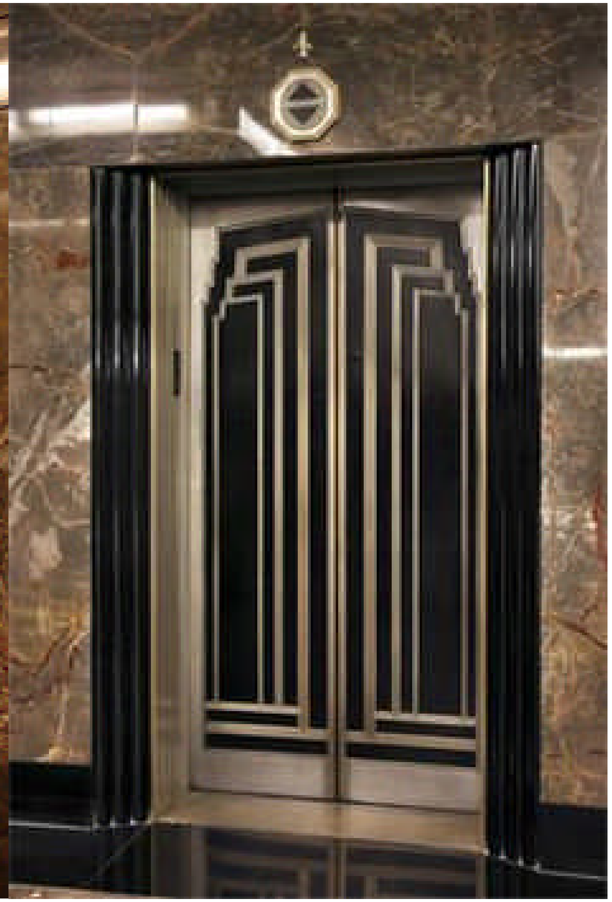
<u>Above</u>: caption: "Speed Comparison Diagram with present-day equipment for New York City" (1931)

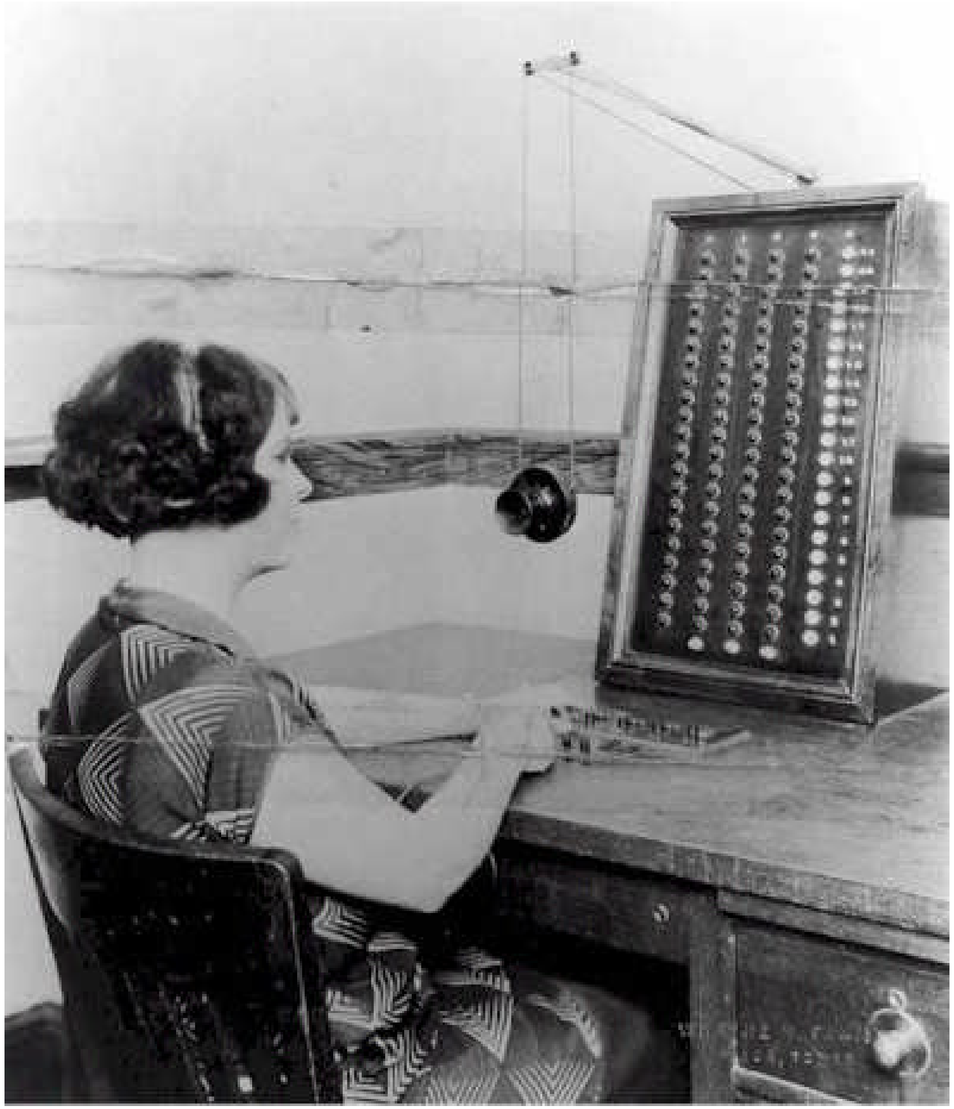


"…That the traffic may be handled with the greatest expediency, an indicating panel and a dispatching panel are adjacent to each bank of cars. On one, lights show at a glance the position of every elevator in the bank; two columns of lights of a different color indicate the floors at which buttons have been pushed by waiting passengers. On the other panel are telephone, switches, and the control of an automatic dispatching device…"

Popular Science, **April 1931**

<u>Above</u>: caption: "Plan of Elevator Lobby"

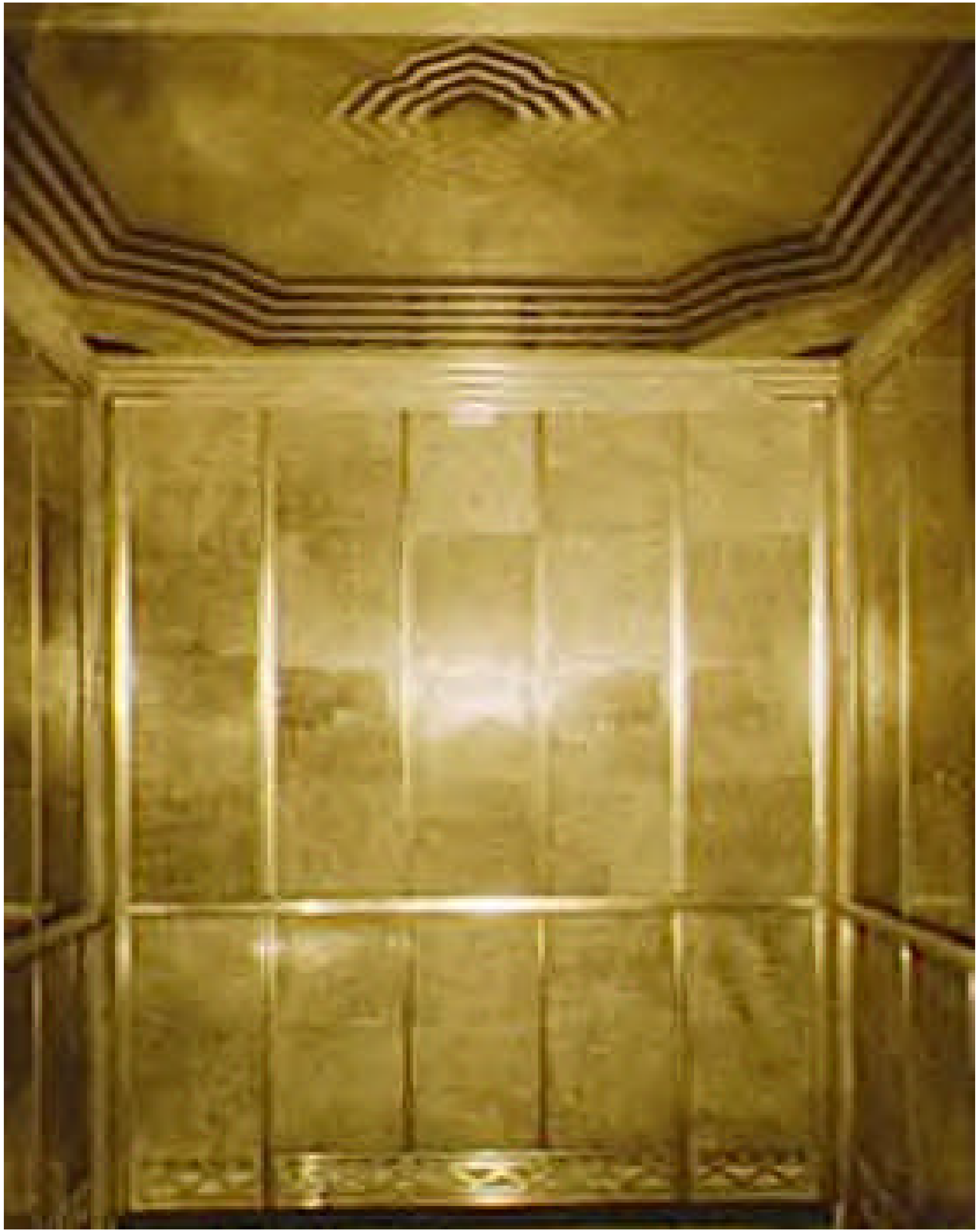




"…Ordinarily this device signals the attendant of a car when his car is next to leave, then gives him another signal at the precise moment he should initiate the closing of the doors. Its operation may be speeded or retarded to suit the traffic, at the will of the dispatcher, or the dispatcher may start or recall cars independent of the device, by manipulating the switches…"

***Popular Science,* April 1931**

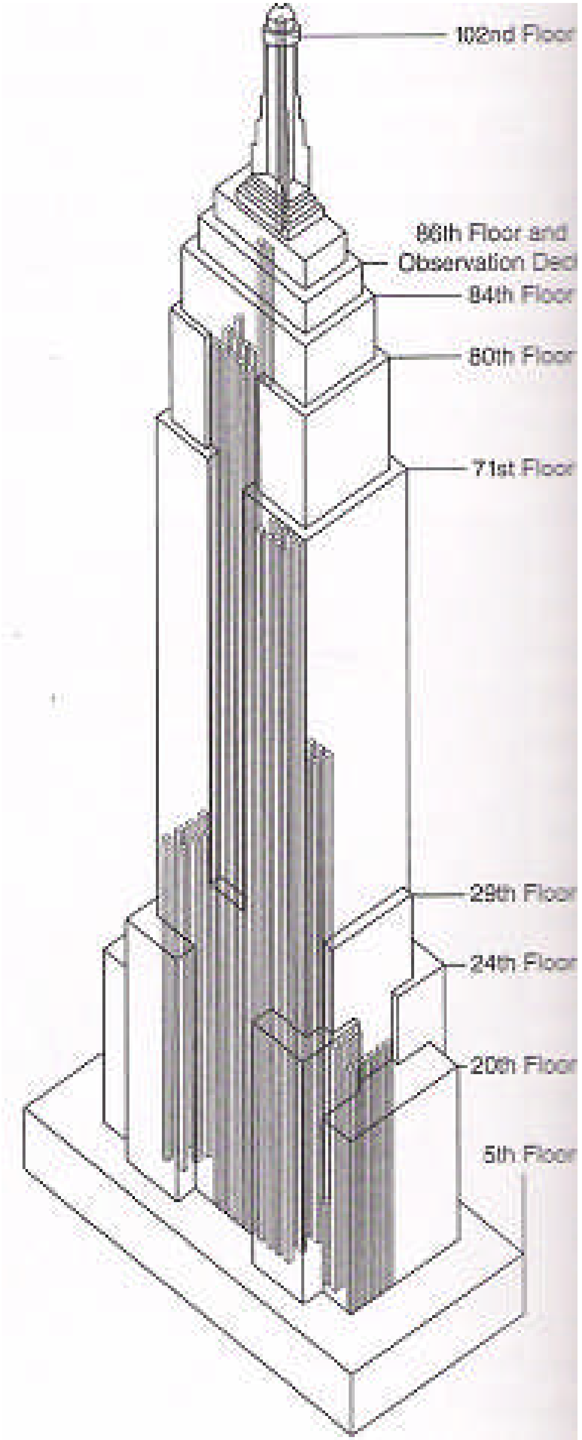
<u>Left</u>: caption: "Elevator Dispatcher"



"…Each elevator has a telephone, inter-connected through an automatic 200-station switchboard with each other, with the starter, the engineer, the superintendent, and with the station on each floor…"

Popular Science, **April 1931**

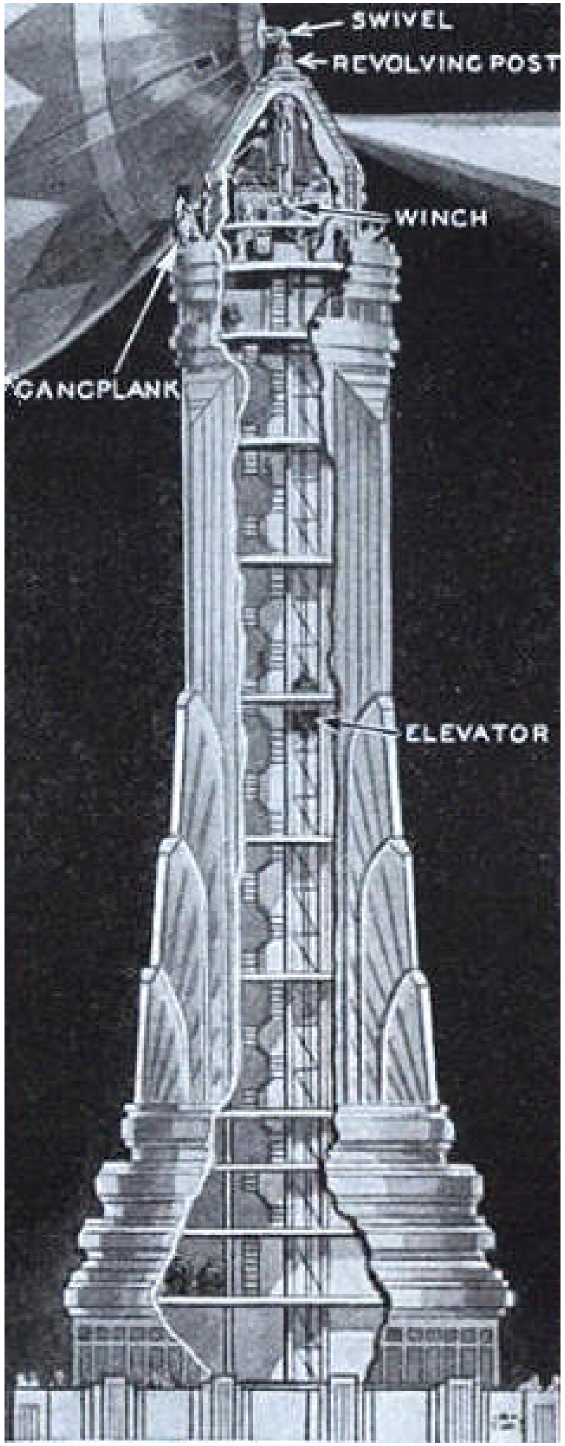
Left: original interior of ESB Elevator Cab



"…It will take sixty-six elevators to serve the world's tallest man-made structure – sixty seven when the elevator is installed in the dirigible mooring mast on the roof, a mast whose tip will be 243 feet higher than the famed Eiffel tower in Paris. Eleven of them. Ten passenger express cars and one freight, will rise as high as the 80th floor, the ten express cars traveling 951 feet, while the freight elevator, which de-scends into the sub-basement as well, will have a vertical rise of 981 feet. The upper tower floors, from the 79th to the 86th in-clusive, will be served by local cars.

Modern Mechanics and Invention, **April 1931**

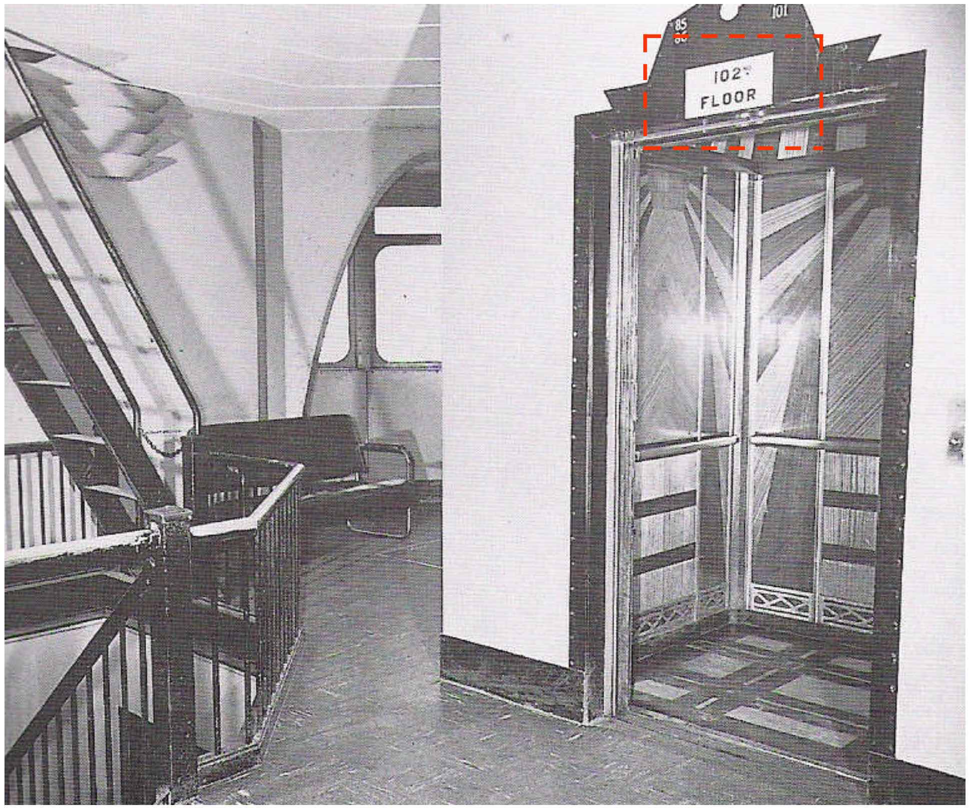
Left: caption: "Empire State Building Elevator Ser-vice Diagram"



"…The highest rise of any of the cars is made by Freight Elev. No. 1, which travels from the sub-basement to the eightieth floor, 986 feet. None of the cars that ascend from the lobby go higher. Two local cars provide service between the 79th and the 86th floors. It is planned to have another elevator in the mooring mast, rising to an observation platform 1,210 feet above the ground…"

***Popular Science,* April 1931**

<u>Left</u>: caption: "Cut-Away view through the 200-foot Mooring Mast showing stairs and elevator"

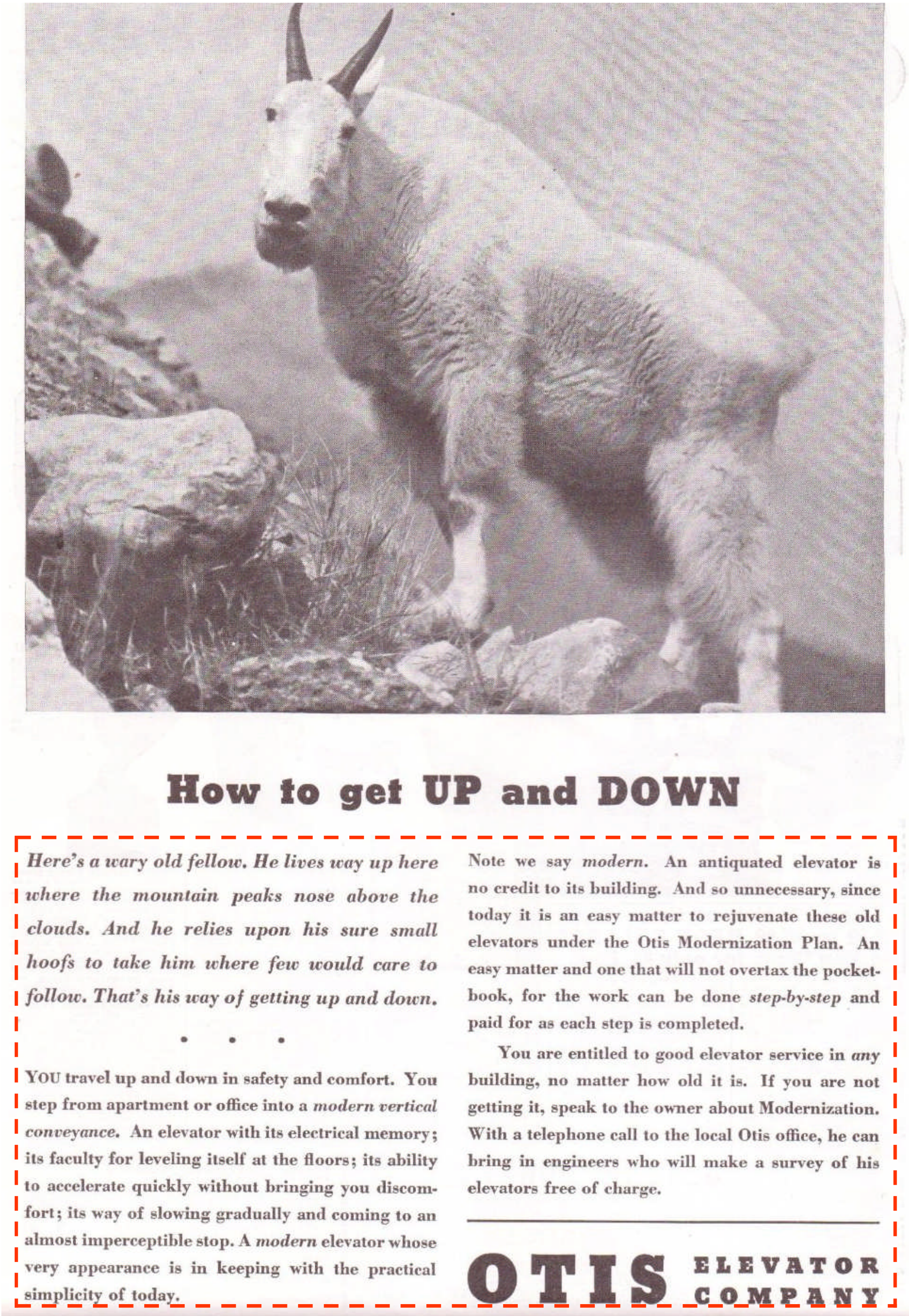


"No one seemed to be staying long in the highest observatory. Nothing to see but mist, nowhere to sit, not a tremendous amount of room, and perhaps a rather odd feeling, being up so high…the dungeon of a medieval keep, painted silvery and raised among the clouds!"

***New York Sun*, 1932**

RE: ESB's 102nd floor *Observatory Deck* (left). Actually, the 101st floor. The 102nd floor was originally to be used as the dirigible landing platform and an open observation deck. The 101st floor was intended to be used as an enclosed observation deck.

Step-by-Step



<u>Left</u>: caption: *"Here's a very old fellow. He lives way up here where the mountain peaks nose above the clouds. And he relies upon his sure small hoofs to take him where few would care to follow. That's his way of getting up and down.* You travel up and down in safety and comfort. You step from apartment or office into a *modern vertical conveyance.* An elevator with its electrical memory; its faculty for leveling itself at the floors; its ability to accelerate quickly without bringing you discomfort; its way of slowing gradually and coming to an almost imperceptible stop. A *modern* elevator whose very appearance is in keeping with the practical simplicity of today. Note we say *modern*. An antiquated elevator is no credit to its building. And so unnecessary, since today it is an easy matter to re-juvenate these old elevators under the Otis Modernization Plan. An easy matter and one that will not overtax the pocketbook, for the work can be done *step-by-step* and paid for as each step is completed. You are entitled to good elevator service in *any* building, no matter how old it is…." (1933 Otis ad)

<u>Left</u>: caption: "Your elevators are the focal point of your building and your best judgment tells you they should always be in first-class condition. But your budget says, 'Take it easy, I can't stand a heavy burden right now.' All right – we can help your best judgment and your budget get together so that it will be unnecessary to postpone elevator modernization. We'll be glad to do the work *one step at a time.* This *step-by-step* plan calls for, first, a complete examination of your elevators by elevator experts. This examination (it's free) includes a report showing condition of your elevators and just what is needed to put them in new-elevator condition. Then the work of modernization is plotted in logical steps, placing the changes in the order of their importance. You pay for each step as it is completed. You get the benefit of partial modernization at once. You work toward complete modernization. When the work is done, there is no financial burden over your head. We shall be glad to go more into detail. The local Otis office is prepared to discuss step-by-step modernization with you." (1936 Otis ad)

The Empire State Re-Building Program

"…Otis wanted a shot at the job when current Empire State Building owner Malkin Properties decided to rethink, ren-ovate and refurbish their entire elevator system…In the midst of a $550 million 'Empire State Re-Building' program, Malkin Properties wanted to further cut energy expenditures in their elevator usage. They also wanted little to no disruption to the existing tenants. 'We're in the process of renovating the entire building and upgrading the tenant base, so when to do the elevators became something we had to really think about,' says Anthony E. Malkin, president of the three-gen-eration 42nd Street-based Malkin Holdings. 'At the present time, we have a lot of changeover of spaces with offices being shown and leased spaces built out. About 1.1 million square feet of space is unoccupied and being prepped to be leased. Now was the time to do it, when physical occ-upancy of the building is low and there will be no disruption to service.'…"

***NY Daily News*, December 2nd 2011**

"…As one of several bids, Otis' early proposal didn't cut the mustard. 'Otis was out of it as far as I was concerned,' says Malkin. 'If they wanted back in, there were three things I told Otis to change. One was the timing. They had to get it done faster with less intrusion. Two, I thought the pricing was wrong. And three, they hadn't told us about personnel, or who would be doing the job.'…"

***NY Daily News*, December 2nd 2011**

"…According to Wilcox, Otis went back and rethought their proposal. They dedicated specific personnel to the project and came up with a better solution with minimal tenant interruption. All elevator banks, for example, will maintain service throughout the project…"

***NY Daily News*, December 2nd 2011**

Left: caption: "Didier Michaud-Daniel, President of Otis Elevator Company, left, and Anthony Malkin, of owner Empire State Building Company, have signed a major modernization and service contract for the iconic building's sixty-eight elevators, the final component of the $550 million Empire State Re-Building renovation and modernization program. The elevator upgrade will deliver improved speed, energy efficiency, and passenger experience."

"When you're young from another country you think of the Empire State Building. The Empire State Building is known worldwide, so in terms of image it's a great opportunity for us to talk about what we're going to do there. I've been working in the industry thirty years and for me, coming from France, it was a dream getting the Empire State Building back. We're extremely proud of it."

Didier Michaud-Daniel*, President – *Otis Elevator Company

RE: only three elevator manufacturers: *Schindler*, *Thyssen-Krupp* and Otis were invited to bid the ESB project. In the end, Otis' innovative staffing system (which included a full-time branch manager to run the project and as many as sixty workers; two shifts per day, six days a week), won the day. The project was scheduled to begin in November 2011 and conclude in March 2014. The new elevators route passengers better while reducing their wait times. The ESB design specifications and bidding process lasted more than a year. The contract (incl-uding a ten-year maintenance agreement) consisted of upgrading all sixty-eight elevators and replacing 13-ton machines with new equipment - all while workers, tourists and other visitors enter and/or leave the landmark building undisturbed. The refurbished elevators carry nearly ten-million passengers annually.

"It's almost like upgrading your kitchen in your house. The equipment is getting too old and too costly to maintain."

Michael Poon*, Director of Technical Support - *Motion Control Engineering Inc.

RE: with life-spans of 15 to 30 years, elevators require frequent upgrades to replace aging, inefficient equipment. However, the ESB upgrade project was unusual for its size and complexity. Elevators have joined the move from analog to digital, requiring frequent upgrades in their electronic system/s.

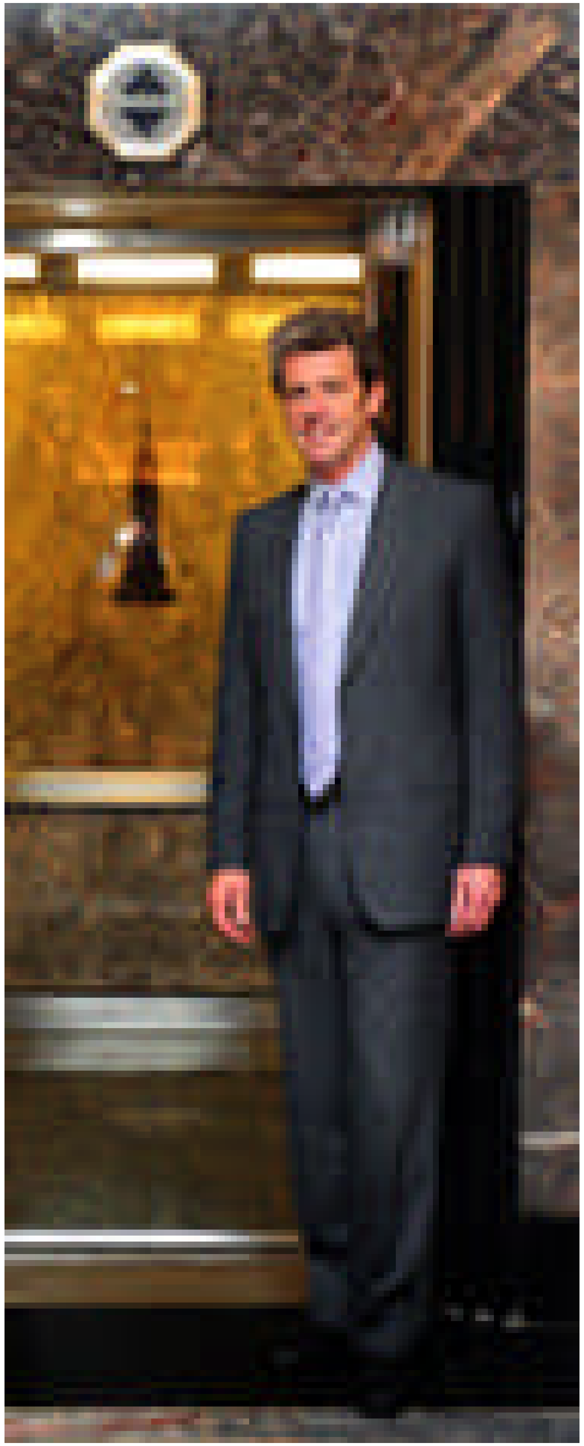
"Otis designed and installed the original elevator system for the Empire State Building and we are thrilled, on the building's 80th anniversary, to have been chosen to help make it one of the most modern and energy efficient office buildings in the world. Throughout its one-hundred and fifty-eight year history, Otis has proven its ability to manage and deliver complex projects like this one. At the Empire State Building, we look forward to applying our expertise to upgrade all sixty-eight elevators in the building and replace existing machines, weighing as much as twenty-six thousand pounds. Otis is proud to be undertaking this modernization project – the largest in our history – in one of the world's most iconic buildings."

Didier Michaud-Daniel*, President - *Otis Elevator Company

RE: the sixty-eight modernized elevators will transport the close to ten million tenants and office/observatory visitors each year in state-of-the-art, modern equipment. Otis' innovative *Compass Destination Management* (CDM) system will be employed. With CDM, during peak operating periods the elevators will transport passengers to their destinations from 20% to 40% faster than the existing conventional elevators. Using Otis *ReGen* drives, the modernized elevators will improve efficiency dramatically, returning regenerated energy back into the building's grid thus reducing elevator energy usage by as much as 30%.

"…On-site now, Otis staff will ramp up the program in January. Between twenty to sixty Otis personnel will eventually be at the building on a daily basis. The last worker on the modernization program will leave the building in a little more than two years. No more than three elevators will likely be refurbished at one time, meaning most of the twenty-seven miles of elevator cable in the building will be operational. The program will reduce Empire State Building elevator energy consumption by 30%. Using Otis new ReGen technology, the elevators will draw energy from a fully loaded descending elevator or a lightly loaded ascending car, convert it to electricity, and return the electricity to the building for use by other systems. It will also use Otis' Compass system. 'We're talking about fewer trips and shorter distances with energy-saving and power regenerating ability,' says Wilcox. 'The construction of the Empire State Building was a very important moment in history for us, and so it is today.'…"

***NY Daily News*, December 2nd 2011**

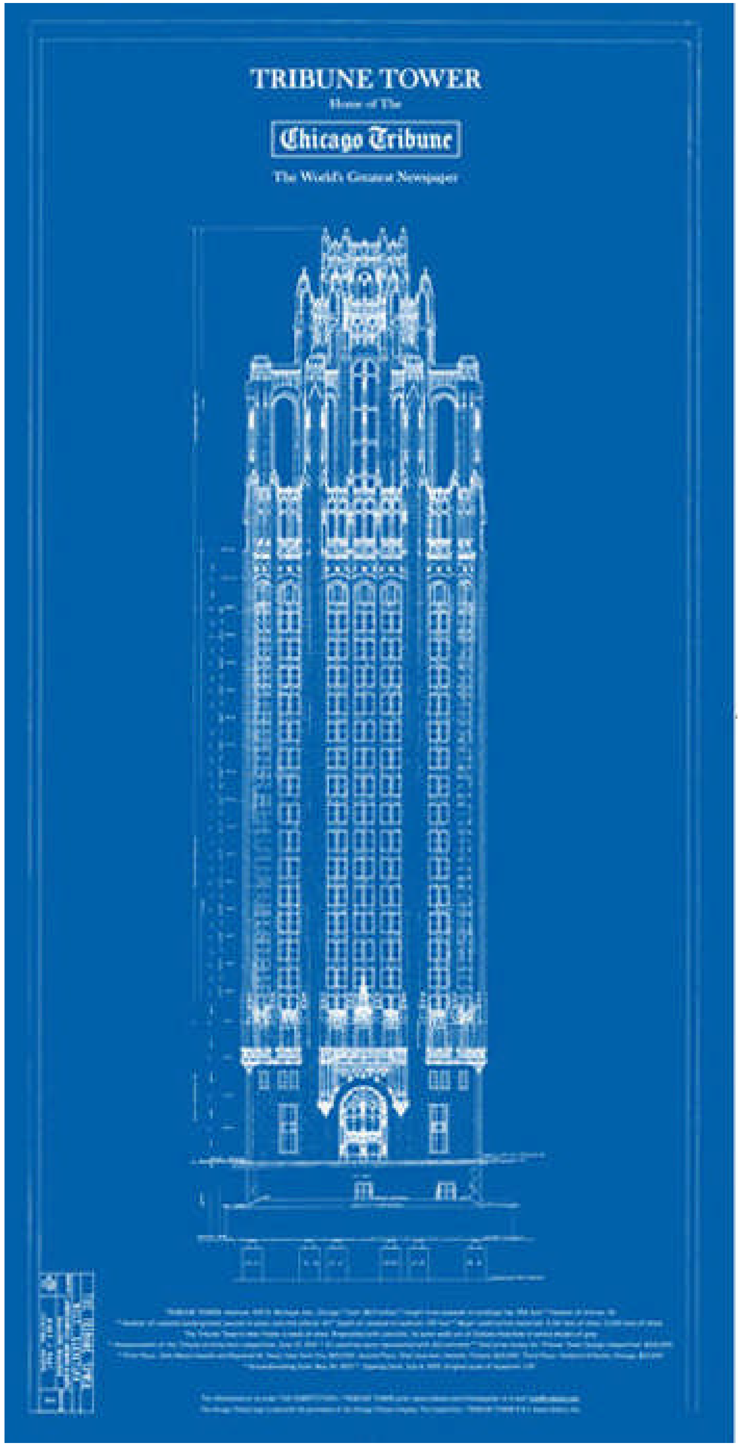


"In the end, this wasn't about price. Otis got the job because of dedication, execution and efficiency. They're taking out space in the building. They will be in-house throughout the entire process, and they will wear co-branded uniforms with an Otis and Empire State logo. They upped their game, and that was important to us when it came to this building…The bidding for our project was challenging and rigorous. Otis won as the clear choice through its technological solutions, innovative scheduling, performance guarantee, commitment of executives and personnel, and pricing. While we have concluded very significant leasing at our re-purposed building, the vast bulk of our new leases are not yet in occupancy. Now is the time to take on this project without disruption to our tenants. Otis' creative approach to minimize disruption through staffing, implementation and scheduling created an impressive and winning result. We are delighted to welcome Otis back to the building and consider them best equipped to deliver the highest level of service to our tenants over the next ten years."

Anthony E. Malkin*, President - *Malkin Holdings

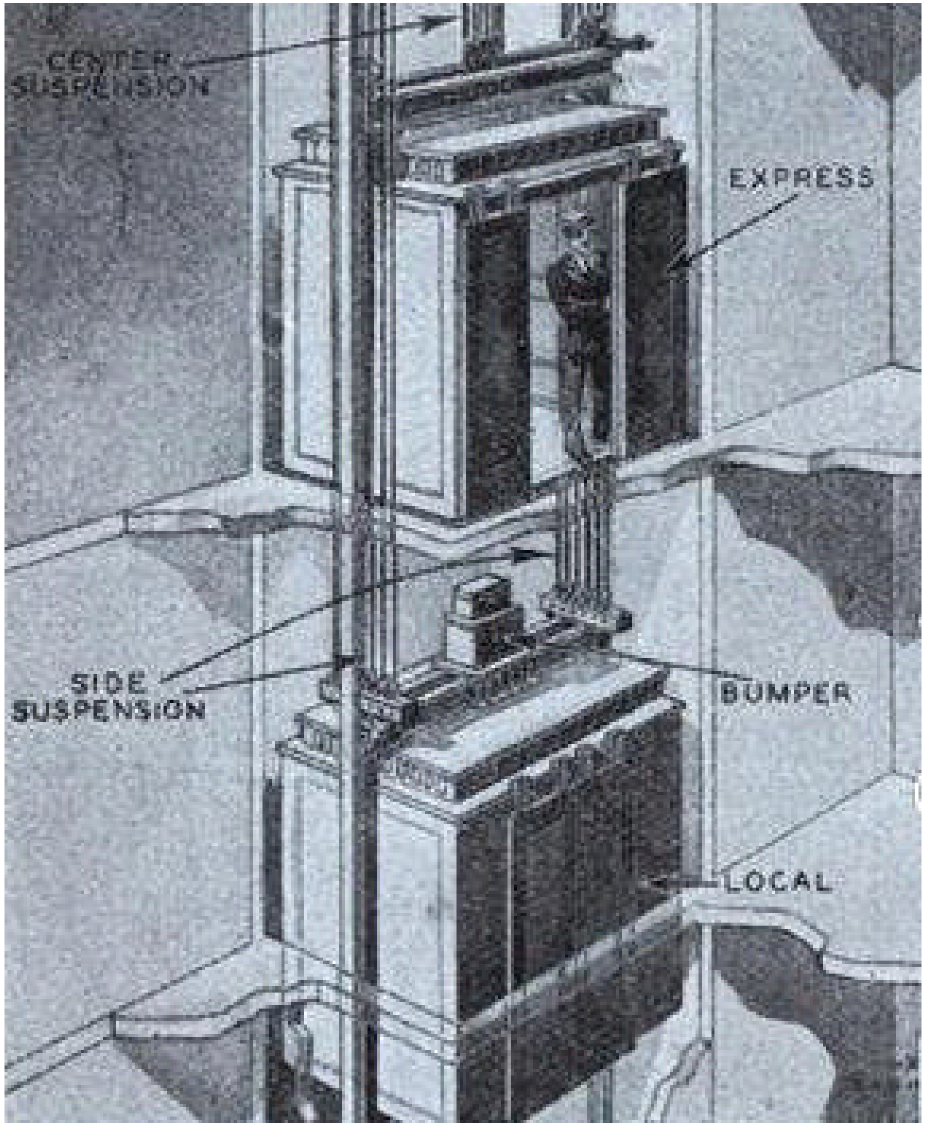
Left: caption: "Anthony Milkin stands in front of an open ESB elevator cab. As part of this contract, Otis was also awarded a ten-year maintenance contract."

Two Pounds of Salami in a One Pound Bag



"…The suggestion of the New York business men that two story elevators, serving two floors at the same time, and two elevators in one shaft be permitted opens up a whole new field of vertical high speed travel. No two deck passenger elevator has yet been built. Though two and even three deck freight elevators have been built for garages. The nearest approach to that is the Tribune Tower in Chicago where a tower elevator operates directly over a local car, but the local stops at the twelfth floor level and the tower car starts at the 23 rd, while the space in between is not an open shaft, but is occupied by offices…"

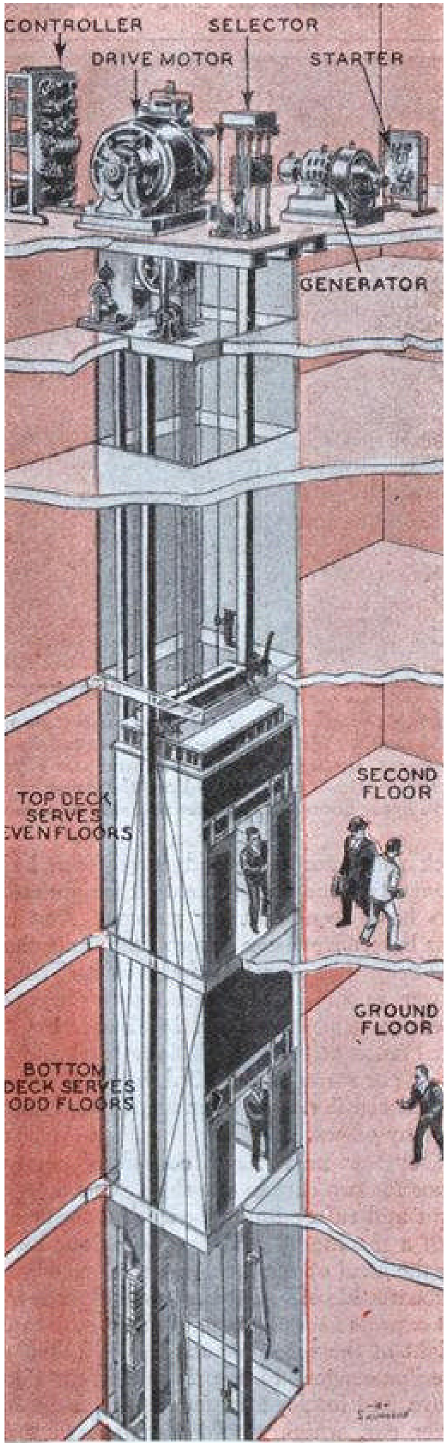
***Modern Mechanics and Invention*, April 1931**



"…Another idea which the elevator builders are considering is two cars in one shaft, moving independently of each other…An elevator system of this sort, with two cars running independently of each other in the same shaft, has actually been built and is in operation in the plant of the Westinghouse Electric Manufacturing Company at East Pittsburgh, where it is demonstrated to prospective builders of new skyscrapers…"

Modern Mechanics and Invention, **April 1931**

Left: caption: "Placing two elevators in one shaft is not as wild as it seems. While the lower car waited in the basement, the upper would load and run express to the top half of the building, the other would serve lower floors. Note center and side suspension."



"...The double-deck car offers problems that are perhaps more serious. One car would stop only at floors with even numbers and the other at floors with odd numbers. A passenger getting on at one level and wishing to get off at the other either would have to transfer some-where en route, and walk up or down one floor, or get off one floor before or beyond his destination, and take the stairs. There would be an operator in each car, but the controls would be interlocked so that neither could start the car until the other was ready. And, finally, all floor levels in the building would have to be exactly the same distance apart…"

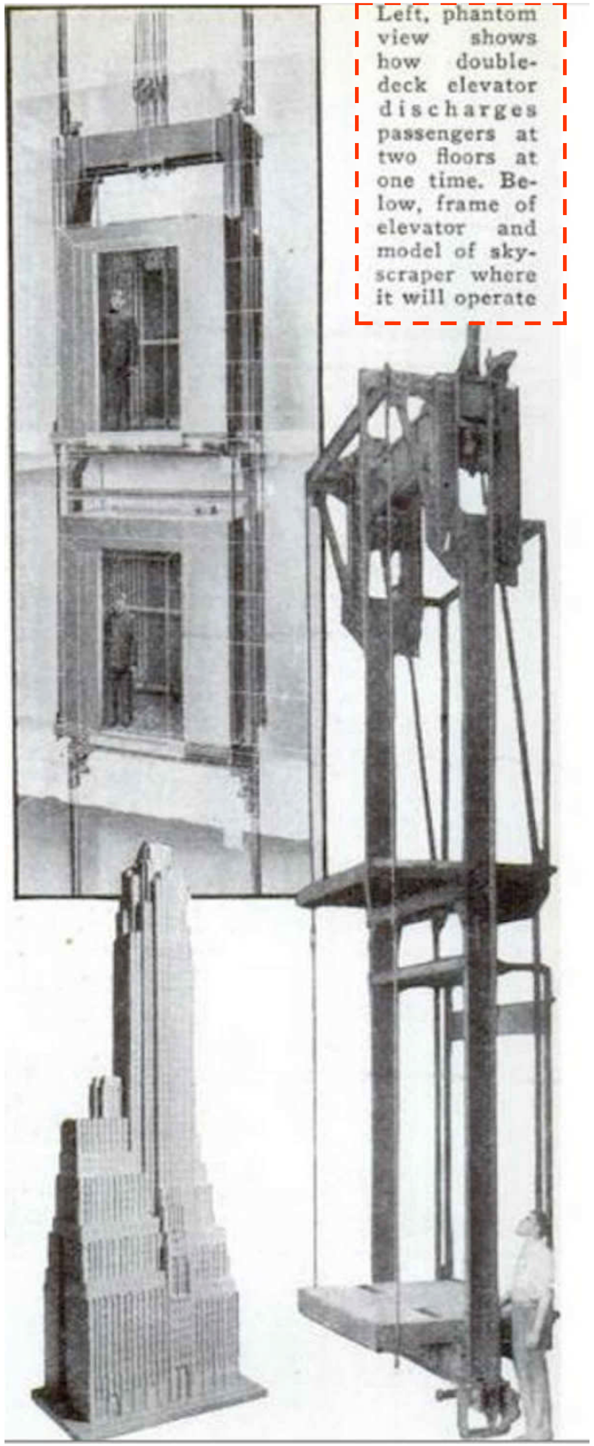
***Modern Mechanics and Invention,* April 1931**

<u>Left</u>: caption: "This is how the double-deck elevator would work. All floors would be the same distance apart, the decks serving alternate floors as shown."

"The world's first double-deck elevators have just been installed in New York City's newest skyscraper. They will enable eight elevator shafts to do the usual work of fourteen in the Cities Services Building, third highest in the world, with a tremendous saving of valuable floor space. At the ground floor, passengers will enter the elevator at two different levels, one cab serving odd-numbered floors and the other the even numbers. When the elevator stops on its way up, passengers for two floors are thus discharged at once. Each cab has its own operator. The elevator will start only when the operating handles of both compartments are in 'start' position and all doors are closed. The national elevator code was revised especially to permit the novel installation. According to Otis Elevator Company engineers, who designed the two-story elevator, the ability to handle twice the number of usual passengers in a single shaft may effect radical changes in the design of tall buildings…"

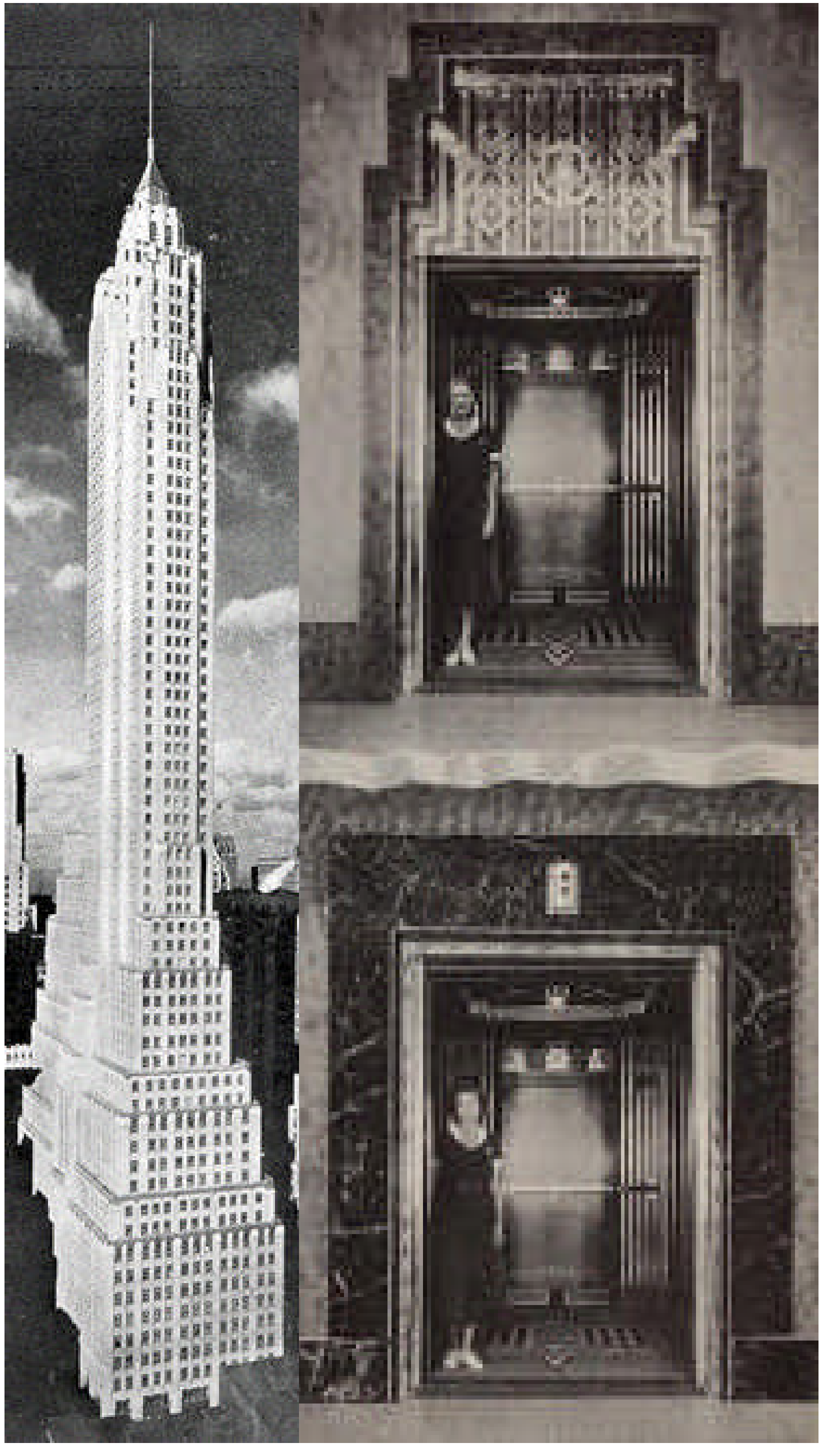
***Popular Science*, January 1932**

Left: caption: "Double-deck elevators carry you swiftly to the higher floors . . Escalators prevent any slowing up of traffic during the rush hours…"
(1932 Otis ad)



Otis' double-deck elevator was designed to save valuable rental space and move more passengers at once. Joined one atop the other in the same hoistway, one car serves even number floors and the other, odd. Passengers board at two separate levels, one above the other, depending on which floor they want to reach. The first Otis double-deck elevator was installed in 1931 in the 67-story *Cities Service Building* at 70 Pine Street in NYC, but was not operated until 1935 when Otis "officially" unveiled the double-deck elevator. The double-deck elevator is an efficient and practical solution for tall buildings with heavy traffic flows at specific times of day. Today, it's used in buildings like *Citicorp* (in NYC), *First Canadian Place* (in Toronto) and the *Treasury Building* (in Singapore).

Left: caption: "Phantom view shows how double-deck elevator discharges passengers at two floors at one time. Below, frame of elevator and model of skyscraper where it will operate."



"…Upon Otis Signal Control and Otis engineering genius also depended the commercial feasibility of such buildings as the sixty-three story Sixty Wall Tower in New York City where the limitations of space dictated the installation of eight double-deck Signal-Control elevators, for lower Service, each of which serves two floors simultaneously and the installation uses only 60% of the hoistway space that would be required if single-deck elevators were used to furnish equivalent service…"

RE: excerpt from *87 Years of Vertical Transportation with Otis Elevators*

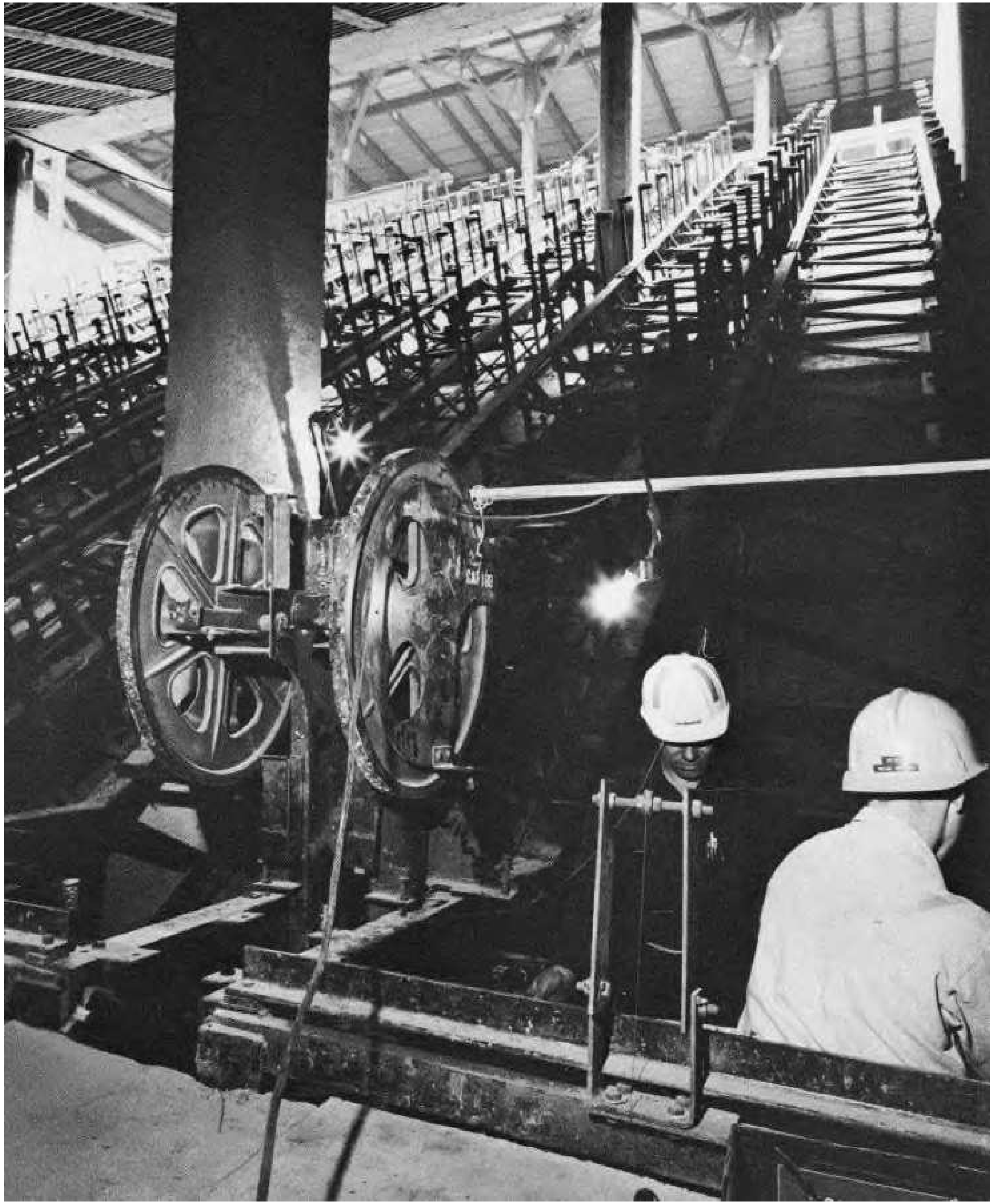
<u>Left</u>: caption: "Double-Deck Elevator"

Above: caption: "60 Wall Street (70 Pine Street). Cities Service building. Interior, elevator bank."
Left: caption: "60 Wall Street (70 Pine Street). Cities Service Co. Interior, double deck elevators."

Otis introduced double-deck elevators in 1935 as a way to move more passengers more efficiently and save valuable building space. While clever, double-deck elevators are not for every building. The system of ropes and counterweights that controls them is unusually complex and the original Otis double-deck elevators require building floors to be at identical distances. That requirement changed in 2003 when Otis introduced a "super double-deck" elevator (developed by *Nippon-Otis*) that uses flexible height technology and does not require evenly spaced floors. Nippon-Otis' first installation of super double-deck elevators was in the 54-story *Mori Tower* (left) in Tokyo's *Roppongi Hills*. It solves the building's space problem by raising or lowering the elevator up to 6.6-feet to align it with the floor.

Ever Higher

In 1967, Otis maintained its distinction of serving the successive highest buildings in NYC by winning the contract to furnish and install the elevators and escalators for the *World Trade Center* complex in lower Manhattan.



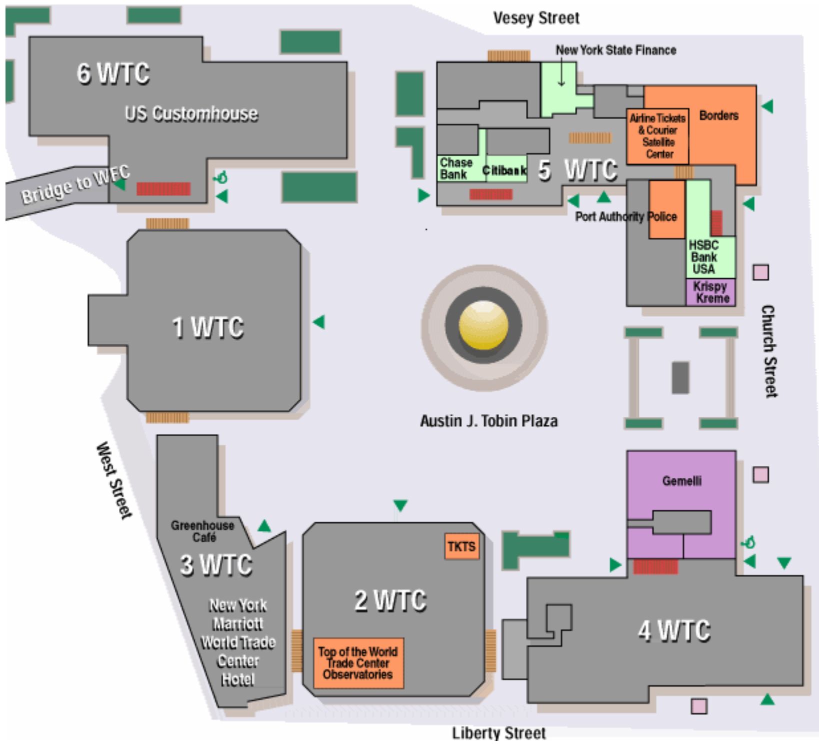
"The Port Authority began taking bids on more than $100 million worth of construction work. The first contract awarded was for $35 million; for the largest contract in the history of the elevator industry, would be awarded to the Otis Elevator Company to design, manufacture and install 46 of the largest high-speed elevator cars ever built, plus 162 standard cars and 49 high-speed escalators, half of which were to serve the PATH station."

RE: excerpt from *102 Minutes*

<u>Left</u>: installing the WTC *Path Station* escalators

“Also included in the Trade Center will be a 250-room hotel and a new Manhattan terminal for the Port Authority Trans-Hudson system, the former Hudson and Manhattan Railroad. It carries over 28-million passengers a year between New Jersey and New York City. The new terminal will replace outmoded facilities nearby. Underground passageways will connect every subway system in lower Manhattan with a concourse beneath the Trade Center plaza. High-speed moving stairs will connect the air-conditioned concourse with street level.”

RE: excerpt from *Engineering News Record*



The WTC project was described as the largest vertical transportation system in history. The buildings were dedicated in April 1973 and until their destruction on September 11th 2001, some 50K people worked in them while another 200K visited or passed through each day.

<u>Above</u>: WTC Site Plan

<u>Left</u>: eight-foot tall model of the WTC complex on view in the ballroom of the *New York Hilton Hotel* (ca. 1968)

Subway in the Sky

"Say you take the Eighth Avenue subway downtown and you want to go to 50th Street. Well, you go from 125th Street to 59th Street, then you get off and cross the platform to another train that takes you to the local stop at 50th Street."

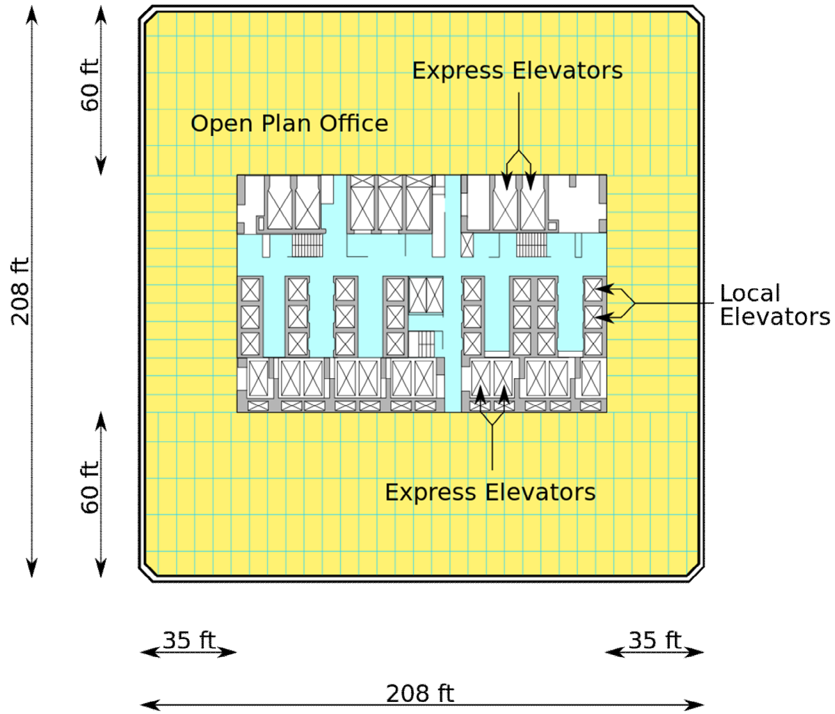
***Herb Tessler*, PANY&NJ Architect**

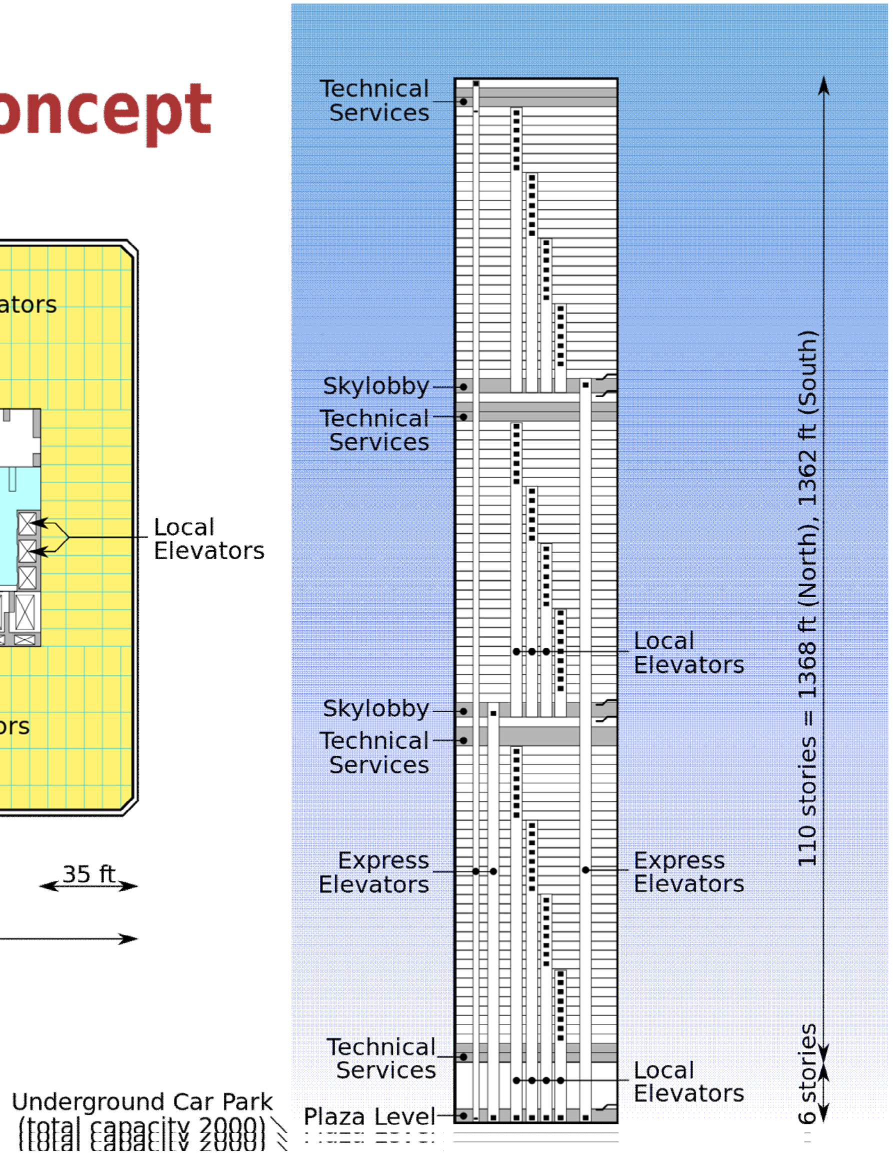
RE: his idea to divide each tower into three "zones" having express and local elevator service within each – akin to the local & express service on NYC's Subway System

"Each tower is 209 x 209 feet in plan and is column-free between the exterior walls and the 79 x 139-foot core, thus providing thirty-five feet clear spans on the east and west sides and sixty-five foot clear spans on north and south sides. In addition to the usual service and utility rooms, the core of each tower will contain 104 elevator cabs running in thirty-six shafts. This unusual arrangement is made possible by the use of twenty-three shuttle express elevators which will discharge passengers into so-called sky-lobbies where they transfer to local elevators. As a result, as many as three elevator cabs will use a single shaft…Elevators will be the world's fastest, at 1,700 feet per minute, and have by far the largest high-speed cabs ever installed "

RE: excerpt from *Engineering News Record.* With each tower rising one-hundred and ten stories (the *North Tower* was 6-feet taller than the *South Tower*), the twin towers contained approximately ten million square feet of rental space. Otis engineered, manufactured, installed and serviced 208 elevators and 49 escalators for the project. The space-saving *Sky Lobby* system was crucial to making the project's 110 stories economically feasible.

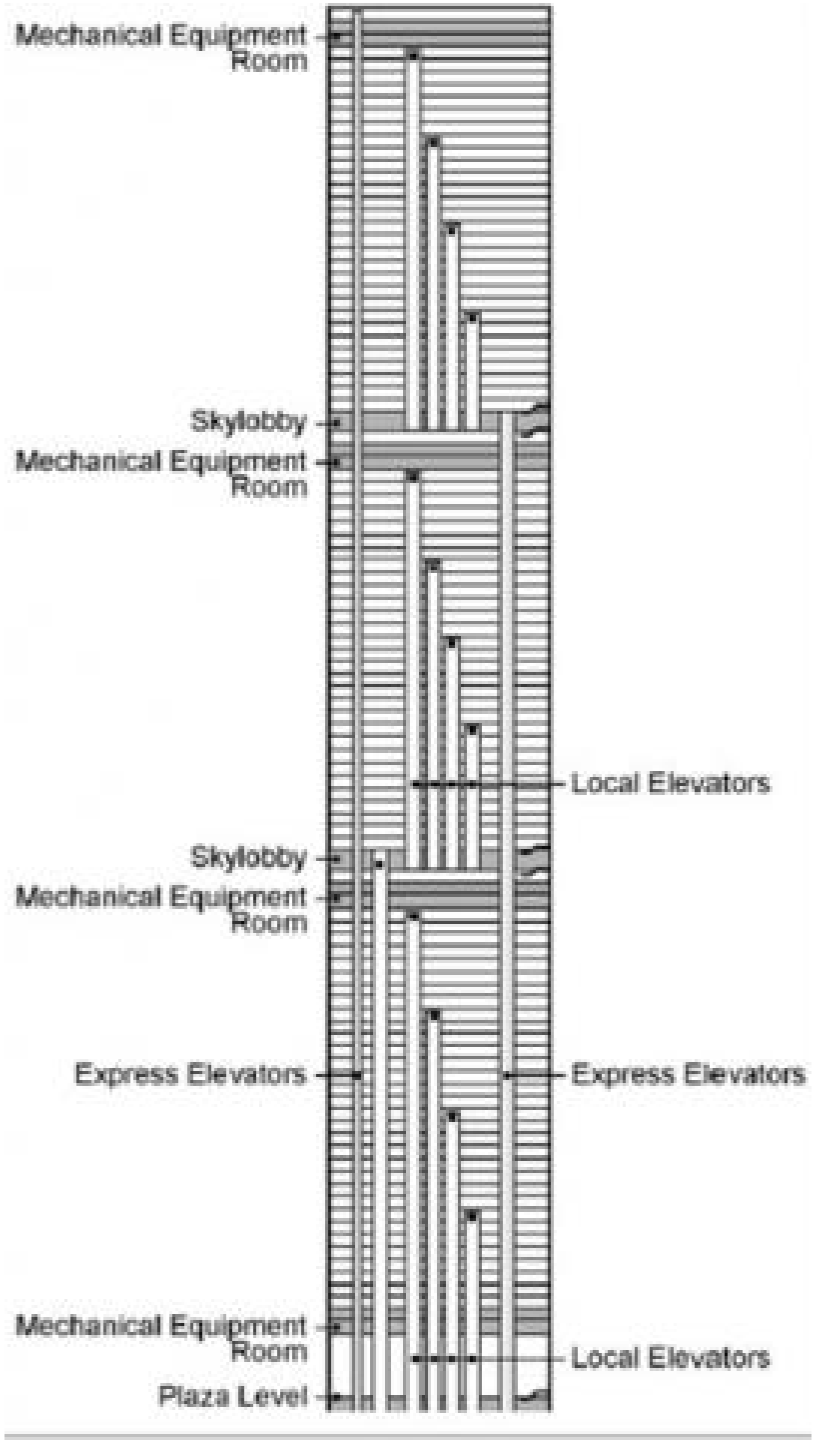
System Design Concept





“The elevators would be huge, the largest ever made - capable of holding as many people as a subway car. The twelve local elevators interfaced with the express elevators at two Sky Lobbies. Rather than requiring twelve individual shafts, the twelve local elevators shared four shafts within the three vertical ‘zones’ of each tower. This configuration eliminated the problem of losing too much floor space to elevator shafts in such a tall building.”

RE: excerpt from *102 Minutes.* “Shuttle-Express” elevators (10K pounds at 1,600 fpm) speeded passengers to Sky Lobbies on the 44th and 78th floors, while local elevators operated using a *Sky Lobby* as their lower terminal, thus enabling the “stacking” of the local elevators one above another in a common hoistway to save space.

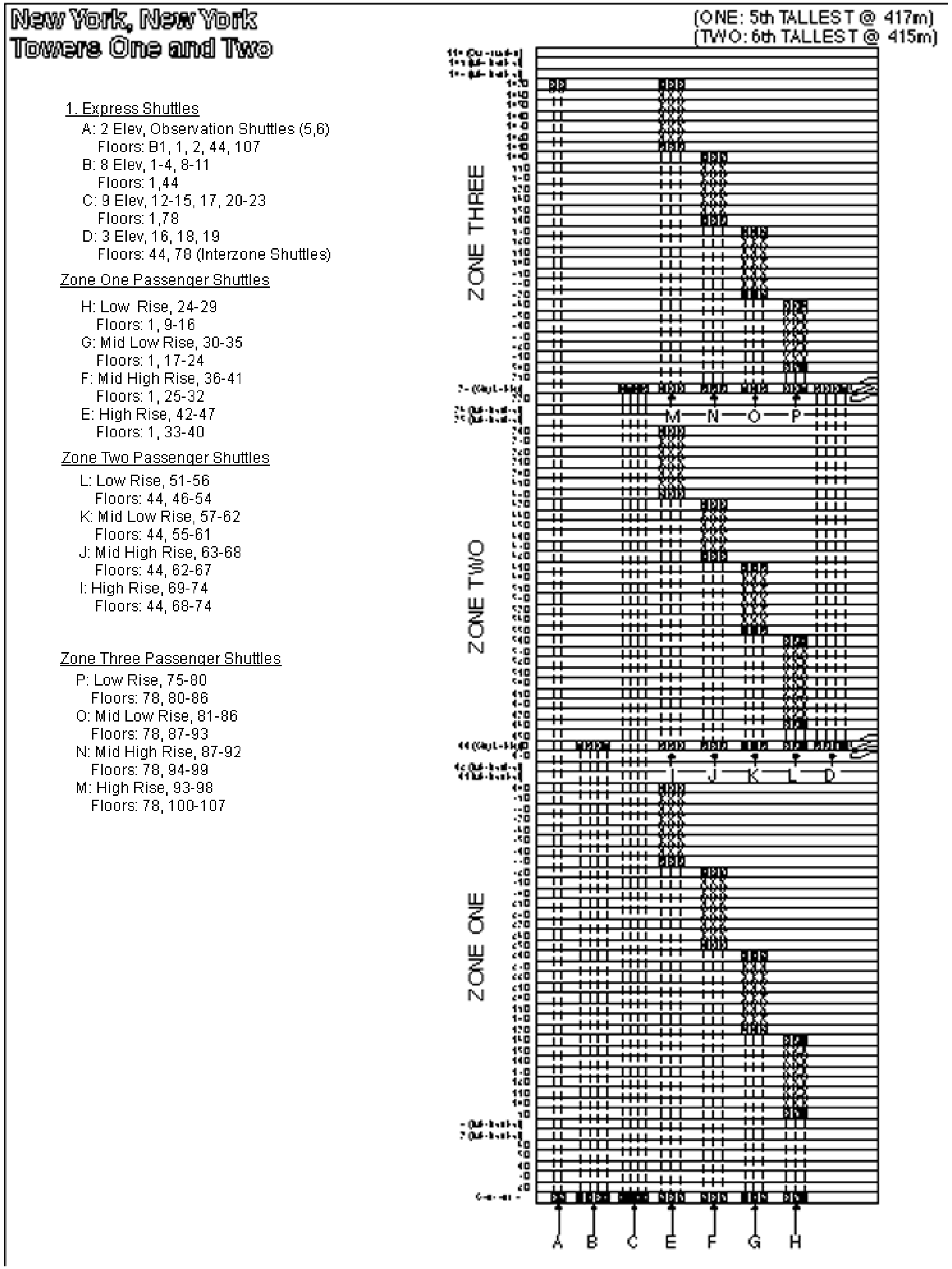


"…The Trade Center will be served by 230 passenger elevators. The towers will incorporate an unusual elevator system to maintain a high ratio of rentable floor area to vertical-transportation area. Each tower building is divided into three zones, one above the other…Each zone will be served by twenty-four elevators, arranged in four banks of six each. But upper-zone elevators will not serve the ground floor. Instead, 55-passenger express elevators will speed at 1,700-feet per minute, from ground level to the 41st and 74th floors, where transfer lobbies will be provided. The lower 'Sky Lobby' will be served by eleven express elevators, the upper one by twelve."

RE: excerpt from *Engineering News Record.* To further facilitate traffic at the Sky Lobbies on the 44th and 78th floors, escalators provided two-way service between the floors immediately above and below.

"Each tower was divided into three zones: up to the 44th floor; up to the 78th floor; up to the 110th floor. Banks of express elevators with each car able to hold fifty-five people ran directly to the staging points on floors 44 & 78; the Sky Lobbies. There, the passengers could catch shuttle elevators to the intermediate floors. A single passenger car in each building ran all the way from the bottom to the top, serving the restaurant in the north tower and the observatory in the south tower. In addition, a freight elevator also had a clear run from the ground to the top. In all, each tower had ninety-nine elevators."

RE: excerpt from *102 Minutes*



"…in 1973, the designers of the World Trade Center introduced the idea of sky lobbies. A sky lobby is like a transfer station: an express takes you there, and then you switch to a local…"

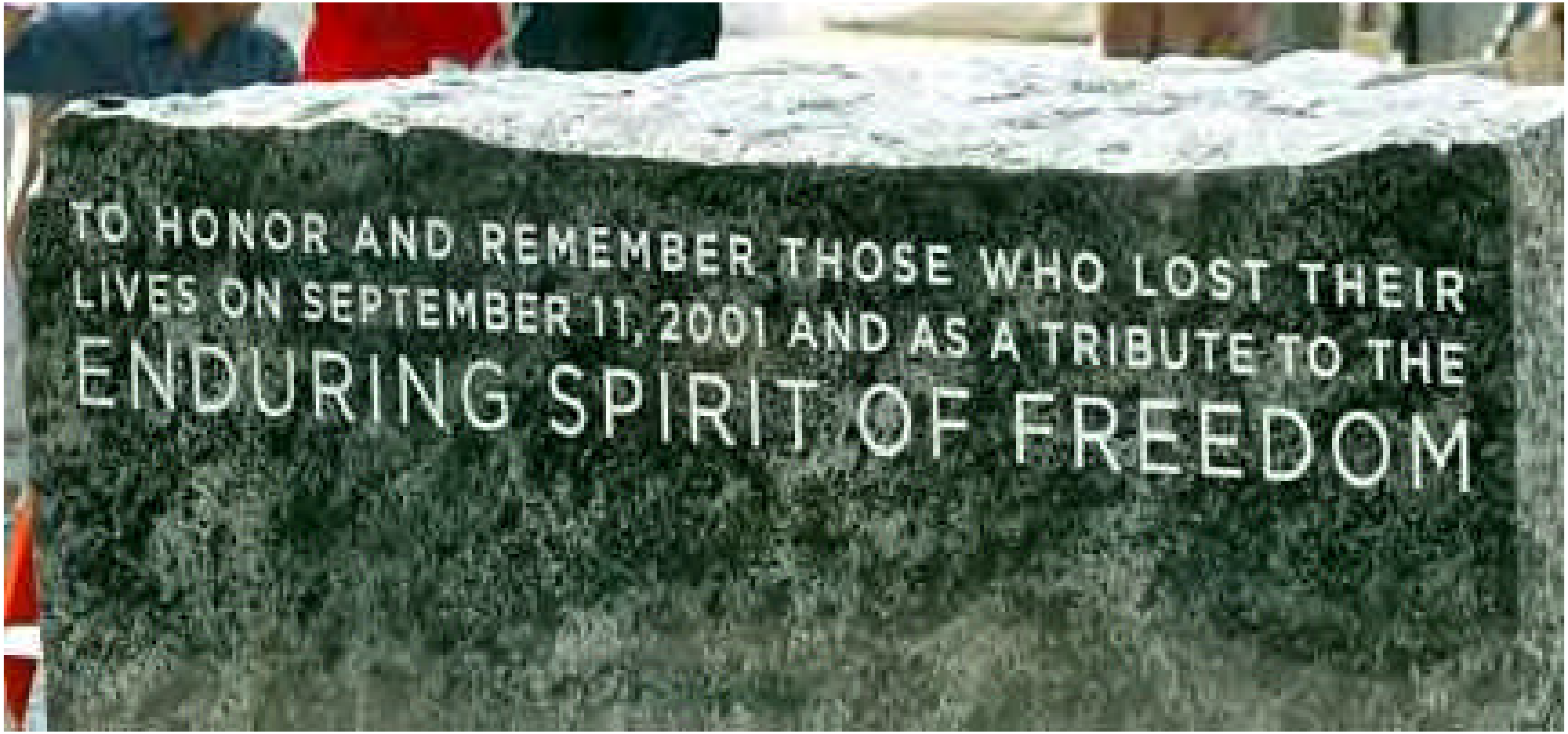
***The New Yorker*, April 2008**

RE: in addition to normal freight service, one freight elevator in each of the towers served a total of one-hundred and twelve stops from the fifth basement to the 108th floor. It rose 1,387-feet - 400-feet higher than the former record rise in the *Empire State Building*. Ten elevators traveled from street level to five basement levels below the plaza.

<u>Left</u>: caption: "Elevator Plan for World Trade Center"

“The Otis engineers found that the plan was a winner. It would leave 75% of the total floor area available for renting rather than the 50% that would have come with a conventional elevator system. It would even provide more elevators than was necessary to carry the 50,000 people who might work in or visit the towers each day. Not only could the Otis people engineer the express elevators to hold fifty-five people and 10,000 pounds, but they could design them so that there were doors on both sides, allowing the first passenger in to be the first out.”

RE: excerpt from *102 Minutes*



"…An estimated two hundred people were killed in elevators at the World Trade Center on September 11, 2001 - some probably in free-fall plunges, but many by fire, smoke, or entrapment and subsequent structural collapse…"

***The New Yorker*, April 2008**

<u>Above</u>: inscription on the cornerstone of the new *One World Trade Center* (a/k/a "Freedom Tower")

Vertical City

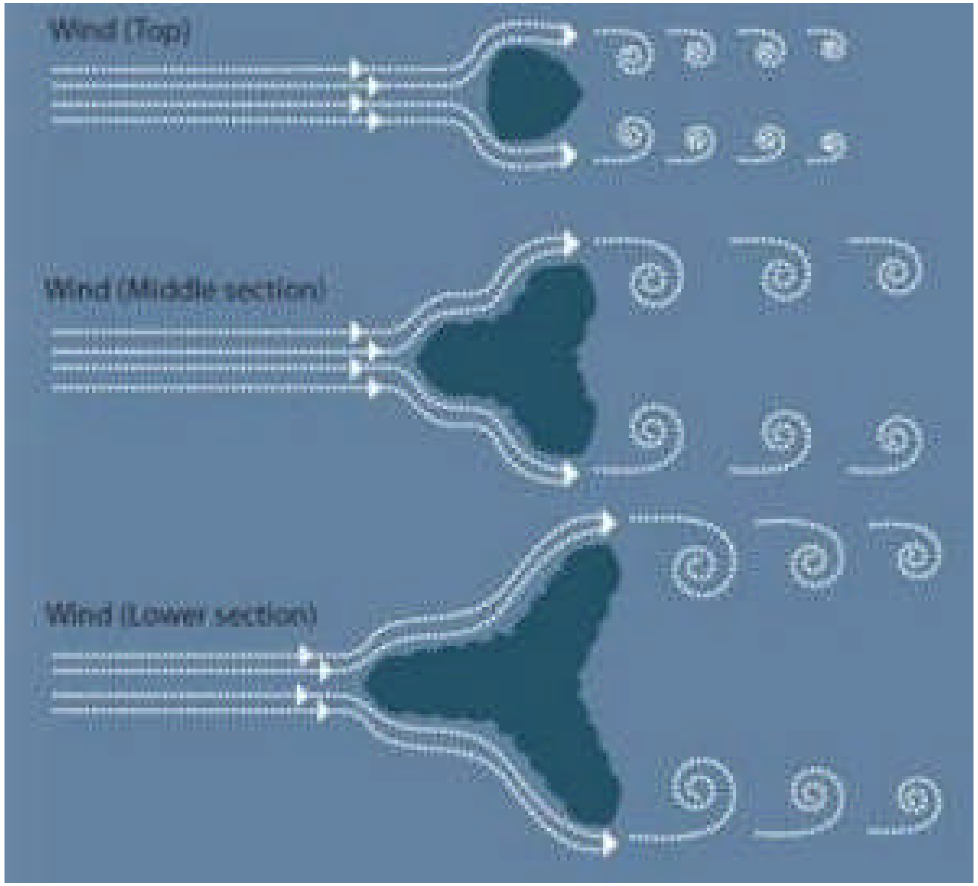
“Burj Dubai is envisaged as a work-live-play environment - a vertical city for all practical purposes, with homes, offices, corporate suites, a luxury hotel, retail outlets and fitness facilities. The advanced elevator technologies used in Burj Dubai are designed for seamless performance with a focus on safety, efficiency and the convenience of users.”

Abdulla Lahej*, Executive Director (Dubai Project Management) - *Emaar Properties

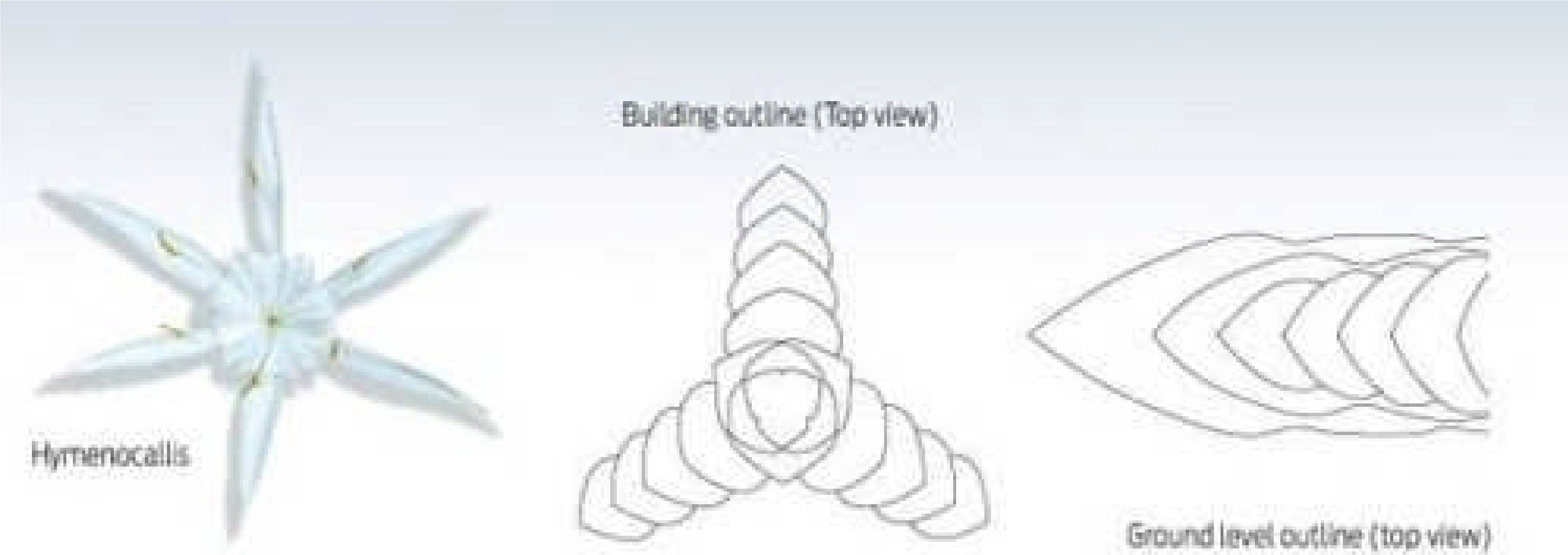
The *Burj Khalifa* (left) opened on January 4th 2010. It's 828-meters to the top of the spire (2,717-feet), and has 162 floors. The mega-skyscraper was designed by *Adrian Smith* of the architectural firm *Skidmore, Owings & Merrill* and constructed by South Korea's *Samsung Corporation* (*Turner Construction International* served as Construction Manager). The mixed-use building features offices, 1,044 residential apartments (including 144 *Armani Residences*) and 160 ultra-luxury hotel rooms at the *Armani Hotel Dubai*. The Corporate Suites comprise 49 floors. Initially, it was called "Burj Dubai," but the name was changed just before completion to honor *Sheikh Khalifa* of Abu Dhabi - the president of the United Arab Emirates (in 2009, he borrowed money to complete the building when Dubai had severe financial difficulties)


The *Burj Khalifa* has become a new symbol of the UAE, not only because it has changed the skyline of *Dubai*, but because it has come to represent its vision of itself for the future. At the time of its opening (January 2010), it held the world's record for:

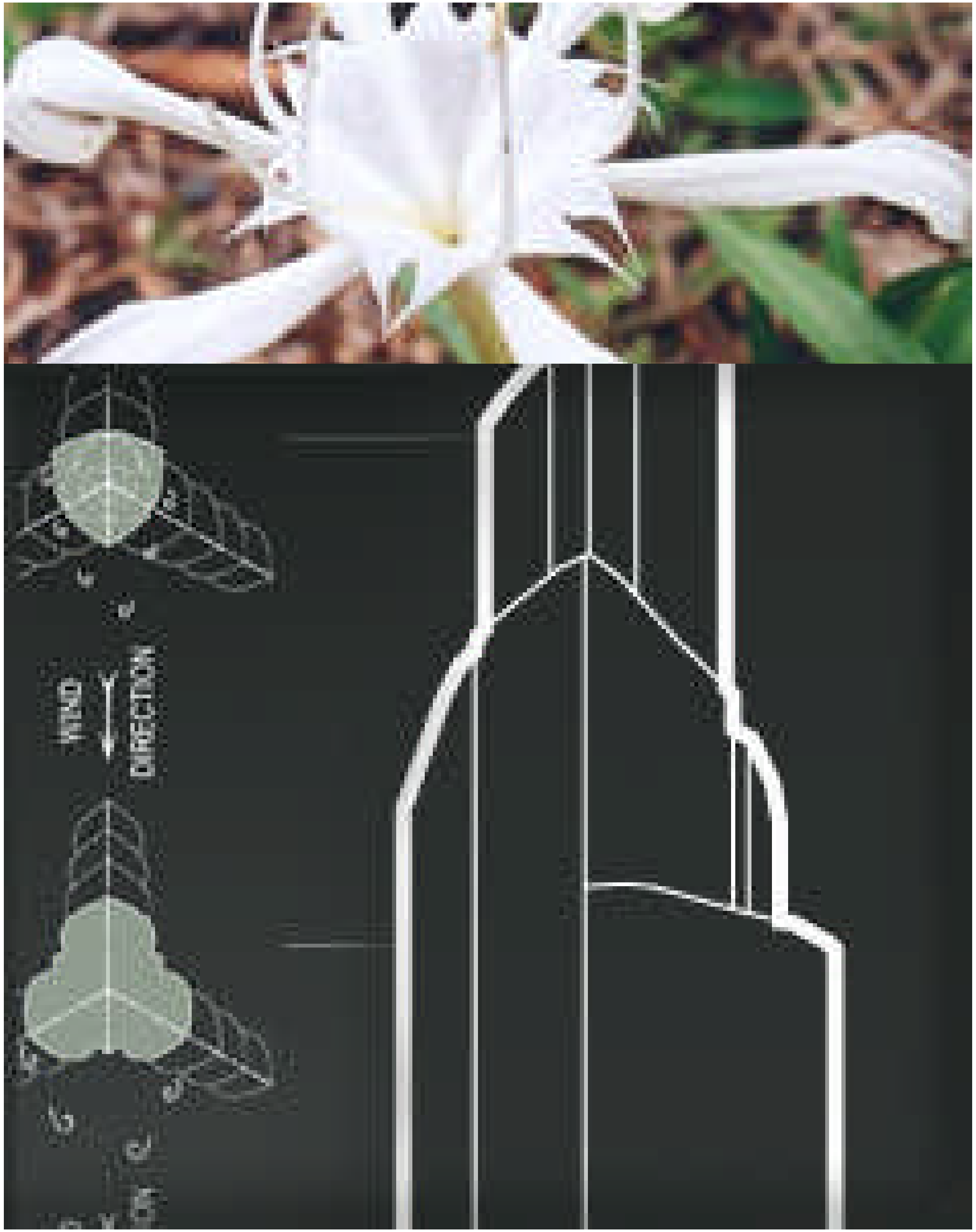
- **Tallest building in the world**
- **Tallest free-standing structure in the world**
- **Highest number of stories in the world**
- **Highest occupied floor in the world**
- **Highest outdoor observation deck in the world**
- **Elevator with the longest travel distance in the world**
- **Tallest service elevator in the world**



Left: over forty wind tunnel tests were conducted on *Burj Khalifa* to examine the effects the wind would have on the tower and its occ-upants. These ranged from tests to establish the wind climate of Dubai, to pressure tests on the building facade. In super-tall buildings, there are changes in pressure and temp-erature with height. Special studies were carried on Burj Khalifa to determine the magnitude of the changes that would have to be dealt with in the building's design.

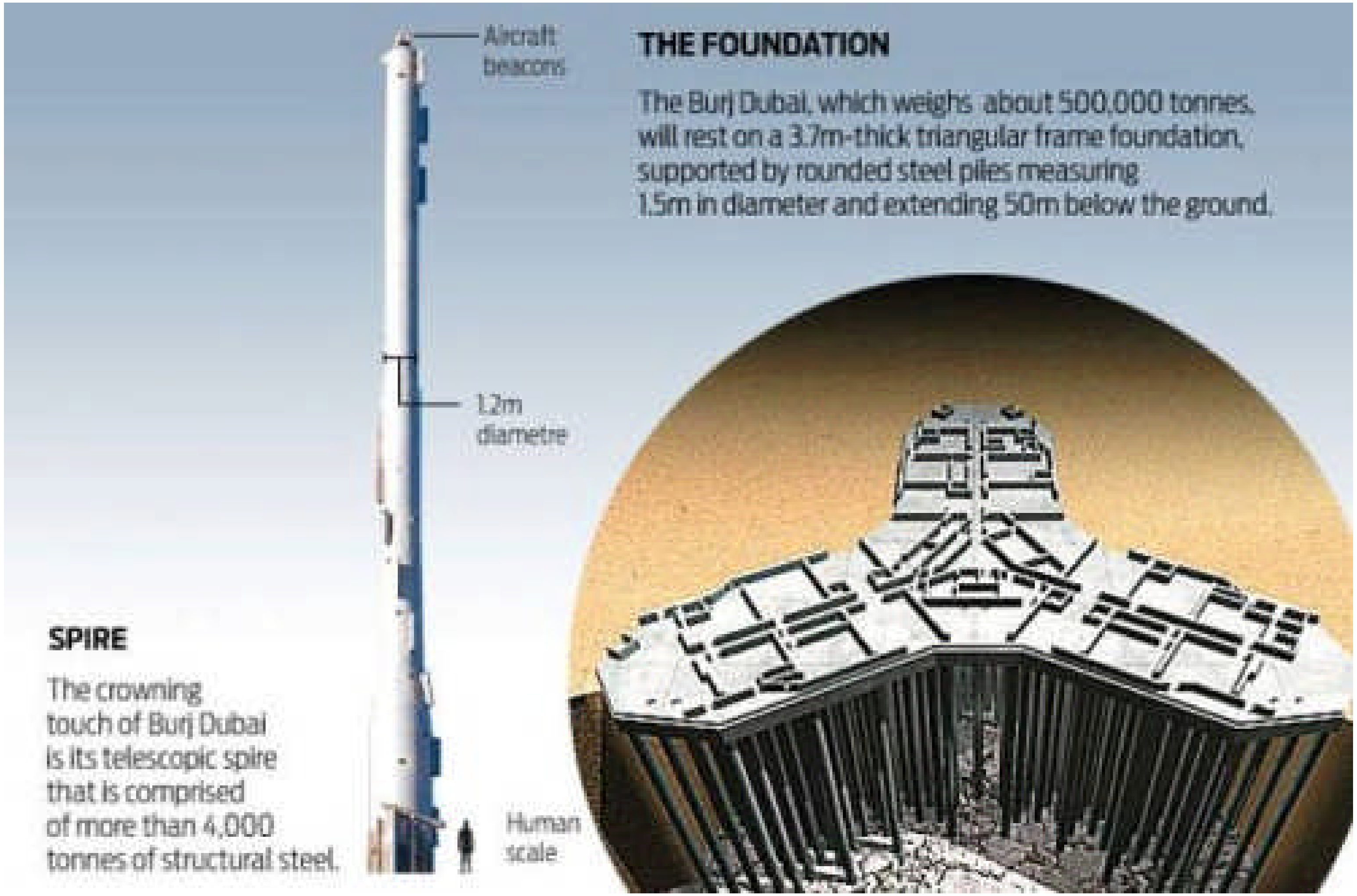


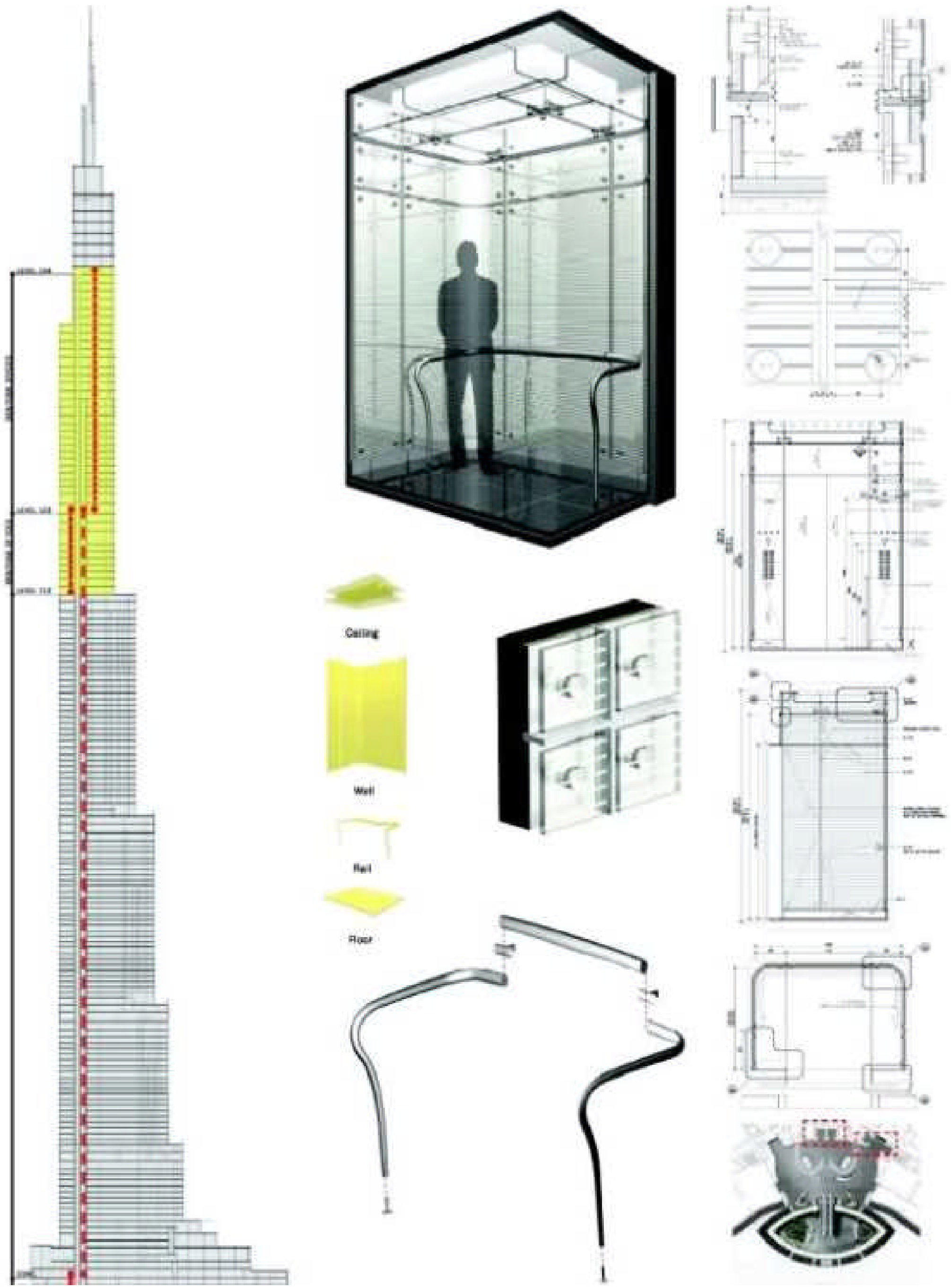
The architects of *Burj Khalifa* incorporated traditional Islamic patterns with modern sophistication. The *Hymenocallis* desert flower (top left) was the main source of inspiration. The design not only reduces the wind forces on the building, but also allows each tenant to have a magnificent view of city, sea and desert. From the top of the structure (middle top), the influences of Islam can be clearly seen, including the use of arches (left) and other features of Islamic architecture



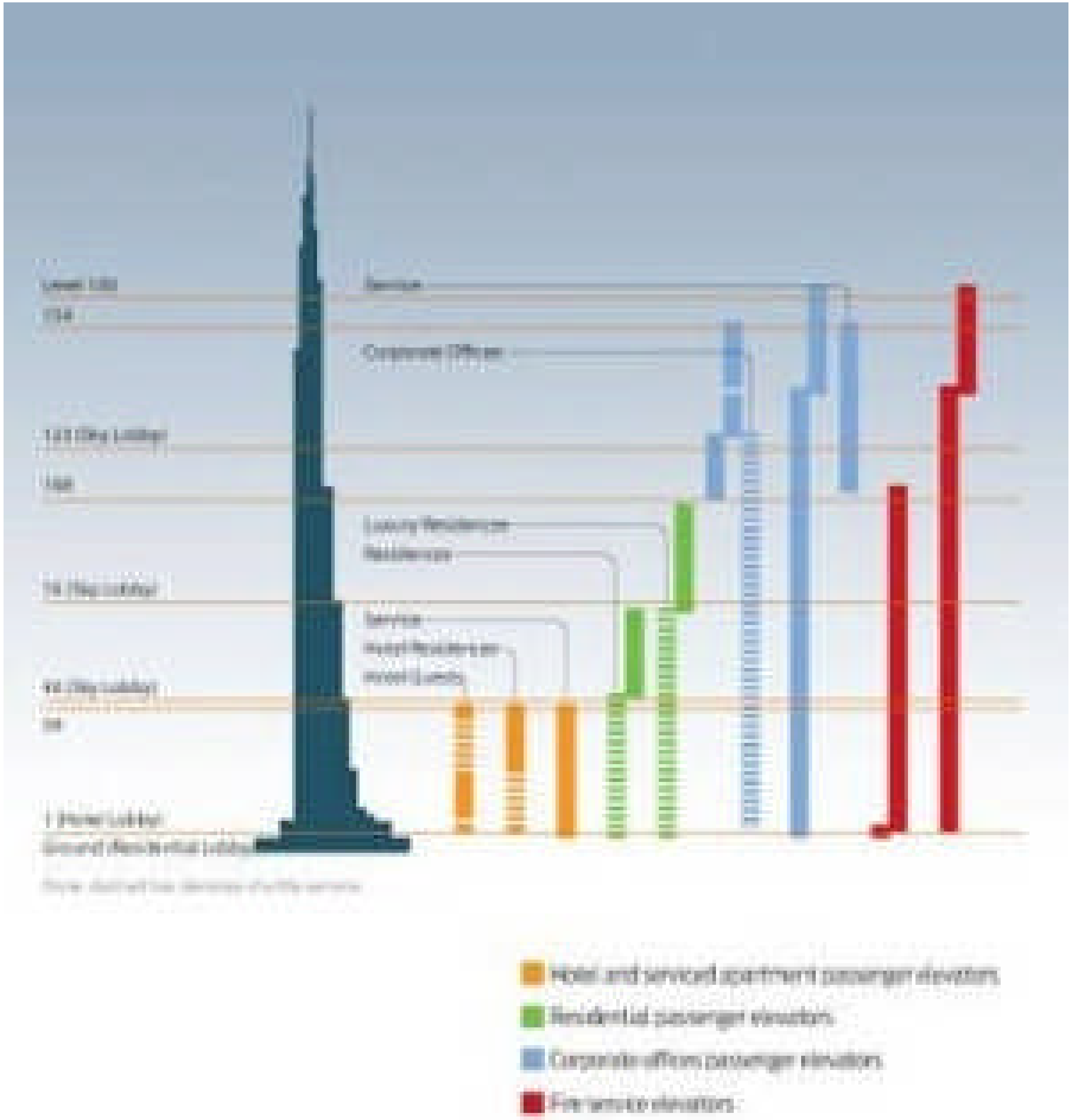
"Like petals from a stem, the tower's wings extend from its central core. No stranger to Middle Eastern design, architect Adrian Smith incorporated patterns from traditional Islamic architecture. But his most inspiring muse was a regional desert flower, the Hymenocallis, whose harmonious structure is one of the organizing principles of the tower's design."

www.burjkhalifa.ae

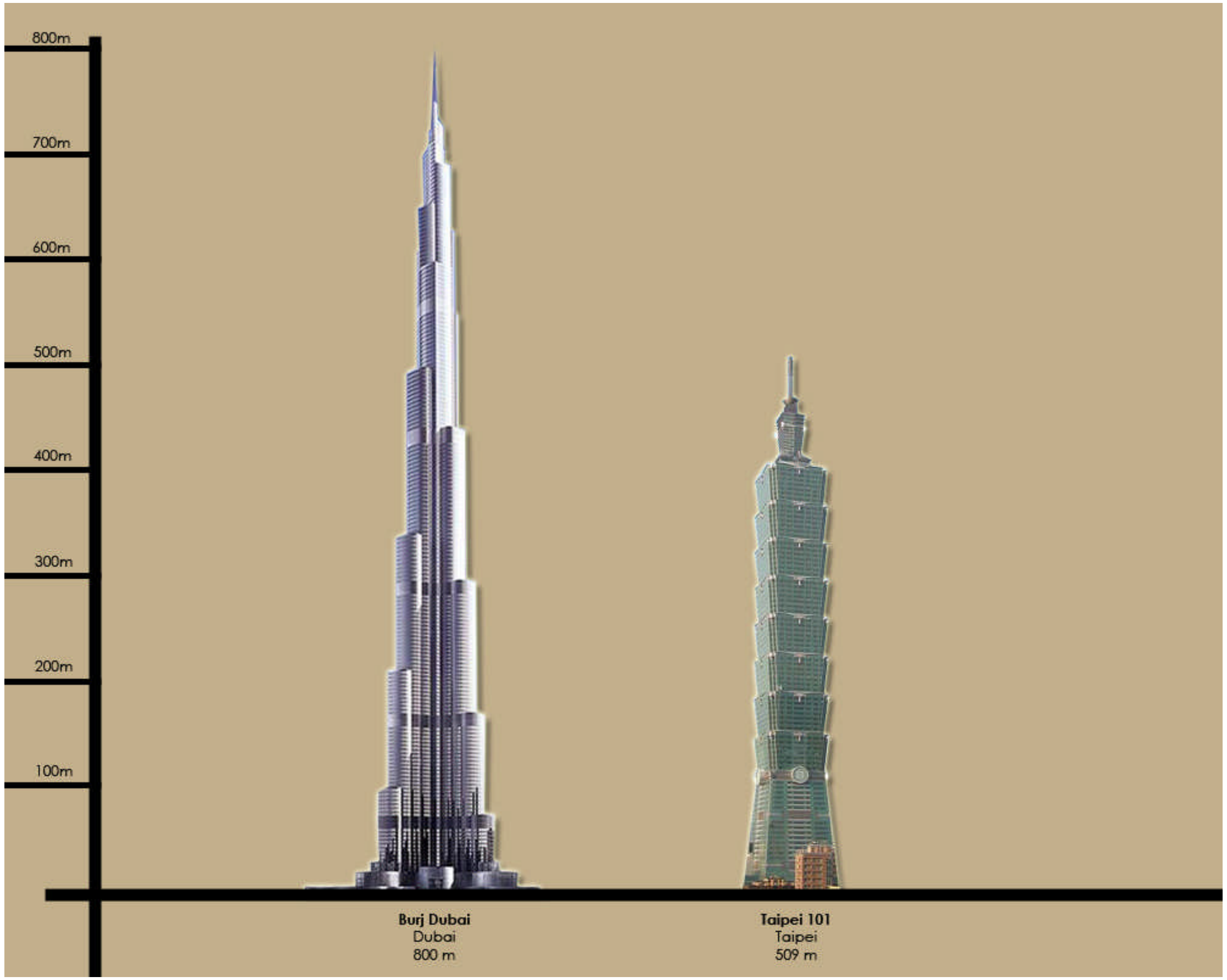

Aircraft beacons
THE FOUNDATION
The Burj Dubai, which weighs about 500,000 tonnes, will rest on a 3.7m-thick triangular frame foundation, supported by rounded steel piles measuring 1.5m in diameter and extending 50m below the ground.
1.2m diametre
SPIRE
The crowning touch of Burj Dubai is its telescopic spire that is comprised of more than 4,000 tonnes of structural steel.
Human scale



<u>Left</u>: to make movement efficient in this "vertical city," the elevators were carefully placed in different zones. Each elevator zone serves different building occupants; visitors, office workers, hotel guests and residents. By the use of a *Sky Lobby* system, elevator service efficiency is maximized resulting in time savings. The Sky Lobby is an intermediate floor where passengers change from an express to a local elevator, which stops at every floor within a certain segment of the building. Burj Khalifa's Sky Lobbies are located on levels 43, 76 and 123 and include a lounge area and a kiosk, among other visitor amenities.


Hotel and serviced apartment passenger elevators
Residential passenger elevators
Corporate offices passenger elevators
Fire service elevators

Otis furnished and installed nineteen energy/environment friendly *Gen2* elevators servicing the low-rise portion of the building and seven high speed *Skyway* elevators (two travel to the Observation Deck). Burj Khalifa's two observatory elevators are double-deck cabs with a capacity of twelve to fourteen people each. No elevators are installed to travel all 160 floors of the building. Instead, they are strategically grouped to align with the floor layout, offering passengers a direct express service to their destination by bypassing other floors. The main service elevator (positioned in the central core) has the world's highest elevator rise at 504-meters (1,654-feet) – more than the height of *Taipei 101* in Taiwan (448-meters) and almost one-and-a-half times as high as *Empire State Building* in NYC (381-meters). It travels at nine meters-per-second (mps) and also has the world's longest traveling distance for an elevator. A service lift in the spire has the world's highest landing at 636.9-meters. Another highlight is the state-of-the-art circular observation elevator that serves three floors in the *Armani Hotel* restaurant area.


800m
700m
600m
500m
400m
300m
200m
100m
Burj Dubai
Dubai
800 m
Taipei 101
Taipei
509 m

"Dubai's Burj Khalifa has the world's third-fastest elevator in the world…the fastest elevators in the world were in Taiwan's Taipei 101, which were manufactured by Japanese corporation Toshiba. A Mitsubishi lift in Japan's Yokahama Landmark Tower was named as the second-fastest lift, while the Otis lifts in the UAE's 828m-high Burj Khalifa shares third spot with three other buildings. However, the Burj Khalifa has the distinction of offering the world's fastest double-decker elevators, with the double-deckers' passengers able to travel the longest distance currently possible in an elevator, exiting after a ride of 504 meters at the world's highest stop - 638m up the building. Upon the completion of the building, the emergency elevator will become the world's longest-travelling elevator, operating over a distance of 578.5m."

ConstructionWeekOnline.com, **January 29th 2013**

"…With a building height of 509m, passengers are cata-pulted at a speed of 1,010 meters per minute, or 60.6 km/h, from the fifth to the 89th floor of Taipei 101. The ride lasts a mere 37 seconds, at the end of which passengers step out already 382 meters above the ground at the observation floor of Taiwan's tallest building. Two of the 61 elevators in the building reach the top speed of 1,010 m/min, and each cost more than $US 2 million…"

ConstructionWeekOnline.com,
January 29th 2013

Left: ***Taipei 101***

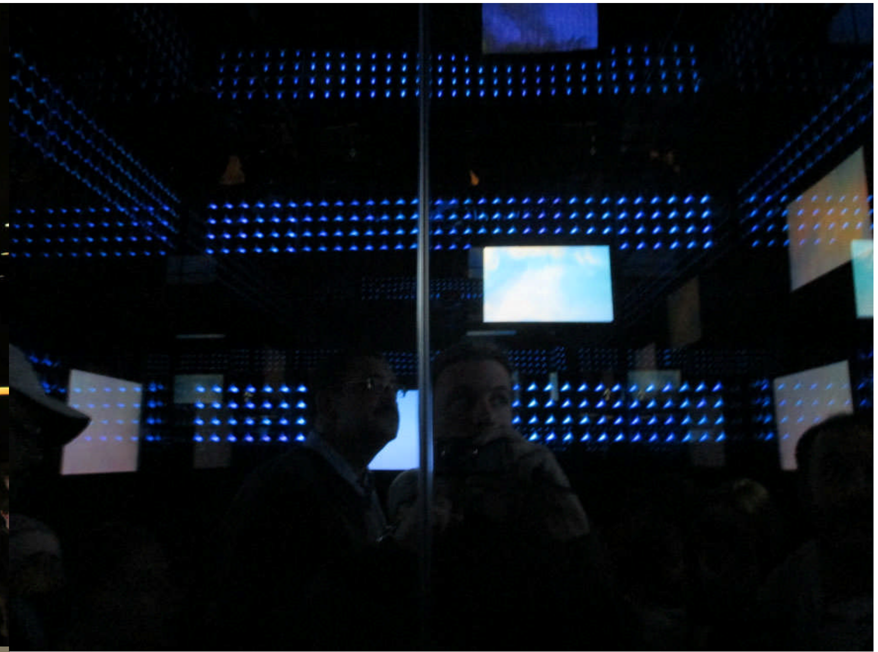
"…Located in the 296m-high Yokohama Landmark Tower, in Japan, this Mitsubishi elevator manages a speed of 750 meters per minute, or 45km/h. With a total of 79 elevators, the building has the fastest elevator in Japan. It only takes 40 seconds to travel from the second to the 69th floor…"

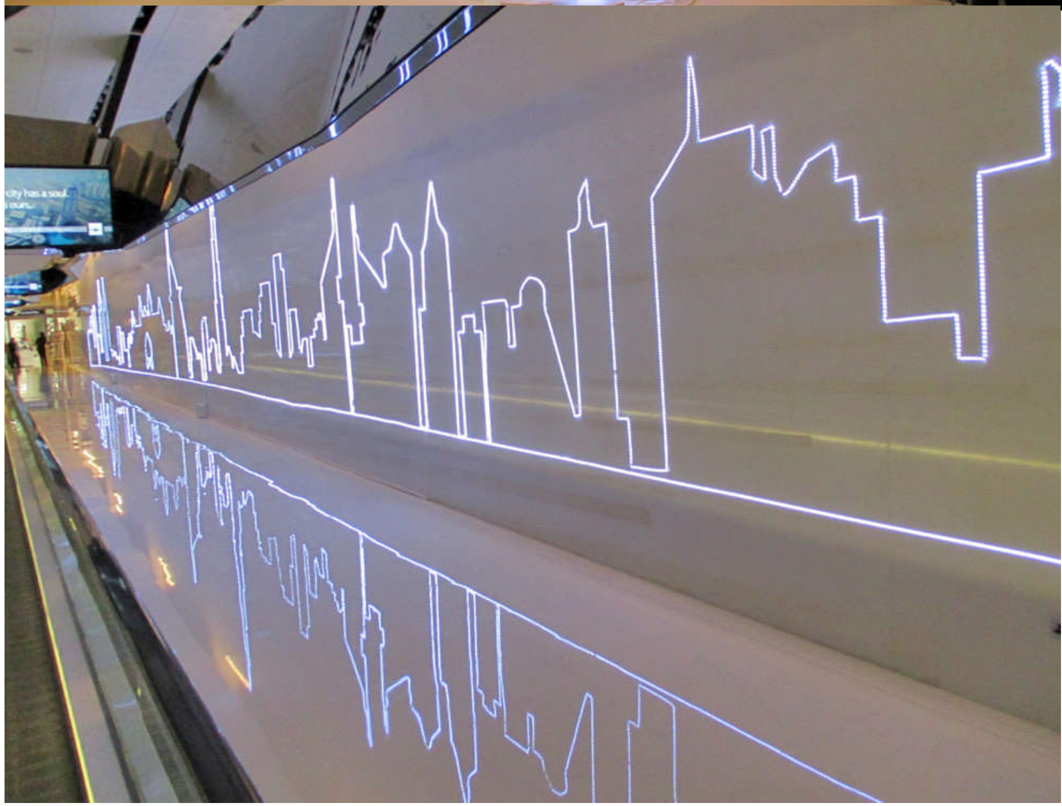
***ConstructionWeekOnline.com*, January 29th 2013**

Left: ***Yokohama Landmark Tower***

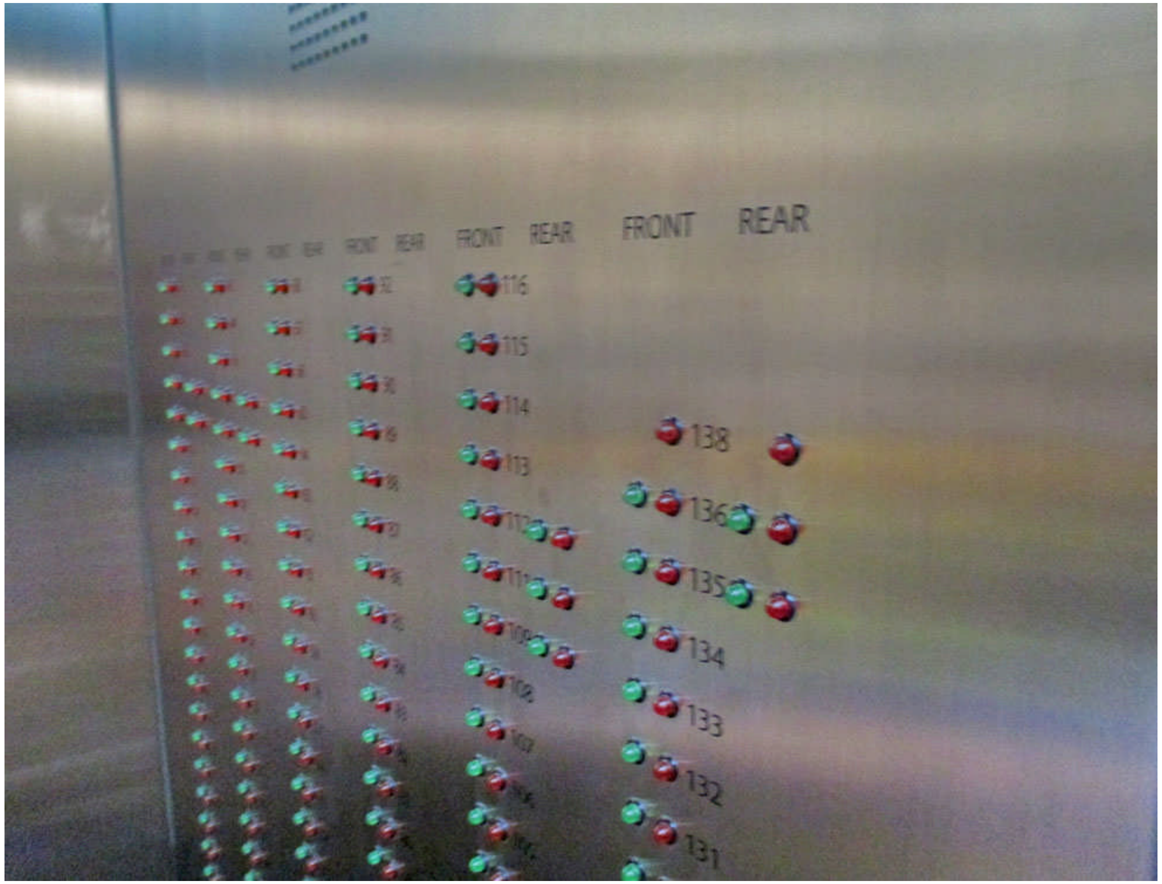
The elegantly designed double-deck elevators with built-in light and entertainment features (including LCD displays) exclusively serve visitors to *At The Top, Burg Dubai* - the world's highest outdoor observation deck (above) on level 124 (at 452-meters), as well as office workers transferring at the *Sky Lobby* (at level 123). These double-deck units (used for the first time in the Middle-East by Otis) are the highest rising double-deck elevators in the world and will travel at the speed of 10 mps (+20 mph).


٤٥٢م
452m





<u>Top Left</u>: caption: “Line to the entrance of the observation deck, Ground Floor, and a model of Burj Khalifa”
<u>Top Right</u>: caption: “There’s a spectacular light show in the elevator while going to the top”
<u>Left</u>; caption: “The moving side-walk towards the exist of Burj Khalifa's observation deck, to Dubai Mall”


FRONT
REAR
FRONT
REAR
116
115
114
113
138
136
135
134
133
132
131

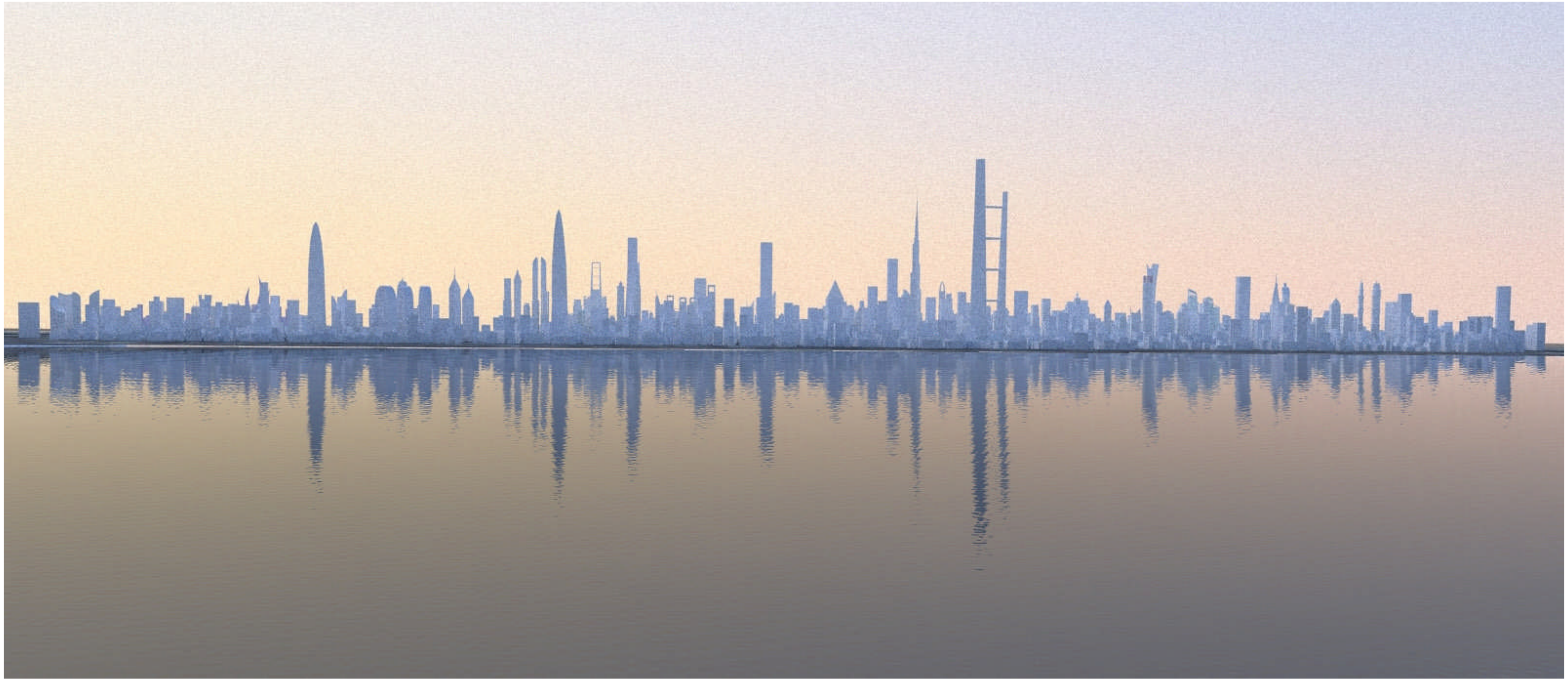
The Elevator Did It

“The elevator made the great building commonly known as the ‘skyscraper’ possible for modern business uses. Two things had to be provided for in creating the business section of a great city like New York or Chicago – concentration and plenty of room. This joining together of two things apparently opposite could only be accomplished by limiting the business section, and extending the buildings into the air. The elevator was the only instrument by which this end could be gained. Its development is one of the best illustrations of the adage: ‘Necessity is the mother of invention.’ It has revolutionized the architecture of our large cities. Without it, the New York City of today, built upon a long, narrow peninsula, with no possibility of extension, except in the direction, would be practically impossible…”

RE: excerpt from an article entitled: “The Elevator Did It.” The article appeared in *Success* magazine (ca. 1900)

"…Two things make tall buildings possible: the steel frame and the safety elevator. The elevator, underrated and over-looked, is to the city what paper is to reading and gunpowder is to war. Without the elevator, there would be no verticality, no density, and, without these, none of the urban advantages of energy efficiency, economic productivity, and cultural ferment. The population of the earth would ooze out over its surface, like an oil slick, and we would spend even more time stuck in traffic or on trains, traversing a vast carapace of concrete. And the elevator is energy-efficient - the counter-weight does a great deal of the work, and the new systems these days regenerate electricity. The elevator is a hybrid, by design…"

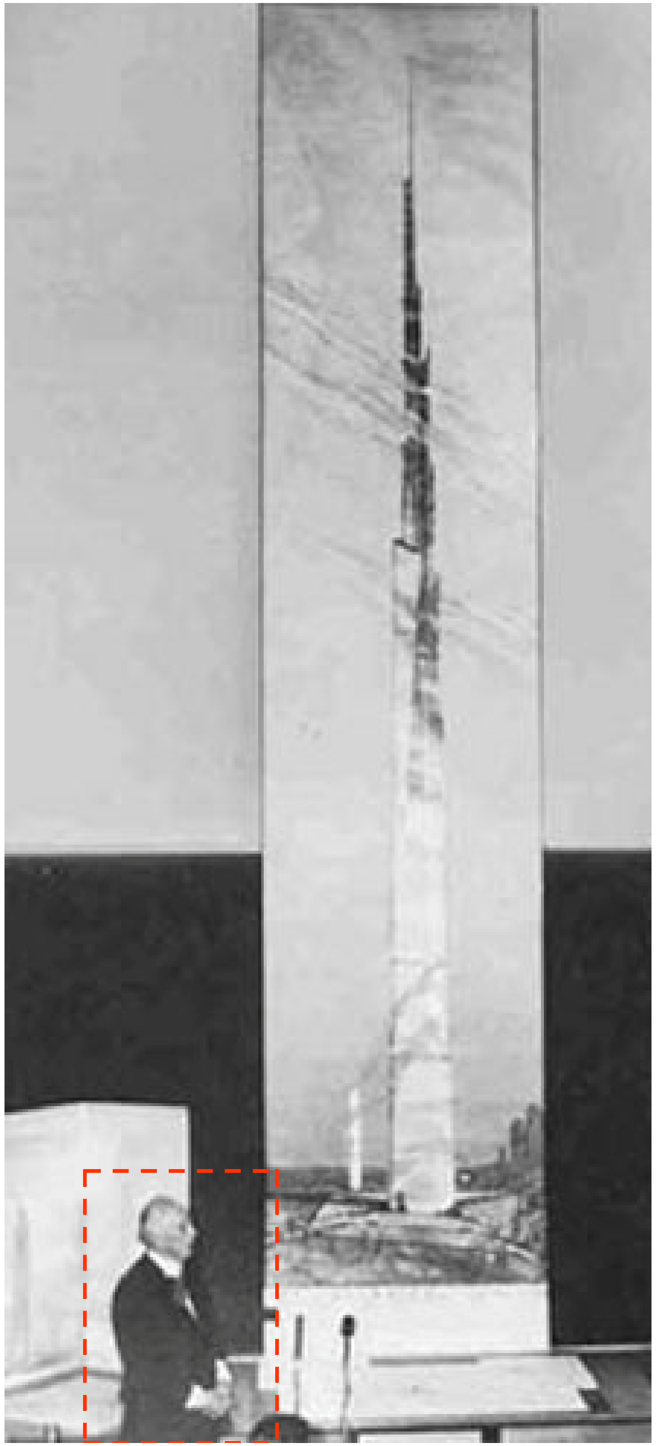
***The New Yorker*, April 2008**



"…The Otis Elevator Company, the world's oldest and biggest elevator manufacturer, claims that its products carry the equivalent of the world's population every five days. As the world urbanizes - every year, in developing countries, sixty million people move into cities - the numbers will go up, and up and down…"

***The New Yorker*, April 2008**

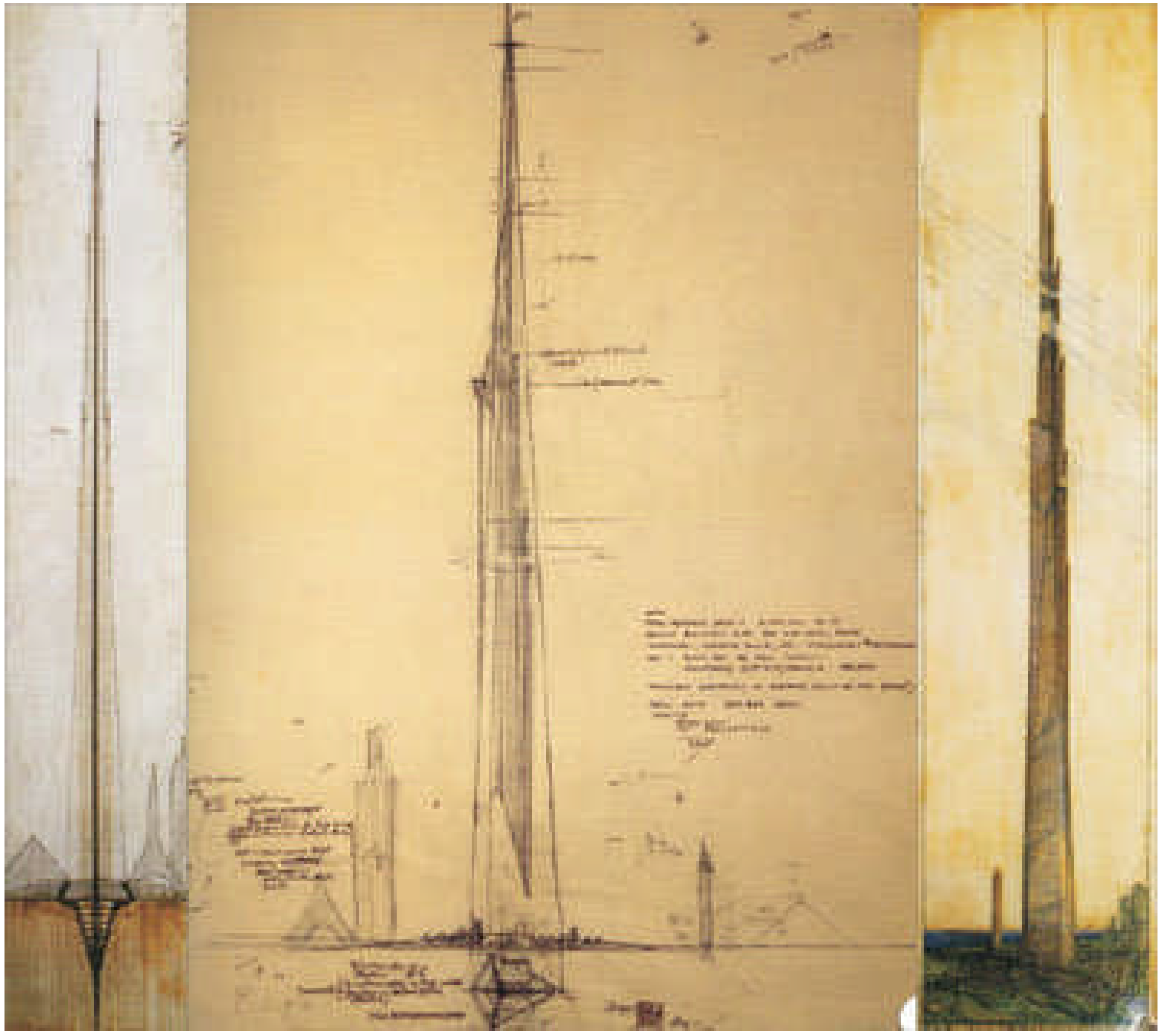
<u>Above</u>: caption: "Future Dubai Skyline"



"…Frank Lloyd Wright designed a mile-high, five-hundred-and-twenty-eight-story tower, called the Mile-High Illinois, in 1956, a kind of architectural manifesto of density. Wright allowed for seventy-six elevators - atomic-powered quintuple-deckers, rising at sixty miles an hour…"

***The New Yorker*, April 2008**

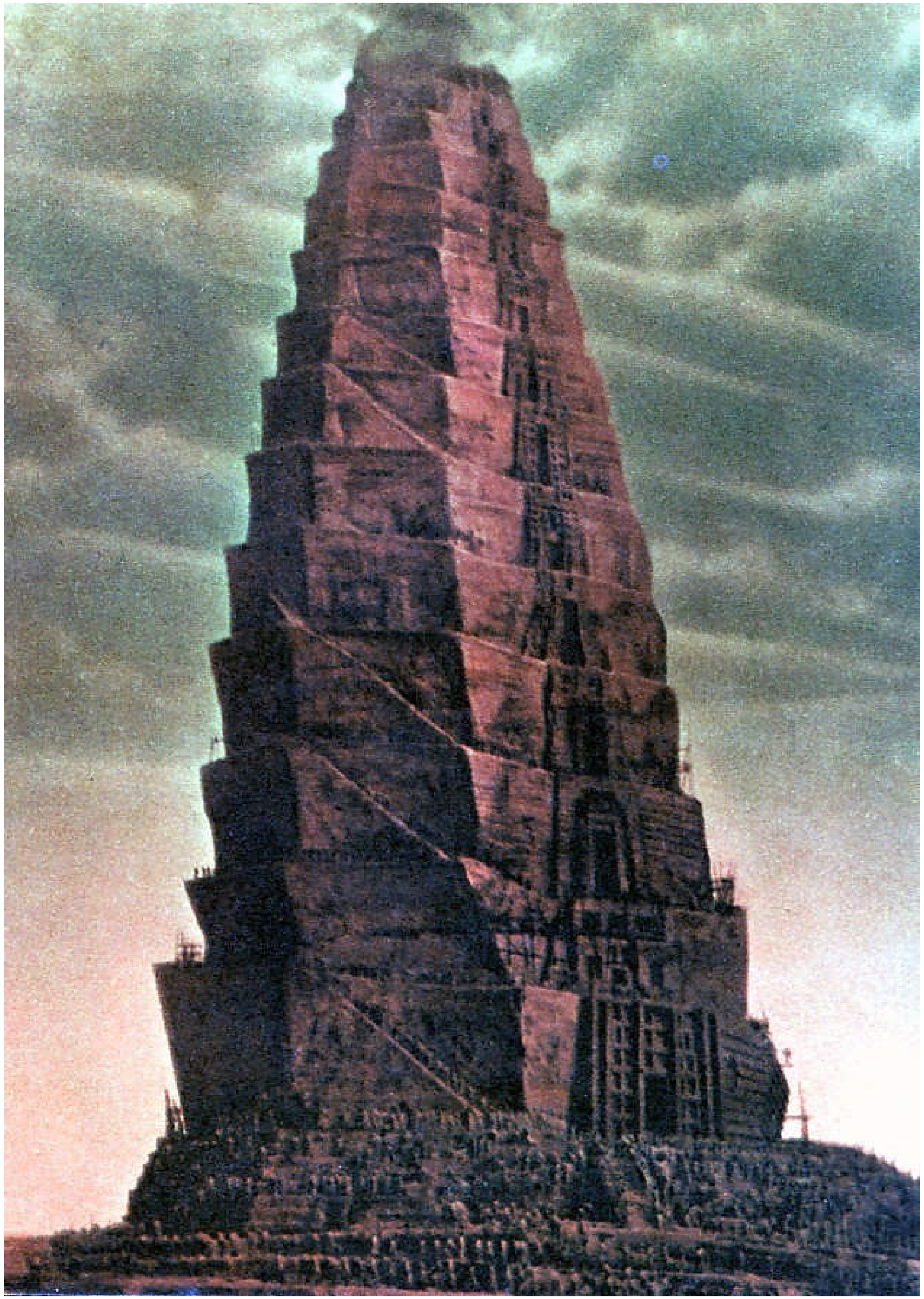
Left: caption: "Frank Lloyd Wright stands in front of a rendering of his Mile-High Building." On October 16th 1956, FLW (highlighted) held a press conference at the *Hotel Sherman* in Chicago to open a three-day exhibition and unveil a 22-foot tall rendering of his "Mile-High" super-skyscraper: *The Illinois,* proposed by the architect for his beloved Chicago. Then mayor *Richard Daley* proclaimed October 17th 1956 "Frank Lloyd Wright Day". FLW died in April 1959 and his grand vision was never realized. In reality, from 215 to 225 elevators would have been required.



"…Two weeks ago, a Saudi prince announced a plan for a mile-high tower in a new city being built near Jeddah - more than twice as tall as Burj Dubai…"

***The New Yorker*, April 2008**

<u>Left</u>: caption: "A new record breaking skyscraper is planned for Jeddah, Saudi Arabia that will be 3,280ft tall at its highest spire. The cost of said project is around 1.2 billion dollars. The ride to the observation tower will take 1 min 40 seconds traveling at speeds of 23mph. The commission went to Adrian Smith + Gordon Gill Architecture to design the skyscraper. The design is very similar to Frank Lloyd Wright's Mile High Illinois project for a mile (5,280-foot) high skyscraper in Chicago in 1956."



"…And they said, 'Come, let us build ourselves a city, and a tower whose top is in the heavens; let us make a name for ourselves, lest we be scattered abroad over the face of the whole earth.' But the Lord came down to see the city and the tower which the sons of men had built. And the Lord said, 'Indeed the people are one and they all have one language, and this is what they begin to do; now nothing that they propose to do will be withheld from them'…"

Genesis 11:4-9

Left: an artist's interpretation of the biblical *Tower of Babel.* Note the inclusion of spiraling ramps around the perimeter. Lacking *Gearless Electric Traction Elevator* service, it was probably the only way to get to the top, which is believed to have been about 680-feet above terra firma (before its demise).

"…'Come, let Us go down and there confuse their language, that they may not understand one another's speech.' So the Lord scattered them abroad from there over the face of all the earth, and they ceased building the city…"

Genesis 11:4-9

<u>Left</u>: caption: "Engraving: The Confusion of Tongues, by Gustave Dore (1865)"


BABELON
GENESIS

Like a Stream of Spit

"…The big ideas tend to falter on the laws of physics. A single elevator can climb no higher than seventeen hundred feet. A hoist rope any longer is too heavy to be practical; at thirty-two hundred feet, it will snap, like a stream of spit in a stairwell. A decade ago, Otis developed a prototype of a conveyance called Odyssey, which could slide out of its shaft and travel on a horizontal track to another shaft, with the help of a linear induction motor. It was scuttled by the 1997 Asian financial crisis. The rising cost of electricity has confounded other lofty dreams, like the ropeless elevator…"

***The New Yorker*, April 2008**


Vertical Transportation
by
OTIS

Part 3

Elevatoring

The Obscure Mystery

"…The term 'elevatoring' refers to the discipline of designing a building's elevator system: how many, how big, how fast, and so on. You need to predict how many people will be using the elevators, and how they'll go about their business. It isn't rocket science, but it has its nuances and complications. The elevator consultant George Strakosch, in the preface to 'The Vertical Transportation Handbook,' the industry bible, refers to it as the 'obscure mystery.' To take elevatoring lightly is to risk dooming a building to dysfunction and its inhabitants to a kind of incremental purgatory. In elevatoring, as in life, the essential variables are time and space. A well-elevatored building gets you up and down quickly, without giving up too much square footage to elevator banks. Especially with super-tall towers, the amount of core space that one must devote to elevators, in order to convey so many people so high, can make a building architecturally or economically infeasible…"

***The New Yorker*, April 2008**

Elevatoring Metrics

"…There are two basic elevatoring metrics. One is handling capacity: your aim is to carry a certain percentage of the building's population in five minutes. Thirteen per cent is a good target. The other is the interval, or frequency of service: the average round-trip time of one elevator, divided by the number of elevators. In an American office building, you want the interval to be below thirty seconds, and the average waiting time to be about sixty percent of that. Any longer, and people get upset. In a residential building or a hotel, the tolerance goes up, but only by ten or twenty seconds. In the nineteen-sixties, many builders cheated a little - accepting, say, a thirty-four-second interval, and 11.5 percent handling capacity - and came to regret it. Generally, England is over-elevatored; India is under-elevatored…"

***The New Yorker*, April 2008**

"…Passengers seem to know instinctively how to arrange themselves in an elevator. Two strangers will gravitate to the back corners, a third will stand by the door, at an isosceles remove, until a fourth comes in, at which point passengers three and four will spread toward the front corners, making room, in the center, for a fifth, and so on, like the dots on a die. With each additional passenger, the bodies shift, slotting into the open spaces. The goal, of course, is to maintain (but not too conspicuously) maximum distance and to counteract unwanted intimacies - a code familiar (to half the population) from the urinal bank and (to them and all the rest) from the subway. One should face front. Look up, down, or, if you must, straight ahead. Mirrors compound the unease. Generally, no one should speak a word to anyone else in an elevator. Most people make allowances for the continuation of generic small talk already under way, or, in residential buildings, for neighborly amenities. The orthodox enforcers of silence - the elevator Quakers - must suffer the moderates or the serial abusers, as they cram in exchanges about the night, the game, the weekend, or the meal…"

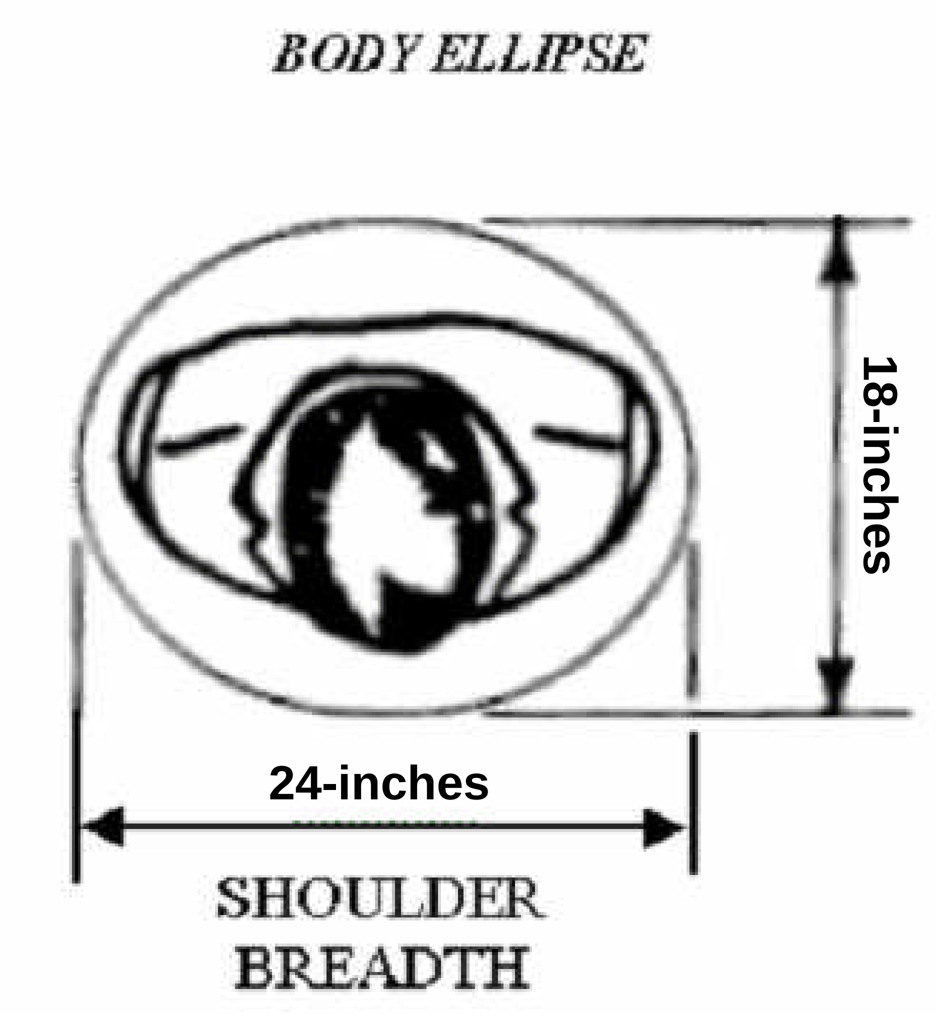
***The New Yorker*, April 2008**

<u>Left</u>: caption: "11 billion elevator trips are made each year in NYC"

Proxemics

"…Bodies need to fit. Designers of public spaces have devised a maximum average unit size - that is, they've figured out how much space a person takes up, and how little of it he or she can abide. The master fitter is John J. Fruin, the author of 'Pedestrian Planning and Design,' which was published in 1971 and reprinted, in 1987, by Elevator World, the publisher of the leading industry magazine, Elevator World…Fruin introduced the concept of the 'body ellipse,' a bird's-eye graphic representation of an individual's personal space. It's essentially a shoulder-width oval with a head in the middle. He employed a standard set of near-maximum human dimensions: twenty-four inches wide (at the shoulders) and eighteen inches deep. If you draw a tight oval around this figure, with a little bit of slack to account for body sway, clothing, and squeamishness, you get an area of 2.3 square feet, the body space that was used to determine the capacity of New York City subway cars and U.S. Army vehicles. Fruin defines an area of three square feet or less as the 'touch zone;' seven square feet as the 'no-touch zone;' and ten square feet as the 'personal-comfort zone.' Edward Hall, who pioneered the study of proxemics, called the smallest range - less than eighteen inches between people – 'intimate distance,' the point at which you can sense another person's odor and temperature. As Fruin wrote, 'Involuntary confrontation and contact at this distance is psychologically disturbing for many persons.'…"

***The New Yorker*, April 2008**


BODY ELLIPSE
18-inches
24-inches
SHOULDER
BREADTH

"…The standard elevator measure is about two square feet per passenger - intimate, disturbing. 'Elevators represent a special circumstance in which pedestrians are willing to submit to closer spacing than they would normally accept,' Fruin wrote, without much parsing the question of willingness. The book contains a pair of overhead photographs, part of an experiment conducted by Otis, of elevators loaded to capacity (by design, cabs are nearly impossible to overweight, unless the passengers are extremely tall). In one, a car is full of women, each of whom has 1.5 square feet of space. In the other, there are men as well as women, and each passenger gets 1.8 square feet per person: men are larger, and women, in their presence, try to claim more space, often by crossing their arms. It is worth noting that, in experiments with prisoners, researchers found that violent or schizophrenic inmates preferred more than fifteen times this area. There's a higher tolerance in Asia than in the United States for tight rides and long waits. 'In China, you'll get twenty-five people in a four-thousand-pound car,' Rick Pulling, the head of high-rise operations at Otis, told me. 'That's unheard of here.' Pulling said that at the Otis headquarters in Hong Kong people wait patiently in line for the elevators, behind a velvet rope overseen by an attendant, and cram in. 'New Yorkers wouldn't stand for it,' Pulling said. 'He'd have two broken legs.'…"

***The New Yorker*, April 2008**

"…a 'probable stop' table, which applies probability to the vexation that boils up when each passenger presses a button for a different floor. If there are ten people in an elevator that serves ten floors, it will likely make 6.5 stops. Ten people, thirty floors: 9.5 stops (the table does not account for the exasperating phantom stop, when no one gets on or off). Other factors are door open and close time, loading and unloading time, acceleration rate, and deceleration rate, which must be swift but gentle. You hear that interfloor traffic kills - something to mutter, perhaps, when a co-worker boards the elevator to travel one flight, especially if that co-worker is planning, at day's end, to spend half an hour on a StairMaster. It's also disastrous to have a cafeteria on any-thing but the ground floor, or one floor above or below it, accessible via escalator…"

***The New Yorker*, April 2008**


140
150
160
170

"…An over-elevatored building wastes space and deprives a landlord of revenue. An under-elevatored building suffers on the rental or resale market, and drives its tenants nuts. In extreme cases, when the wait becomes actually long, instead of merely perceptibly long, things fall apart. The Bronx family-court system, for example, was in a shambles last year because the elevators at its courthouse kept breaking down (the stairs are closed, owing to security concerns). This led to hour-long waits, which led to missed court dates, needless arrest warrants, and life-altering family strife…"

***The New Yorker*, April 2008**


Main Lobby
150
Records Management

During its long history, the *Otis Elevator Company* has produced products other than elevators and escalators including:

- **Windlasses and electric hoists for theater curtains;**
- **A “horse-power” elevator**
- **An electric printing press**
- **Several varieties of steam engines and hydraulic pumps**

The hand windlass appeared about 1900 and could lower stage curtains via automatic gravity release, but they had to be hand-cranked up. Otis also once turned out custom-made items such as castings for bridges and elevated highways.

Otis Elevator Company
New York, Chicago, San Francisco

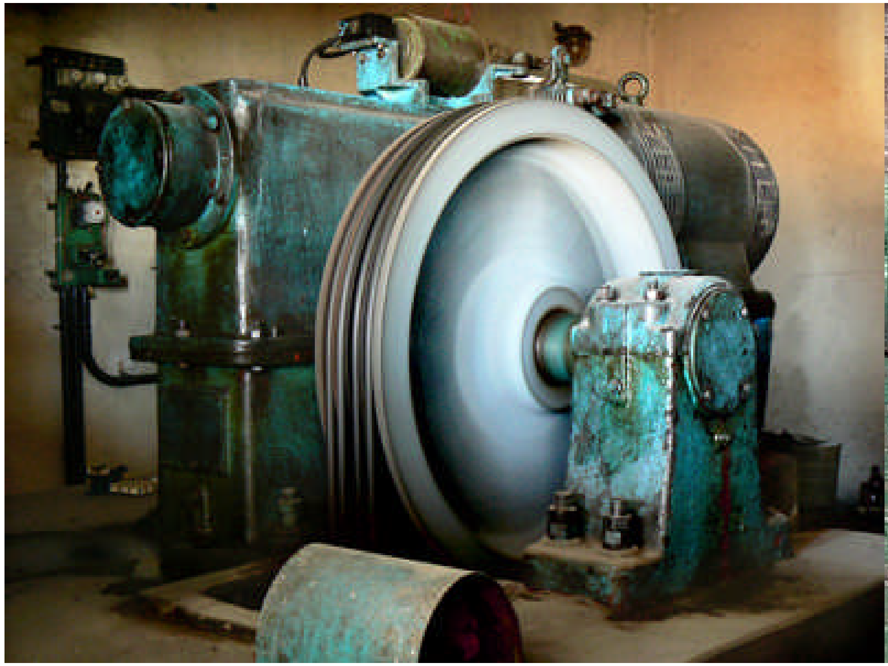
Builders of

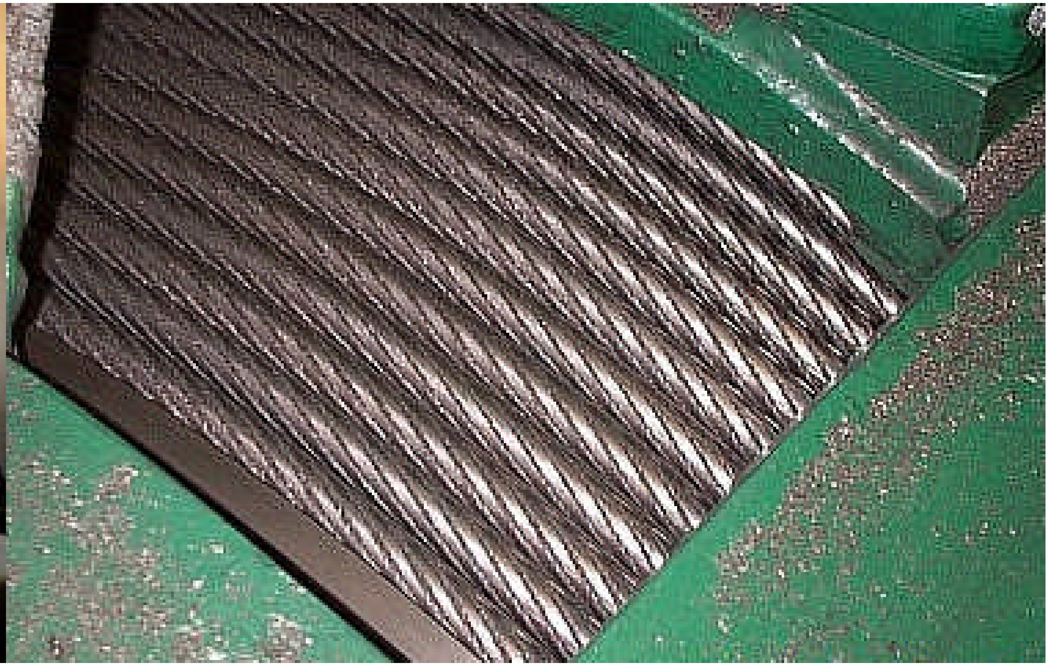
- **Hydraulic and Electric Passenger and Freight Elevators**
- **Electric Passenger Elevators and Dumb-waiters with push-button control**
- **Escalators (moving stairways)**
- **Electric Hoists for Mines, Docks, Warehouses, Building Operations, etc.**
- **Electric Hoists for Blast Furnaces for both Vertical and Incline Hoisting, with Automatic Skip for furnace duty and Slow-down movement**
- **Electric and Hydraulic Whip Hoists**
- **Electric Dock Hoists – portable and stationary**
- **Steam Hoisting Engines for Blast Furnaces. Mines, Inclines, etc.**
- **Steam Freight Elevators**
- **Inclined Railways**
- **Worm and Spur Gear Power Elevators**
- **Gravity Conveyors**

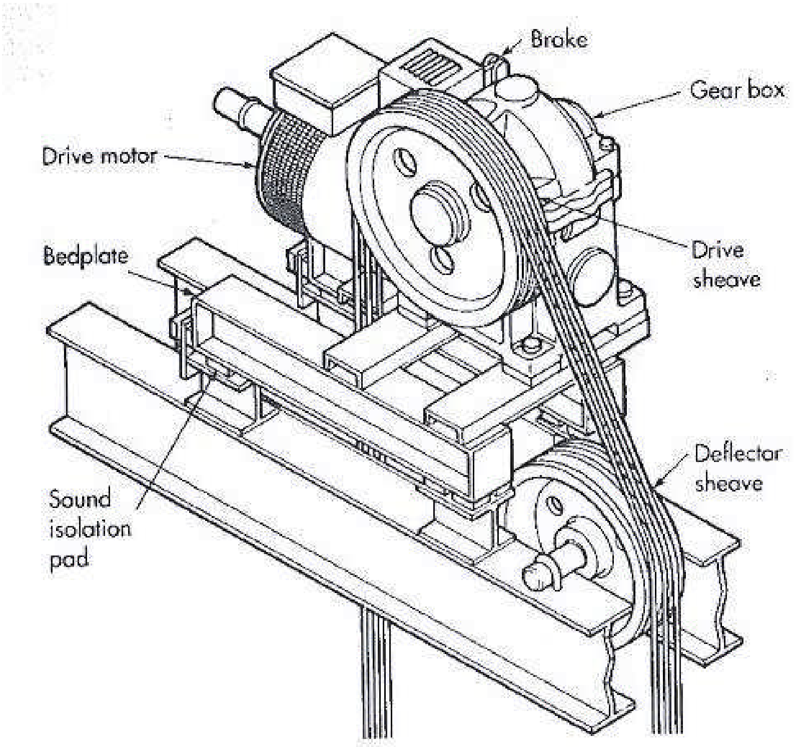
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1900)

In 1910, the Otis Elevator Company got into the automobile manufacturing business, producing "Sultan" automobiles in the company's Springfield, Mass., shops. The finished product carried a price tag of $3K-$4K.

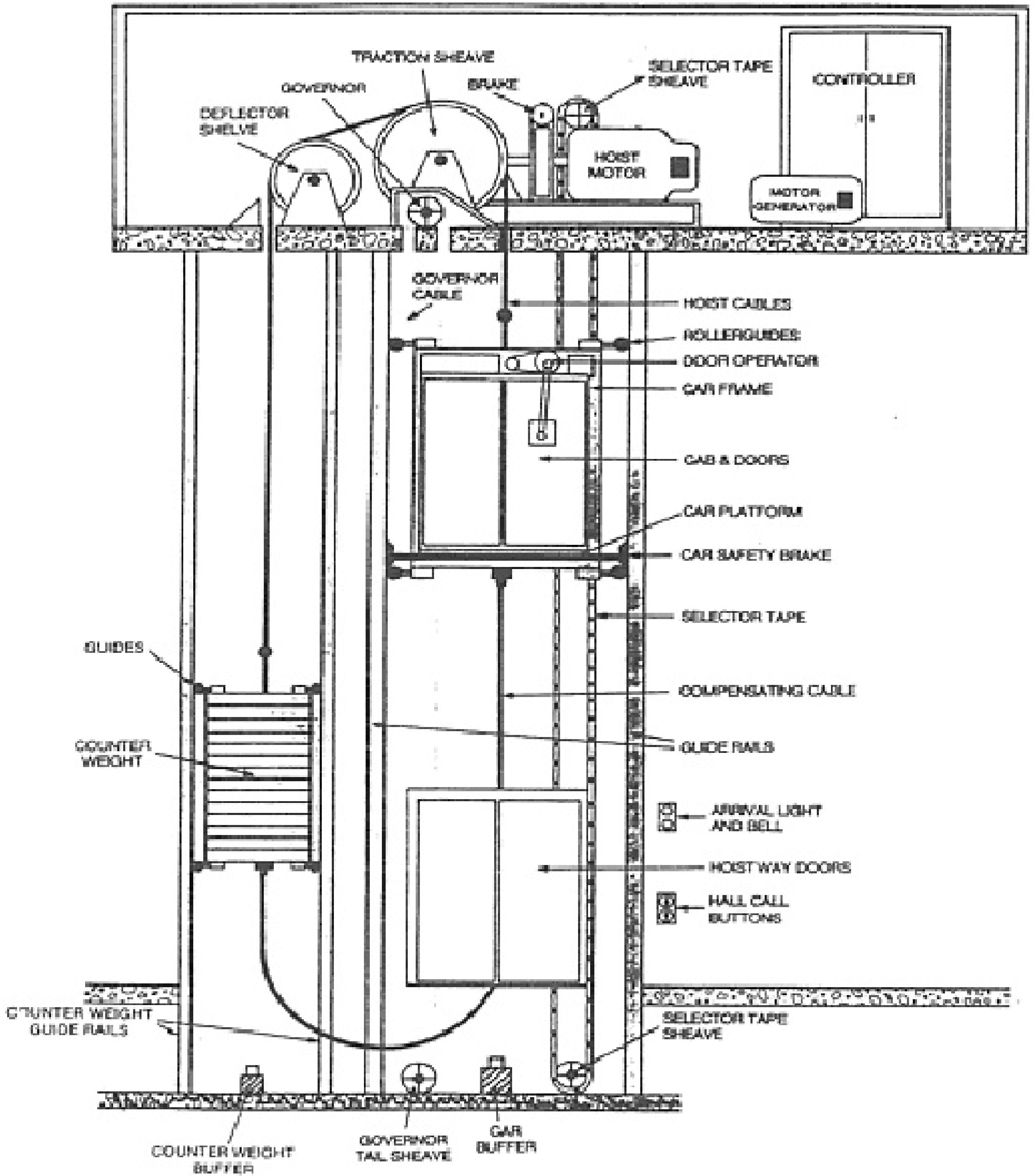
The Cable System



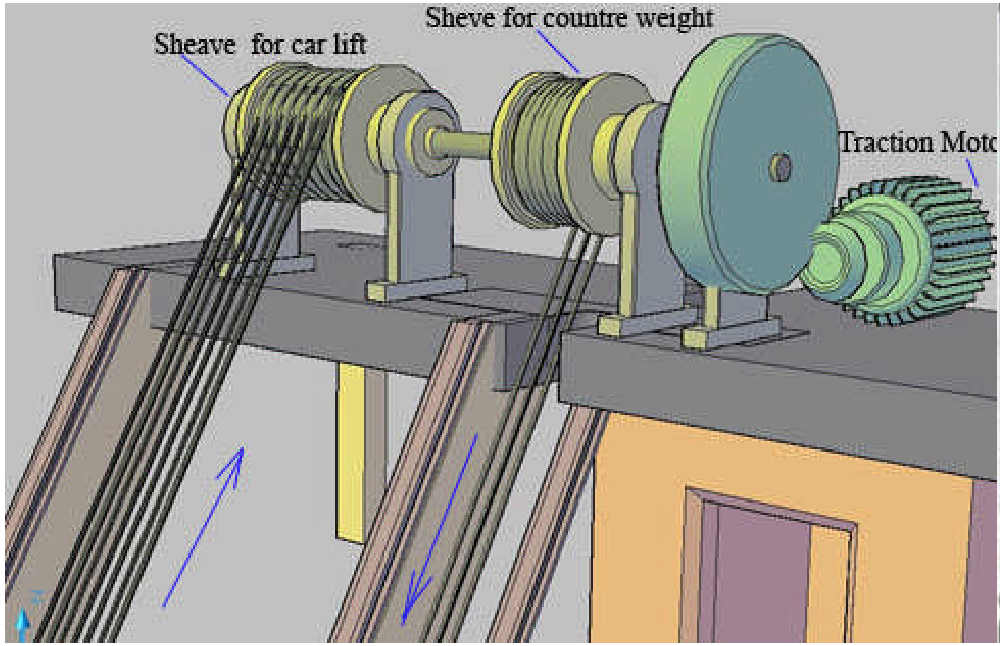




The most popular elevator design is the roped elevator. In roped elevators, the car is raised and lowered by traction steel ropes. The ropes are attached to the elevator cat and looped around a sheave. A sheave is a pulley with grooves around its circumference. The sheave grips the hoist ropes thus, when the sheave rotates, the ropes move up or down (depending on the rotation-direction of the sheave).

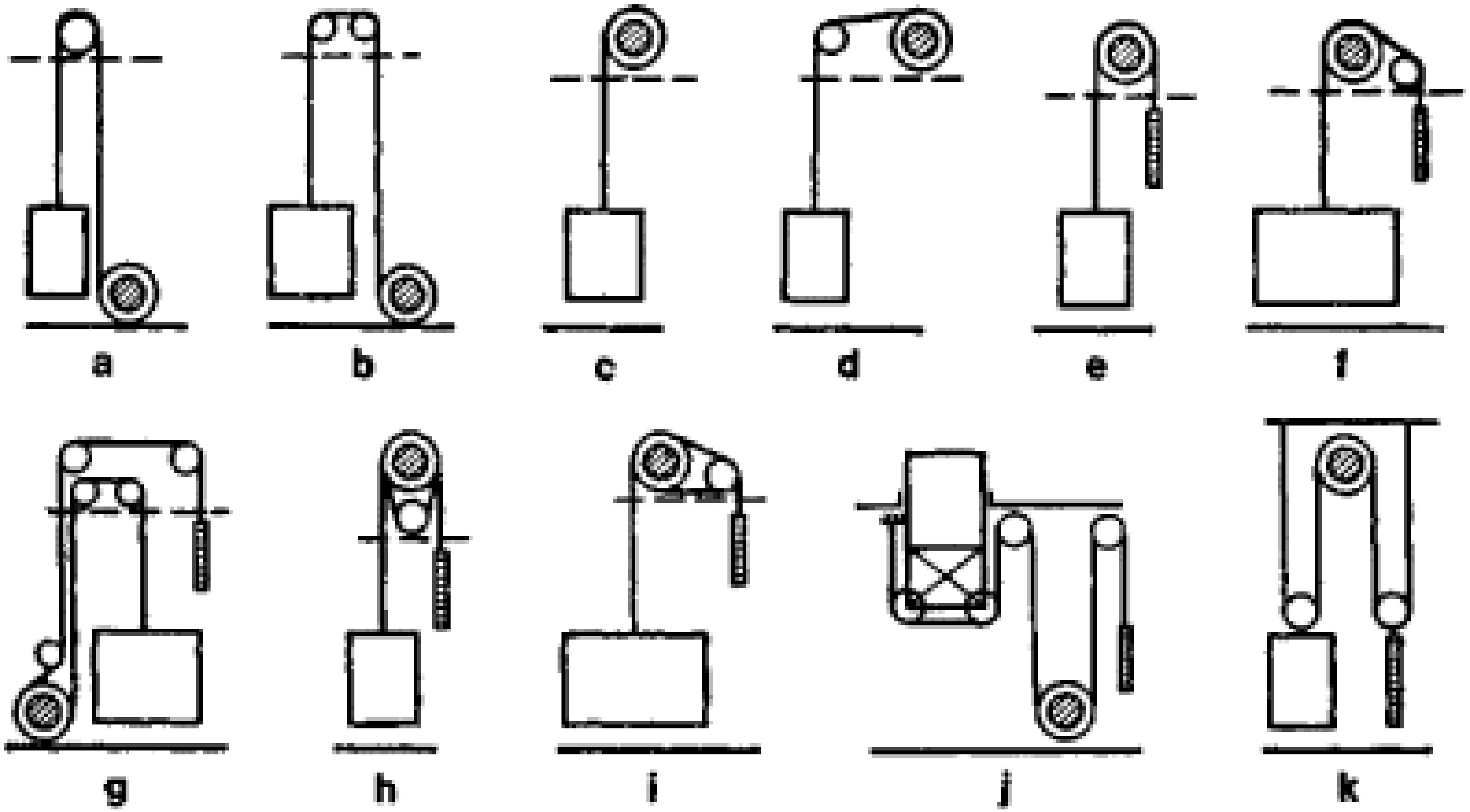


<u>Left</u>: roped elevator schematic. The sheave is connected to an electric motor and when the motor turns one way, the sheave raises the elevator and vice-versa. In gearless elevators, the motor rotates the sheave directly. In geared elevators, the motor turns a gear train that rotates the sheave. Typically, the sheave, motor and control system are all housed in a machine room above the elevator shaft.



The ropes that lift the car are also connected to a counterweight which hangs on the other side of the sheave. The counterweight weighs about the same as the car filled to 40% capacity. Thus, when the car is 40% full (average capacity), the counterweight and car are in perfect balance. The purpose of this counter-balancing is to conserve energy. With equal loads on each side of the sheave, it takes only a little bit of force to tip the balance one way or the other. In effect, the motor only has to overcome friction – the counterweight on the other side does most of the work. Put another way, the balance maintains a near constant potential energy level in the system as a whole. Using up the potential energy in the elevator car (allowing it to descend to the ground) builds up the potential energy in the counterweight (the counterweight rises to the top of the shaft and vice-versa).

Left: caption: "Elevator system with separate pulley for counterweight"
Right: caption: "Elevator counterweight in shaft"



<u>Above</u>: caption: “Functional diagrams of elevator mechanisms: (a) and (b) with winch located at bottom of shaft, (c) and (d) with winch located at top of shaft, (e) and (f) with winch located at top of shaft and with a counter-weight, (g) with winch located at bottom of shaft and with a counter-weight, (h) and (i) with winch located at top of shaft and with a cable guiding sheave and counter pulley, (j) with looped cable, (k) with pulley block suspension of car and counterweight.”

Electric Elevators

"…Our long and varied experience in manufacturing elevators enabled us to produce the first successful Electric Elevator, and by applying to the improvement of our machines the highest grade of electrical and mechanical talent, we have kept our product in a superior class, absolutely unrivalled by that of any other manufacturer. Since we introduced the Electric Elevator its success has exceeded our most sanguine expectations. Our first Electric Elevator installation has been in continuous and satisfactory operation for over fifteen years, and we have since installed in this and foreign countries over 20,000 elevators of this type. The vitally important questions of safety and control have been for years a subject of study by our experts, resulting in the perfection of a number of devices, simple in construction, positive, effective and practically automatic in operation…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

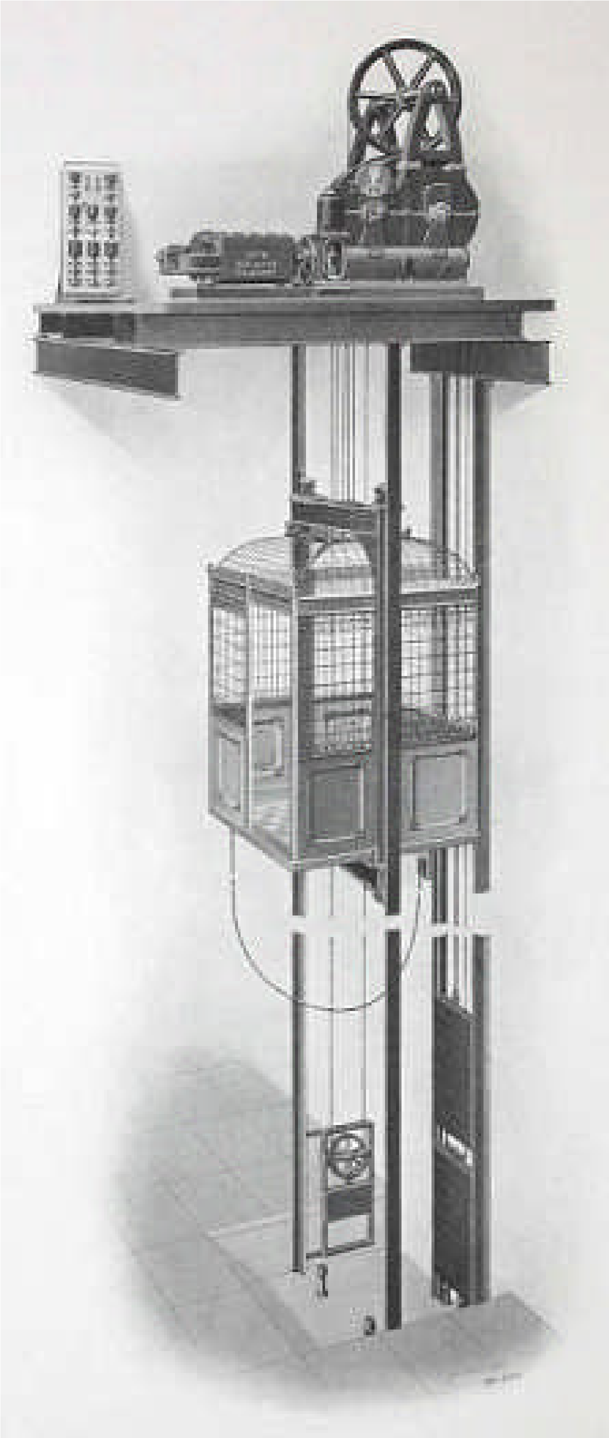
“…The Electric Elevator is built for any lifting capacity required. Car speed may be provided from 30 to 40 feet per minute. The car or platform may be controlled by hand switch, lever device, hand wheel or hand cable. Electric Elevators for Passengers and Freight:

- *Government and Municipal Buildings*
- *Elevated, Surface and Underground Railway Stations*
- *Office Buildings*
- *Stores*
- *Warehouses*
- *Apartment Houses, and*
- *Private Residences…”*

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1900)

“…We use, instead of the magnet system, where high speed of service is not required, the hand cable controller. We build this machine for both passenger and freight service, changing the style and type of the engine as requirements demand. All of our engines are fitted with our positive automatic stop, bringing the car to a standstill at the upper and lower terminals, independently of the operator in the car; all of our elevators have the Otis speed governor safety device, tested by actual use for over thirty years. Its action and control of the safety apparatus is entirely independent of the breaking of the lifting cables. The Otis electric elevator engines have passed beyond the stage of experiment having now been on the market some sixteen years, during which time we have installed over fifteen thousand electric passenger and freight elevators…”

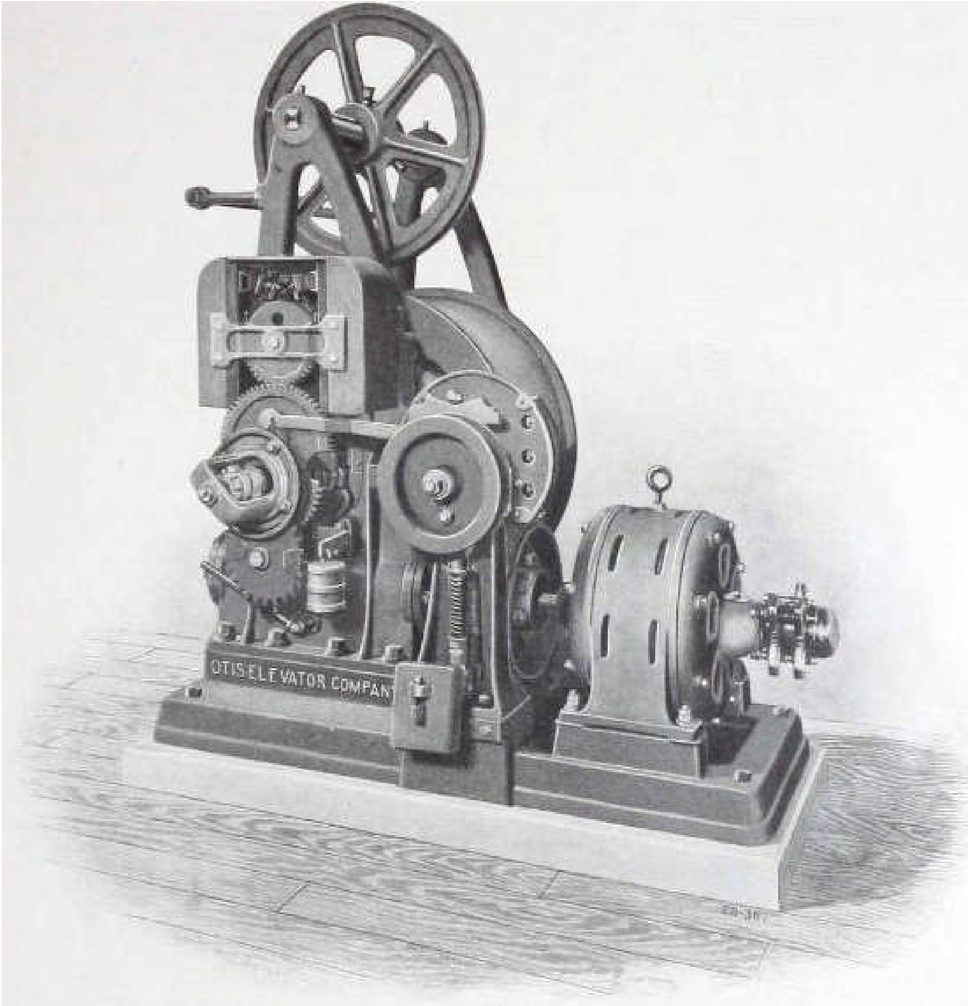
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1900)



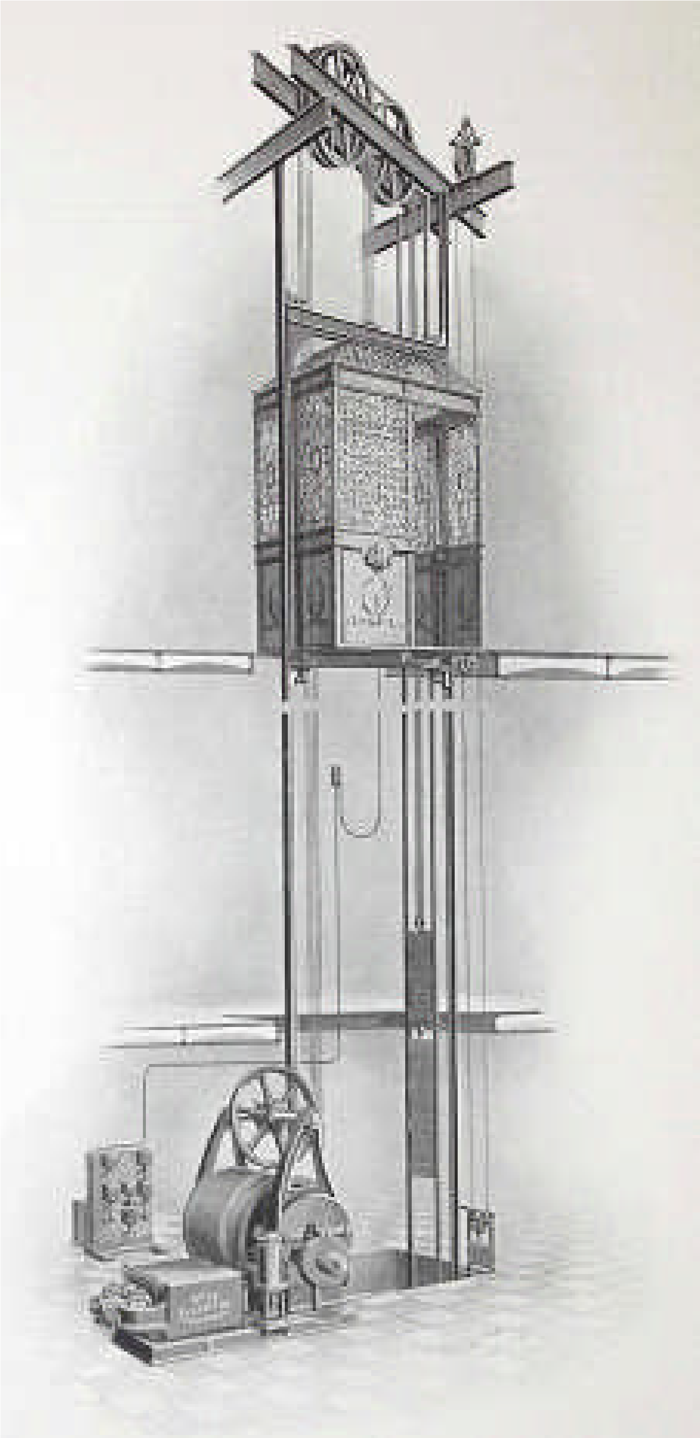
"…The illustration shows the Otis standard drum type of the direct connected Elevator Engine placed immediately over the hatchway where ordinarily the overhead sheaves would be located. This method of installation has many desirable features, among which is the fact that basement space, which in many buildings is very valuable, is entirely free from elevator machinery. The double-worm electric machine is recommended for high-speed passenger service, rather than the single-worm type. It is provided with electrical control only, the controlling apparatus being also located overhead adjacent to the engine. The double-worm machine is equally adapted, of course, for installation in the basement and is so located in thousands of buildings where basement space is of no particular value or where this method is, for other reasons, favored by the architects or engineers…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1903)

Left: caption: "Double Worm and Gear Electric Elevator, Overhead Installation"



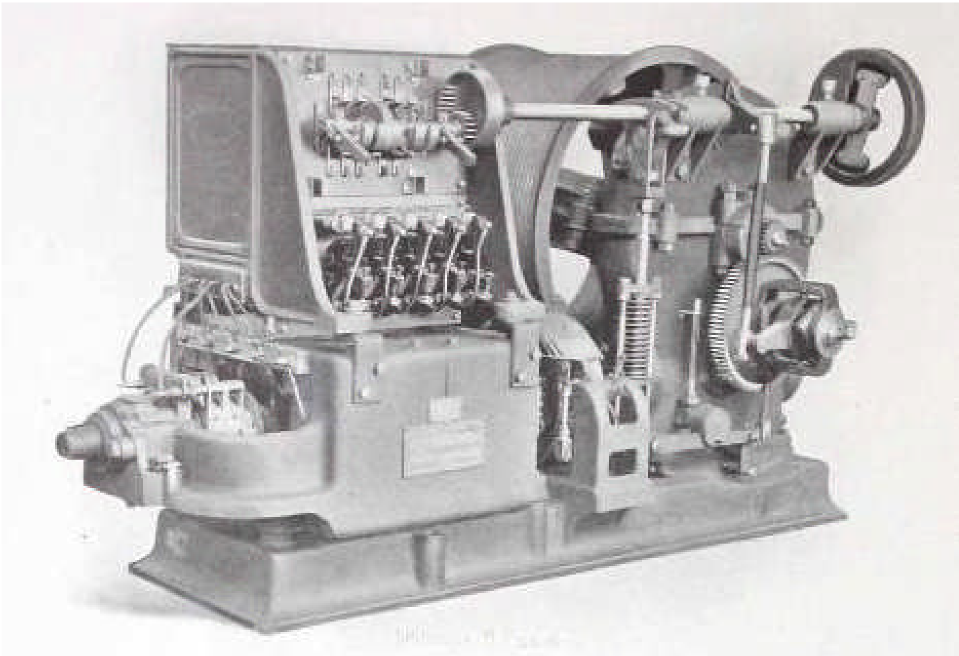
Left: caption: “Otis Single Worm Electric Elevator Engine, with alternating-current motor, built to operate on two and three-phase circuits of any commercial voltage. This machine has the ease of control and superior running qualities of our direct-current types and is designed with various operating devices. The machine shown is arranged for mechanical controling device in car, either wheel, lever or cable”



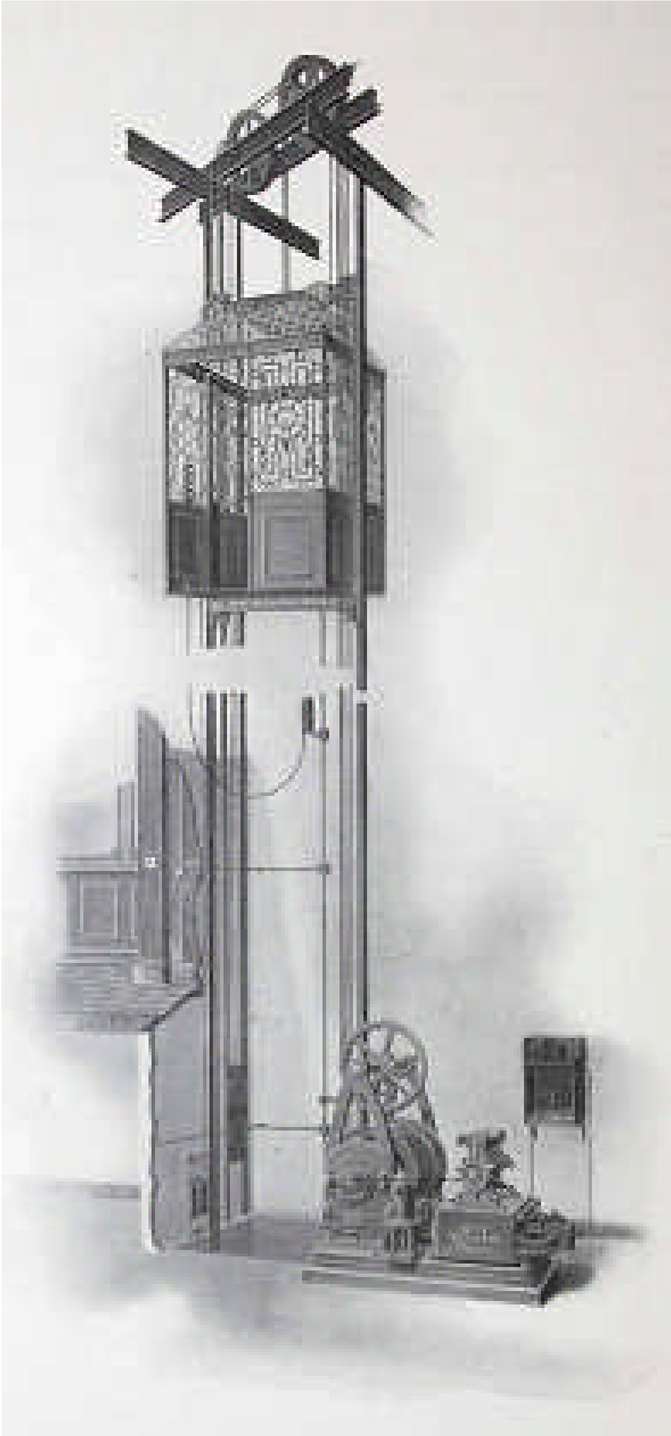
"….The installation illustrated is that of our Drum Electric Elevator, with engine located in basement. The engine shown is of the single worm type and is unexcelled for the service required of an elevator in office buildings, stores, apartment houses, etc., of the smaller class, and within the limits of its capacity is fully equal to the more powerful duplex worm machine in smoothness of running, ease of control and other essential features. The elevator may be controlled from the car by means of our electric switch and magnet device as shown, or by means of wheel, lever or other mechanical arrangement. The single-worm engine may, of course, be located above the hatchway if the conditions make this style of installation desirable…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

Left: caption: "Single Worm and Gear Electric Elevator, Basement Installation"



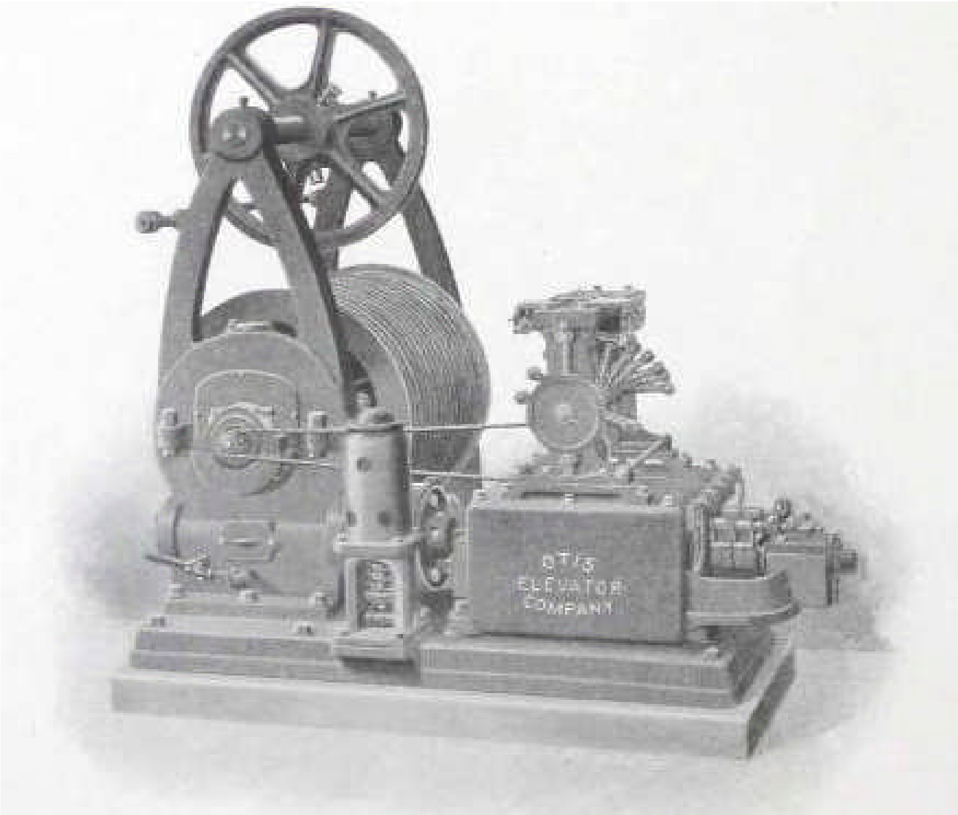
Left: caption: “The Otis Electric Elevator Engine with single worm and gear, and with controller box mounted on motor. The machine shown is arranged for mechanical operating device in car, either wheel, lever or cable.”



"…This type is designed particularly for private residences. No attendant is required, the elevator is always ready for service, and it is equipped with every safeguard which human ingenuity can devise against the possibility of accident. A passenger desiring to use the elevator presses a button placed near the elevator shaft, and the car, if not in use, immediately travels to that floor and stops automatically. When the car has come to rest at that floor, the door can be opened. The passenger then enters the car and closes the door. The car will not leave that floor unless the door is tightly closed. Inside the car there is a series of push buttons, numbered to correspond with the various floors. The passenger pushes the proper button and the car proceeds to the desired landing and stops automatically. Not until the passenger has left the car and closed the door can the elevator be controlled from any other floor. Should the passenger desire, for any reason, to stop the car at any point of its travel, he can do so instantaneously by merely pushing the safety button with which the car is provided…"

RE: excerpt from *OEC* brochure (ca. 1903)

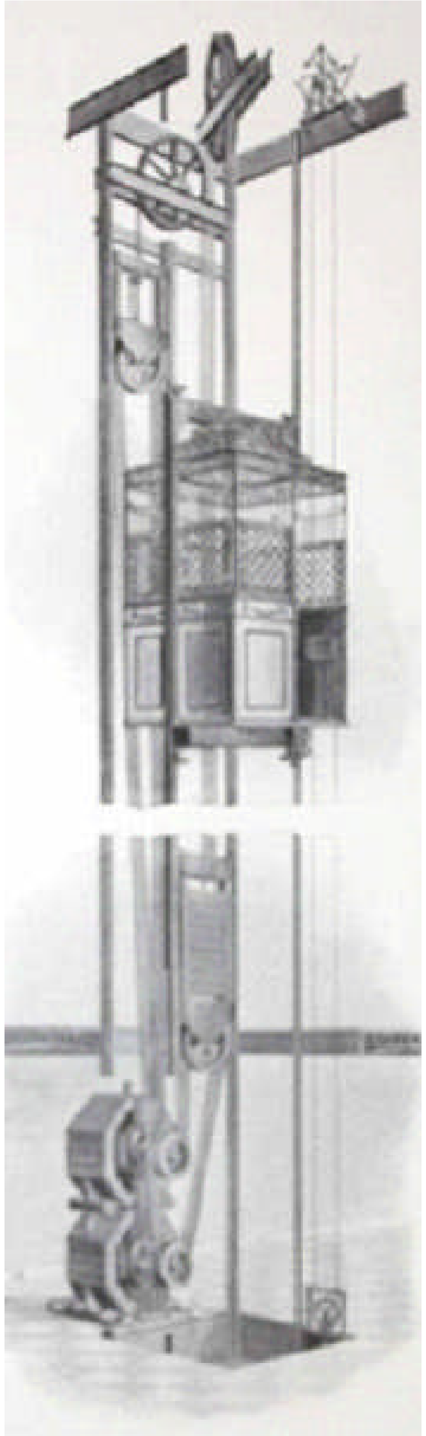
<u>Left</u>: caption: "Electric Elevator with Push-Button Control"



"…The extreme simplicity of the push-button method of control and the absolute provision against accident render the operation of this elevator easy and safe for any member of the household…"

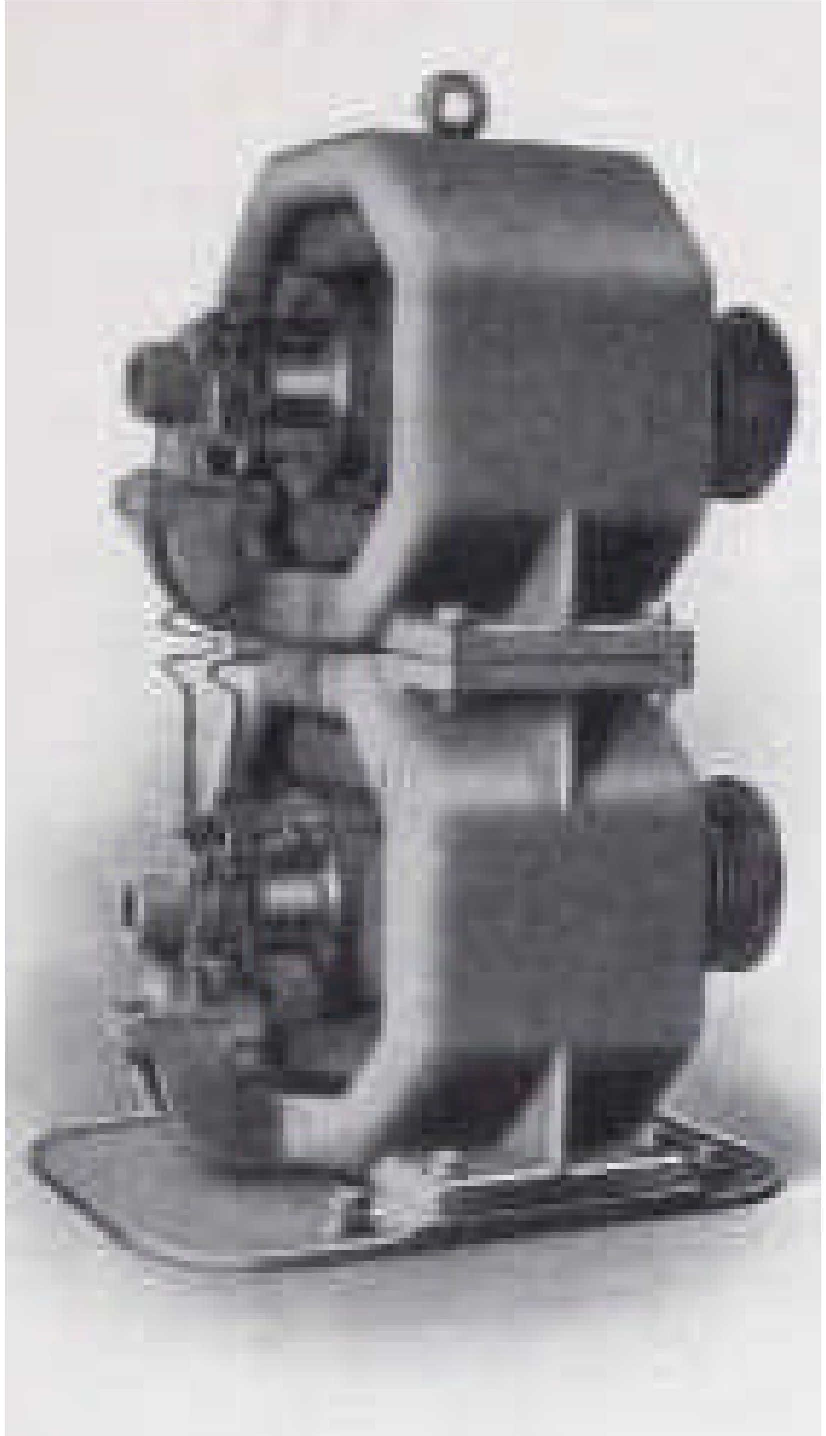
RE: excerpt from *OEC* brochure (ca. 1903)

Left: caption: "The Otis Electric Elevator Engine with automatic push-button controlling device mounted on motor"



"…The Duplex Motor Electric Elevator illustrated is specially adapted for high-speed passenger service. A car speed of 600 feet per minute or more per minute, in either direction, is readily obtained, and the stops are made at the various floors without shock or jar while running at the highest speed. In the Duplex Motor Elevator, gearing of any kind has been eliminated, the ropes leading from the sheaves on the armature shafts of the motors, thence to the car, giving absolute ease of motion obtained in no other electric elevator. The elevator is operated and controlled by electric devices, and every safety feature is employed to give perfect service. We build these machines having a lifting capacity of 2,000 to 5,000 pounds, and a car speed of 400 to 800 feet per minute…"

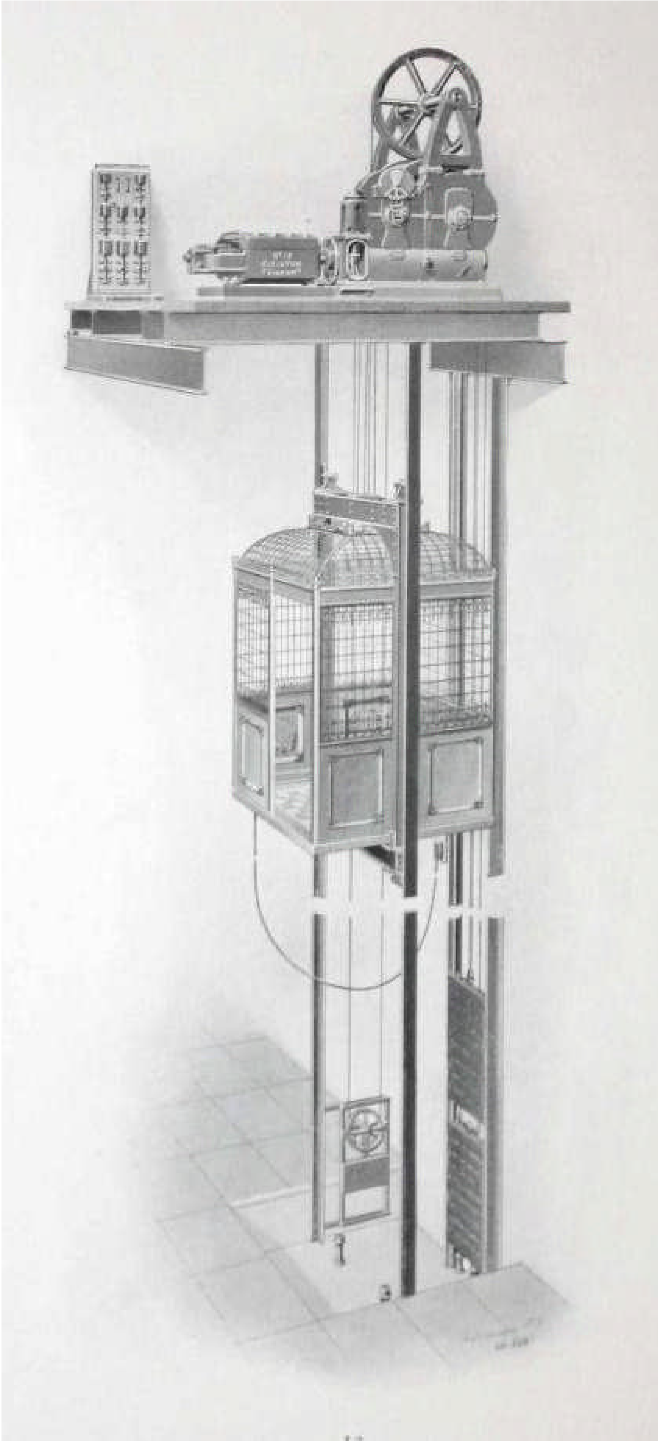
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1900)



"…In this type of Electric Elevator the drum is dispensed with and a sheave is placed on the end of each armature shaft, and endless cables pass round these sheaves and are connected to the car and also to the counterweights. The motors run in opposite directions, and as one or the other of the motors accelerates, the car moves up or down in the hatchway, its speed being proportional to the difference of speed of the two motors. When both motors are running at the same rate of speed the car is stationary, the same thing happening when the motors are stopped. This type of electric elevator is particularly suitable for the service required by the modern high building, in which a long car travel and fast car speed are essential features…"

RE: excerpt from *Otis Elevator Company* brochure (ca. 1903)

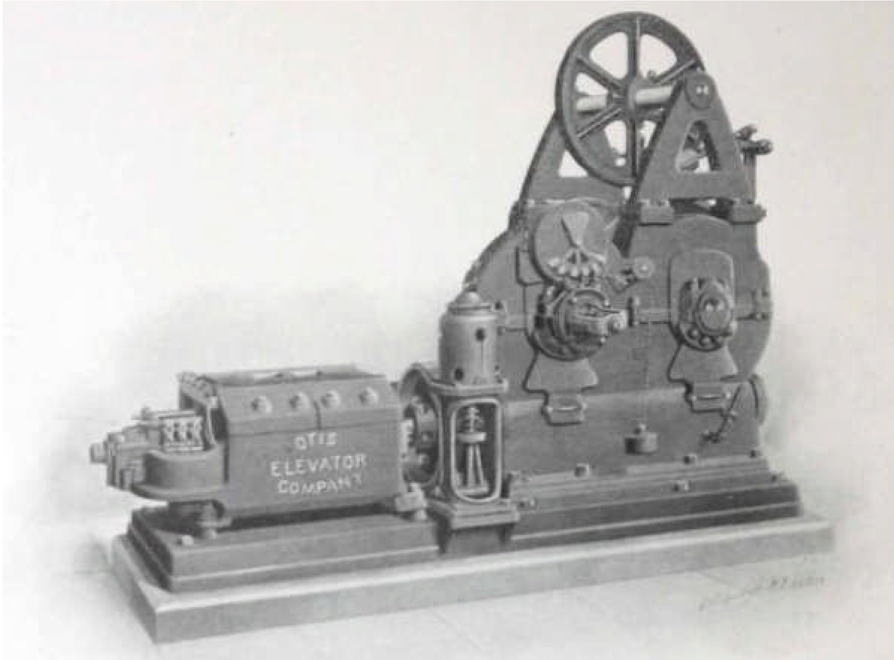
<u>Left</u>: caption: "Duplex Motor"



"…The installation illustrated is that of our Direct-connected Drum Type Electric Machine located over the hatchway, but more often the machine is placed in the basement, the structural conditions at the building, and the requirements of the business carried on, being the factors which determine the most suitable location. The machine shown is our duplex worm type, and is operated from the car by our improved electric switch and magnet controlling device, which gives the operator perfect control of the elevator, at the high car speeds which this type is capable of attaining. This type of elevator is especially adapted for the service required in high-class office buildings, department stores, hotels, etc., and we have installed them in great numbers in buildings of this class…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

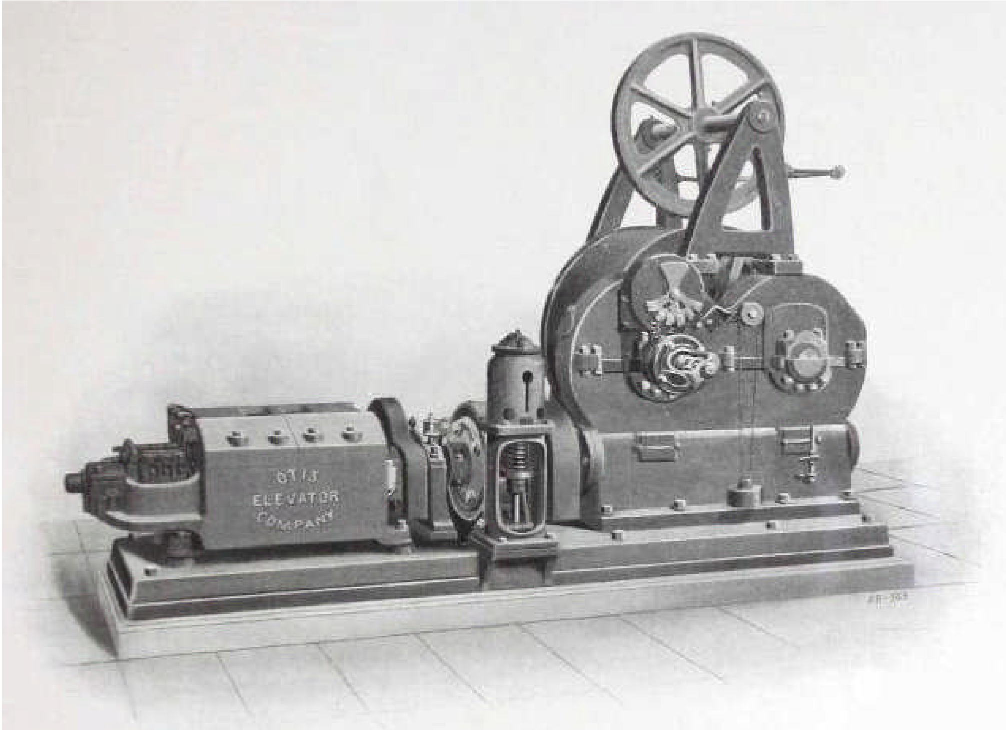
Left: caption: "Double Worm and Gear Electric Elevator, Overhead Installation"



"…The Duplex Worm Gear Engine, shown above, has screws cut from a solid steel forging, the right and left-hand threads intermeshing phosphor-bronze worm wheels, eliminating the thrust and adapting this machine to high car speeds and capacities beyond the limits of the single worm type. A powerful magnetic brake on the worm shaft holds the winding machine immovable whenever the car is stopped, or in the event of the operating current being interrupted or cut-off from any cause. This is the type of machine we installed to operate the cars having the highest travel of any electric elevators in any commercial building in the world, 326 feet…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

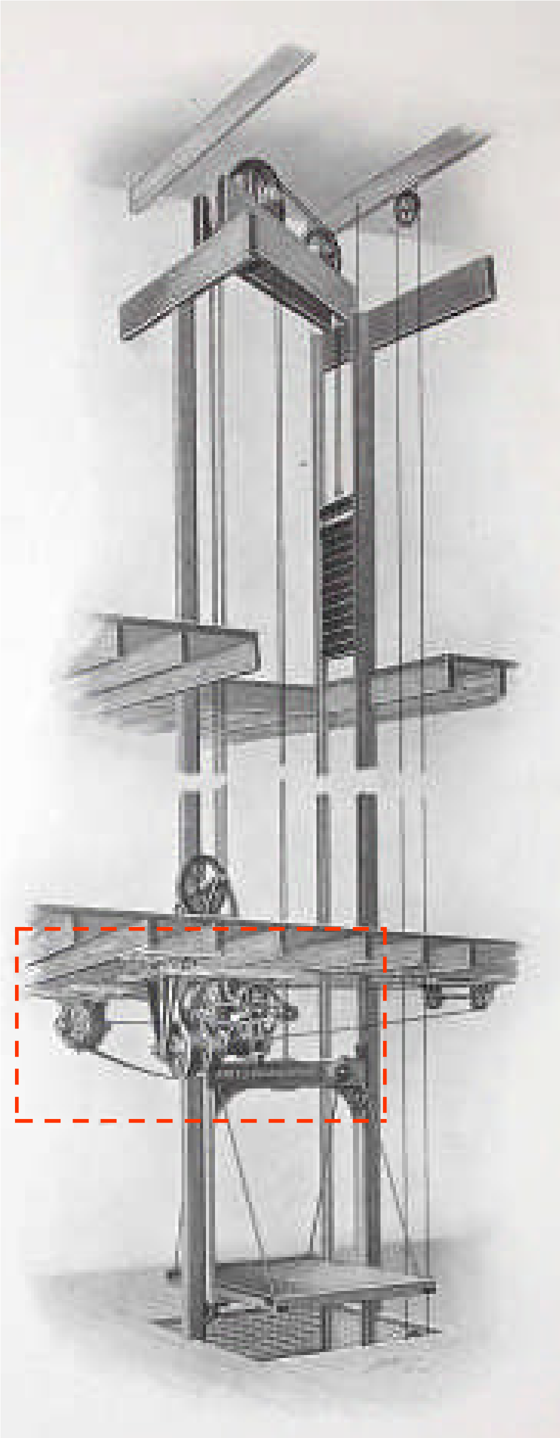
<u>Above</u>: caption: "The Otis Electric Elevator Engine"



"…The Duplex Worm Gear Engine, shown above, is designed so the armature shaft is ordinarily directly coupled to the worm shaft and the car operated at the speed and to lift the load required to meet the conditions of regular passenger service. But it is so arranged that this direct coupling can be disconnected and a back gear thrown in, largely increasing the lifting capacity and reducing the car speed proportionately. This change can be readily and quickly made by any engineer or mechanic capable of taking care of the machine in ordinary service. A machine of this kind is a necessity in office and other buildings equipped with electric elevators where safes or other very heavy freight are occasionally handled…"

RE: excerpt from *Otis Elevator Co.* brochure (ca. 1905)

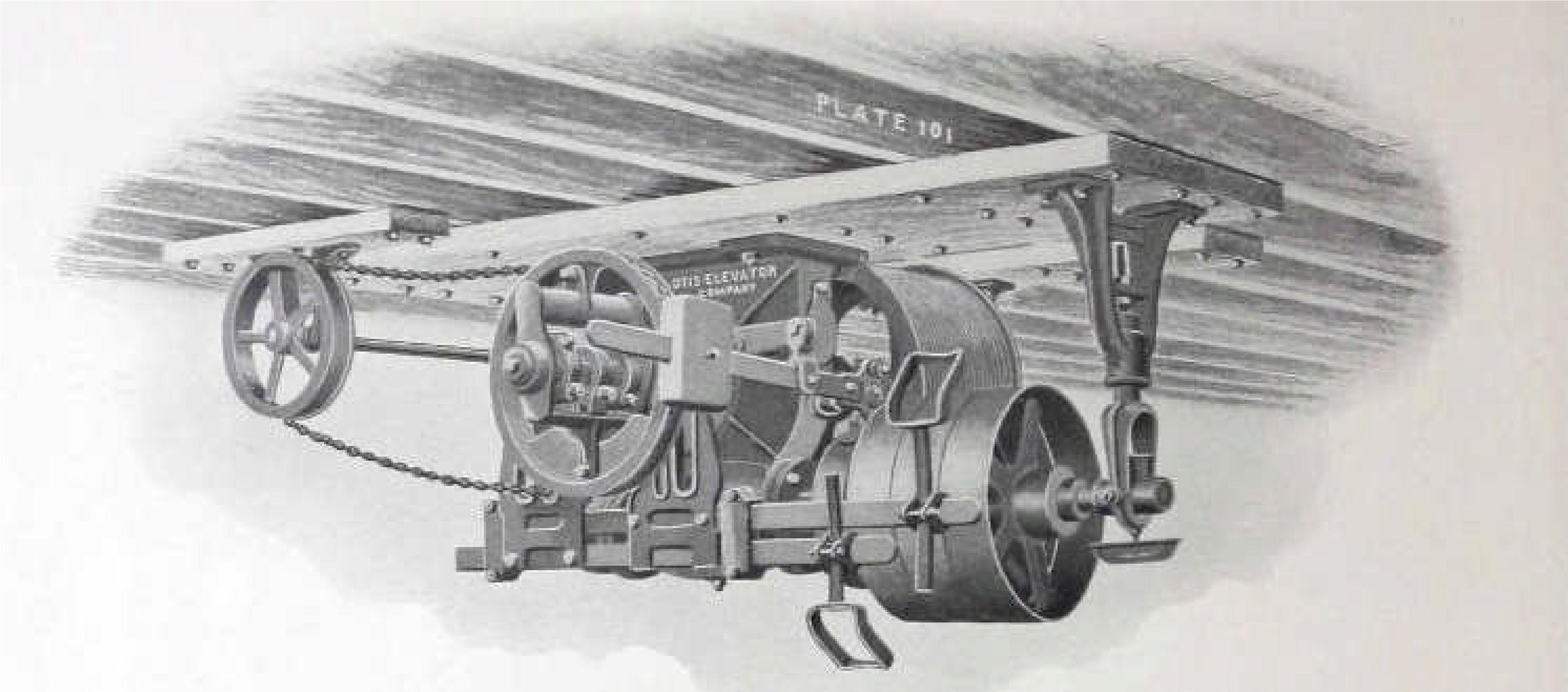
Above: caption: "Combination Passenger and Freight Electric Elevator Engine"



"…This type of Electric Freight Elevator is much used where moderate lifting capacity at low speed is all that is required, and as it costs less than a direct-connected elevator of equal capacity it frequently commends itself to purchasers on that account. The winding machine and the electric motor can be placed either on the ceiling or the floor, but we show both attached to the ceiling, as this is the method of installation commonly adopted. The motor is of round pattern with compound winding and of the reversible type. Both motor and controller are specially designed for this style of elevator, and in practice are proving entirely satisfactory…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

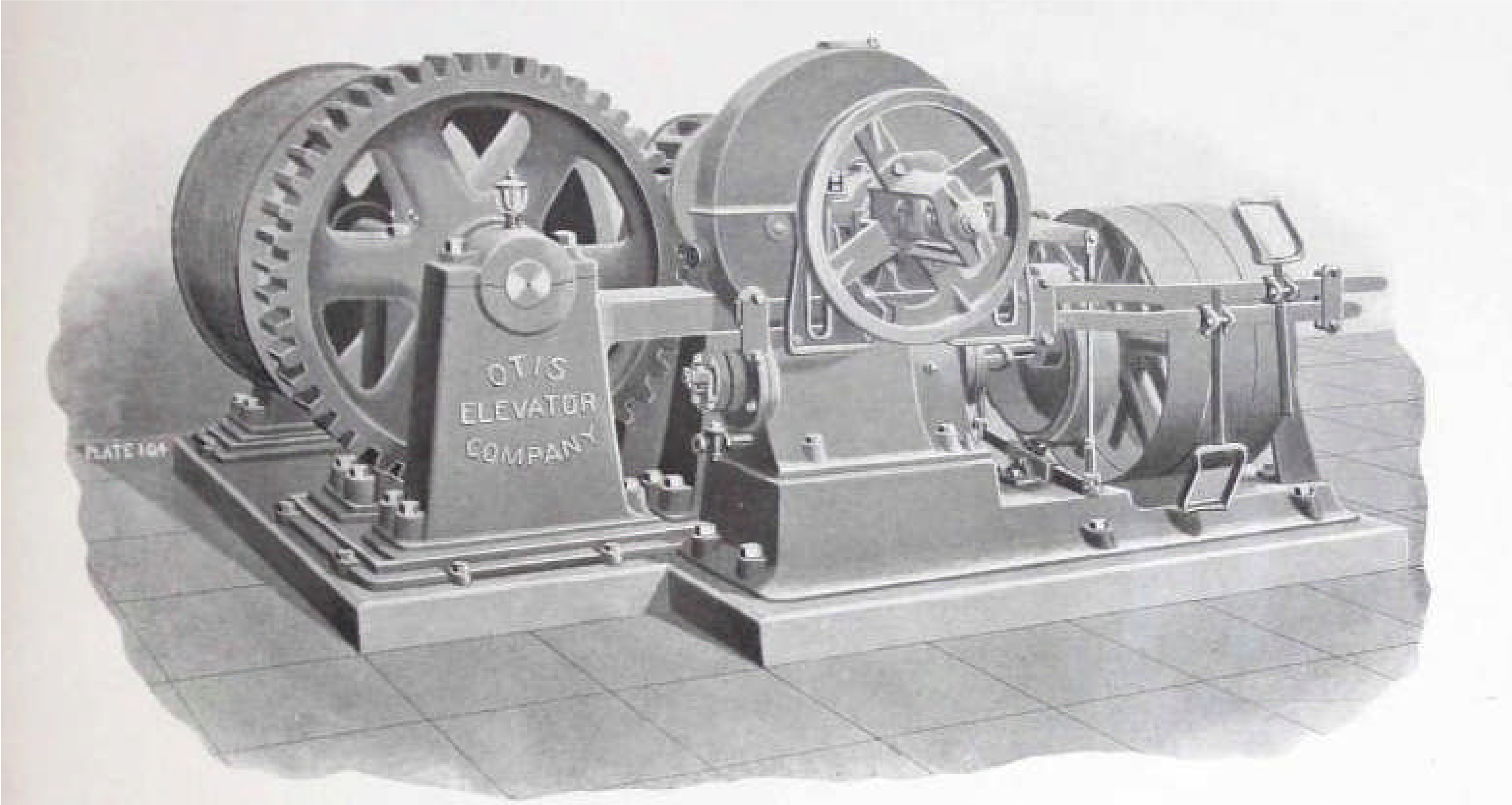
Left: caption: "Single-belt Electric Freight Elevator"



"…This is one of the oldest types of power Freight Elevator and is driven by belts from a line shaft, or by a gas engine or electric motor through a countershaft. A large number of elevators of this type are used on account of the comparatively low cost and where individual motive power for the elevator is not feasible nor desired. The winding machine is usually attached to the ceiling, as shown in the Figure. This type is made in sizes to suit capacities up to 6,000 pounds…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

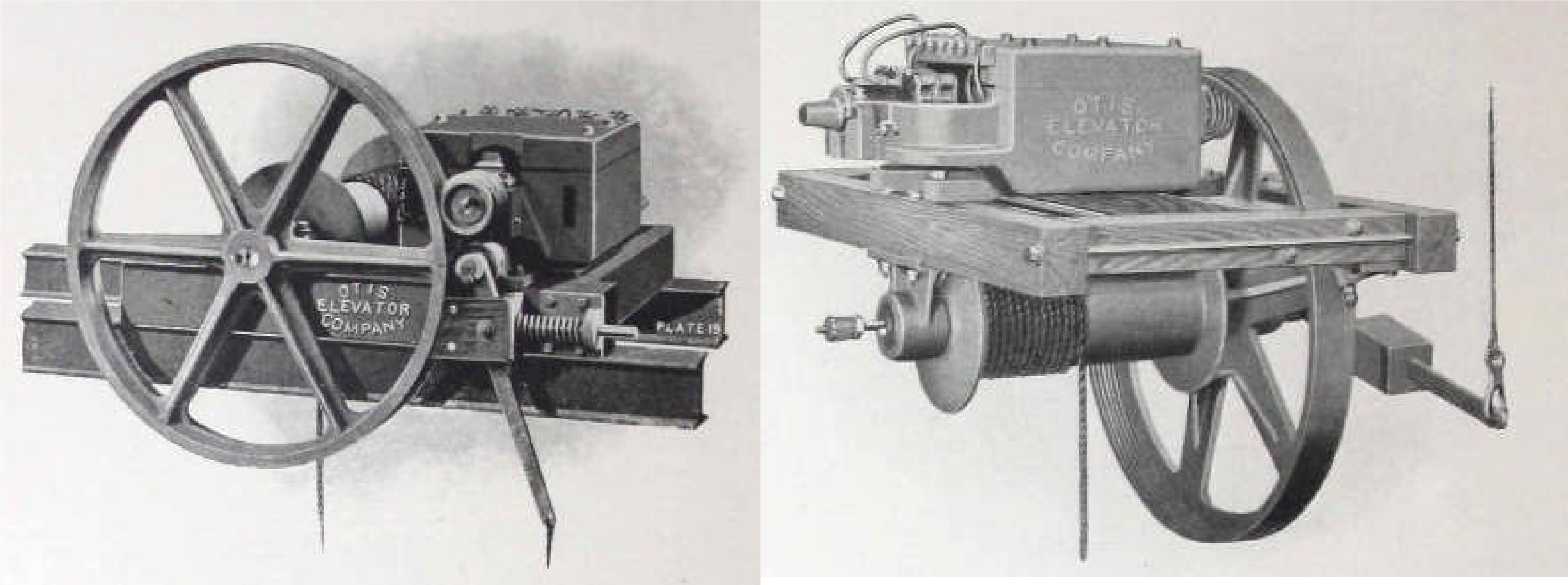
Above: caption: "Double-Belt Ceiling Machine"



"…The Otis Duplex-geared Belt Machine of the floor type, shown above, the first motion being a worm gear and the second a spur gear, is built for heavy duties up to 16,000 pounds. We also build a similar machine of the ceiling type…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

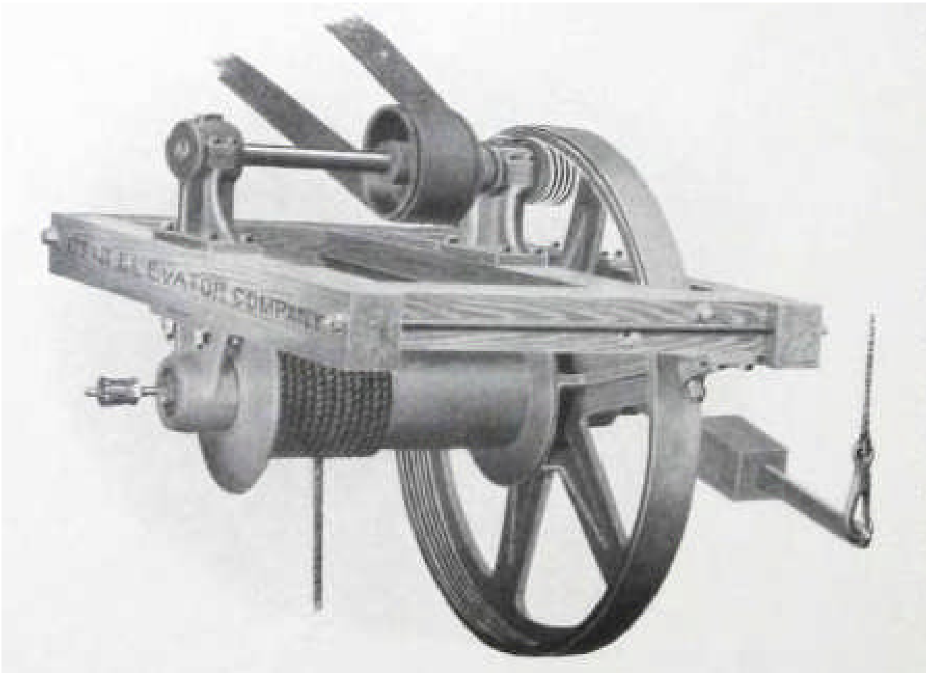
<u>Above</u>: caption: "Double-Belt Machine for Heavy Duty"



"…The Figures above show the Otis Electric Whip Hoist, which is designed for light and rapid hoisting for stores, warehouses, etc. The friction sheave is engaged with the lifting drum sheave by simply pulling the lever upward, and the machine can be operated and controlled from any distance. The moment the lever is released the brake is automatically applied, holding the load at the desired point. The hoist can be furnished with a special automatic control, which prevents the operator from running the hoist or raising the load beyond a terminal point of travel that may be fixed…"

RE: excerpt from *OEC* brochure (ca. 1905)

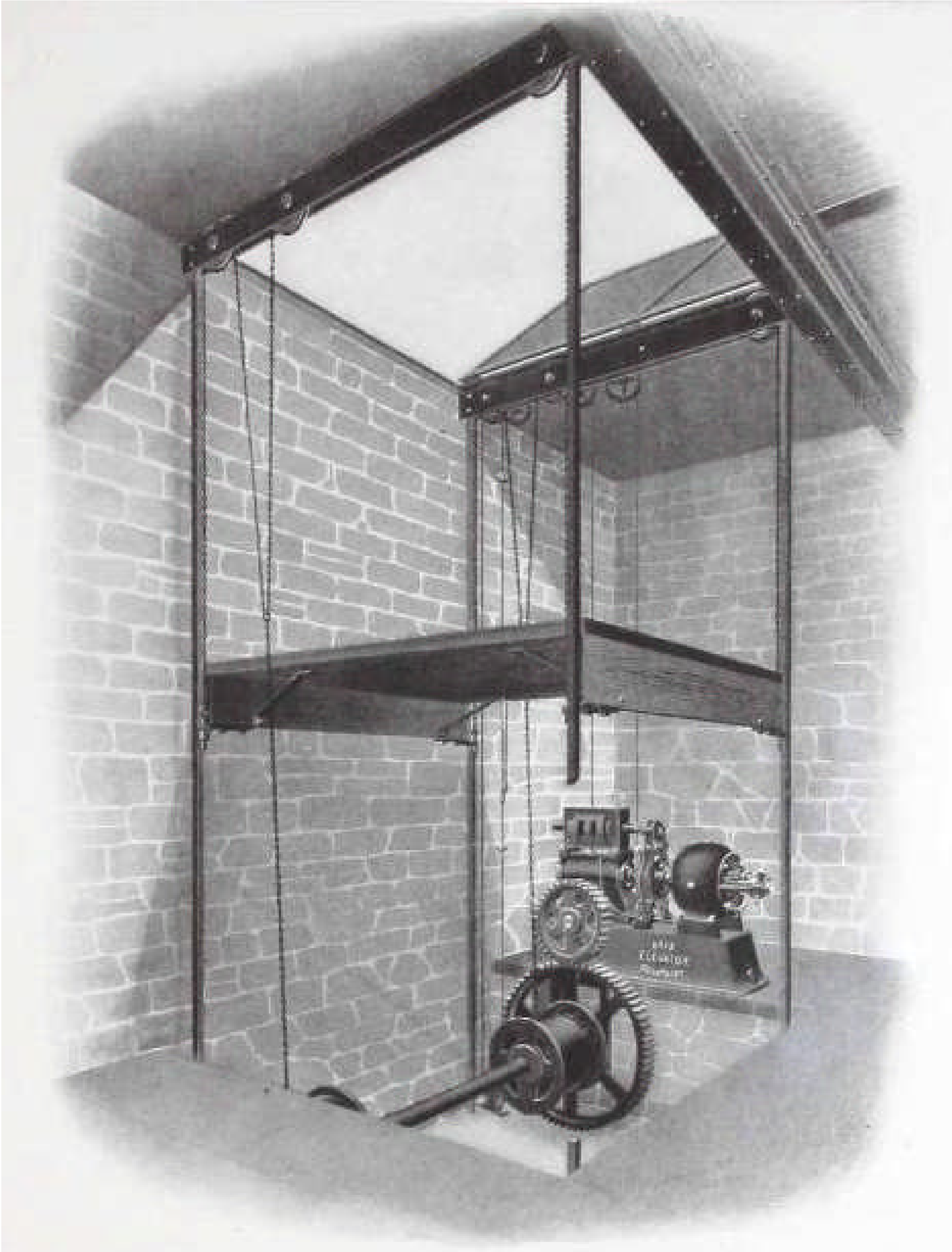
<u>Above L&R</u>: caption: "Electric Whip Hoist"



"….The figure shows the Whip Hoist arranged to be operated by belt power from line shafting instead of the electric motor. The lifting capacity, speed, and sizes are the same as in the electrically-operated hoist…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

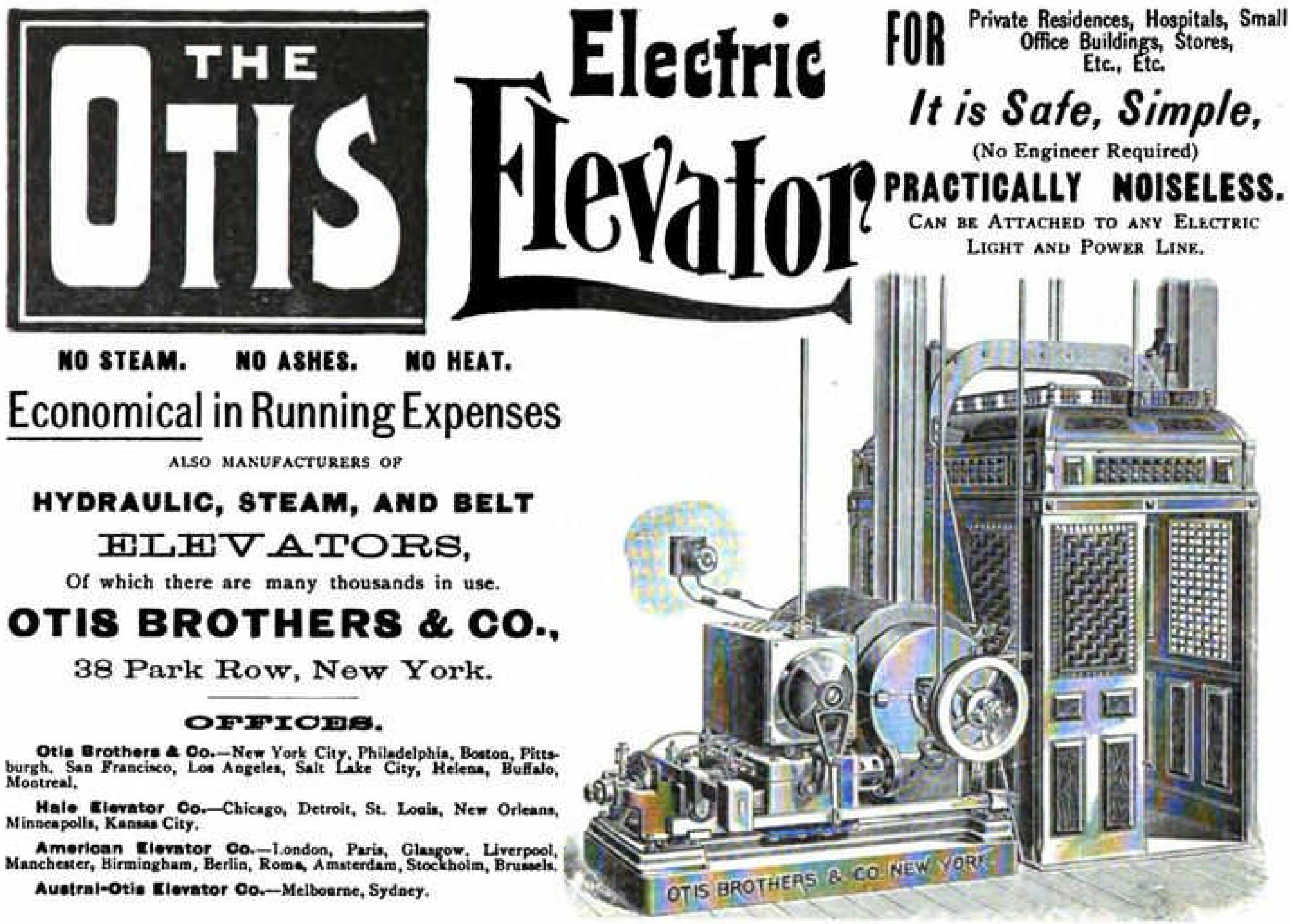
Left: caption: "Otis Belt-Power Whip Hoist"



"…The figure shows the Otis direct-connected Electric Side-walk Hoist. As can be seen from the illustration, the mach-ine is extremely compact and very simple in construction and the hoist can readily be installed in any basement. This machine is quite inexpensive, both in first cost and in the cost of operation, and the many situations in which its installation will be highly de-sirable readily suggest them-selves…"

RE: excerpt from *Otis Elevator Company* brochure (ca. 1903)

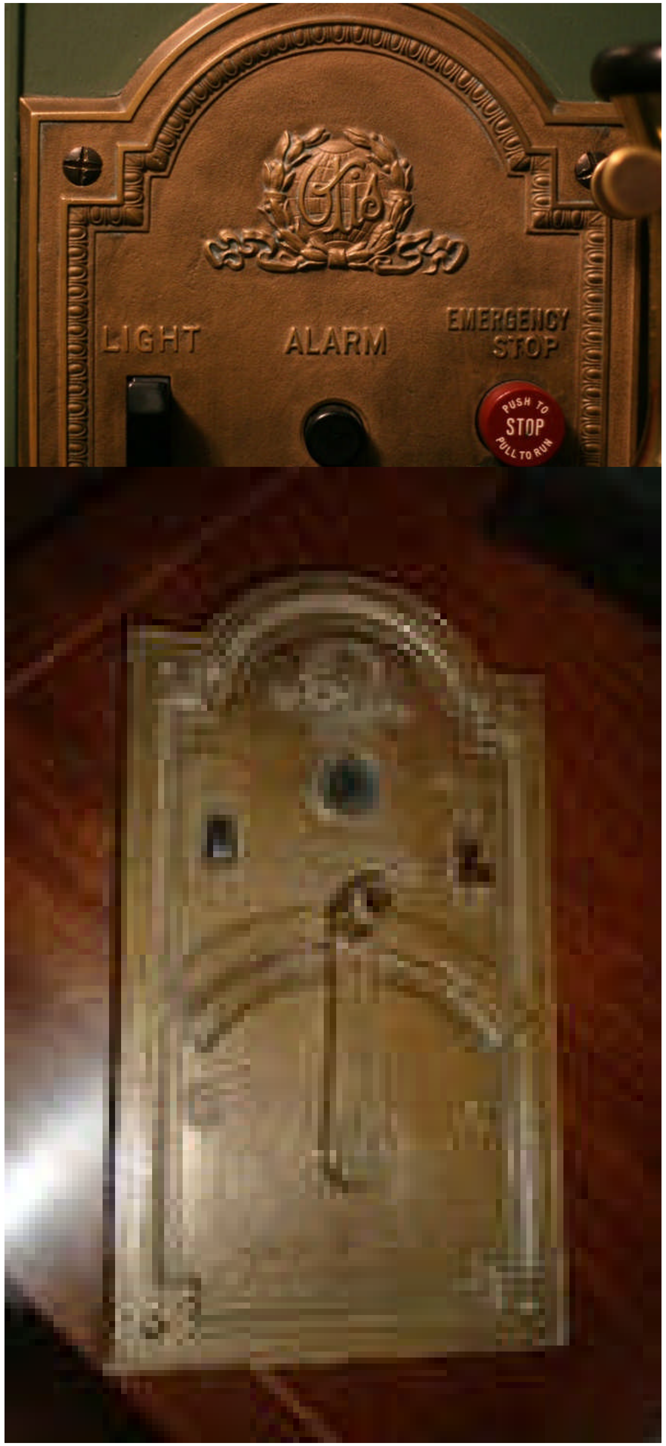
<u>Left</u>: caption: "Electric Sidewalk Hoist"


THE
OTIS
Electric
Elevator
FOR Private Residences, Hospitals, Small Office Buildings, Stores, Etc., Etc.
It is Safe, Simple,
(No Engineer Required)
PRACTICALLY NOISELESS.
CAN BE ATTACHED TO ANY ELECTRIC LIGHT AND POWER LINE.
NO STEAM. NO ASHES. NO HEAT.
Economical in Running Expenses
ALSO MANUFACTURERS OF
HYDRAULIC, STEAM, AND BELT
ELEVATORS,
Of which there are many thousands in use.
OTIS BROTHERS & CO.,
38 Park Row, New York.
OFFICES.
Otis Brothers & Co.—New York City, Philadelphia, Boston, Pittsburgh, San Francisco, Los Angeles, Salt Lake City, Helena, Buffalo, Montreal,
Hale Elevator Co.—Chicago, Detroit, St. Louis, New Orleans, Minneapolis, Kansas City.
American Elevator Co.—London, Paris, Glasgow, Liverpool, Manchester, Birmingham, Berlin, Rome, Amsterdam, Stockholm, Brussels.
Austral-Otis Elevator Co.—Melbourne, Sydney.
OTIS BROTHERS & CO. NEW YORK

Control

"…The question of control of Electric Elevators has been for years a subject of study by our corps of experts, and the result has been the perfection of a number of controlling and safety devices, positive in operation, simple in construction, and practically automatic in the performance of their functions…We build electric engines with motors for any commercial voltage of direct current, and for two-phase and three-phase alternating current, each with a system of control most appropriate for that particular type. There are two systems of control for electric elevators - the electrical and the mechanical. In the former, the elevator is controlled by a small switch within the car, operating pilot circuits which open and close the main line and reversing switches. On starting, there is considerable resistance within the armature circuit, and as the motor accelerates this resistance is automatically cut out step by step by electrically operated switches. By this means, the current is absolutely prevented from increasing above the amount for which the motor is designed and a gentle start, proportionate to load, is secured…"

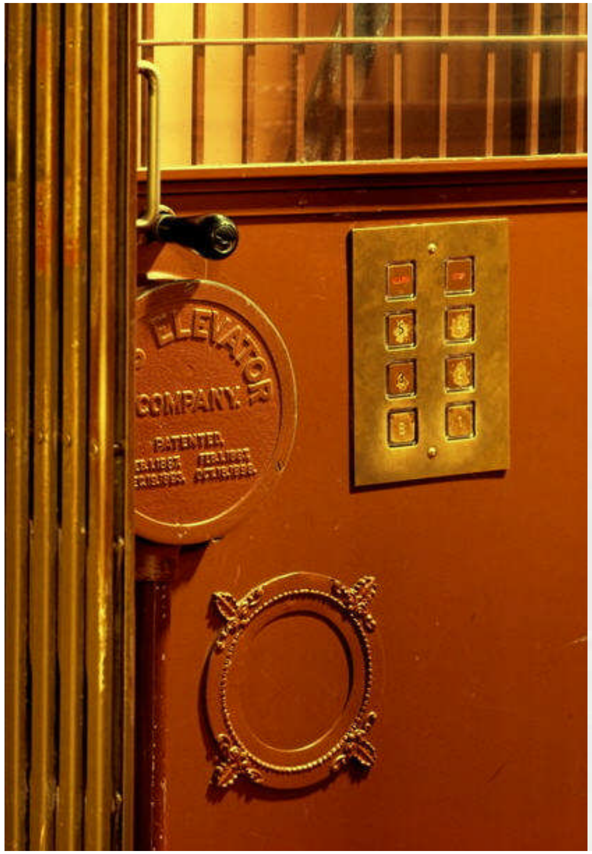
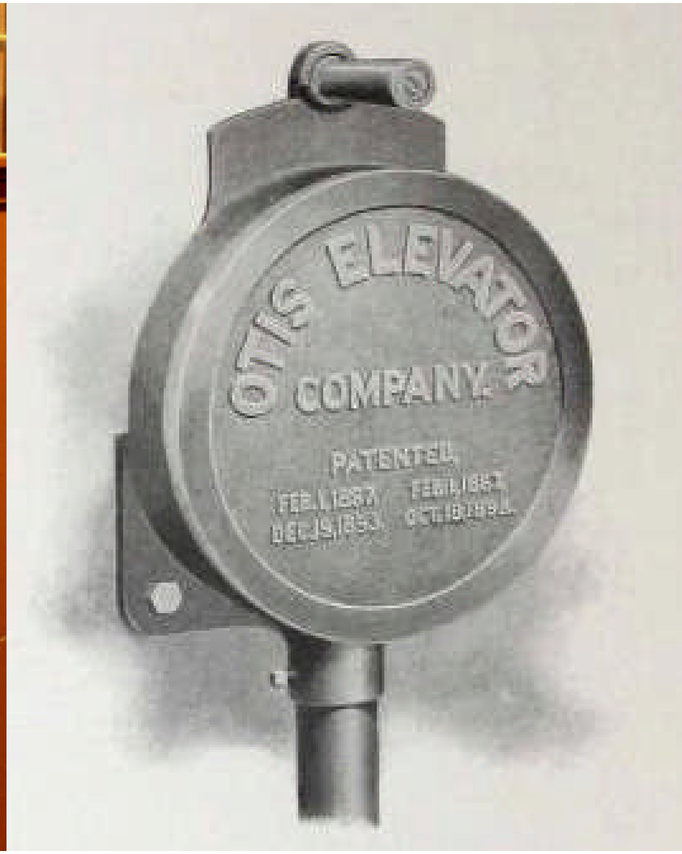
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1903)



"…The mechanical system of control differs from that just described in that the line switch is opened, closed, and reversed through the medium of a lever or a hand-wheel within the car, by purely mechanical means. Closing the switch admits starting current only to the motor and thereafter the control proceeds in the manner already des-cribed in the respect that the starting resistance is cut out from the armature circuit by automatic switches step by step as the motor accelerates, the same protection of the motor against heavy currents being thereby afforded…"

RE: excerpt from an *Otis Elevator Company* bro-chure (ca. 1903)

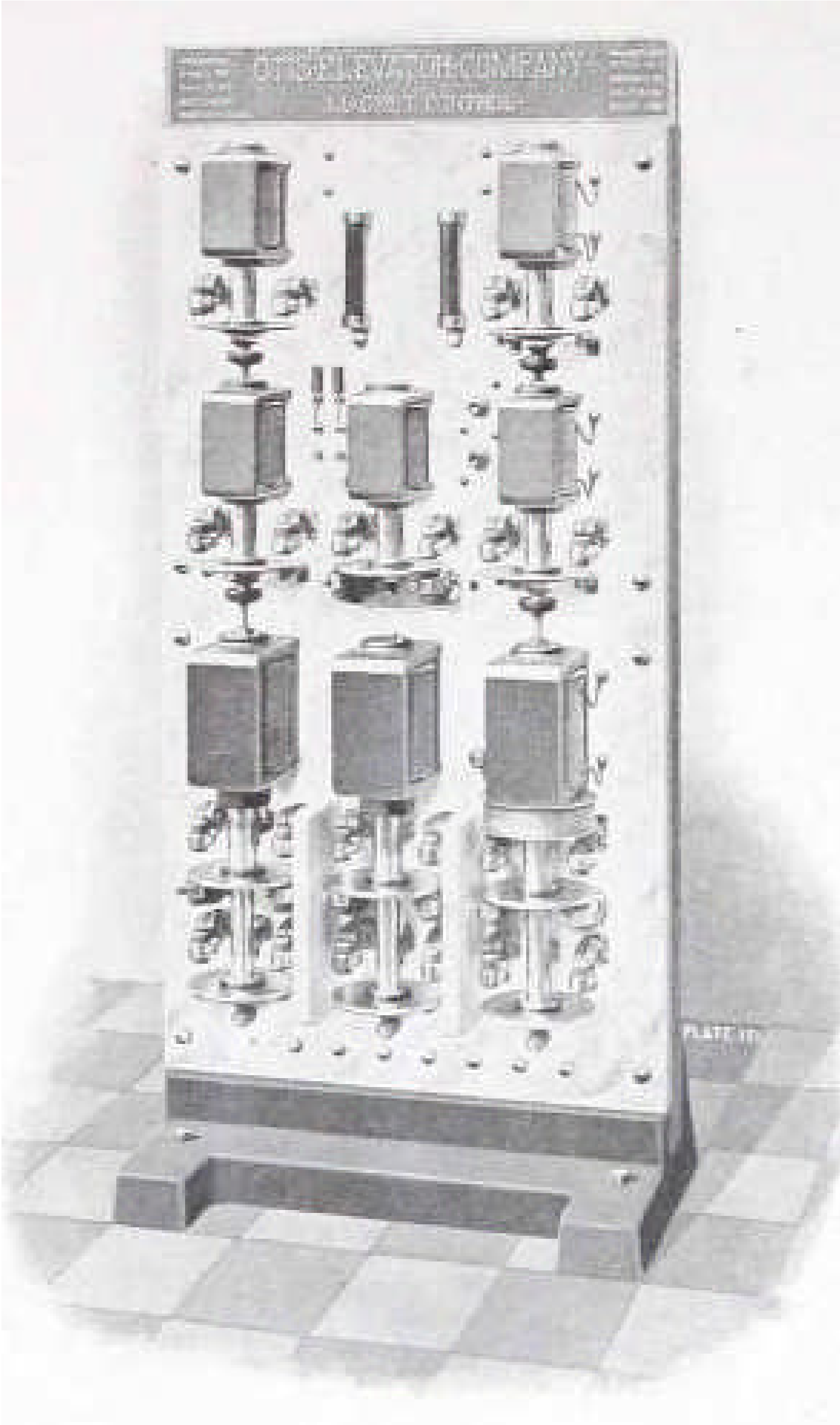
<u>Left T&B</u>: caption: "Otis Lever Control"


ELEVATOR
COMPANY.
PATENTED.

OTIS ELEVATOR
COMPANY.
PATENTED.

OTIS ELEVATOR
COMPANY.
PATENTED.


OTIS ELEVATOR
PATENTED
DATES ON MACHINE
COMPANY

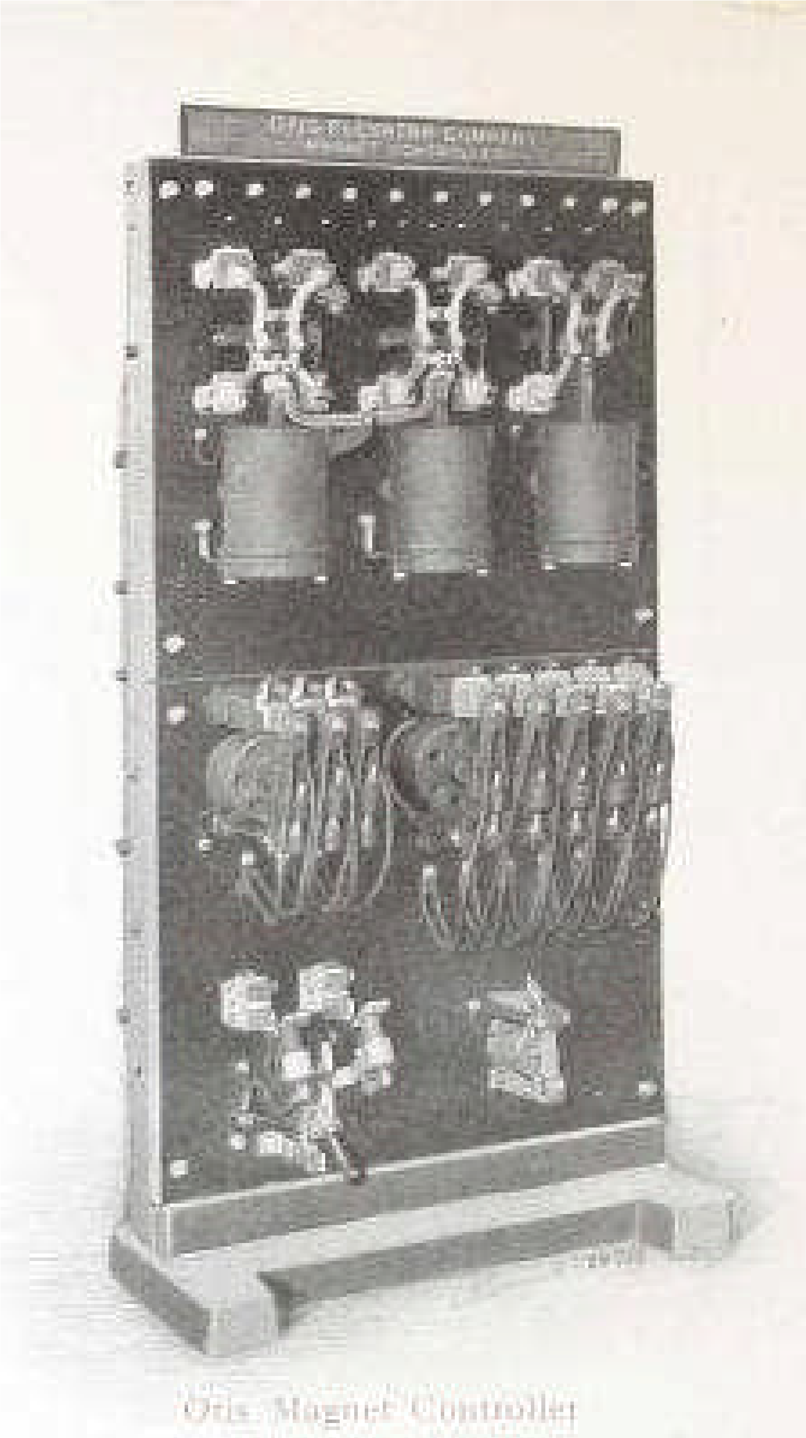
Magnet Control



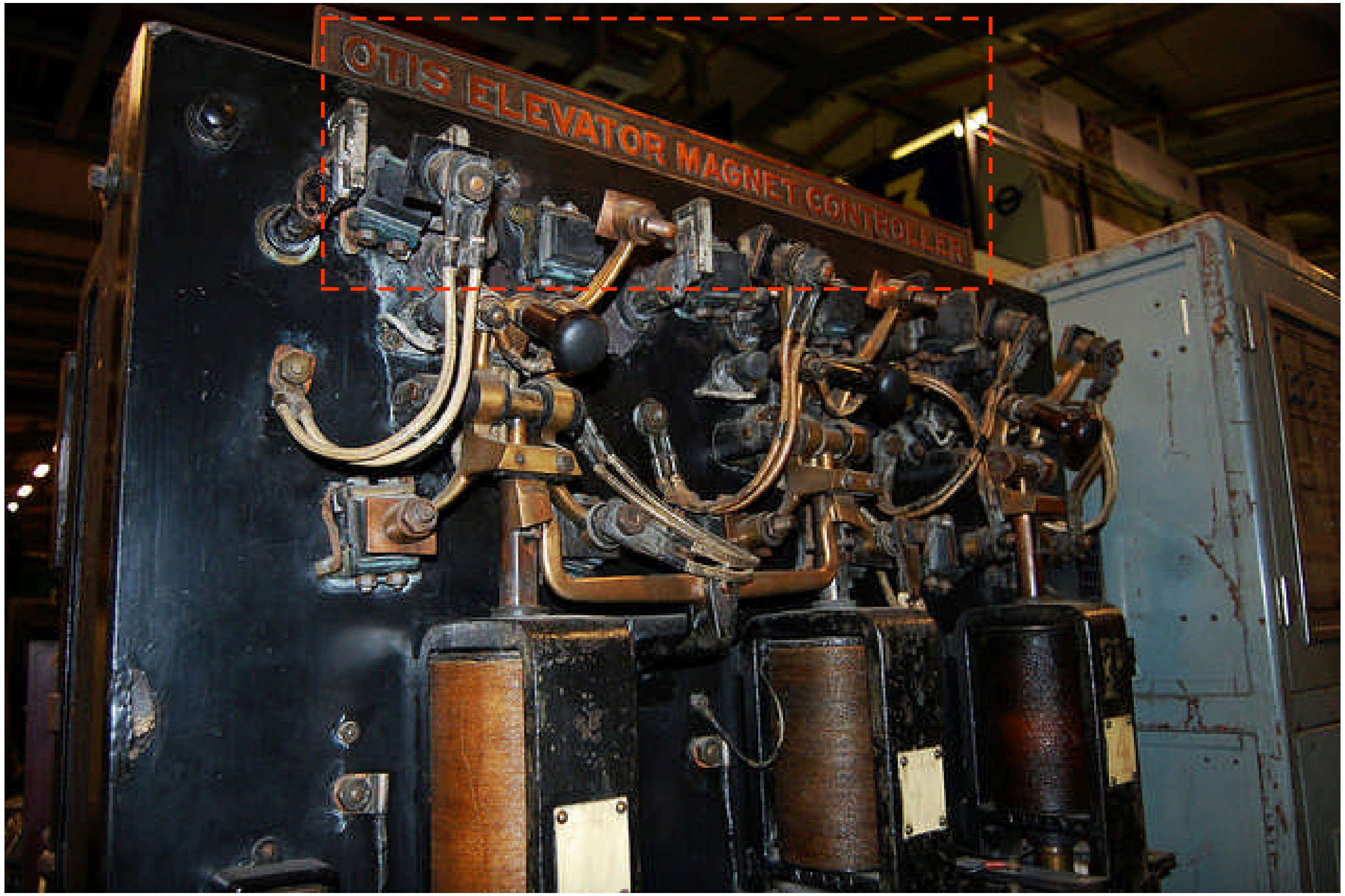
"…The Otis Electric Magnet Control, with Lever Car Switch, is the most improved type of electric elevator operating device, as with it the current is automatically and gradually admitted to the motor, enabling the operator to start and stop the car without shock or jar. This controlling device is constructed to secure the motor against damage by any overload or excess of current; these features are automatic in their operation, are independent of the operator in the car, and are designed to prevent more current being admitted to the motor than is required to do the maximum work of the elevator…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1900)

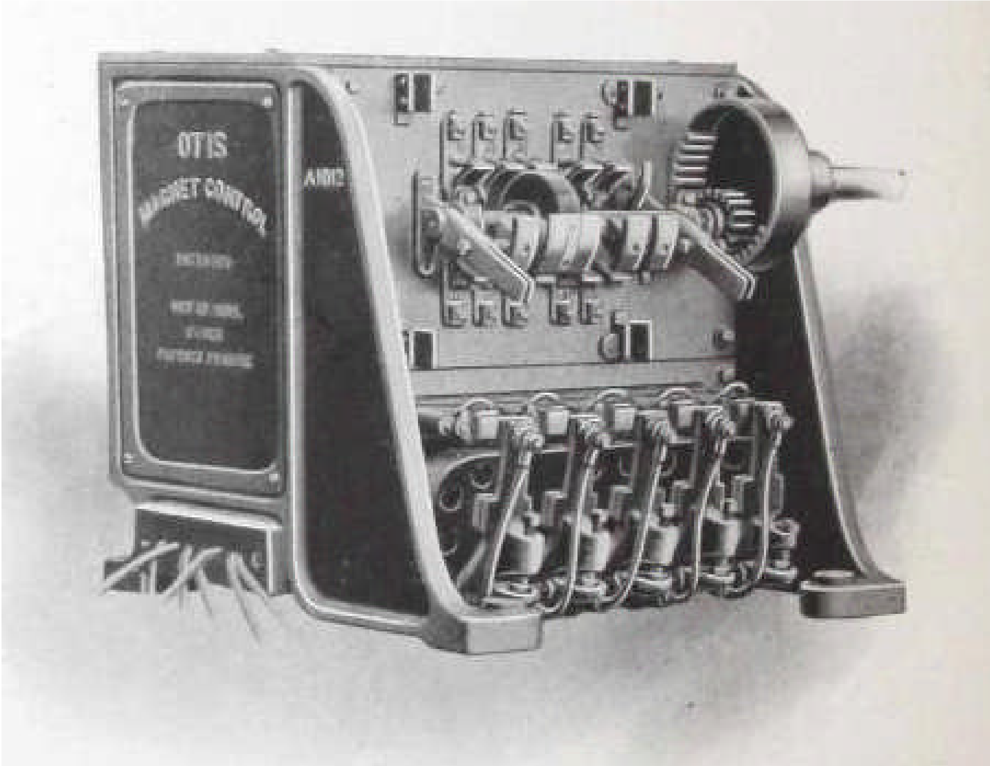
<u>Left</u>: caption: "The figure shows the apparatus used in conjunction with the electrical system of control. The contacts are of liberal proportions and every part is built in the most substantial manner."

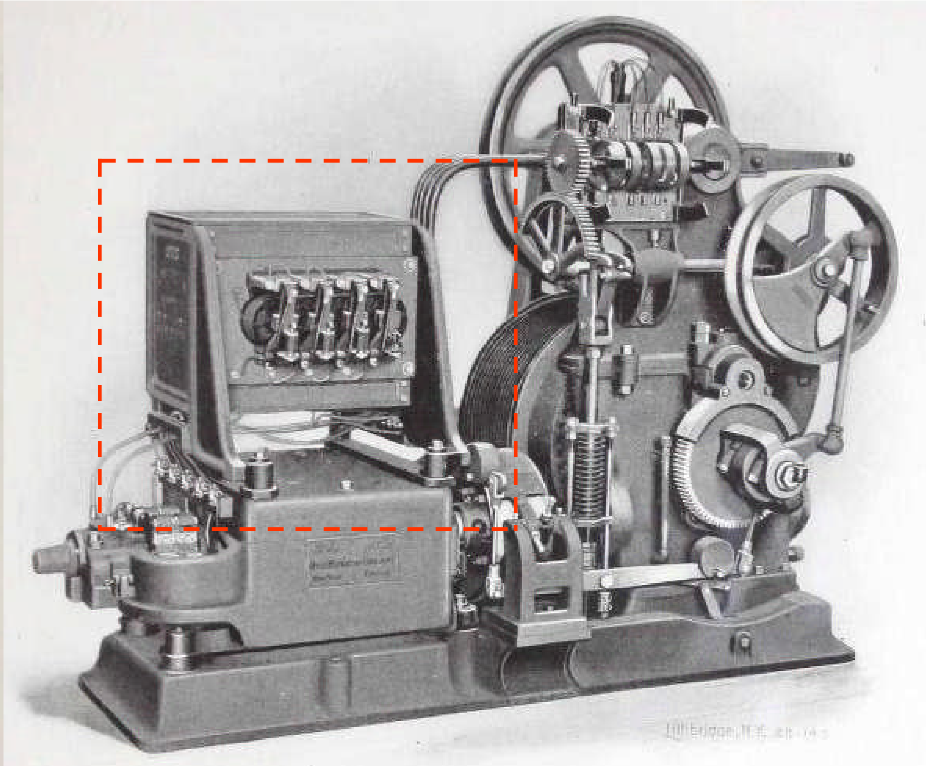


<u>Left</u>: caption: “Otis Magnet Controller”
<u>Above</u>: caption: “Otis A.C. Magnet Controller”


OTIS ELEVATOR MAGNET CONTROLLER

Semi-Magnet Control





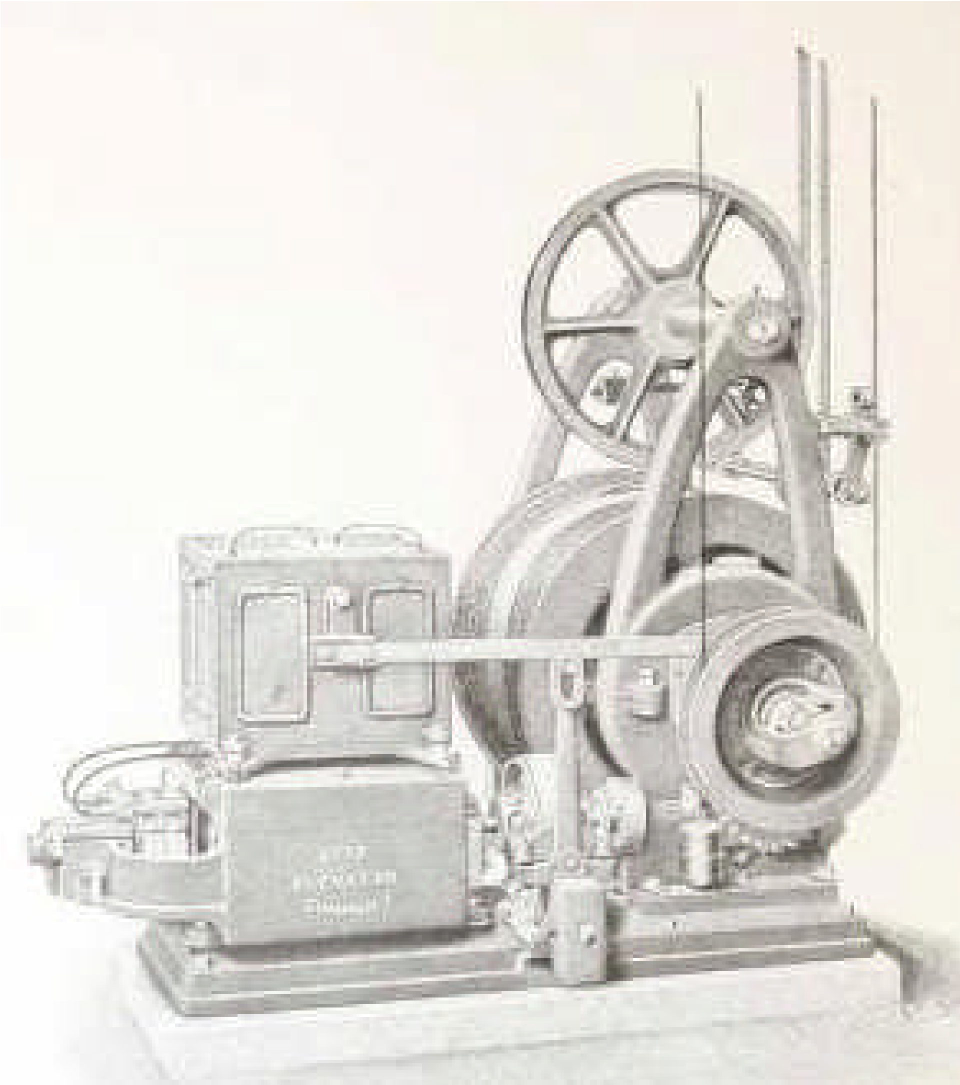
"…The Semi-Magnet Control differs from the full-magnet system in that the line switch is opened and closed mechanically through the medium of a hand wheel, lever or hand rope in the car. Closing the switch admits starting current to the motor and thereafter the control operates automatically in a manner similar to that already described system, the motor being fully protected against overload…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

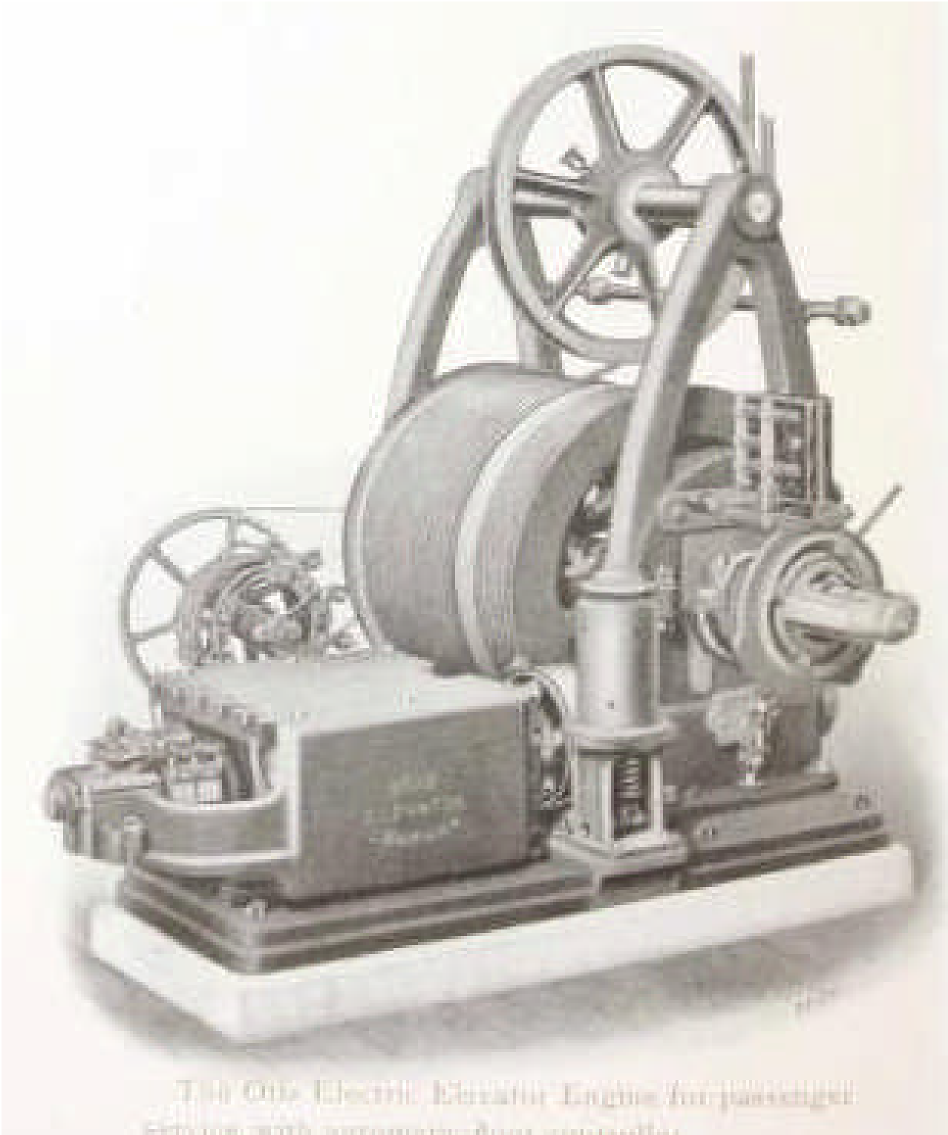
<u>Left</u>: caption: "In the Figure is shown the apparatus for mechanical control. The main line or reversing switch shown in the upper part of the illustration is operated mechanically and the smaller switches below, which cut-out the starting resistance, are operated by magnets as in the larger controller."

<u>Right</u>: caption: "Otis Direct-Controlled, Internal-Geared Electric Freight Elevator Engine with Semi-Magnet Control"

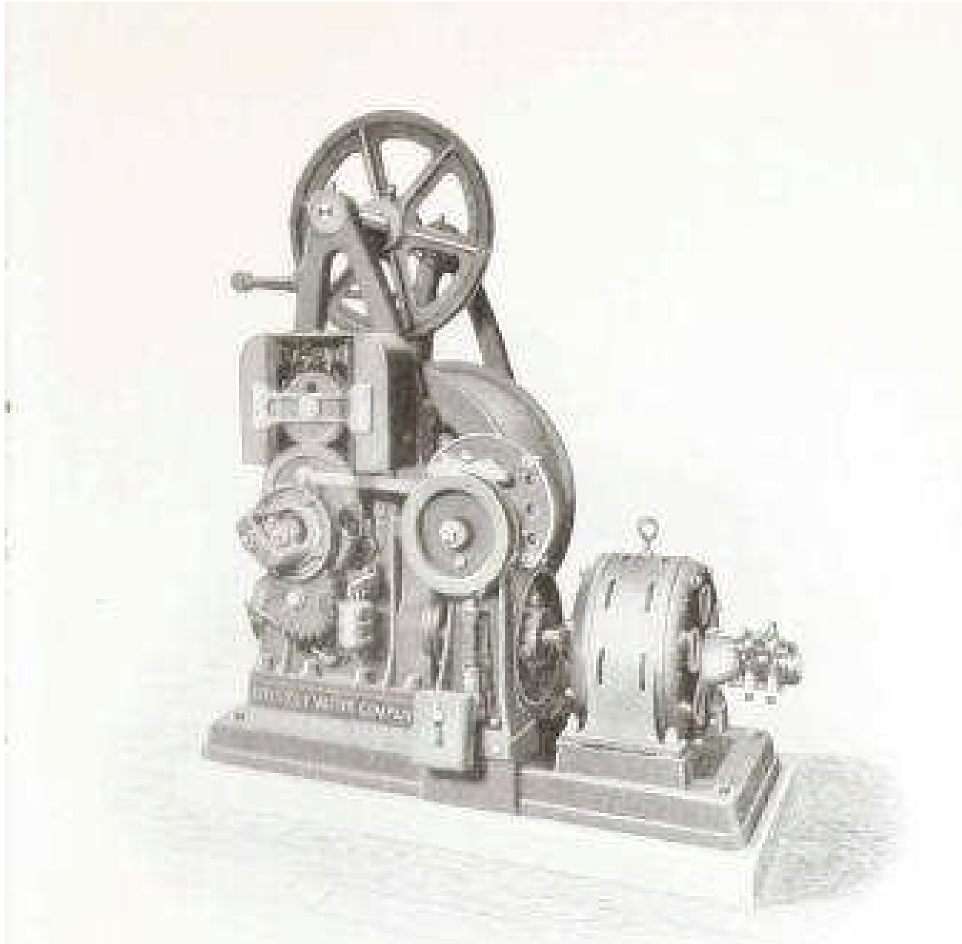
Electric Hoisting Engines



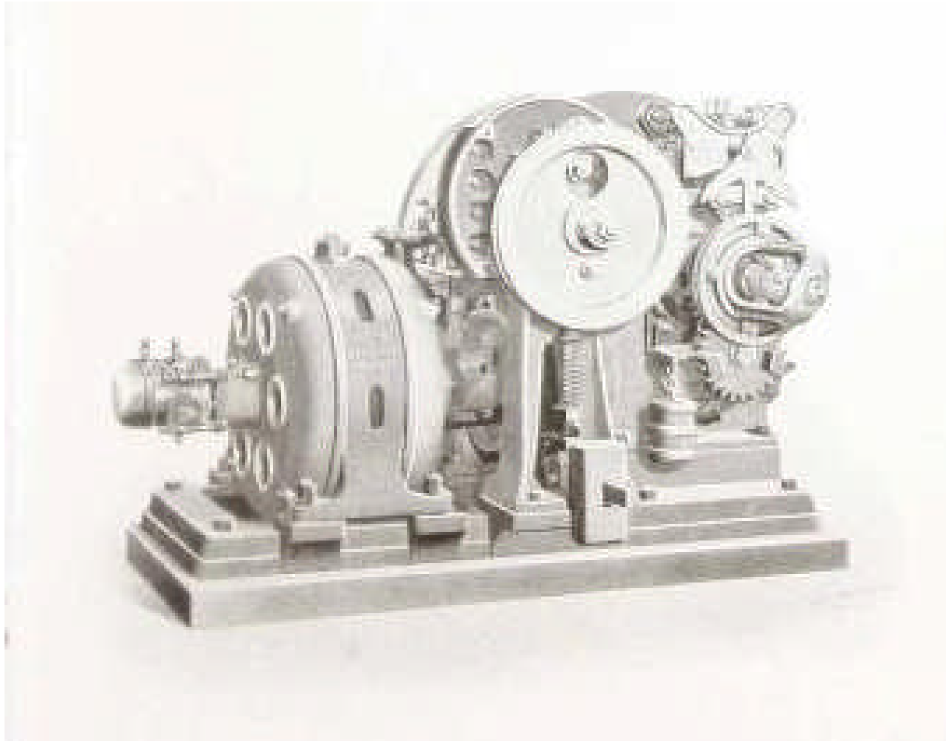
<u>Left</u>: caption: “The Otis Electric Elevator Engine for passenger or freight service, with hand cable or other mechanical control”



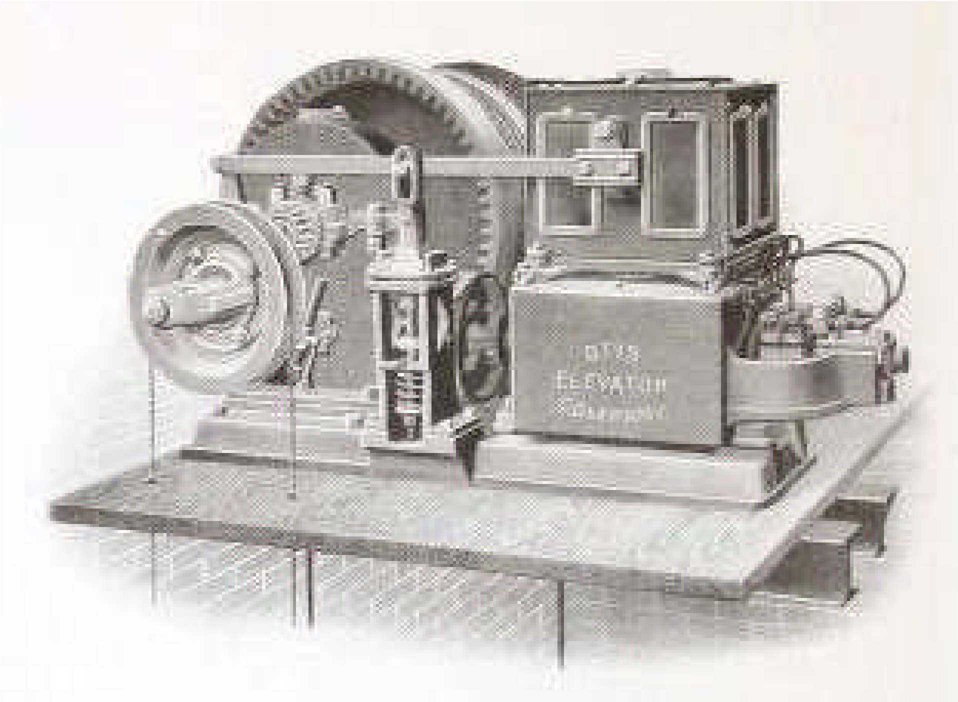
<u>Left</u>: caption: “The Otis Electric Elevator Engine for passenger service, with automatic floor controller”



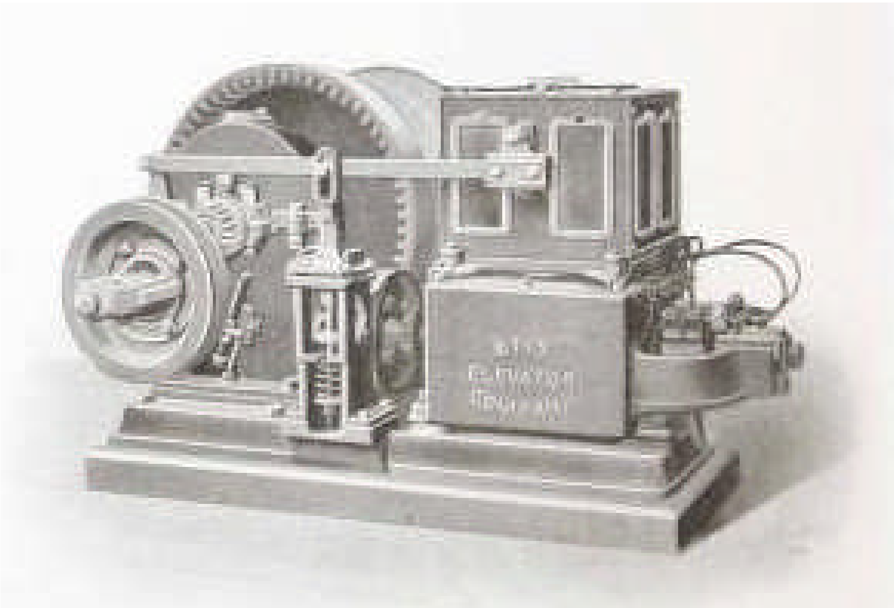
<u>Left</u>: caption: "The Otis Electric Elevator Engine for passenger or freight service, with alternating current motor. Controlled by hand cable, mechanical or electrical device."



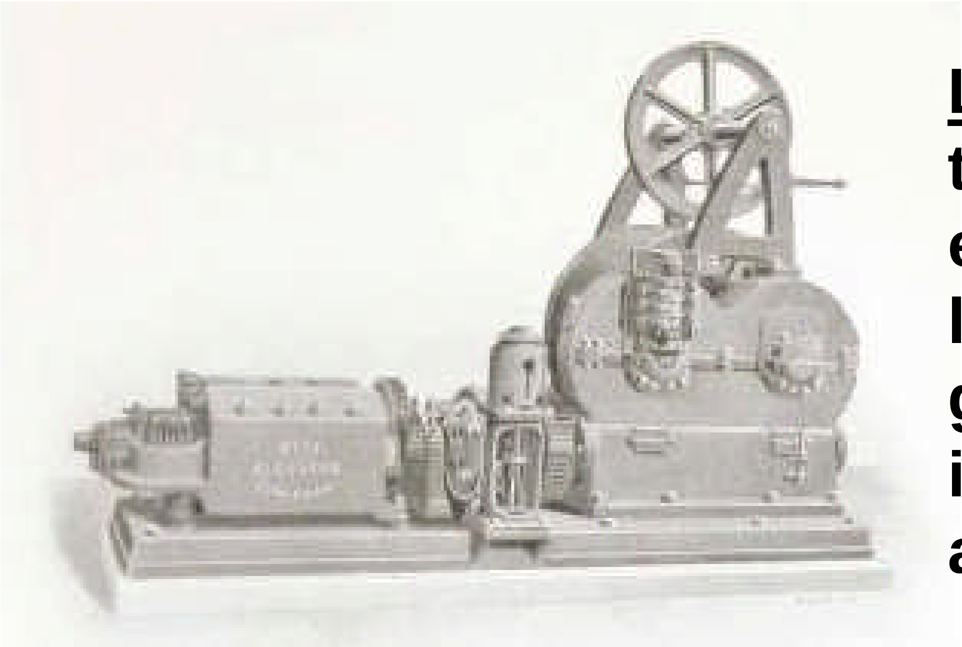
Left: caption: “The Otis Electric Elevator Engine for passenger or freight service, with alternating current motor. Controlled by hand cable or mechanical device.”



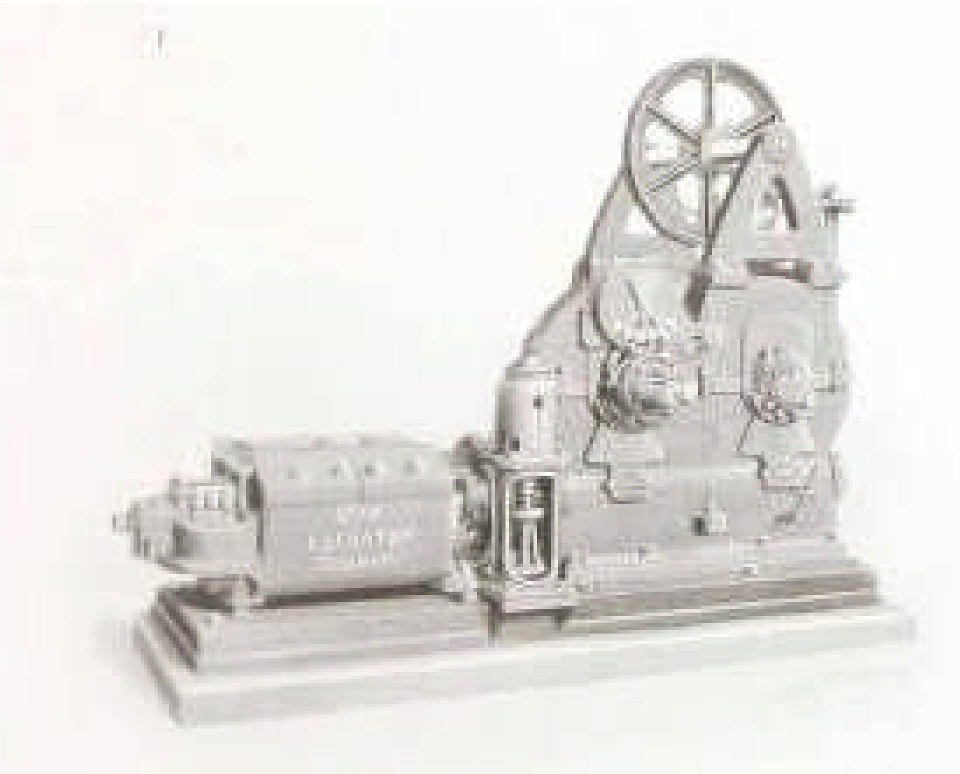
Left: caption: “The Otis Electric Elevator Engine (internal gear) for freight service. Built for placing over the hatchway. With hand cable or other mechanical control.”



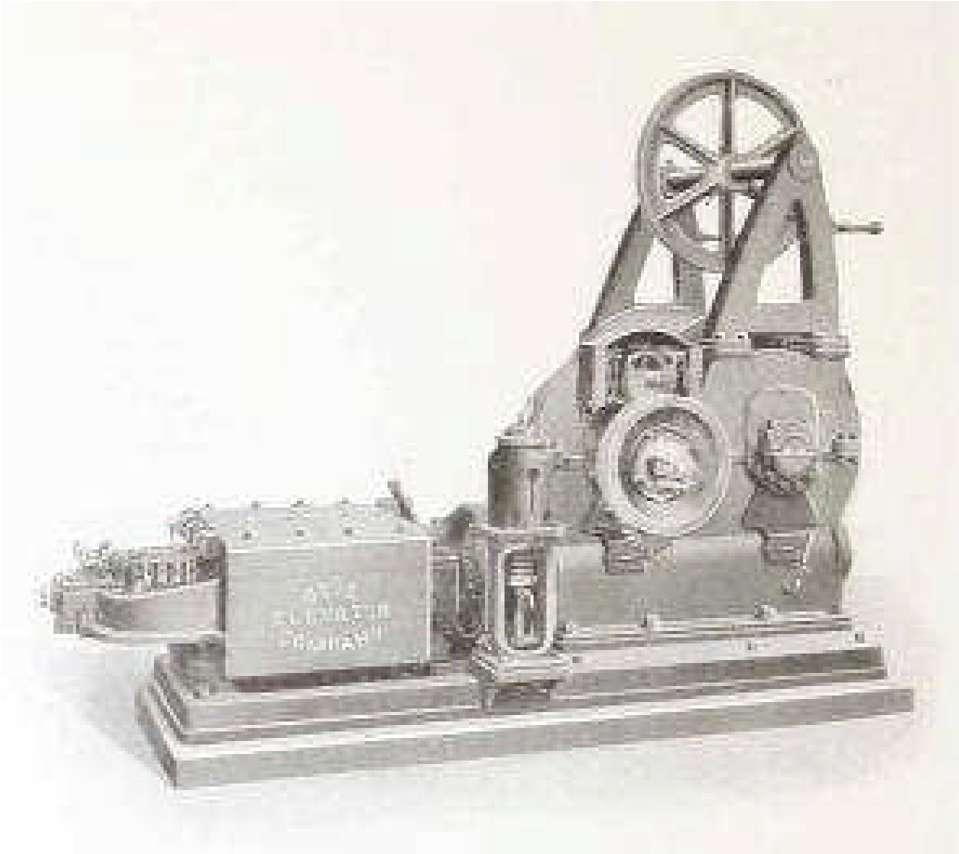
<u>Left</u>: caption: **"The Otis Electric Elevator Engine (internal gear) for freight service. Built for placing over the hatchway. With hand cable or other mechanical control."**



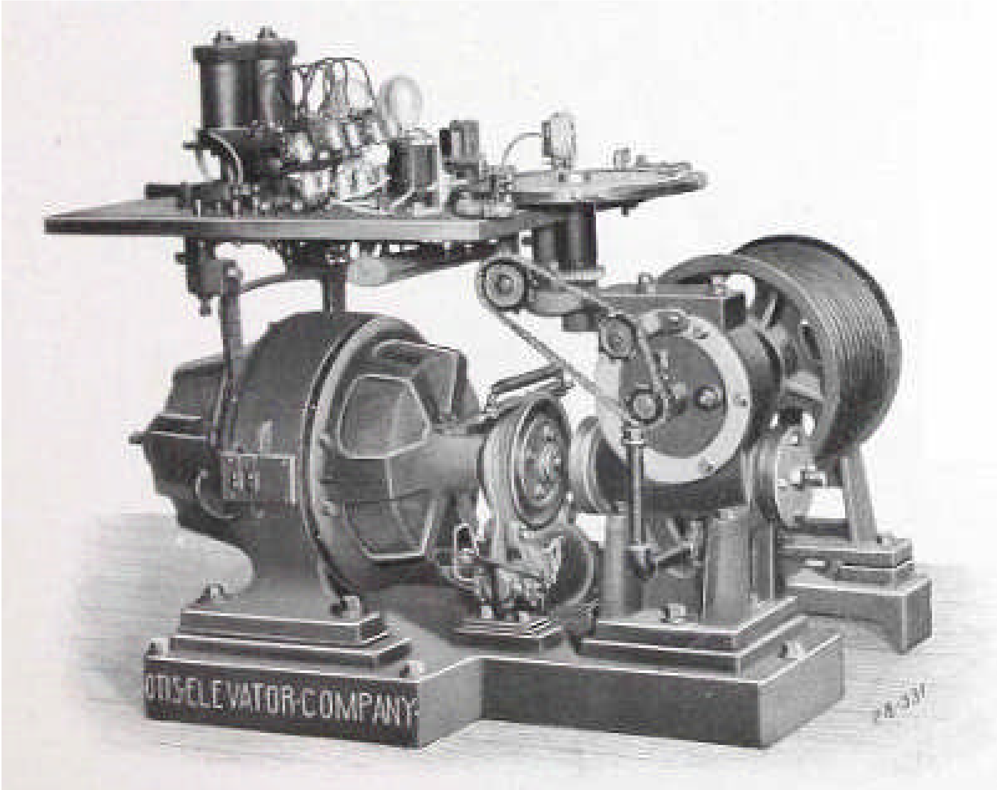
Left: caption: “The Otis Electric Elevator Engine for passenger or freight service. Duplex worm and gear. With back gear attachment for safe lifting, etc. Controlled by mechanical or electrical device.”

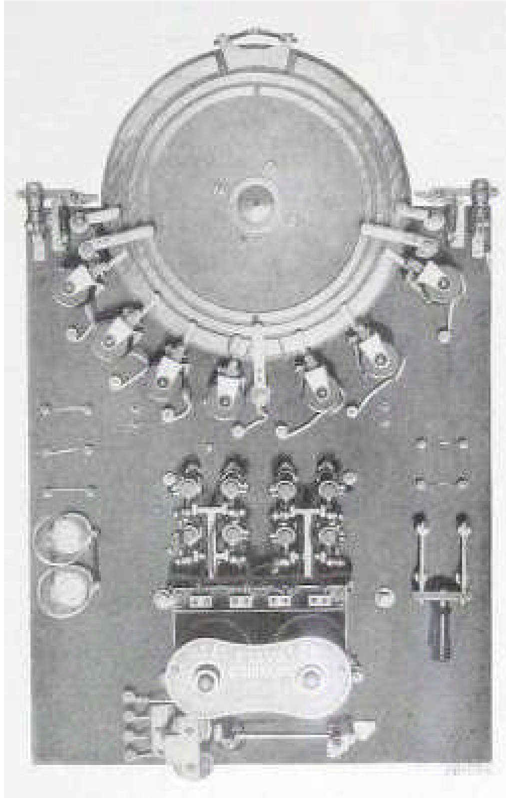


<ins>Left</ins>: caption: "The Otis Electric Elevator Engine for passenger or freight service. Duplex worm and gear. With back gear attachment for safe lifting, etc. Controlled by mechanical or electrical device."



Left: caption: “The Otis Electric Elevator Engine for passenger or freight service. Duplex worm and gear. Controlled by wheel or other mechanical device.”



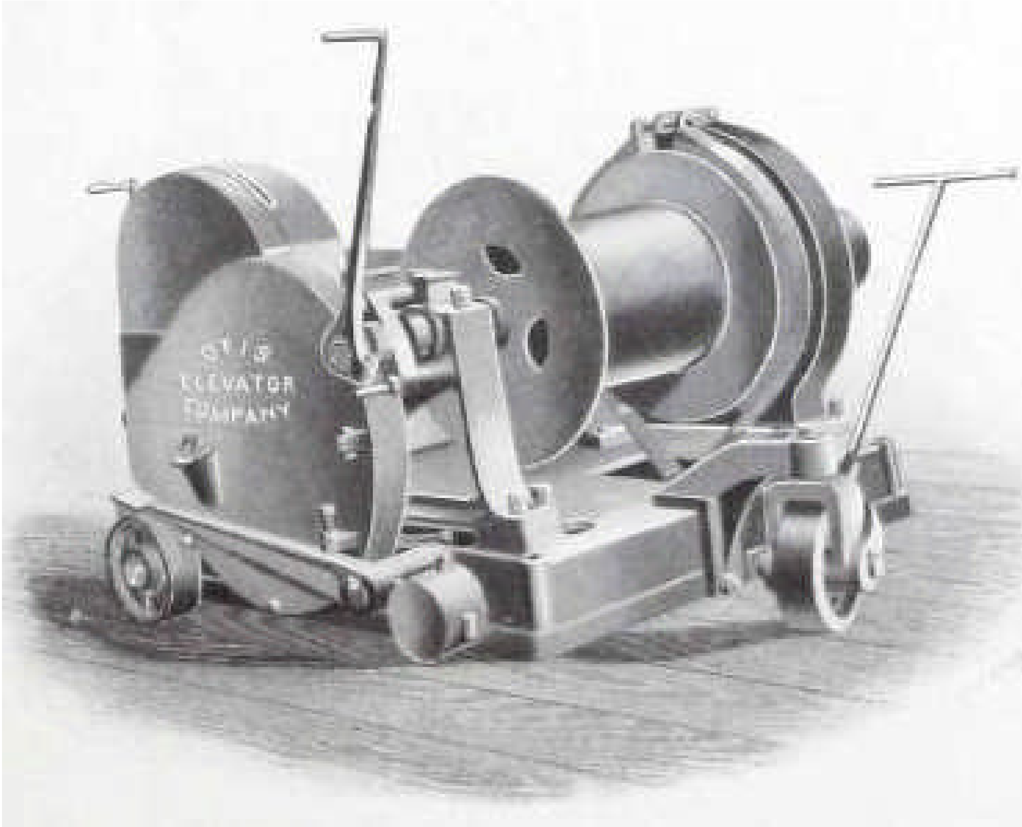


"…The Otis Electric Engine and Control Board for dumb-waiter service, shown above, may be located above or below hatchway, or in almost any convenient position. It is ordinarily built with automatic push-button control, which can be arranged to meet the requirements of any situation. We illustrate above the mechanism of the Push-button Control Board. This type of dumb-waiter has become an essential part of the equipment of high-class hotels, restaurants, hospitals, libraries, etc., in which class of buildings we have installed great numbers. These machines may also be controlled mechanically…"

RE: excerpt from an *Otis Elevator Co.* brochure (ca. 1905)

Left: caption: "Electric Dumb-waiter Engine and Switchboard"

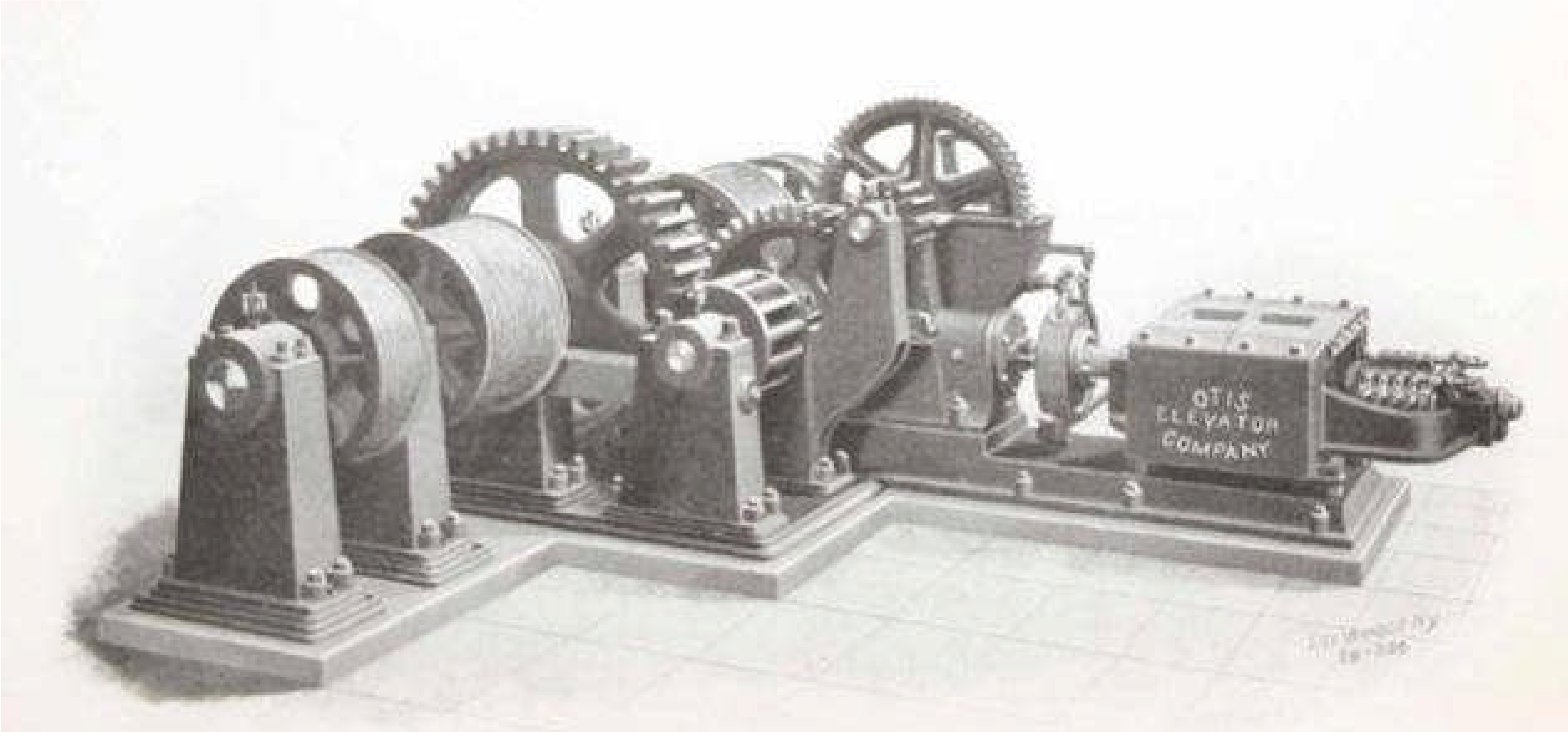
Right: caption: "Control Board"



"…The figure shows the Otis Electric Hoisting Engine but wheels can be removed and engine bolted to foundation. The 'V' clutch and powerful hand brake give perfect control of the engine in hoisting and lowering at variable speeds. The machine has been so constructed as to give the greatest economy in operation and maintenance…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

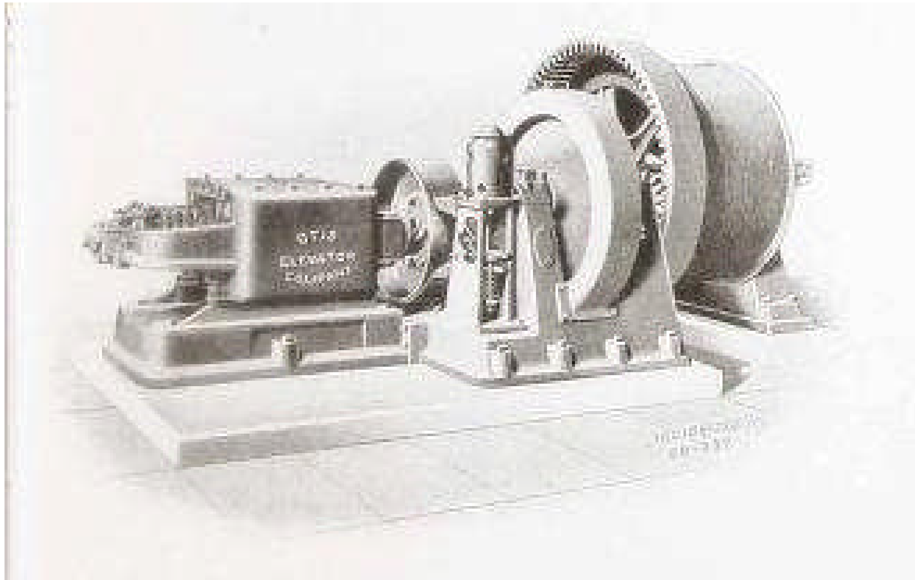
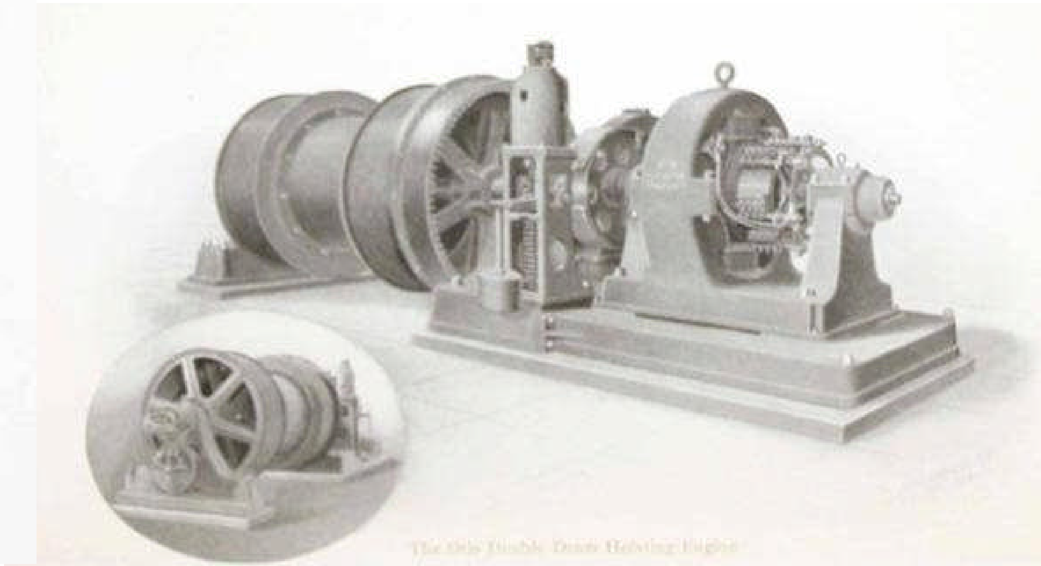
<u>Above</u>: caption: "Electric Dock Hoist"



"...The illustration above shows our new Triplex Geared Electric Hoisting Engine. The detail of the engine is so faithfully carried out in the drawing that it is hardly necessary to give a description of all its parts. While it is massive in construction, its compactness can be seen at once…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1900)

<u>Above</u>: caption: "Otis Triplex Geared Electric Hoisting Machine"

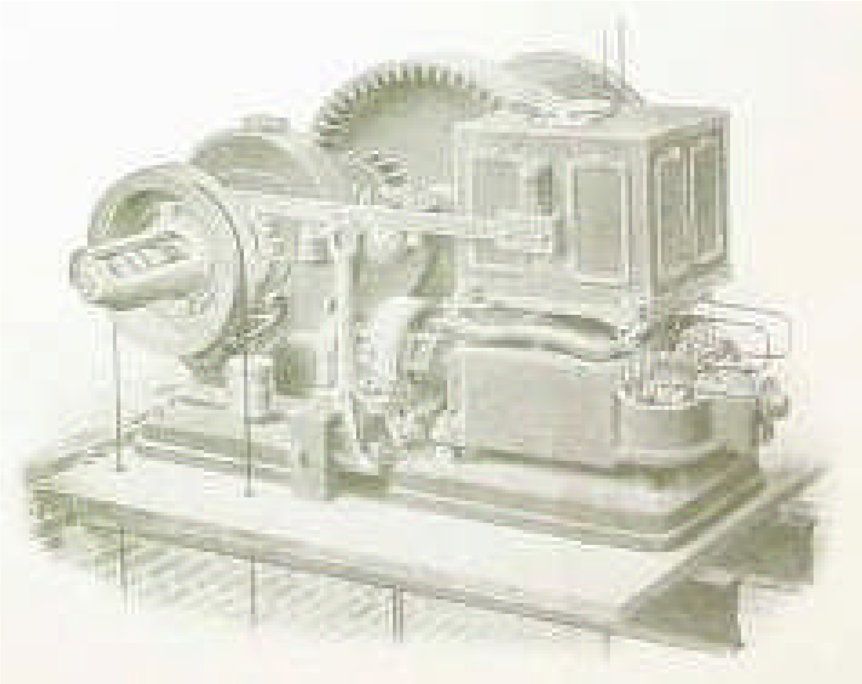
 

"...The illustration shows our Electric Hoisting Engine, designed and built for extra heavy service. We build them with single and double drums, and of lifting capacity from 4,000 to 40,000 pounds. This type of engine is specially adapted for blast furnaces, with vertical and incline hoisting, with automatic stop and slow-down motion for skip. This slow-down motion is a special feature of the Otis Electric Engine and is shown in the small drawing of the rear end of drum. The engine is also adapted for mines, inclines, warehouses, etc. The engine is operated and controlled by our reversing switch and magnet control…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1900)

Left: caption: "The Otis Single Drum Hoisting Engine"

Right: caption: "The Otis Double Drum Hoisting Engine"



"…Electric Hoisting Engines:
- ***Vertical Lift or Incline Charging***
- ***Hoists for Mines, etc.***
- ***Electric Whip Hoists for Warehouses, Docks and Vessels…"***

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1900)

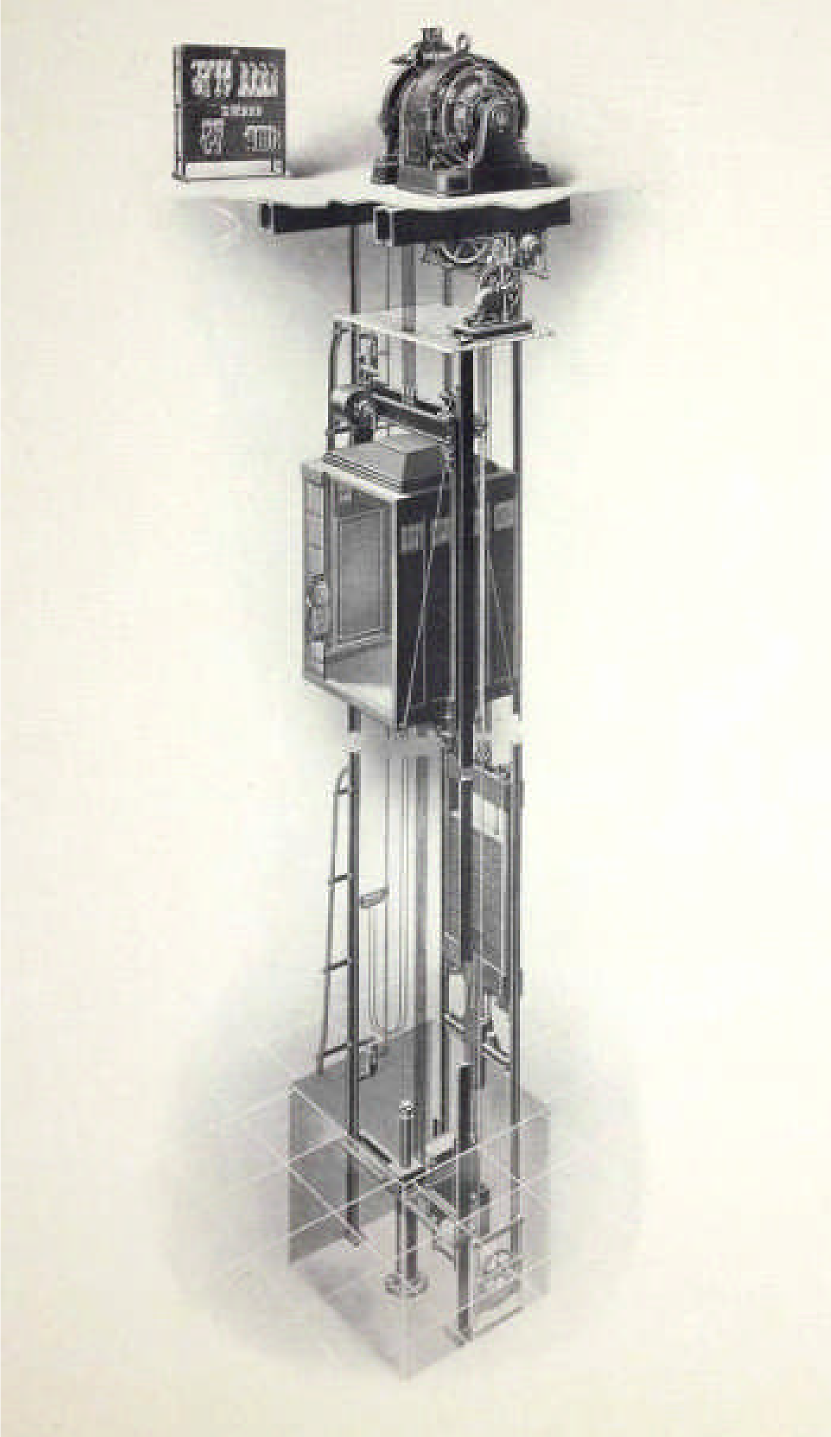
Gearless Traction Machine

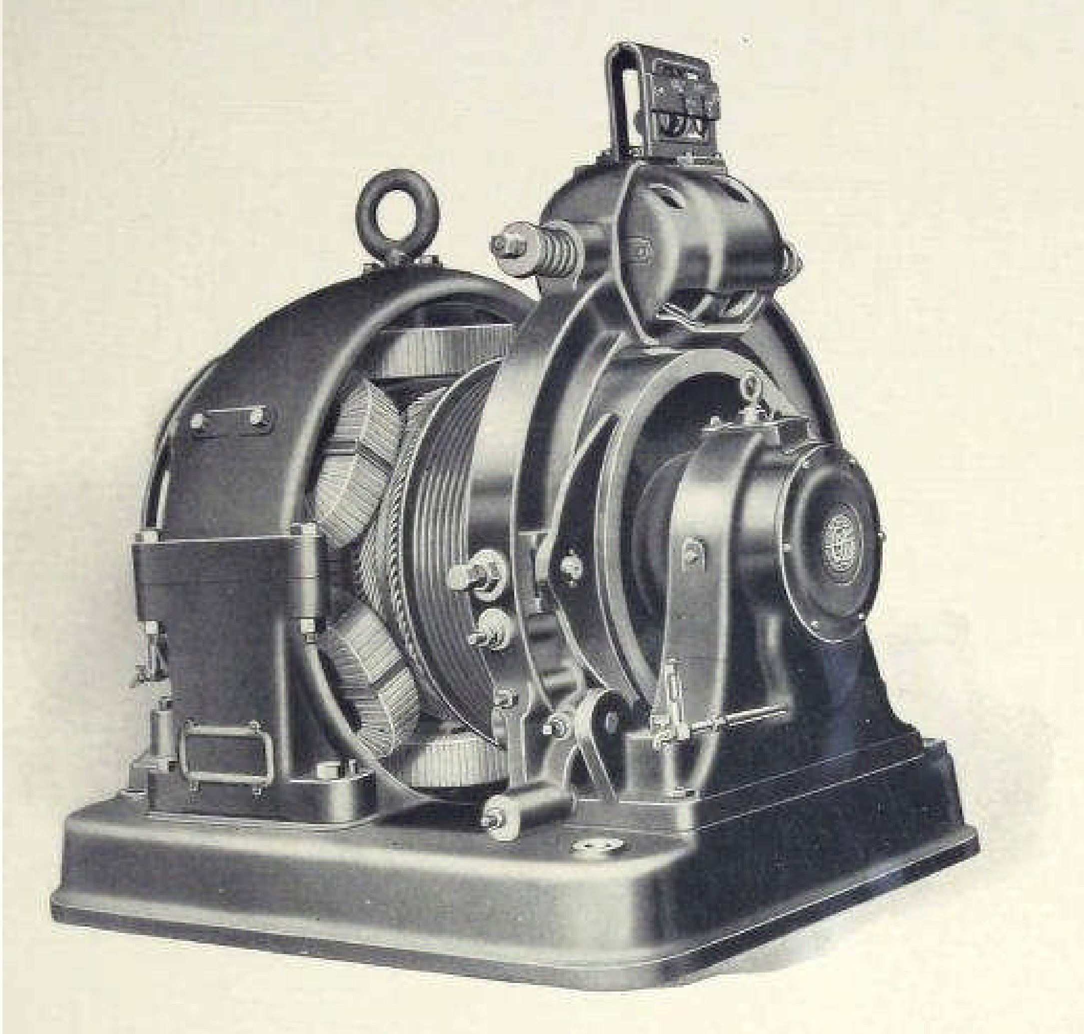
"…The Otis Gearless Traction Machine consists of traction driving sheave, extremely slow speed motor, and electric brake. In order to maintain proper alignment, all parts are mounted on a heavy continuous cast iron bed plate, provided with stiffening ribs. Direct drive is obtained from the armature of the main motor through a traction driving sheave, eliminating all intermediate gear reduction between the motor and the car. The traction driving sheave of large diameter is made of the best grade of semi-steel, is accurately turned, and provided with grooves of special design to maintain continually constant traction and with minimum wear on the hoisting ropes. The sheave is mounted directly on, and securely bolted to, the armature spider, which is integral with the armature shaft. The characteristics of the machine, in conjunction with the system of drive, produce exceptionally high efficiency, absence of vibration, minimum wear, and economy of operation. An inherent safety feature of the traction drive is the reduction of the tractive effort upon the bottoming of the car or counterweight, which eliminates the possibility of either of these being drawn into the overhead work…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1922)

"…All bearings are amply proportioned, provided with large bearing surfaces, and equipped with suitable means for proper lubrication. The bearings are of the self-aligning type, with babbitted linings, provided with dust covers and with chains for automatic lubrication. A spring-actuated, electrically released brake of a powerful type is provided to hold the car securely with maximum load. The brake wheel is mounted on, and bolted directly to, the armature spider. Swivel brake shoes are applied to the brake wheel simultaneously, and with equal pressure, by means of a pair of powerful helical springs. The brake magnet is designed for quick release, and is arranged with adjustable, automatically controlled, magnetic retardation, for the purpose of obtaining smooth and gradual application of the brake shoes. All exposed cast surfaces are filled and rubbed down, and have uniform semi-gloss rubber finish. The entire equipment is finished in a neat and distinctive manner…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1922)





<u>Above</u>: caption: "Otis Gearless Traction Machine"
<u>Left</u>: caption: "Otis Gearless Traction Passenger Elevator"

"…The direct current motors used with Otis Gearless Traction Machines are Otis designed and manufactured in Otis factories. These motors are designed to develop high starting torque with low starting current, to produce quiet operation, and to meet fully the exacting requirements inherently necessary for motors used with Gearless Traction Elevators. The motor is of special Otis design, and is the result of our wide experience gained in the continued development of extremely slow speed gearless traction elevator motors, and represents the highest development in the design and construction of motors used for high speed elevator service. The motor is shunt wound, multi-polar type, and provides variable speeds under the control of the operator. The motor is so designed as to produce exceptionally high efficiency; the maximum starting current is only applied with maximum load, and the maximum efficiency is obtained with average load, which is an extremely desirable feature, as elevators in regular service operate the greater part of the time with average loads. The extremely slow speed at which the motor operates results in very low kinetic energy which, together with the special features of control, produces smooth and rapid acceleration and retardation…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1922)

"…The armature is built up of thin laminations of special iron, separately pun-ched and insulated to prevent undue heating. The coils are form wound and thoroughly insulated. The armature is electrically and mechanically balanced. The armature shaft is made of cast steel hollow construction, of special design to secure uniform strength by having a large diameter where the load requires it. The shaft is cast integral with the armature spider, thus eliminating the use of keys. The design insures minimum weight consistent with the rigidity and strength required to with-stand the severe stresses to which elevator machines are subjected…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1922)

<u>Above</u>: caption: "Otis Motor for Gearless Traction Machine"

“…The commutator is made of rolled copper bars of high conductivity, thoroughly insulated, and is of exceptionally large diameter, providing an unusually large number of bars, thus resulting in perfect and sparkless commutation under all conditions of loading. The commutator is thoroughly insulated from the armature shaft, and has ample radial depth for wear. The brushes are made of a special grade of carbon, of large cross sectional area, and mounted in a series of brush holders providing collective adjustment of the brushes. The wear on the bearings and the commutator is reduced to a minimum, on account of the extremely slow speed of the armature. The field coils are form wound, thoroughly impregnated, and are easily removable The motor has a steel frame, is strongly and substantially built, and accurately machined. All parts are easily removable for replacement. All exposed cast surfaces are filled and rubbed down, and will have uniform semi-gloss rubber finish. All exposed brass and copper parts are buffed and lacquered….”

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1922)

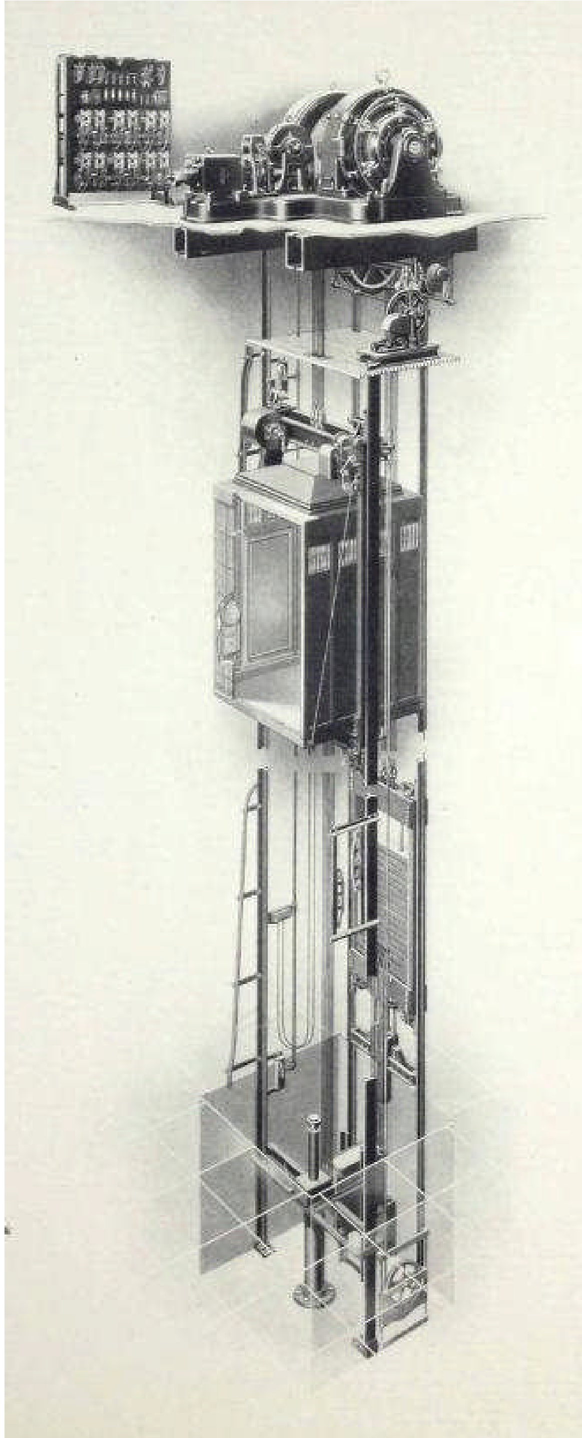
Gearless Traction Micro-Drive Machine

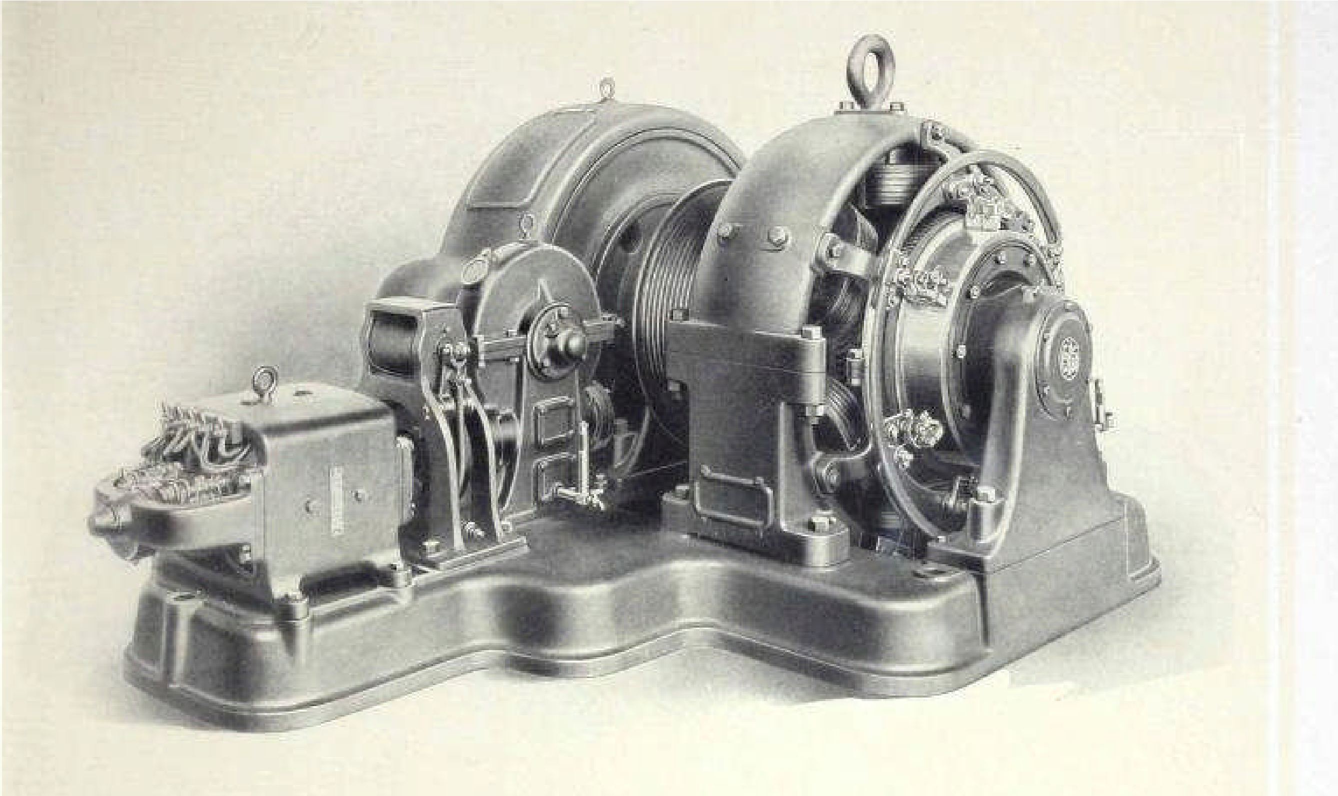
“ The Otis Gearless Traction Micro-Drive Machine consists of traction driving sheave, extremely slow speed main motor, self-leveling Micro-Drive motor, main and leveling electric brakes and auxiliary worm and gear for leveling operation. In order to maintain proper alignment, all parts are mounted on a heavy continuous cast iron bed plate, provided with stiff-ening ribs. Direct drive is obtained from the armature of the main motor through a traction driving sheave, eliminating all intermediate gear reduction between the motor and the car. The traction driving sheave of large diameter, is made of the best grade of semi-steel, is accurately turned and provided with grooves of special design to continually maintain con-stant traction and with minimum wear on the hoisting ropes. The sheave is mounted directly on, and securely bolted to, the armature spider which is integral with the armature shaft…”

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1922)

"…The characteristics of the machine, in conjunction with the system of drive, produces exceptionally high efficiency, absence of vibration, minimum wear and economy of operation. An inherent Safety Feature of the Traction Drive is the reduction of the tractive effort upon the bottoming of the car or counterweight, which eliminates the possibility of either of these being drawn into the overhead work. All bearings are amply proportioned, provided with large bearing surfaces, and with suitable means for proper lubrication. The main bearings are of the self-aligning type, with babbitted linings, provided with dust covers, and with chains for automatic lubrication. The leveling motor bearings are self-aligning, with bronze bushings. Spring actuated, electrically released brakes of a powerful type are provided to hold the car securely with maximum load. The main brake wheel is mounted on, and bolted directly to, the armature spider. Swivel brake shoes are applied to the brake wheel simultaneously, and with equal pressure by means of a pair of powerful helical springs. The main brake magnet is designed for quick release, and is arranged with adjustable, automatically controlled, magnetic retardation, for the purpose of obtaining smooth and gradual application of the brake shoes. All exposed cast surfaces are filled and rubbed down, and have uniform semi-gloss rubber finish. The entire equipment is finished in a neat and distinctive manner…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1922)

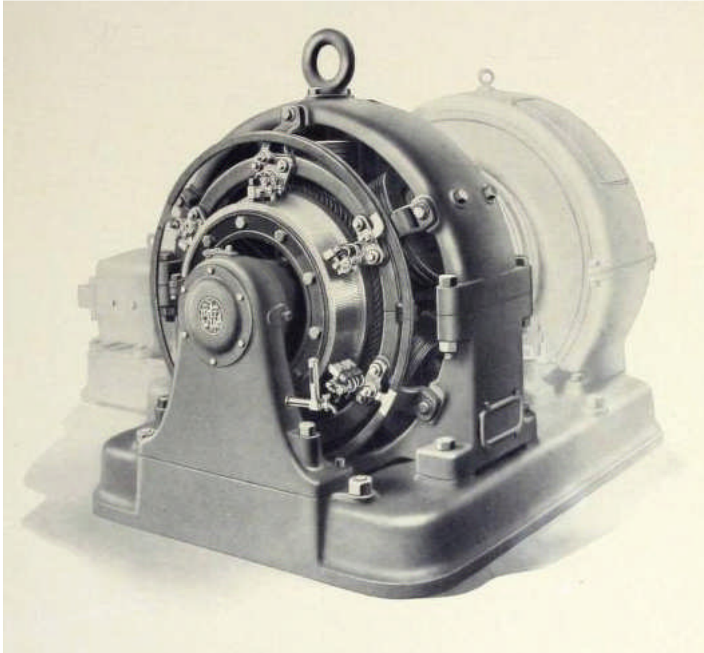




<u>Above</u>: caption: "Otis Gearless Traction Micro-Drive Machine"
<u>Left</u>: caption: "Otis Gearless Traction Micro-Drive Passenger Elevator – Multi-Voltage Control"

"…The direct current motors used with Otis Gearless Traction Micro-Drive Machines are Otis designed and manufactured in Otis factories. These motors are designed to develop high starting torque with low starting current, to produce quiet operation, and to meet fully the exacting requirements inherently necessary for motors used with Self-Leveling Machines. The main motor is of special Otis design, and is the result of our wide experience gained in the continued development of extremely slow speed gearless traction elevator motors, and represents the highest development in the design and construction of motors used for high speed elevator service. The main motor is shunt wound, multi-polar type, of extremely slow speed, and provides variable speeds under the control of the operator. The motor is so designed as to produce exceptionally high efficiency; the maximum starting current is only applied with maximum load, and the maximum efficiency is obtained with average load, which is an extremely desirable feature as elevators in regular service operate the greater part of the time with average loads. The extremely slow speed at which the main motor operates results in very low kinetic energy which, together with the special features of control, produces smooth and rapid acceleration and retardation…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1922)



"…The armature is built up of thin laminations of special iron, separately punched and insulated to prevent undue heating. The coils are form wound and thoroughly insulated. The armature is electrically and mechanically balanced. The armature shaft is made of cast steel, hollow construction, of special design to secure uniform strength by having a large diameter where the load requires it. The shaft is cast integral with the armature spider, thus eliminating the use of keys. The design insures minimum weight consistent with the rigidity and strength required to withstand the severe stresses to which elevator machines are subjected…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1922)

Above: caption: "Otis Motor for Gearless Traction Micro-Drive Machine"

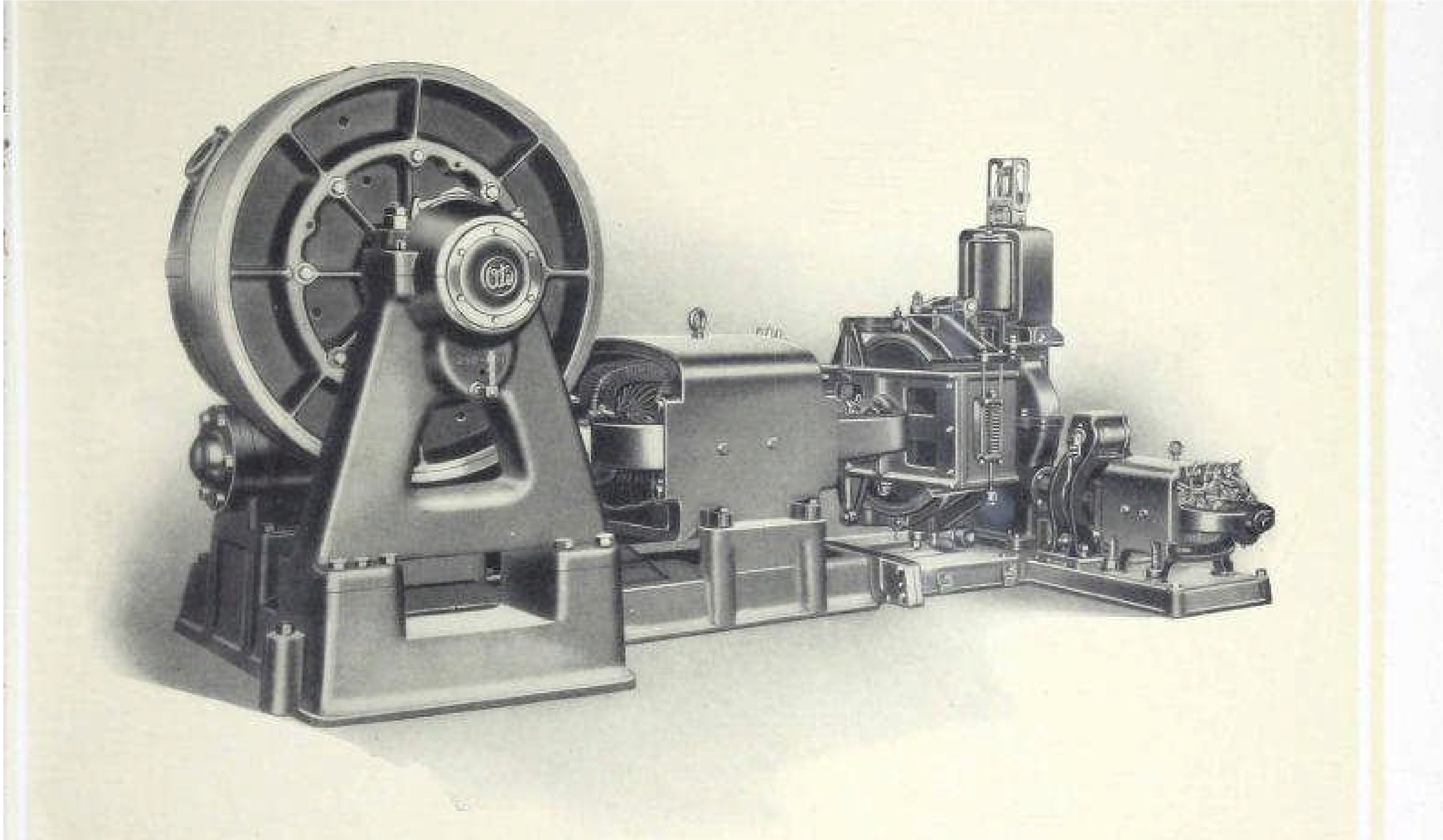
"…The commutator is made of rolled copper bars of high conductivity, thoroughly insulated, and is of exceptionally large diameter providing an unusually large number of bars, thus resulting in perfect and sparkless commutation under all conditions of loading. The commutator is thoroughly insulated from the armature shaft, and has ample radial depth for wear. The brushes are made of a special grade of carbon, of large cross sectional area, and mounted in a series of brush holders providing collective adjustment of the brushes. The wear on the bearings and the commutator is reduced to a minimum, due to the extremely slow speed of the armature. The field coils are form wound, thoroughly impregnated and are easily removable. The leveling motor is of Otis design, Micro-Drive type, compound wound, equipped with self-aligning bearings and especially designed for smooth and rapid acceleration and retardation as required for motors used with Self-Leveling Machines. The motors have steel frames, are strongly and substantially built, and accurately machined. All parts are easily removable for replacement. All exposed cast surfaces are filled and rubbed down, and will have uniform semi-gloss rubber finish. All exposed brass and copper parts are buffed and lacquered…"

RE: excerpt from *Otis Elevator Company* brochure (ca. 1922)

Single Wrap Traction Machine

"…The Single Wrap Traction Type of machine consists of traction driving sheave, worm and gear, oil tight housing, electric brake and motor. In order to maintain proper alignment all parts are mounted on a heavy continuous cast iron bed plate, provided with stiffening ribs. The Traction Driving Sheave is made of semi-steel, the cables passing around the sheave in machined grooves specially designed to obtain proper traction, and with minimum wear on the hoisting ropes. The sheave is mounted between bearings on a solid forged steel shaft and is driven directly from the worm gear through a spider, which is securely bolted to both the worm gear and sheave, thereby relieving the shaft of torsional stresses. The Worm Gear is made of a special grade of phosphor bronze accurately machined with hobbed teeth, designed to produce smoothness of operation, eliminate vibration and give highest possible efficiency. The worm is cut from a solid, high carbon steel forging integral with worm shaft, and is accurately cut and machined. The thrusts in both directions are taken up by special Otis designed, ball thrust bearings of the self-aligning type…"

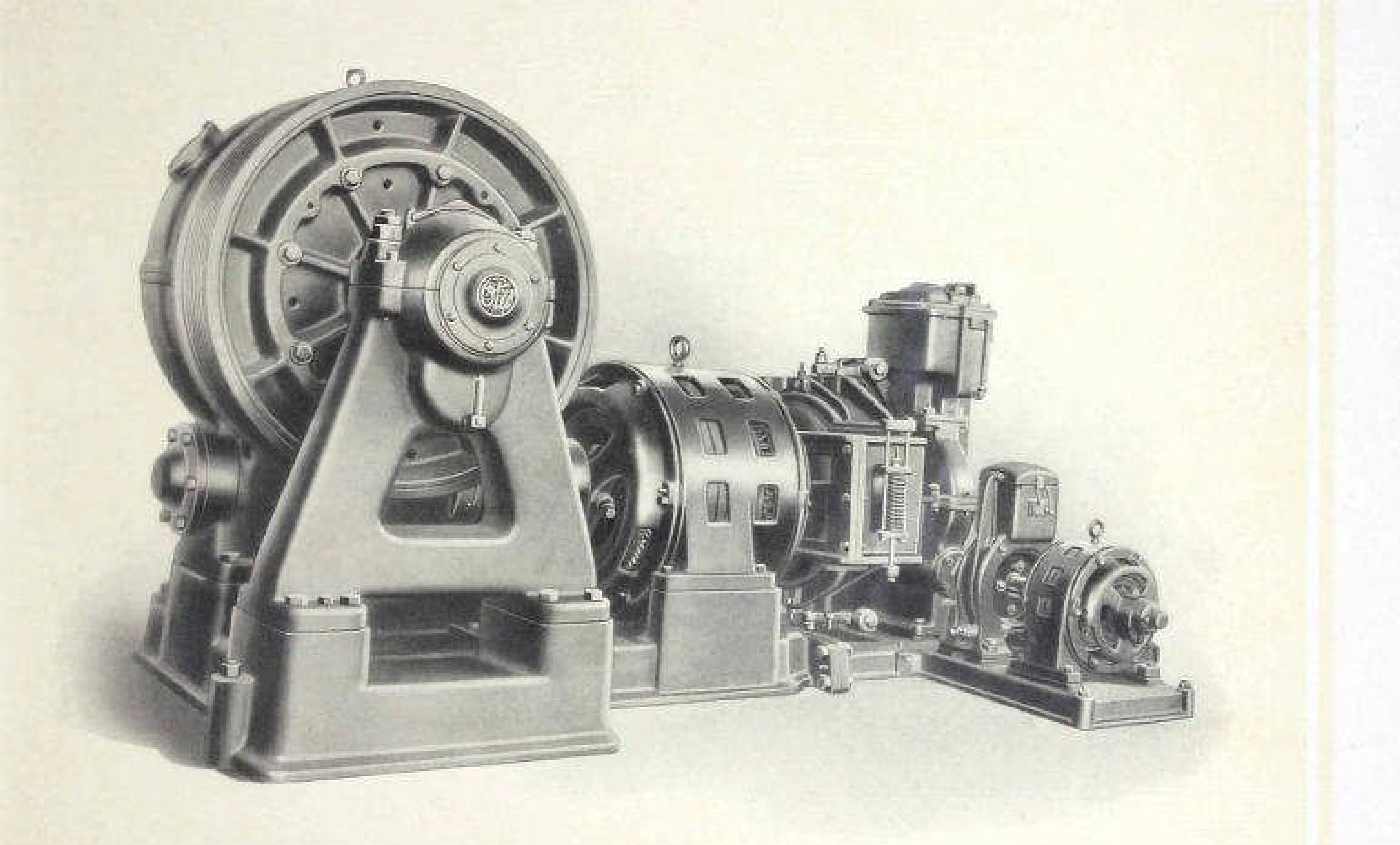
RE: excerpt from *Otis Elevator Company* brochure (ca. 1922)



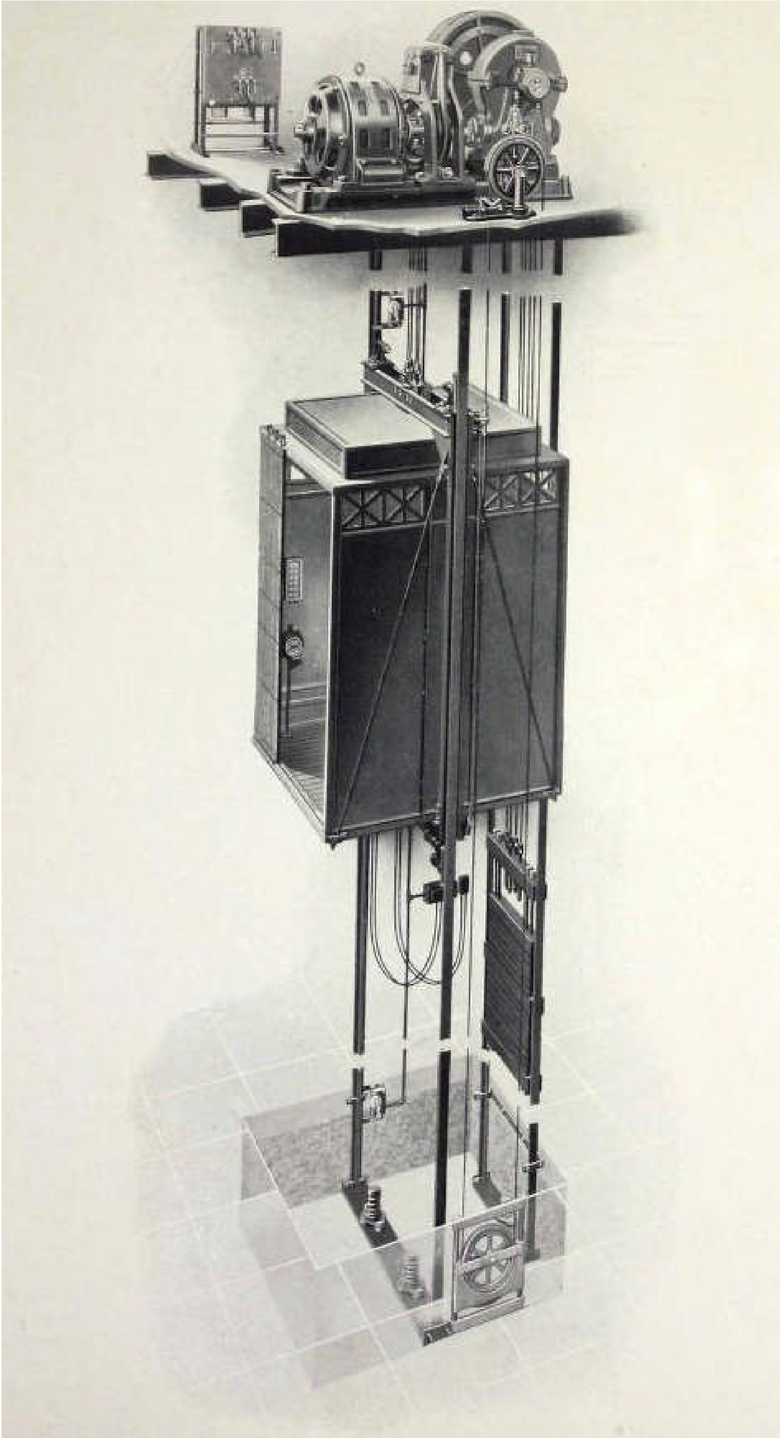
<u>Above</u>: caption: "Otis Micro-Drive Machine – Single Wrap Traction – Direct Current"

"…The Worm, Gear and Thrusts run in oil, in an oil tight housing, which is made of cast iron, strongly built to maintain perfect alignment of worm and gear, and to withstand the severe stresses to which it is subjected. Babbitted Bearings of ample size are provided for the shaft and are equipped with suitable means for lubrication. A combination coupling and brake pulley of large diameter is mounted on the worm shaft, and is provided with powerful spring actuated, electrically released brake shoes, which are applied simultaneously with equal pressure on both sides of the brake pulley. The brake is so arranged that it is automatically applied when the car is being brought to rest, or upon failure of current from any other cause. The machine, motor, controller and electric brake are Otis designed and manufactured in Otis factories. They are specially designed to function together as a unit, producing the highest possible efficiency and smoothness of operation without any appreciable vibration or undue noise. All parts are proportioned for strength, rigidity and wear, and are made interchangeable for ready replacement…"

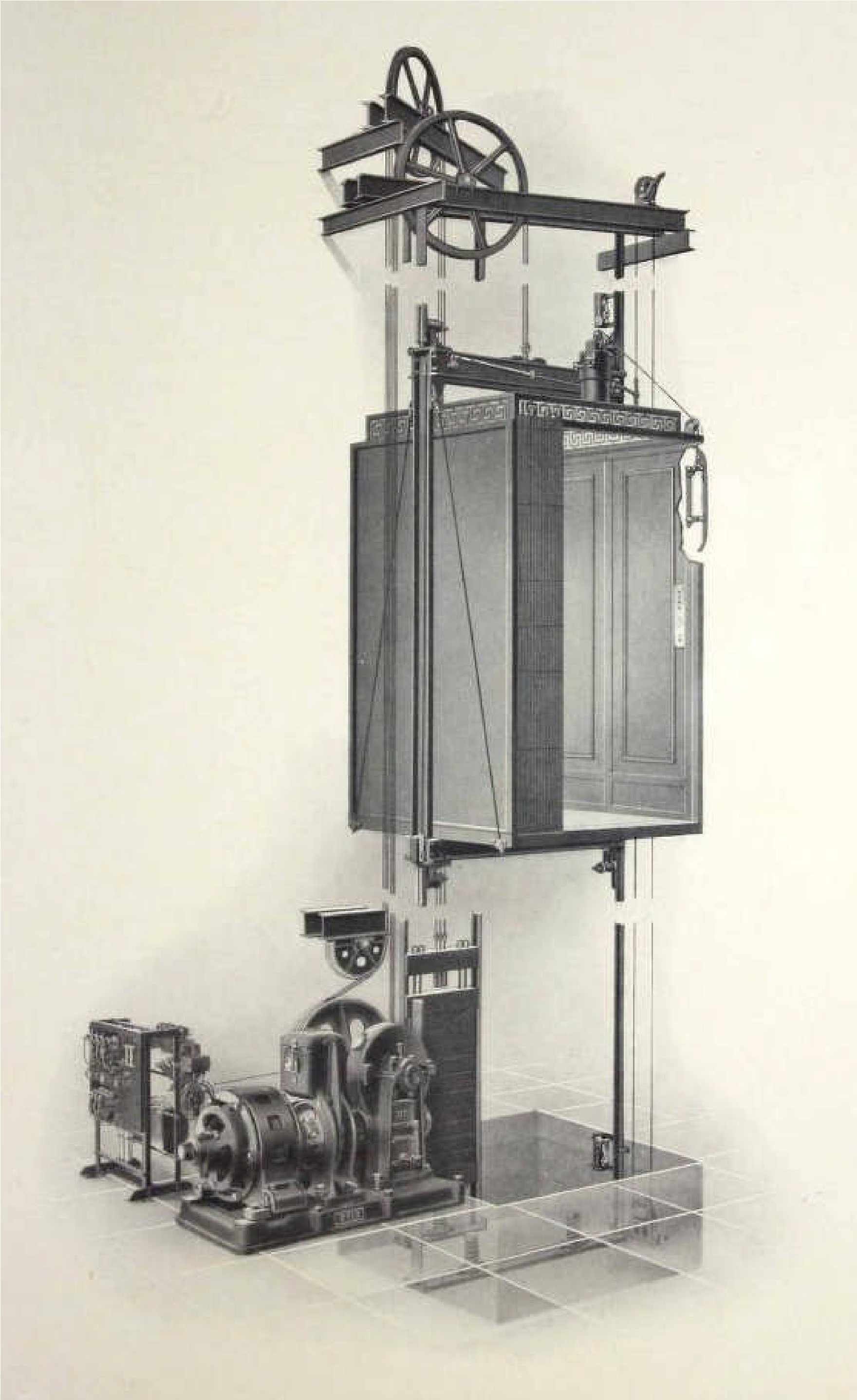
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1922)



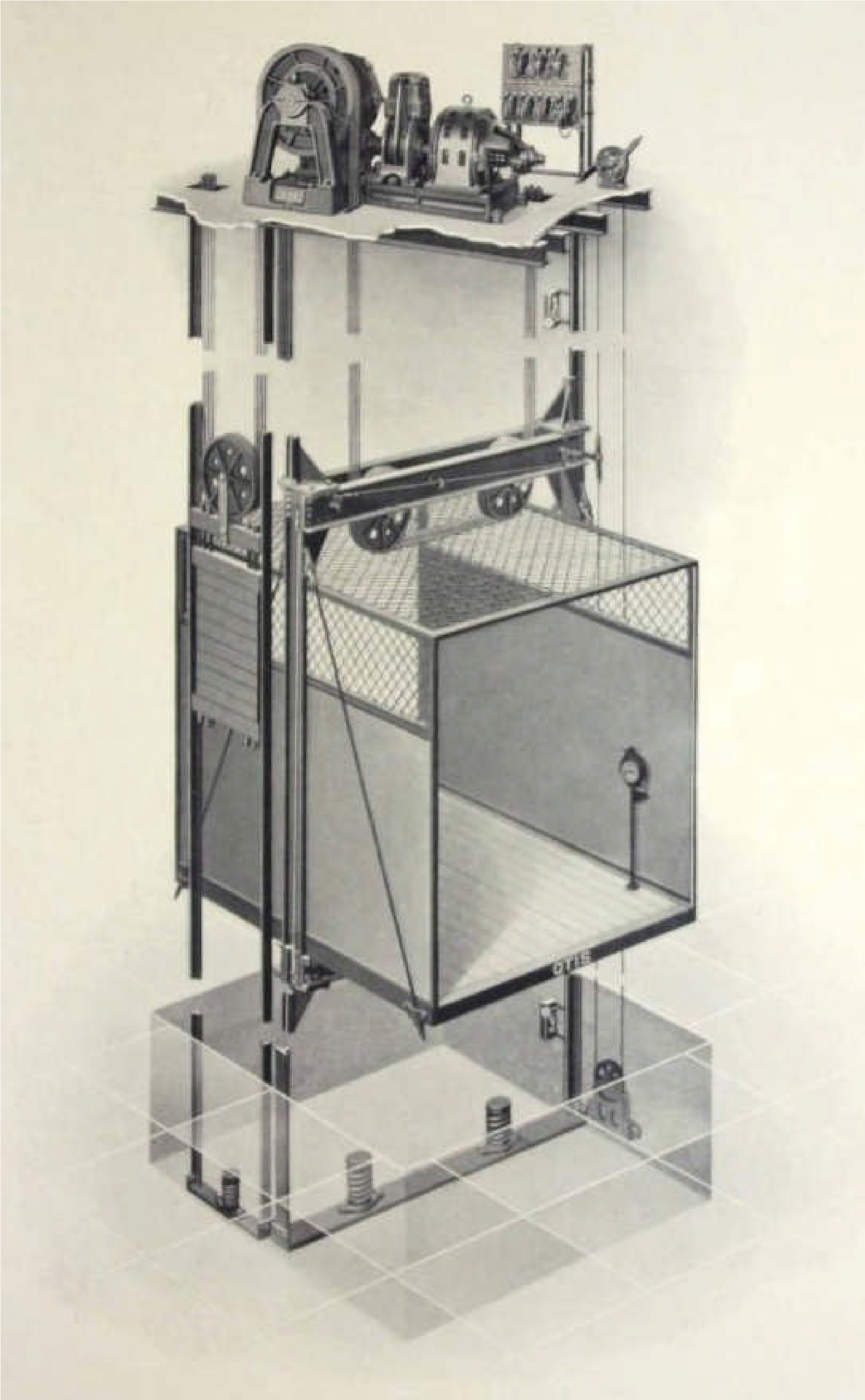
<u>Above</u>: caption: "Otis Micro-Drive Machine – Single Wrap Traction – Alternating Current"



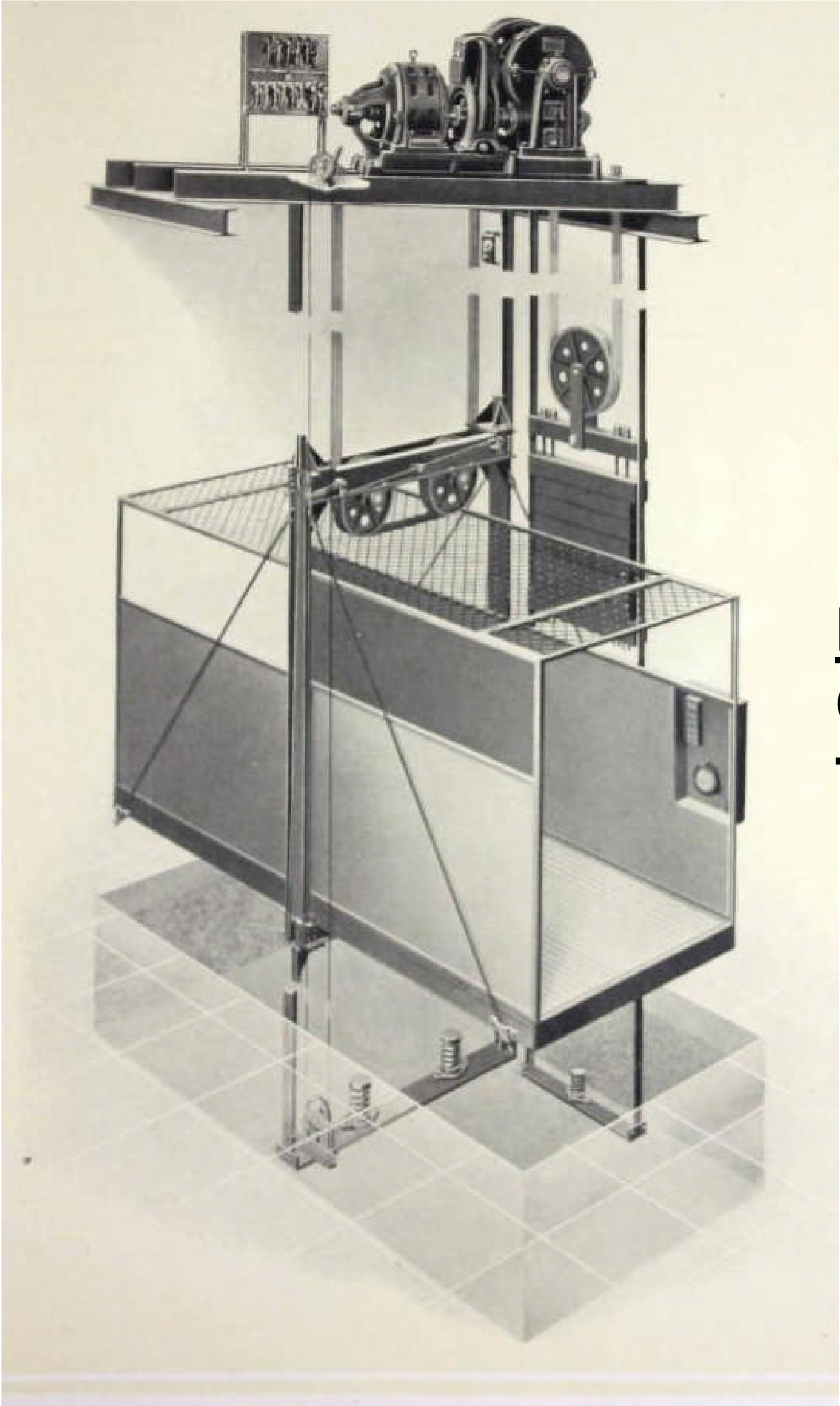
<u>Left</u>: caption: "Otis Geared Passenger Elevator – Single Wrap Traction"



<u>Left</u>: **caption: “Otis Geared Push Button Elevator – Single Wrap Traction”**



<u>**Left**</u>**: caption: "Otis Geared Freight Elevator – Single Wrap Traction"**



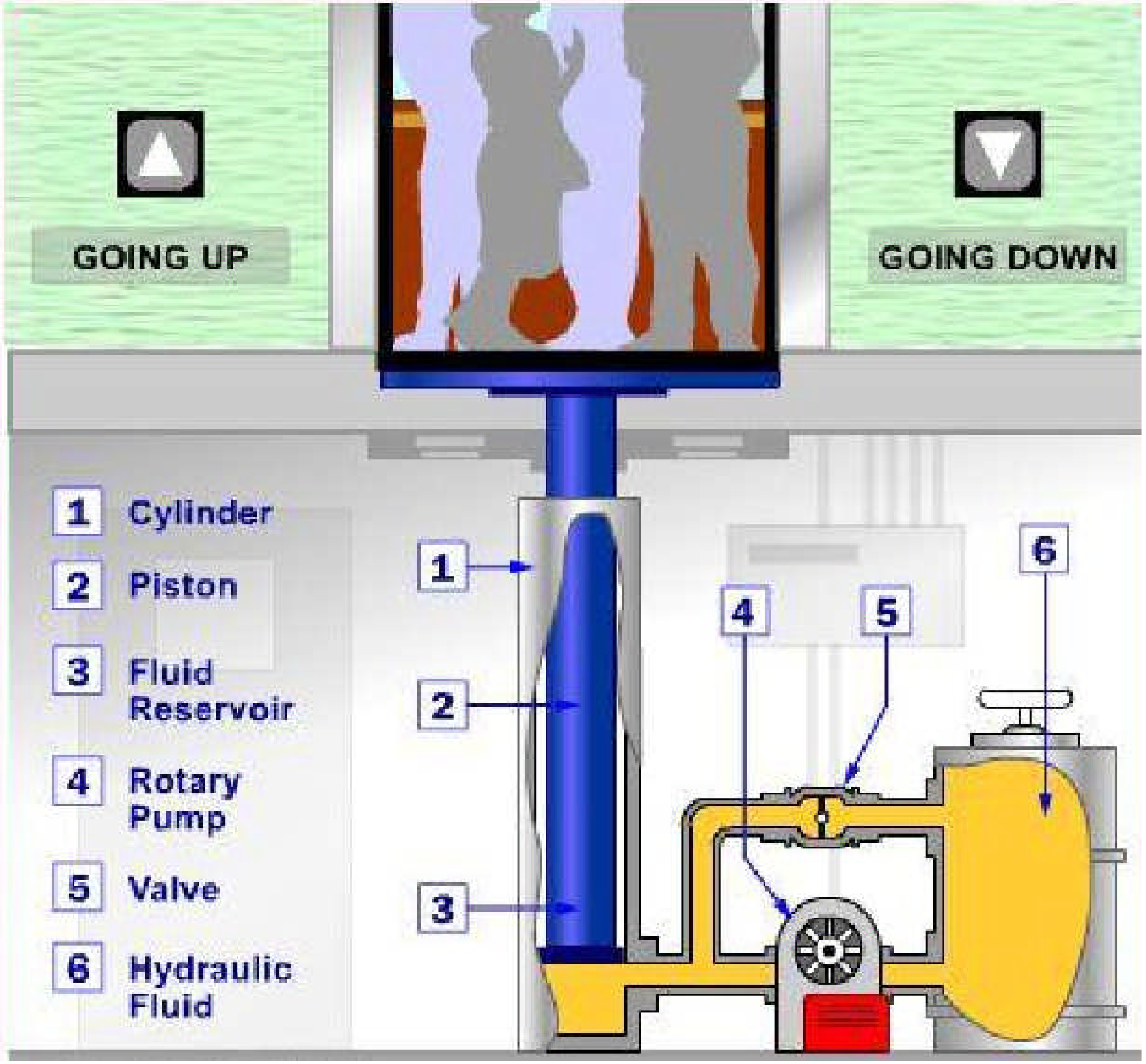
<u>Left</u>: caption: “Otis Geared Garage Elevator – Single Wrap Traction”

Hydraulic Elevators

Hydraulic Elevator **systems lift a car using a ram; a fluid driven piston mounted inside a cylinder. The cylinder is connected to a fluid-pumping system (typically hydraulic oil or other incompressible fluid) and consists of three basic parts:**

- **Tank (fluid reservoir)**
- **Pump (powered by an electric motor)**
- **Valve (between the cylinder and the reservoir)**

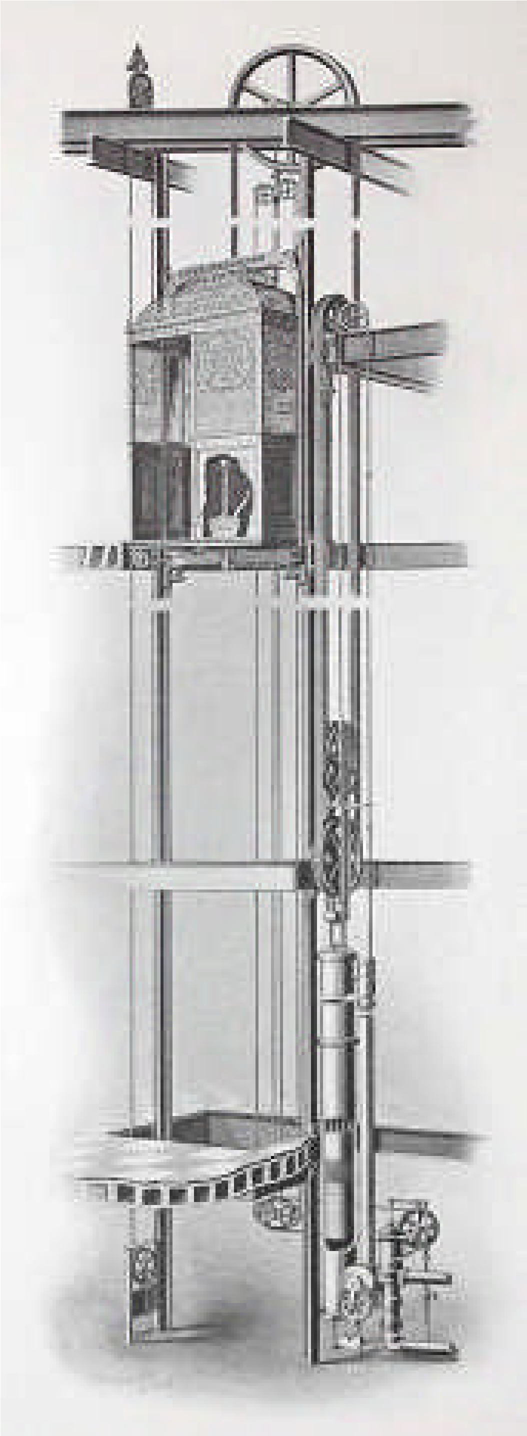
The pump forces fluid from the tank into a pipe leading to the cylinder. When the valve is open, the pressurized fluid will take the path of least resistance and return to the fluid reservoir. When the valve is closed, the pressurized fluid has nowhere to go except into the cylinder. As the fluid collects in the cylinder, it pushes the piston up, lifting the elevator car. When the car approaches the correct floor, the control system sends a signal to the electric motor to gradually shut-off the pump. With the pump off, there's no more fluid flowing into the cylinder, but the fluid that's already in the cylinder cannot escape (it can't flow backward through the pump and the valve is still closed). The piston rests on the fluid and the car stays where it is. To lower the car, the elevator control system sends a signal to the valve. When the solenoid opens the valve, the fluid that has collected in the cylinder can flow out into the fluid reservoir. The weight of the car and the cargo pushes down on the piston, which drives the fluid into the reservoir. The car gradually descends. To stop the car at a lower floor, the control system closes the valve again.


GOING UP
GOING DOWN
1 Cylinder
2 Piston
3 Fluid Reservoir
4 Rotary Pump
5 Valve
6 Hydraulic Fluid
1
2
3
4
5
6

The main advantage of hydraulic systems is that they can easily multiply the relatively weak force of the pump to generate the stronger force needed to lift the elevator car. But these systems suffer from two major disadvantages. The main problem is the size of the equipment. In order for the elevator car to be able to reach higher floors, the piston must be longer. The cylinder must be a little bit longer than the piston since the piston needs to be able to collapse all the way down its well when the car is at the bottom floor. In short, the taller the building the longer the cylinder. The problem is that the entire cylinder structure must be buried below the bottom elevator stop meaning the higher the building, the deeper the excavation. Another disadvantage of hydraulic elevators is that they're relatively inefficient. It takes a lot of energy to raise an elevator car several stories and in a standard hydraulic elevator, there is no method of storing this energy. The *Energy of Position* (potential energy) only works to push the fluid back into the reservoir. To raise the elevator car again, the hydraulic system must generate the energy all over again.

"…The Otis Hydraulic Elevator for passenger and freight service is built in various types, including the standard vertical hydraulic machine, the Plunger or Direct Lift Hydraulic Machine, the Horizontal Hydraulic Engine of the pushing type, and the Horizontal Hydraulic Engine of the pulling or tension type. The Hydraulic Elevator may be operated from water pressure obtained from the street mains, by gravity-pressure from an open tank on the roof of the building, or by pressure tank placed on the roof or in the basement of a building, and can be built for operation at any pressure from 50 pounds per square inch upward. These Elevators have been tested by many years of actual service, and may be built to be run at any desired speed from 20 feet to 1,000 feet per minute…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1900)



"…The illustration shows the Otis Vertical Cylinder Hydraulic Elevator, the perfected modern development of the machine which gave the name 'Otis' its worldwide reputation for safe and speedy elevator service, and made possible the modern 'skyscraper.' This type of elevator is particularly suited for elevator service in tall office buildings where hard, continuous use at high car speeds is demanded. The hydraulic machine is equipped with a device which automatically regulates the speed at which the water flows into and out of the cylinder, effectually preventing the cars 'running away,' even when overloaded. The installation shown is provided with our improved lever operating device for operating the main valve through the medium of a pilot valve, giving not only ease of control, but enabling the operator to run the car at any desired variation from its maximum speed. The machine shown is geared 4 to 1, but we gear them 2 to 1, 4 to 1, 6 to 1 or 8 to 1, to meet requirements, and it can be operated by water pressure from compression or gravity tank systems, or from street mains where sufficient pressure is available. It can be built for any car speed up to 800 feet per minute…"

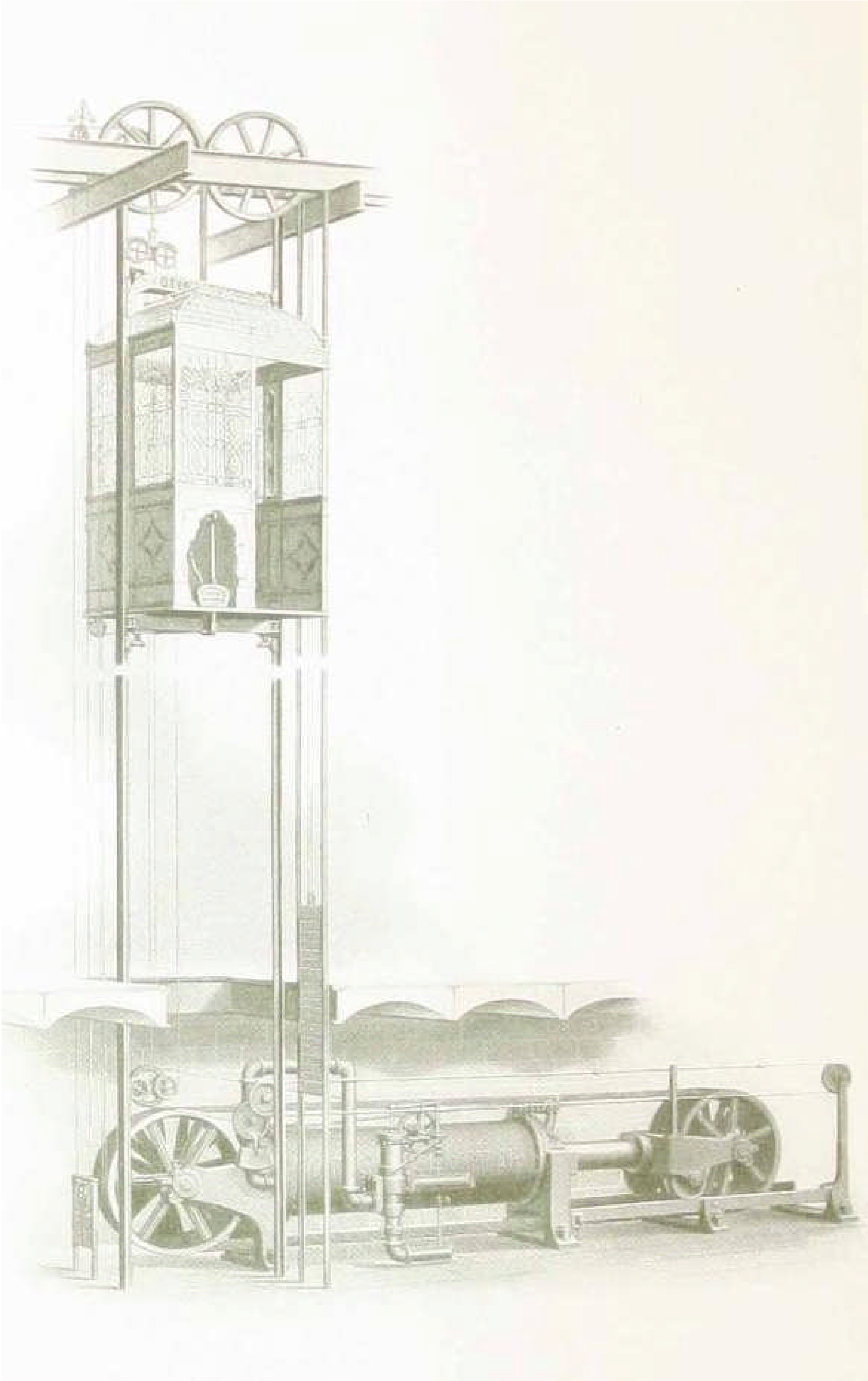
RE: excerpt from an *Otis Elevator Co.* brochure (ca. 1905)

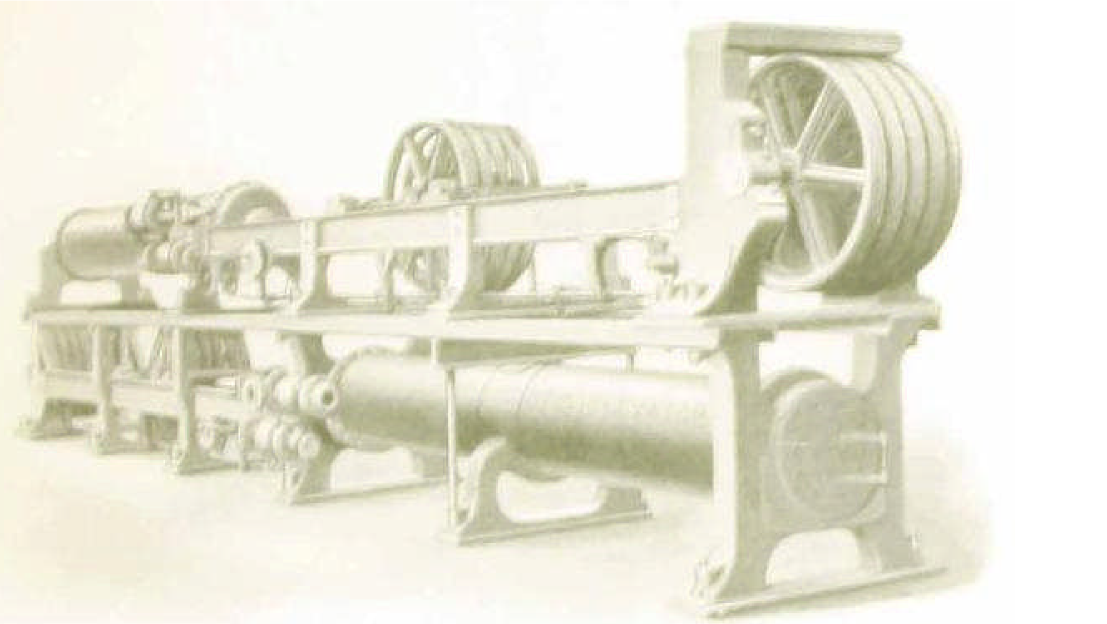
Left: caption: "Vertical Cylinder Hydraulic Elevator"

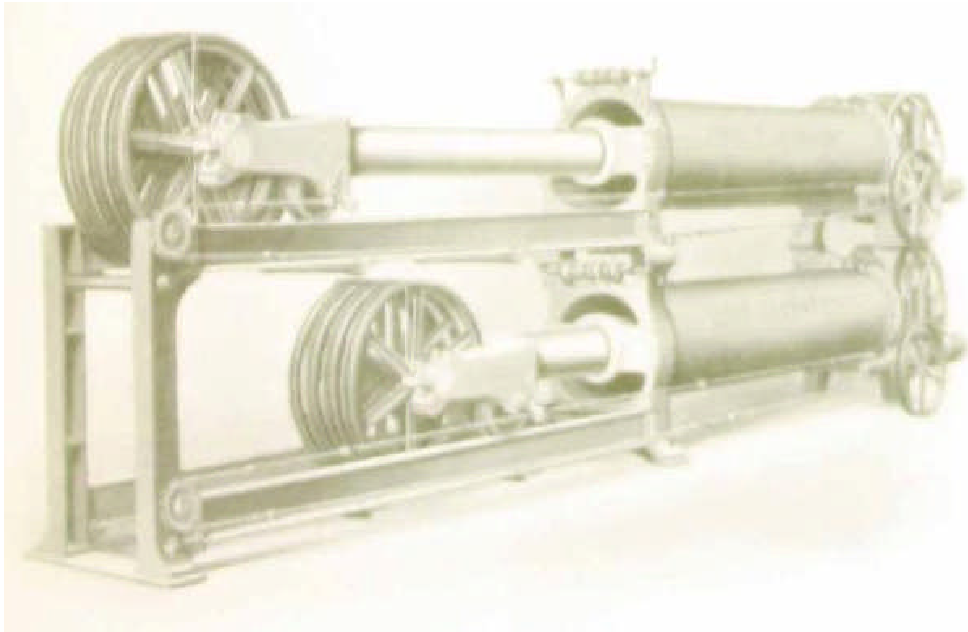
"…The illustration shows the Otis Hydraulic Elevator with horizontal cylinder, designed for buildings where it is deemed advisable to install all of the elevator machinery in the basement. In smoothness of operation, speed, safety, and other requisites of a high class elevator it is equal to the vertical cylinder type. For buildings of a considerable height, we gear these elevators as high as 12 to 1. Where several are to be installed, the cylinders may be placed one above the other in a 'double deck' or 'triple deck' arrangement, thus further economizing floor space. The illustration shows, in connection with the elevator, a compound duplex elevator pump, compression and discharge tanks and the necessary piping connections. The tanks are here shown in the basement, but, in large plants especially, it is often found more convenient to place the compression tank on roof or in attic…"

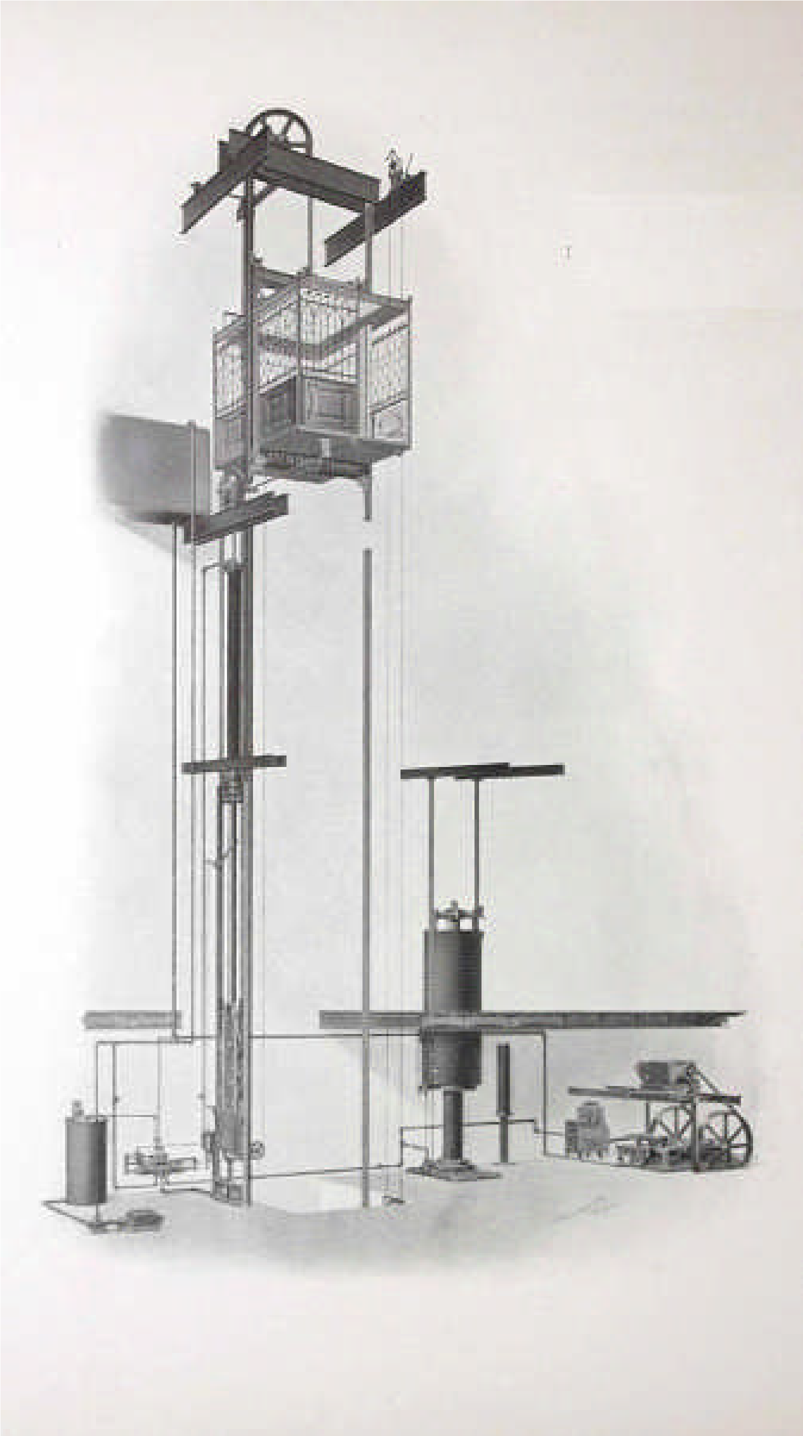
RE: excerpt from an *OEC* brochure (ca. 1905)

Left: caption: "Horizontal Cylinder Hydraulic Elevator"





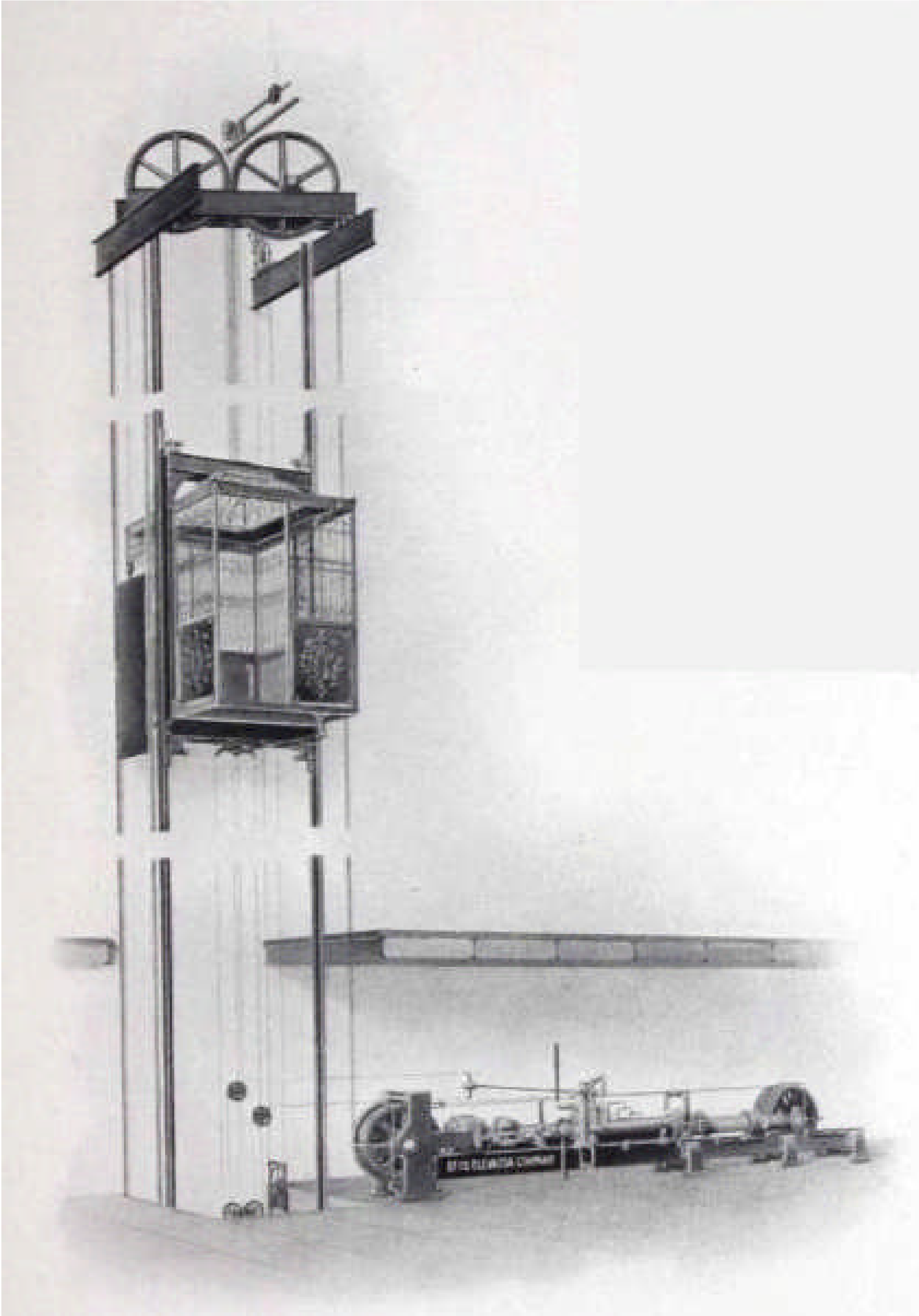




“…The Otis High Pressure Inverted Plunger Elevator illustrated is designed to be operated at a water pressure of from 600 to 800 pounds per square inch, to maintain which a weighted accumulator is used as shown in illustration. The cylinder and plunger being small in diameter can be suspended in the hatchway at back of or between the cars. Usually but one accumulator is required for each plant. The installation shown has a motor-driven triplex pump, pumping directly into the weighted accumulator. The operation of the pump motor is governed by the position of the accumulator weight, which, as it descends, due to the consumption of water by the elevator, closes the electric circuit, admitting current to the motor until the pump delivers the amount of water required to supply the accumulator, and then the circuit is automatically opened. This system can also be installed with steam pumps. We have many of these elevators in operation and in regular service they show the highest degree of efficiency and economy. A number of the largest elevator plants ever installed are of this type…”

RE: excerpt from an *OEC* brochure (ca. 1905)

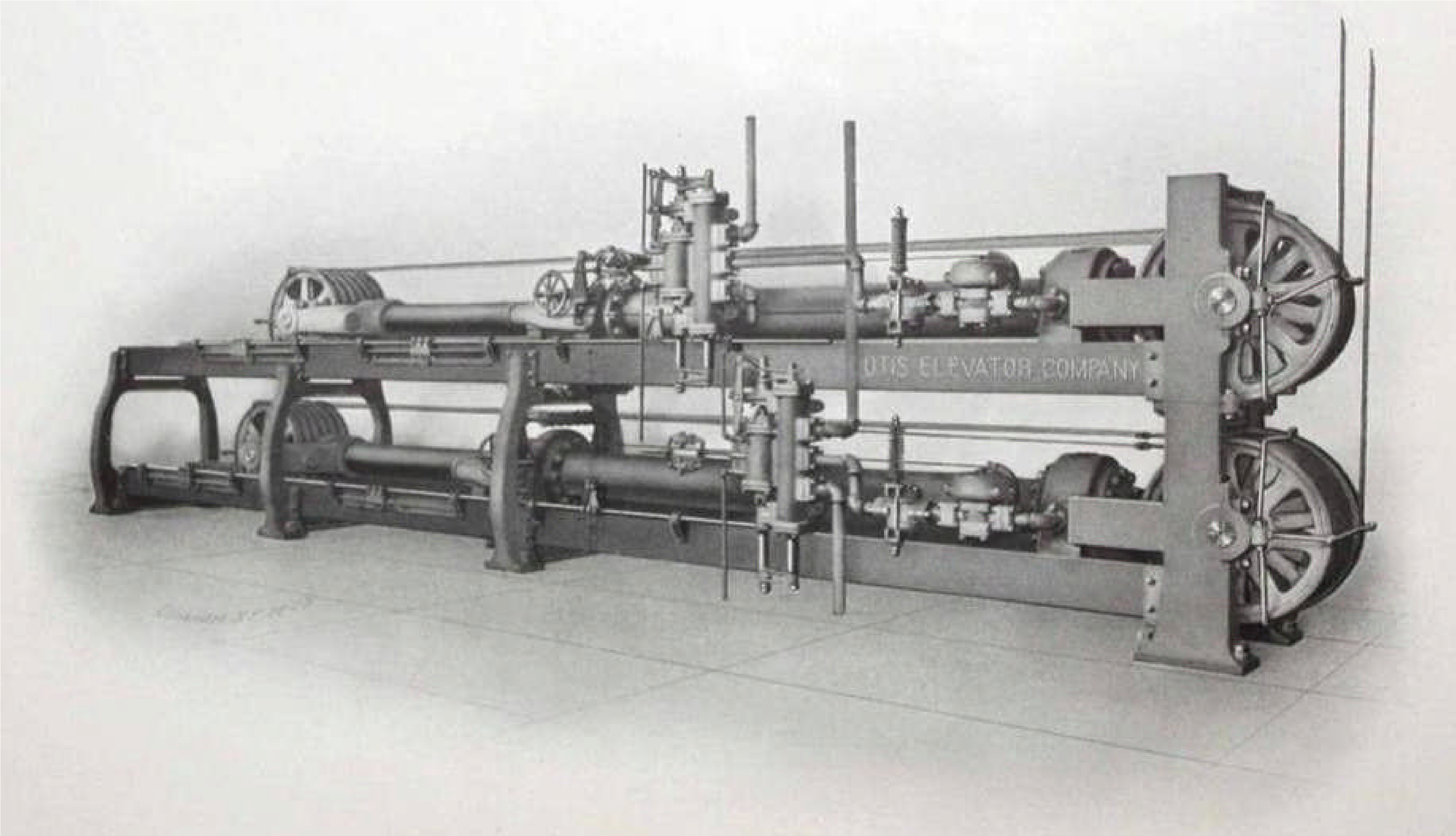
Left: caption: “High Pressure Inverted Plunger Hydraulic Elevator”



"… We illustrate here the Otis Horizontal Cylinder High Pressure Elevator, designed to operate under water pressures of 600 to 800 pounds, as described for the Inverted Plunger Type. We have a number of these machines successfully operating passenger cars at high speeds. The double deck arrangement of this machine is for the purpose of economizing floor space, the machinery for operating two cars occupying the same floor area as ordinarily required for one…"

RE: excerpt from an *OEC* brochure (ca. 1905)

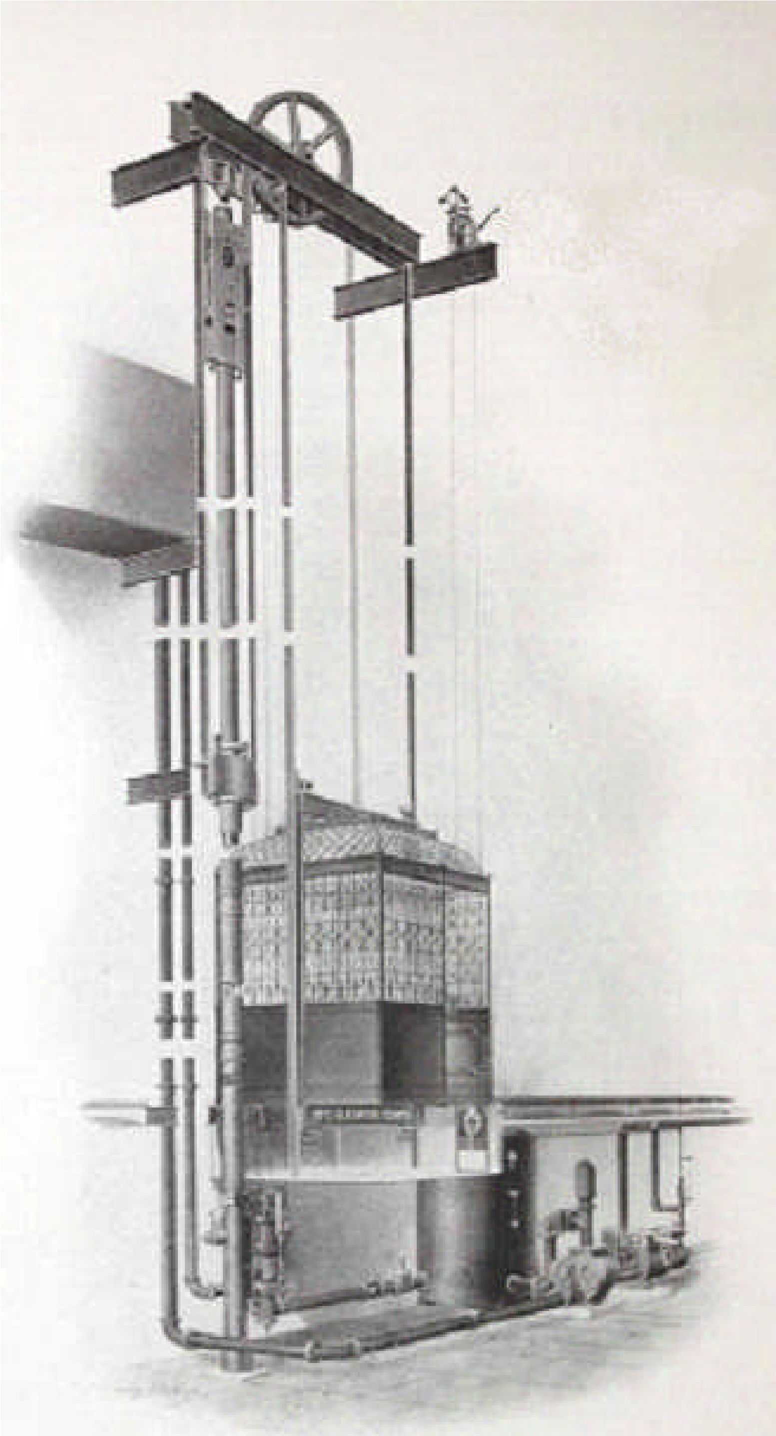
Left: caption: "High Pressure Hydraulic Elevator with Horizontal Cylinder"



Above: caption: “Otis Horizontal Cylinder High Pressure Elevator Engine (Double Deck Arrangement)”

"…The Otis Pulling Plunger Type of Hydraulic Elevator, when lifting the load, does not consume water but, rather, discharges it from the cylinder. With this type of elevator the column of water in the cylinder supports a solid steel plunger, and when the valve is opened the weight of the descending plunger forces the water out of the cylinder into the discharge tank and lifts the car and its load. In descending, water is delivered into the cylinder at sufficient pressure to raise the plunger and allow the car to descend. The speed is regulated by the amount of water admitted or discharged through the operating valve. This elevator was designed to meet the requirements of high buildings, and on account of its economy in operation, very high speed, and the quickness with which stops and starts can be made, ranks high among hydraulic elevators. As this machine is operated under a medium pressure, rarely exceeding 300 pounds per square inch, it is possible to use the compression-tank system, but it is also perfectly adapted to the weighted accumulator system…"

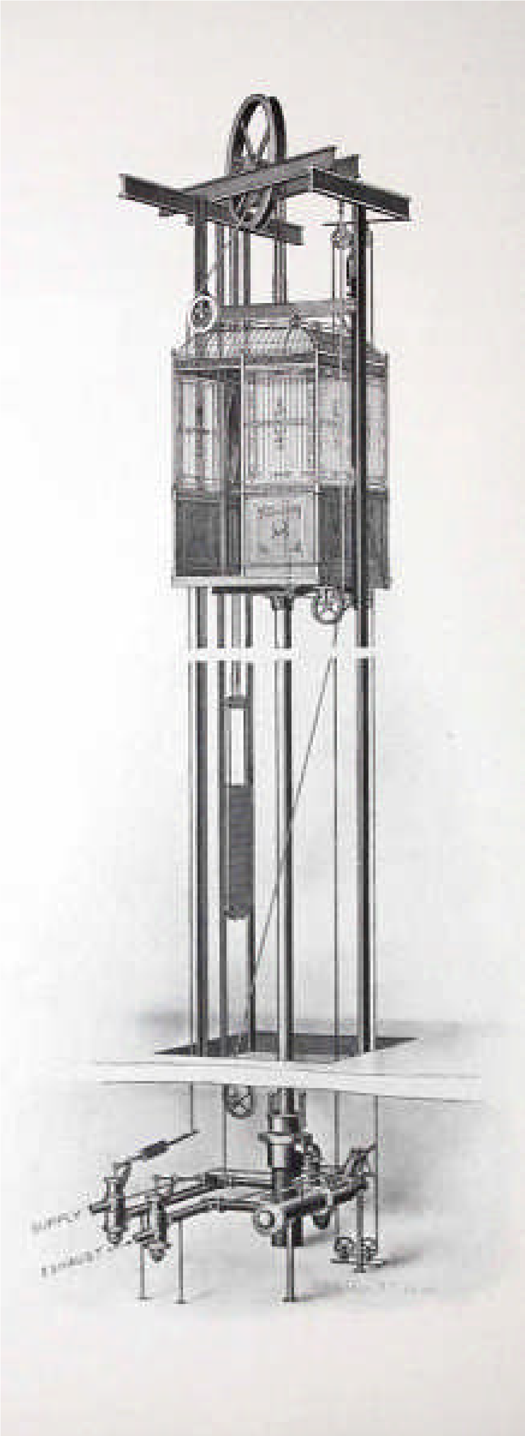
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)



"…This cut illustrates the Otis Pulling Plunger Type of Hydraulic Elevator, which differs from any other in the respect that when lifting the load it does not consume water but discharges it from the cylinder. In this elevator the weight of the plunger itself, which is of solid steel, lifts the load, the plunger descending into the cylinder as the car rises in the hatchway. When the operation is reversed and the car descends, the water is pumped up to the required pressure and, assisted by the weight of the car, raises the plunger and the car descends. This elevator was designed to meet the requirements of high buildings, and on account of its economy in operation, very high speed, and the extreme rapidity with which stops and starts can be made, ranks high among hydraulic elevators. As this machine is operated under a medium pressure, rarely exceeding 250 pounds per square inch, it is possible to use the compression-tank system. The illustration shows a compound duplex pump with compression and discharge tanks, together with the necessary piping connections. The compression tank is usually placed in the basement and the discharge tank either on the roof or in any convenient location at least as high as the top of the cylinder, so that the cylinder is always filled with water, thereby acting as a safety brake…"

RE: excerpt from an *OEC* brochure (ca. 1905)

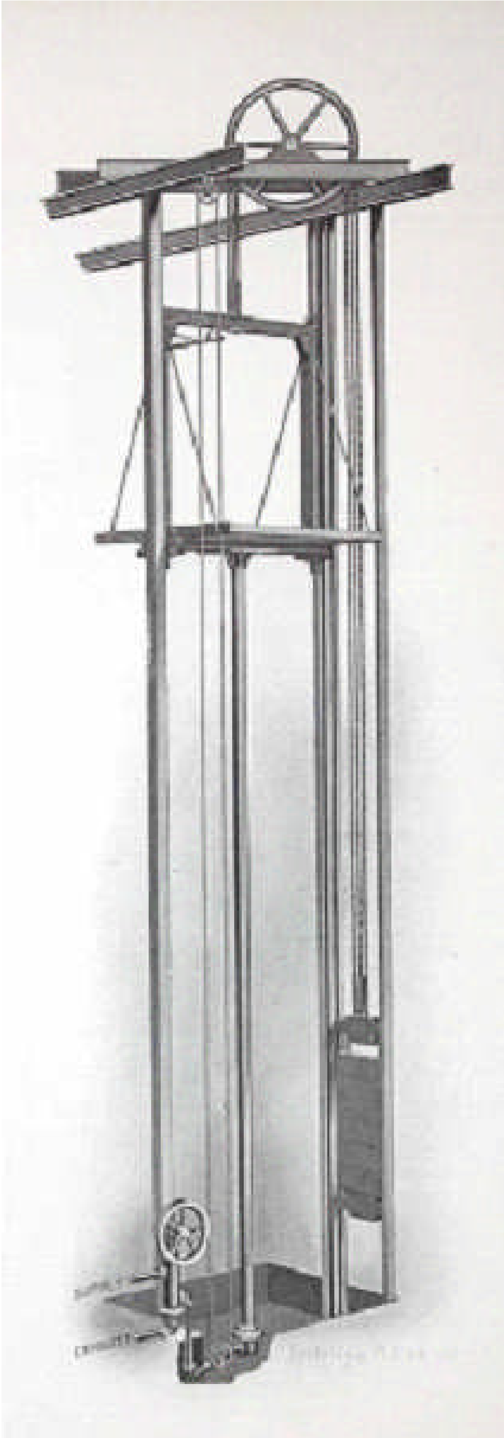
Left: caption: "Pulling Plunger Hydraulic Passenger Elevator"



"…The Direct-acting Plunger Elevator illustrated represents our modernization of the primeval hydraulic lift. It consists of a cylinder set vertically in the ground directly under the car, and of length slightly greater than the travel of the elevator. In this cylinder is a plunger of the same length, carrying a car on its upper end. The bottom of the plunger is supported by an incompressible body of water, and the car cannot descend faster than the water is forced out. The success of this elevator depends largely upon the merits of the operating mechanism. As a result of many years of experiment and study, we have perfected and patented a system of valves which gives absolute ease and smoothness of control. As it is necessary to sink the hole to a depth equal to the height of the building, the nature of the soil has a direct bearing on the time of completion and cost of the installation. For many years we have installed this type of elevator for both passenger and freight service, and have numbers of equipments of this kind in operation in all classes of buildings throughout the country…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

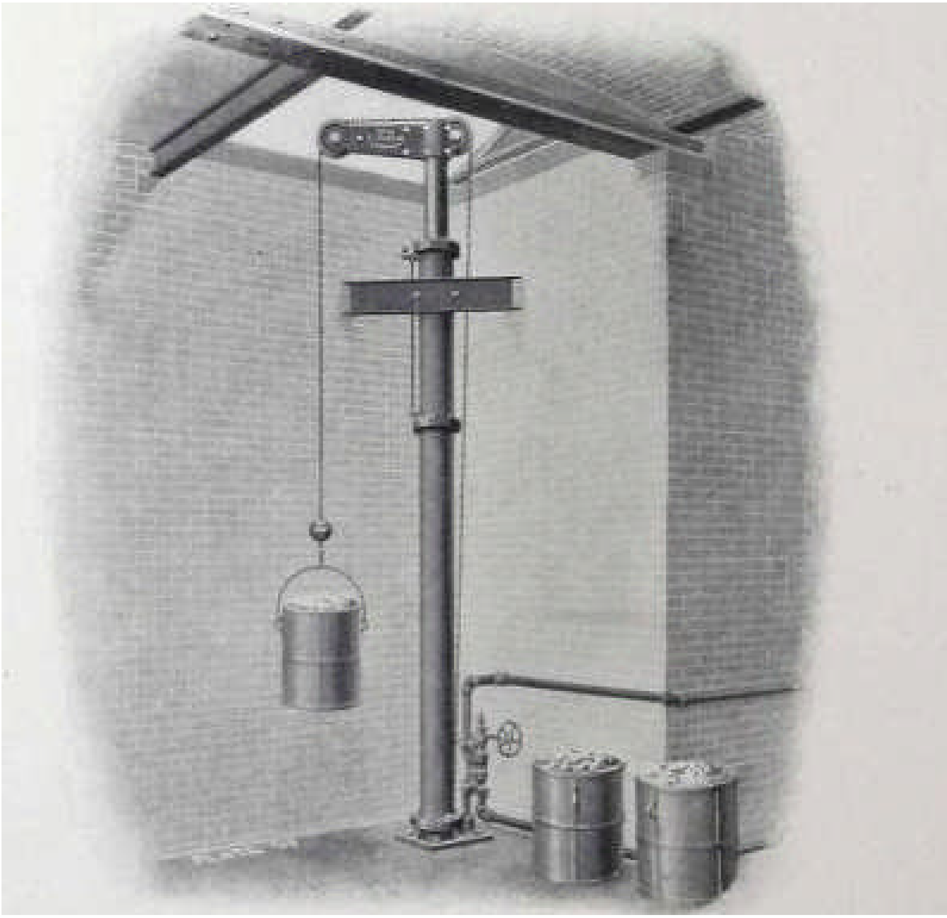
Left: caption: "Direct-acting Plunger Elevator"



"…The Plunger Elevator is conformable for either passenger or freight service and has a high degree of efficiency, due to the fact that the power is exerted direct without the intervention of sheaves or cables. The car is always supported from beneath by the plunger, and therefore there is no necessity for providing it with the safety appliances used on the car in other types of elevators. Owing to the fact that a cylinder of a length equal to the car travel must be sunk in the ground, the nature of the soil has a considerable bearing upon the cost of the installation. For passenger service, we have built plunger elevators with travels as high as 225 feet and with speeds as great as 600 feet per minute. For freight service, we have built them with a lifting capacity up to 80,000 pounds, and we regard this type as particularly suitable to these very heavy loads. In the vignette is shown the plunger elevator arranged as a sidewalk hoist, a service for which it is very well adapted, as the very simple elevator machinery can be placed underneath the platform. If required, the elevator can be so constructed as to raise the platform any height above the sidewalk, for convenience in loading or unloading trucks…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1903)

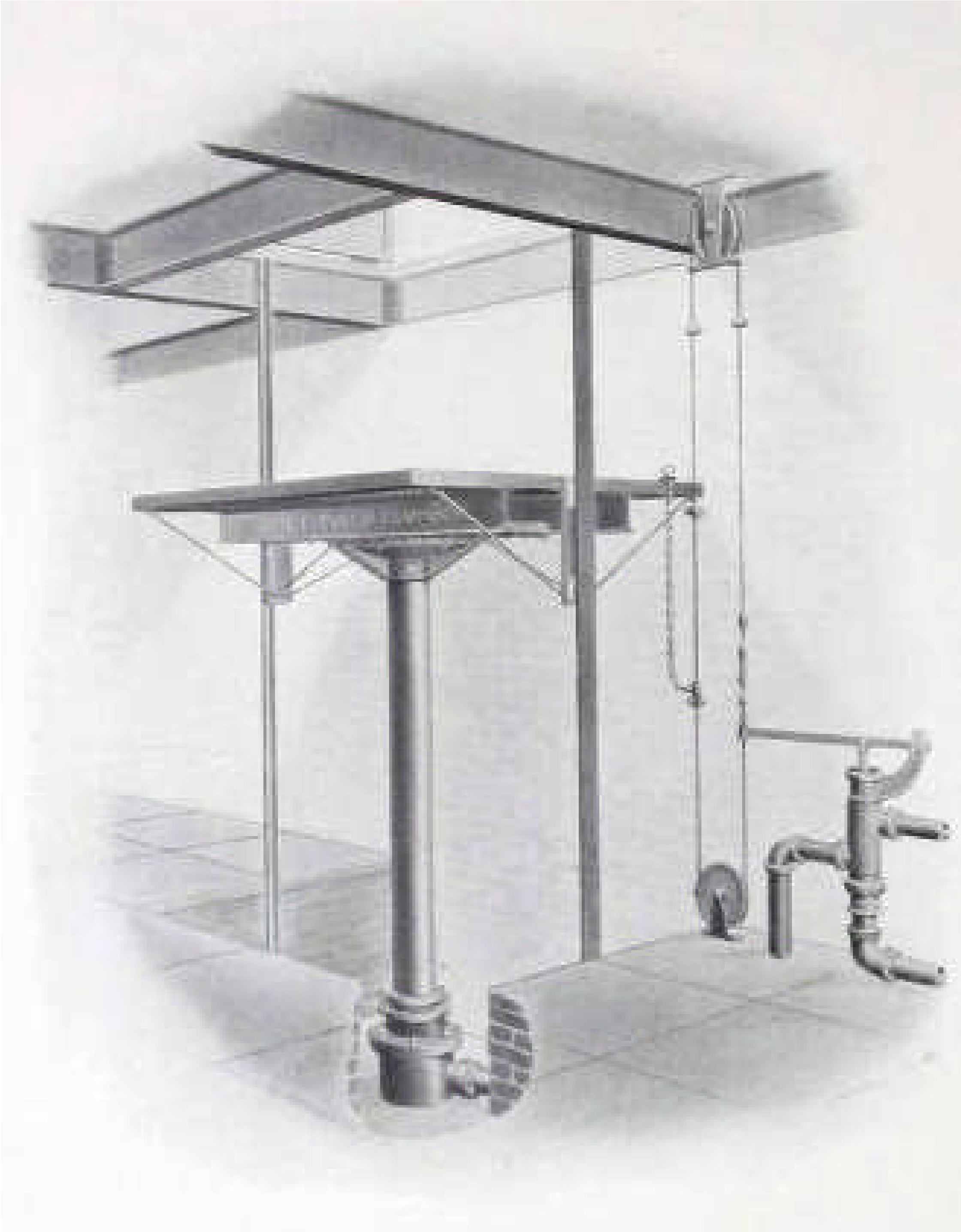
Left: caption: "Plunger Elevator"



"…The illustration shows the Plunger Elevator arranged as a sidewalk hoist, a service for which it is very well adapted, as the very simple elevator machinery can be placed underneath the platform. If required, the elevator can be constructed so as to raise the platform any reasonable height above the sidewalk, for convenience in loading or unloading trucks…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

<u>Left</u>: caption: "Hydraulic Ash Lift"

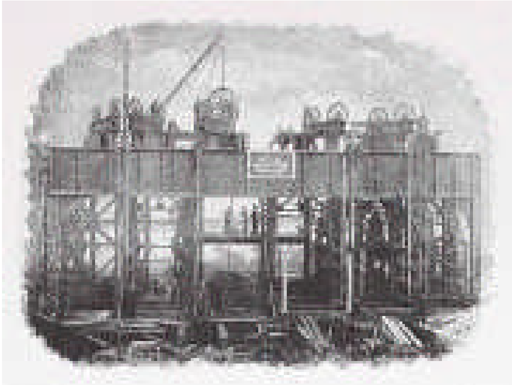


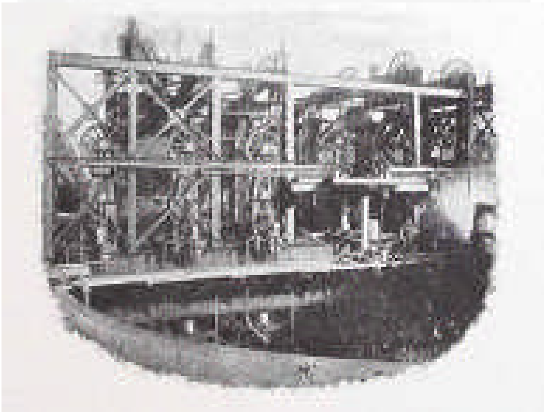
"…The figure shows the Otis Hydraulic Ash Lift, for raising ashes, etc., from the cellar to the sidewalk. The extreme simplicity of construct-ion and operation and the extraordinary comp-actness strongly recom-mend this type or hoist for this class of ser-vice…"

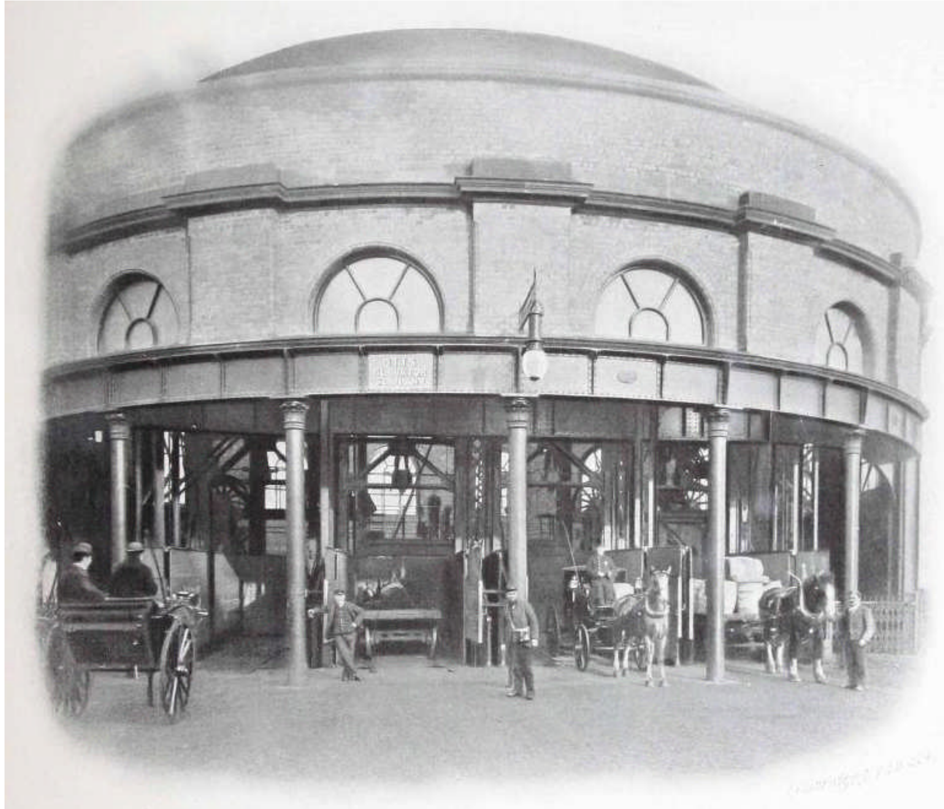
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

Left: caption: "Plunger Side-walk Hoist"

Glasgow Harbor Tunnel Elevators







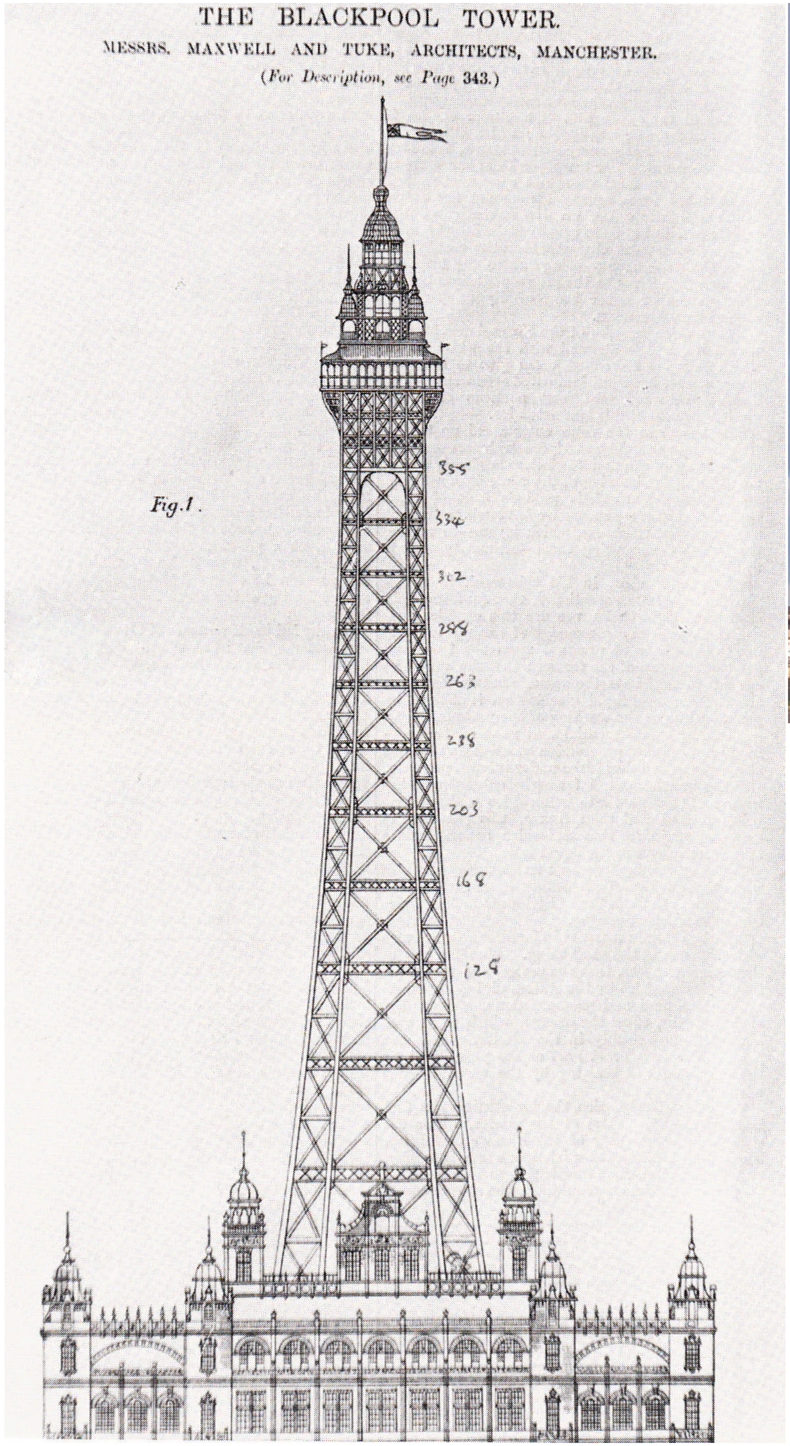
"…The photograph above shows the entrance depot to Glasgow Harbor Tunnel Elevators, built and erected by us. The plant consists of twelve elevators, having a car travel of 80 feet. Platforms are 10 feet wide by 28 feet long, giving a lifting capacity for wagon and team of horses at a car speed of 250 feet per minute. The elevators are operated under our high-pressure hydraulic system, using steam pumps and accumulators, the hydraulic pressure being 800 pounds…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

Left T&B: caption: "Tunnel Elevators Under Construction (ca. 1883)"

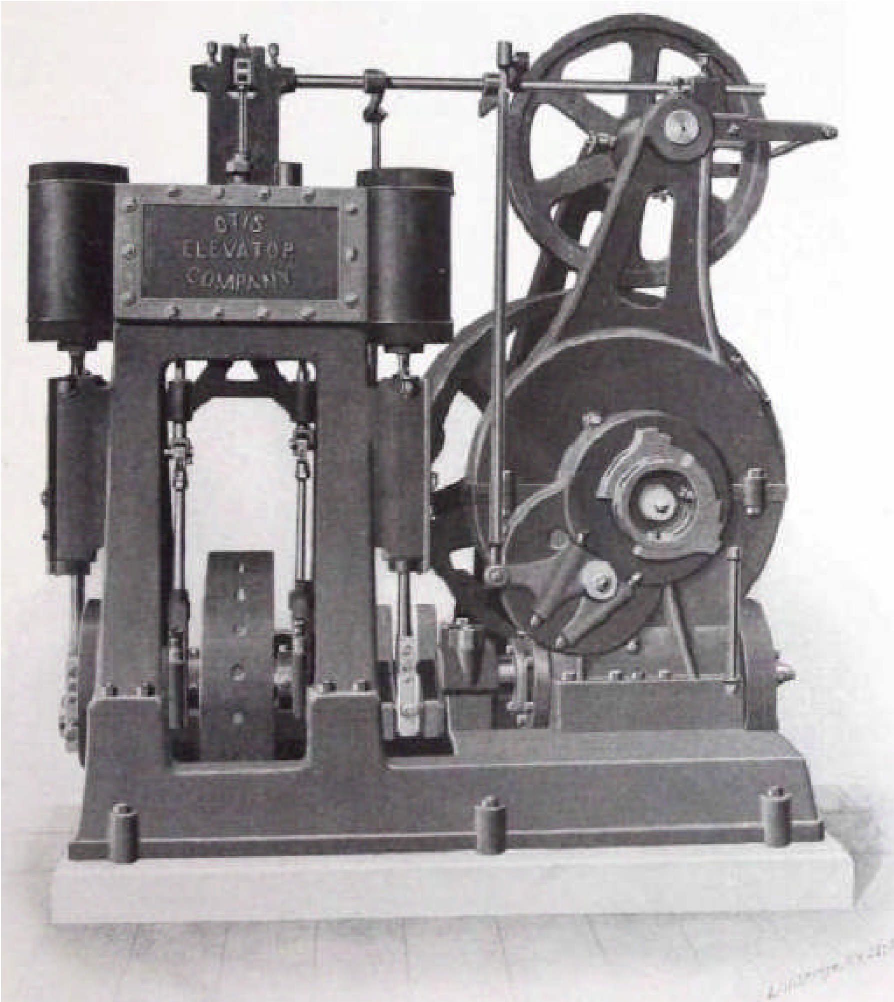
Right: caption: "Depot Entrance, Glasgow Harbor Tunnel, 1884"

Blackpool Tower



The *Blackpool Tower* (above & left), on the *Irish Sea* coast, was constructed between 1891 and 1894 in England. The two original elevators that were installed in the tower were hydraulically operated, with a capacity of twenty-six passengers at a speed of 450 fpm. Interestingly, the original elevators the used of iron roller guides in their construction. These were later modified to use rubber-tired roller guides.

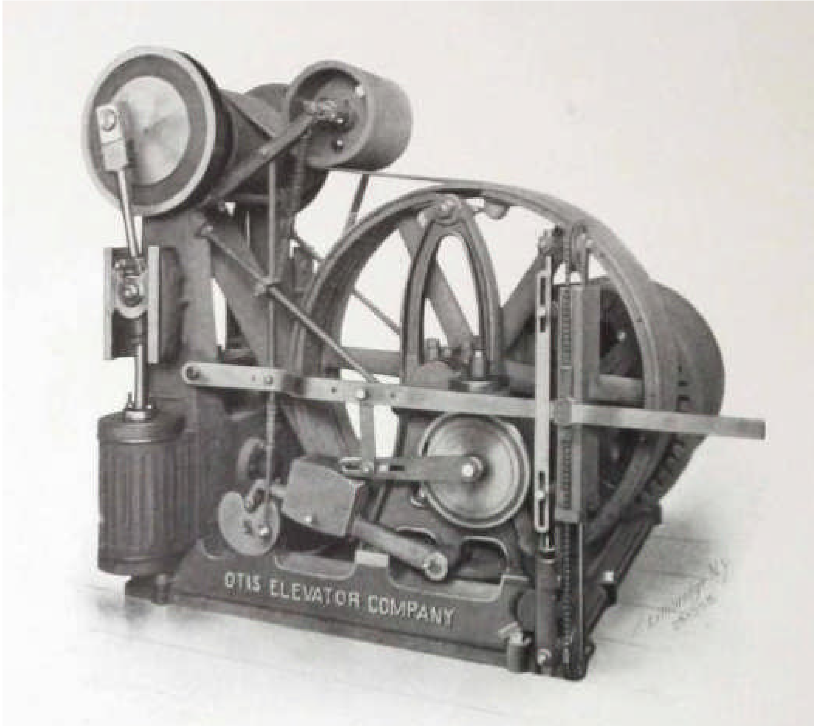
Steam Elevators



"…Illustrated is the Otis High-speed, Worm-geared Passenger Elevator Engine. This design is the result of much experiment to perfect a steam engine which would combine speed, smoothness of running, and ease of control, which are essentials in any elevator for passenger service. For economical reasons this type of elevator has been largely superseded by the electric, but for certain locations, and where electric current cannot be obtained, it holds its place as the highest type of the steam passenger elevator. Our engine, if required, is capable of developing a car speed of 400 feet per minute, which no other elevator builders have been able or willing to guarantee with this style of elevator…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

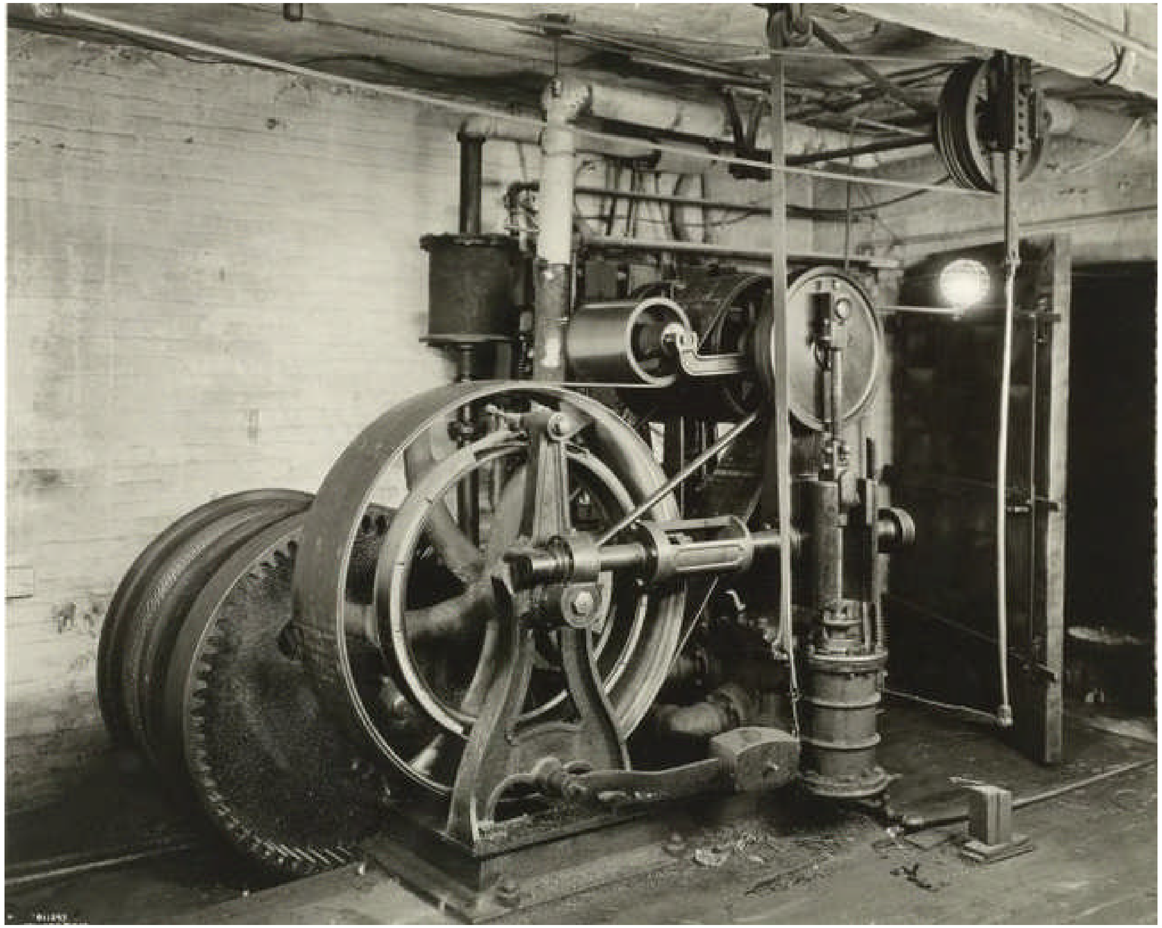
<u>Left</u>: caption: "Worm-Geared Steam Passenger Elevator Engine"

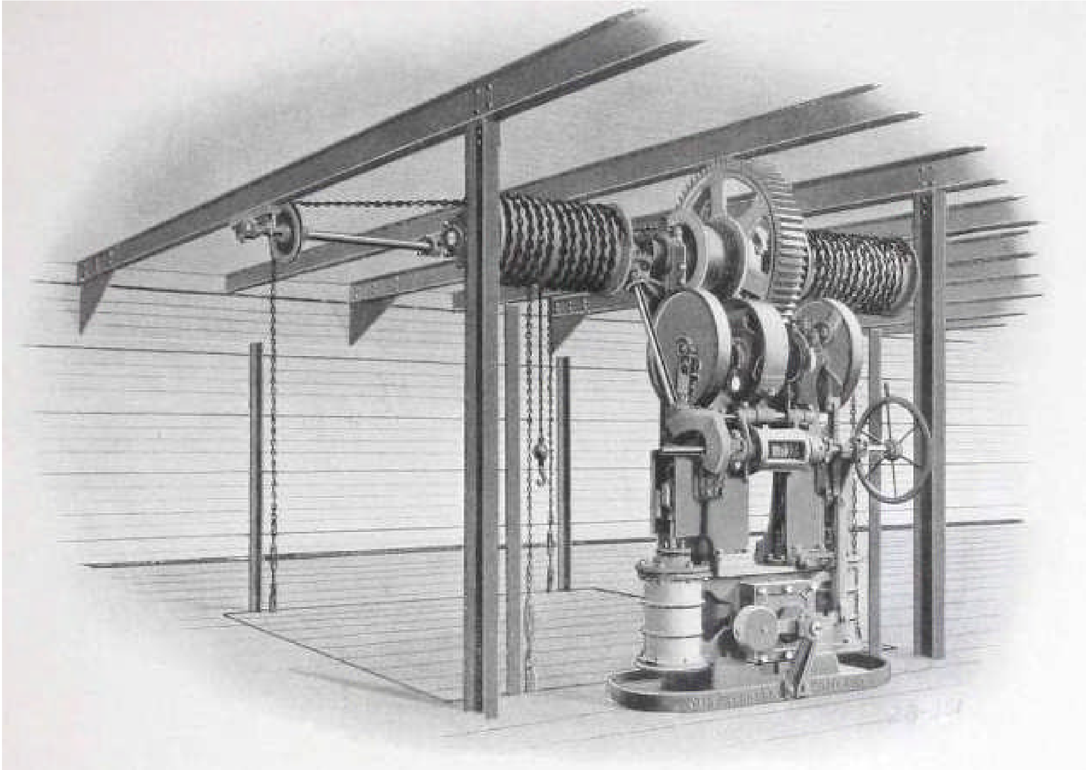


"…the engine in the illustration was at one time considered the best for freight purposes. During the last few years it has given way to the modern hydraulic and electric elevators, hut it still is recognized as the standard machine of its class. Hundreds of these elevators have been in continuous operation for over twenty years in prominent mercantile buildings in New York, Chicago other cities, and are giving satisfactory service today. The general construction of the engine remains substantially as first designed, but devices have been added to still further increase its safety and facilitate its control…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

<u>Above</u>: caption: "Belt and Geared Steam Freight Elevator Engine"

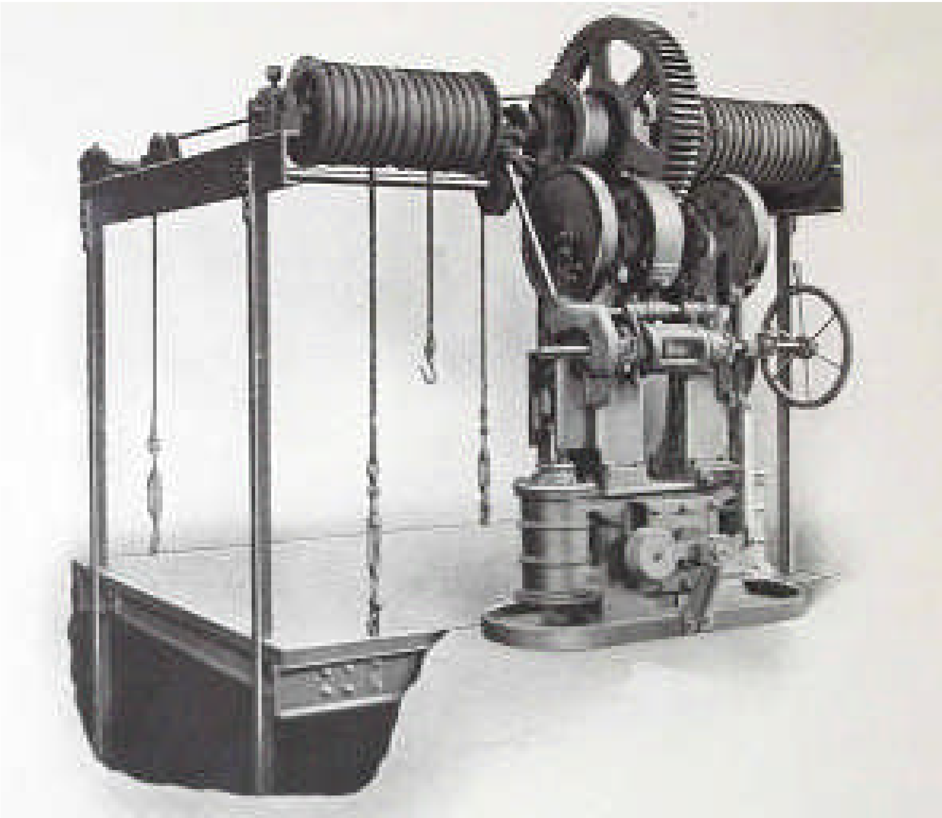




"…The figure above shows a new type of Steam Hoist designed particularly for use aboard ships. The engine can be fitted with an automatic device whereby, at the beginning of a loading operation, the engine is automatically brought to a stop when the platform reaches the lowest deck. When this deck is completely loaded, the device is readjusted to stop the engine automatically when the platform is lowered to the next higher deck, and so on. When all the decks are completely loaded, the platform is lowered to the bottom of the hatchway. The main winding drums are then thrown out of gear and the auxiliary whip hoist can be used to fill the hatchway. In unloading, these operations are, of course, reversed…"

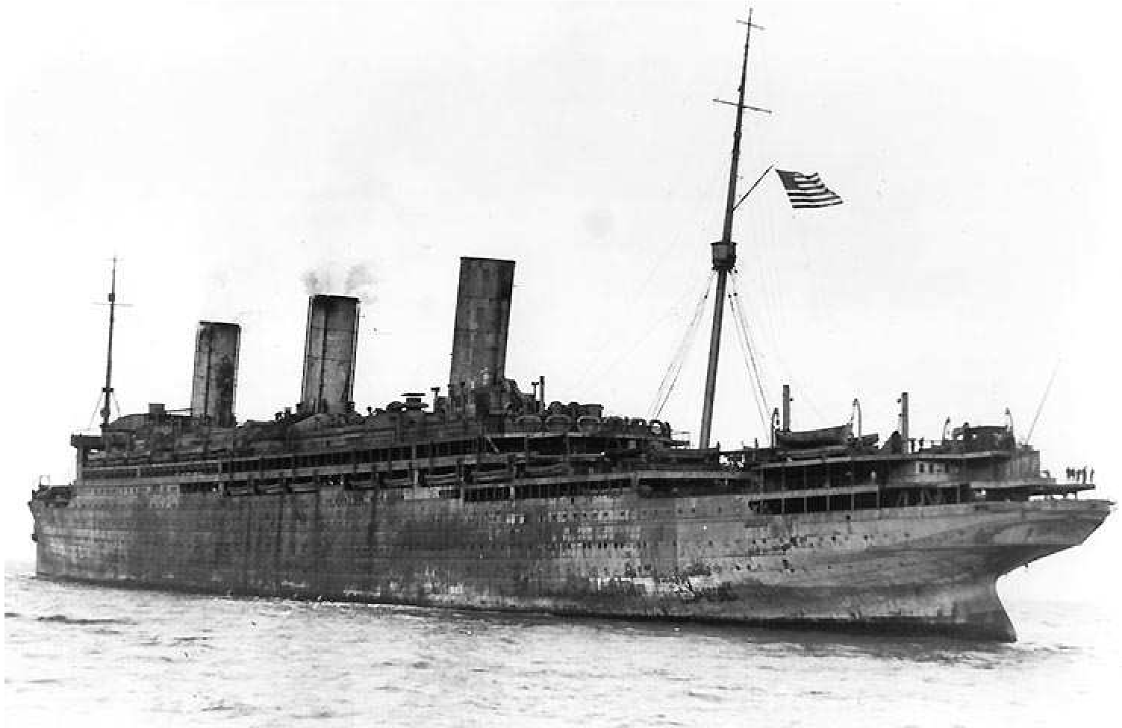
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

<u>Above</u>: caption: "Steam Hoist For Use Aboard Ship"



"…A marked economy in loading and unloading has resulted in those vessels where these hoists have been installed. The particular hoist illustrated has a capacity of 4,000 pounds net load at a speed of 100 feet per minute, the size of the platform being seven by ten feet. Hoists of this character, however, can be made with any desired rating…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1903)



In 1915, Otis contracted with the *U.S. Navy* for an elevator system that would accurately stop and level in a rolling sea (for the loading of guns and mine-laying equipment from an adjacent platform). To accomplish this, Otis designed a small auxiliary machine for the floor-leveling operation. The automatic level feature was quickly adapted for use in Otis commercial passenger elevators, reducing annoying and potentially dangerous stumbling hazards and speeding up door-closing operations. In 1923, when reconditioned after service during WWI, the *S.S. Leviathan* was equipped with eleven Otis elevators: four passenger and seven service and freight elevators. The passenger elevators were self-leveling, car-switch operation with a speed of 150 fpm. At the time it was Otis' largest ship installation.

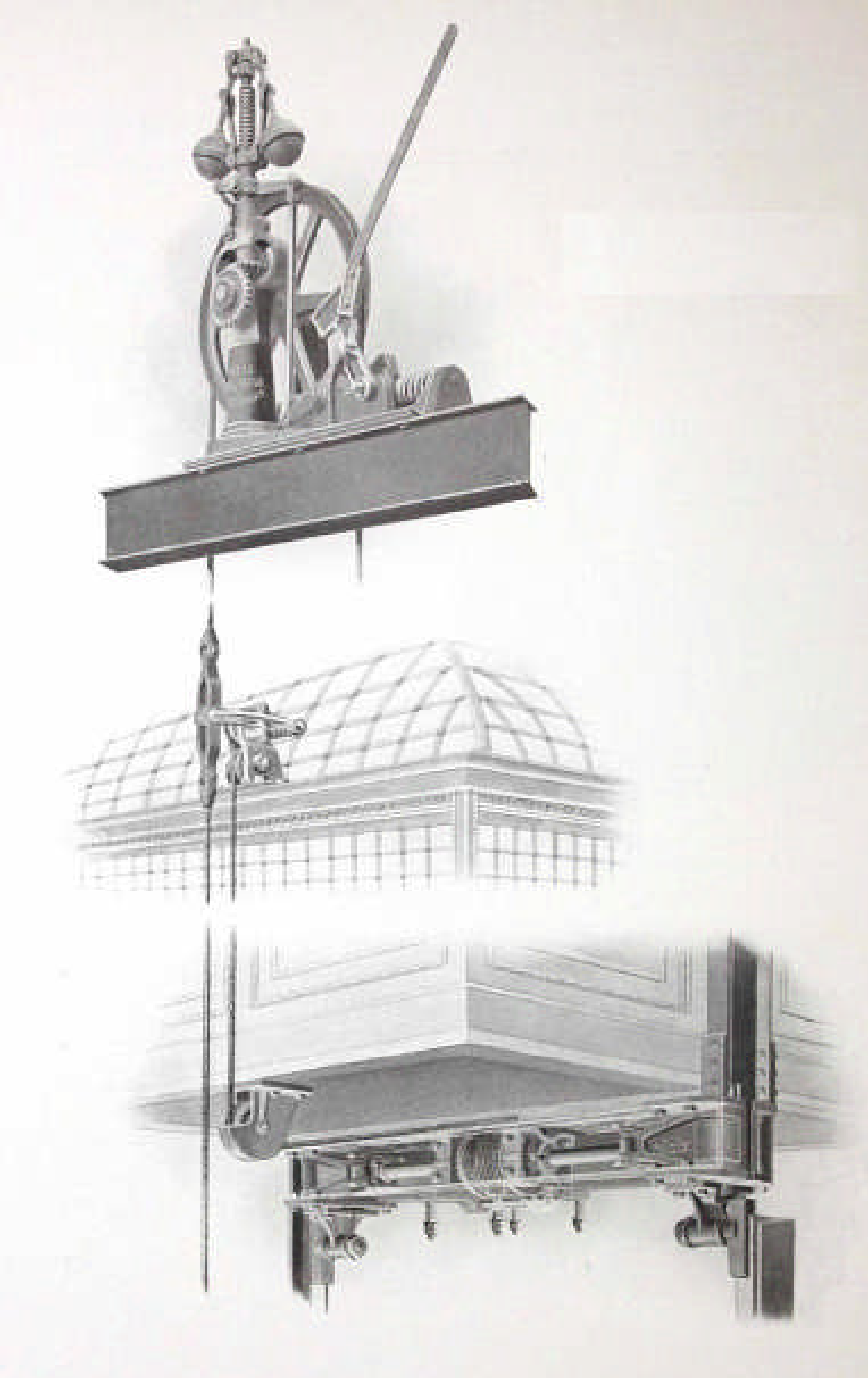
<u>Above</u>: caption: "S.S. Leviathan during reconditioning for commercial service"

The *Cunard White Star* liner *Queen Mary* was launched in 1934 with a total of twenty-one Otis elevators; then the largest elevator installation afloat. The May 1936 edition of the Otis employee publication; ***The Otis Bulletin***, described the elevators as representing the triumph of engineers over problems quite different from land problems. The elevators were built to resist the rigors of rolling seas and the corrosive action of salt air.

The Factor of Safety

"…While a high safety factor is used in the construction of Otis Elevators, each elevator is also provided with special safeguards against all known forms of elevator accidents. The principle of having a centrifugal governor to operate grips or clutches on the car when it exceeds a predetermined speed does not differ materially from that of thirty years ago, but the greatly increased car travels and speeds of many modern installations necessitate car safeties that will invariably exert a resistance in proportion to the car speed so that the car will slide a distance proportional to its velocity at the time the safety acts. To meet these varying requirements we manufacture a number of devices which have been proven effective and absolutely reliable in actual service…"

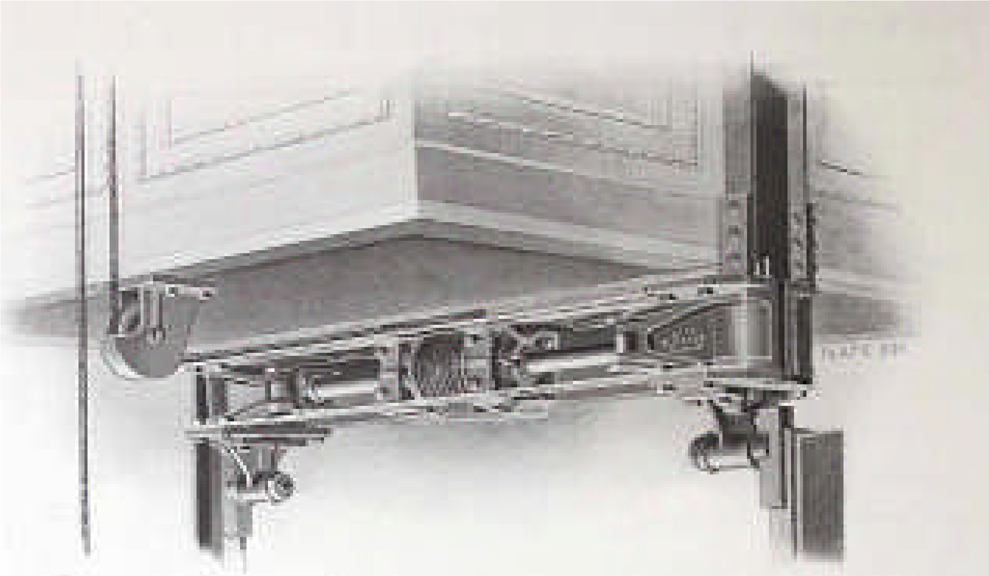
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)



"…Illustrated is the the Otis Governor directly connected to our Wedge Clamp Safety Device, designed for use in connection with steel tee guides. When the car exceeds its normal speed the governor applies the car safety, the jaws clamping the guide rails with a gradual and constantly increasing pressure, bringing the car to an easy but positive stop…"

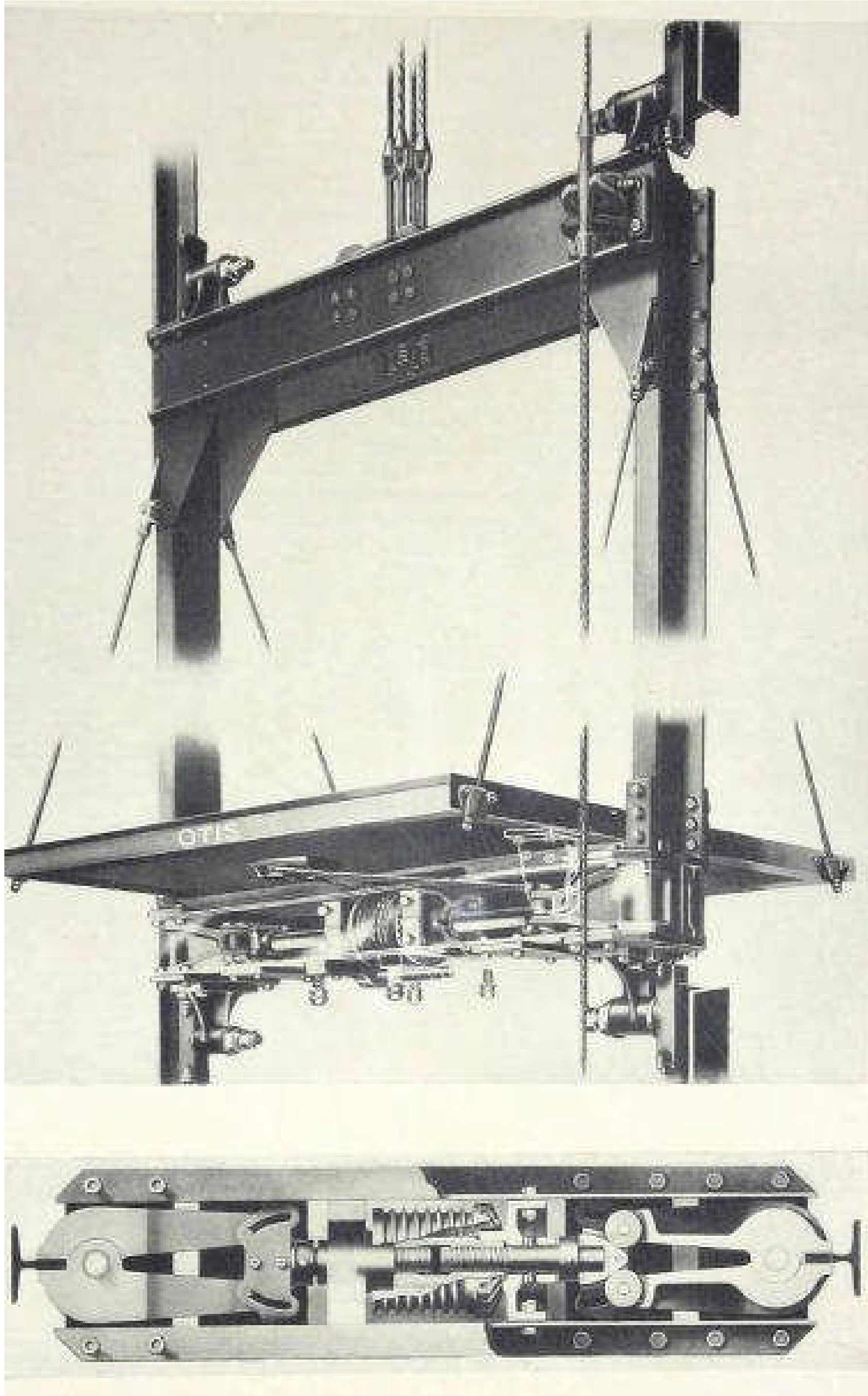
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

Left: caption: "Safety Device for Steel Guides"



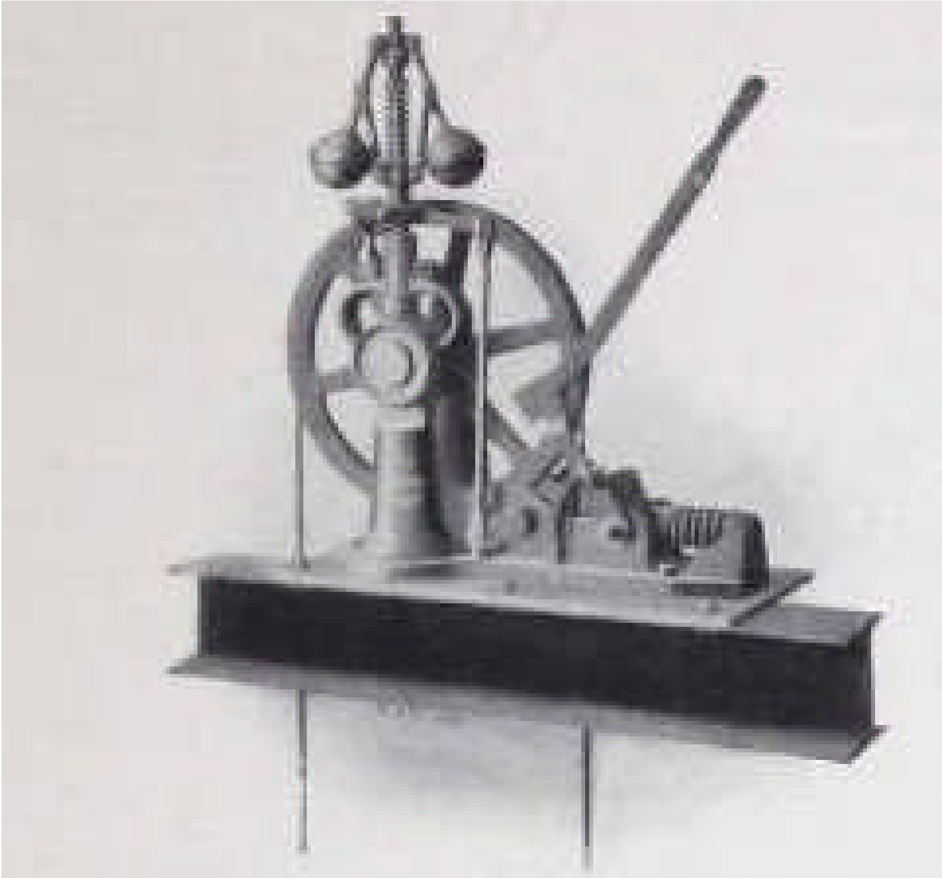
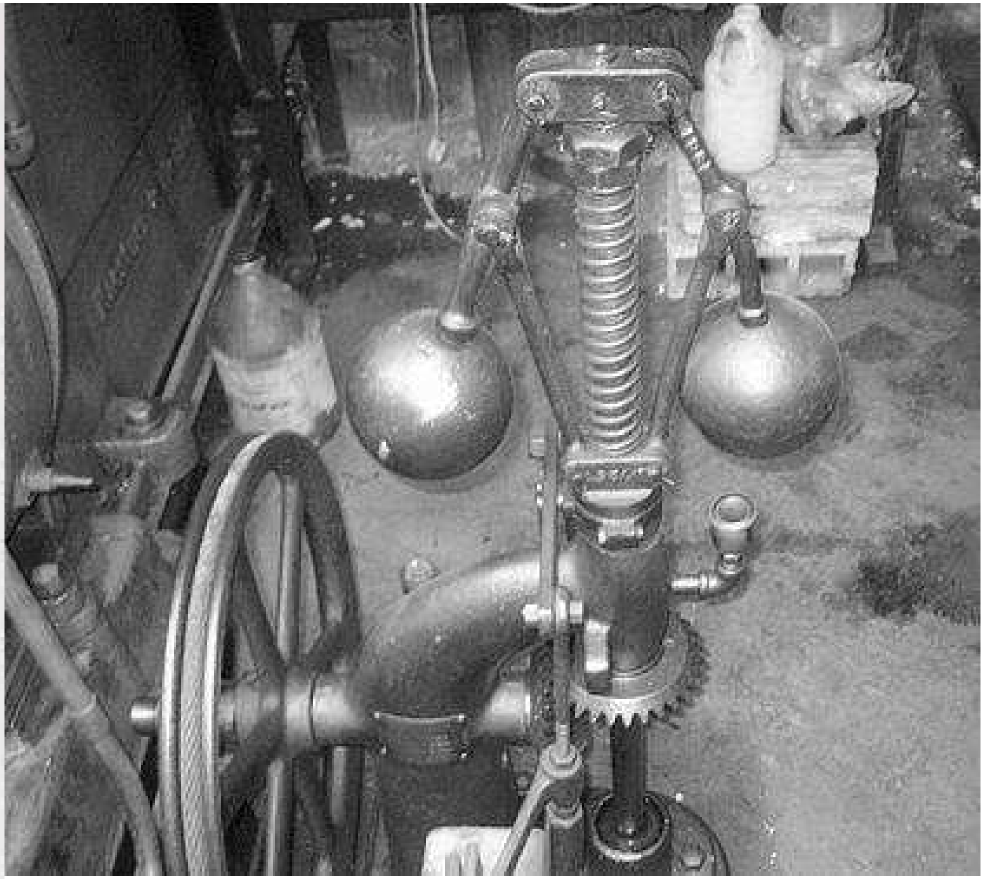
"…While the factor of safety in the construction of Otis Elevators is materially in excess of any strain to which they may be liable in their operation, each elevator is provided with special safeguards against all known forms of elevator accidents. The safety stopping device does not differ materially in principle from that which proved its worth thirty years ago, such changes as have been made being principally to adapt it to the heavier loads and higher speeds which now prevail. The governor is located at the top of the elevator hatchway and is suitably connected to the car, entirely independent of the lifting cables. Should the elevator car, for any reason, exceed the predetermined speed for which the governor has been set, the powerful clutches located beneath the car grip the guide posts, bringing the car to a safe and easy stop. The form of grip shown in Figure Twenty-three is used with steel guide posts, and the form shown in Figure Twenty-four is used with wooden guide posts. From the time of the formation of the company, our experts have made the question of safety a special study, and every feature which tends to ensure immunity from accident has been embodied in the Otis product…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1903)
<u>Left</u>: caption: "Figure 23. Safety Clutch for Steel Guide Posts"
<u>Right</u>: caption: "Figure 24. Safety Clutch for Wooden Guide Posts"



"...The car safety device is mounted underneath the car platform and is connected by means of a rope to an Otis centrifugal speed governor at the top of hatchway. In case the car attains excessive descending speed, the governor is tripped and grips the rope, which in turn causes the safety jaws to grip both sides of the wood guides, thereby preventing further descent of the car…"

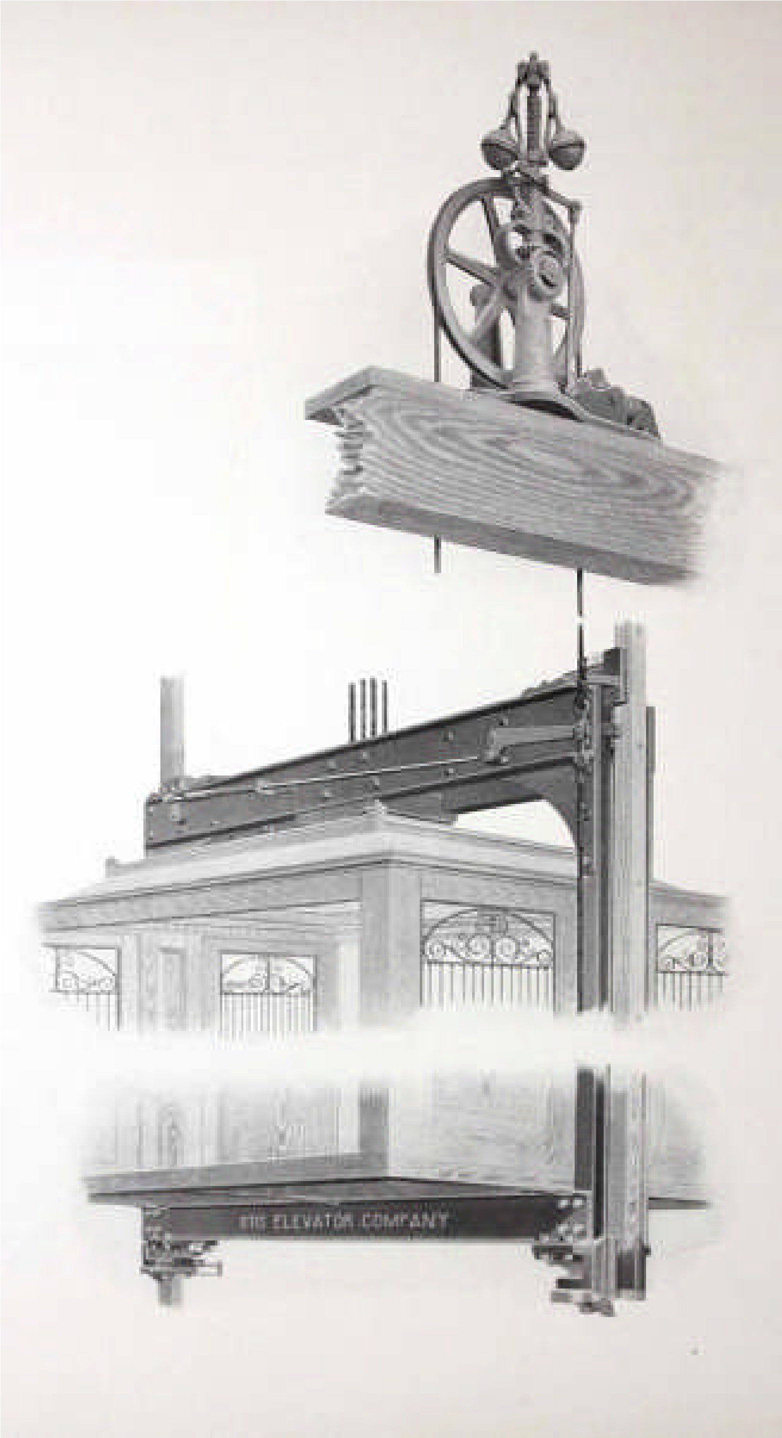
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1922)

"…This speed governor has been tested by actual use for over thirty years, and has never failed to limit the speed of the car to the rate to which it is adjusted. Its action is also entirely independent of the lifting cables, so that in the possible contingency of the breakage of these cables, it will bring into action the car safety device to which it is connected, and will bring the car to a safe and easy stop. Various standard types of car safeties and guides are made to suit the conditions to be met…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1900)

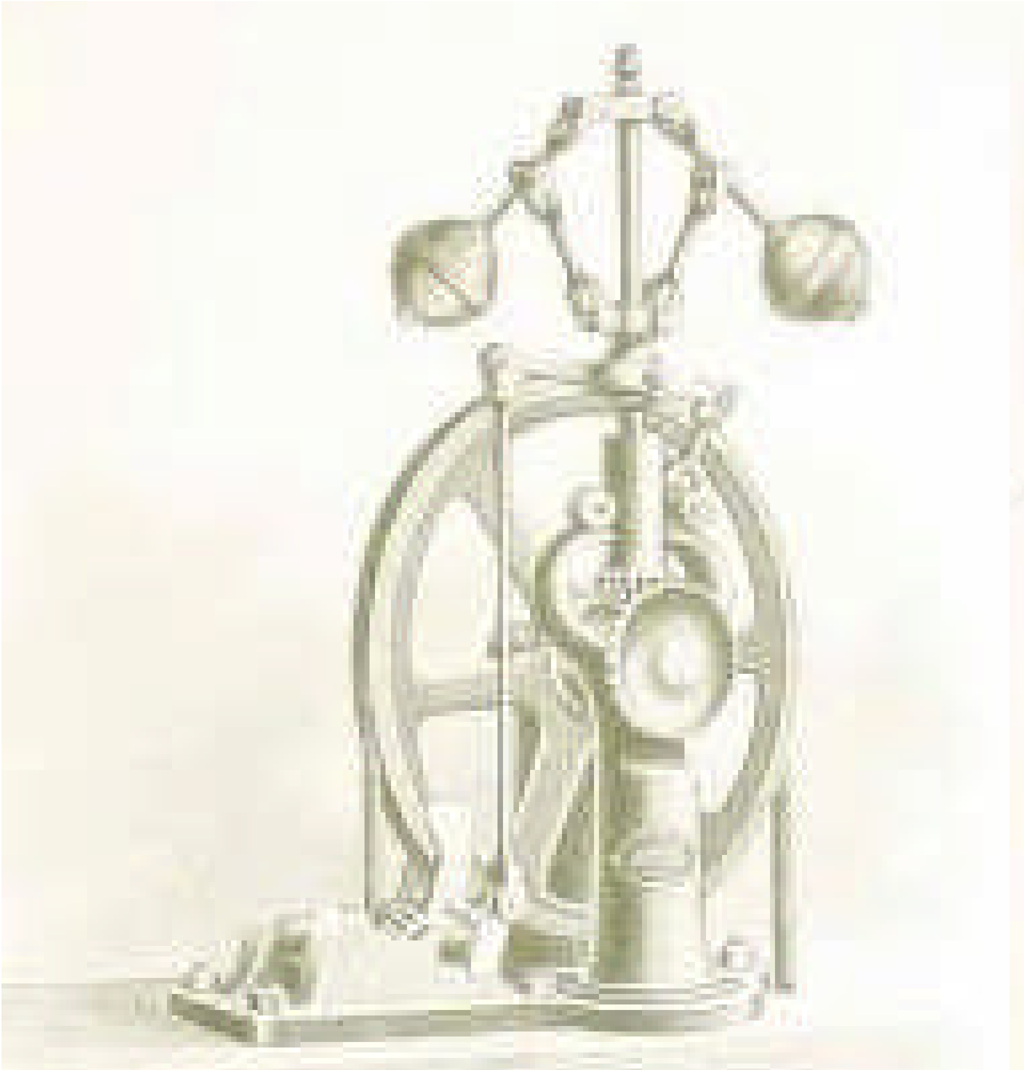
Above L&R: Otis "Swinging Ball-Type" speed governor

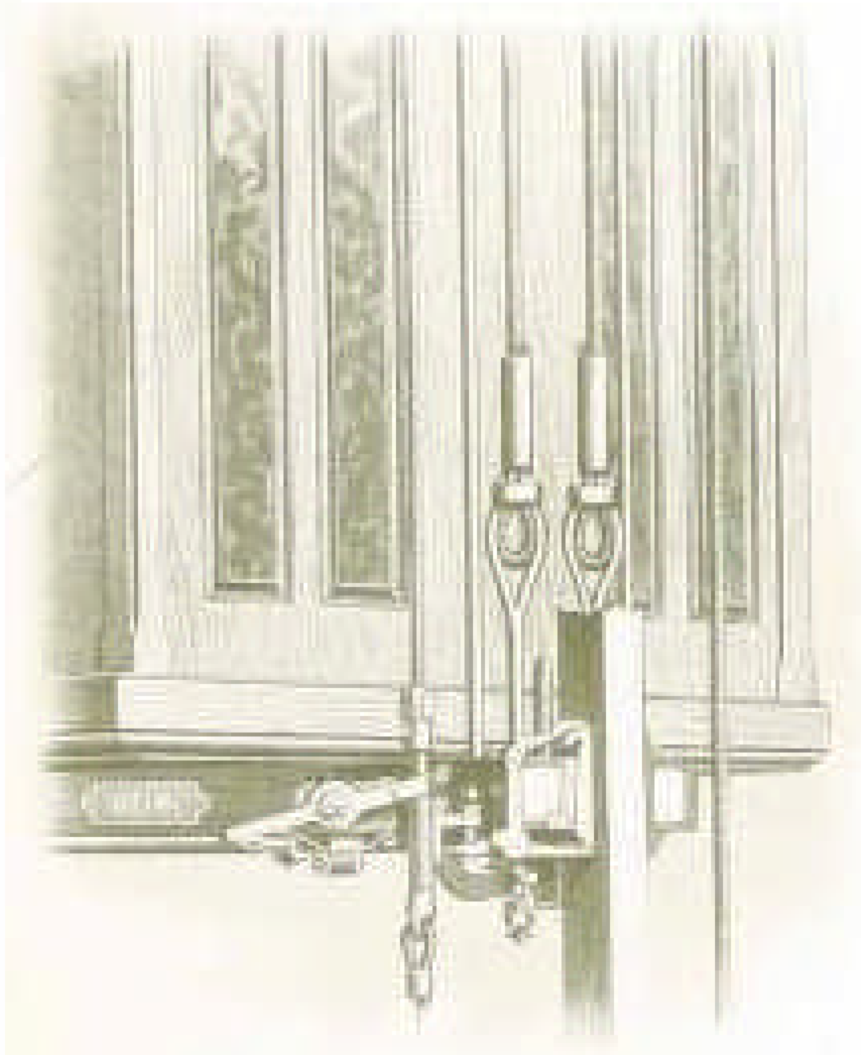


"…The illustration shows the Otis Governor directly connected to our Triple Grip Safety Device, for use in connection with hardwood guides, and for the purpose for which it is designed is equal in effectiveness to the wedge clamp…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

Left: caption: "Otis Safety Governor and Triple Grip Safety Device"





"…The illustration shows our Steel Frame Platform with Roll Safety Device, which is suited for either passenger or freight service where the car speed is low and a quick, positive stop is not objectionable…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

<u>Left</u>: caption: "The Otis Freight Platform with Corrugated Roll Safety for use with Steel Tee Guides"

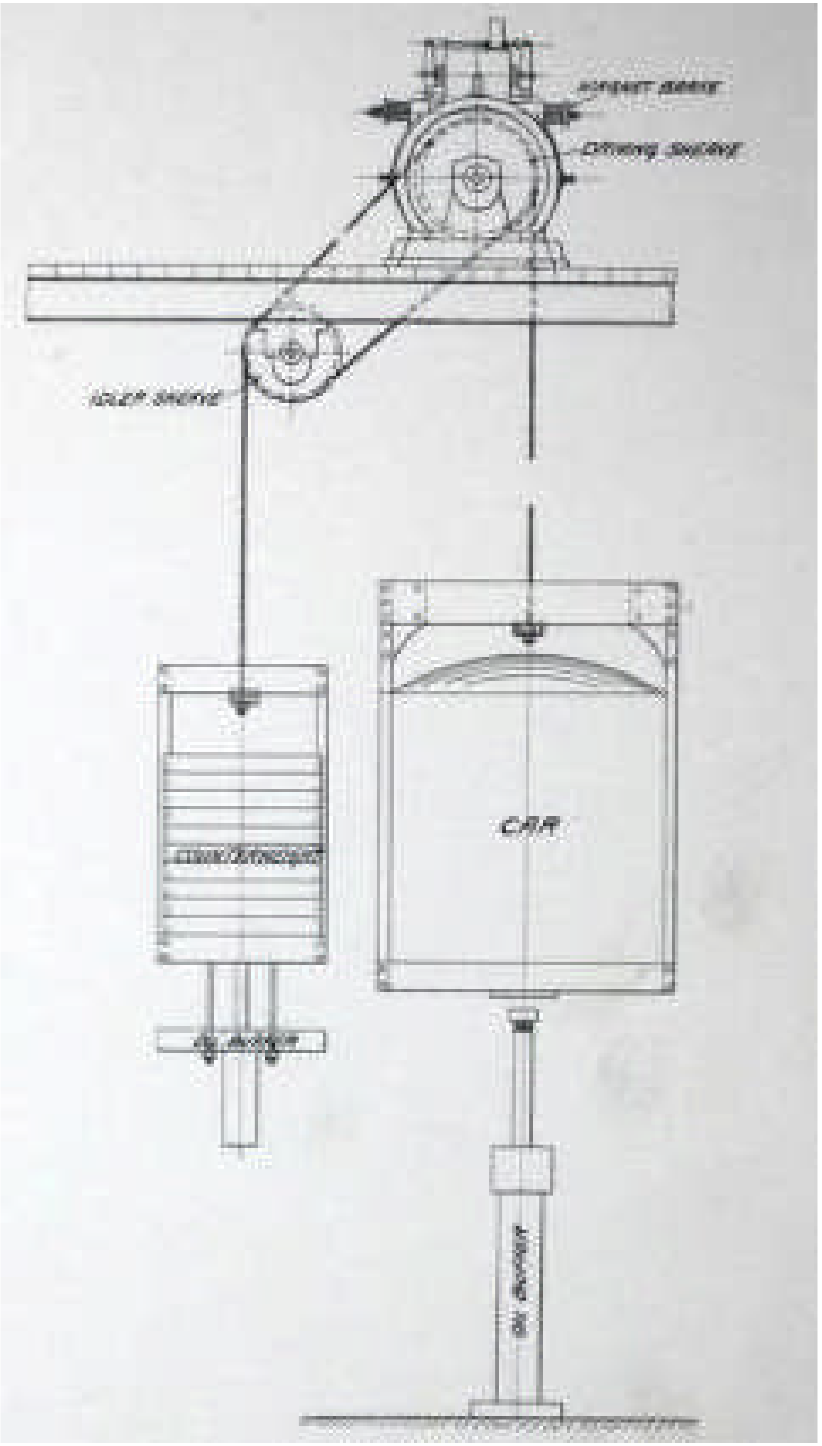
OTIS TRACTION ELEVATORS

Otis Elevator Company, Yonkers Works, Yonkers, N. Y.

Gearless Traction Elevator (1:1 Roping)

"This invention, unique in elevator patents, is the logical result of the tendency of the day to the greatest simplicity, combined with maximum economy and the highest possible degree of safety. No one who has ridden on one of these elevators has failed to appreciate that the machine able to accomplish what this one does so easily and smoothly, at the same time impressing the passenger with such a feeling of solidity and security, is the machine which the public has wanted and will want from now on. As the public is intensely interested in anything relating to the greatest buildings of modern times, the Metropolitan, Singer, and Woolworth towers, and especially in the apparatus which will take it to the tops of these 600 and 700-foot structures in one minute from the street level, the following brief description of the elevators that accomplish this will undoubtedly prove of interest…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)



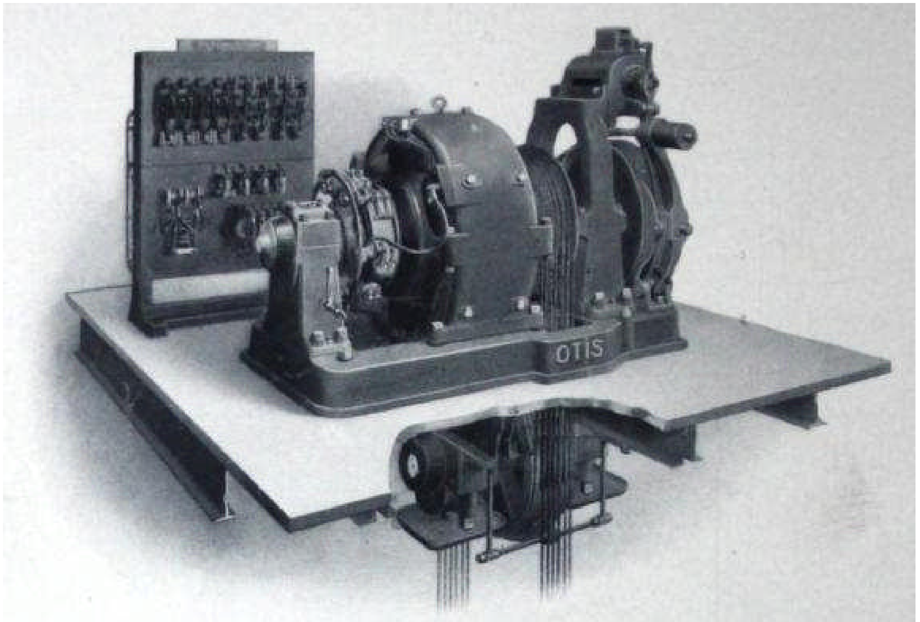
"…The Otis Electric Traction Elevator derives its name from the fact that motion is obtained by means of the traction existing between the driving sheave and the hoisting cables. In order to produce the necessary tension for this result, the hoisting cables, from one end of which is suspended the car and at the other end the counterweight, pass partially around the traction driving sheave in lieu of a drum, continuing around an idler leading sheave, thence again around the driving sheave, thereby forming a complete loop around these two sheaves. The principle and method of roping just outlined is plainly shown in Figure 1…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

<u>Left</u>: caption: "Figure 1. General Arrangement of Roping for Otis 1:1 Gearless Traction Elevator Installation"

“…In this type of elevator the working parts have been reduced to the simplest possible elements, but at the same time absolute safety and perfection of operation have been secured by the application of a sufficient number of highly ingenious devices and controlling features…”

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)



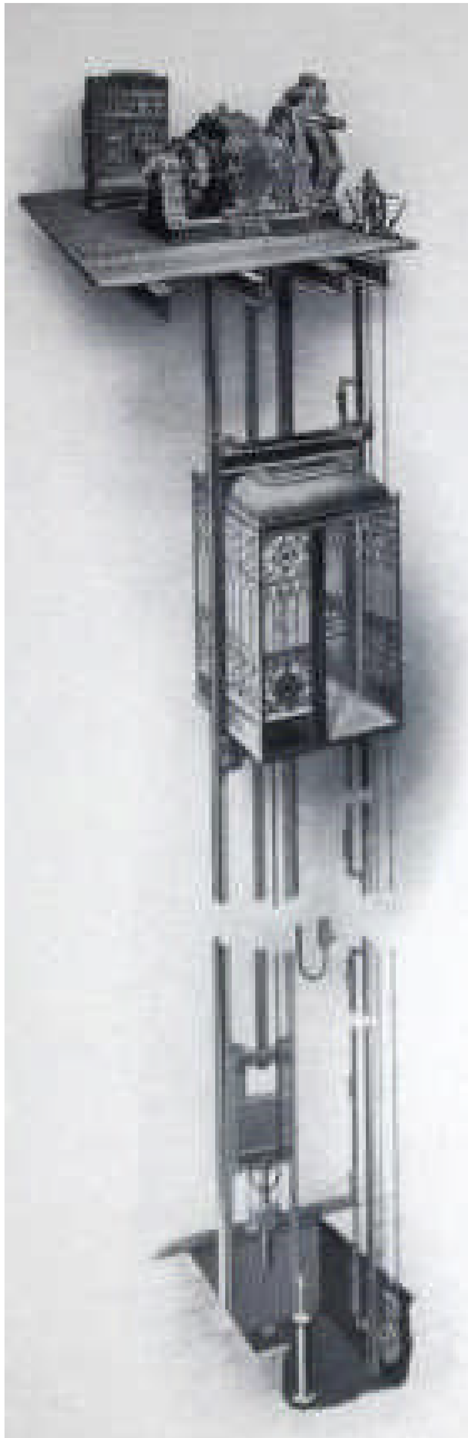
"…The machine itself consists essentially of a motor, a traction driving sheave and a magnetically released spring applied brake, all compactly grouped and mounted on a continuous heavy iron bed. Instead of the high-speed motor customarily used with the Geared Electric Elevator, a slow speed shunt wound motor designed especially for the service is employed. These motors, contrary to an erroneous popular belief in regard to slow speed motors in general, have a remarkably high efficiency. The armature shaft which is of high tensile steel of ample strength serves merely as a support for the load and on it are mounted the brake pulley and driving sheave. The actual drive from the armature Spider to the sheave is effected through a flange integral with the spider and bolted directly to the sheave, thus eliminating all torsional strains to the shaft, and the use of keys…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

Above: caption: "Gearless Traction Elevator Machine 1:1 Roping"

"…The advantages of this type of elevator over the Geared Drum type are obvious. The Gearless Traction Elevator may be used for any rise whatsoever, because this invention does not have to consider a drum upon which the hoisting cables are wound. The direct drive and consequent elimination of all intermediate gearing between the motor and driving member results in a machine of very high efficiency and absolutely prevents any possibility of vibration or noise that might perhaps occur from the imperfect wearing of a system of gears. With the slow speed motor employed the armature momentum is much less than with a smaller high speed armature, and therefore permits of greater ease in starting and stopping, resulting in a smooth and practically faultless movement of the car. Moreover, the compact and simple arrangement of parts permits of the greatest simplicity of installation and economy of space, especially if the machine itself be located over the hoistway…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)



"…The controller used with these elevators embodies the very latest and approved application of electro-magnetic switches. It is actuated by a master switch in the car and gives starting, accelerating, retarding and stopping effects unexcelled by even the most costly, high-grade, hydraulic equipments. The controller is so designed in connection with the motor that the initial retardation of the car in coming to rest is independent of the brake, the latter being requisitioned to bring the car to a final and positive stop and to hold it at the landings. The motor is also governed in such a way. electrically, as to prevent the car from attaining any excessive speed, no matter what the load in it may be…"

RE: excerpt from an OEC brochure (ca. 1912)

Left: caption: "Complete Gearless Traction Elevator Installation"

“…In designing the controlling equipment, one of the features demanding greatest consideration, in view of the very high speed at which the cars run. is the automatic retarding of their speed to a final stop at the upper and lower terminals of travel This result is very satisfactorily attained by two multi-arm switches located on the car - one for the up and one for the down motion These switches are operated by cams in the hatchway, that open the contacts, one after the other as the car approaches the limits of travel This automatic feature is entirely independent of the operator in the car and is effective even though the car operating device be left in the full speed position…”

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

"…The usual safety devices installed in connection with modern high-grade apparatus, are used with this type of elevator, including speed governors, wedge clamp safety devices for gripping the rails in case of the car attaining excessive speed and potential switches. One particularly prominent safeguard resulting from the arrangement and the method of driving the cables, is the decrease in traction which follows the bottoming of either the car or the counter-weight on their oil buffers. This minimizes the lifting power of the motor, until normal conditions are resumed. Inasmuch as in any properly constructed elevator the roping is so arr-anged that the counterweight will rest on its oil buffer before the car reaches the overhead work, or vice versa, it therefore will be seen that the above mentioned decrease in tractive effort is a very valuable and effective safety feature inherent in this type of elevator…"

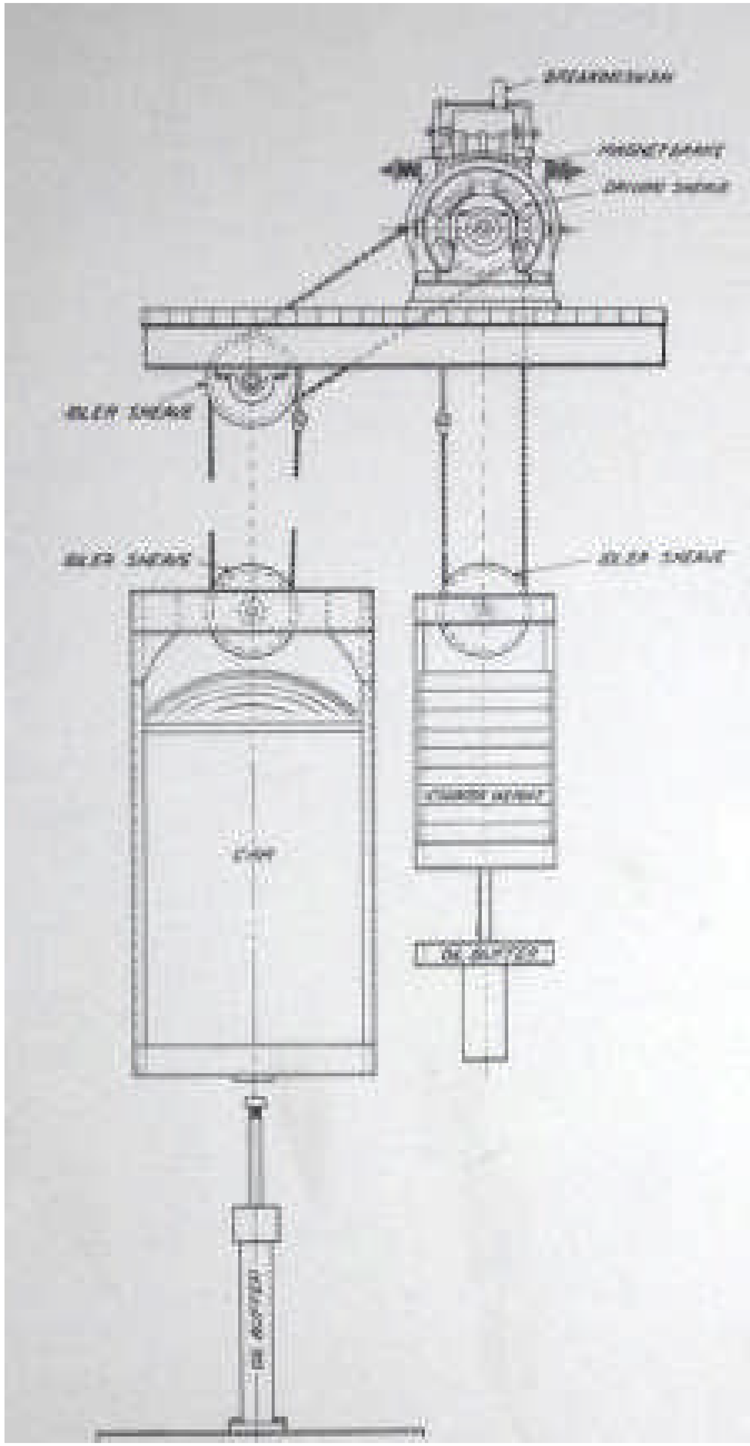
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

"…A feature of security of the greatest interest and importance is provided in the Otis Patented Oil Cushion Buffers, a cut of which will be found on this page. These are placed in the hoistway, one under the car and one under the counterweight, and are arranged to bring either the car or the counterweight to a positive stop, through the displacement of the oil in the buffer at a carefully calculated rate of speed which is regulated by the escape of oil from one chamber of the buffer to another. The buff-ers have been proven capable by test of bringing a loaded car safely to rest from full speed without discomfort to those in the car and in this respect are unique among elevator safety features…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

<u>Left</u>: caption: "Otis Patented Spring Return Oil Buffer"

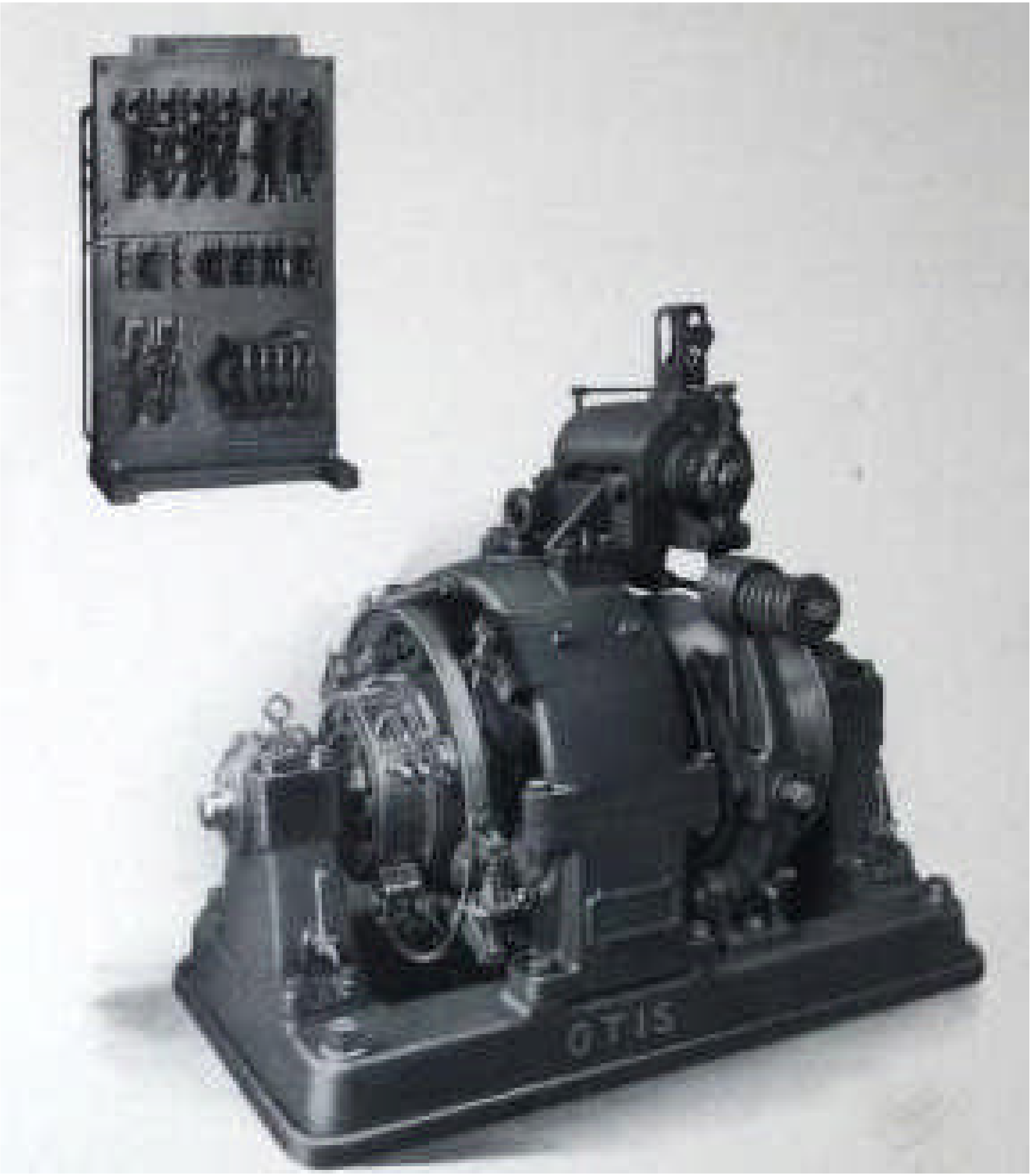
Gearless Traction Elevator
(2:1 Roping)



“…This elevator is an adaptation of the High Speed Gearless Traction Type, permitting of slower speeds by roping the car and counterweight 2:1. still retaining a slow speed motor with Gearless Drive…”

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

<u>Left</u>: caption: “General Arrangement of Roping for Otis 2:1 Gearless Traction Elevator Installation”

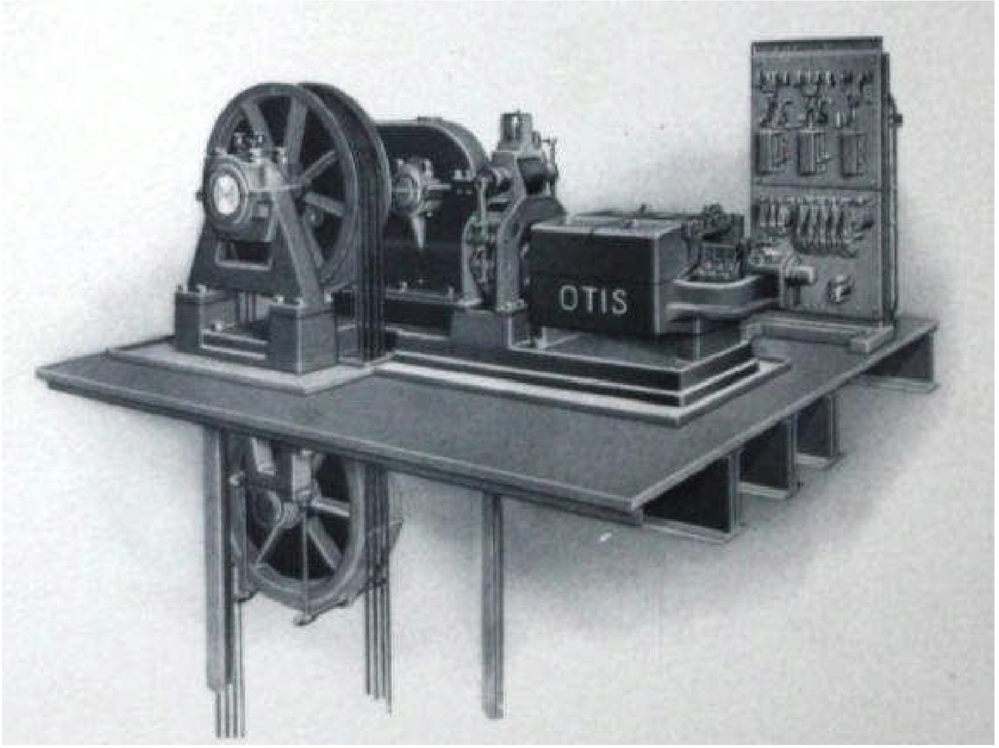


<u>Left</u>: caption: "Gearless Traction Elevator Machine. 2:1 Roping"

Geared Traction Elevator

"…The modern adaptation, in the Otis Traction Elevator, of the traction principle for elevator service which utilizes the patented feature of operating the car by means of driving the cables direct from the motor without the intervention of retarding rigging, showed so conclusively the merits of that principle that the question naturally arose as to the feasibility of employing this method of drive in the low speed machines as well. The result was the introduction of what is commercially known as the Otis Geared Traction Elevator, which embodies many of the good points of its larger contemporary. It might be well to state here that the traction principle is neither new nor experimental, as is demonstrated by its use In the familiar type of carriage hoist, this being in reality a low duty hand power traction elevator driven by means of a hemp rope; also this method of drive has been employed on dumb-waiters for some time. However, as applied to the high speed passenger machines used in our tall office buildings, it must be referred to as a comparatively new and improved development of former types…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)



"…The Geared Traction machine is similar in appearance to the standard drum machine, except that a multi-grooved driving sheave is mounted in place of the drum, and a non-vibrating idler leading sheave takes the place of the vibrating sheave necessary on the drum type. The car and the counterbalance weight hang directly from the driving sheave - one from either end of the cables - in precisely the same manner as with the Otis Gearless Traction Elevator, the necessary amount of traction being obtained by the extra turn of the cables resulting from passing around the idler sheave. The machines are built in two classes, double screw and single screw, depending upon the duty required…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

<u>Above</u>: caption: "Otis Direct Current Double Screw Traction Elevator Machine Designed for Overhead Installation"

***"…The double screw machine is designed for the heavier duties, and the gearing consists of a right and left hand worm, accurately cut from a solid forging. This worm, coupled directly to the electric motor, runs sub-merged in oil and meshes with two large bronze gear wheels which in turn mesh with each other. The effect of the three-point drive thus obtained in conjunction with the right and left hand thread, is the entire elimination of end thrust on the worm shaft - a most desirable feature. The complete gear is fully protected in an oil tight iron case and is well lubricated in every part. Where space permits, three bearings are provided, supporting the driving sheave, worm wheel and their shaft. The shaft passes directly through the driving sheave and the worm wheel center, and is securely keyed to both, thus providing a mechanically strong and satisfactory drive*…"**

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

"…When compelled to use but two bearings, what is termed a 'buffer neck drive' is employed. This consists of a buffer neck or driving spider, with extending arms and a flange that is bolted to the gear wheel near its periphery. Similar projecting arms are provided on the driving sheave. These two sets of arms are bolted together, but flexible spacers are placed between them in order to distribute the load equally on all arms. The machine is equipped with a mechanically applied and electrically released double shoe brake. The shoes are applied against a pulley of ample diameter and width to dissipate any heat generated, which also serves as a coupling between the motor shaft and the worm shaft. The brake shoes, normally, are bearing against the pulley with a pressure corresponding to the compression of the two helical springs. When current is admitted to the solenoid brake magnet, and then only, the action of the springs for the time is overcome, so that the shoes are released. It will be seen, therefore, that the brake will apply with full force should a failure of current occur, resulting in an immediate stop of the elevator…"

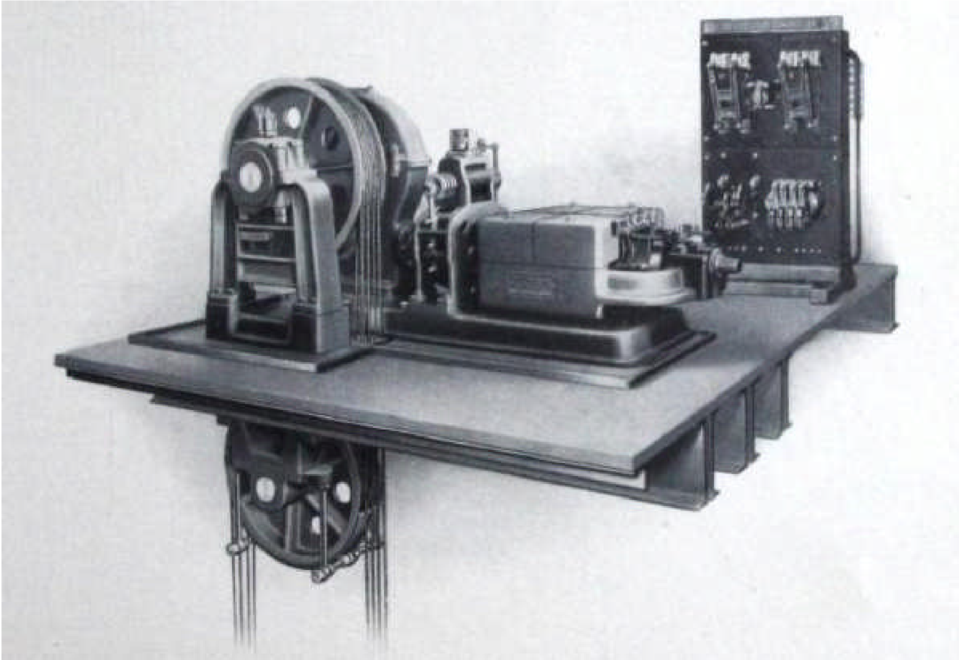
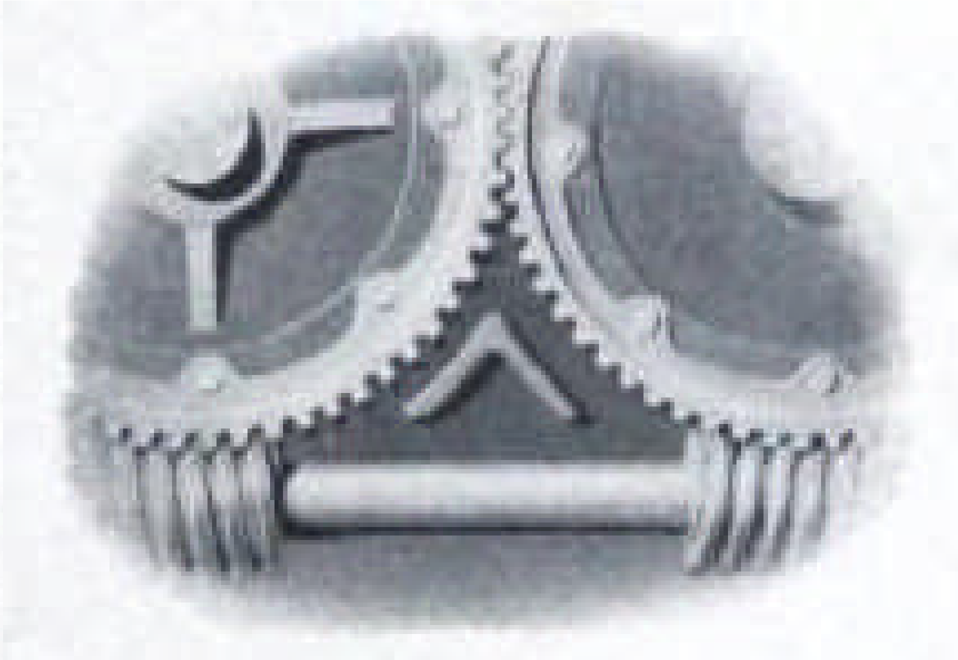
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

"…The motor is compound wound and runs usually at about eight hundred revolutions per minute at full car speed and load. The series field is used only at starting to obtain a highly saturated field in the shortest possible time, and is then short-circuited, allowing the motor to run as a plain shunt wound type. In stopping, a comparatively low re-sistance field is thrown across the armature, providing a dynamic brake action and a gentle slowing down of the car. the brake being called upon only to effect the final stop and to hold the load at rest. Resistance in series with this 'Extra Field,' as it is called, is controlled by magnets which depend, in their operation, on the speed of the armature. It is therefore evident that the dynamic or retarding effect of the field is proportional to the speed, and therefore to the load in the elevator; hence good stops under all conditions are easily obtained…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

"…Rope guards are provided to prevent the cables from leaving their grooves in the event of either car or counterweight bottoming. The same effect is obtained on these machines as on the Otis Gearless Traction Elevators when the cars or counterweights strike their buffers in the pit; namely, that the tractive effort is so much reduced as to make it impossible for the sheave to drive the cables. This is a most desirable characteristic inherent in all traction machines for the reason that rope strains can never increase beyond a certain limit, well within the factor of safety of the cables and fastenings. This means that the danger of the car or weight dropping, as a result of being pulled into the overhead work, and thus breaking cables or fastenings, is eliminated. The Controller, whose magnets operate the various switches, is complete in every detail and consists of 'Potential,' 'Reversing' and 'Fast Speed' switches. 'Accelerating,' 'Load' and 'Auxiliary Load' magnets. The resistances are all carried on the back of the Controller and are easily accessible…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

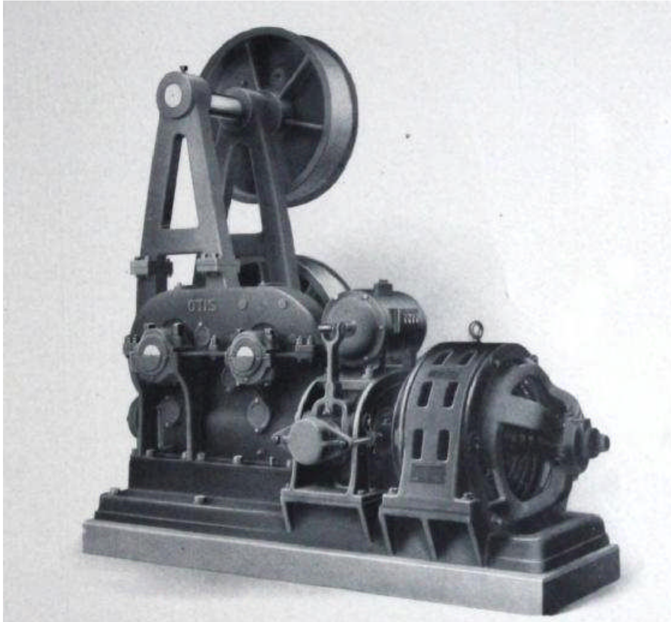
 

"…These machines can be arranged for car speeds up to 400 feet per minute with 2.500 pounds, or decreased speeds with corresponding increased loads. For the lighter duties the single screw machine referred to is furnished, and is essentially the same as the double screw except that it has a single worm meshing with a single gear wheel - a cut of this type being shown above…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

<u>Left</u>: caption: "Otis Direct Current Single Screw Traction Elevator Machine Designed for Overhead Installation"

<u>Right</u>: caption: "Three-Point Drive Eliminating End Thrust on Worm Shaft"



"…To meet the demands in districts where Alternating Current is in use, the same apparatus described is furnished except that the direct current motor and controller give place to an alternating current motor and controller. The Alter-nating Current machines are made in two classes also, single and double screw. The cut shown above represents a double screw machine designed for basement installations. The brake is slightly different in appearance but performs the same functions as does the direct current brake. The safeties used on the Otis Gearless Traction Elevators are found on the Geared Traction Elevators. The main diff-erence between the two machines lies in the ability to use on the latter a small high speed motor with gearing, instead of the large, slow speed highly efficient, but more expensive motor of the Otis Gearless Traction Elevator…"

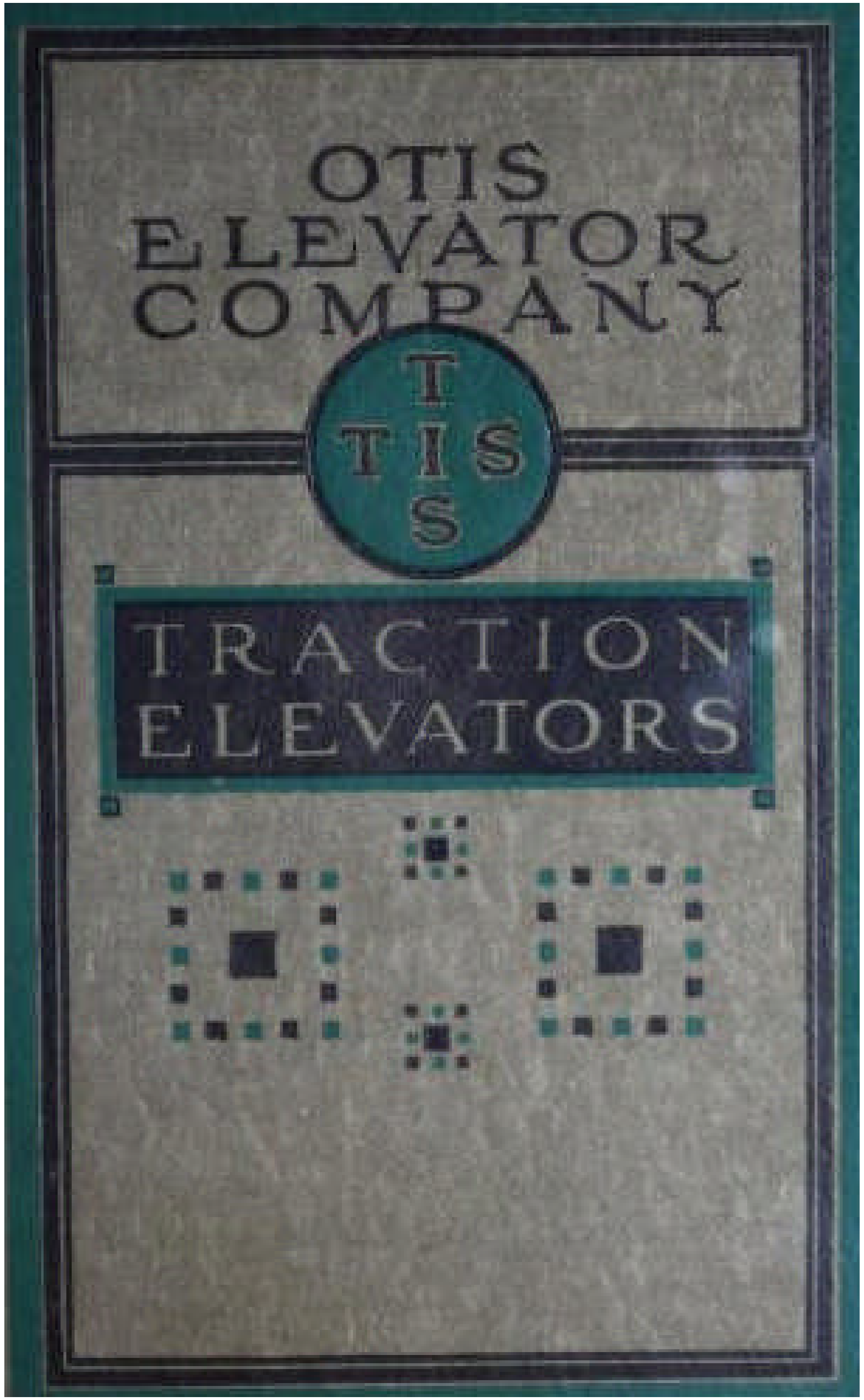
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

Above: caption: "Otis Alternating Current Double Screw Traction Elevator Machine Designed for Basement Installation"

The Herringbone Gear Traction Elevator

"…In addition to the application of the traction principle already described we are now building machines of the traction type that employ herringbone gears in place of worm and gear or ordinary spur gear arrangement. These machines are the result of a popular demand for the production of a machine with high gear efficiency using motors of moderate speed. The gears employed are of the Wuest type, and are not made up of separate helical gears bolted together, but consist of one gear rim on which are cut two sets of helical teeth, properly staggered. The pinion and shaft driving these are in one solid piece, and the teeth are cut in a manner similar to the gear. These gears are cut with great accuracy, and run in perfect alignment, immersed in an oil bath. The controlling and safety features for these machines are practically the same as for the ordinary Otis Geared Traction Machine, already described…"

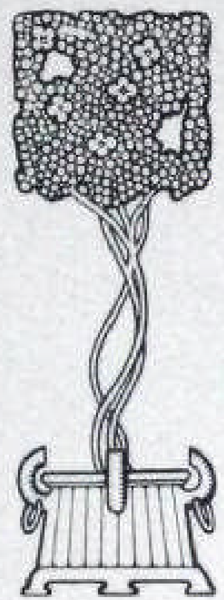
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)



"…In general it may be said that the refinements that have been worked out and the perfection that has been reached have resulted in an apparatus which has given a remarkable demonstration of its safety, economy and traffic handling efficiency, and has adequately satisfied the demand for an elevator of this type. This is conclusively indicated by the large number of existing installations in all parts of the country. Those who have already had the opportunity of seeing all of New York and the surrounding country for a radius of 35 or 40 miles spread at their feet, should bear in mind the fact that to the elevator more than to any other one device are due the structures which give them this lofty outlook..."

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

OTIS
RESIDENCE ELEVATORS



A 1903 advertisement in the popular *McClure's* magazine stated: "The day is not far distant when all houses will be equipped with elevators..." The ad, which emphasized the elevator's modest cost and energy efficiency, suggested that an Otis automatic electric elevator was: "...an important addition to comfortable living..." Otis had been manufacturing electric elevators starting in the 1880s, when the company saw a market for them in high-end residences.

<u>Left</u>: McClure's, May 1903

For Houses of Pretension

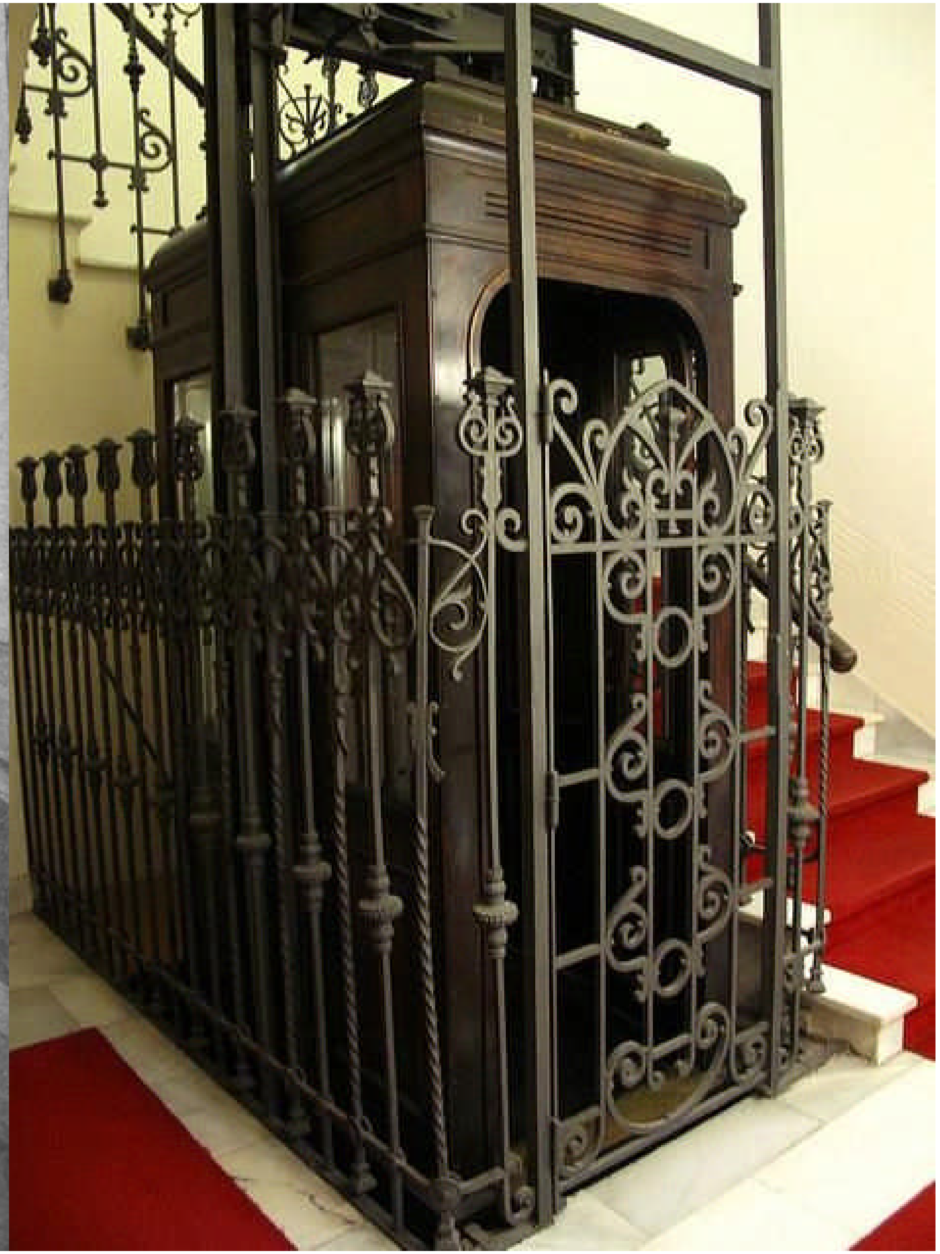
"…Electric Passenger Elevators for private residences is an Otis specialty, and is now regarded as an essential feature of every fine residential establishment. These elevators are built to be operated by push buttons at the landing doors and in the car. If it is desired to bring the car to a particular landing, it is only necessary to press the button opposite that door at the landing. This will bring the car to the landing, when the door may be opened, and while open the car cannot be removed from the landing. There is a system of automatic door locking devices connected with the operating mechanism of the elevator. The car is provided with a series of buttons corresponding in number to the number of the floor landings…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1900)

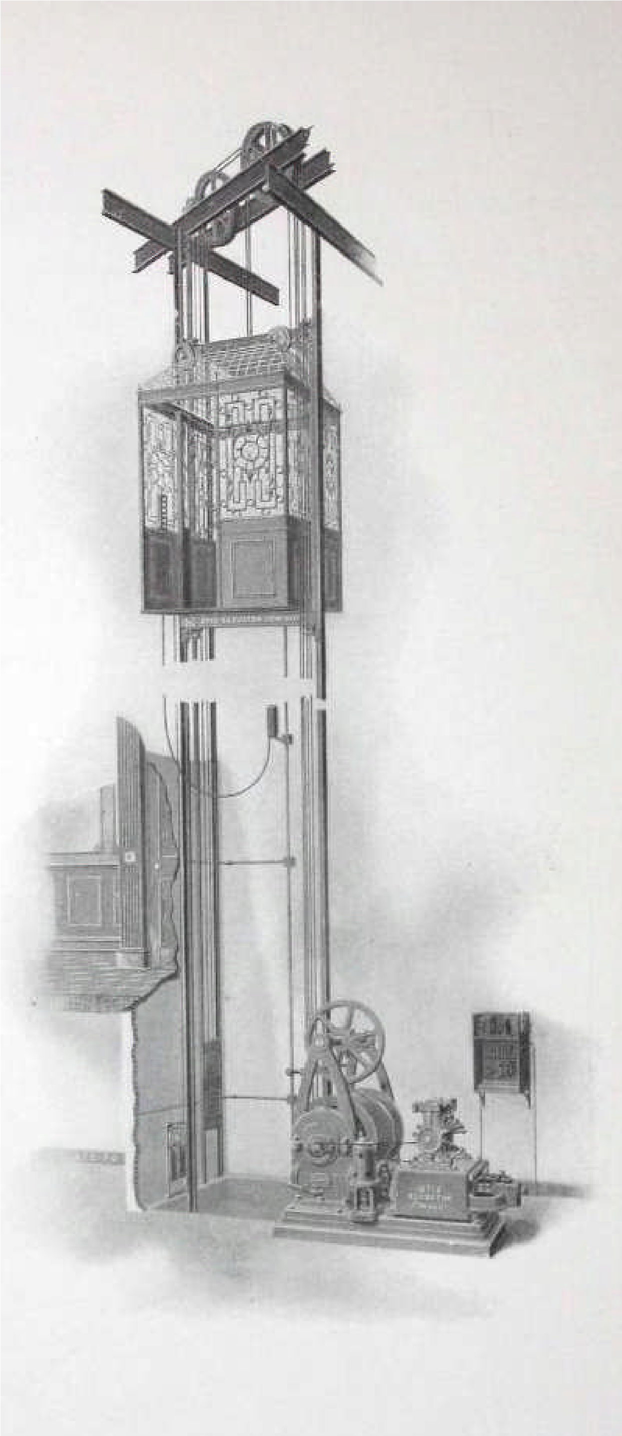
"…The constantly increasing demand for completeness in appointments of the modern private dwelling has evolved the perfection of a most ingenious piece of machinery known as the Otis Automatic Residence Elevator. This type of machine, as its name implies, is designed for use without a regular operator in attendance, its movements being controlled by its passengers or by those who desire its service, and who in general are entirely unfamiliar with the operation of elevators. For this reason it is most essential that every detail of the apparatus be absolutely reliable, that the installation be safe beyond any degree of doubt, and that it shall be so simple that even children may be their own operators without the slightest danger…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

<u>Above</u>: caption: "Typical Entrance to an Otis Residence Elevator"



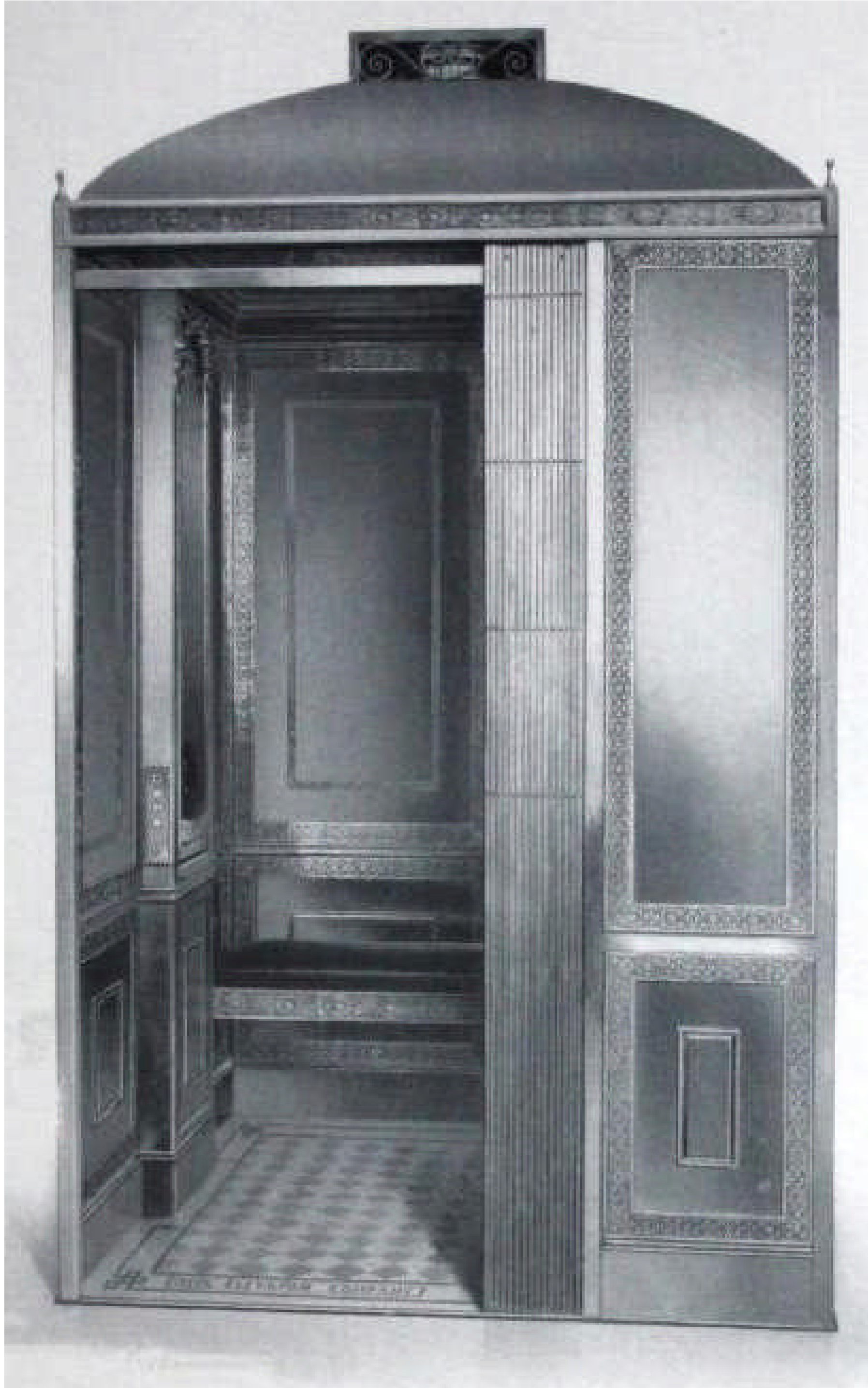
<u>Left</u>: caption: “Otis Automatic Electric Elevator for use in residences is an addition to the comfort of every member of the household; and at the same time increases the value and salability of property more than cost of installation. No house of pretension should be without one. We frequently install elevators in houses already built. It is not as much an undertaking as one might think to thus bring an old house up-to-date”



"…An installation consists of an electric motor-driven winding machine, a 'controller' for closing and opening the main line circuits to the motor through electromagnetic switches, and a 'floor controller' whose duty it is to properly stop the elevator car at the desired floor. The car itself is made of hardwood or ornamental iron…This type of elevator, although originally designed for private residences, has been installed with most satisfactory results in apartment houses, hospitals, and other places where the service is intermittent and it is desired to do away with the expense of an attendant…"

RE: excerpt from an OEC brochure (ca. 1912)

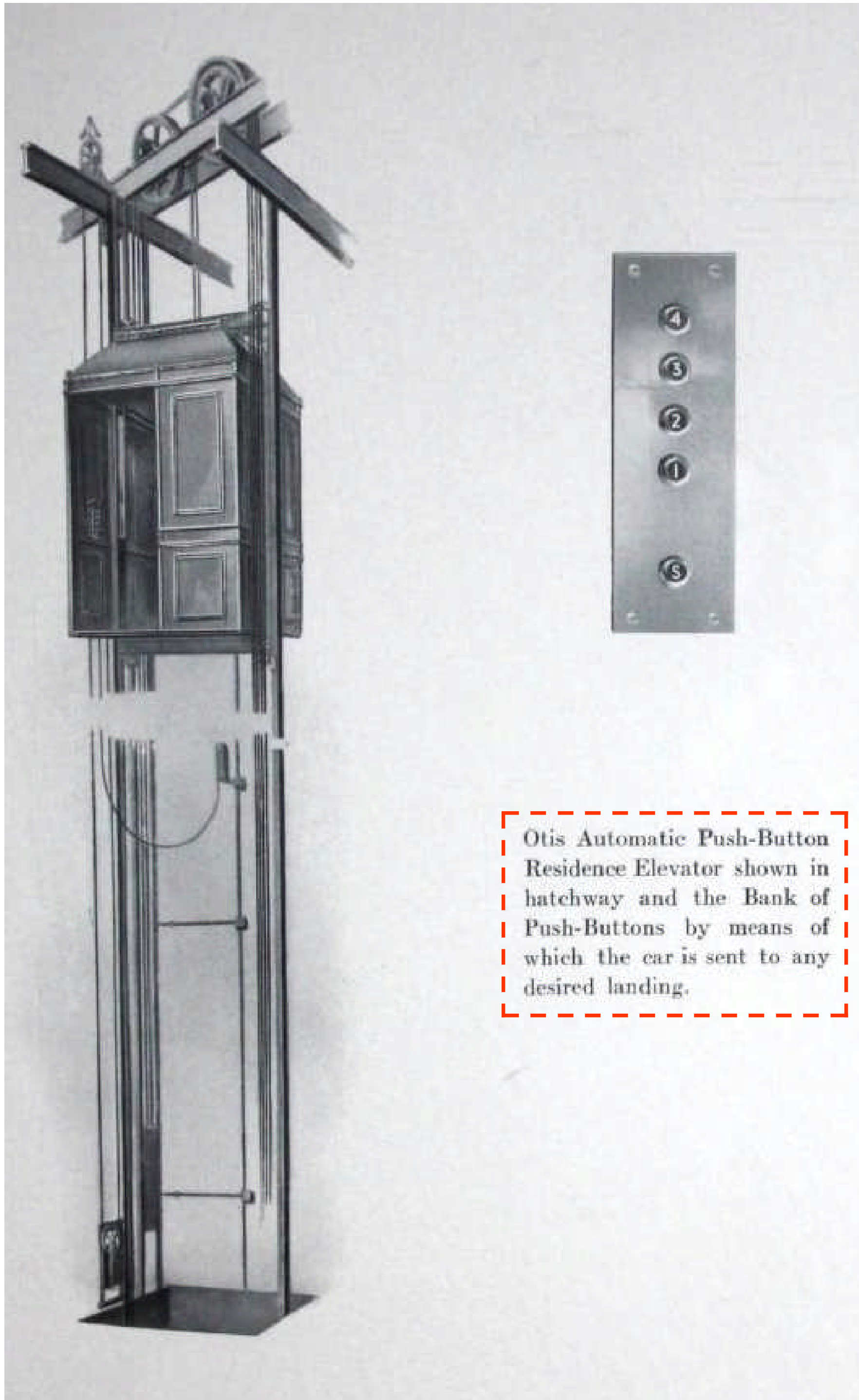
<u>Left</u>: caption: "Otis Electric passenger Elevator, with Push-Button Control"



"…In order to meet the conditions imposed upon the automatic elevator, provision must be made for the foll-owing requirements: (1) That a person may step into the car, press a button, and be carried to the floor he desires without interference from any one in the halls who may want the car. (2) That a person may call the car, pro-vided it is not in motion or occupied, to any floor on which he happens to be. (3) That all doors in the halls must be automatically locked while the car is in motion, and only after it has stop-ped at a landing can that door be op-ened. (4) That in an emergency the passenger may stop the ear positively at any point and at any time…"

RE: excerpt from an OEC brochure (ca. 1912)

<u>Left</u>: caption: "Design of Automatic Push-Button Elvt'r. Car for Private Resid-ence"



Otis Automatic Push-Button Residence Elevator shown in hatchway and the Bank of Push-Buttons by means of which the car is sent to any desired landing.

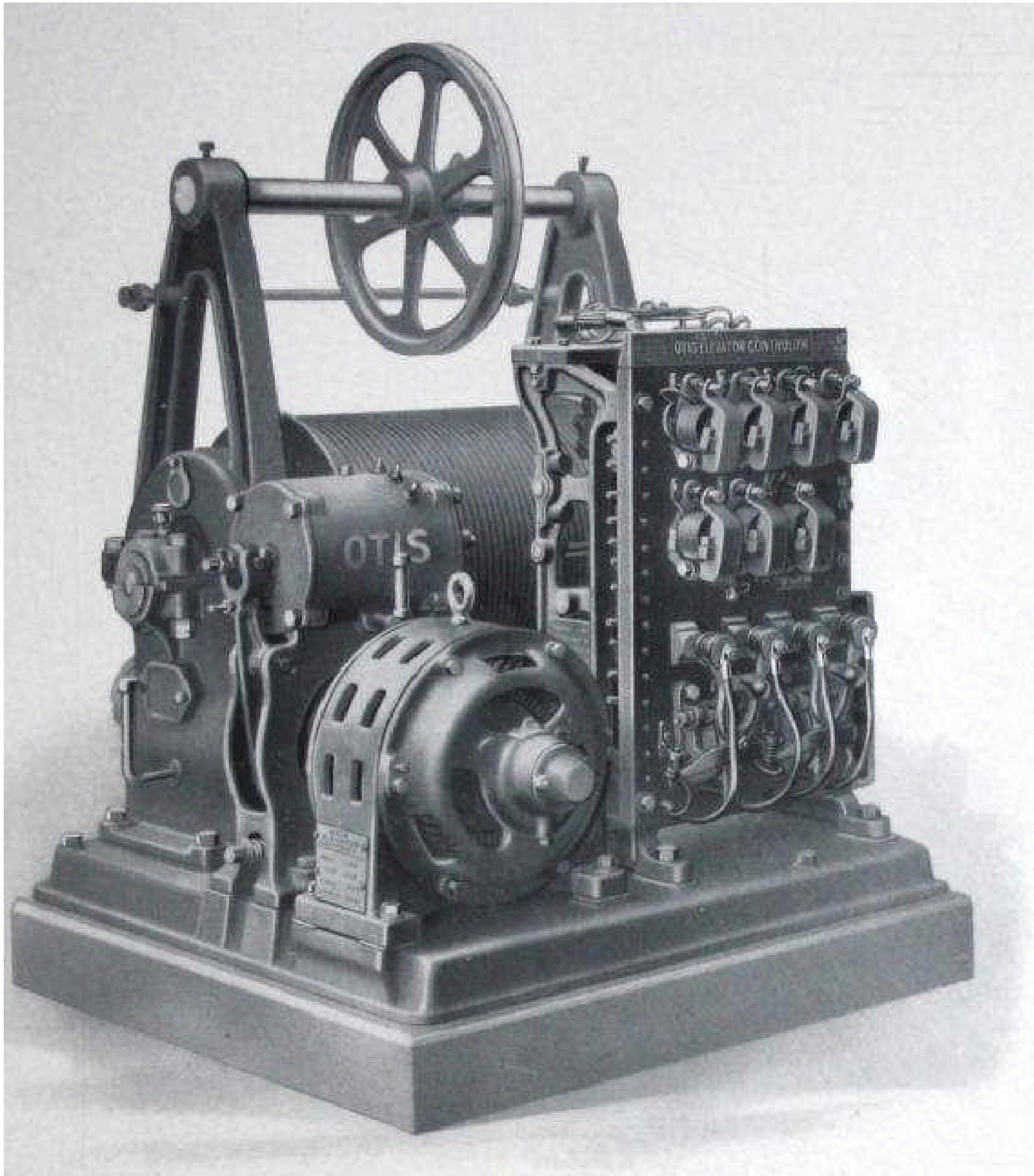
"…At each floor there is a button similar in appearance to the ordinary call bell and is pressed momentarily by the person wishing the car. If unoccupied; it will start from whatever point it last stopped, come to the proper floor, stop and unlock the door. All the doors except the one opposite to which the car stops are automatically locked. This is accomplished by a patent door lock at each floor, whose operating lever projects slightly into the hatchway. A swinging cam mounted on the car engages this lever only when the car is at rest and opposite a floor, at which time the door may be opened. When the elevator is started the cam is swung clear of all the operating levers and remains so during the car's travel up or down the shaft. It will be seen that were this cam stationary it would momentarily unlatch each door as the car passed its lock, and should any one be trying to open this particular door lie would be able to do so. By the method employed, however, the danger of opening a door at a time when the ear is in motion or not at the floor is eliminated…"

RE: excerpt from an OEC brochure (ca. 1912)

<u>Left</u>: caption: "Otis Automatic Push-Button Residence Elevator shown in hatchway and the Rack of Push-Buttons by means of which the car is sent to any desired landing"

"…a person may step in the car and press the fourth button with the intention of going to that floor, but having changed his mind or wishing to return, a pressure of the 'Stop' button will immediately bring the car to rest and set all the magnets in their initial stop position, ready for another start. This has been found very convenient and is an especially appreciated feature…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

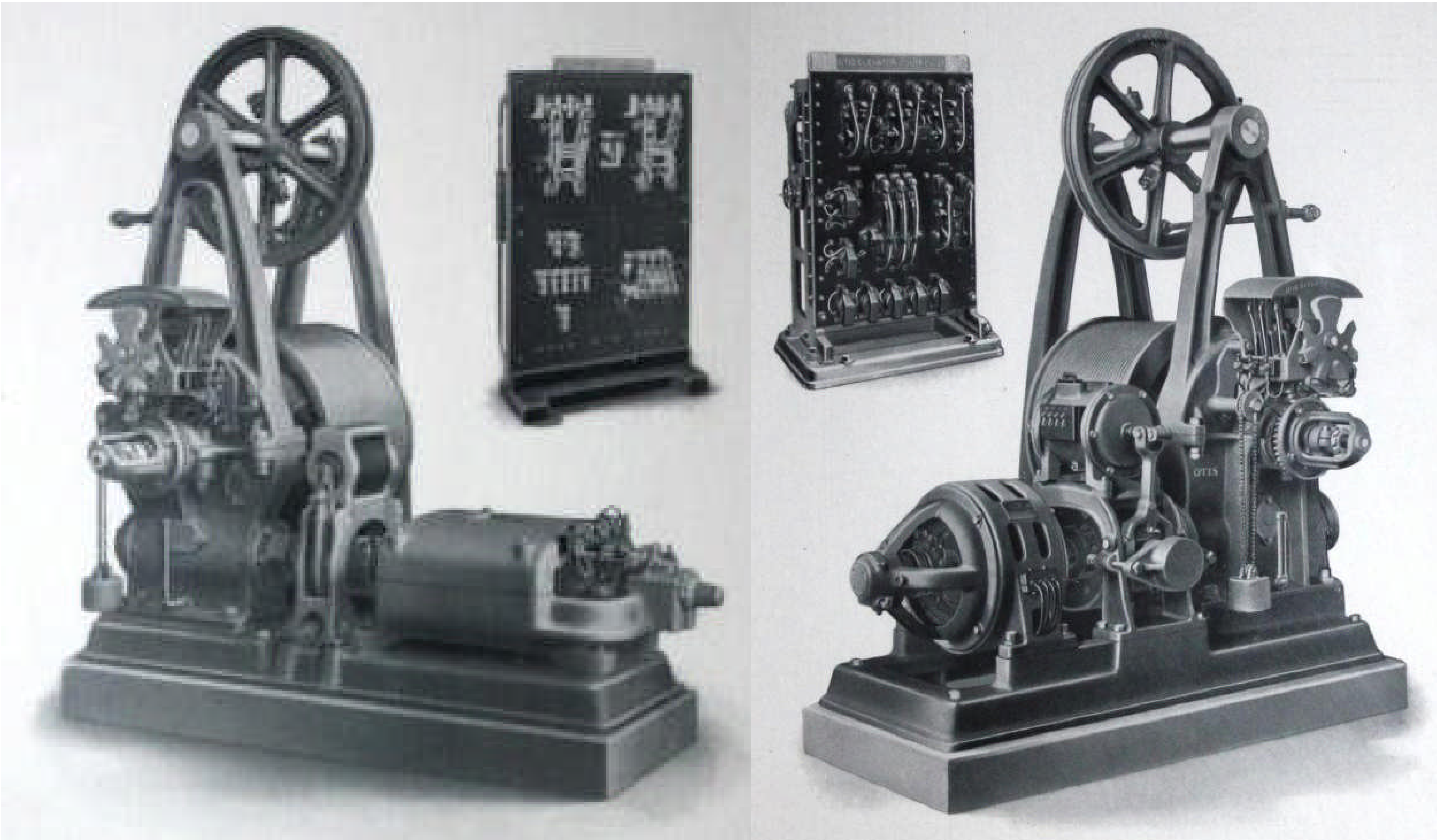


<u>Above</u>: caption: “Light Duty Single-Phase Alternating Current Residence Elevator Full Automatic Control”

<u>Left</u>: caption: “Light Duty Direct Current Residence Elevator Full Automatic Control”

"…A device known as a 'slack cable' switch is provided which stops the car, when for any reason, the hoisting cables become slack. The operating circuits are also opened by 'limit' switches, one being placed in the hatchway at each end of the travel and are engaged by a rigid angle iron cam mounted vertically along the side of the car. These switches are opened only when the car has gone from four to six-inches beyond its normal limits of travel, and effect an immediate stop when operated. The car itself is equipped with what is called a 'safety plank,' this being the main support of the car bottom and enclosure and embodies a device for clamping the guide rails in the event of the hoisting cables parting. In this way a gentle but positive stop is applied and prevents a fall to the bottom of the wellway…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

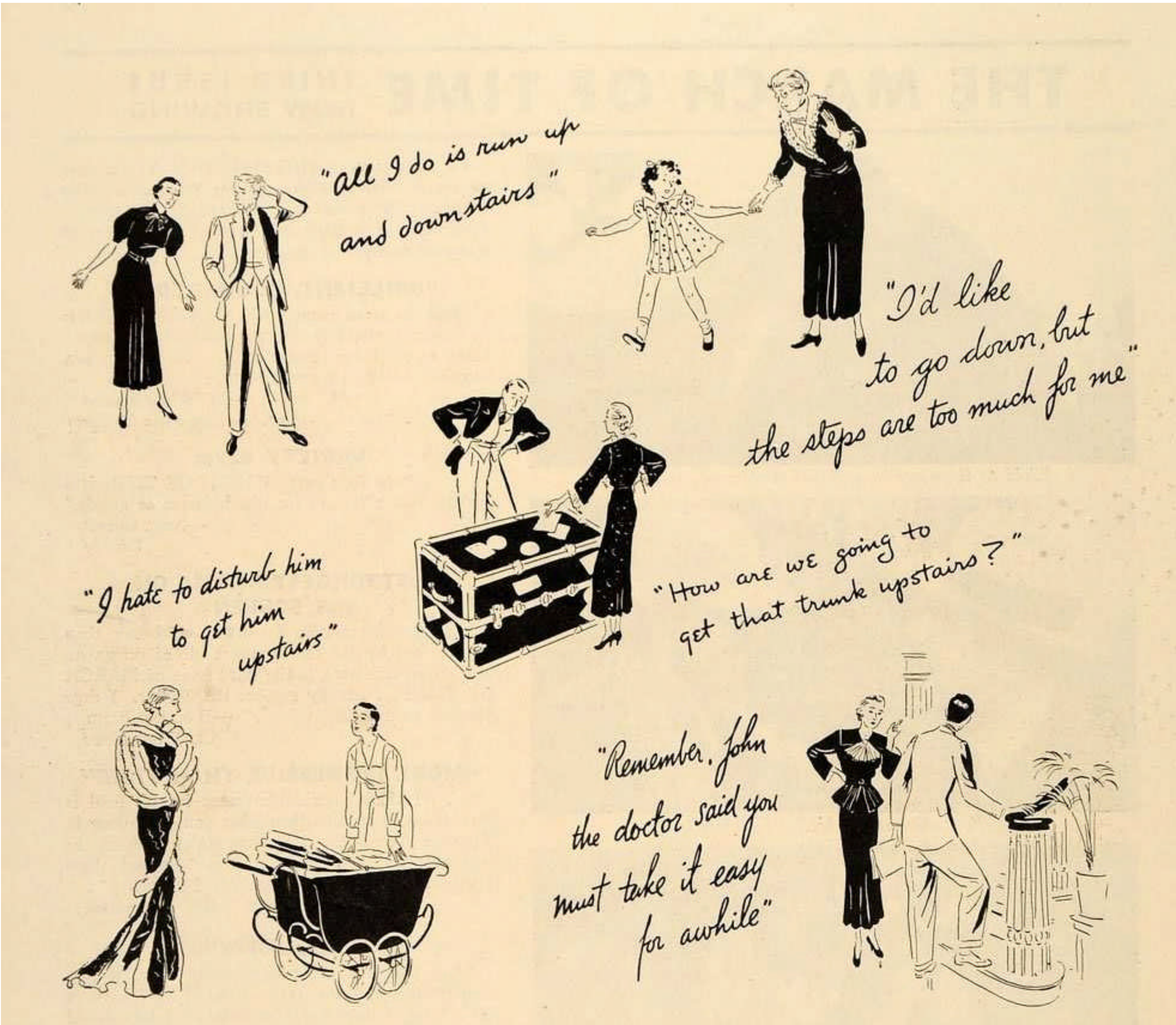


<u>Left</u>: caption: “Heavy Duty Direct Current Residence Elevator - Full Automatic Control”
<u>Right</u>: caption: “Heavy Duty Alternating Current Residence Elevator - Full Automatic Control”

The Personal-Service Elevator

<u>Left</u>: caption: "For him who takes pride in home and a lively interest in the newer things that make a home more comfortable, Otis Elevator Company has built the Personal-Service Elevator. Its purpose is pure utility - to remove the burden of stair climbing - to serve him (or her) who is vigorous and hea-lthy and him who is aged and infirm - to take the members of your house-hold and their burdens up and down. It turn the stairs into part of the house dec-oration - useful only on such rare occ-asions as when, for instance, the bride needs a vantage point from which to toss her bouquet. The Personal-Ser-vice Elevator is suited to any home. It can be installed in the existing dwell-ing as rapidly as the one that is no more than a blue-print. It is built to harmonize with its surrounding. When its outer door is closed, no one would suspect its presence. It can be installed at reasonable cost. Any one who can press a button is a full-fledged oper-ator…"

(1937 Otis ad)


"All I do is run up and downstairs"
"I'd like to go down, but the steps are too much for me"
"I hate to disturb him to get him upstairs"
"How are we going to get that trunk upstairs?"
"Remember, John the doctor said you must take it easy for awhile"

"…this home elevator is practical in <u>any</u> home where modern convenience is appreciated. This elevator is a self-contained unit - can be readily installed in existing dwellings with little alteration. It is an unobtrusive unit - no more conspicuous than a hallway closet - and the car can be designed and decorated to suit the architecture of the building. It is as complete in design and construction as the down-town Otis Elevator, only smaller. And any one who can push a button can operate it safely!…"

RE: excerpt from a 1936 Otis ad

a home that has everything — including an Otis Personal-Service Elevator.

The dwelling on a beautiful estate — it has an Otis Personal-Service elevator

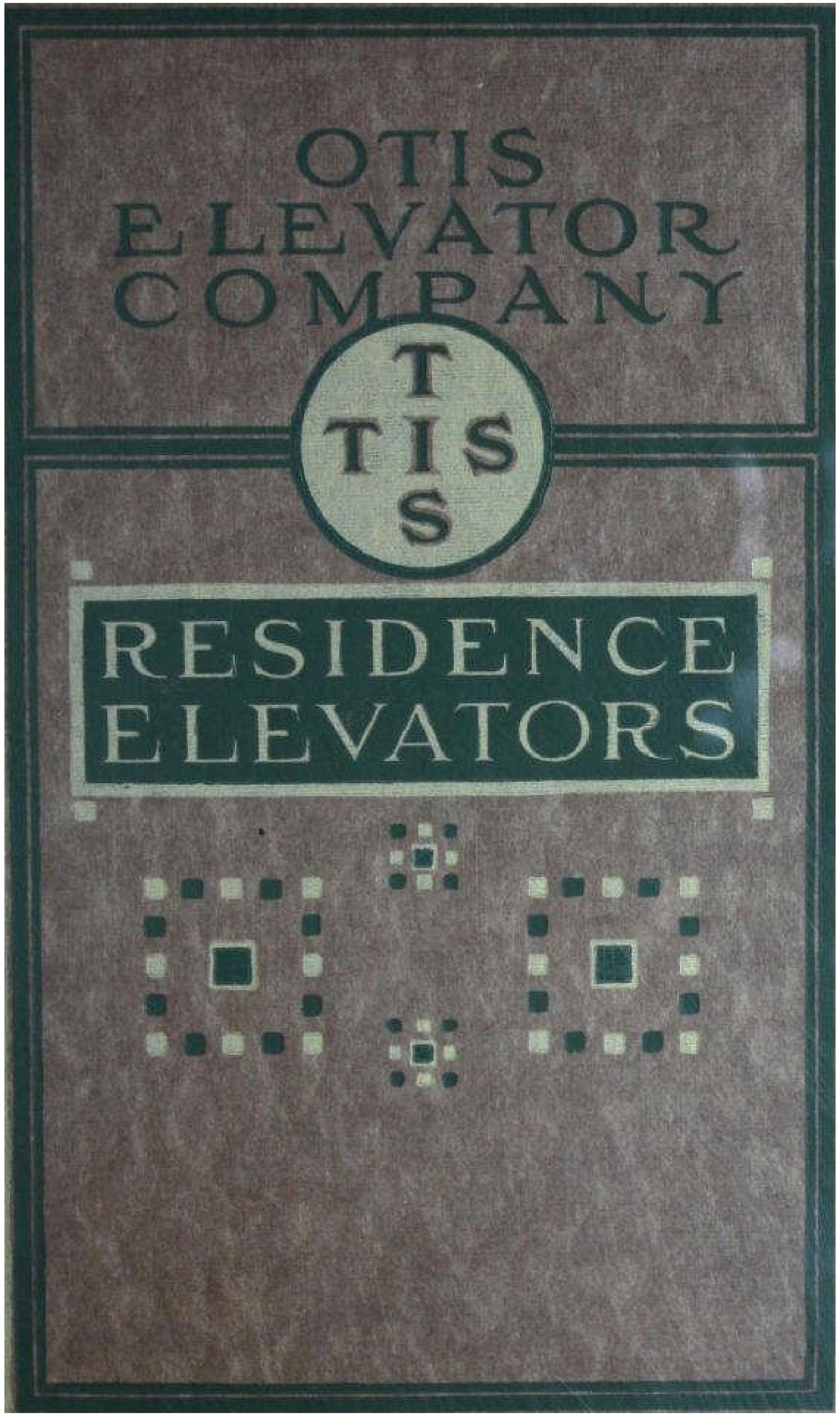
A Personal-Service Elevator adds to the comfort of this small home —

Attractive outside, convenient inside — it has an Otis Personal-Service Elevator

This suburban home has an Otis Personal-Service Elevator —

<u>Left</u>: caption: "Comfort is the key-note of the home of today. Comfort combined with good taste. Bathrooms for family guests. Telephone extensions at strategic points. More up-to-date heating systems with air conditioning in the offing. And still another house feature is finding ready acceptance in this age of thoughtful consideration for every member of the family - *it is a clever little home elevator manufactured by Otis*. Grandmother - young in spirit, but a little unsure of her footing - this Otis Personal-Service Elevator helps minimize the difficulties of advancing age. Mother with untold household responsibilities - the Personal-Service Elevator removes the burden of the stairs. Father, son, daughter - illness and disabilities come to everybody - the little elevator is a real friend. A truly modern convenience for a modern age…It stands on its own legs and can be readily installed in existing dwellings. It tucks away in a space compatible to the dimensions of a hallway closet and its entrance conforms to any interior architecture…"

(1936 Otis ad)



"…Although the requirements for this type of elevator may seem rather severe, they are amply met and with no great complication, as can readily be seen in any of our many installations. An actual test will prove to the most skeptical their great merit, absolute practicability, safety and simplicity…"

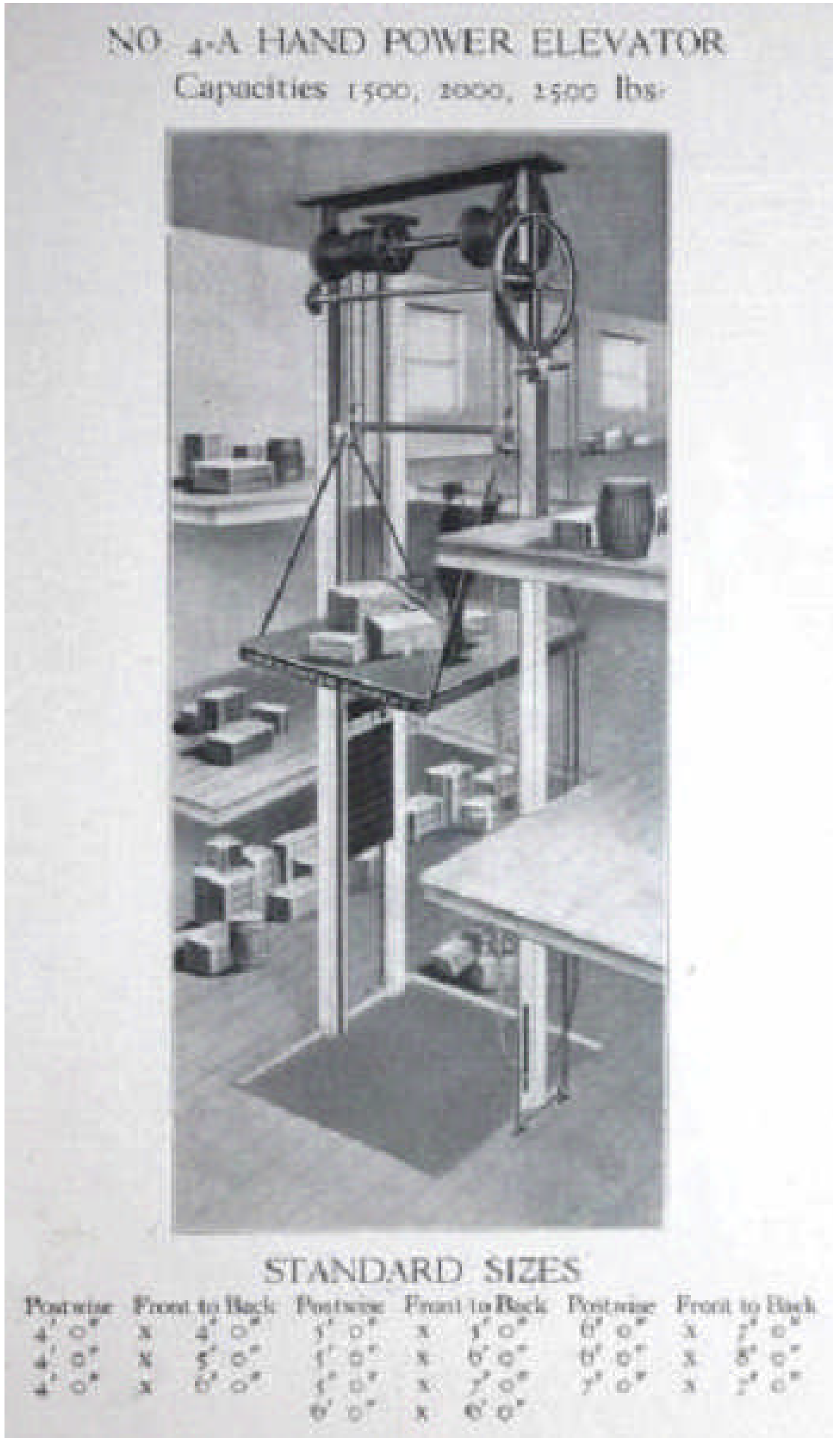
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

OTIS
HAND POWER
ELEVATORS

"…It has been an aim of the Otis Elevator Company for many years to produce the highest grade of Hand Power Elevators at a cost low enough to place these machines within the means of everyone whose business demands a hoist of this type. In submitting the several different types of Hand Power Apparatus shown in this catalog, we wish to call particular attention to the Steel Construction which is the Otis Standard and is explained in detail on the following pages…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1914)

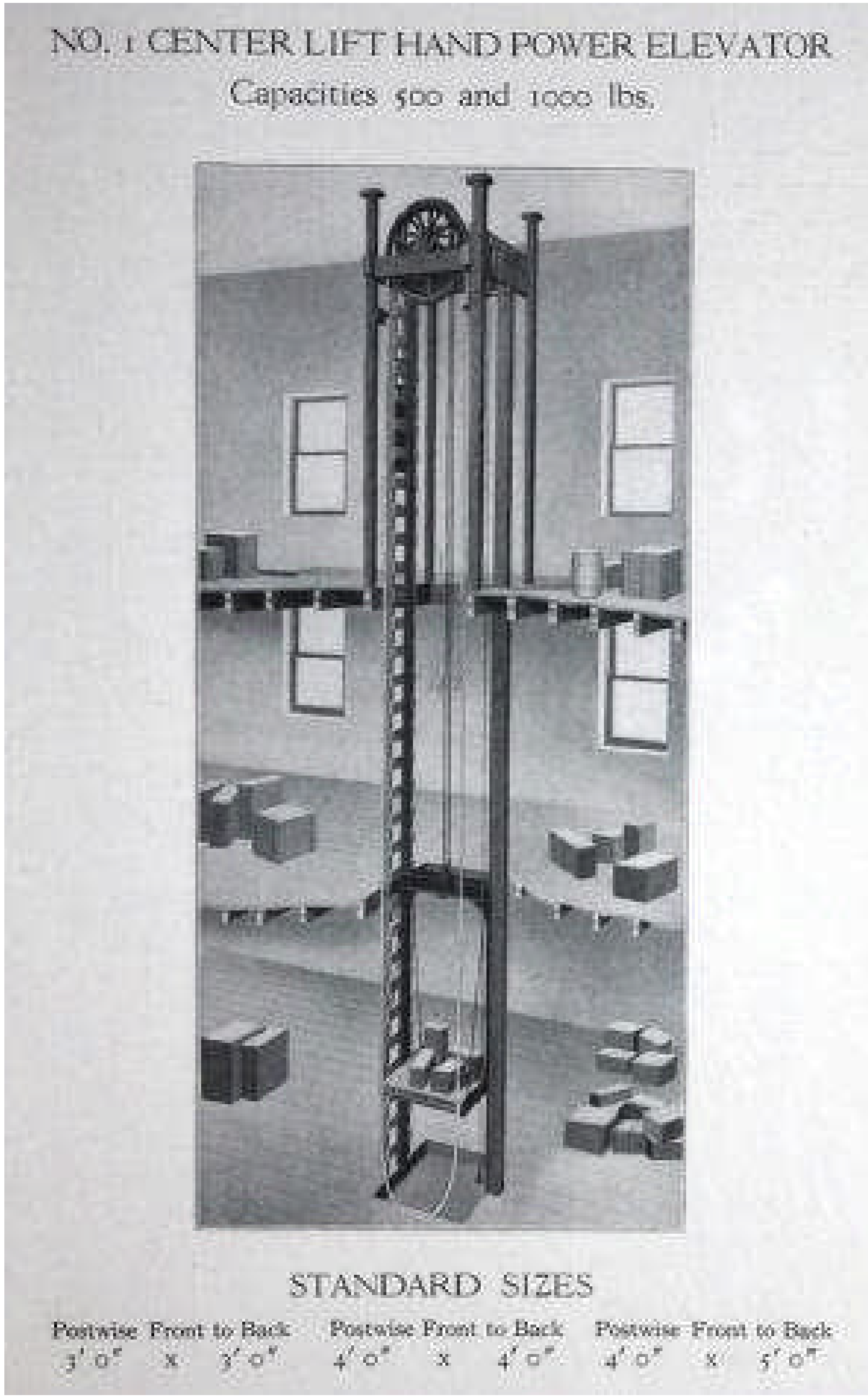
Most Popular



"…The No. 4-A is the most popular type and well deserves the great popularity which it has attained, being within its range, the best and most economical Hand Power Elevator ever built for the handling of general merch-andise. It is simplicity itself to erect (another economical feature) and its easy running qualities and durable construction have met with ever growing favor. It is not adapted for an enclosed hatch-way, comer guides, nor for pull wheel in front.."

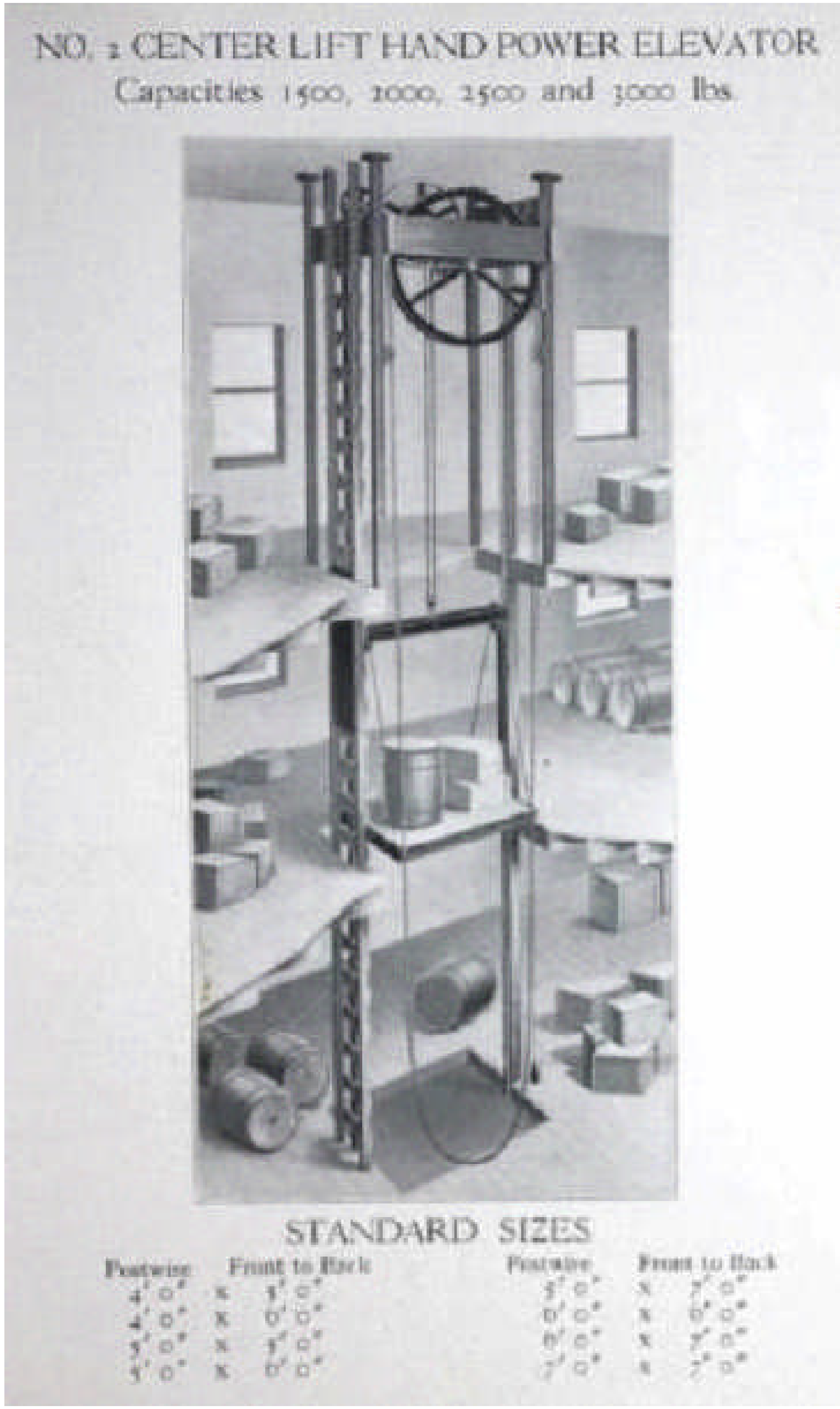
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1914)

Center Lift



"…The No. 1 Hand Power is especially adapted for light loads and small platform sizes. The rope or pull wheel may be placed at either the front or at the side, thus making it possible to install this type in either an open or enclosed hatchway. We strongly recommend the sidepost arrangement shown in illustration. When conditions are such that the guide posts must be placed in the corners of hatchway, we can furnish special construction, for which drawings are necessary in each case to show size of hatchway required. Special attention is called to the Steel Frame Platform and 'Power' Type Safety Device furnished with all Otis Hand Power Elevators. These features differ slightly on the various types as conditions demand…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1914)



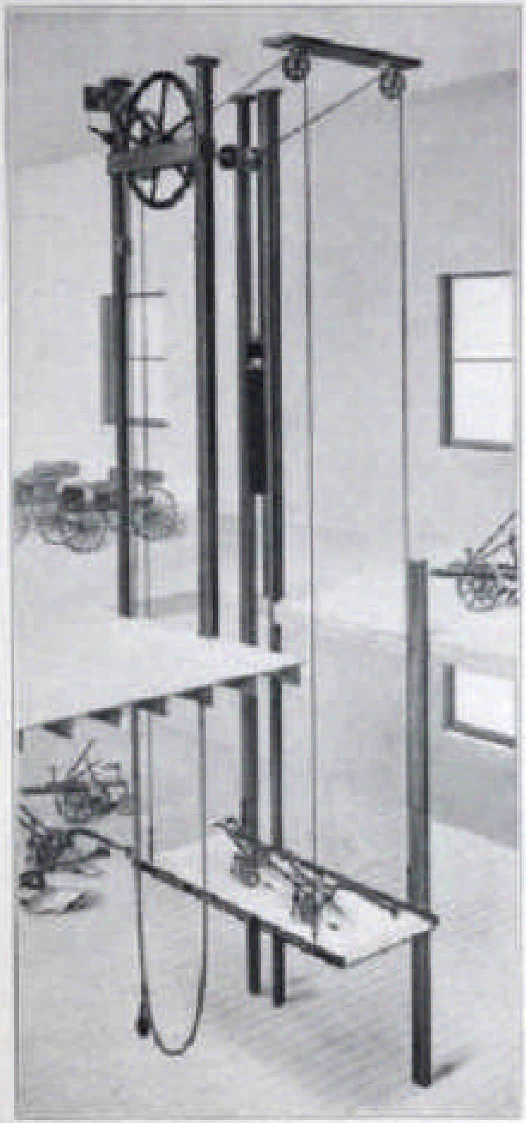
"…The No. 2 is a type of elevator expressly designed for heavy loads and hard service. To meet these requirements we furnish a strongly braced steel frame car (with ample counter-balance) and gearing of the highest efficiency. The rope or pull wheel may be placed at either the front or at the side, thus making it possible to install this type in either an open or enclosed hatchway. We strongly recommend the sidepost arrangement shown in illustration. When conditions are such that the guide posts must be placed in the corners of hatchway, we can furnish special construction, for which drawings are necessary in each case to show size of hatchway required. The illustration shows the construction to be a radical improvement over the old-fashioned 'Wooden Type'…"

RE: excerpt from an *Otis Elevator Co.* brochure (ca. 1914)

Carriage Type

NO. 1 CARRIAGE TYPE ELEVATOR

Capacities 1500 and 2000 lbs.



STANDARD SIZES

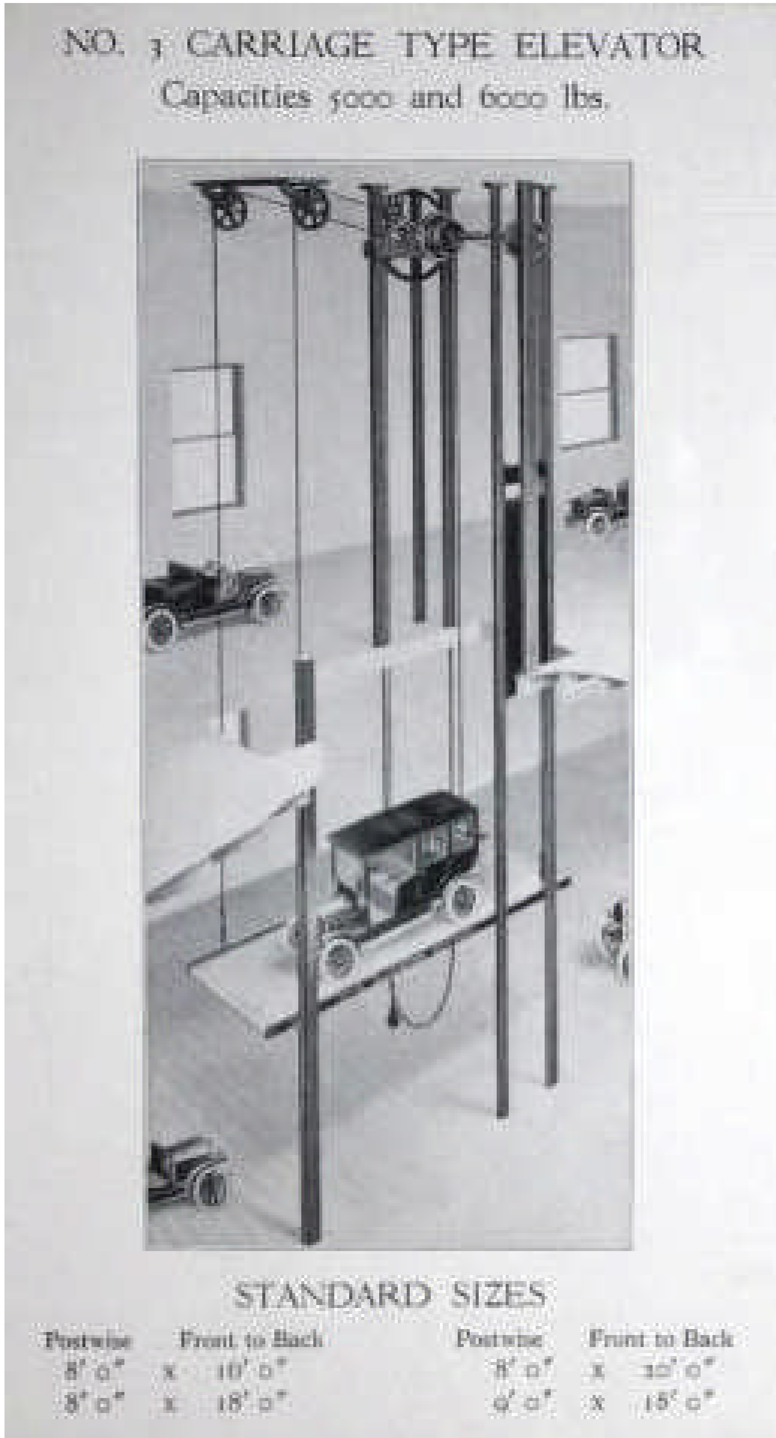
Postwise		Front to Back	Postwise		Front to Back	Postwise		Front to back
6' 0"	x	12' 0"	6' 0"	x	14' 0"	7' 0"	x	14' 0"

"…The No. 1, commonly called the 'Carriage Elevator,' is designed for use where the articles to be handled are large in size but light in weight. This type is used extensively in implement houses, livery stables, barns, etc. Particular attention is called to the channel side rails on the platform; this makes a most rigid construction. Another important feature (to be found on all Otis Elevators of this type) is the beveled or sloping edges of the platform. This permits of an installation without the usually required pit, thus saving not only expense of erection, but also the necessity of cutting or otherwise disfiguring the lower floor…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1914)

"…The No. 2, or intermediate size of the 'Carriage Type,' meets the requirements of an ever-growing demand for a powerful, easy running automobile or wagon lift at a reasonable price. Its wide range of capacities, 2,500, 3,000 and 4,000 pounds, exclusive of weight of car. makes this an ideal machine for general use…"

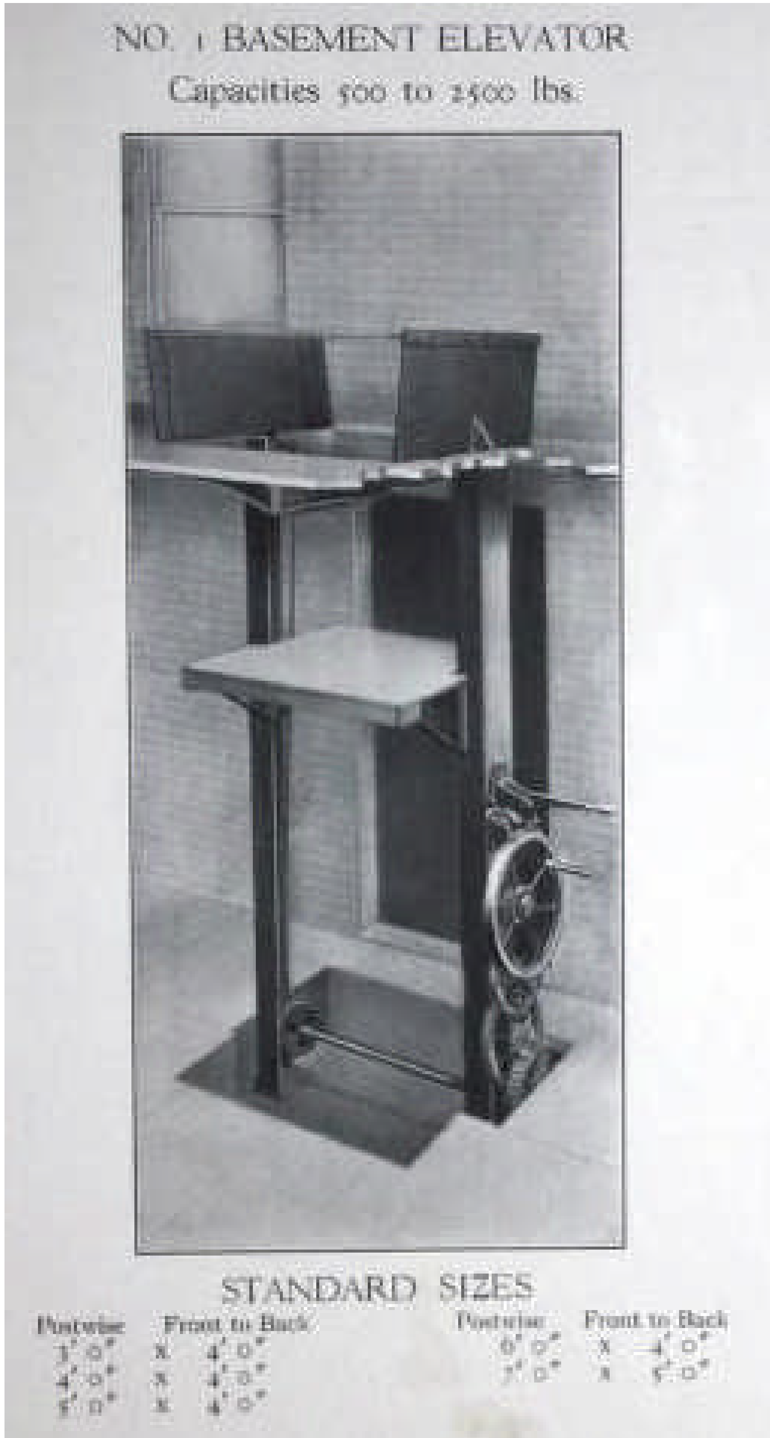
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1914)



"…The lifting capacity and ease of operation of the No. 3 'Carriage Type' elevator are increased materially beyond the range of the ordinary elevator of this general type by the adoption of a Double Reduction Gear, the use of which, combined with high-class workmanship, enables us to offer a machine to meet the maximum necessities of garage service. If you wish to convert the second story of your garage into a 'Money Maker' write us for prices and further particulars…"

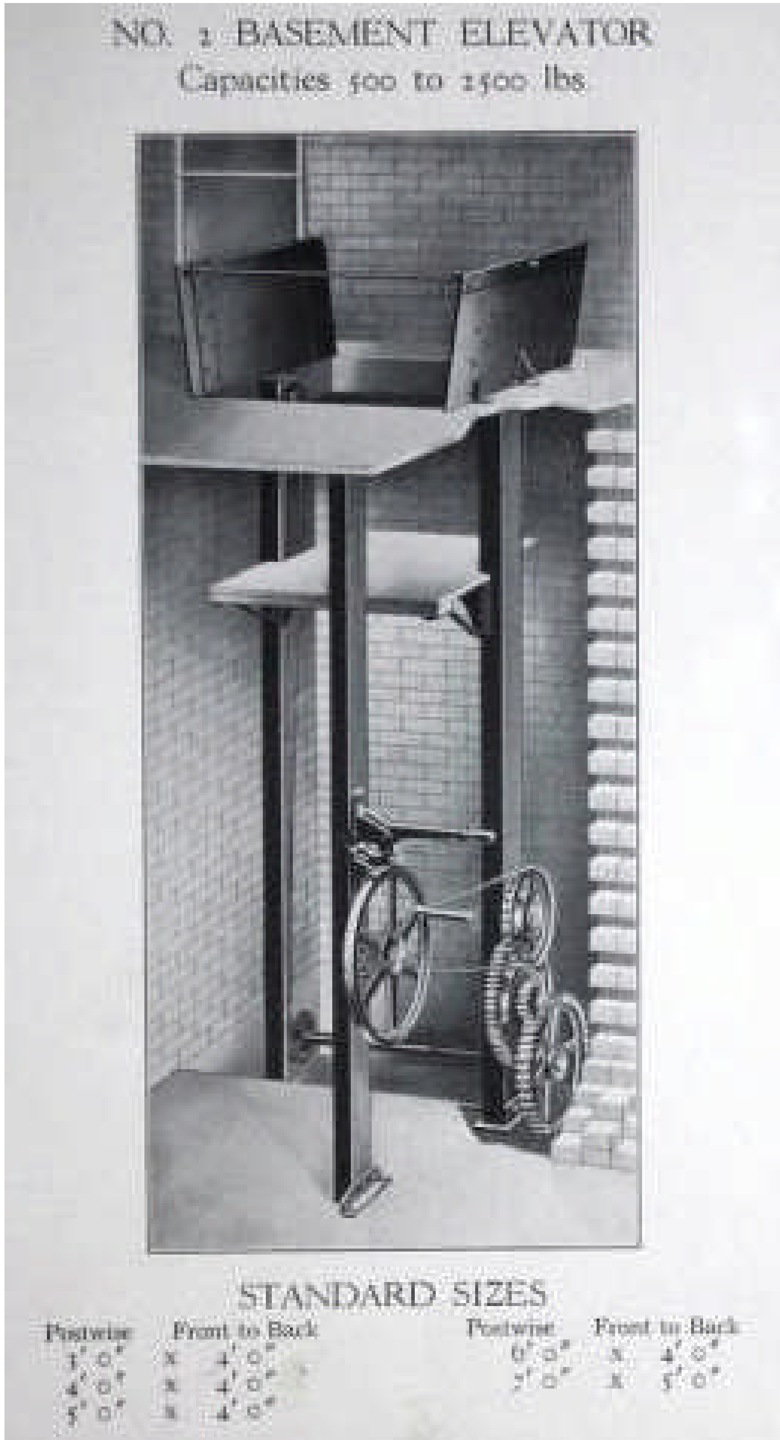
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1914)

Basement Type



“…The No. 1 ‘Basement’ or ‘Sidewalk’ Elevator is the acme of simplicity and perfection, and requires the smallest amount of space of any machine of this type yet produced. By attaching the iron lifting cables to each side of the platform a very simple construction is obtained, while the equipment is made entirely self contained or self supporting except for the top and bottom anchorages, by carrying the drums and gearing on the guide angles. The features outlined above result in a very considerable saving in erection labor. This type cannot be installed in an enclosed shaft, nor with the gears close to a wall or partition…”

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1914)



"…The No. 2 'Basement' Elevator is of the same general design as the No. 1, but differs therefrom in the position of the hand wheel, which is set away from the main gearing. This arrangement is necessary where the gearing is too close to the wall to permit of operating the hand wheel as it is arranged on the No. 1…"

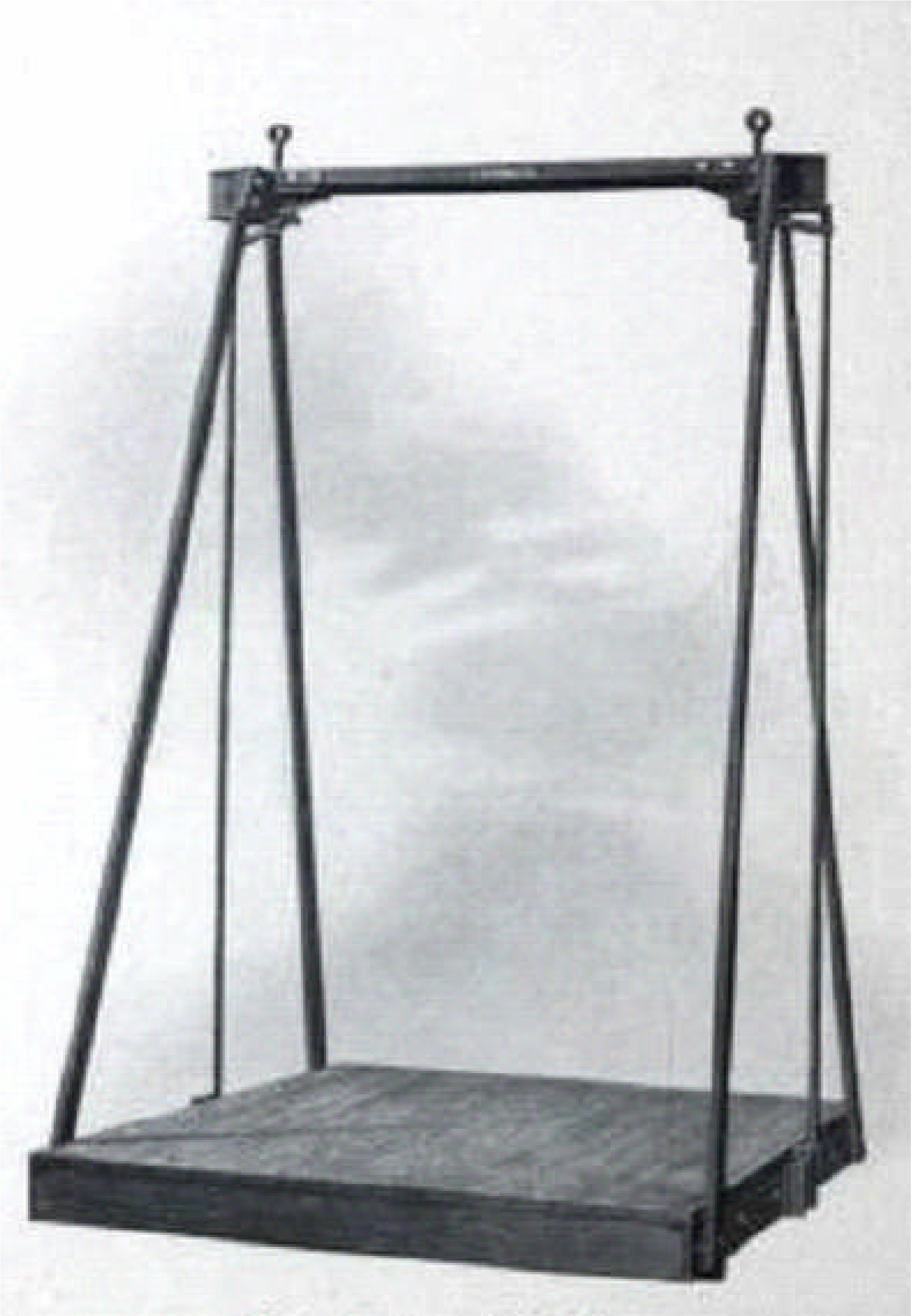
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1914)

The Maximum Value for a Dollar

"…In order to prove the Otis claim of superiority and in line with the policy of furnishing '<u>The maximum value for a dollar</u>' we show herewith cuts of the various parts which clearly illustrate in detail, the design, workmanship and method of constructing Otis Standard Hand Power Elevators…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1914)

Platforms



"…Alive to the fact that platforms made of wood do not always give the best satisfaction, we have designed a Steel Frame Car (Figure 1) with no wood used in this construction except for the flooring. Further, this car is equipped with a type of safety similar to that used on Electric and other 'Power' Elevators, thus making a much more effective device than the old style of Beam Spring Safety…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1914)

Left: caption: "Figure 1 – 4-A Platform"

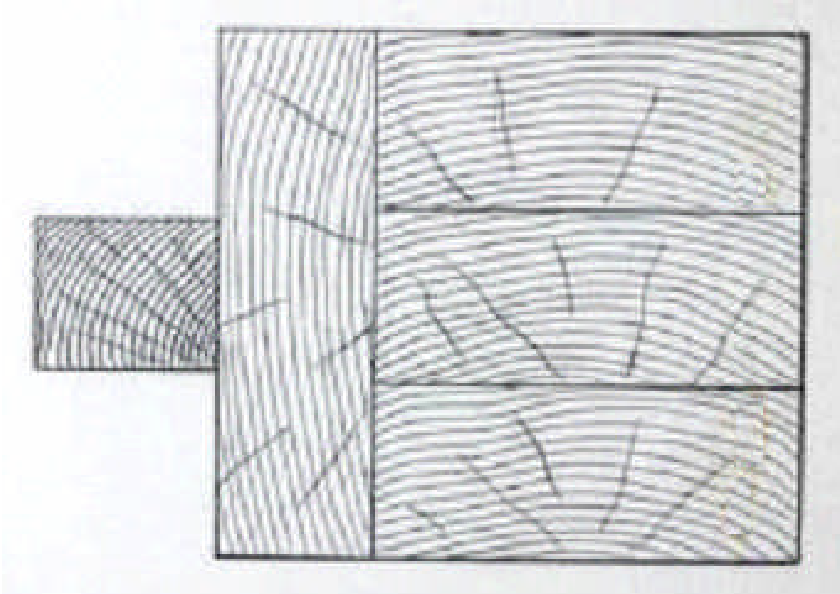
"…In Figure 2 a bottom view of the platform is shown, giving a clear idea of the safety dogs, the method of bracing, and the strong construction…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1914)

Left: caption: "Figure 2 – Bottom View of Platform"

<u>Left</u>: caption: “The Otis Steel Freight Platform”
<u>Right</u>: caption: “Freight Platform, Corner Post”
(ca. 1900)

Guide Posts & Strips

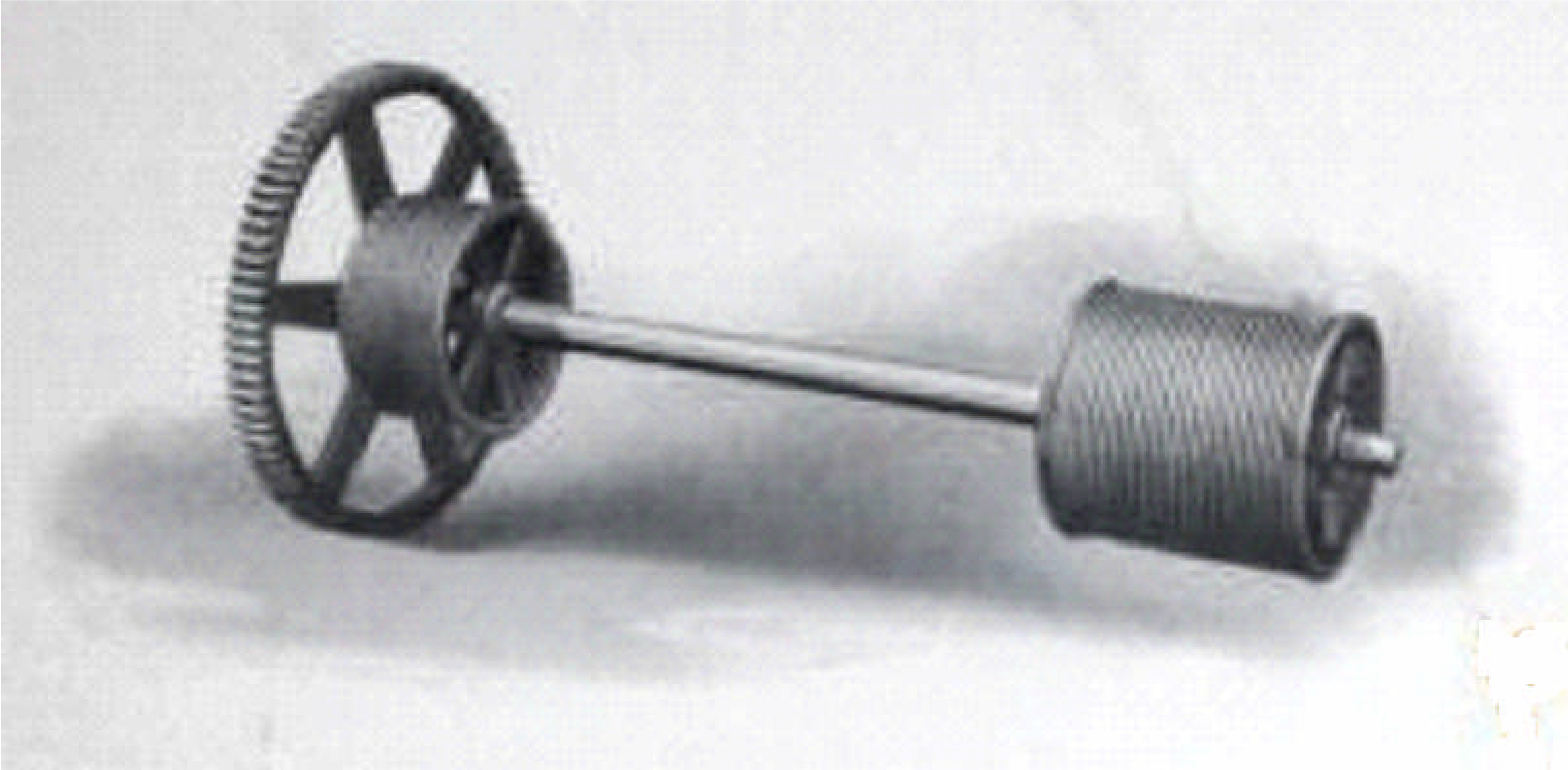


"…Owing to the fact that guide post stock can be obtained from any lumber yard, the customer often prefers to purchase his posts locally and save the freight charges. A solid post of proper size can be used, but we strongly recommend the use of a compound post as shown in Figure 3, in order to eliminate warping and twisting. Although the cost of this post is greater than the old style solid one, we furnish compound posts in all cases, when posts are ordered, thus assuring the purchaser of absolutely true runways for his platform. The guide strips are made of well-seasoned kiln-dried maple, being tongued, grooved and drilled on a special machine built for this purpose. No difficulty can be experienced in accurately erecting…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1914)

Above: caption: "Figure 3 – Compound Guide Post"

Gears & Drums



"…Particular attention is directed to the gear and drums shown in Figure 4. These drums are made of iron with machine scored grooves. This construction is a marked improvement over the wood or cast groove drums…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1914)

Above: caption: "Figure 4 – Gear and Drum"

"…Another indication of Otis quality is shown in Figure 5. This is the steel anti-friction roller bearing in which all shafts are mounted, thus making a smooth and easy running elevator instead of the usual 'Man Killer.'…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1914)

<u>Left</u>: caption: "Figure 5 – Roller Bearing"

Rope Wheel

"…The parts shown in Figure 6 are the Rope or 'Pull' Wheel and Pinion. These are accurately made and mounted on a heavy steel shaft. The flange of the Rope Wheel, on which the brake operates is accurately machined insuring a positive and easy stop…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1914)

<u>Left</u>: caption: "Figure 6 – Rope Wheel"

Brake

"…Realizing the importance of the brake, every care has been taken to provide Otis Elevators with the best possible braking appliance. The illustration (Figure 7) shows the cam or rocker style (used with the 4-A elevator) a type which has proven most safe and efficient. The brake is made substantially throughout and the shoe is lined with leather to insure both gripping efficiency and quietness of operation…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1914)

<u>Above</u>: caption: "Figure 7 – 4-A Brake"

Information Required upon which to Base an Estimate

- **State character or kind of building**
- **Where building is located**
- **How many elevators will be required**
- **Whether for passenger or freight service**
- **Give the desired lifting capacity and speed of car**
- **State size of car or size of hatchway**
- **State about the value of car if for passenger service**
- **Give the travel, in feet or meters, of car or platform**
- **State the number of stories the elevator will travel**
- **If convenient, give diagram of building showing location of the elevators and where machinery can be placed**
- **If an *electric elevator* is required, if direct current, give voltage; if alternating current, give phase, voltage and cycles**

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1900)

Continued…

• If hydraulic elevator, give water pressure from the street main at the level of the basement floor; or if the hydraulic system is to be used in connection with steam pump – by pressure tank in basement or tank on roof – give steam pressure available at the pump; if *electric* pump is to be used, give data for current as above

• If steam elevator, give pressure available at the engine

• If belt power elevator is required, give position and distance of line shafting from hatchway. When belt machine is operated by motor, give data for current as above

• Give horse-power and class of your power plant

• Keep the maximum lifting capacity of the elevator as low as possible

Note: with all f.o.b. orders we will give full instructions and drawings for erection

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1900)

OTIS ELEVATORS

Part 4

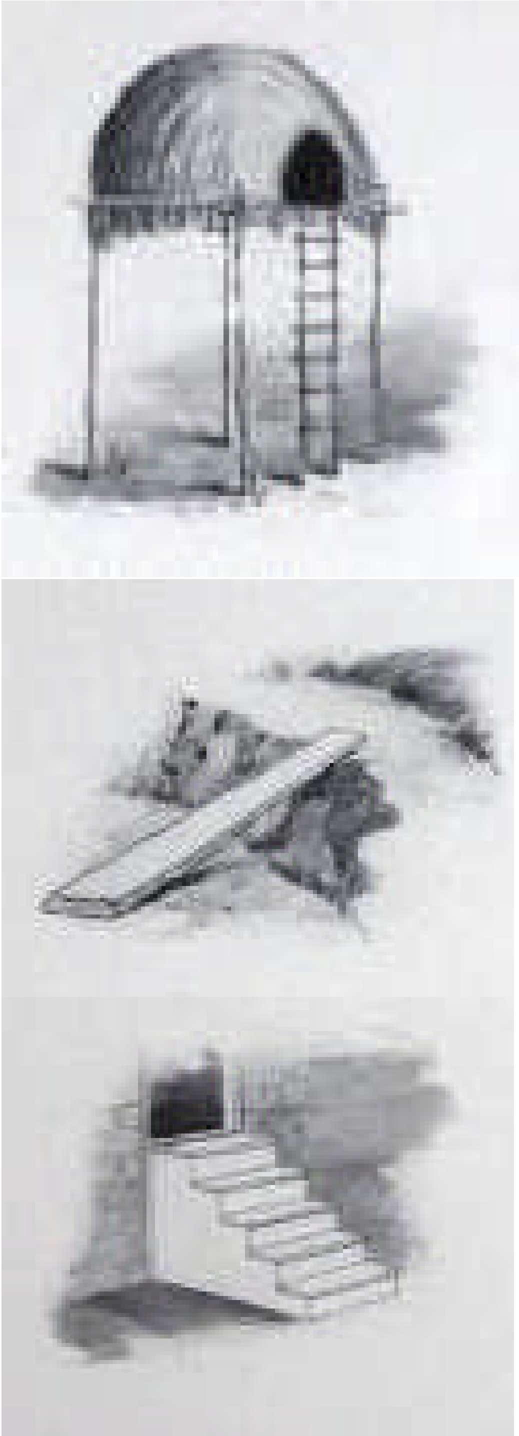
Escalating

O T I S
ESCALATORS

Means of Traversing From

"…The word Escalator was coined in the latter part of the year 1805. Its root is found in the Latin 'Scala.' With 'E' as a prefix and 'tor' as a suffix, the entire word may be roughly translated 'means of traversing from'…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912). In 1895, *Charles D. Seeberger* coined the word "Escalator" (derived from the Latin word "scala" or ladder) for application to his moving stairway. He included it with his 1895 patent, but the term was rejected by the patent office. However, the word *Escalator* was later trademarked and registered to Seeberger (in 1900). At the time, Seeberger was working with Otis to develop the Escalator. He later sold his business (including the patents and the trademark) to Otis. The first moving stairway was set up in 1898 at Otis' *Yonkers Works*. The unit was moved to France to be exhibited at the *Paris Exposition* of 1900 and was there labeled as an Escalator. The word "escalator" entered the public domain in 1950, losing its capital "E."

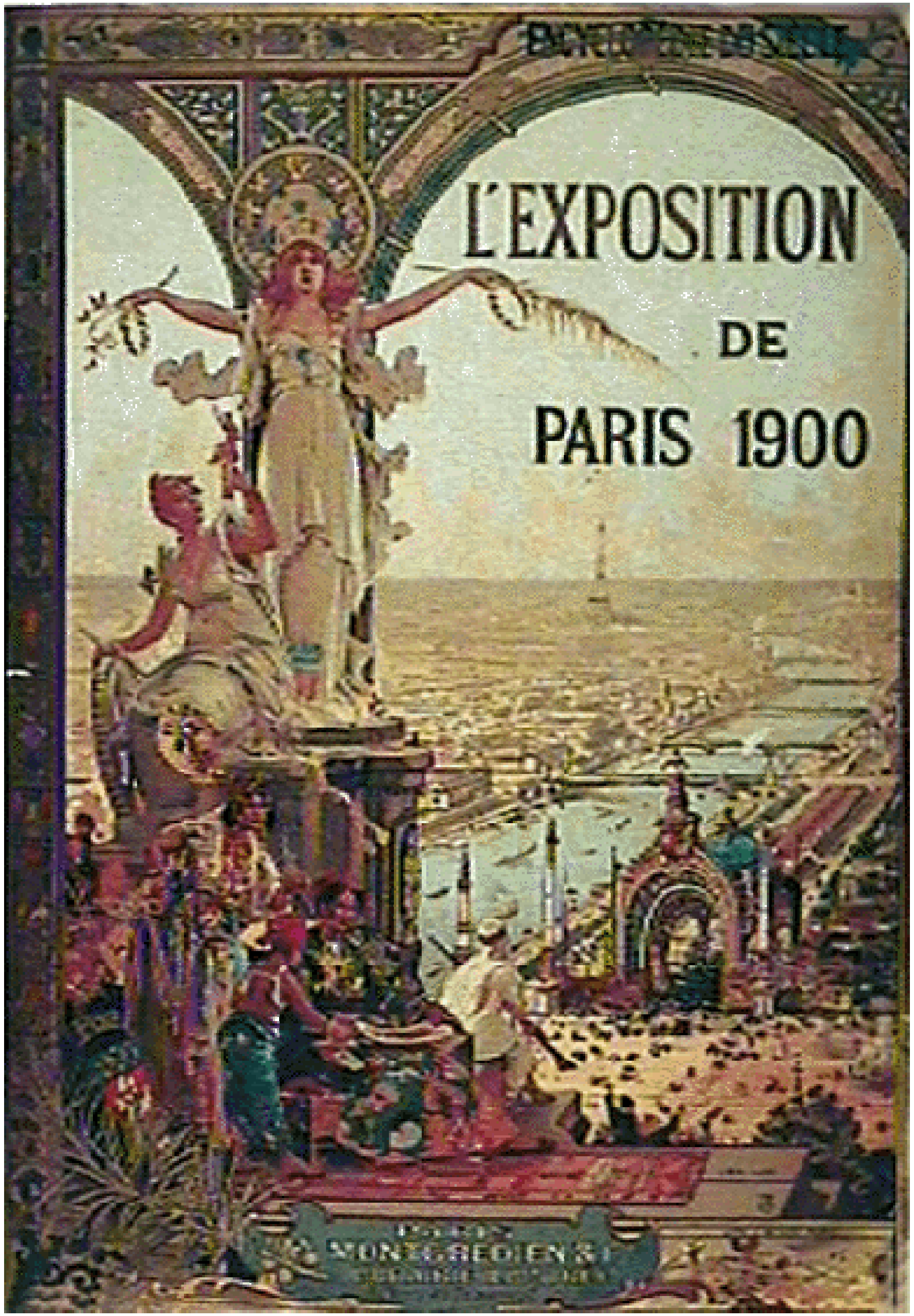


"…The inclined plane is one of the simplest mechanical elements. When man wanted to go from one level to another he first built himself a ladder, stretched it from the ground to a tree and scaled the distance. Then he discovered that it was easier to ascend at an incline than to pull himself up vertically, so he fashioned his primitive inclined plane, a crude device, but one that enabled him more easily to make his ascents, and to trundle up heavy loads. Then, from the inclined plane evolved the stairway, the most useful and comfortable application of the idea. Then, from the inclined plane evolved the stairway, the most useful and comfortable application of the idea…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

"…The stairway, the ladder, the inclined plane, all are useful, but all require human effort to bring one from a lower to an upper level. Eliminate the physical effort and you have the ideal means of ascent and descent for short rises. The suggestion to move the stairway was the solution; so we placed the stairway on a set of wheels, connected it to a motor and made the Escalator; just as simple and primitive in its idea as the rough plank which our ancestors employed, but infinitely more useful…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)



"…Prior to the year 1900 the Escalator was unknown to the public, but faithfully and steadily our engineers had been working to perfect it, and in 1900 at the Paris Exposition, the first Escalator was introduced. That very Escalator is still in operation in one of our largest department stores. Its instant popular approval insured its success. The public had been patiently awaiting a moving stairway for years. Now Escalators are operating in all parts of the world; in the gigantic railway terminals; in our department stores and large mills; in our theatres; in the elevated and subway stations of our great cities; everywhere, in fact, where it is necessary to keep thousands of people moving constantly and rapidly…"

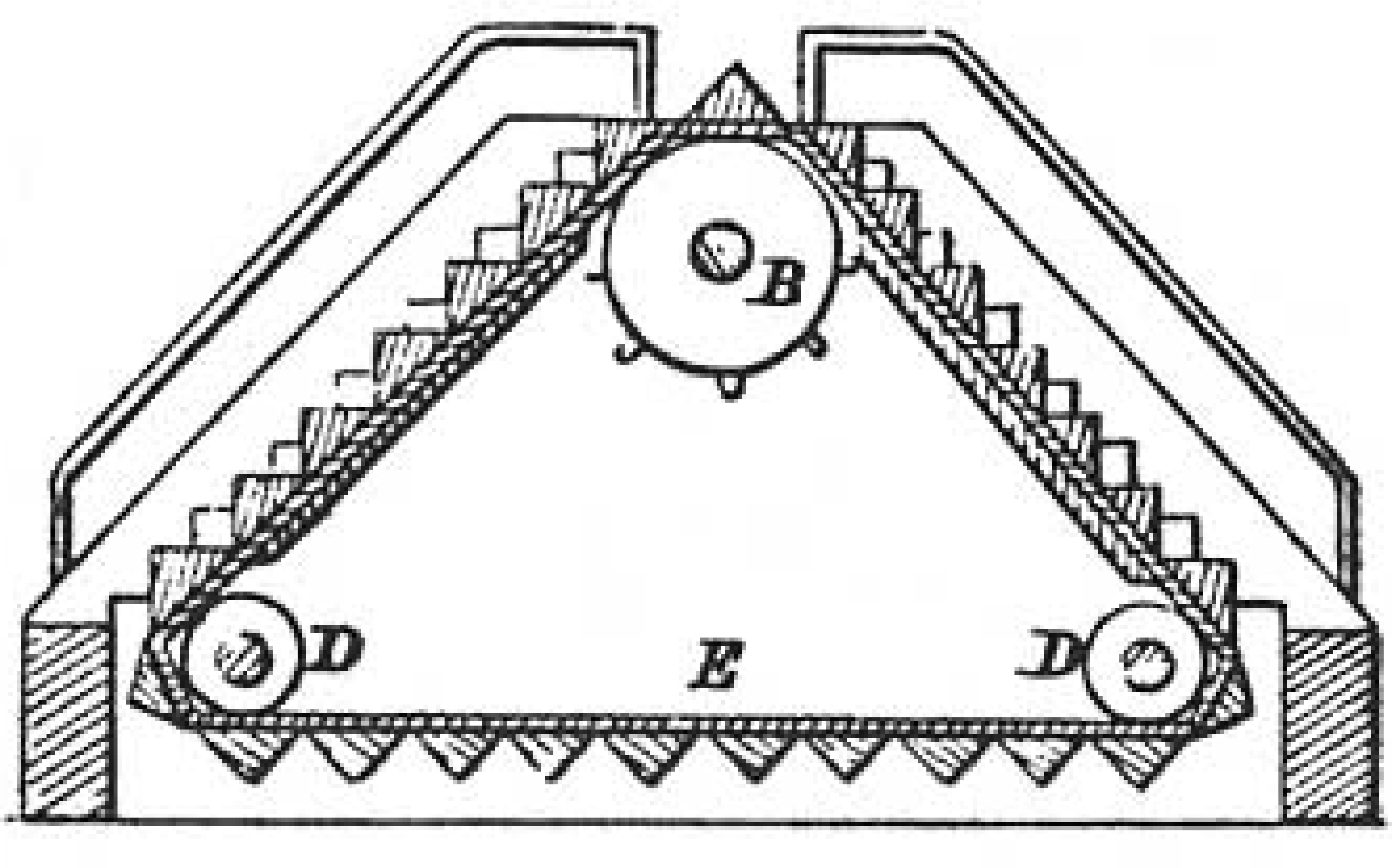
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

<u>Left</u>: original poster from the *Paris Exposition* of 1900

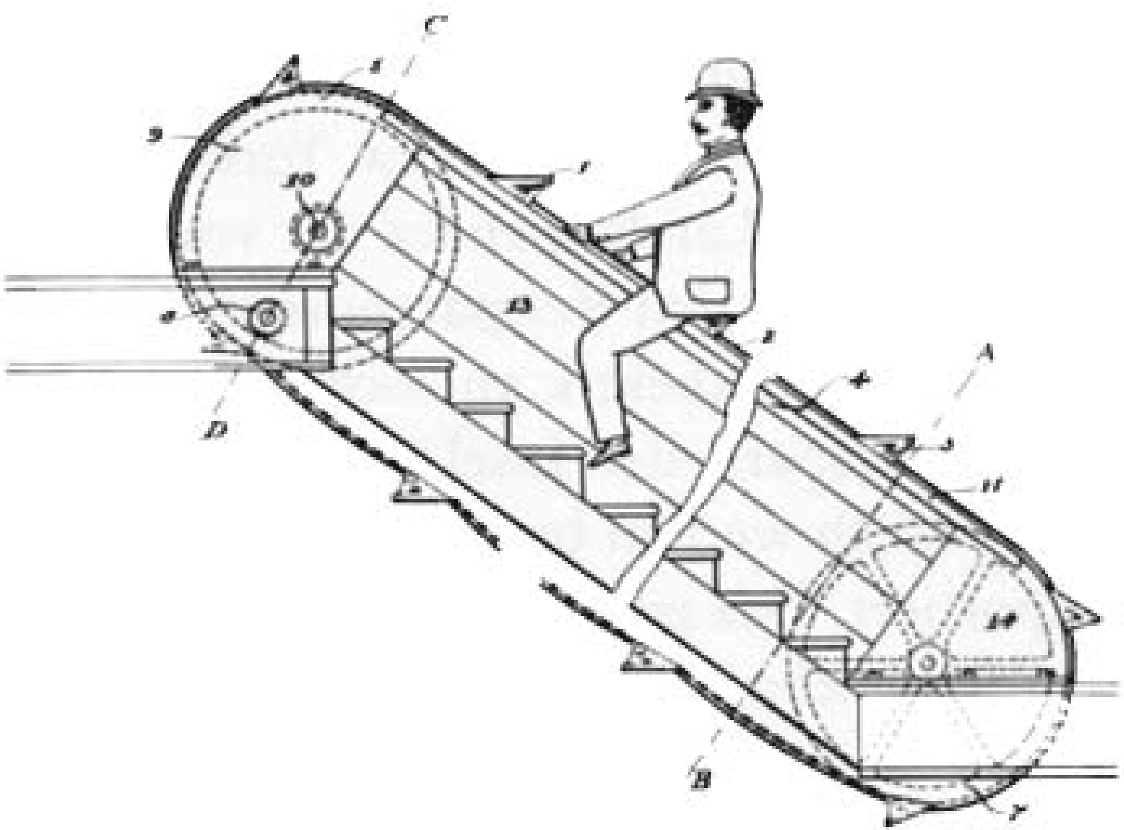
"…The success of the Escalator in solving the problem of inter-floor travel is due to its continuity of motion and its enormous capacity. The Escalator is constantly moving; you may step upon it at any moment and be carried upward or downward at a moderate rate of speed, comfortably, safely and without physical effort. It has been aptly called 'an elevator with the doors always open.' There is no time lost in loading, starting, stopping and unloading, and consequently its capacity is tremendous; approximately 11,000 people can be carried in an hour without overloading the machine…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

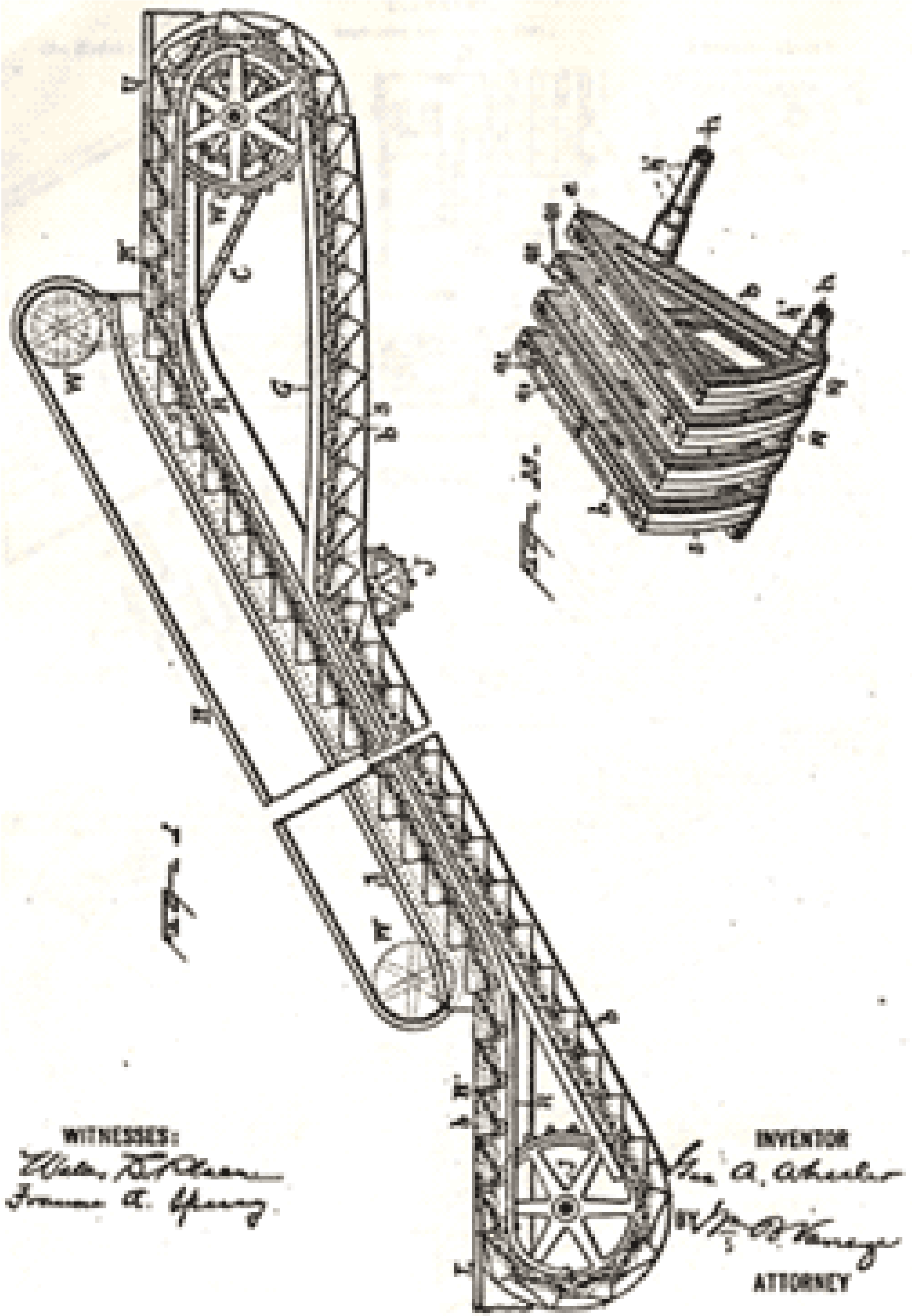
The first patent for an escalator-like machine was granted in 1859, but it was not until the late 1890s that rudimentary escalators began appearing. *Jesse Reno* and *Charles Seeberger* were prominent innovators at the time, along with Otis. Reno first exhibited an "Escalator" (more akin to a conveyor belt for people) at *Coney Island* in 1895. An estimated 75K visitors took the opportunity to be elevated 7-feet. Within five years, improved versions of Reno's machines appeared in department stores, exhibition halls and railway stations. Meanwhile, Seeberger had aligned with Otis and Otis-Seeberger machines were showing up in the U.S. and Europe. By 1911, Otis had bought out Reno's patents. The first true escalator appears to have been built in 1899 at the Otis factory in Yonkers, N.Y. (based on a Seeberger design). Otis spent $30K in its research and development of the Escalator demonstrated at the 1900 *Paris Exposition*.



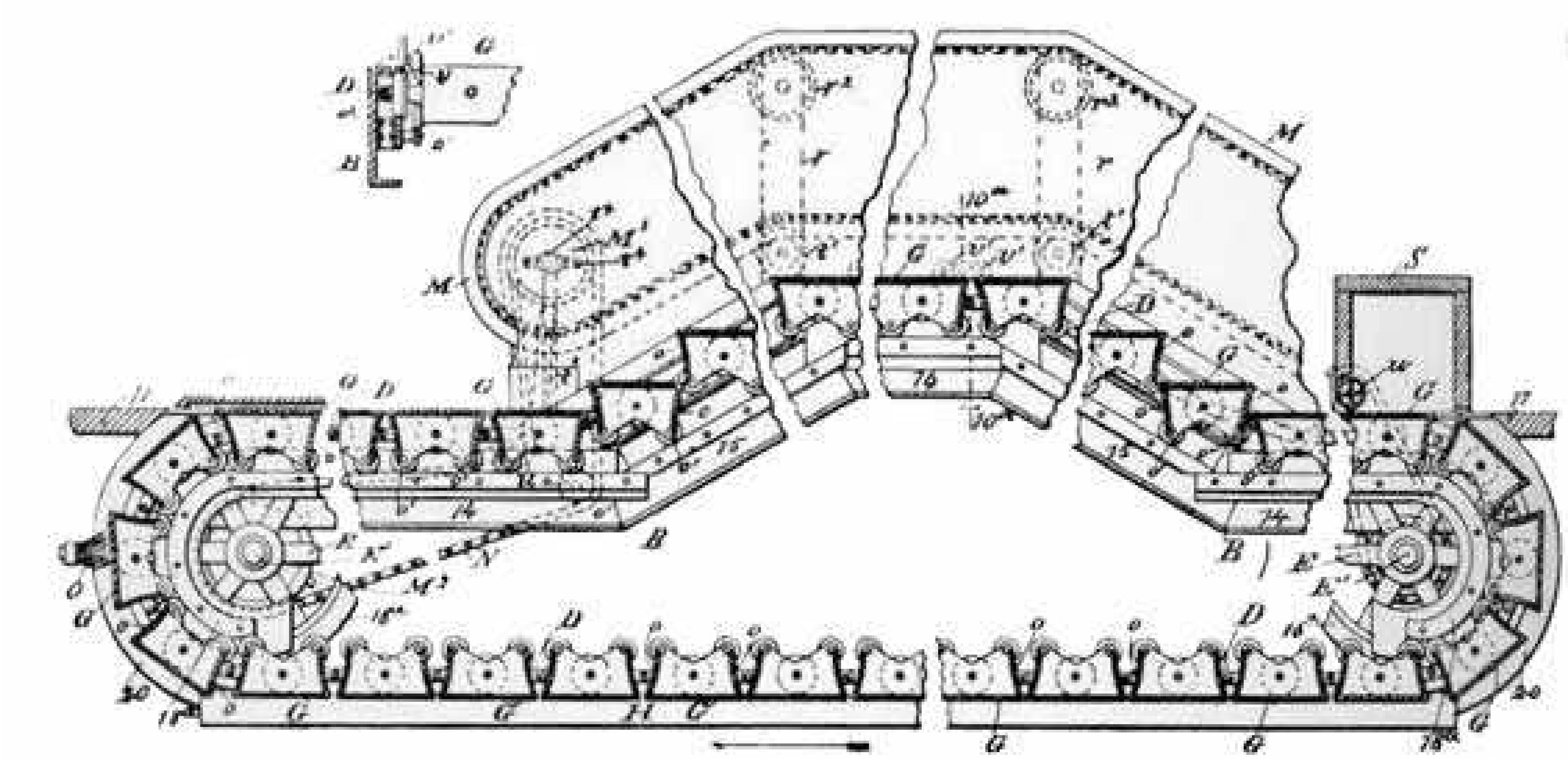
<u>**Above**</u>**: on August 9, 1859, the *U.S. Patent Office* granted *Nathan Ames* a patent for a revolving stairway in the form of an equilateral triangle. A substantial amount of agility would have been required to mount or dismount this device; however, this rendering is the first idea for such a lifting mechanism. Neither Ames nor his moving stairway was heard from thereafter.**



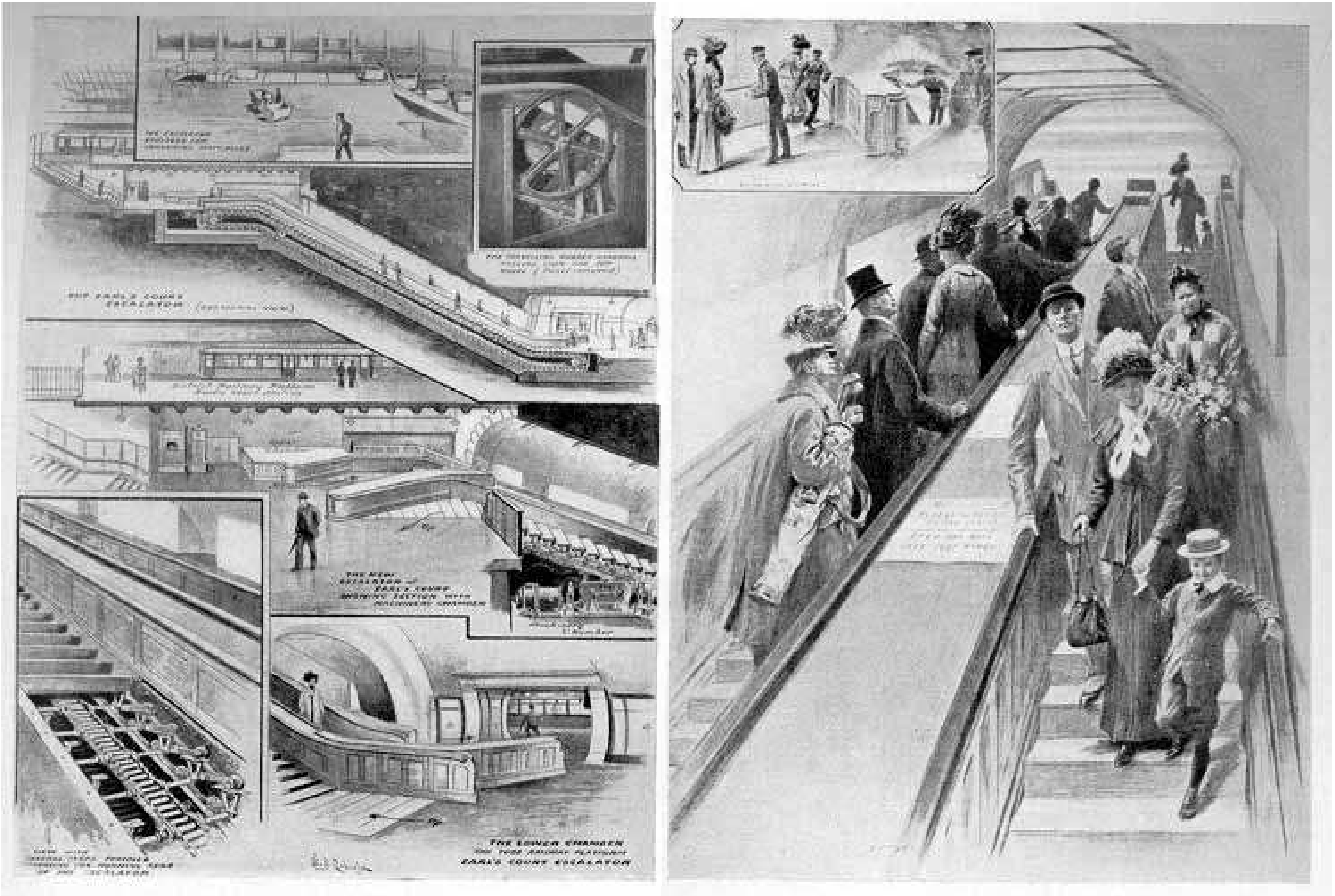
<u>Above</u>: Jesse Reno's initial moving stairway invention in 1891 was more of an inclined bicycle. The bold rider sat astride whereas the more gentile lady was expected to ride "sidesaddle." This device, installed by Reno as a pleasure ride at *Coney Island* in Brooklyn, had a vertical rise of 7-feet, an inclination of 25 degrees and a speed of 75 fpm.



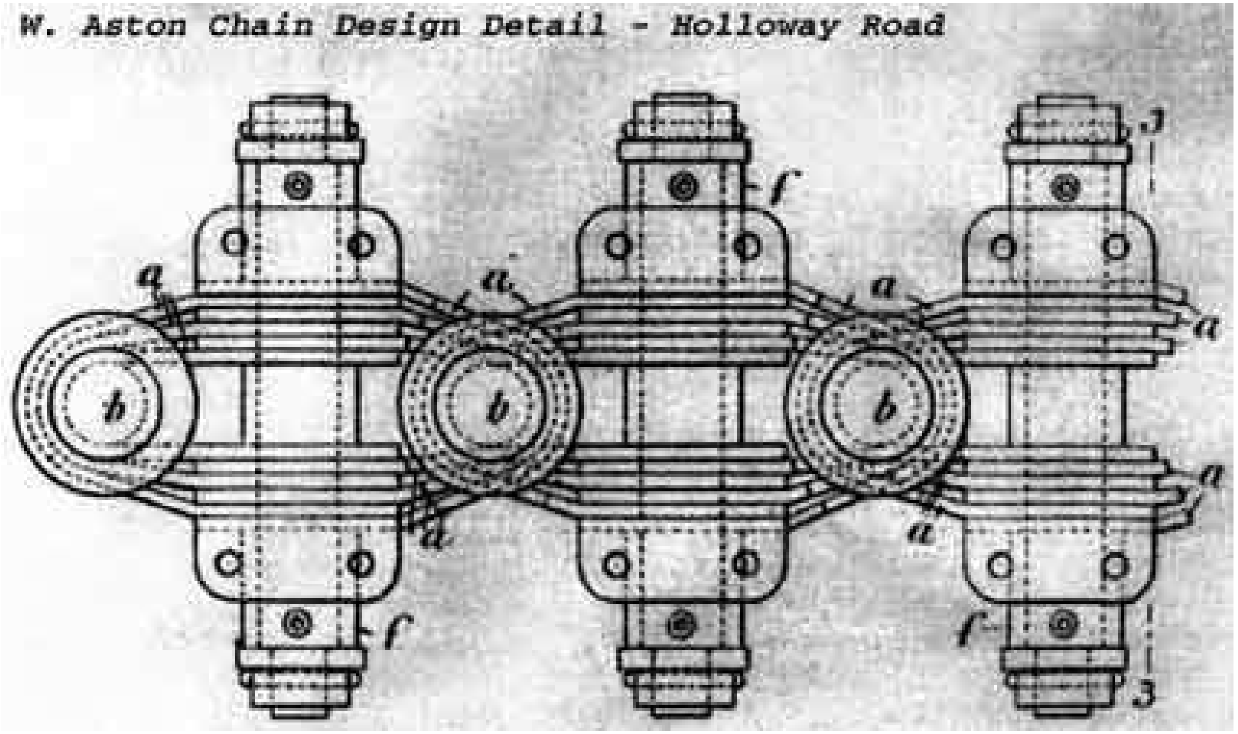
<u>Left</u>: on April 16, 1887 *G.A. Wheeler* applied for a *U.S. Patent* for a moving stairway (with most of the features present in the modern-day escalator). The patent was granted on January 17th 1899. The continuous chain drove pallet steps, triangular in shape, could be swept through combplates at the terminals (note the number of flat steps leading to the upward transition giving the passenger time to become accustomed to the movement). It took manufacturers about ninety years to finally adopt this feature. By 1890, Wheeler had made improvements in the drive, step design and handrail drive mechanism.



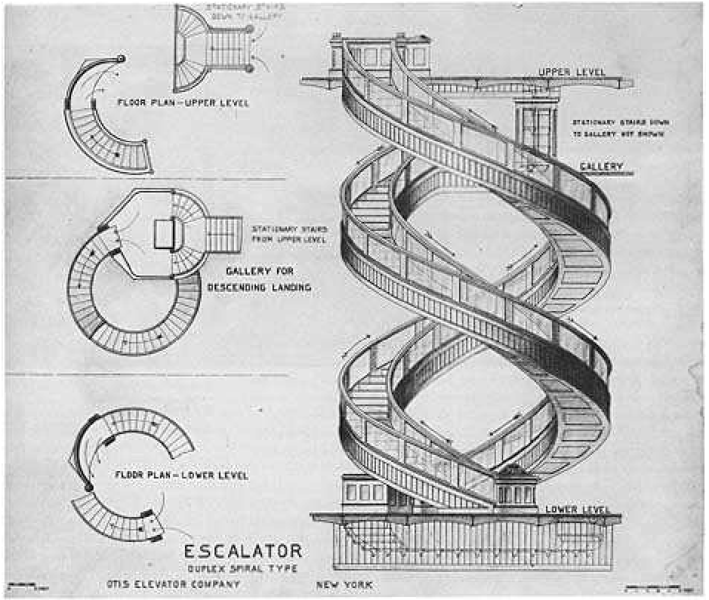
Patents for moving stairways had been granted to *George A. Wheeler* in 1892 and to *Charles D. Seeberger* in 1898. They joined forces and developed a mechanism similar to the drawing above and sold the design to the *Otis Elevator Company* in 1899. Competition between the two moving stairway companies: *The Reno Electric Stairway and Conveyors Organization* and Otis became intense. Eventually, in 1911, Otis bought Reno's Company and for a time sold both the Seeberger "A-type" and the Reno *Duplex Cleat Type*. In fact, the first two escalators installed in the *London Underground* (in 1911) were the Seeberger A-type machines.

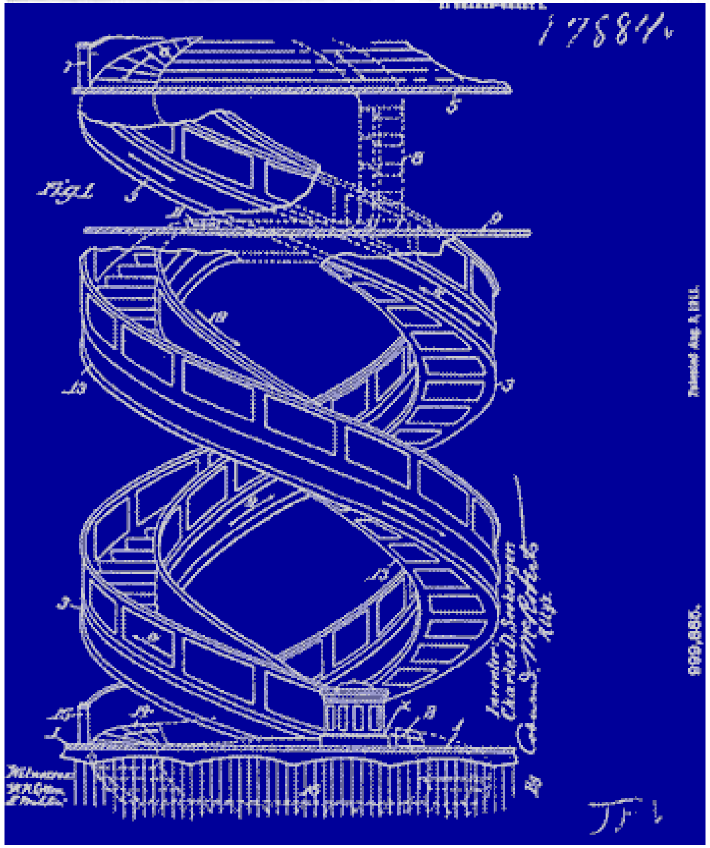


<u>Above</u>: caption: “Escalator at Earls Court Station, London”



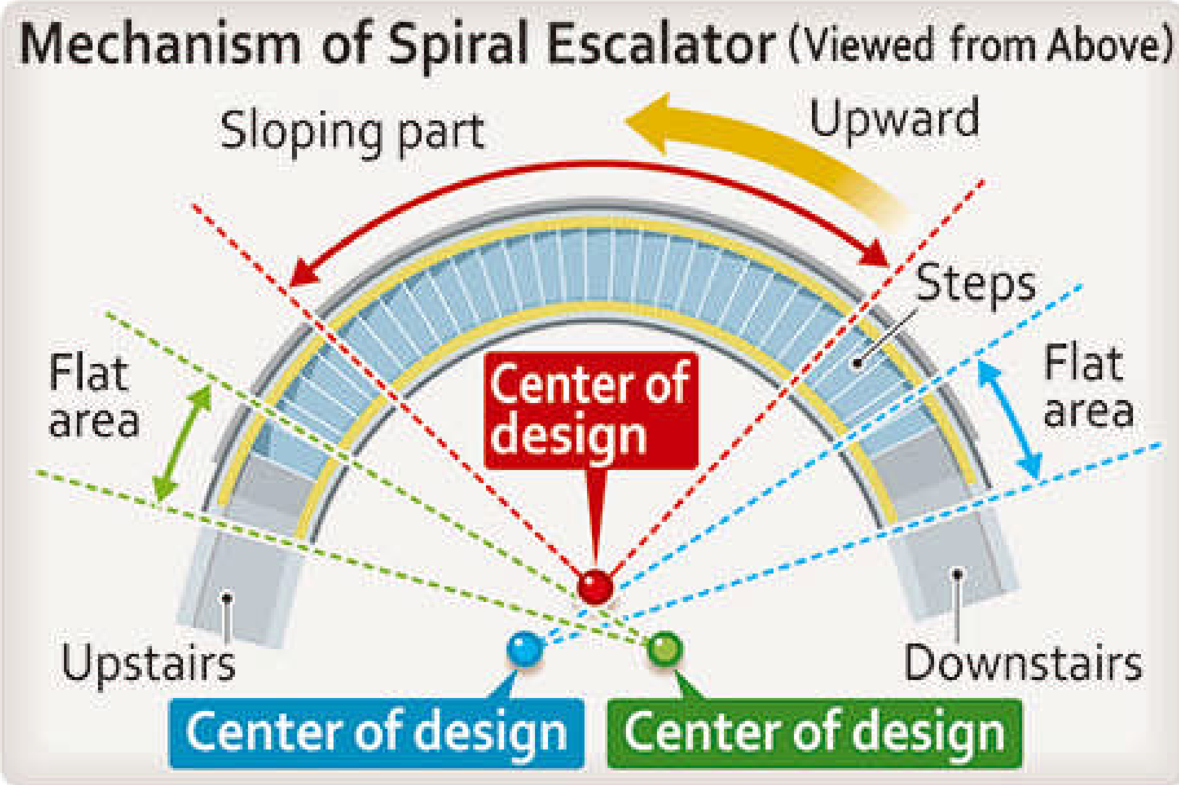
Jesse Reno **moved to London in 1900 and devoted himself to creating what would become the first walkway. In 1902, his efforts were realized and his walkway was presented at the** ***Earls Court Exhibition*** **and then utilized as an amusement ride for four years. The patent for the flexible chain drive (above) was held by** ***William Henry Aston*****, making the unique electric walkway a joint engineering effort of both men and their companies. The mechanism featured a handrail that moved in-sync with the ascending and descending pallets. The walkway occupied a 23-foot diameter shaft with a vertical rise of 35-feet. The installation was made at the** ***Holloway Road Station*** **of the** ***Great Northern, Piccadilly and Brampton Railway,*** **but was never approved by safety inspectors for public use. Its failure had an adverse effect upon Reno and his company. Within five years, he sold his patents to Otis and returned to the U.S. in 1911.**

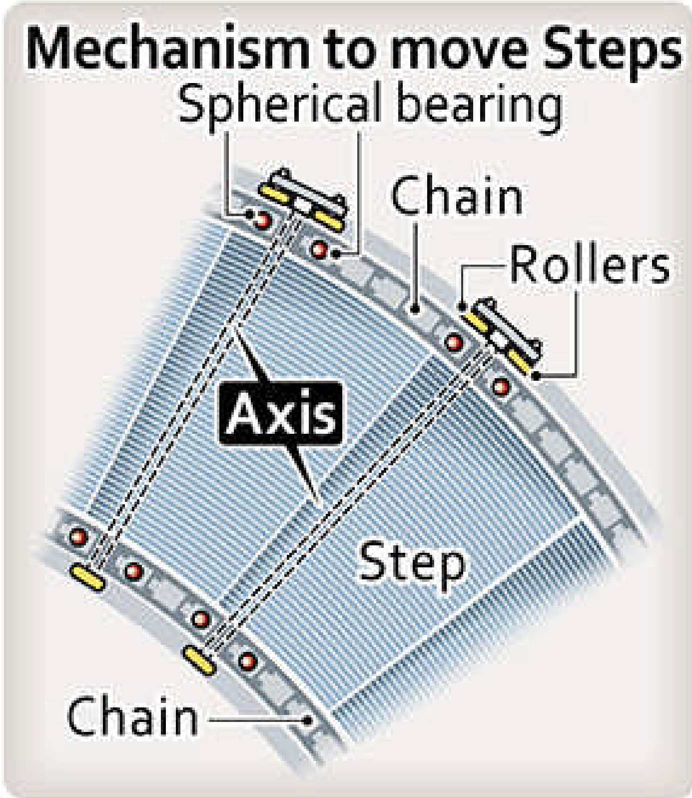


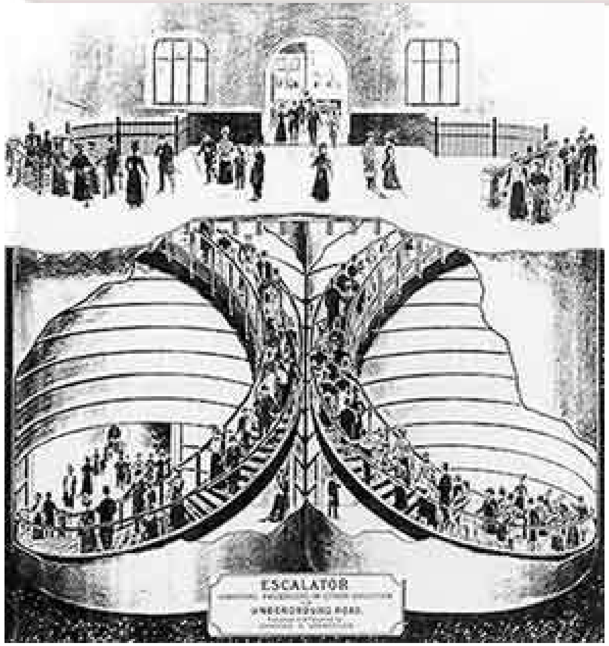


Seeberger was making an attempt at creating a practical *Spiral Escalator* between 1900 and 1910. He designed many unique parts, including the "C-shaped" handrail. His mechanism was never placed in operation, despite the quality engineering of its components. The failure/s of both Reno and Seeberger - both engineering giants of their day, no doubt discouraged others from assuming the challenge. It was not until the mid-1980s that Japan's *Mitsubishi* developed and marketed a practical Spiral Escalator.

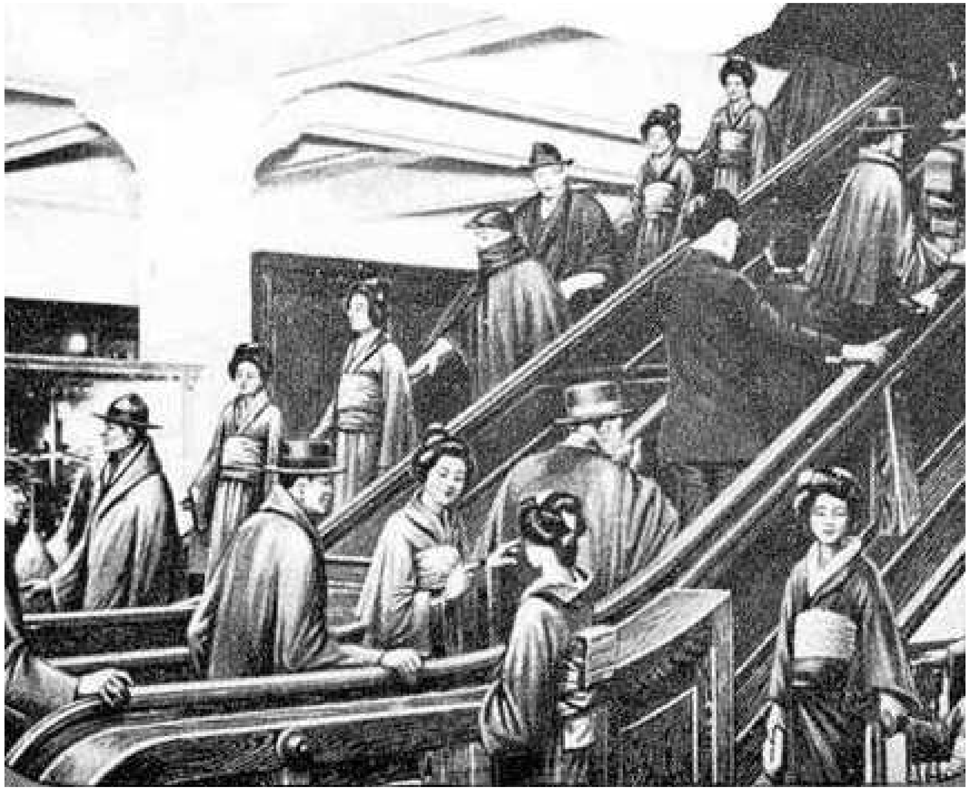
<u>Left T&B</u>: caption: "Charles Seeberger developed this plan of a duplex spiral escalator for Otis Elevator Company about 1900"







<u>Left</u>: caption: "An early rendering for a proposed Spiral Escalator (ca. 1900)"
<u>Above L&R</u>: caption: "Spiral Escalator Mechanism"



<u>Left</u>: in 1914, six Otis escalators were installed in the ***Mitsukoshi Department Store*** in Tokyo; the first escalators installed in Japan. A 1927 Otis ad stated the escalators had given such satisfaction that Mitsukoshi installed two escalators in its store at Osaka and one at Yokohama. The first escalators in the Hawaiian Islands were installed in 1941 in the Mitsukoshi Department Store in Honolulu. The escalators were two-feet wide ML-C type units, serving from the 1st to the 2nd floor and were provided with ***Series No. 1A*** balustrading.

"…There are two types of Escalators, known as the Step and Cleat types. The Step type begins as a moving platform; then as it goes onward it breaks into steps rising slowly into a perfect staircase, but moving steadily and noiselessly a little faster than one can ordinarily walk. On either side, a hand rail of flexible material moves upward at the same speed as the stairs, thus affording the passengers a secure support as they ascend. At the top the steps flatten out into a moving platform again from which the passenger steps to the stationary landing on the same level so easily that the transition from the moving to the stationary surface is hardly noticed. At the upper landing, the side corresponding to the balustrade of an ordinary staircase turns inward and the moving platform disappears under it. The moving hand rail continues along this balustrade so that a passenger who had not noticed that the top had been reached would be gently pushed off to continue on his way. An electric motor drives the mechanism running on rollers on an inclined plane, which supports the treads and risers at the proper angle…"

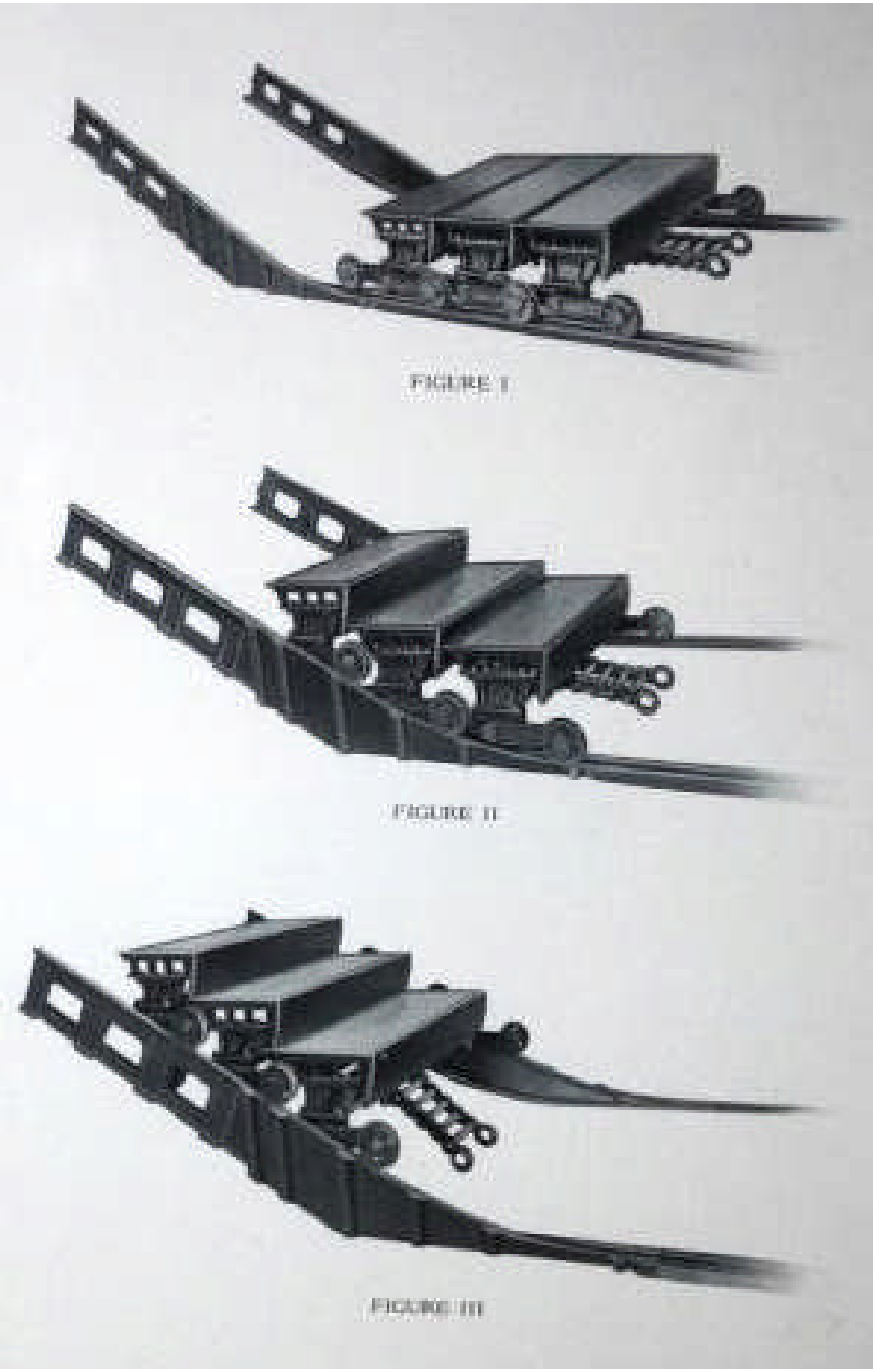
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

Top: caption: "Step Type"

Bottom: caption: "Cleat Type"

"…The Escalator is a perfect staircase at all times, whether in motion or at rest. The steps are always horizontal. At the landings the steps travel horizontally, flush with the floor, for an interval more than sufficient to meet the requirements of the aged and infirm, thereby rendering the Escalator not only available to all classes and conditions of the public, but assuring absolute safety. A traveling hand rail at each side of the Escalator, moving at the same rate as the steps, is provided for the convenience of those accustomed to using a hand rail on stationary stairways. Escalators may be built for ascent or descent, or reversible at will. They may be operated continuously or started and stopped by push button where continuous operation is not desired…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)



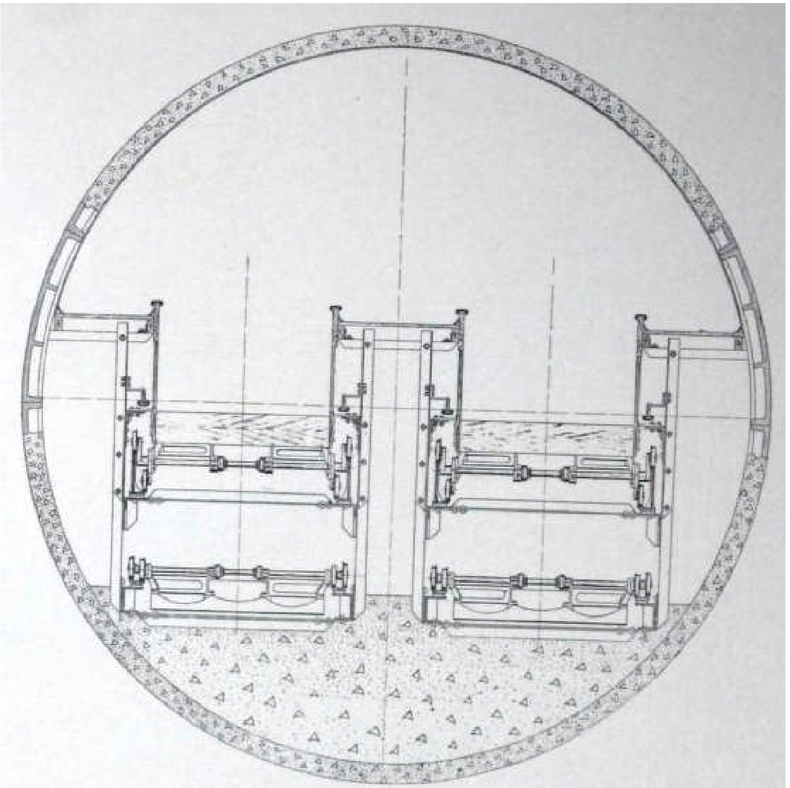
"…The accompanying cuts are illustrative of the step action at the lower end of the Escalator. It will be noted that on the landing the treads are flush (Fig. I), forming a moving platform on to which the passenger steps from the stationary floor plate. As they approach the incline, the wheels rise on the curved tracks producing a step formation gradually at first and more rapidly thereafter (Fig. II), until the incline portion is reached where we have the full riser development (Fig. III). The steps continue up the incline without altering their relative positions, until the upper end of the machine is reached, where the reverse action of that already described takes place and the steps once more flatten into a moving platform from which the passenger alights to the stationary floor…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

Q: "'*Why do handrails on escalators always seem to move at slightly different speeds than the steps themselves?'*

A: ***Escalator handrails and walkways are driven by the same motor. The steps are driven by a chain, so there's a direct connection between the motor and the steps. Handrails, by contrast, are driven by traction – generally speaking, a rubber-covered belt that presses against the inside of the handrail. 'As the rubber cover wears, it may cause the handrail to run somewhat slower than the steps or walkway. This is corrected by replacing the driving wheels or belts before the difference in speed affects the safety of passengers,' says Dave Steel of Otis Elevator. Another cause of this condition may be dimensional tolerances in the mechanical parts. 'When parts are manufactured, you can't make them to an exact, precise dimension,' says Steel. 'Everything has a plus or minus tolerance.' These factors can produce slight variations in speed. A significant speed difference between the handrail and steps or walkway, however, may indicate a larger problem. The handrail drive system may be broken or need adjustment. If this is the case, the escalator should be shut down and repaired."***

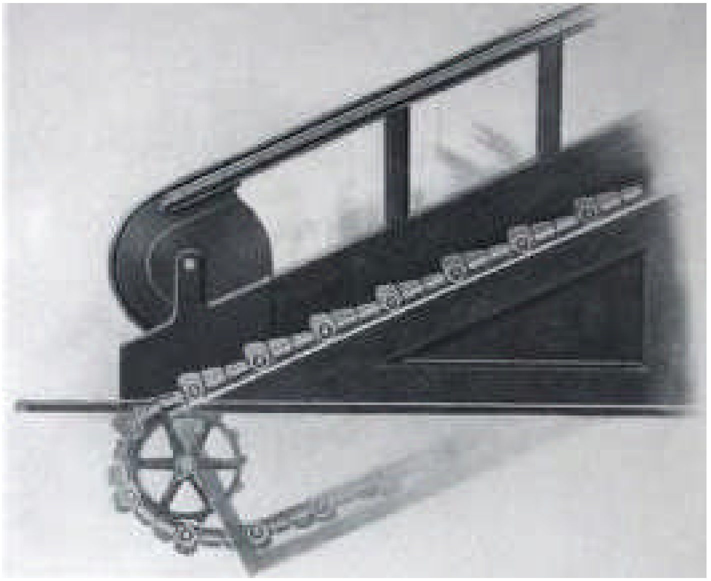
Popular Science, **October 1995**



<u>Left</u>**: caption: "Step Escalators – Section Through Incline, Showing Ascending and Descending Machines"**

"…The Cleat type is a moving stairway without the steps. It is an endless moving platform formed of hardwood cleats located in longitudinal ridges and grooves. There is a hand-rail on either side moving at the same speed. The platform revolving over the lower sprocket glides through the prongs of a comb at the lower level and journeys upward at a moderate speed. At the upper landing it disappears through a comb and revolving over a sprocket, travels downward. The passenger slides off upon the prongs of the comb at the top in safety and without jar or shock. Both types of Escalators can be made to operate either up or down, by employing a reversing switch. Such machines are known as Reversible Type Escalators. When traffic must be handled in both up and down directions simultaneously, two machines are used, one moving upwards and one downwards. Such arrangement is known as a Duplex Escalator…"

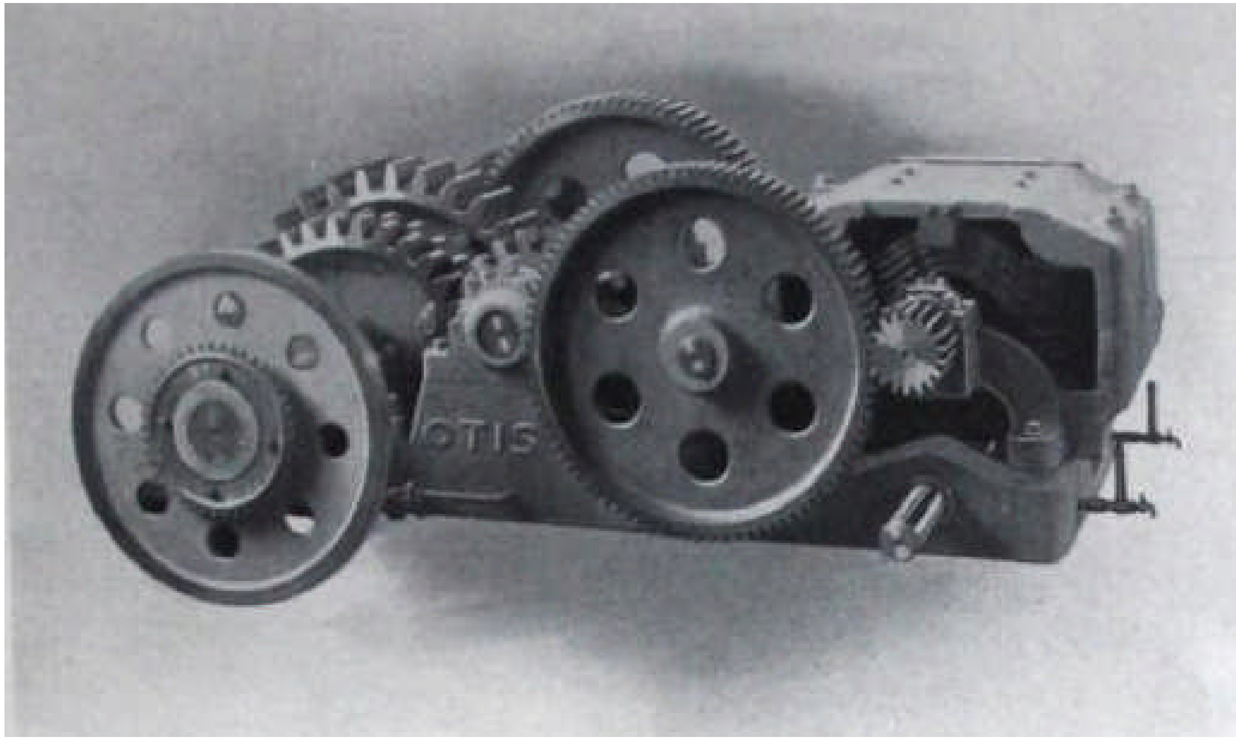
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)



"…The illustration shows the construction of the tread for the Cleat type of Escalator and it has proven itself to be very practicable and safe in operation. The step treads are so nearly horizontal, the angle being only 12½ degrees, that the foot of the passenger is in a very comfortable position while riding either up or down the Escalator. They are made of hard maple bolted to a steel bushed chain which passes over sprocket wheels at the upper and lower ends of the machine. Attached to the treads at intervals of one foot are self-lubricating iron wheels which roll upon steel tracks. The surface of the moving plane is produced by a series of parallel cleats about one inch apart, forming longitudinal ridges and grooves. The object of this construction is to enable the passenger to be landed safely and comfortably at the floor line upon a comb-shaped plate, the prongs of which project into the grooves between the ridges of the treads; the passenger is therefore transferred to the landing without any attention on his part…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

<u>Above</u>: caption: "The Cleat Type Tread"



"…The illustration shows a form of Escalator driving machinery which is employed in situations where it is necessary to place this mechanism within the body of the Escalator proper. It consists of a standard Otis motor of a capacity suitable for the work to be performed, with spur gear reductions to the main driving shaft on which is mounted the bronze sprocket wheel. In situations where space is available at the side of the Escalator beneath the upper landing we prefer to employ a worm gear driving apparatus, which has the advantage of being more accessible for purposes of inspection…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

<u>Above</u>: caption: "Motor and Reduction Gearing Step Type Escalator"

“…Wherever large numbers of people are to be handled, the Escalator is applicable. On the following pages are illustrated some of our most interesting and important installations…”
RE: excerpt from *Otis Elevator Company* brochure (ca. 1912)

Railway Terminals

"…Every railway terminal where the tracks are either elevated or depressed, or where passengers must be moved from level to level, needs Escalator service. The watchful and progressive railroad companies have spared no expense to make travel pleasant and comfortable. They have provided safe and luxurious coaches, the speediest of electric and steam locomotives and the safest of signal systems; and now the time is ripe to furnish the public a quick, easy access to and exit from trains in the station…"

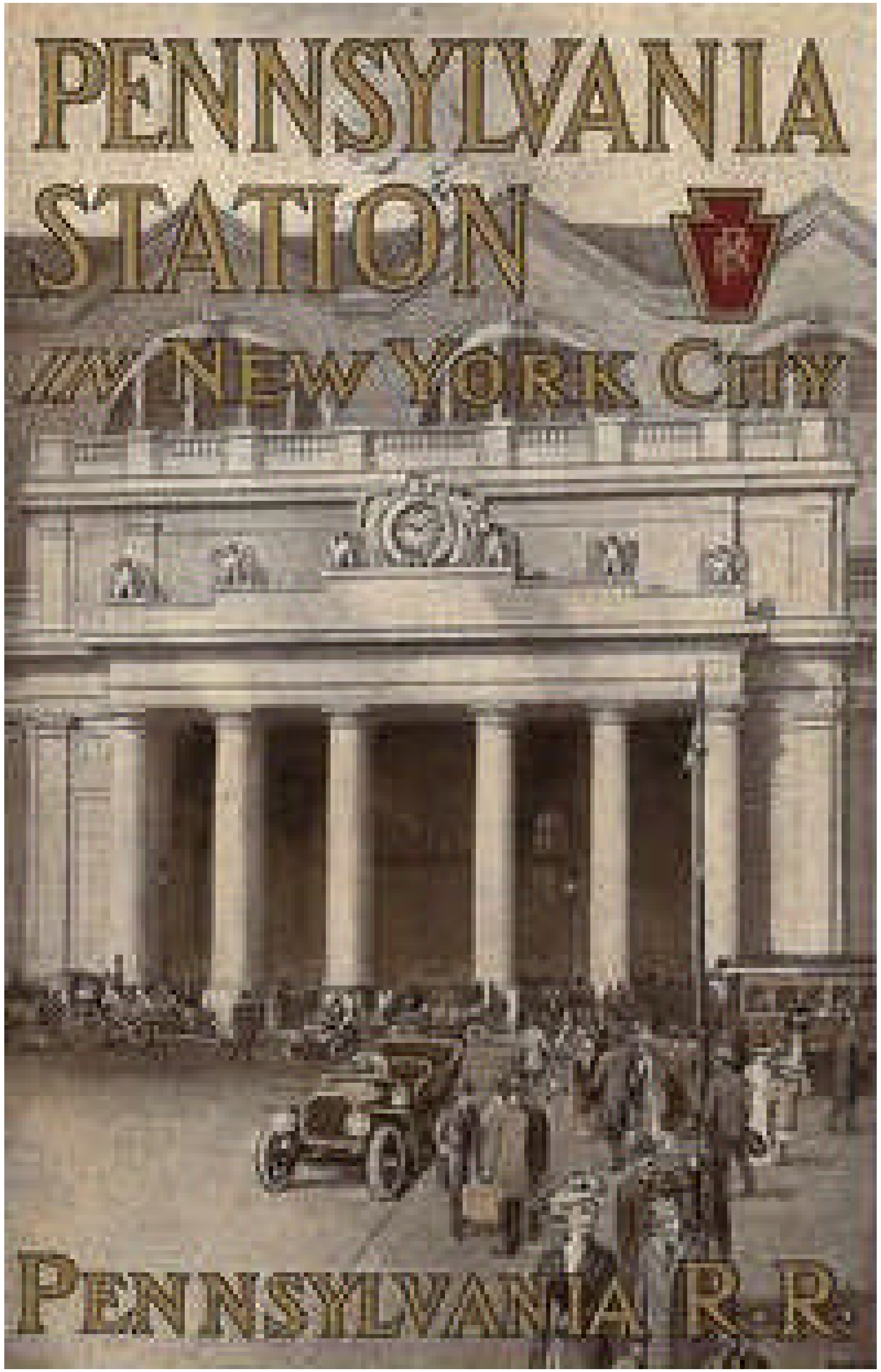
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

"…The Pennsylvania Railroad has inaugurated this movement at the Thirty-fourth Street exit of its New York terminal, by an Escalator installation operating between the mezzanine floor in the station and the sidewalk level, a distance of about twenty-six feet. During the morning hours the service is taxed practically to its capacity, about 11,000 people per hour. …"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

Above: caption: "Escalator – Pennsylvania RR Terminal – View Taken During Morning Rush Hours"

Left: caption: "Escalator – Pennsylvania RR Terminal, NYC"



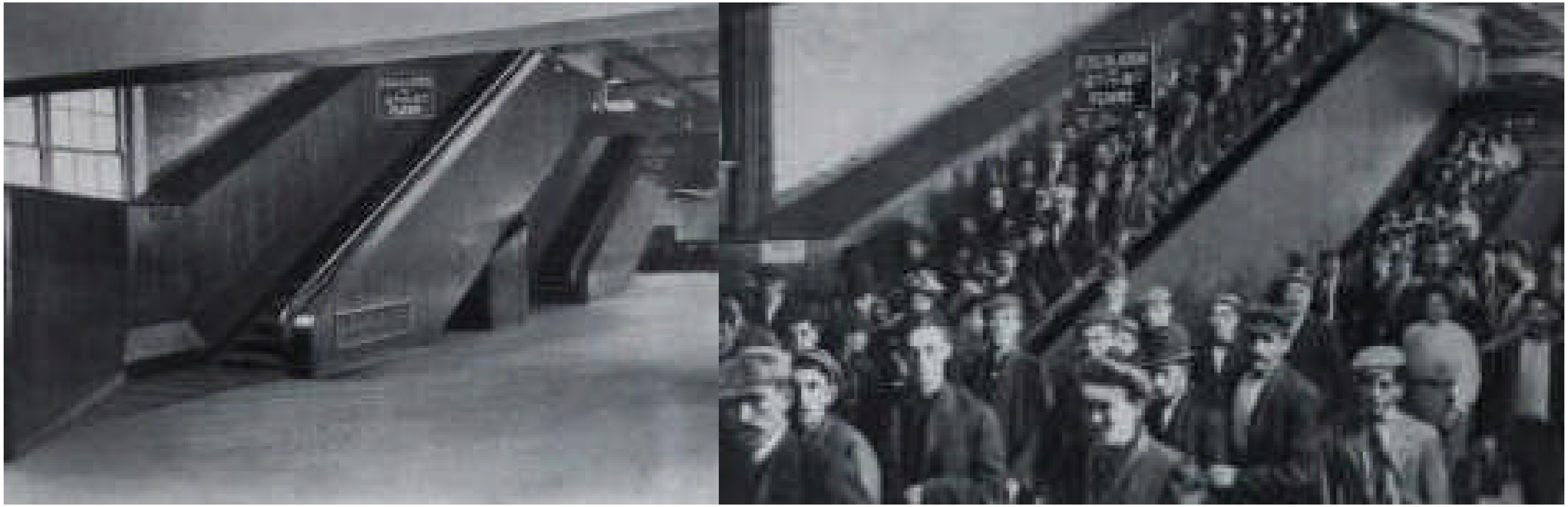
"…That the Escalator is popular with the traveling public is evident from a glance at the illustration. Ninety-eight per cent of the people using this exit, travel on the Escalator. The old-time stairway adjoining has been practically abandoned. No one will sap his strength or waste his energy in climbing stairs when he can ride, and many people will walk considerable distances to ride one or two stories on an Escalator. The Railway or Transportation Company that installs Escalators for its patrons is bound to realize heavily on its investment. The quick and comfortable transfer of passengers is a great deal in itself, but the good will and friendly attitude of the public is worth in advertising value many, many times the initial expense of the Escalators…"

RE: excerpt from an *Otis Elevator Co.* brochure (ca. 1912)

Mills & Factories

"…There is no more interesting example of the large place that the Escalator has found for itself in commercial fields than the installation in the Wood Worsted Mills at Lawrence, Mass. To those who have been accustomed to look upon the Escalator as an unnecessary luxury, let them but study for a moment the practical foresight that led the largest worsted mill in this country to equip its plant with two batteries of four Escalators (Step Type), each…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)



"…To serve the 500 operators employed in the mills, the eight Escalators are run upward in the morning, down again at noon, upward after lunch hour and finally downward at night, carrying the employees between the second and sixth floors. The time of the trip for the individual passenger to or from the sixth floor is about two minutes, and each of the machines will carry ten to eleven thousand persons per hour. The ill-ustration shows the operators leaving the mill at the noon hour. The buildings are emptied rapidly and noiselessly…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

<u>Above</u> L&R: caption: "Escalator – Wood Worsted Mills, Lawrence, Mass."

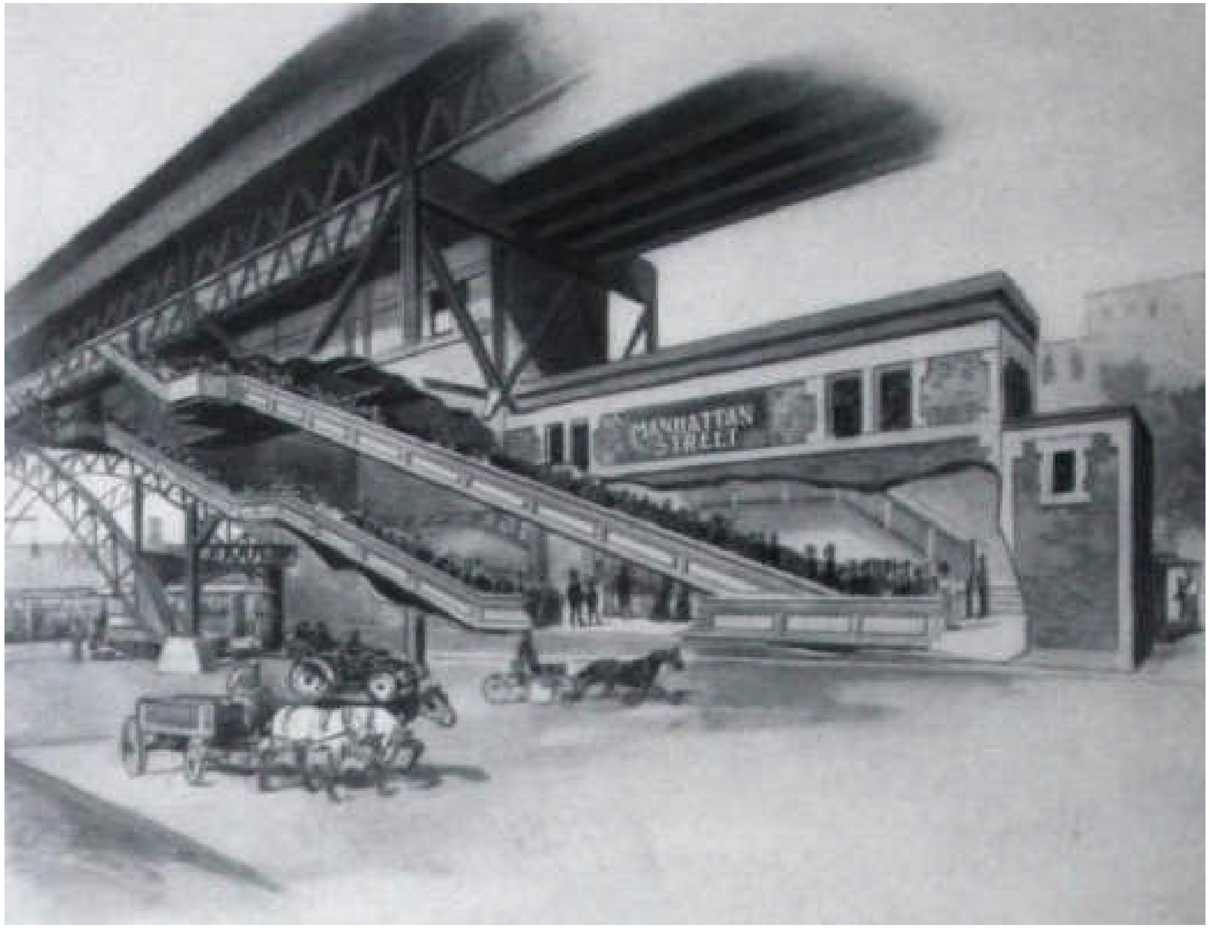
"…The machines are motor driven and can be started stopped or reversed at will. As they operate a total of about only one hour per day, and as low power motors are used, the annual operating costs are very small. The profitable and practicable feature of the Escalator from the viewpoint of the owner is the increased efficiency of each operator due to the elimination of stair climbing. While it is almost impossible to figure the saving in dollars and cents, a careful study has convinced the directors of the mills that in the course of a year, a vast sum of money is saved through the conserved energy of the employees. Then too, it has been learned that expert operators are more easily obtained in mills where their welfare and health are conscientiously cared for, and the Escalator is now looked upon as one the most potent forces in the accomplishment of that purpose…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

Subways & Elevated Stations

"…All of our big cities have their problems, and the greatest of these is transportation. Indeed, in the largest cities of the world the traffic question is one that demands the study of the keenest minds, and those cities that accept every method of improving their transportation conditions, are and should be proud of their enterprise. The crowds must be kept moving; the slightest congestion or block causes annoying delays to thousands of people. In New York, Boston, London, and other large cities where the elevated and subway systems carry hundreds of thousands of people daily, the Escalator has been installed at many of the busiest centers, and other stations are now being equipped…"

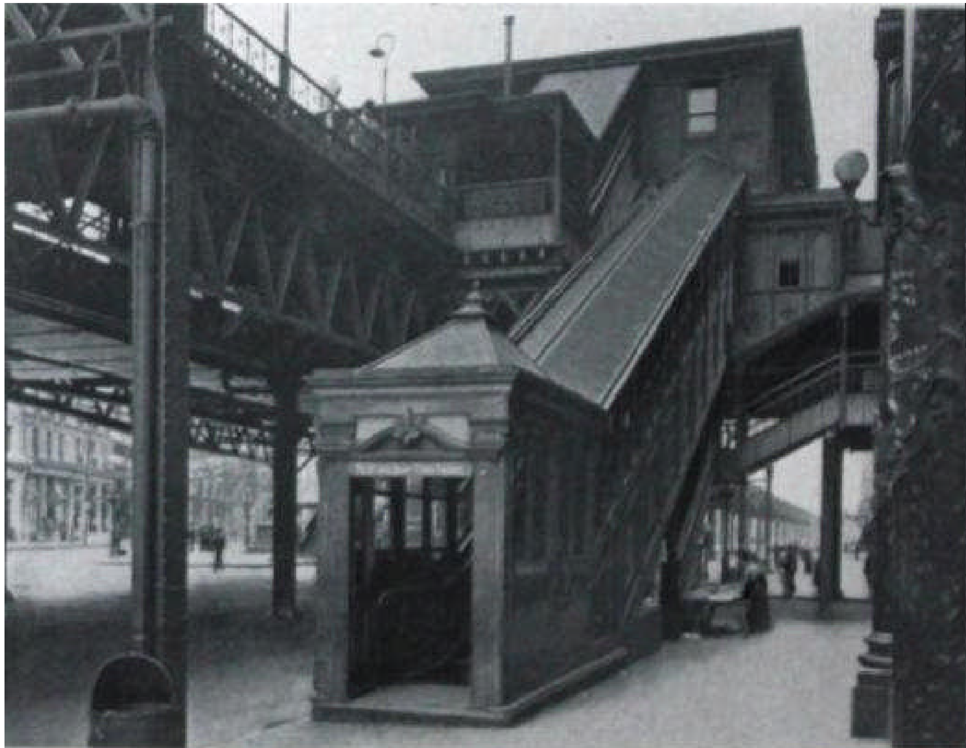
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)



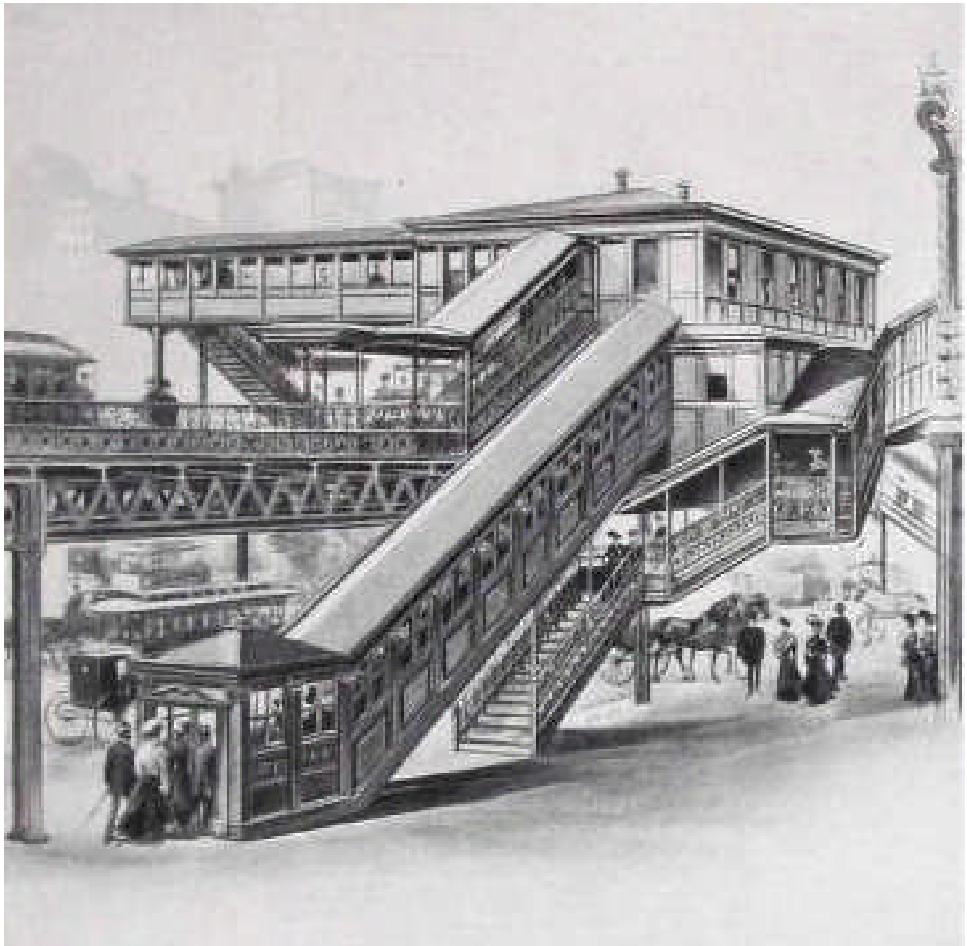
"…A glance at the illustrations shows a few of the New York City Elevated Stations and the Boston Subway Stations where Escalators are now operating. It is of common occurrence that persons will walk out of their way to use an elevated or subway station which is reached by an Escalator. The fatigue of stair climbing is shunned by even the strongest, while, to the weak and infirm, the Escalator has been a real blessing…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

Above: caption: "Step Type Escalator – Manhattan Street Subway Station, NYC"



<u>Top Left</u>: caption: “Step Type Escalator – Sixth Avenue and Thirty-third Street, NYC”
<u>Top Right</u>: caption: “Cleat Type Escalator – Westchester and Intervale Avenues, New York Subway”
<u>Left</u>: caption: “Escalator Exit – Park Street Station, Boston, Mass., Subway”



"…Public sentiment is strong in demanding more Escalators. One never thinks of walking up a long, tedious flight of stairs in a building where there is an elevator, and no more should he submit to stair climbing in the subway or elevated station, where the Escalator is the <u>only</u> practical means of ascent, for the great crowds that must be carried. The Amusement Parks have been quick to add Escalators to their equipment as a means to circulate the crowds to their various attractions. They are proving very valuable for this purpose…"

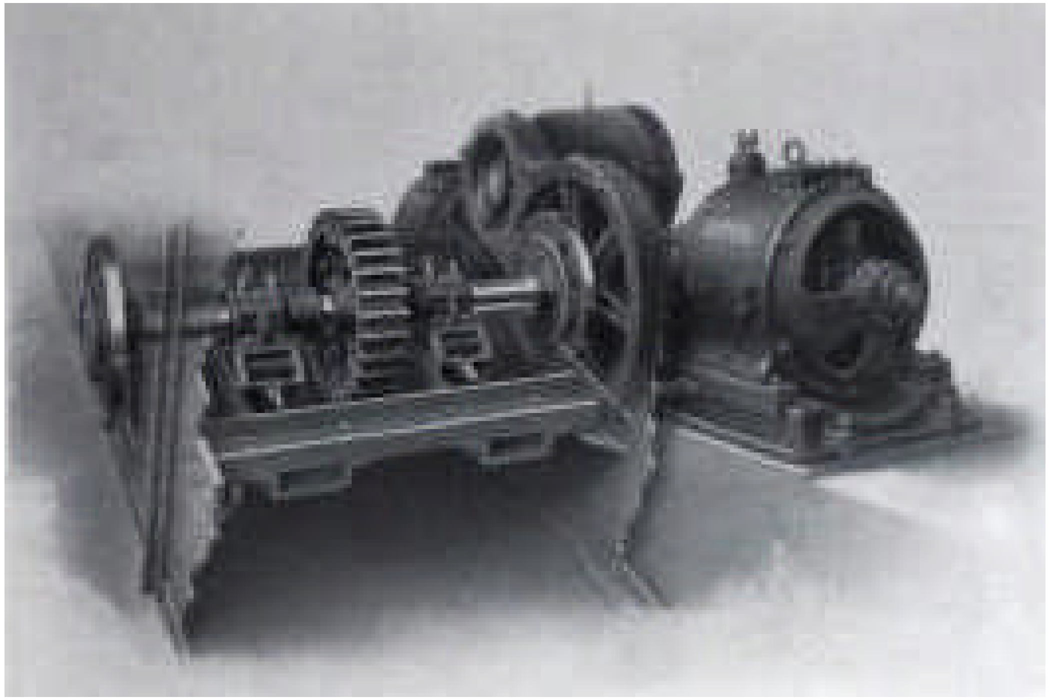
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

<u>Top</u>: caption: "Step Type Escalator - Park Street Station, Boston, Mass., Subway"

<u>Bottom</u>: caption: "Double File Cleat Type Escalator - Park Street Station, Boston, Mass., Subway"

"…The hearty welcome that the Escalator received in England is worthy of special mention. In October, 1911, two Escalators of the Step Type, one ascending and one reversible, were installed at the Earl's Court Station, to connect the Piccadilly Tube with the District Railway, London. England. With a carrying capacity of 10,800 people per hour in each direction, the Escalators proved to be so invaluable that soon two more were installed and ten others are now being built; a battery of fourteen Escalators that will have a total capacity of over two million passengers a day…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)



"…The driving mechanism for each Escalator consists of one standard bronze sprocket wheel with a spur gear reduction to a double worm geared elevator outfit, with a 50 H. P. motor at each end of the worm. These motors are coupled to the worm shaft in such a way that either one or the other may be used at will, thus avoiding shut-downs due to minor motor troubles…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

<u>Above</u>: caption: "Motor and Reduction Gearing of Step Type Escalator at Earl's Court Station"

"London has come into line with New York in the matter of the Escalator and two moving staircases now connect the Picadilly Tube and the District Railway at Earls Court Station. The Escalators are proving not only very useful, but providing Londoners and country cousins alike with a new amusement. There have been not a few so fascinated by the device that they have traveled up. then down and up again before the curiosity and desire for a fresh sensation have been satisfied. Passengers on their wav to the city have even been seen to leave a train, go up with the stairs and down with the stairs, and catch the next train."

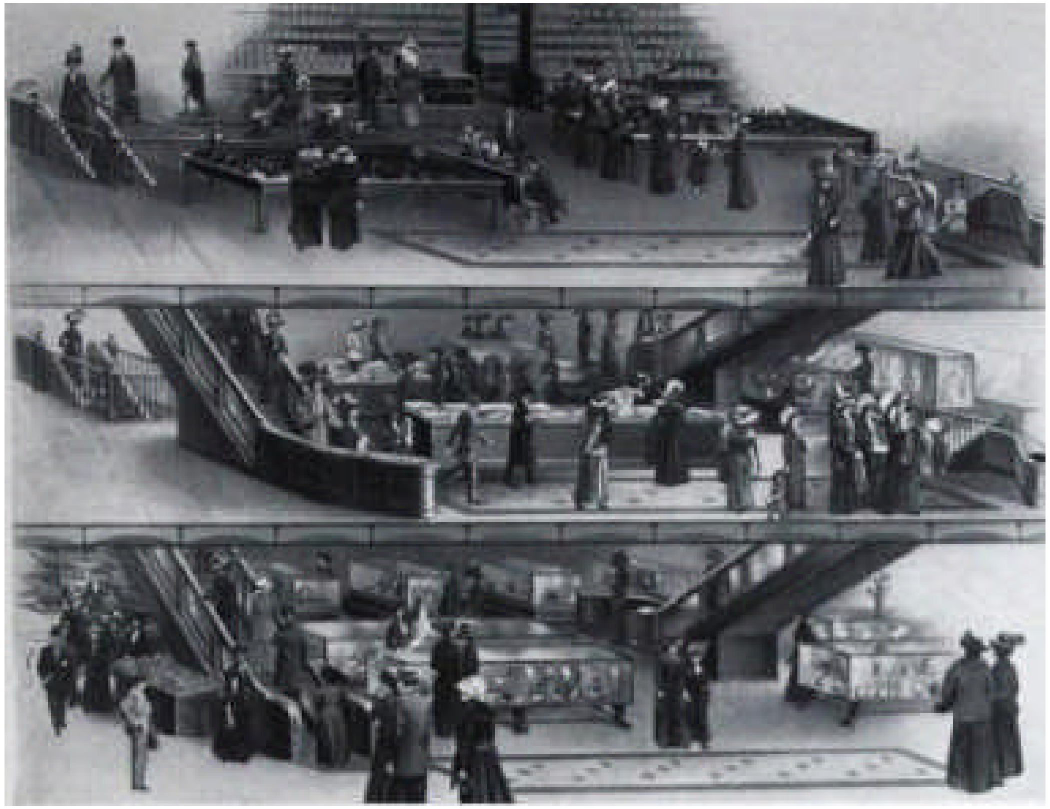
Illustrated London News **(ca. 1912)**

The first two escalators to be used by *London Transport* as passenger conveyors were installed in October 1911 at *Earls Court Underground Station*. They were Otis "A-type" flat-step units, the forerunners of the heavy-duty escalator. The two escalators were so successful that between 1911 and 1915, twenty-two machines were installed on the *London Underground* system and the escalator became the prime mode of passenger transportation from station platform to street level.

Department Stores

"…The Department Store is an ideal location for an Escalator. No other one class of buildings has lent itself so readily to extensive installations and nowhere has the Escalator been more valued as a sound commercial investment. It is only necessary to observe the large number of stores with Escalators in various cities throughout the United States, to realize that the Escalator in the Department Store has come to stay. It supplements beautifully the functions of the elevator, and does much that the elevator, from the very nature of its construction, cannot do. The opinion once general that the store equipment should be proportioned to the average size of business, is no longer held by the more progressive merchants. and they now regard it as essential that facilities should be planned to meet the requirements of the largest business of a very short season. This is certainly logical, for business is done when the people are in the store, and if at such times the facilities are inadequate, it results in loss of sales; furthermore, in equipping for the largest day's sales, the merchant has provided also for the growth of the average business without overtaxing his resources…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)



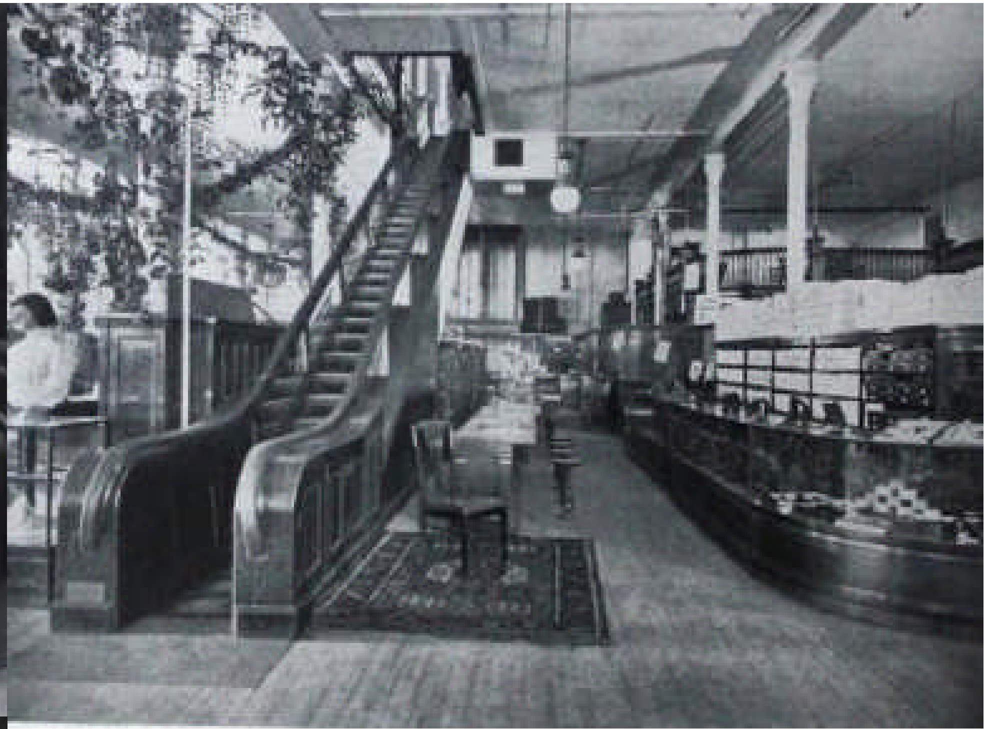
"…The 'radius of action' of a piece of elevating apparatus is not large and for that reason the apparatus should not be 'bunched' or crowded in one part of the floor. It has been interesting to watch the growth of the Escalator idea in the stores which have introduced it. In a number of cases the first installation was a single machine to be followed later by other machines in the upper floors. Then comes the second stage of the Escalator idea, namely, a duplication of the equipment by installing Escalators at other points on the same floor, to bring those points within the 'radius of action' of elevating facilities…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

Above: caption: "This Arrangement, Showing a Battery of Escalators, Will Produce Proper Circulation in a Department Store Obtainable by no other Method"

"…At the outset it was believed unnecessary to provide descending Escalator service, but from observations in stores fully equipped with both ascending and descending Escalators, it has been learned that descending service is not only a convenience but a means of a very greatly increased circulation, by reason of inter-floor travel. No enterprising or progressive merchant any longer clings to the old idea of crowding the greatest possible number of departments and counters containing the staple year-round sellers, on the first floor, with a space allotment to each of less than might be profitably employed, and of employing the upper floors for departments of short seasons and for large space devoted to lines of a very limited number of sales. The Escalator has changed this condition by providing a uniform circulation throughout the store. It has made the upstairs space just as valuable as ground floor space, and has readjusted the old-time ideas as to the aisles and location of departments…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)



Top Left: caption: “Step Type Escalators – Henry Siegel Company Store, Boston, Mass.”
Top Right: caption: “Step Type Escalator – Denver Store, Denver, Colorado”
Left: caption: “Duplex Cleat Type Escalator – R.H. White & Company Store, Boston, Mass – Installed in 1901”

"…We have studied long on the problem of circulating humanity through the Department Store, and it has become clear to us that the problem, though complex to a greater degree, is as truly a matter for an engineer as are the simpler problems of circulating steam, electricity and the like. We have collected data of all sorts on which to base our recommendations for the aisles, department locations, etc., and are more than willing to lend ourselves and our experience to those considering Escalator requirements…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

<u>Top</u>: caption: "Duplex Cleat Type Escalator – Siegel, Cooper & Company, Chicago, Ill."

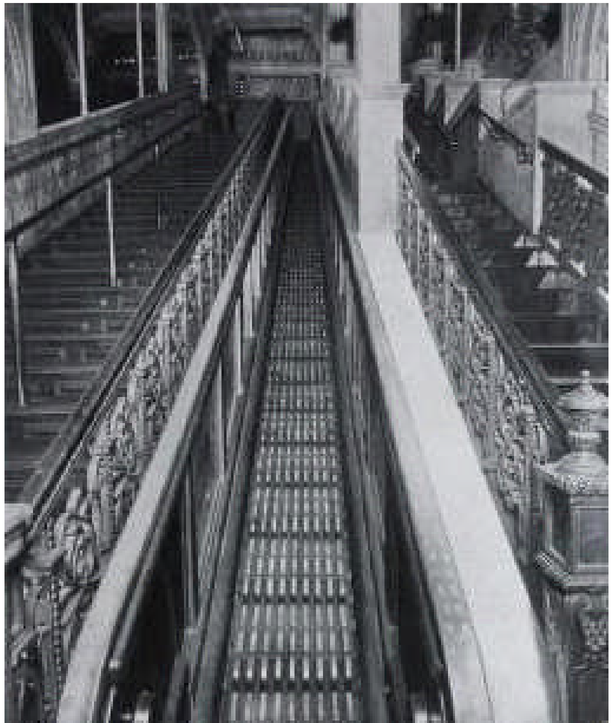
<u>Bottom</u>: caption: "Step Type Escalator – R.H. Macy & Company, New York City"

Left: caption: “Escalators in the store of Messrs. R.H. Macy & Co., New York, showing the upper landing of the first Escalator and the second Escalator in the background. The ample space allowed in which to step from the Escalator is clearly shown, and the moving hand rails and the shunt may also be seen. The Escalators serving the upper floors are located above.”

Theatres

"…The Escalator in the theatre is more than an innovation. It is a valuable adjunct to the equipment of every playhouse. The theatre owner and manager is at his wits' end to fill the balconies and galleries. The moving picture show, with its cheaper prices, has appreciably detracted from the balcony and gallery patronage of the 'legitimate' theatre. A few theatres, however, have found that by making the upper seats convenient of access and egress, thousands of amusement-loving people, who cannot afford to pay prices for orchestra seats, will avail themselves of the Escalator to reach the balconies. To this end the Escalator has been used in several theatres with pronounced success. In one popular theatre where reserved seats are not sold, the management, by having an Escalator, does not open the doors to the orchestra until the balcony is well filled, and it has been found that the Escalator makes the balcony seats just as popular as the orchestra seats, if not more so…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)



"… The Escalator is looked upon, also, as invaluable in case of fire. The people appreciate that, because of its tremendous capacity, it will carry them quickly to safety, and this very fact allays fear which otherwise might cause panic. It will be observed that the Escalator is sightly and ornamental. It is an added architectural attraction to the finest appointed theatres. The two Boston theatres illustrated here have led the way and there are several others whose managers have announced their intention of installing Escalators…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)

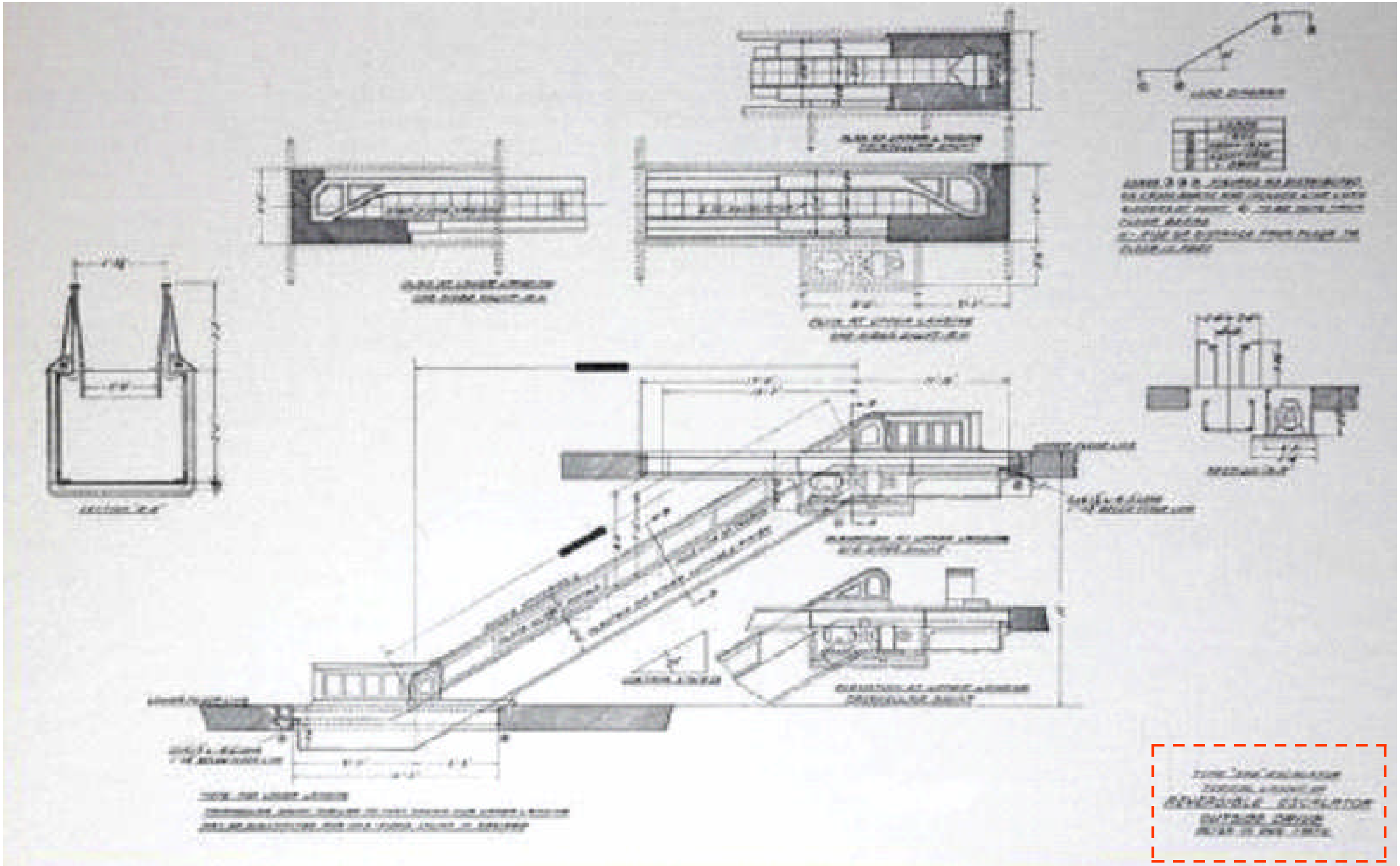
<u>Top</u>: caption: "Cleat Type Escalator – Bijou Dream Theatre, Boston, Mass."

<u>Bottom</u>: caption: "Cleat Type Escalator – Gordon-Olympia Theatre, Boston, Mass."

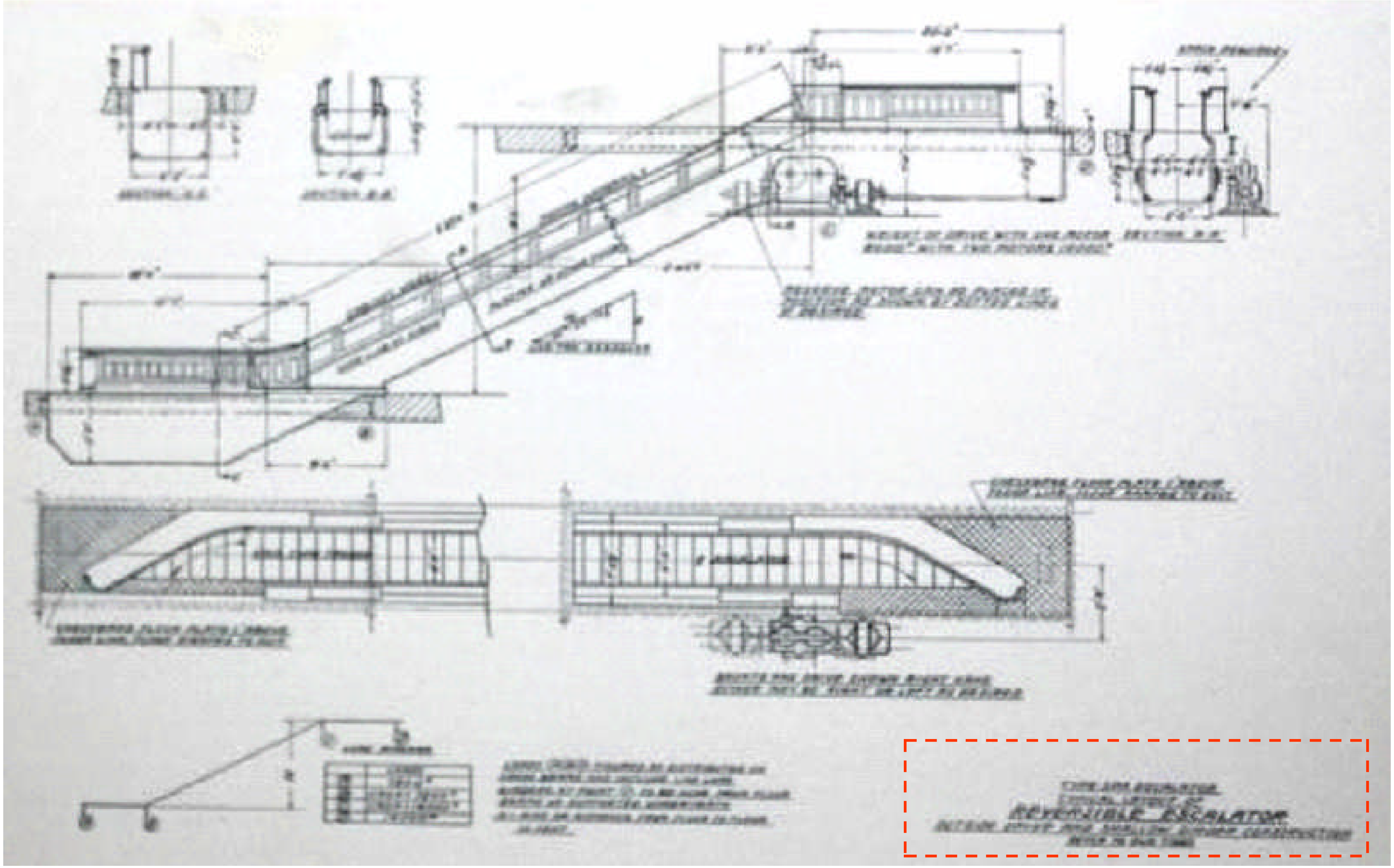
Configurations

"…On the following pages are shown typical layouts of the Step and Cleat types of Escalators. They are intended to give necessary preliminary information to architects in estimating the space requirements and necessary floor openings for any installation…"

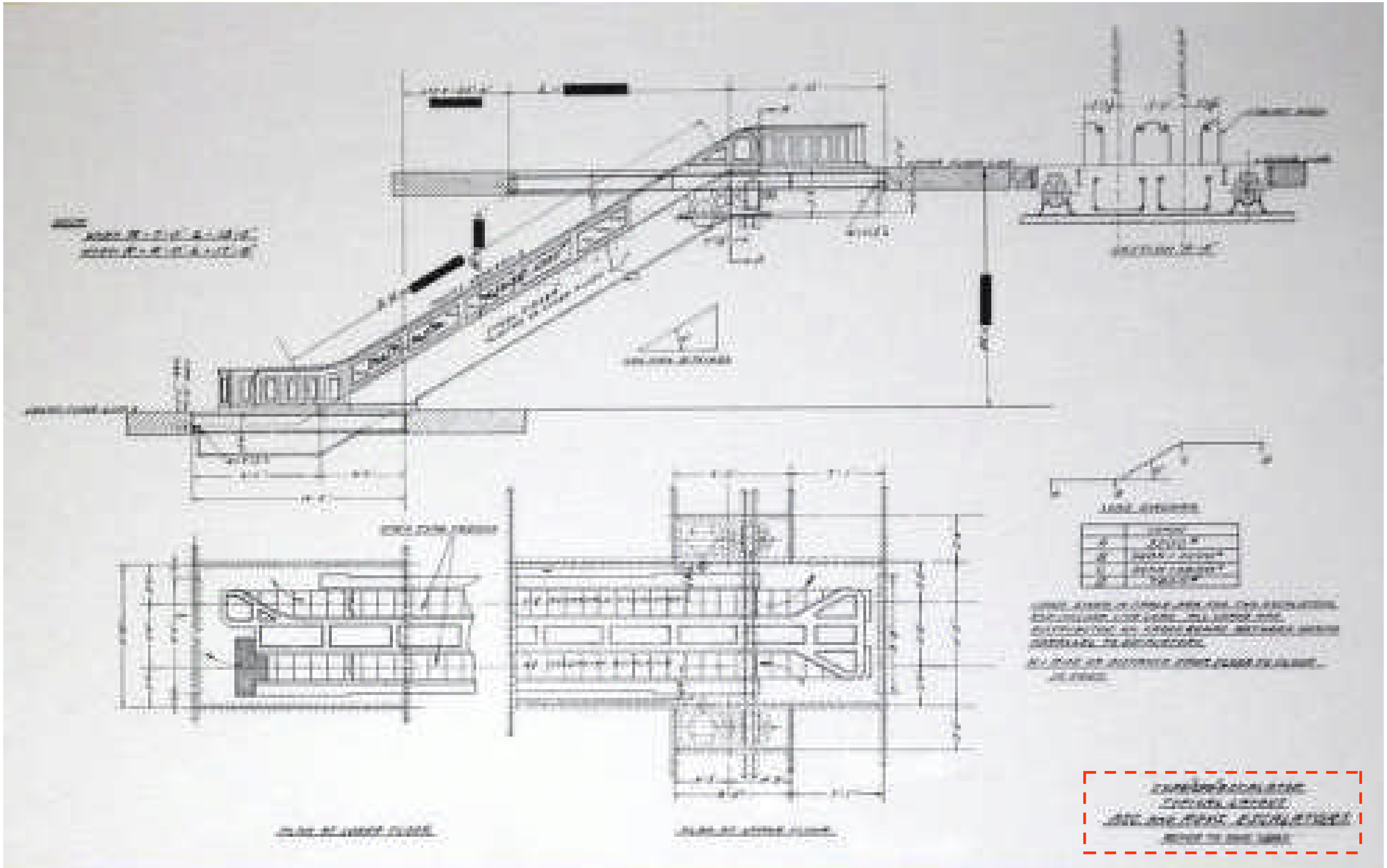
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1912)



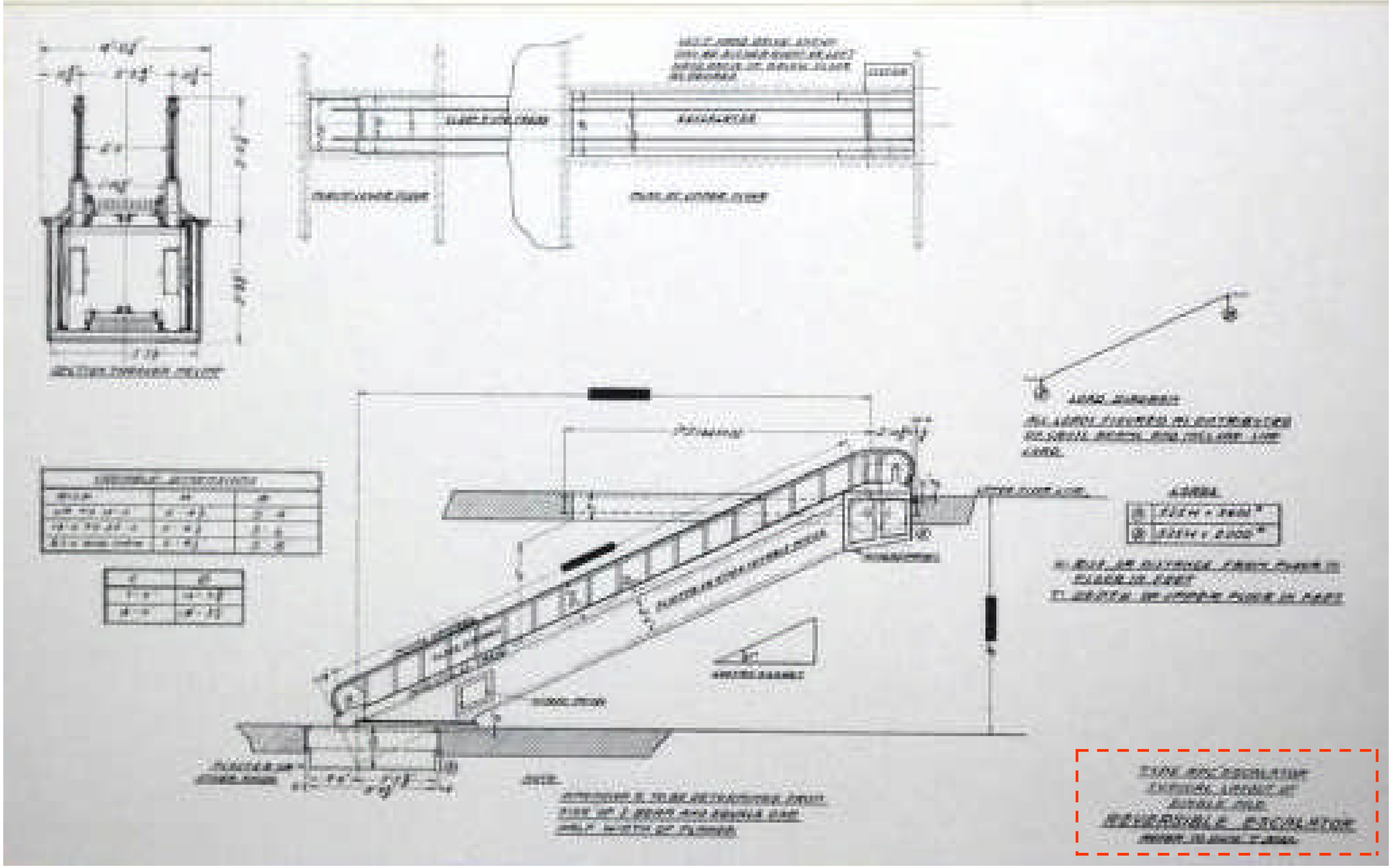
<u>Above</u>: caption: “Typical Layout of Reversible Escalator – Outside Drive”



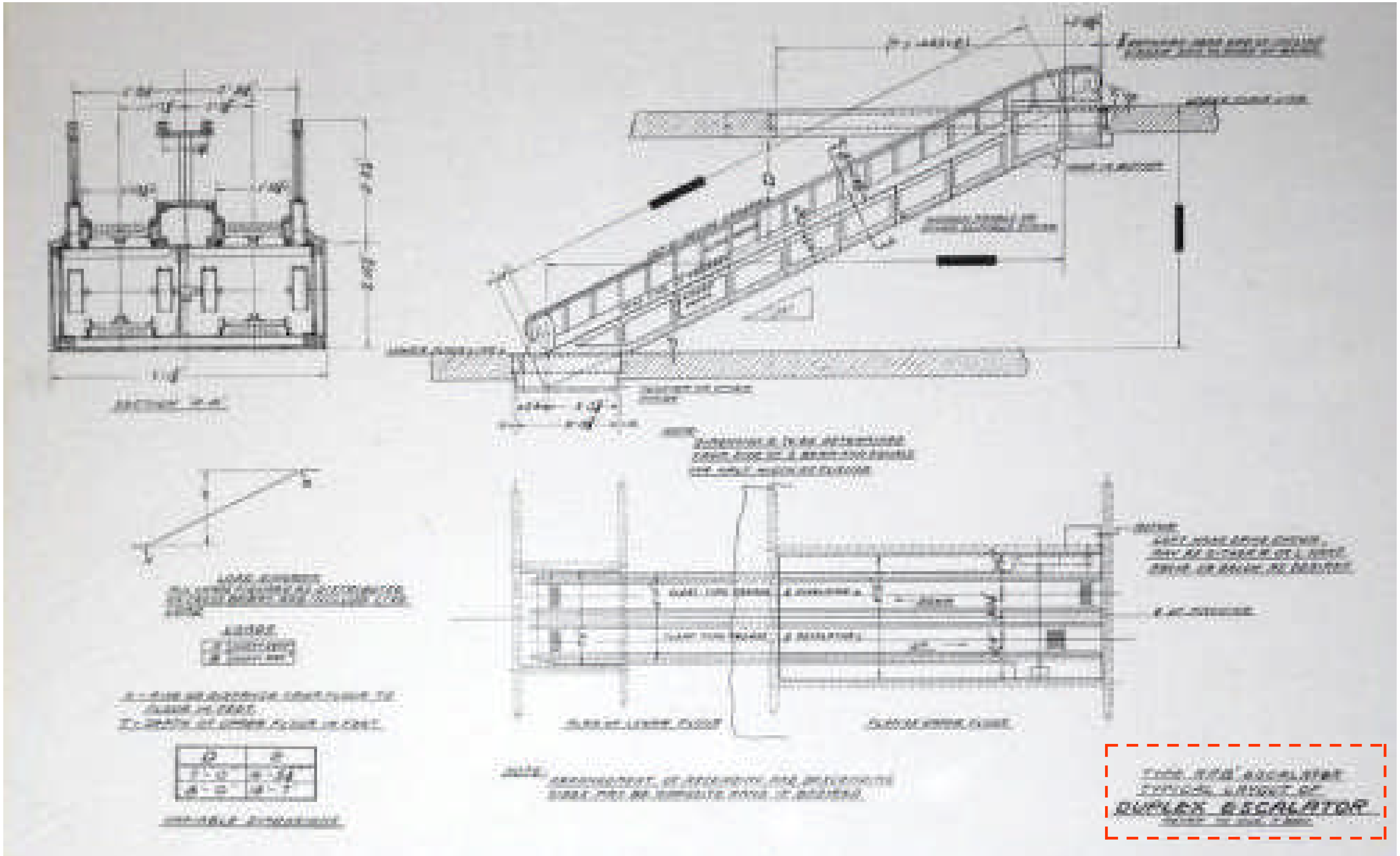
<u>Above</u>: caption: “Typical Layout of Reversible Escalator – Outside Drive and Shallow Girder Construction”



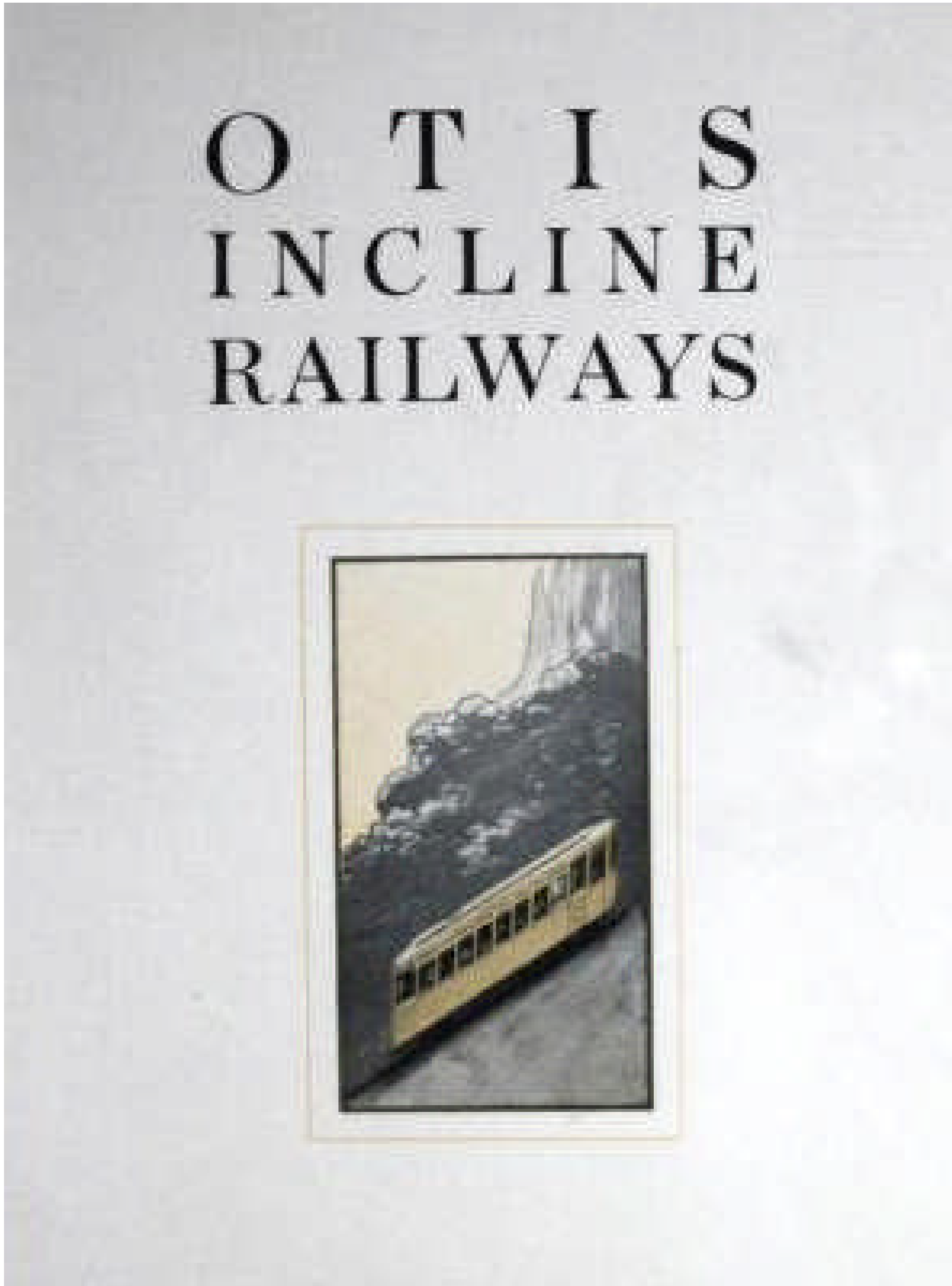
<u>Above</u>: caption: “Typical Layout - Asc. And Revs. Escalators”



<u>Above</u>: caption: “Typical Layout of Single File reversible Escalator”



<u>Above</u>: caption: “Typical Layout of Duplex Escalator”


OTIS
INCLINE
RAILWAYS

"…In presenting this catalogue to engineers and others interested in Incline Railway hoisting, we desire to call attention to the fact that the widely varied and exacting duties which hoisting engines of this class are called upon to perform, prohibits illustrating in a work of this kind, machines that will meet the requirements of all conditions that may arise. Our many years of successful experience in designing and manufacturing steam, hydraulic and electric hoisting machinery, places us in a position to solve any problem that may be encountered, whether it merely requires the modification of the standard types shown herein or the design of an entirely new type of apparatus. It is the purpose of this catalogue to bring to the attention of those interested the many advantages of Incline Railways for developing and enhancing the value of property that otherwise would be practically of no value. Very little in the way of literature can he found bearing upon this subject other than a few articles that have been published in engineering magazines concerning some particular installation. In addition to pointing out the advantages, we will attempt to give a brief description of the most prominent Incline Railways installed by the Otis Elevator Company. Incline Railways may be divided into three classes, namely:

Tourist and Passenger Inclines

Traffic Inclines

Commercial Inclines…"

RE: excerpt from an *Otis Elevator Company* catalog (ca. 1913)

Tourist and Passenger Inclines

"…The Tourist or Passenger Incline Railways are used as a means of reaching some high point on a mountain or in a mountain range, where the view of the surrounding scenery is particularly attractive. Usually at the upper terminus of the Incline Railway a hotel or summer colony is established, and the adjacent land, because of the Incline Railway, is converted from almost valueless property into an attractive, popular and profitable mountain resort. These Incline Railways, in the majority of cases where hotels have been erected or summer colonies established, have proven to be very profitable investments. This quick and comfortable means of transportation also results in developing the land on the mountain side for residential purposes, bringing large returns from its sale. There are, moreover, other conditions that make the Incline Railway an attractive investment for the purchaser. There are large tracts of land throughout the country that are practically of no value, their elevation making them inaccessible. These tracts of land, especially if in close proximity to a city, or even within the city itself, could be made extremely desirable and valuable for residential purposes if there were some easy means of approach. The Incline Railway provides the means of developing such tracts of land and makes them accessible and valuable…"

RE: excerpt from an *Otis Elevator Company* catalog (ca. 1913)

Traffic Inclines

"…Many of our cities are so situated, due to the topography of their location, that the walking public and teaming traffic are seriously handicapped in traveling from one part of the city to another, because of the many steep grades. A great many of the grades are so steep that general use even for pedestrians is prohibitive, and enormous sums of money are expended to build long winding roads or viaducts of easy grades to overcome this difficulty. The distance traveled and time consumed, however, is a serious objection, often resulting in retarding the development of that particular section. In a great many cities Traffic Incline Railways have been installed to meet this condition. These Inclines, where installed and operated either by cities or private capital, whether easy grade approaches are provided or not, have proven to be excellent investments, and at the same time are of great assistance and convenience to the public that they serve. They may be located at a point to suit best the traffic conditions. The rapid development and perfection of electric- driven hoisting machinery with automatic controlling devices for the safe operation of such machinery, opens up a new and greater field for this method of transportation…"

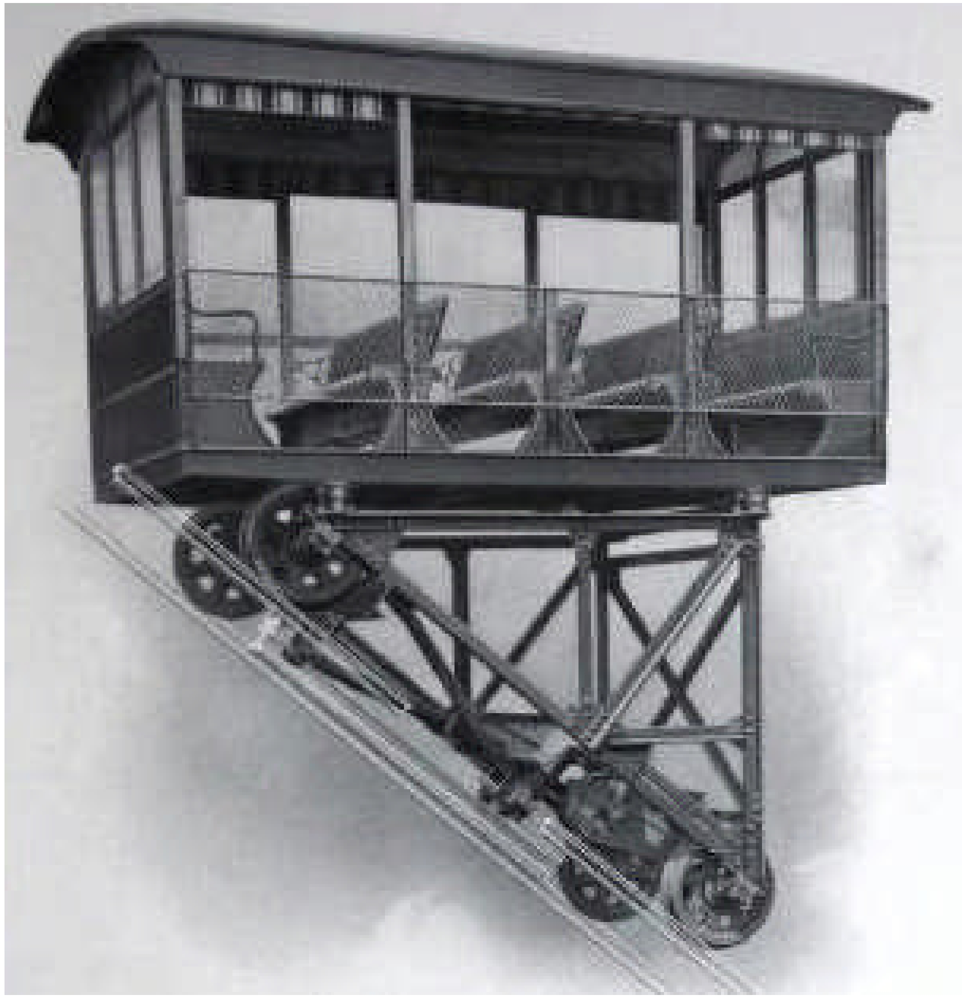
RE: excerpt from an *Otis Elevator Company* catalog (ca. 1913)

Commercial Inclines

“…In the above class we include Incline Hoisting outfits used in industrial enterprises for various purposes, such as hoisting stone in quarries or cement plants to be dumped into crushers or cars; hoisting of ore, coke and limestone in blast furnaces, roasting furnaces or coke plants, and for transferring baggage and freight from a lower to an upper level where sections of adjoining railroads are on different levels. The possible and practical application of this class of Incline Hoisting is almost unlimited…”

RE: excerpt from an *Otis Elevator Company* catalog (ca. 1913)

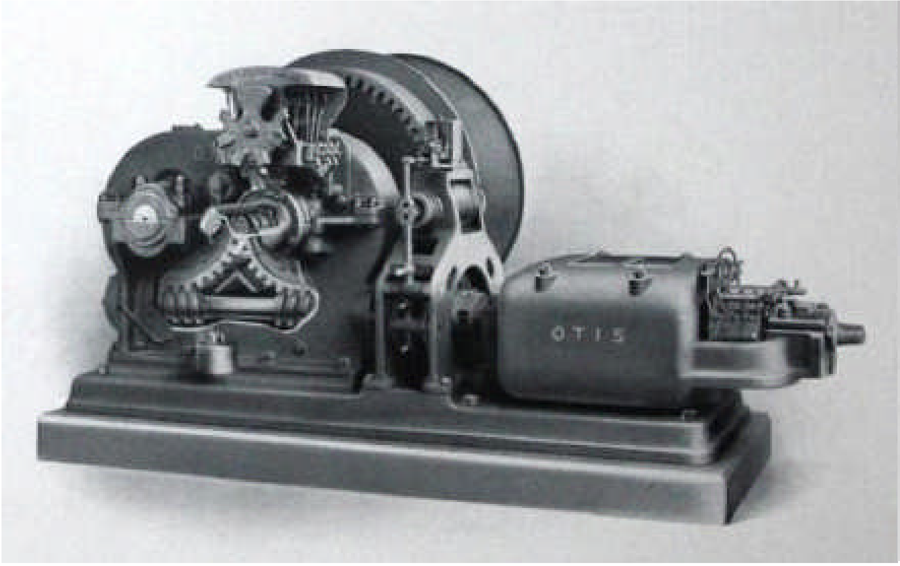
Equipment

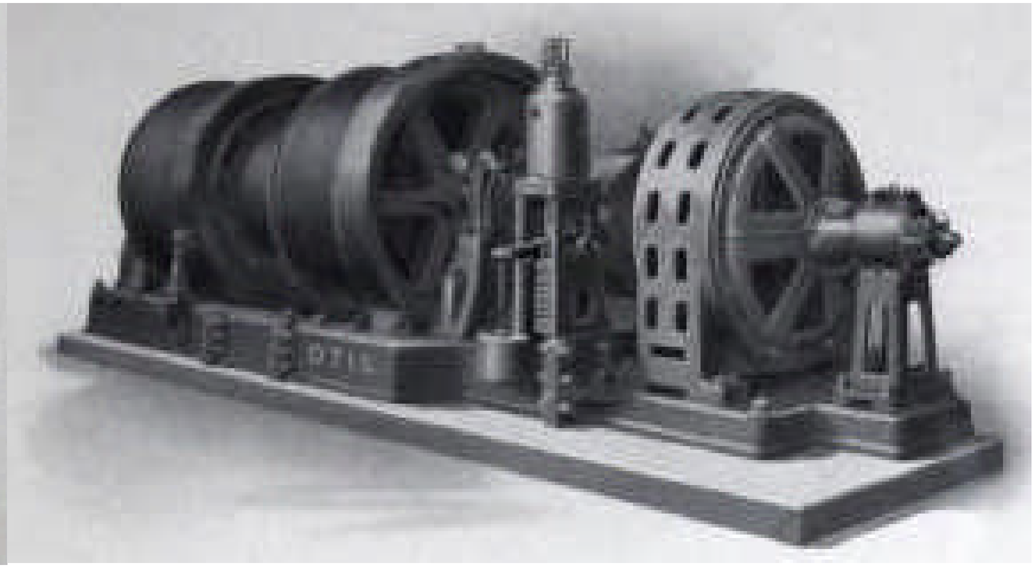


"…The successful and safe operation of the many installations furnished by this company has been made possible by the Otis automatic controlling and safety devices, in addition to the efficient work of designing by our expert engineers employed on this class of work, and the high standard of our apparatus. Each individual case is carefully studied by our engineers, apparatus is selected to suit the purpose most satisfactorily and changes in conditions are suggested, if feasible, to increase the efficiency of the outfit…"

RE: excerpt from an *Otis Elevator Company* catalog (ca. 1913)

<u>Left</u>: caption: "Typical Passenger Car used for short, steep inclines"



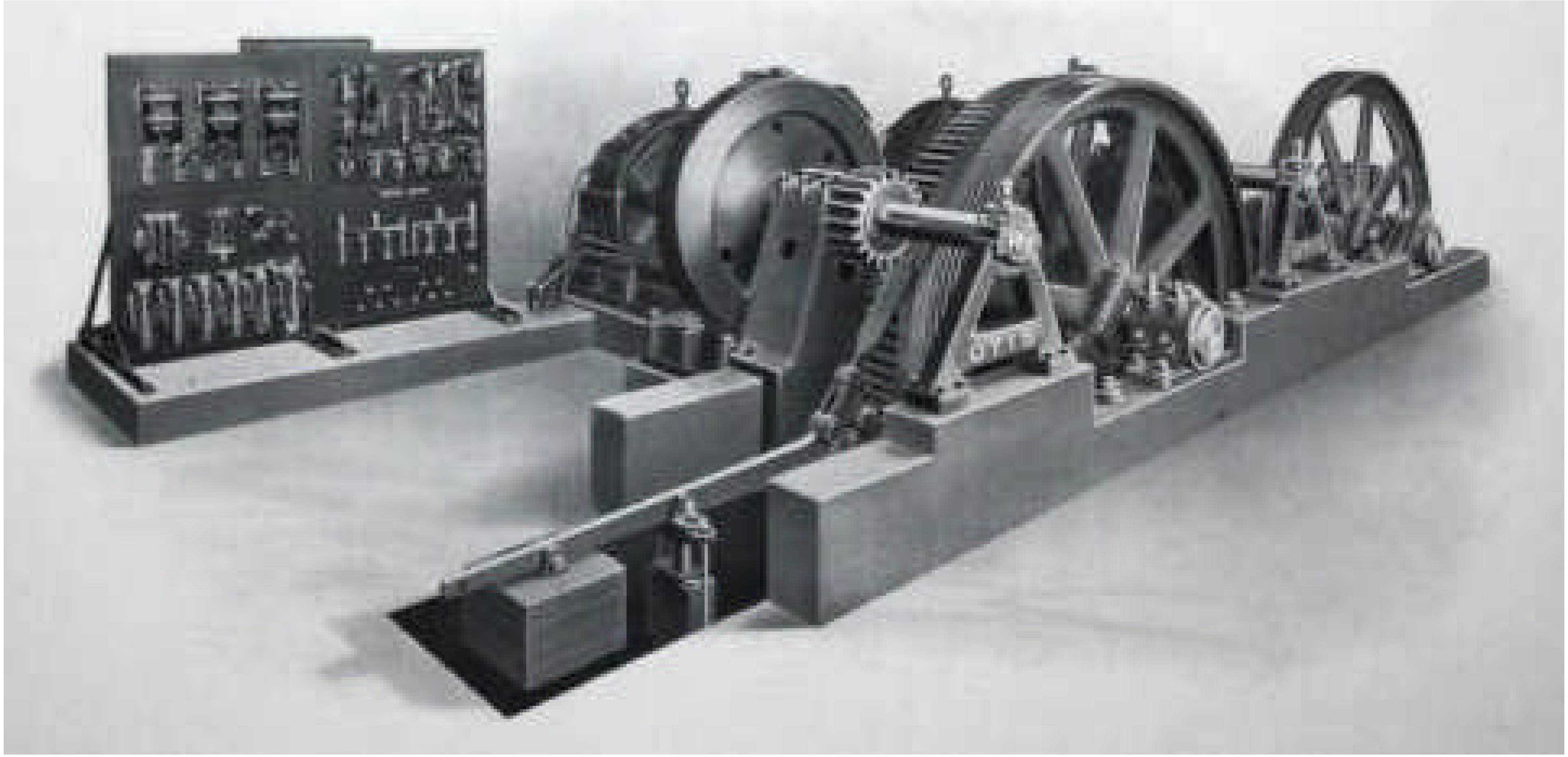


"…The ideal Incline Railway equipment consists of two cars arranged to run in opposite directions on a single track with the Brown Patent Turnout midway on the incline and the roadbed so graded that no matter what the distance traveled (with equal load on the cars) the outfit will be at all times in balance, operated by full automatic controlling and safety devices and (if used for passenger service) equipped with safety devices adjusted to stop and hold the cars from excessive speed due to breaking of cables or other causes. The Drum types of Machines are used for Inclines where the distance is comparatively short, but in no case should the rope be permitted to overwind on the drums…"

RE: excerpt from an *Otis Elevator Company* catalog (ca. 1913)

<u>Left</u>: caption: "Typical Drum Type of Machine used for short Inclines and medium loads"

<u>Right</u>: caption: "Typical Spur Geared Type of Hoist used for handling heavy loads on short Inclines or where the length of travel permits the use of the Drum Type of machine"



"…In case the distance is too great to permit of the use of the drum machine, the traction type is used, the hoisting-ropes passing over a traction driving and idler sheave, and the number of turns depending on the traction required…"

RE: excerpt from an *Otis Elevator Company* catalog (ca. 1913)

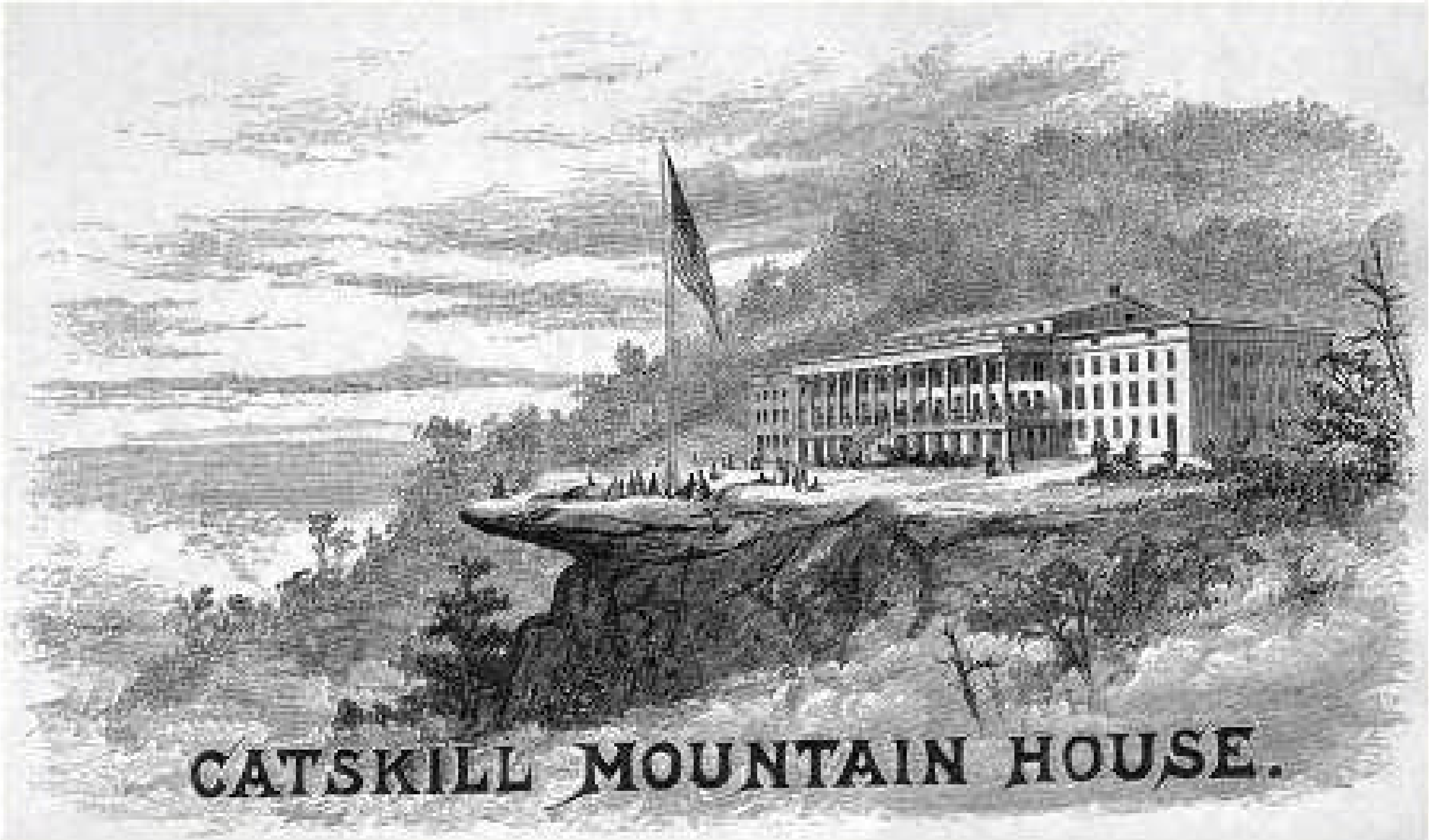
Above: caption: "Typical Spur Geared Hoisting Machine as used for Inclined Railways of great length requiring the traction type of drive"

Tourist/Passenger Installations

"…On the following pages are illustrated a few of the most important Incline Railways installed by this company, with a brief description of each. We will furnish, upon application, necessary information and estimates with sketches for this class of work. We invite correspondence with those who contemplate the installation of Incline Railways for any purpose, whether the high class Tourist and Passenger Incline or the plain, substantial Incline as used for handling material in stone quarries, blast furnaces, etc. We are in a position to furnish expert advice and will be pleased to cooperate with those interested and their engineers; or we will furnish engineers to act in a consulting capacity to successfully work out problems pertaining to this class of work. It is important that all possible data be furnished us for contemplated Inclines and blank data sheets for this purpose will be furnished upon application…"

RE: excerpt from an *Otis Elevator Company* catalog (ca. 1913)

The Otis Elevating Railway



In 1824, the luxurious *Catskill Mountain House* was opened high atop its namesake, overlooking the *Hudson River Valley*. The new resort would cater to the wealthy of New York and New England and become an opulent and exclusive retreat throughout the remainder of the 19th Century. As the hotel enjoyed success, other luxury hotels in the area also flourished, and competition for well-to-do clientele became keen. A major drawback was that the Catskill Mountain House was more difficult to reach than many of its competitors given its lofty location. In fact, early in the hotel's history, the trip from the nearby steamship landing to the hotel was a bumpy four-hour ride via stagecoach. Later, the ride from the railroad station was reduced to about an hour.

Otis worked with *Charles Beach*, owner of the *Catskill Mountain House*, to meet the challenge of providing easier access for its guests. *Charles Otis* was at the helm of the company when he met with Beach to formulate a solution to this unique challenge. It was decided that an inclined railway would be built on which cars would be hoisted directly up the side of the mountain by wire ropes, propelled by twin steam engines. Thus, in 1892 the *Otis Elevating Railway* was born. The railroad track, far too steep for conventional locomotives to climb, extended 7K-feet and rose nearly one-third of a mile at 1,630-feet as it traveled up "The Wall of the Manitou" (as that side of the mountain was referred to). It was driven by two massive winding drums, 12-feet in diameter, each handling nearly 10-tons of rope. Two cars counterbalanced each other; one ascended the mountain while the other descended. The cars shared the majority of the track, but diverged to separate tracks at the middle of their travel in order to pass one another. As a result, passengers could now reach the top of the mountain easily, comfortably and in just ten minutes.

"…The construction of the Catskill Mountain Incline Railway was commenced in the latter part of January, 1892, and the road was opened for service on August 4th, of that year. The total length of the road is 7,000 feet, and the vertical rise 1,630 feet. Maximum grade; 34 per cent; average grade, 23 per cent; gauge of track; 3 feet. The road is of the three-rail type, the middle rail being common to the two tracks. There are two cars fixed to the cable ends, one of them making a down trip while the other is making the up trip. The cars pass each other midway on the line, where a fourth rail is introduced for a distance of about 200 feet. Each train consists of one passenger and one baggage car. The passenger cars have a clear length of 40 feet, and are 7 feet 6 inches wide. They seat comfortably 75 passengers, though a maximum of 90 can be attained. The baggage cars are open, being simply platforms with sides, but no tops. The cars run at a speed of about 700 feet per minute, or 8 miles an hour, and the trip is made in about 10 minutes. The hoisting machinery is operated by Otis engines located at the top of the mountain. Each of the two cables is 7,250 feet long, and weighs about ten tons…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1913)

"…The cars are provided with a safety device which is entirely independent of the ordinary brakes on the ear and has three seriated gripping surfaces, one of which forms part of a pivoted dog. This dog is acted upon by a special speed governor. When in action the dog sinks its teeth into one side of the wooden guard rail placed between each outer and middle line of rails, and thereby draws the other serrated surface against the other side and the top of the guard rail. The clutch then grips the guard rail on three sides and has a holding power of about 30,000 pounds…"

RE: excerpt from an *Otis Elevator Co.* brochure (ca. 1913)

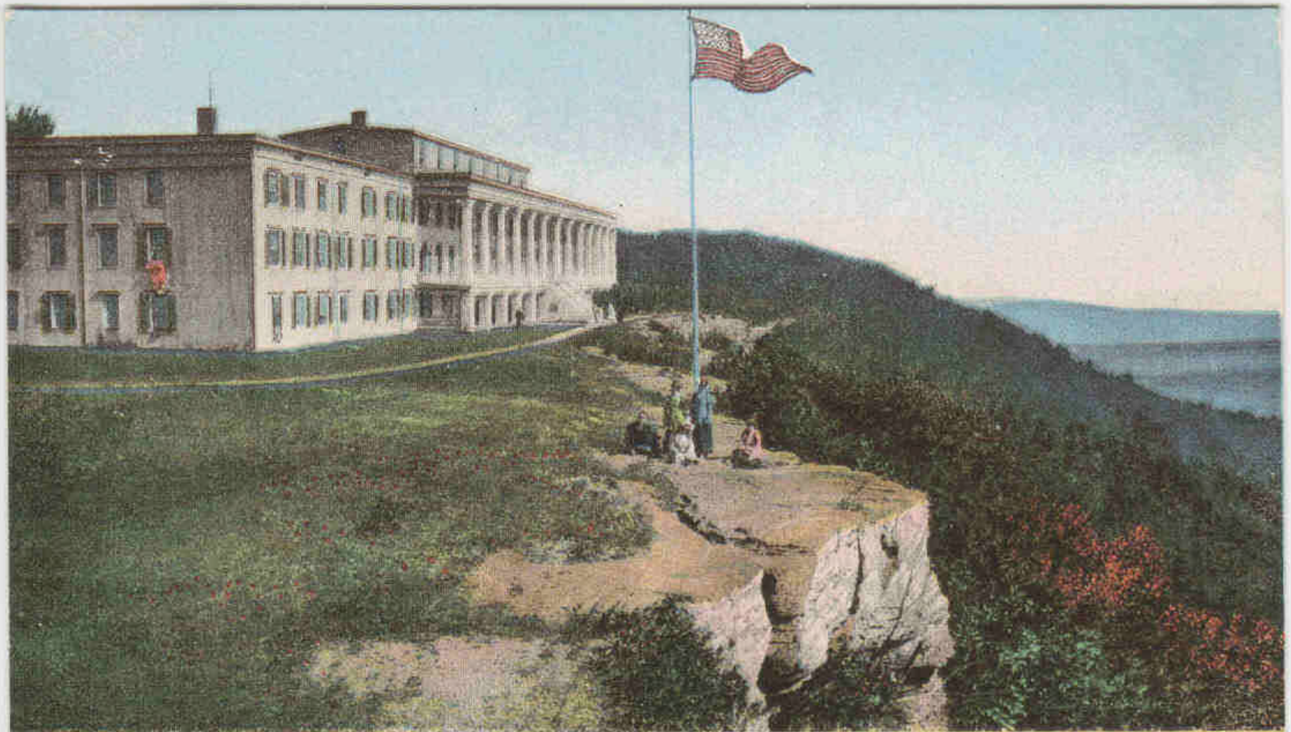
"…The road operates trains in connection with the regular trains on the Catskill Mountain Railway and the steamboat lines on the Hudson River. Its upper terminus is within a few rods of the Catskill Mountain House, and from it some of the most popular summer resorts of the mountains can be rea-died by drives or by the Catskill and Tannersville Railroad. Each of the engines in the power house is filled with a strap brake, applied from the Operating room above by a lever. The main hoisting drum, which is geared to the engines, is also fitted with a strap brake. The terminal stations and the cars are connected by telephone and electric gong signals…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1913)

"…Incline Railway installations of this character call for a very careful and expert study of the topography of the site contemplated for the roadbed, because the grades, horizontal curvatures and other conditions directly affect the costs of cutting and filling and the efficiency of the Incline in its power consumption…"

RE: excerpt from an *Otis Elevator brochure* (ca. 1913)

Some of the design components were directly borrowed from another recent elevator project; the *Eiffel Tower*, completed three years earlier (in 1889). Specific mechanical components were identical to those used in the Paris project, including the governors which would protect the passengers in the event of rope breakage and the cabin design which allowed passengers to remain vertical even as the pitch of the rail car varied. The *Otis Elevating Railway* was one of the company's most impressive, if lesser known, engineering achievements of its first fifty years. It strongly positioned the *Catskill Mountain House* as the nation's premier mountain resort as it entered the 20th Century.



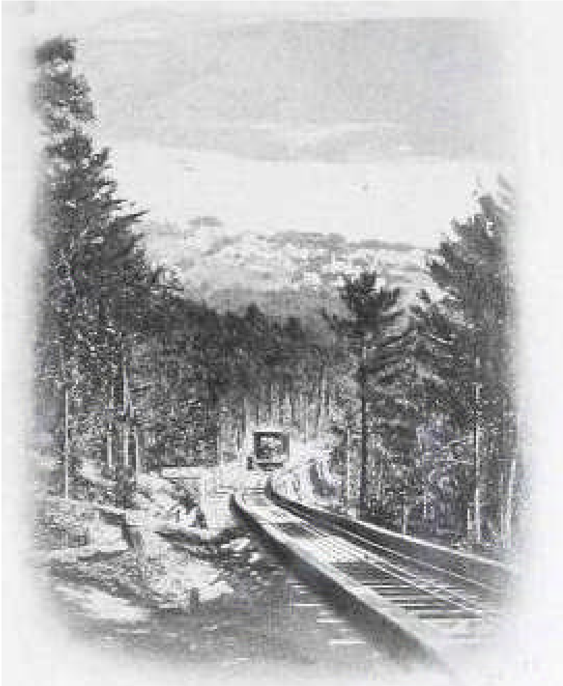
Mountain House, Catskill Mountains, N. Y. 28-7

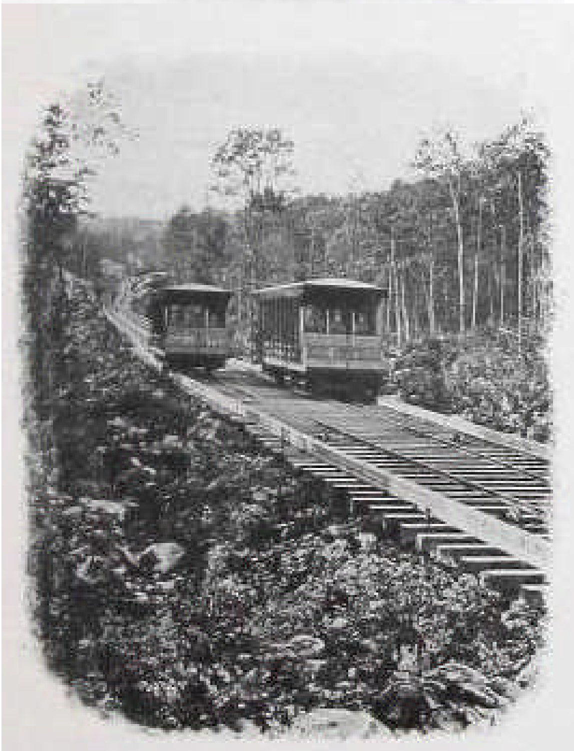
Park Hill Incline Railway

"…This Incline was Installed in 1894. The total travel of the car is about 162 feet, and the vertical distance approximately 107 feet. The angle of the track is 40 degrees from the horizontal. The car is 5 feet 9 inches x 6 feet, carrying ten people at a speed of 165 feet per minute, and is equipped with safety devices. It is operated by an Otis Hydraulic Machine of the horizontal type. The machine is located underneath the tracks near the top landing. The object of this Incline was to develop and enhance the value of the land for residential uses, and it has accomplished this purpose with excellent results…"

RE: excerpt from an *Otis Elevator Company* catalog (ca. 1913)

Lake George Incline Railway





"…The Lake George Incline Railway, built by this company, is about 7,000 feet long, with a rise of 1,600 feet and a maximum grade of 46 per cent. The motive power is steam, using two Otis duplex engines. The carrying capacity is sixty people, at a speed of eight miles per hour…"

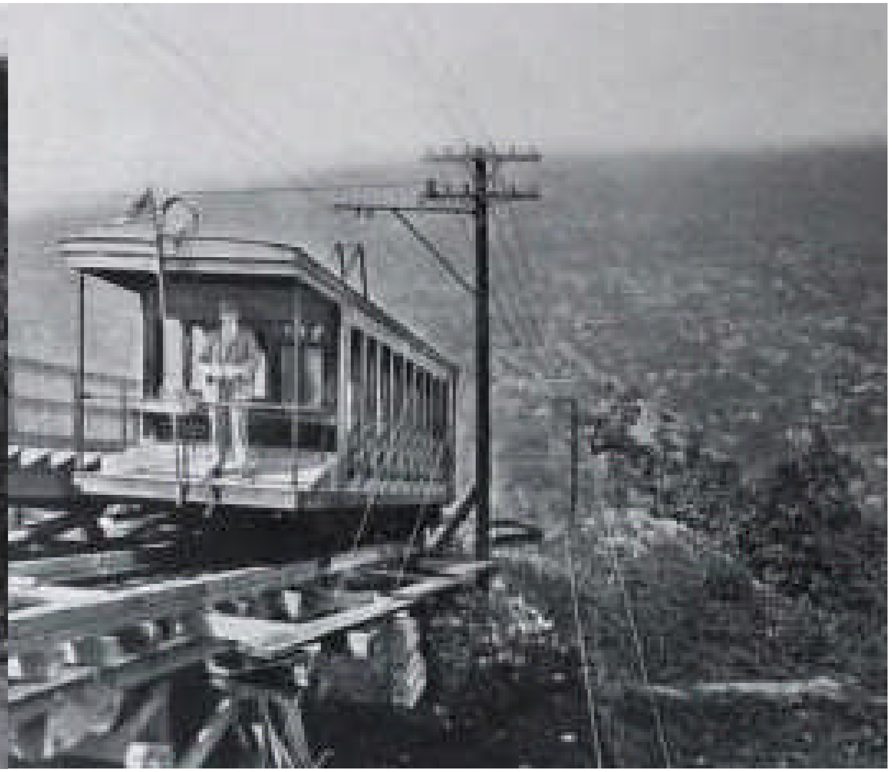
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

<u>Left T&B</u>: caption: "Lake George, NY Incline Railway"

Mt. Beacon Incline Railway

"…This Incline is located on and ascends the sleep face of North Beacon, Fishkill Mountains, and was opened May 30, 1902. Revolutionary memories have made the mountain famous, for on its top and on that of its twin, the South Beacon, burned the signal fires which gave warning of approaching danger to the surrounding country and the valley of the Hudson River. The Incline extends from the base to the top of the mountain, a distance of 2,900 feet, rising in places at the rate of 68 feet in a hundred feet of length. There are two cars, each about 34 feet long, with a carrying capacity of 80 passengers. This road is equipped with Brown Patent Turn-out, and apparatus previously described. A hotel, Casino and bungalows are located on top of this mountain, and the easy and comfortable means of approach has resulted in making this resort very popular…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1913)



<u>Above</u>: caption: "Incline Railway – Beacon Mountain, Fishkill, NY"
<u>Left T&B</u>: caption: "The cut above shows a general view of Beacon Mountain with the Mt. Beacon Hotel at the peak. Below are seen two cars passing each other at the turn-out."

"…The Mt. Beacon Incline Railway was built by this company. The length of this road is 2,200 feet, with a rise of 1,200 feet. The average grade is 64 per cent. The speed of each car is 500 feet per minute and the seating capacity 54 persons. Each car is equipped with the Otis double-grip safety device. The Otis Electric Hoisting Engine for operating these cars is provided with two 75-horse-power electric motors controlled by the Otis electric switch and magnet system…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1905)

Above: caption: "Mt. Beacon Incline Railway Car"

Lookout Mountain Incline Railway

“…Lookout Mountain is famous the world over for its beautiful view from Point Lookout and the ‘Battle above the Clouds,’ fought during the Civil War. The top of the mountain is reached by an Incline Railway which was originally operated by steam, and recently reconstructed by the Otis Elevator Company, with electric hoisting equipment of the latest and most improved design…”

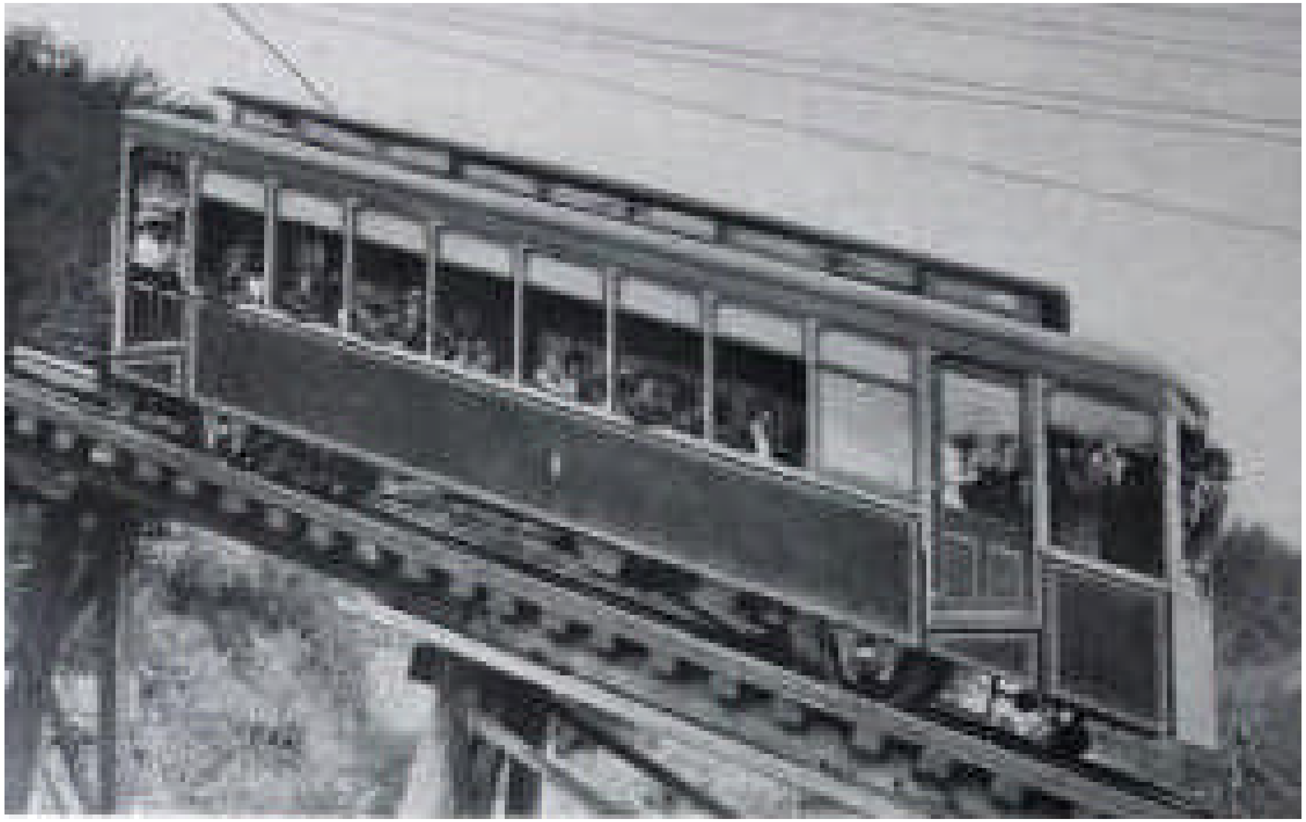
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1913)

"…The road runs from St. Elmo, at the base of the mountain, to the top, a distance of 4,750 feet, with intermediate stations, the vertical height from the lower to the upper terminal being 1,500 feet. The average grade is about 35 per cent, and the maximum grade is reached at a point near the top where it is about 67 per cent. The trip up or down is made in eight minutes, and each car has a carrying capacity of 45 persons, in addition to freight. The roadbed consists of a single track system from the lower terminal to a point half-way up the incline, where the turnout is located to permit the cars to pass each other; from that point to the top a three-rail road is used, the middle rail being common for both cars…"

RE: excerpt from an OEC brochure (ca. 1913)

"…The arrangement of tracks at the turnout is such that the cars automatically take their proper course without the use of switches. The Hoisting Machine is of the traction type, and is driven by two electric motors of 130 horsepower each, either motor being capable of maintaining schedule should one motor become disabled…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1913)



"…Each car is equipped with the Otis 'double grip' safety device, capable of holding 50,000 pounds. This device is automatically operated by a centrifugal governor, should an excessive speed be attained from any cause. Each safety is also provided with a hand operating device, by means of which it may be operated at any time by the attendant in charge of the car…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1913)

"…An additional safety feature, termed an Emergency Brake, is provided to engage the traction driving sheave on the machine, and is operated automatically by a centrifugal governor should the Hoist reach a pre-determined speed above normal. It may also be operated at will by the operator whose station is at the head of the incline, from which point he controls the movement of the cars. The Incline is also provided with Otis Electric Track Limit Switches which are operated by the ears and so arranged that cars are automatically and gradually brought to a stop at the upper and lower terminal. The action is entirely independent of the operator. A suitable signaling system is provided as a means of com-munication between the cars and the operator. A positive indicator is located at the head of the Incline in full view of the operator, and is illuminated at night, enabling the operator at all times to note the position of the cars. This is essential on account of the intermediate stations. The dense fogs which prevail on the mountain side render such an indicator extremely important, as the cars are often completely hidden from the view of the operator…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1913)

Uncanoonuc Mountain Incline Railway

"…This road is operated by an overhead trolley system, and is equipped with Brown Patent Turnout, safety devices and signals, as furnished on our other installations, and was opened to the public in May, 1907. There are two cars, carrying 60 people each. The road is 2,700 feet long, and rises to an altitude of 650 feet, with a maximum grade of 31½ per cent. The installation of this road has resulted in the development of the property on the mountain side, and a summer colony has been established at the upper terminus, including a hotel and places of amusement. Intermediate stations are located at points along the line to accommodate those who have established homes on the mountain side…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1913)

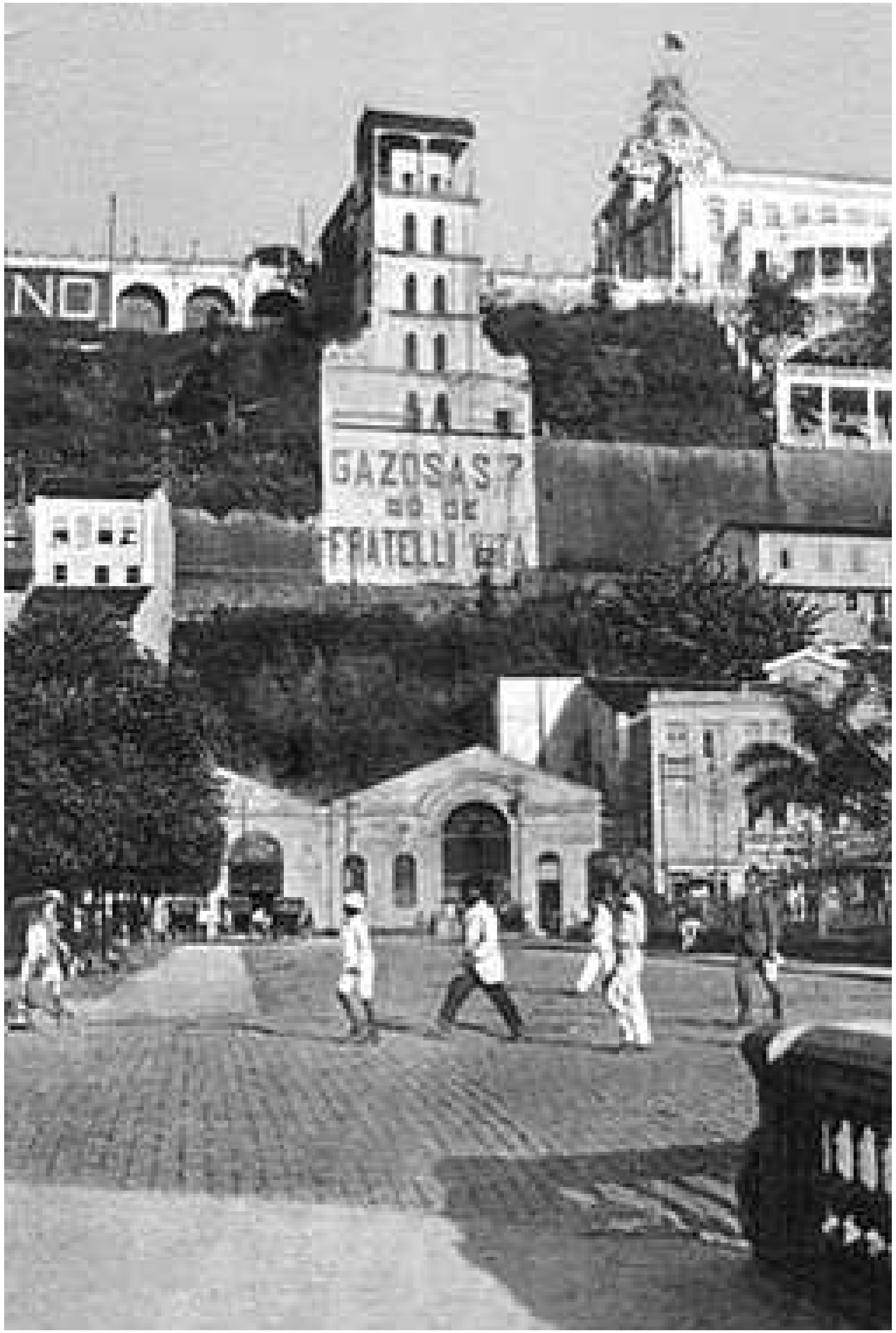
<u>Above</u>: caption: "Intermediate Station for boarding and/or alighting passengers"
<u>Left T&B</u>: caption: "Rail Cars traveling on the Inclined Railway – Ucanoonuc Mountain, Manchester, New Hampshire"

South of the Border

"…Giant express elevators carry most of the pedestrian traffic between the upper and lower sections of Bahia, Brazil. The business section of the city borders the bay, while the residential district is on top of a hill 195-feet above. Engineers at the Otis Elevator Company were consulted and, at their recommendation, the monumental La-Cerda tower was built of reinforced concrete, 240-feet high, and connected with a structure on top of the hill by a bridge. The tower house two large elevators comparable in size and speed with those in American sky-scrapers…"

Popular Mechanics, **March 1932**

Left: caption: "The LaCerda Elevator was electrified in 1907 and enlarged and rebuilt in 1930. Its 'bridge' is 236-feet above the street."

"…The city of Bahia is the capital of the State of Bahia, Republic of Brazil, South America. It is a city of about 240,000 inhabitants and is topographically peculiar in that a short distance back from the waterfront a cliff rises abruptly, and a portion of the city is located on the top of this bluff. It is thus divided into an Upper and a Lower City. All of the wholesale business is located in the Lower City, and a part of the retail business as well. The balance of the retail business and the residence sections are located in the Upper City; consequently there is much traveling back and forth…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1913)

"…To meet the city's requirements the Otis Elevator Company has already installed four electric elevators in two large vertical towers for providing ready means of communication between the Upper and Lower Cities, To supplement this service, an Otis Incline Railway has been installed which travels in a selected portion of the cliff, at an angle of about 40 degrees from the horizontal, making a trip up or down in one and a half minutes..."

RE: excerpt from an OEC brochure (ca. 1913)

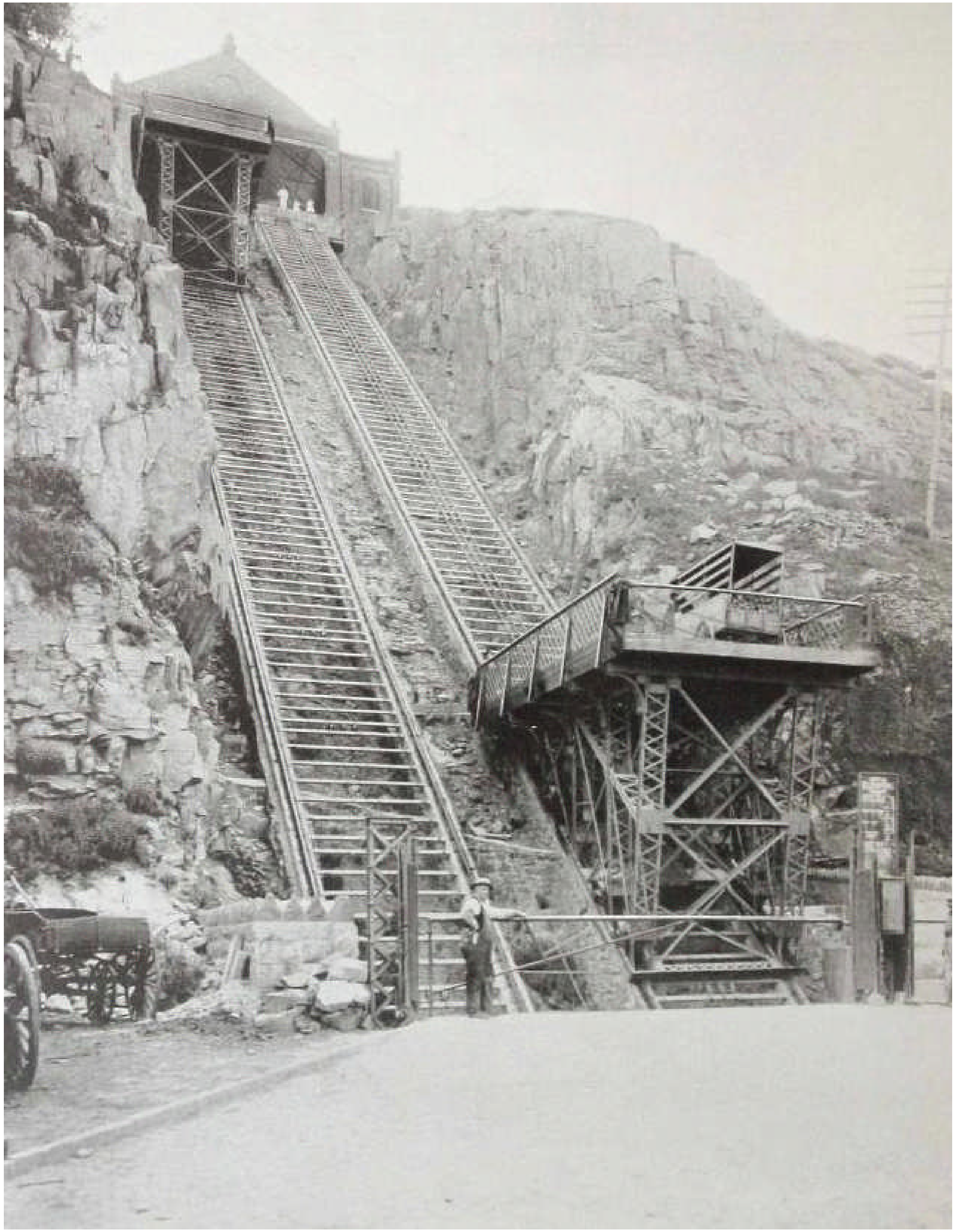
"…This Incline Railway consists of two balanced cars, each car capable of carrying about 20 people and a freight load of 1,500 pounds, one car traveling up as the other car travels down. The electrical machinery for operating the Incline is located in the head-house at the upper level, and electric switch control is applied together with the carefully worked out Otis safety devices for the machine and for the cars. As Bahia is in the Torrid Zone, no devices for heating the cars are necessary, but proper provision is made for protecting the passengers or freight from the elements…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1913)

The Palisades Incline Railway

"…An Incline Railway which was constructed up the face of the Palisades, at Weehawken, N.J., for the transportation of trucks to the top of the hill, was opened for traffic about April, 1900. Prior to that time, teamsters and others, in order to reach the top of the cliffs at that point, were compelled to take a long, circuitous route, which meant a tedious climb and a loss of over an hour in time. Many of the vehicles were weighted down with unusually heavy loads, making it extremely difficult for the horses to ascend the steep grade and resulting in their frequently becoming stalled. In such cases, it was of course necessary to take part of the load from the wagon. To avoid this, a Traffic Incline Road was constructed up the face of the cliffs for the transportation of trucks and other vehicles. The road runs from the base of the Palisades in a direct line to the summit…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1913)



<u>Left</u>: caption: “The photo shows the Weehawken Incline Double-track Railway, built by the Otis Elevator Company. The cars for passengers and vehicles are 20 feet wide by 40 feet long, capable of carrying a load of 50,000 pounds at a car speed of 300 feet per minute. The engines are electric and are operated by 300-horse-power motors. The car travel of this incline is 300 feet; grade, 72 percent.” 723

"…The distance is only 290 feet, yet the grade rises to a height of 72 feet in each 100. From a distance the road looks as if it were perpendicular. Two large cars of massive steel construction are run in balance and accommodate several heavily laden trucks at a time. This installation is probably one of the most profitable Traffic Inclines in use today. An Otis Incline Railway Hoisting Engine of special design is used to operate these cars, controlled by an Otis Full Magnet Controlling Device…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1913)

Commercial Installations

Powell River Paper Company
(Powell River, British Columbia)

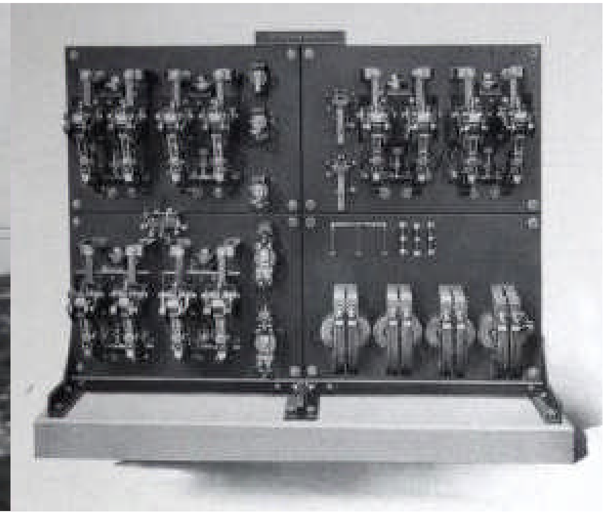
"…This Incline is of the Commercial type, designed to carry loads of paper weighing 60,000 pounds, on an incline of 32 degrees from the horizontal, and is for the purpose of distributing this material to the various levels of the paper mill as desired. This particular Incline is operated by means of Hand Rope Control, although for similar service an operating switch may be employed…"

RE: excerpt from an *Otis Elevator Company brochure* (ca. 1913)

"…There are numerous instances where this type of Incline may he used to advantage; each individual case, however, requires special consideration due to varied conditions, such as load, speed, angle of incline, voltage, safety features, control and arrangement of landing. Special data sheds are provided as a guide in submitting data for estimate…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1913)

Otis Multiphase AC Skip Hoist



"…The illustration shown above is our latest approved type of full magnet Controller, designed for use in connection with the Otis Multiphase Alternating Current Skip Hoist. This controller is of unusually heavy and substantial construction, to withstand the severe and exacting service requirements. All switches are provided with laminated copper contacts and protected by auxiliary copper contacts and carbon breaking contacts, which are also protected by powerful blowout magnets where required…"

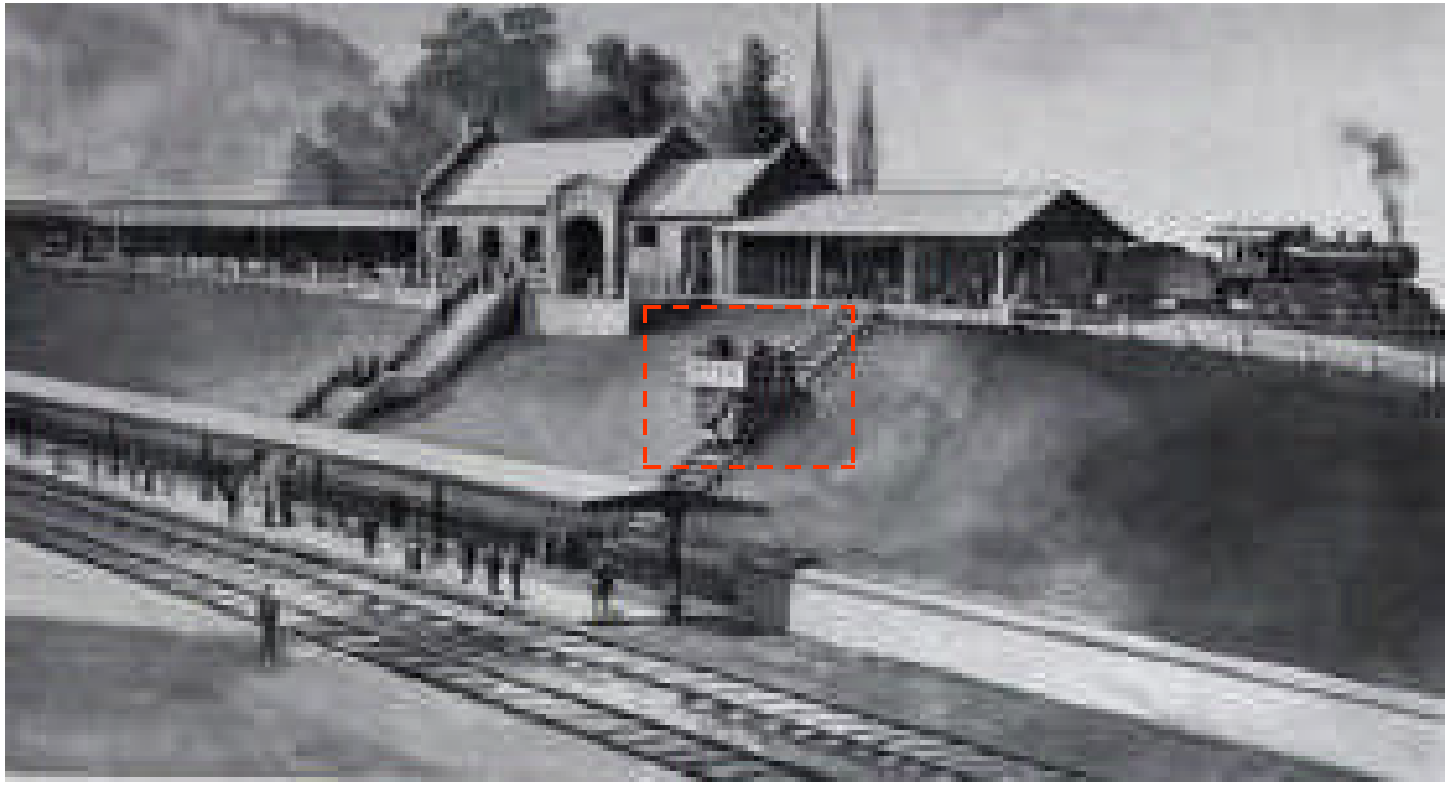
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1913)

<u>Left</u>: caption: "Application of Skip Hoist to Blast Furnace"

<u>Middle</u>: caption: "Application of Skip Hoist lo Limestone Plant"

<u>Right</u>: caption: "Otis Full Automatic Skip Hoist Controller - Alternating Current"

Otis Incline Baggage Hoist



"…The above illustration shows the application of an Otis Incline Baggage Hoist for use in transferring baggage at railway junctions where a difference in the level exists between the station platforms, permitting of a quick, easy and efficient means of transferring baggage to and from each platform. These Incline Hoists can be operated by either direct or alternating current, with mechanical or electrical control. They are provided with the usual automatic safety devices and can be operated with single platform, with or without counterbalance, or with double platform in balance with each other…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1913)

Part 5

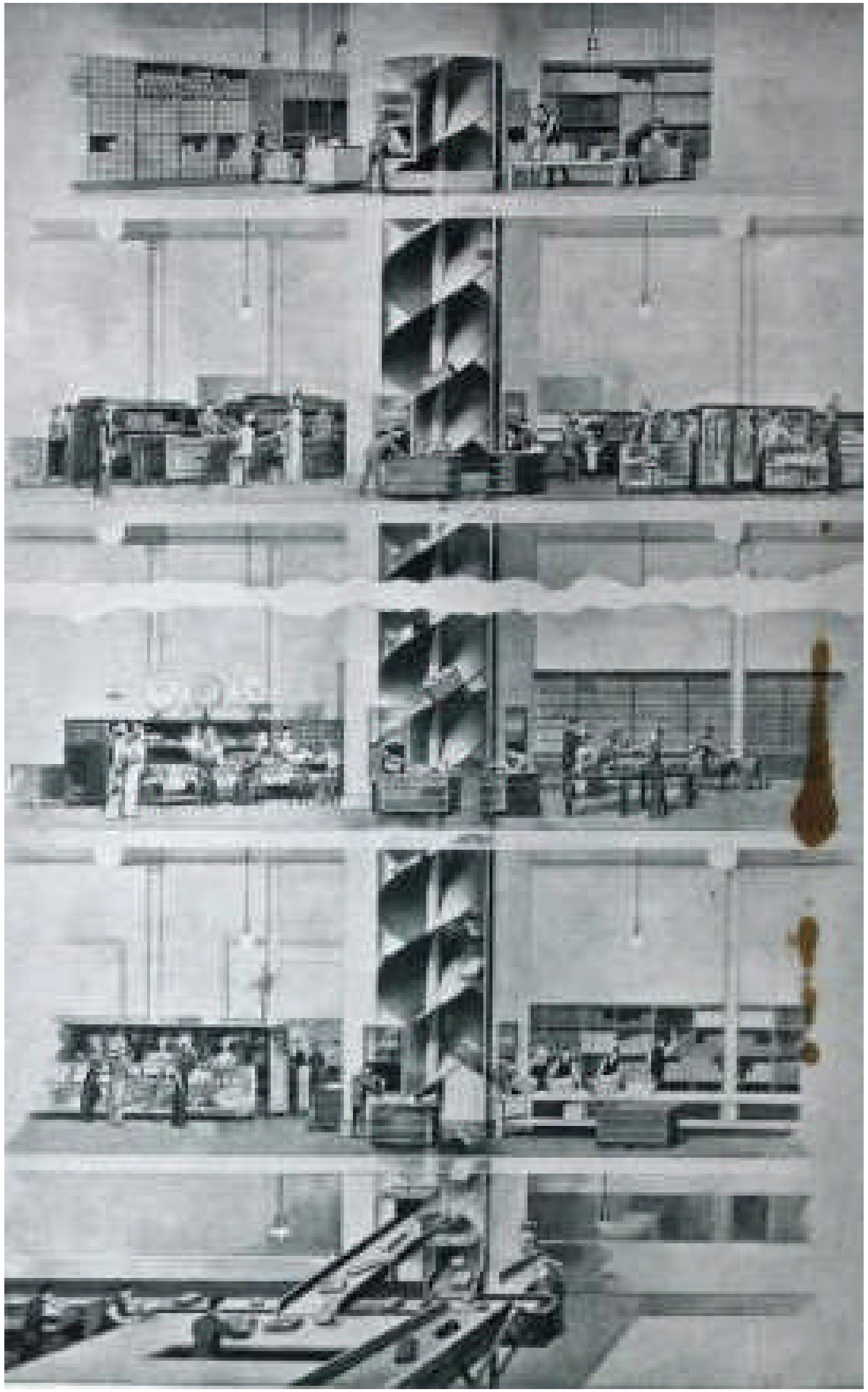
Law of Gravity

OTIS GRAVITY SPIRAL CONVEYORS

For lowering packaged mer-
chandise and boxed, cased,
bagged and barrelled goods

“…Otis Gravity Spiral Conveyors utilize the force due to gravity to convey merchandise upon fixed spiral blades within a circular shaft from upper floors to lower floors or to shipping and assorting rooms below. They are adapted also for use in factories where the manufacturing process is from the top floor downward, to move unfinished parts from floor to floor. They afford a continuous delivery service, require no power, are always ready for use and have a practically unlimited capacity. Every business establishment occupying two or more floors and having packages, boxes or barrels to ship can reduce its handling expense and at the same time speed up its deliveries by using Otis Gravity Spiral Conveyors. These Conveyors may have inlets at all floors or at any desired floor, through which the merchandise to be moved is placed upon the spiral blades. The pitch of the blades is in every case calculated with such precision that the packages are carried downward rapidly but in absolute safety to the outlets. The number of floors which may be served by a Conveyor is practically unlimited…”

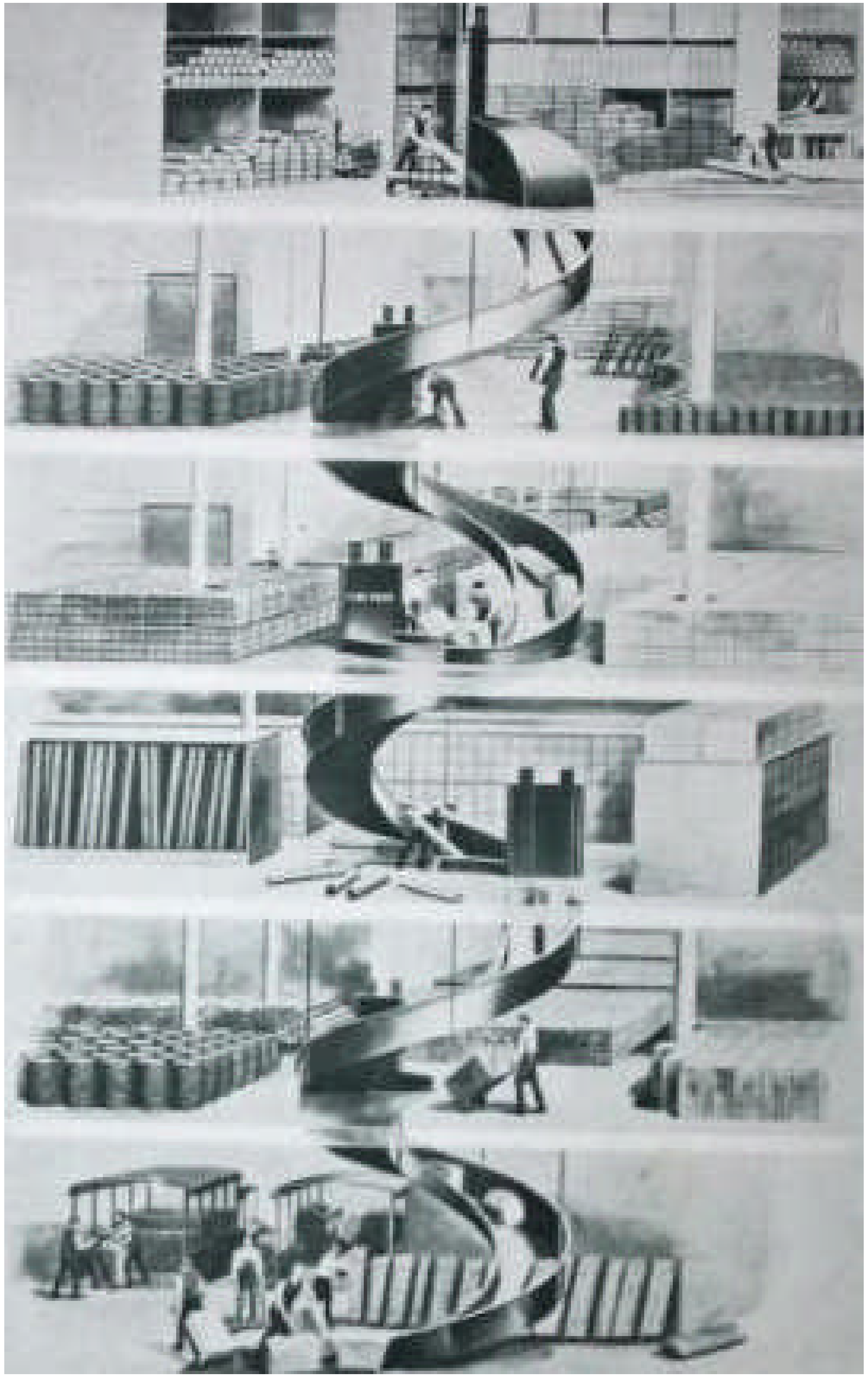
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915). By 1915, Otis had developed a full line of spiral gravity conveyors for use in department stores and elsewhere. They cost practically nothing to operate, but they took up valuable floor space and, occasionally, someone had to slide down the spiral to break up logjams. Ultimately, they were eliminated from Otis’ product line.



"…A great variety of types, each useful in its sphere of application, makes it possible for every factory, warehouse, store and public building where small packages or large boxes and barrels are handled, to install this economical and speedy system of inter-floor merchandise handling. The diameter of the Conveyors while varying with the different types and the work they are to do, usually range from 3 to 12 feet…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

<u>Left</u>: caption: "Cross Section View Showing Construction and Arrangement of triple Spiral Closed Type Conveyor"



"…The remarkable success of the early single spiral install-ations in furnishing a safe, speedy and economical method of merchandise handling led quickly to the development and adoption of Conveyors with two and three spirals. The latter, as well as giving increased cap-acity, permit the segregation of different classes of merchan-dise if desired…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

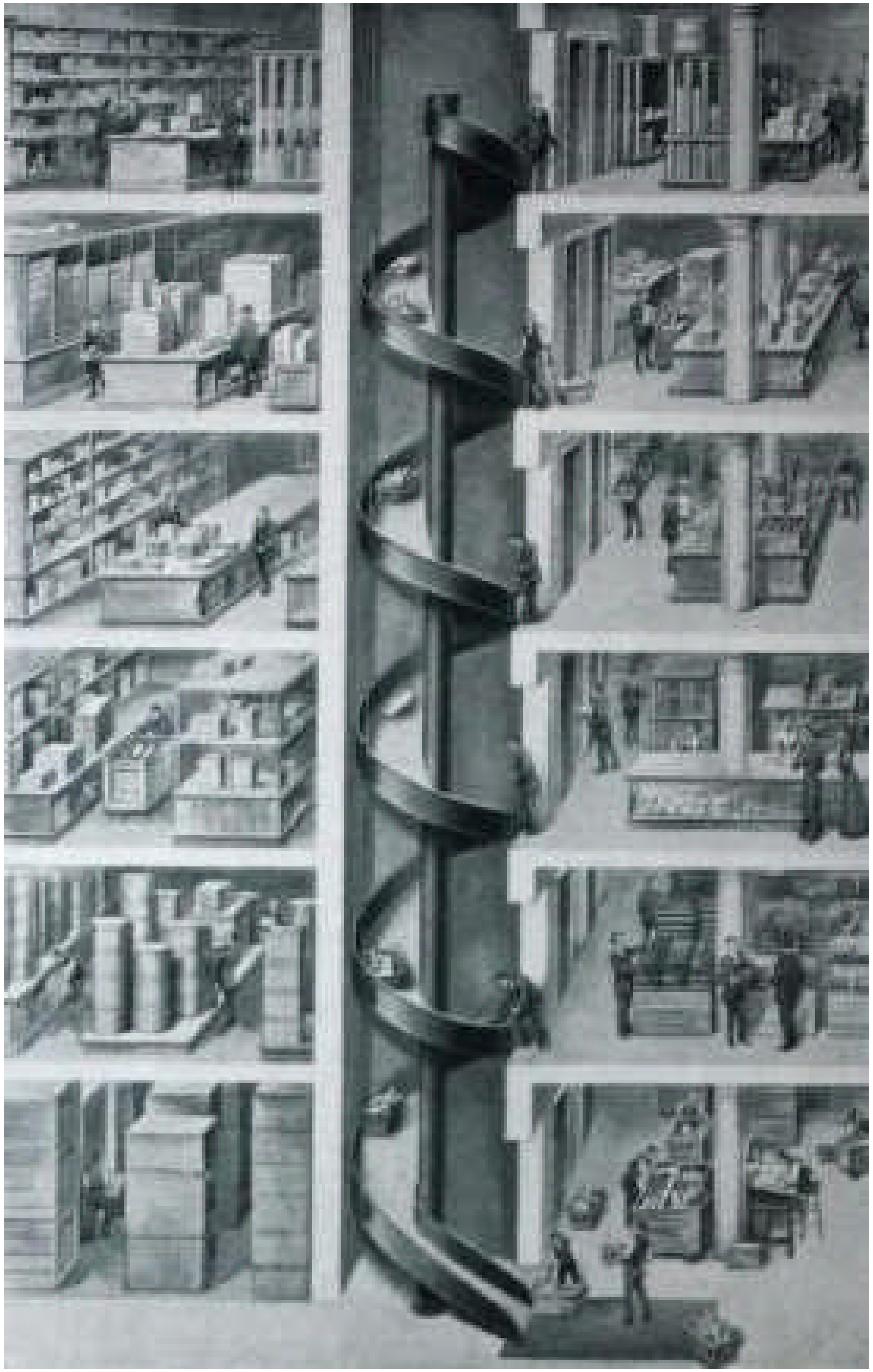
Left: caption: "Cross Section View Show-ing Construction of Single Spiral open Type Conveyor Without Supporting Core"

"…Since the first installation in 1903, we have furnished nearly four hundred of these Gravity Spiral Conveyors for many lines of industry. These installations, many of them repeat orders, testify to the efficiency and reliability of Otis Gravity Spiral Conveyors. Superior design, high-class workmanship and the relentless inspection to which every Conveyor is subjected give assurance of satisfactory and lasting service…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

<u>Left</u>: caption: “One of the Conveyor inlets located at all floors”
<u>Above</u>: caption: “Outlet of Conveyor in shipping room showing baskets used for conveyance of purchased goods”

Types



"…To handle innumerable different sizes, shapes and weights of packages, it has been found desirable to adopt two general types - open and closed - the open type having one or two spiral blades unenclosed; the closed type having one, two or three spirals contained in a cylindrical metal shaft. The choice of a type that will give the best results depends entirely upon the requirements of the user Complete descriptions of each Conveyor and the purpose for which it is designed will be found in the following pages…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

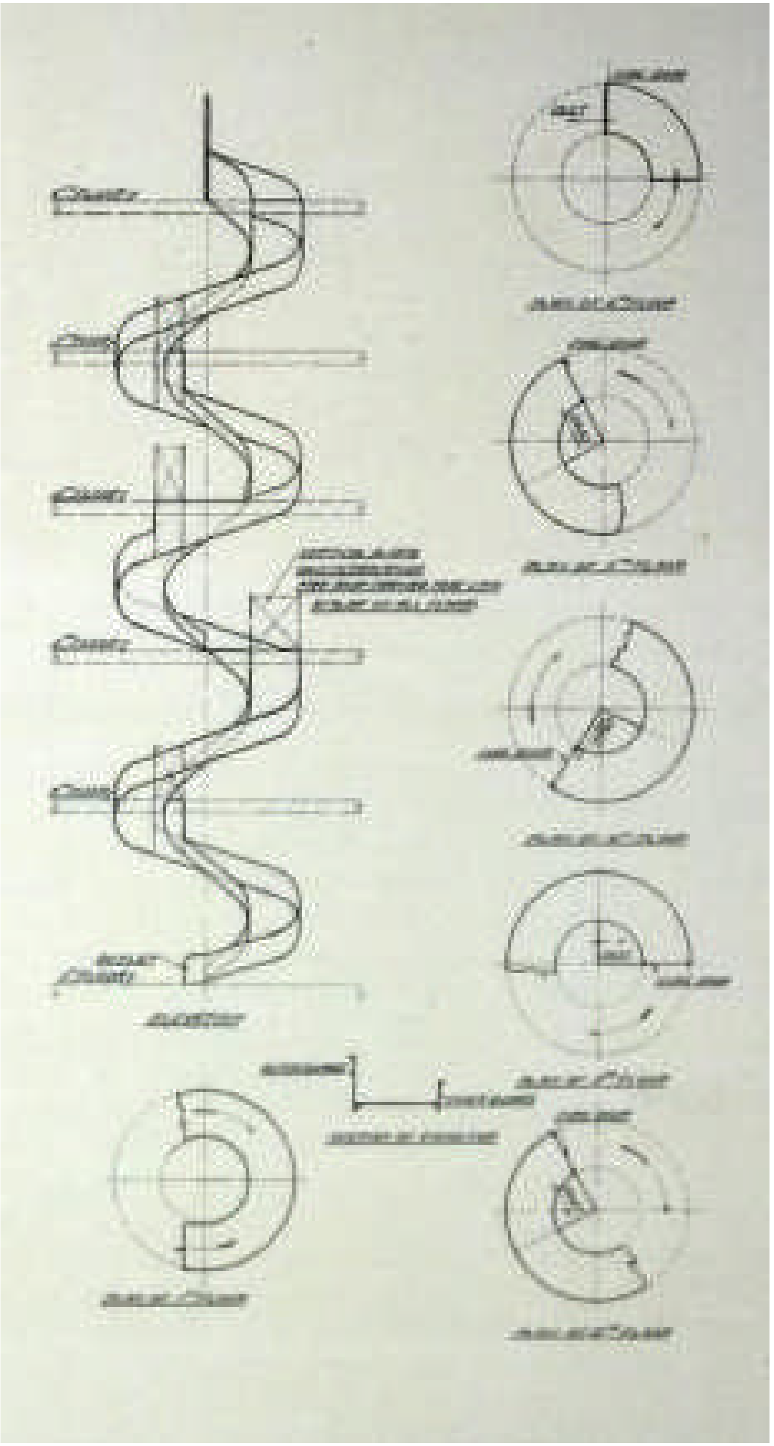
Left: caption: "Cross Section View Showing Construction of Single Spiral Open Type Conveyor With Supporting Core"

Open Type

"…In a general way, it may be stated that the open type of Conveyor is particularly suitable for handling heavy, bulky merchandise, such as boxed and cased goods, wholesale and warehouse merchandise, factory products and the like. Even barrels of crockery and glass, packed in the usual way, can be safely conveyed in this manner. The inlets are located near the floor level, enabling goods to be placed on the Conveyor without being lifted…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

Single Spiral
(Without Supporting Core)



"…For handling the more bulky classes of merchandise in manufacturing plants and wholesale houses the large sizes of open type Conveyors have met with great success and are being used extensively in many lines of business to handle packages and boxes of various kinds, weights and sizes. This open type Conveyor, having no enclosure to support the blades, is supported from the ceiling by iron braces as shown in the illustration. It is built with one spiral only…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

<u>Left</u>: caption: "Typical layout of Single Spiral Open Type Conveyor Without Supporting Core"

"…Notice the small amount of floor space which this type of Conveyor requires, leaving free for use valuable space under and around the blade. The inlets are placed on the inside of the spiral, further decreasing the amount of space required. This type of Conveyor is usually equipped with Otis patented vertical sliding fire doors to close up the floor openings in case of fire. However, in case the local authorities do not require these doors they may be omitted…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

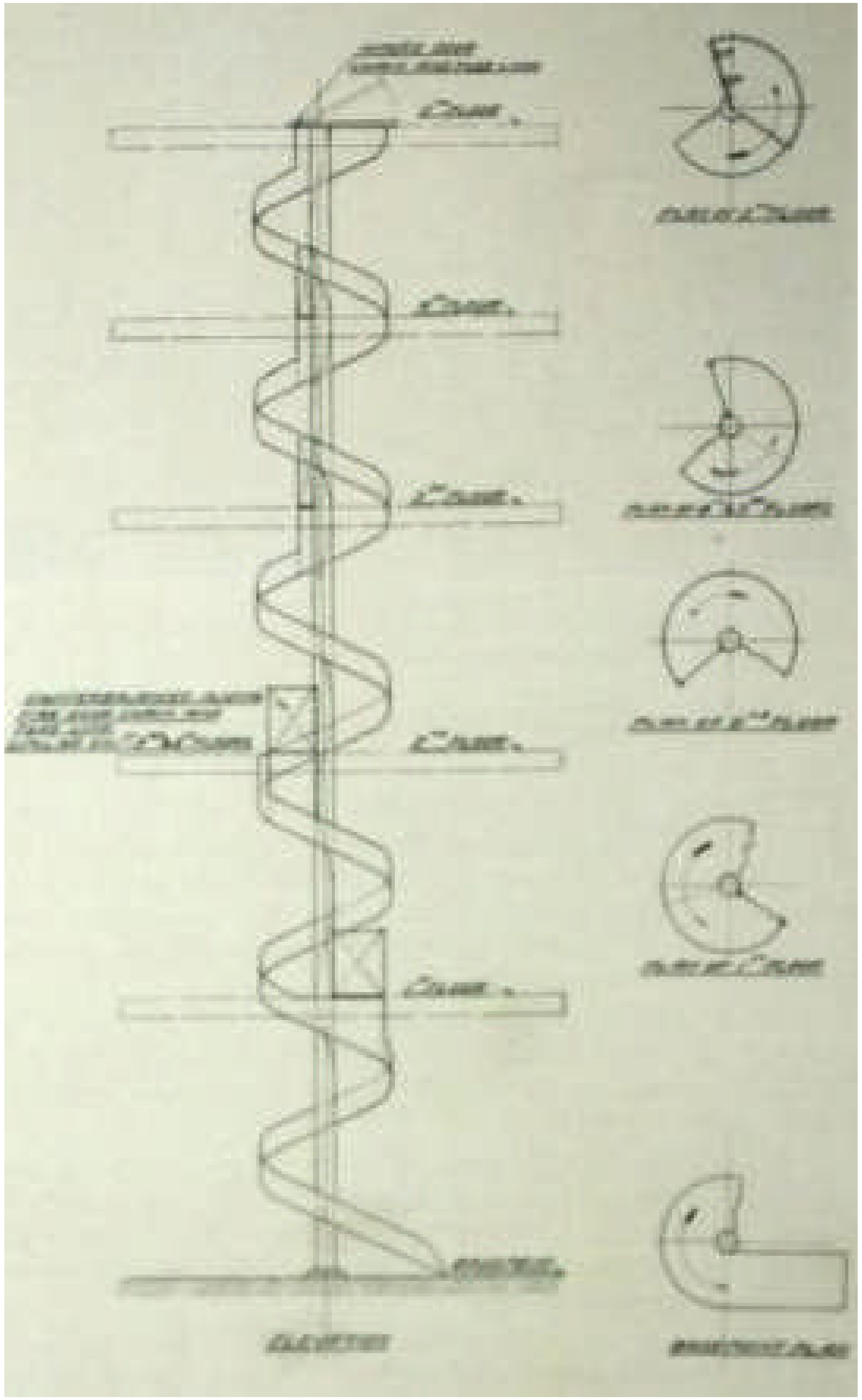
Above: caption: "Otis Gravity Single Spiral Conveyor (Open Type) With-out Supporting Core - Baltimore Bargain House, Baltimore. Md."

"…In the stock and shipping building of the Boston Woven Hose and Rubber Company at Cambridge, Mass., a single spiral open type Conveyor is used for lowering crated boxes and burlap bundles, weighing from 60 to 600 pounds, from the 4th, 3rd and 2nd floors to the boxing and shipping departments on the first floor…While it might appear that considerable confusion would be caused by this system of sending from any one of the floors at the same time, such details are easily straightened out through a system of signal bells. The Conveyor delivers the goods in a constant and uniform manner, handling the entire output of the factory…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

Above: caption: "Single Spiral Open Type Conveyor in Boston Woven Hose and Rubber Company"

Single Spiral
(With Supporting Core)

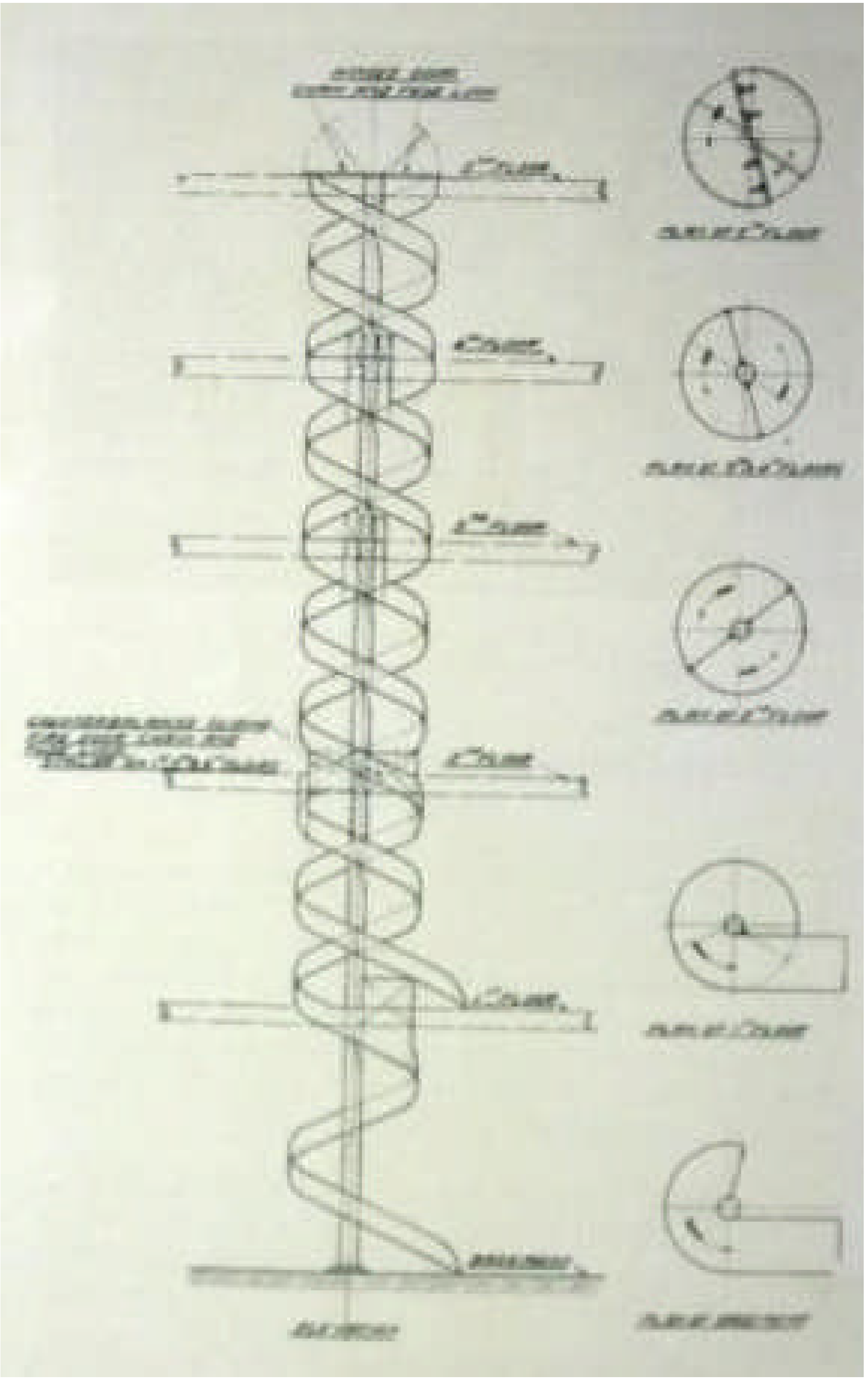


"…This type of Conveyor is designed for installation in closed or open shafts, or in any location where for various reasons a closed type Conveyor may not be considered desirable. In existing buildings old dumbwaiter and elevator shafts are often utilized for the installation and in such cases fire doors on the conveyor are usually unnecessary due to the fact that the hatchway openings are already protected. The spiral blade Is substantially supported by an iron core to which the blade is riveted and around which it describes a spiral. This core rests on the lower floor and extends upward the entire length of the Conveyor. In loading goods upon this type of Conveyor, the packages are lifted over the outside guard and placed direct upon the spiral blade…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

Left: caption: "Typical Layout – Single Spiral Open Type Conveyor with Supporting Core"

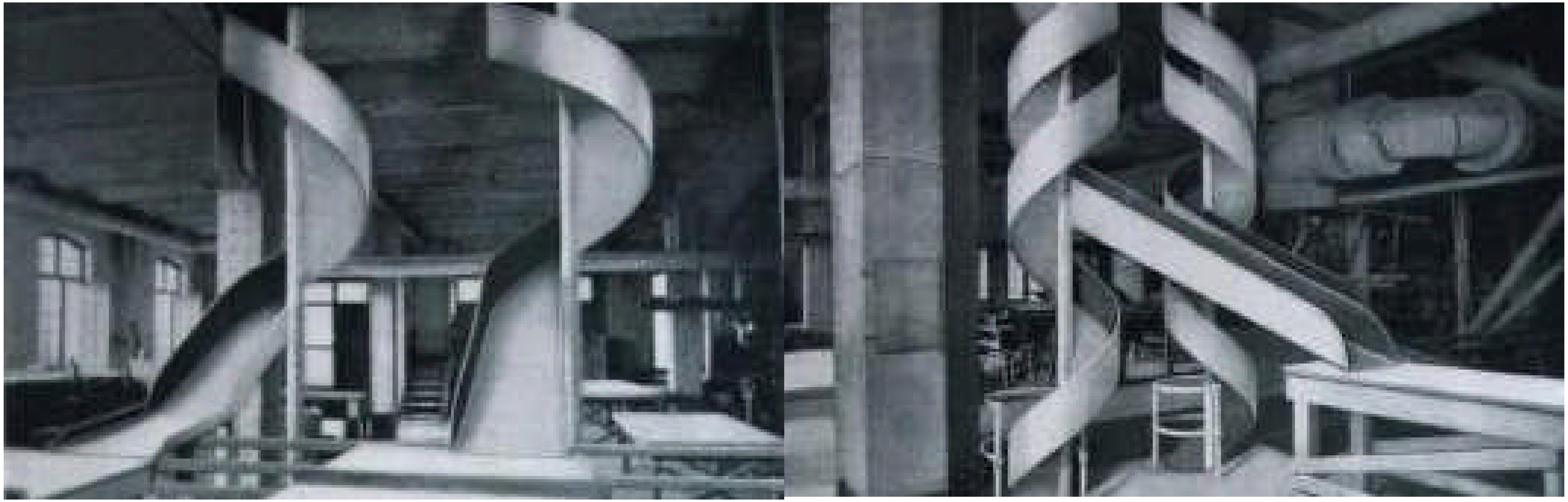
Double Spiral
(With Supporting Core)



"…This type of Conveyor is designed for use in establishments where a closed type is not desired but where the separation of goods by classes is advantageous. It is substantially the same as the double spiral closed type Conveyor except that no outer shell is used to enclose and support the spirals. Support is given by the iron core which extends the entire length of the Conveyor and to which the blades are securely riveted. The outer edges of the spirals are provided with guards of sufficient height to keep packages on the blade…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

<u>Left</u>: caption: "Typical Layout - Double Spiral Open Type Conveyor with Supporting Core"



"…The double spiral open type Conveyor may be used with various combinations of spirals to suit different conditions. It has no special form of inlet, the packages in most cases being placed over the outside guard upon the spiral blade. The layout on the opposite page shows a Conveyor of this type with two spirals beginning at the fifth floor, one delivering at the first floor and the other in the basement. Both spirals have inlets at all intermediate floors…"

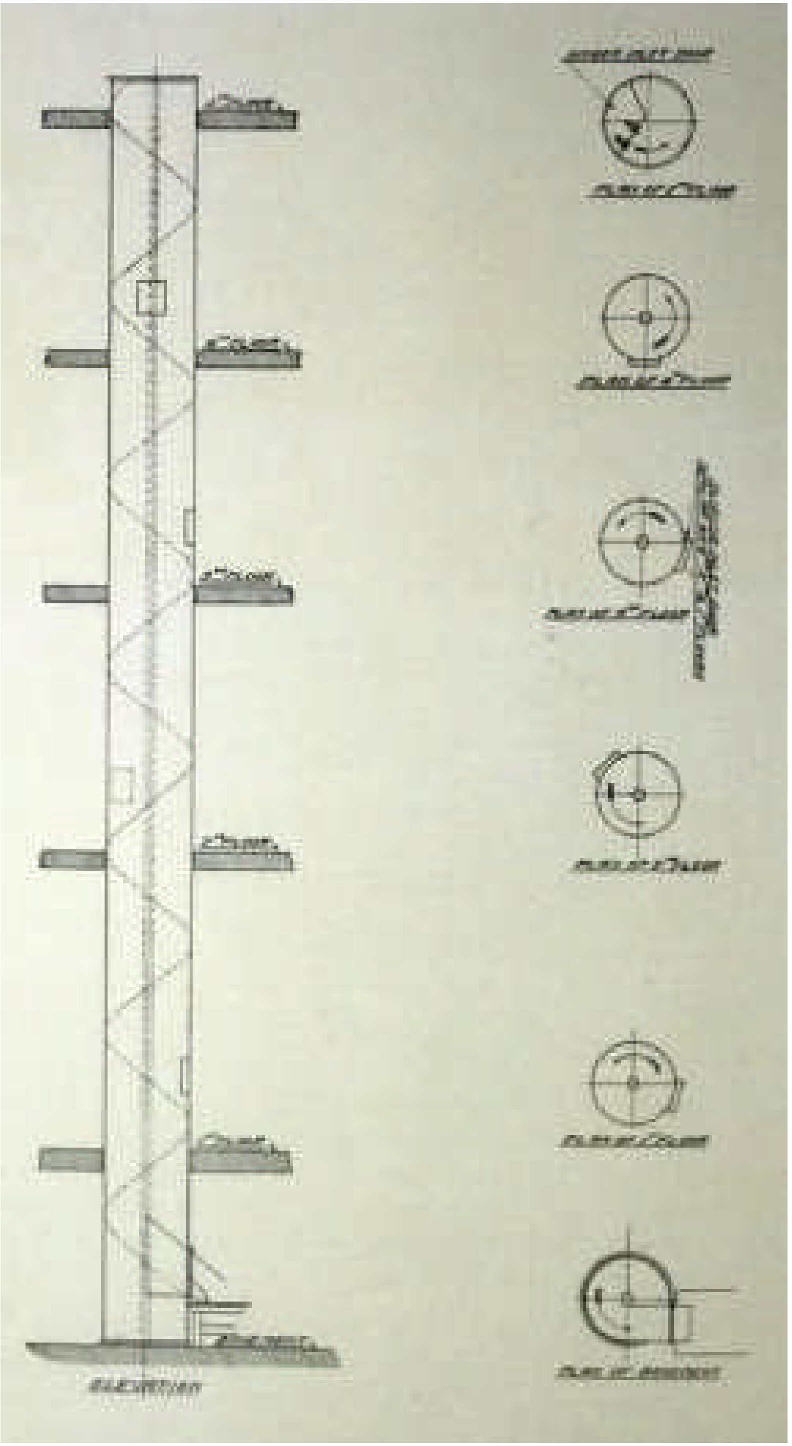
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

Above L&R: caption: "Otis Gravity Double Spiral Conveyors (Open Type) With Supporting Core - Federal Sugar Refining Co., Yonkers, N.Y."

Closed Type

"…The closed type is usually recommended for handling a great variety of small articles such as packages in department and dry goods stores and small parcels of miscellaneous character. Heavy, compact merchandise, including boxed, cased and even barreled goods, can also be handled satisfactorily with the closed type. Moreover, the use of this type precludes the possibility of strayed or stolen packages, an inconvenience which might occur in the handling of thousands of small packages on an open type conveyor…"
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

Single Spiral



"…In establishments where packages may be sent promiscuously to the shipping room regardless of the method and destination of shipment and where there is no need of separating different classes of packages, a single spiral Conveyor will usually suffice. The layout on the opposite page shows a typical arrangement of this type…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

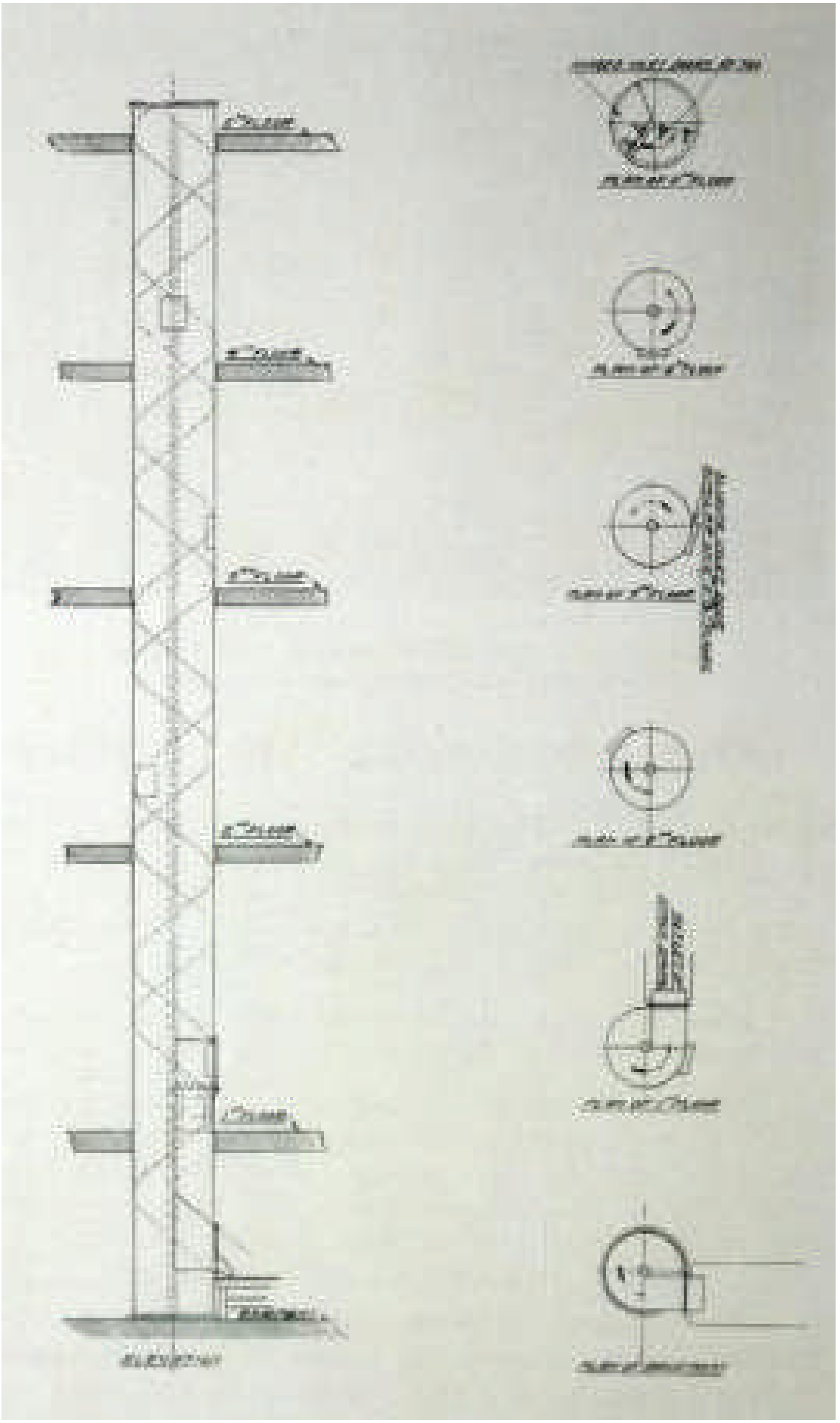
<u>Left</u>: caption: "Typical Layout of Single Spiral Closed Type Conveyor"

"…It is often requested that this Conveyor be built to allow head room under the shell in the basement. In such a case the shell, instead of resting on the basement floor, is cut-off just below the basement ceiling and is supported by a floor beam or column, the outlet, however, retaining its normal position. The single spiral is the simplest form of the Otis Gravity Spiral Closed Type Conveyor, and has such a wide application that a place for it can be found in nearly every line of business to economically lower bags, packages, boxed, cased and barreled goods or loose material in baskets…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

<u>Above</u>: caption: "Otis Gravity Single Spiral Conveyor (Closed Type) – Hockanum Association, New York City"

Double Spiral



"…In retail stores where it is desirable to separate packages by classes of material, by delivery routes or by express and parcel post, a two spiral closed type Conveyor is recommended. This Conveyor will also suffice in wholesale houses and manufacturing establishments where not more than two classifications are required. The layout on the opposite page shows a typical arrangement for retail stores. One spiral, which runs from the fifth floor to the first floor, is used as a stock spiral for the delivery of merchandise from the stock room to the lower floors of the store and has but one inlet located at the fifth floor…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

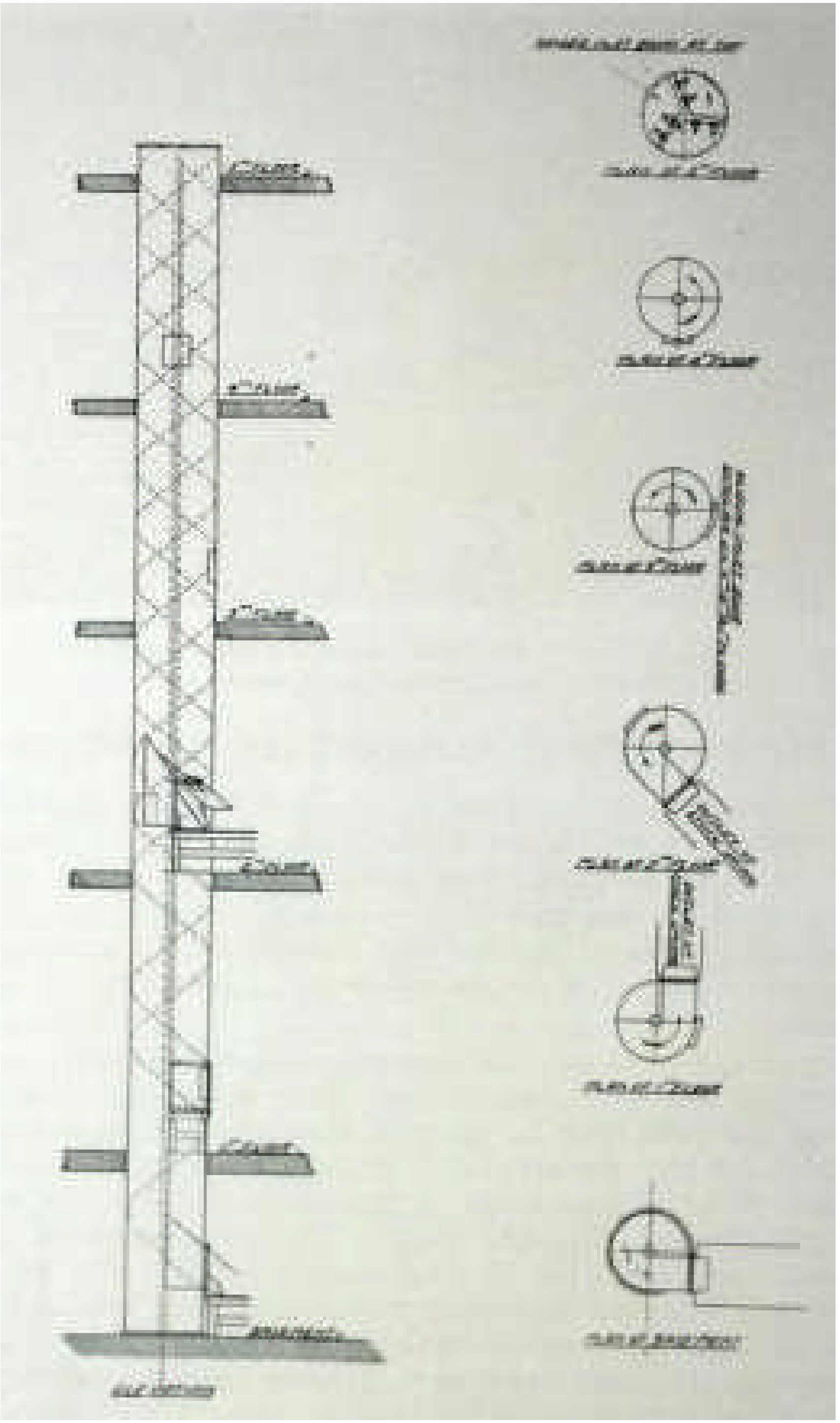
<u>Left</u>: caption: "Typical Layout of Double Spiral Closed Type Conveyor"

"…This spiral could, if desired, have inlets at all intermediate floors. The spiral running from the fifth floor to the basement, with inlets at all floors and delivering upon a receiving table in the delivery room, is used as a general delivery spiral of 'sold' packages. The spirals in this Conveyor may be used in a number of different ways to meet the merchandise handling requirements of each business where it is to be installed.."

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

Above: caption: "Otis Gravity Double Spiral Conveyor (Closed Type) – McFaddcn Coffee & Spice Co., Dubuque, Iowa"

Triple Spiral



"…This type of conveyor is especially efficient in department stores but is also used extensively in wholesale and mail order houses and factories. For department store service two of the spirals in this conveyor may be used for the delivery of packages from the stockroom above to the sales floors below, leaving the remaining spiral to convey 'Sold' packages from all sales floors to the assorting room in the basement, as shown in the layout on the opposite page…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

<u>Left</u>: caption: "Typical Layout of Triple Spiral Closed Type Conveyor"

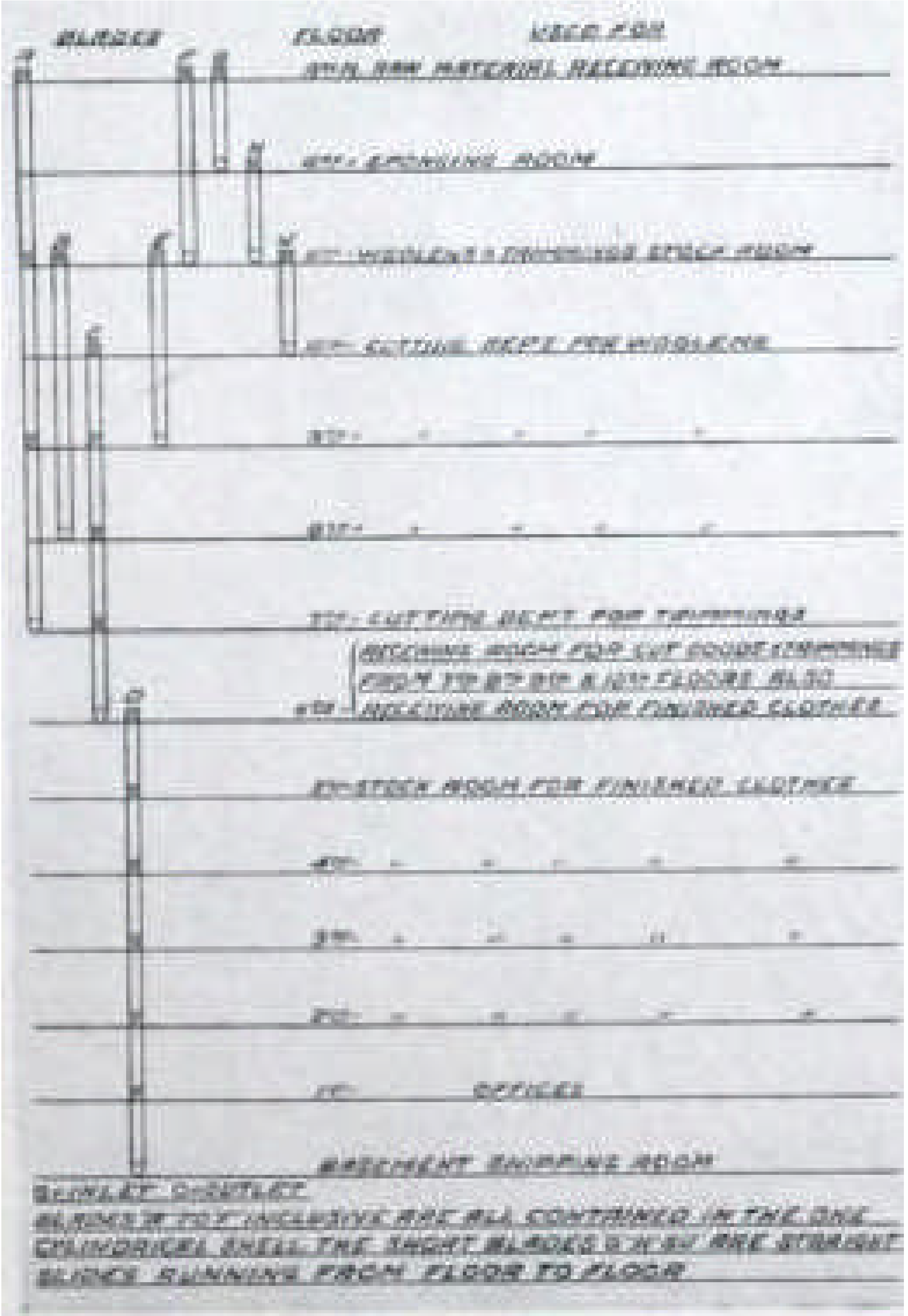
"…Where only one stock spiral is desired both of the remaining spirals are generally used for conveying 'Sold' packages to the assorting room, one spiral being used to carry 'Charge' and the other 'C. O. D.,' 'Transfer' and 'Paid' packages. In wholesale houses this conveyor usually has an inlet to each spiral at all floors, with all outlets in the shipping room, the three spirals being used to separate city deliveries, out-of-town express shipments and out-of-town freight shipments. In mail order houses this same type of conveyor is used to separate express, parcel post and freight shipments…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

<u>Left</u>: caption: "Top inlets of Triple Spiral Conveyor at Sixteenth floor"

<u>Right</u>: caption: "Otis Gravity Triple Spiral Conveyor (Closed Type) – Outlets in Basement - Mandel Brothers' Department Store, Chicago, Ill."

Multi Spiral



"…This type of conveyor is especially efficient in department stores but is also used extensively in wholesale and mail order houses and factories. For department store service two of the spirals in this conveyor may be used for the delivery of packages from the stockroom above to the sales floors below, leaving the remaining spiral to convey 'Sold' packages from all sales floors to the assorting room in the basement, as shown in the layout on the opposite page…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

<u>Left</u>: caption: "Diagram showing arrangement of Spiral blades in Multi-Spiral Closed Type Conveyor at factory of Hart, Schaffner & Marx, Chicago, Ill."

The two inlets of the Multi-Spiral Conveyor at 13th floor receiving room.

Outlet of Spiral "C" at 6th floor.

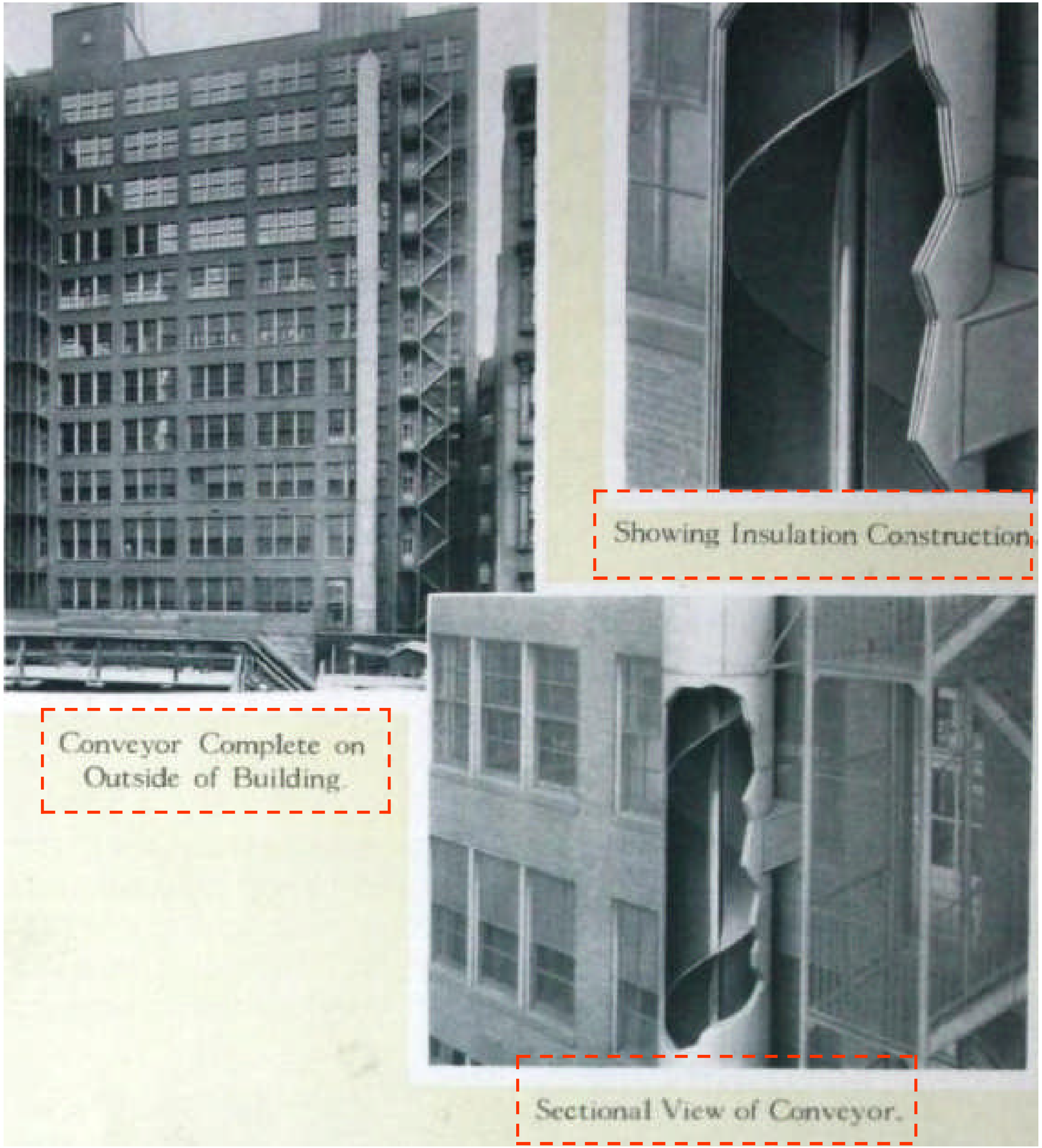
Outlet of Spiral "D" in Basement Shipping room.

Top: caption: "The two inlets of the Multi-Spiral Conveyor at 13th floor receiving room"
Middle: caption: "Outlet of Spiral 'C' at 6th floor"
Bottom: caption: "Outlet of Spiral 'D' in Basement Shipping room"

Outside Spiral

"…Owing, in rare instances, to extremely limited space conditions inside of building, the Conveyor may be located against the outside building wall, the inlet throat-pieces extending through available windows or other openings. Exposed as it is to varying weather conditions, insulation is necessary to prevent condensation on the spiral blades…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)



"…As clearly shown by the cut away section, this insulation consists of two one-inch air spaces, a center lining of asbestos and an outer shell of light iron We can recommend only the smaller diameter Conveyors handling light articles for this sort of installation…"

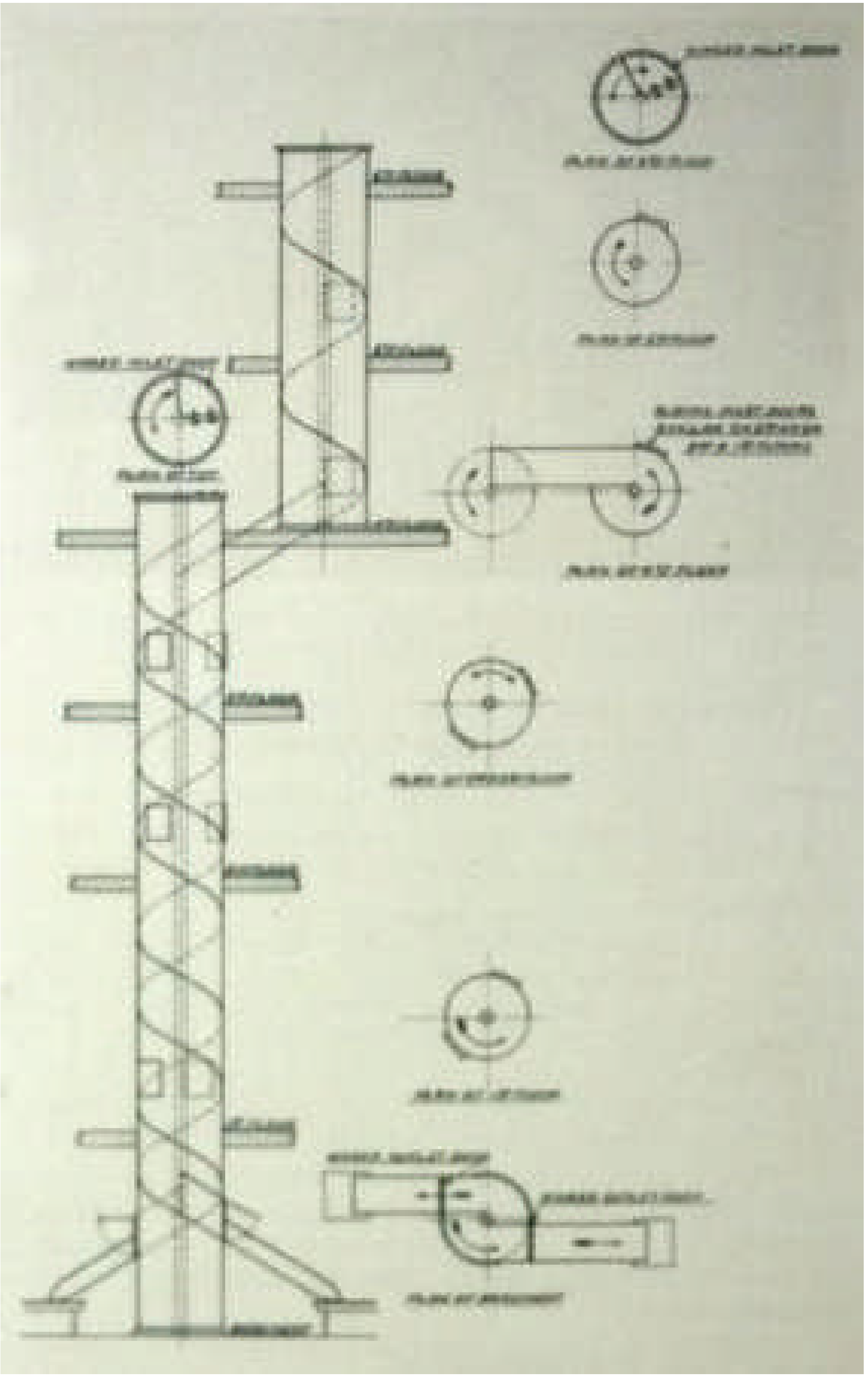
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

Upper Left: caption: "Conveyor Complete on Outside of Building"

Upper Right: caption: "Showing Insulation Construction"

Lower Right: caption: "Sectional View of Conveyor"

Interlocking



"…In buildings where a single spiral Conveyor will suffice to serve several consecutive upper floors and where the upper section of the Conveyor must be in a different location from that of the lower section, the packages, however, to be delivered to the same point in the shipping room, an interlocking Conveyor can be installed. The flexibility of this interlocking system makes it possible to install conveyors in almost any existing building without interfering with line shafts, partitions, etc…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

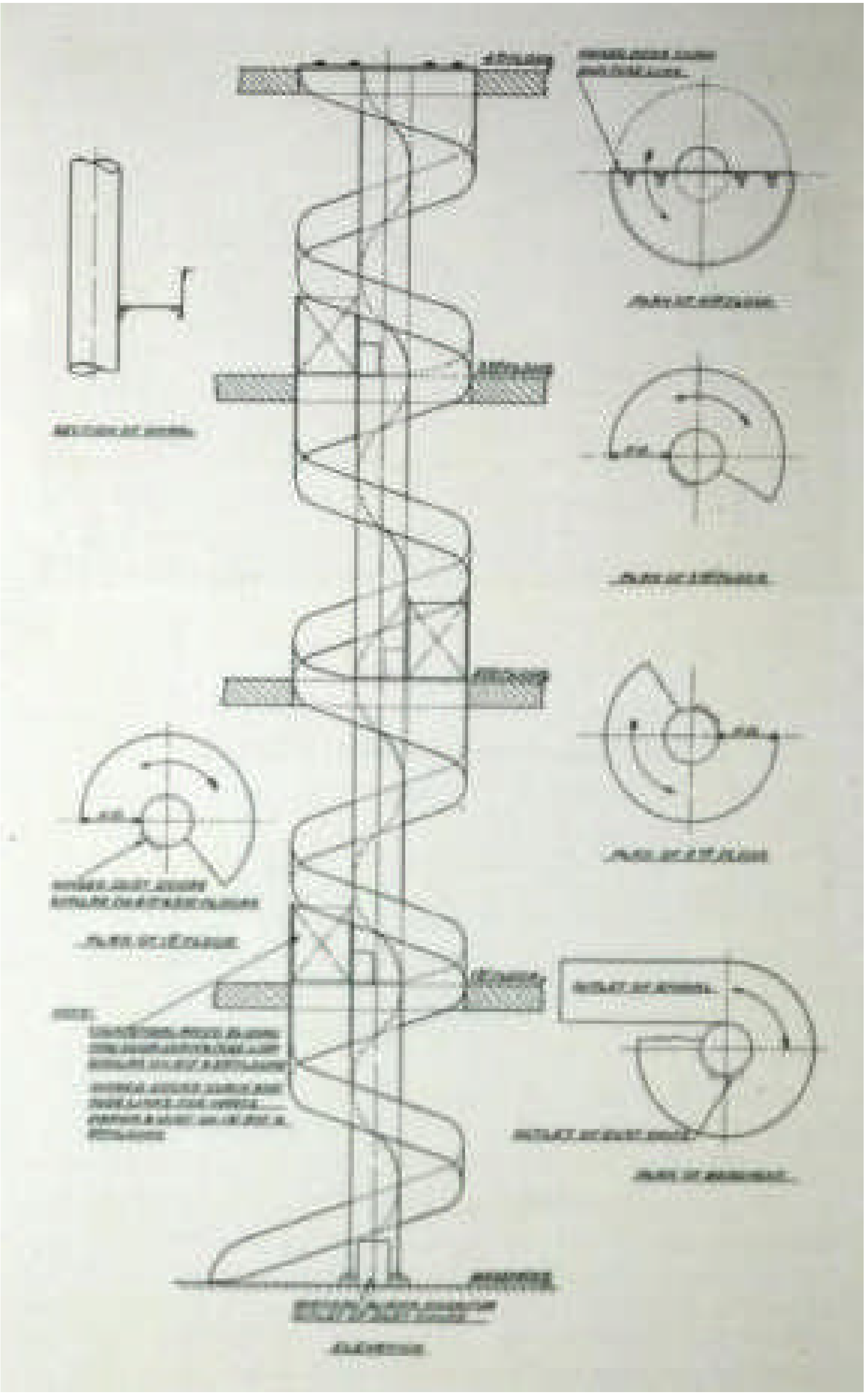
<u>Left</u>: caption: "Typical Layout – Closed Type Interlocking Conveyor"

"…The Conveyor may be carried for a part of the distance on the inside of a building in the regular way, then extended outside of the building in order to encircle floors occupied by other tenants and again brought back within the building to allow the conveyance of merchandise through inlets at all floors below. This interlocking feature can be used with both open and closed types of conveyors…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

<u>Above</u>: caption: "Otis Gravity Single Spiral Interlocking Conveyor (Closed Type) - A. Beller & Co., New York City"

Combination



"…This type of Conveyor is designed especially to provide a quick and economical means of sending waste and dirt from all floors of a building directly to the basement as well as to convey merchandise to the shipping room. It is essentially nothing more than an open type conveyor with a core large enough to carry the refuse. Goods can be loaded upon the spiral blade at all floors, while the hollow core, provided as it is with inlets at each floor, is used exclusively for dirt and waste which is removed from time to time through a door at the bottom…"

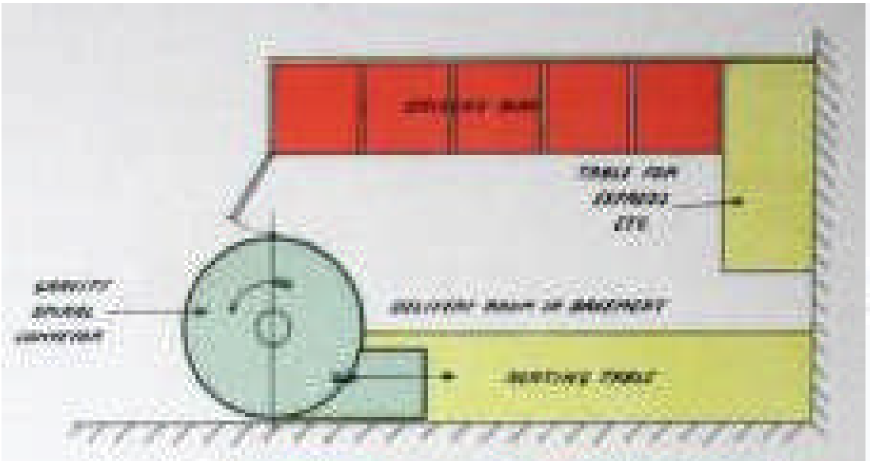
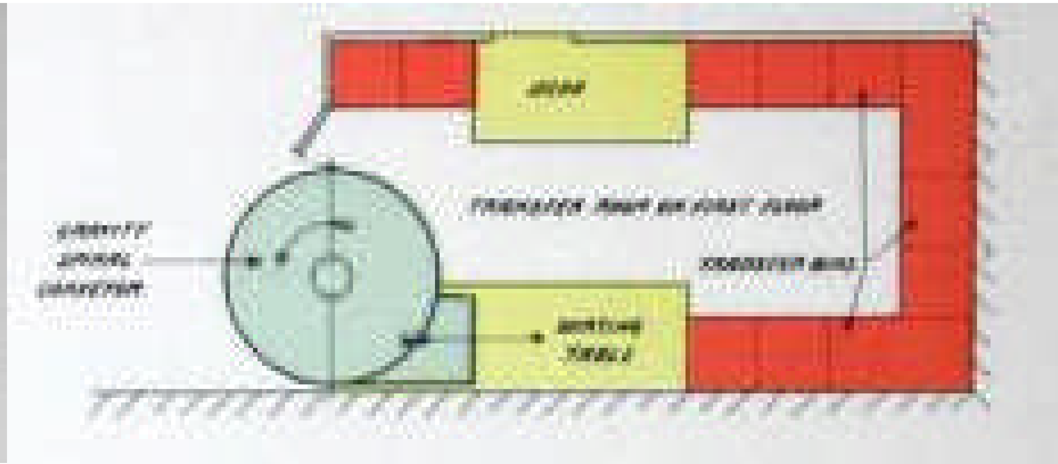
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

<u>Left</u>: caption: "Typical Layout – Combination Single Spiral Conveyor and Dirt Chute"

"…By making one shaft serve two distinct purposes, maximum efficiency and economy is obtained from this type of Conveyor. It is useful in wholesale houses, factories and retail stores where only one spiral blade is needed to carry merchandise, and where favorable conditions exist for locating this type of Conveyor. Still another type of Conveyor known as a Waste Chute is frequently used by concerns which may not require the merchandise spiral delivery feature but which have considerable waste paper and rubbish accumulation on the upper floors, for conveying this waste material directly into a bin at the first floor or basement. Such a chute may be advantageously placed on the outside of a building. For this work a cylindrical shell without spiral blades is furnished with inlet doors of either the vertical sliding or hinged type placed at every floor. The top of the chute is usually extended above the roof for purposes of ventilation…"

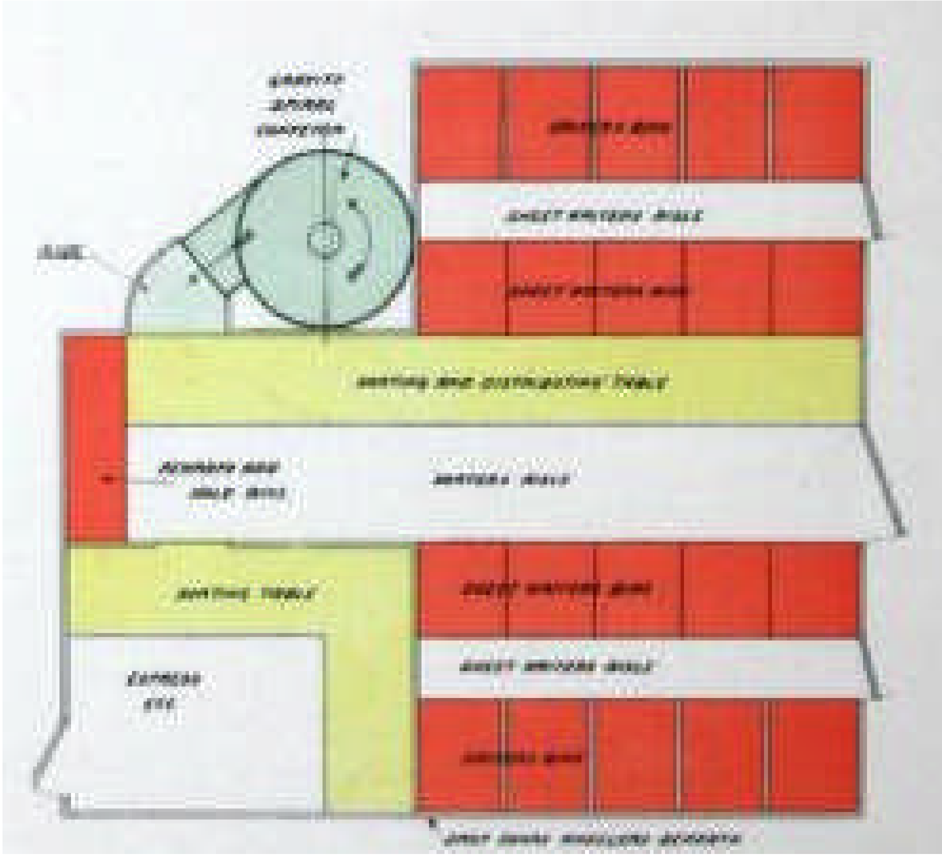
RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

Delivery Room

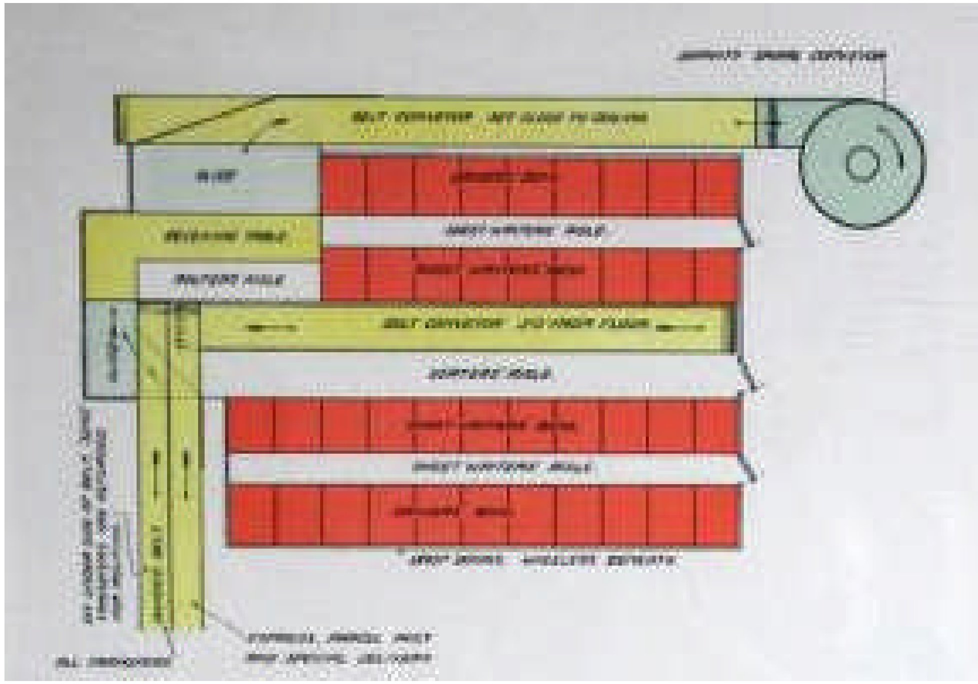
"…The two diagrams illustrated above show a typical delivery room arrangement for a small store, in this particular case a Double Spiral Conveyor being used. One spiral ends on the sorting table in the delivery room, which is located in the basement. All goods which are to be delivered by wagon pared post or express are sent down this spiral to the sorting table where they are sorted according to routes and methods of delivery. The other spiral is used for goods purchased on transfer cards, those purchased on a 'will-take' transfer are placed together in a bin and when the last purchase has been made are wrapped and delivered to the customer. Articles purchased on a 'send' transfer are wrapped and placed on the delivery room spiral, on which they are conveyed to the delivery room in the basement…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)



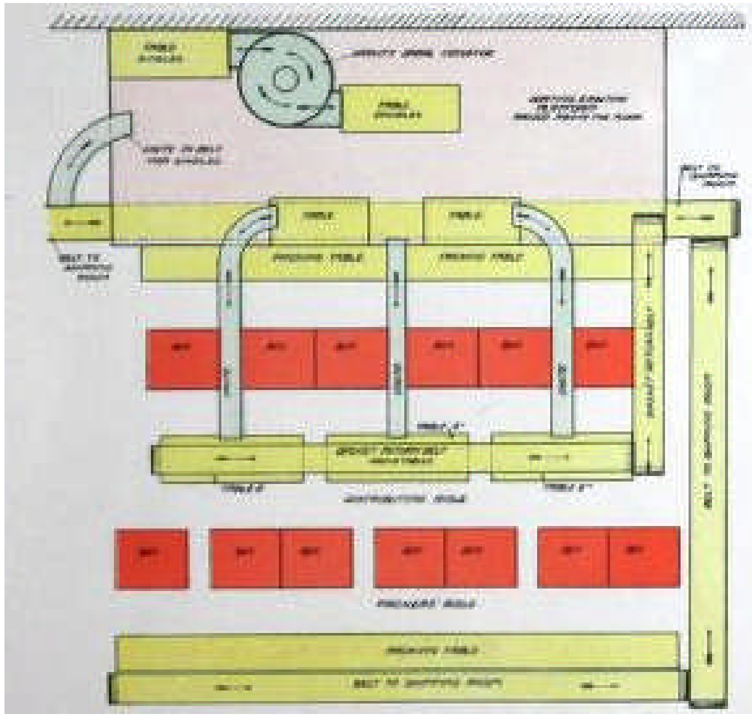
"…Above is a delivery room arrangement for a larger store. As shown it provides bins for 10 drivers but this can be increased to meet conditions. In this case the large number of local routes requires that the express, parcel post and special delivery parcels be handled in a separate room. Parcels to he delivered by wagon are received by the sorters and routers who mark the route on each parcel and place it in the corresponding sheet writer's bin The sheet writer, after entering the articles on his sheet, places them in the drivers' bins…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)



"…An arrangement for the delivery room of a large Department store is illustrated by the diagram above. All packages to be delivered are sent down on one of the Gravity Spiral Conveyor blades and discharged at one central point, whence they are moved on a belt conveyor to the receiving table. If the parcels are marked for delivery they are placed on a belt conveyor, from which they are picked by the sorters. Packages to be delivered by express, parcel post or special delivery are placed on one side of a divide belt, which discharges them into a room set apart for this class of goods. Transfer packages are placed on the other side of the divided belt from which they are discharged into the transfer room. After the 'send' transfers are assembled and wrapped they are returned to the routers on the underside of the belt, whence they follow the same route as the 'send' parcels…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)



"…The diagram above illustrates an arrangement for mail order houses, or houses that send most of their shipments by freight, parcel post or express. Orders divided into 'singles' and 'doubles' according as they come from one department or from several different departments. The single department orders, which land in the table marked 'singles' after being prepared for shipment are sent down the chute directly to the belt leading to the shipping room. Orders containing articles from various departments are sent down the Gravity Spiral Conveyor and land on the table marked 'doubles.' All articles belonging to one order are then gathered together in a basket and sent down one of the three chutes leading to the distributing tables, A, A', A." Here the articles are checked with the order and placed in the packers' bins. After being wrapped the packages are placed on the belt conveyor on which they an carried to the shipping room. The empty baskets are returned to the routing and sorting platforms by means of overhead belts or by a belt running under the tables with an inclined belt leading up to the raised platform…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

General Construction

"…Otis Gravity Spiral Conveyors are designed with a high factor of safety which allows for wear and which guarantees long life under severe and continuous usage. They are built entirely of heavy, high-grade sheet steel without a single weak spot, all parts being riveted firmly together to form a strong, rigid and permanent structure. The Conveyors are temporarily assembled in the factory for inspection before shipment, but to avoid damage in transit are shipped kno-cked-down…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

Inlets & Outlets

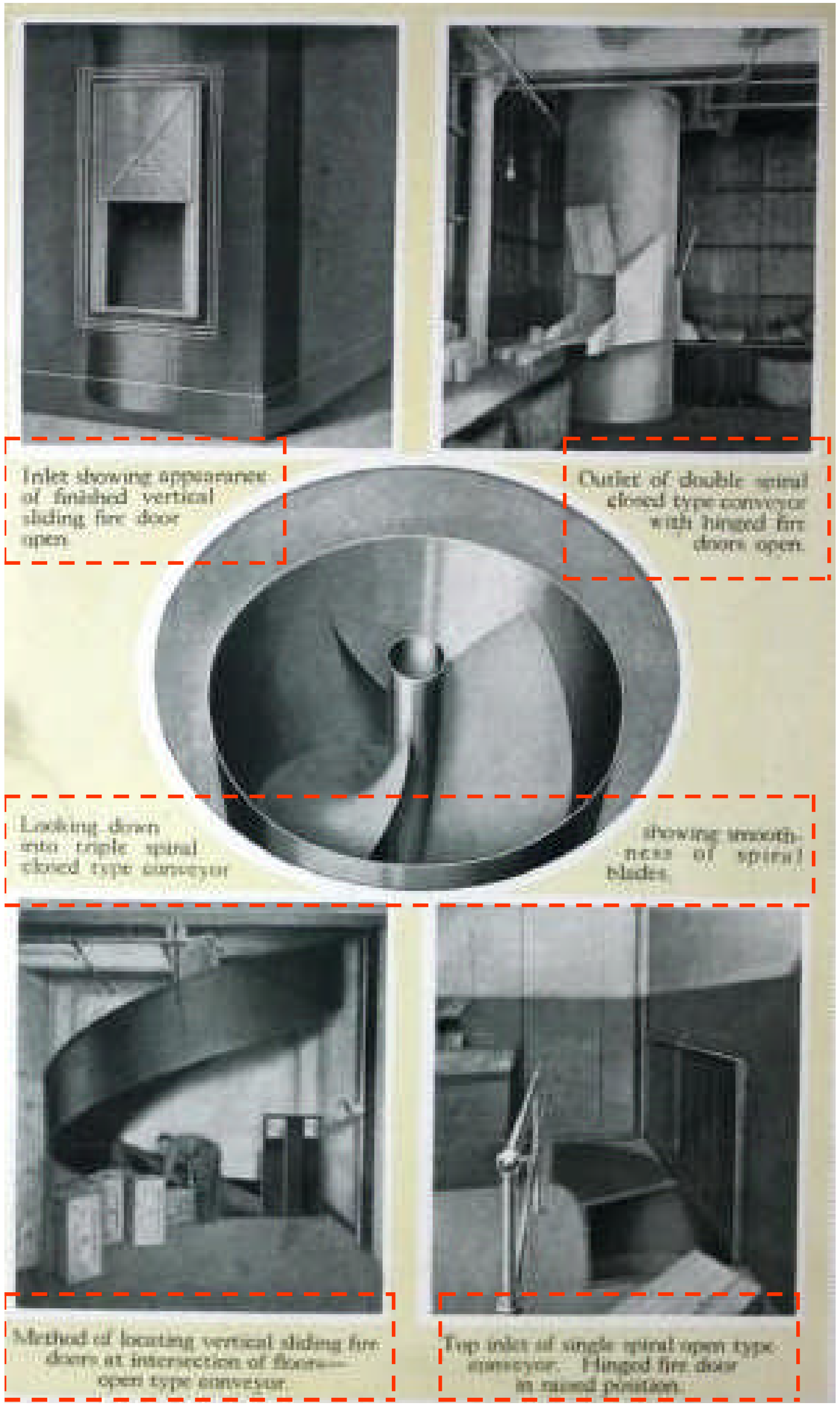
"…There are so many determining factors in locating the inlets and outlets at the various floors that no standard arrangement can be stated. A study of conditions enables us in every case to offer suggestions for an arrangement of spirals, inlets and outlets that will satisfactorily take care of delivery requirements…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

Fire Doors

"…An important and unique feature of Otis Gravity Spiral Conveyors is the complete equipment of Automatic Fire Doors required, usually, by the local Board of Fire Underwriters. These fire doors are furnished in two designs, known as the vertical sliding and hinged types. The vertical sliding fire door is used at all side inlets of the closed types of conveyors and at the intersection of all floors of the open types. When furnished for the closed types, the doors are so counter-balanced that while they can be easily raised, they will close unless fastened This fastening consists of a latch and fusible link which melts in case of fire, releasing the door and allowing it to close. For the open types of conveyors, the doors are provided with a patented counterbalance made up in two sections, the total weight being such that, while the door can be moved easily, it will remain stationary at any point desired. In case of fire, the melting of the fusible link, which is located just below the floor opening, releases a part of the counter-balance, allowing the door to descend into the trough of the conveyor beneath the floor. This method of counterbalancing is especially good because the fusible links support only a small share of the total weight; hence the doors can be raised and lowered whenever desired without damage to the links. The hinged fire doors are usually furnished at the outlets of the closed types of conveyors and at the top inlets of both open and closed types. These doors are held open by a chain and fusible link, the link being placed close to the opening through which the fire would take its path, and the chain being fastened to the ceiling, a nearby wall or shell of the conveyor…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)



<u>Upper Left</u>: caption: “Inlet showing appearance of finished vertical sliding fire door open”

<u>Upper Right</u>: caption: “Outlet of double spiral closed type conveyor w/hinged fire doors open”

<u>Middle</u>: caption: “Looking down into triple spiral closed type conveyor showing smoothness of spiral blades”

<u>Lower Left</u>: caption: “Method of locating vertical sliding fire doors at Intersection of floors - open type conveyor”

<u>Lower Right</u>: caption: “Top inlet of single spiral open type conveyor. Hinged fire door in raised position.”

Switchout Plates

"…It is evident that a spiral can receive packages at as many floors as may be desired, but that unless some means are provided for deflecting the packages at intermediate floors it can discharge them at one point only, the outlet at the bottom of the conveyor. In order to deflect packages from the spiral blade at floors above its bottom termination, Switchout Plates are used. These are of various designs according to the type of conveyor used, but all accomplish the same purpose, that is, they intercept the normal flow of the goods down the spiral and deposit the packages at the floors where the switchouts are in use. There is a certain disadvantage in the use of switchout plates compared with the use of an independent spiral delivering to a certain floor, since the former must be placed in position whenever delivery to that floor is desired, while the latter is always ready, the desired delivery being obtained by merely loading packages into the proper inlets…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

"…A switchout system must be protected by inter-floor signals. We, therefore, recommend the use of switchout plates only where a conveyor already has as many spirals as possible, and where delivery at intermediate floors is infrequently required…"

RE: excerpt from an *Otis Elevator Company* brochure (ca. 1915)

<u>Top</u>: caption: "Switchout Plate of Stock Spiral in raised position allowing free passage of packages and merchandise to lower floors"

<u>Bottom</u>: caption: "Switchout Plate of Stock Spiral lowered to deflect packages from stock rooms at Sales floor"

Part 6

A Fair to Remember

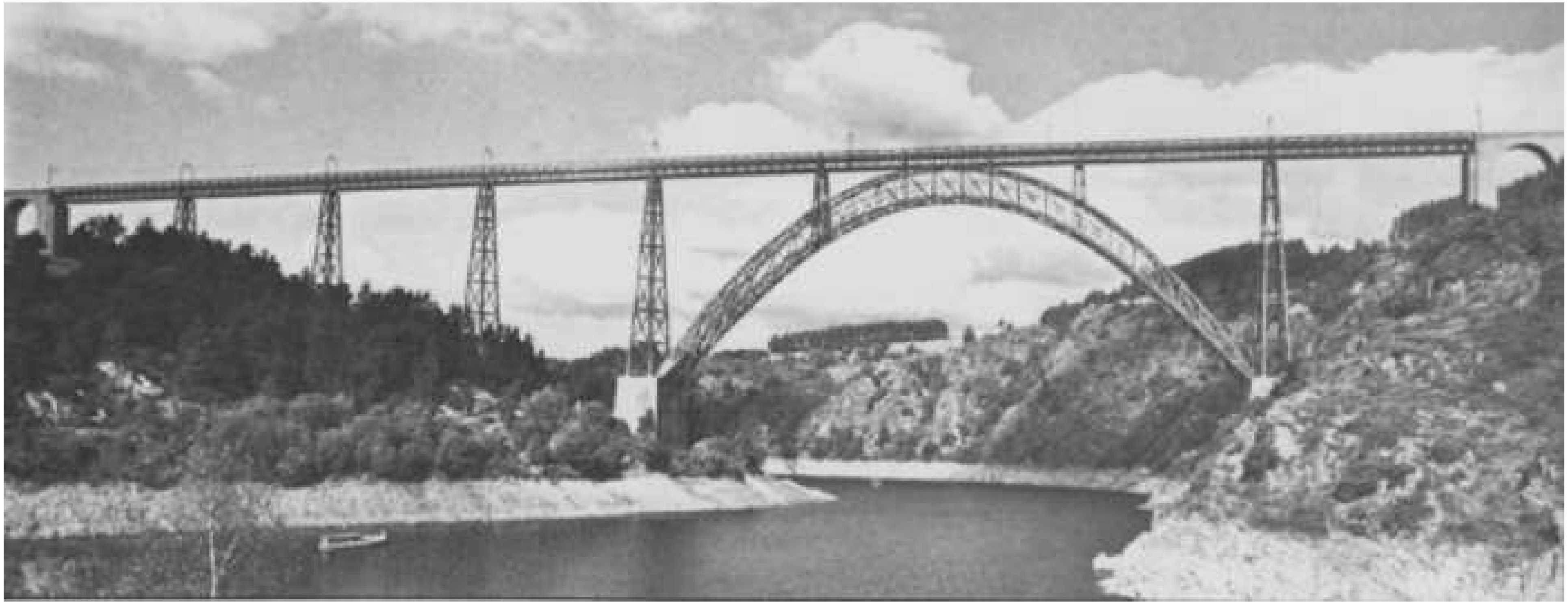
La Tour de 300 Meters

"The 1,000-foot tower that formed the focal point and central feature of the Universal Exposition of 1889 at Paris has become one of the best known of man's works. It was among the most outstanding technological achievements of an age which was itself remarkable for such achievements. Second to the interest shown in the tower's structural aspects was the interest in its mechanical organs. Of these, the most exceptional were the three separate elevator systems by which the upper levels were made accessible to the Exposition visitors. The design of these systems involved problems far greater than had been encountered in previous elevator work anywhere in the world. The basis of these difficulties was the amplification of the two conditions that were the normal determinants in elevator design - passenger capacity and height of rise. In addition, there was the problem, totally new, of fitting elevator shafts to the curvature of the Tower's legs. The study of the various solutions to these problems presents a concise view of the capabilities of the elevator art just prior to the beginning of the most recent phase of its development, marked by the entry of electricity into the field…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

"…The great confidence of the Tower's builder in his own engineering ability can be fully appreciated, however, only when notice is taken of one exceptional way in which the project differed from works of earlier periods as well as from contemporary ones. In almost every case, these other works had evolved, in a natural and progressive way, from a fundamental concept firmly based upon precedent. This was true of such notable structures of the time as the Brooklyn Bridge and, to a lesser extent, the Forth Bridge. For the design of his tower, there was virtually no experience in structural history from which Eiffel could draw other than a series of high piers that his own firm had designed earlier for railway bridges. It was these designs that led Eiffel to consider the practicality of iron structures of extreme height…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*



"…In the year 1885, the Eiffel firm, which also had an extensive background of experience in structural engineering, undertook a series of investigations of tall metallic piers based upon its recent experiences with several lofty railway via-ducts and bridges. The most spectacular of these was the famous Garabit Viaduct (1880-1884), which carries a railroad some 400-feet above the valley of the Truyere in southern France. While the 200-foot height of the viaduct's two greatest piers was not startling even at that period, the studies proved that piers of far greater height were entirely feasible in iron construction. This led to the design of a 395-foot pier, which, although never incorporated into a bridge, may be said to have been the direct basis for the Eiffel Tower…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

Above: caption: "Le viaduc de Garabit"

"…Preliminary studies for a 300-meter tower were made with the 1889 fair immediately in mind. With an assurance born of positive knowledge, Eiffel in June of 1886 approached the Exposition commissioners with the project. There can be no doubt that only the singular respect with which Eiffel was regarded not only by his profession but by the entire nation motivated the Commission to approve a plan which, in the hands of a figure of less stature, would have been considered grossly impractical…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

<u>Left</u>: caption: "Gustave Alexandre Eiffel (1832-1923)"

"We protest in the name of French taste and the national art culture against the erection of a staggering Tower, like a gigantic kitchen chimney dominating Paris, eclipsing by its barbarous mass Notre Dame, the Sainte-Chapelle, the tower of St. Jacques, the Dome des Invalides, the Arc de Triomphe, humiliating these monuments by an act of madness…"

RE: editorial that appeared in several Paris newspapers in 1887. The exposition's commission was inspired by the desire to create a monument to French technological achievement for the centennial of the revolution in 1889. However, there arose a protest ("Le Protest des Artistes") by Paris' intelligentsia against the tower. Although the Tower's every aesthetic aspect was viciously attacked, there was little criticism of its engineering/structural feasibility.

<u>Left</u>: caption: "Caricature of Gustav Eiffel, published in 1887 at the time of 'The Artist's Protest'"

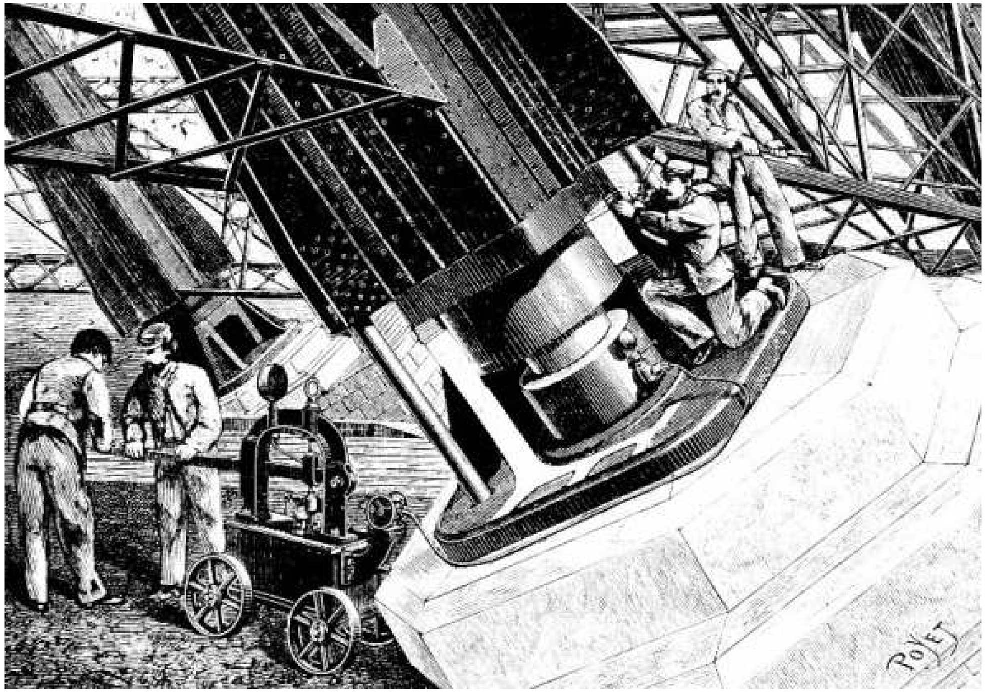
"…The design of the Tower was not actually the work of Eiffel himself but of two of his chief engineers, Emile Nouguier and Maurice Kœchlin - the men who had conducted the high pier studies - and the architect Stephen Sauvestre. The material which would otherwise have been used for the continuous lattice of diagonal bracing was concentrated in the four corner columns of the Tower, and these verticals were connected only at two widely separated points by the deep bands of trussing which formed the first and second platforms. A slight curvature inward was given to the main piers to further widen the base and increase the stability of the structure. At a point slightly above the second platform, the four members converged to the extent that conventional bracing became more economical, and they were joined…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

"…That this theory was successful not only practically, but visually, is evident from the resulting work. The curve of the legs and the openings beneath the two lower platforms are primarily responsible for the Tower's graceful beauty as well as for its structural soundness…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

<u>Left</u>: caption: "The Eiffel Tower at the time of the Universal Exposition of 1889 at Paris"

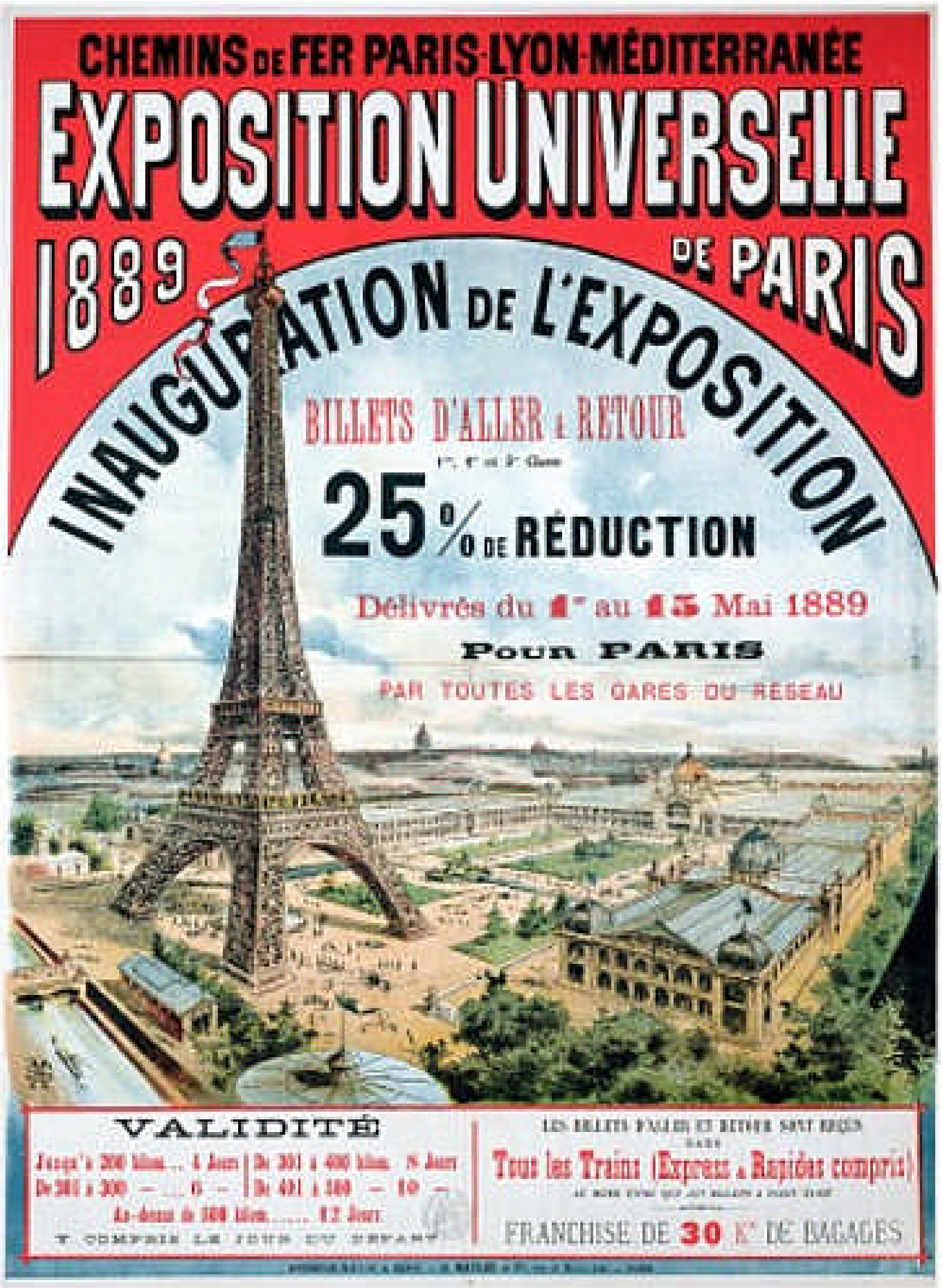


"…In the planning of the foundations, extreme care was used to ensure adequate footing, but in spite of the Tower's light weight in proportion to its bulk, and the low earth pressure it exerted, uneven pier settlement with resultant leaning of the Tower was considered a dangerous possibility. To compensate for this eventuality, a device was used whose ingenious directness justifies a brief description. In the base of each of the sixteen columns forming the four main legs was incorporated an opening into which an 800-ton hydraulic press could be placed, capable of raising the member slightly. A thin steel shim could then be inserted to make the necessary correction. The system was used only during construction to overcome minor erection discrepancies…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

<u>Above</u>: caption: "Correcting erection discrepancies by raising pier member – with hydraulic press and hand pump - and inserting shims"

State of the Art



"…In order to appreciate fully the problem which confronted the Tower's designers and sponsors when they turned to the problem of making its observation areas accessible to the fair's visitors, it is first necessary to investigate briefly the contemporary state of elevator art…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

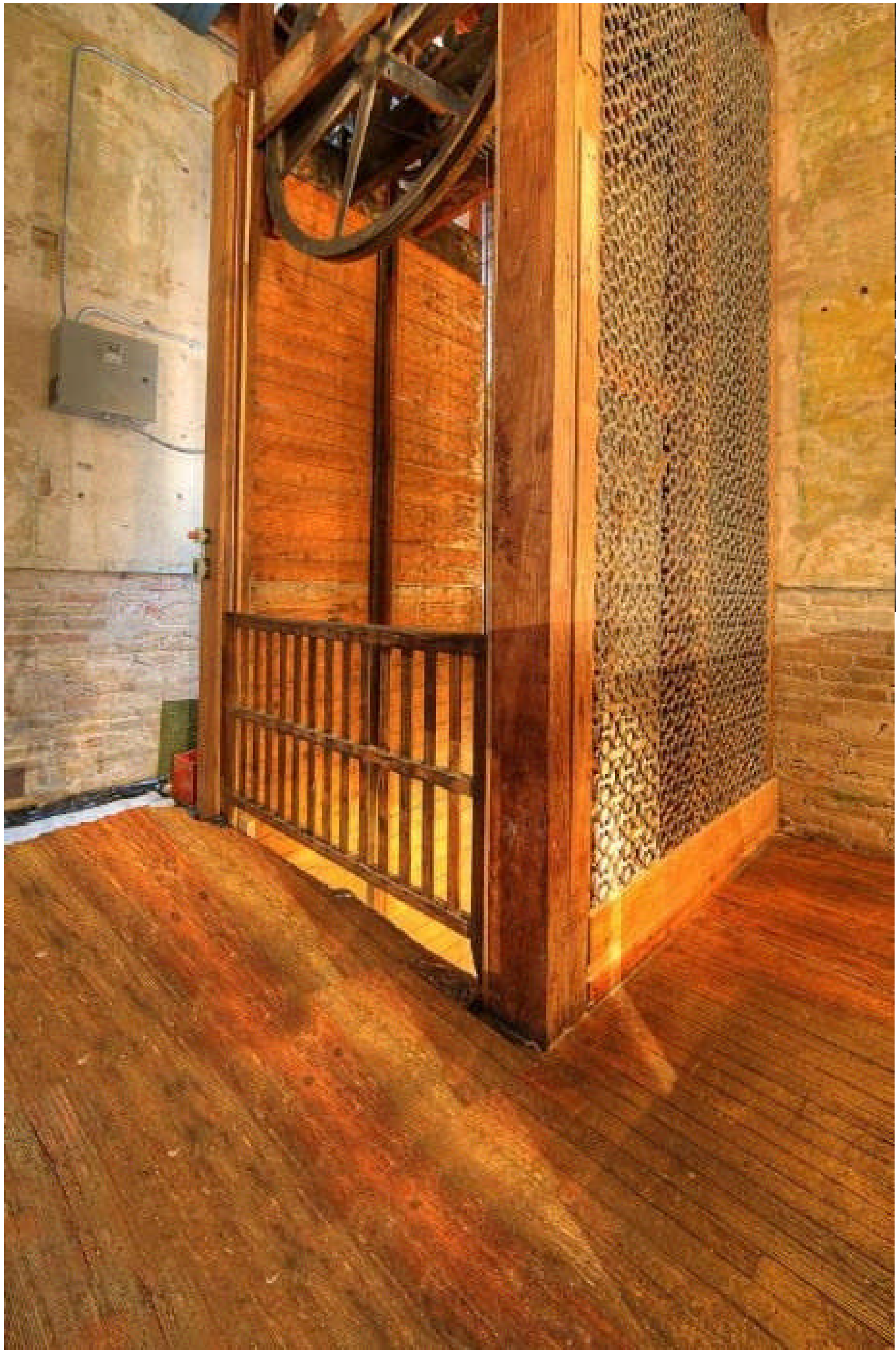
<u>Left</u>: original exposition poster

"…While power-driven hoists and elevators in many forms had been used since the early years of the 19th century, the ever-present possibility of breakage of the hoisting rope restricted their use almost entirely to the handling of goods in mills and warehouses. Not until the invention of a device which would positively prevent this was there much basis for work on other elements of the system. The first workable mechanism to prevent the car from dropping to the bottom of the hoist-way in event of rope failure was the product of Elisha G. Otis (1811-1861), a mechanic of Yonkers, New York. The invention was made more or less as a matter of course along with the other machinery for a new mattress factory of which Otis was master mechanic…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

"…The importance of this invention soon became evident to Otis, and he introduced his device to the public three years later during the second season of the New York Crystal Palace Exhibition, in 1854. Here he would demonstrate dramatically the perfect safety of his elevator by cutting the hoisting rope of a suspended platform on which he himself stood, uttering the immortal words which have come to be inseparably associated with the history of the elevator – 'All safe, gentlemen!'…"

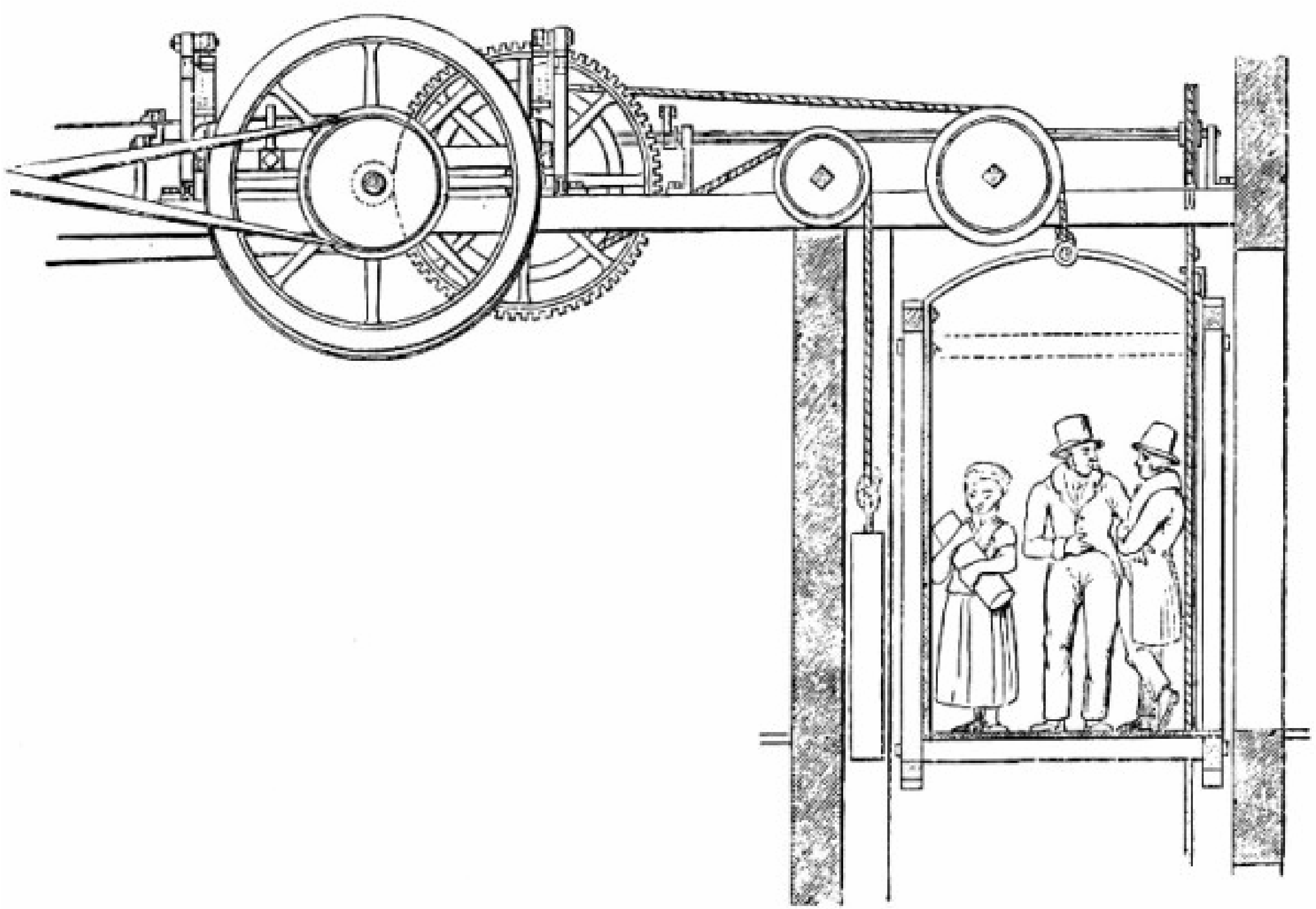
RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*



"…The invention achieved popularity slowly, but did find increasing favor in manufactories throughout the eastern United States. The significance of Otis' early work in this field lay strictly in the safety features of his elevators rather than in the hoisting equipment…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

<u>Above & Left</u>: early *Otis Elevator Company* hoisting machinery



"…His earliest systems were operated by machinery similar to that of the Teagle elevator in which the hoisting drum was driven from the mill shafting by simple fast and loose pulleys with crossed and straight belts to raise, lower, and stop. This scheme, already common at the time, was itself a direct improvement on the ancient hand-powered drum hoist…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

<u>Above</u>: caption: "Teagle elevator in an English mill about 1845. Power was taken from the line shafting."

"…The first complete elevator machine in the United States, constructed in 1855, was a complex and inefficient contrivance built around an oscillating-cylinder steam engine. The advantages of an elevator system independent of the mill drive quickly became apparent, and by 1860 improved steam elevator machines were being produced in some quantity, but almost exclusively for freight service. It is not clear when the first elevator was installed explicitly for passenger service, but it was probably in 1857, when Otis placed one in a store on Broadway at Broome Street in New York…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

BROADWAY: THE STORE OF MESSRS. E. V. HAUGHWOUT AND CO.

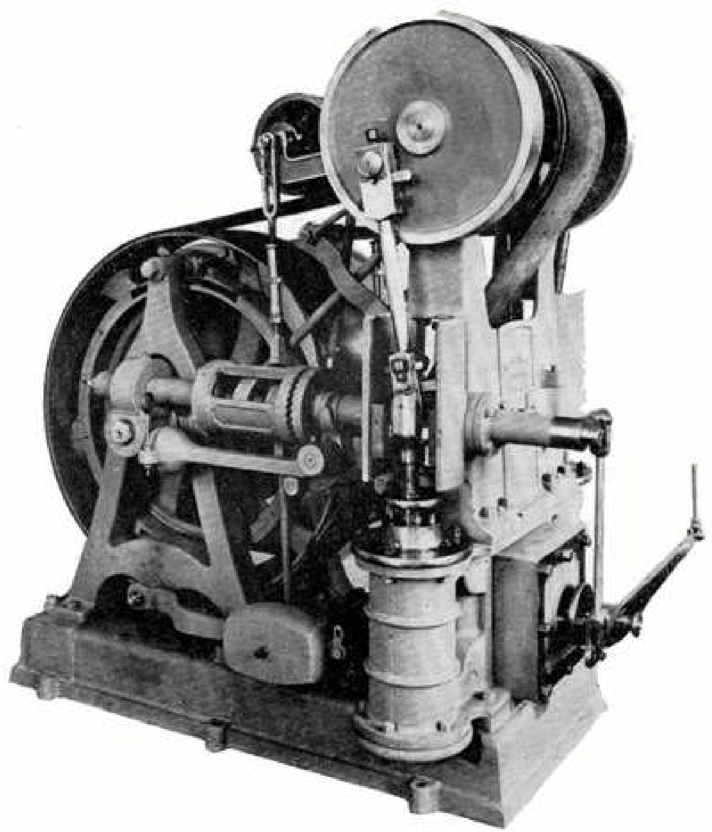
Post-Civil War

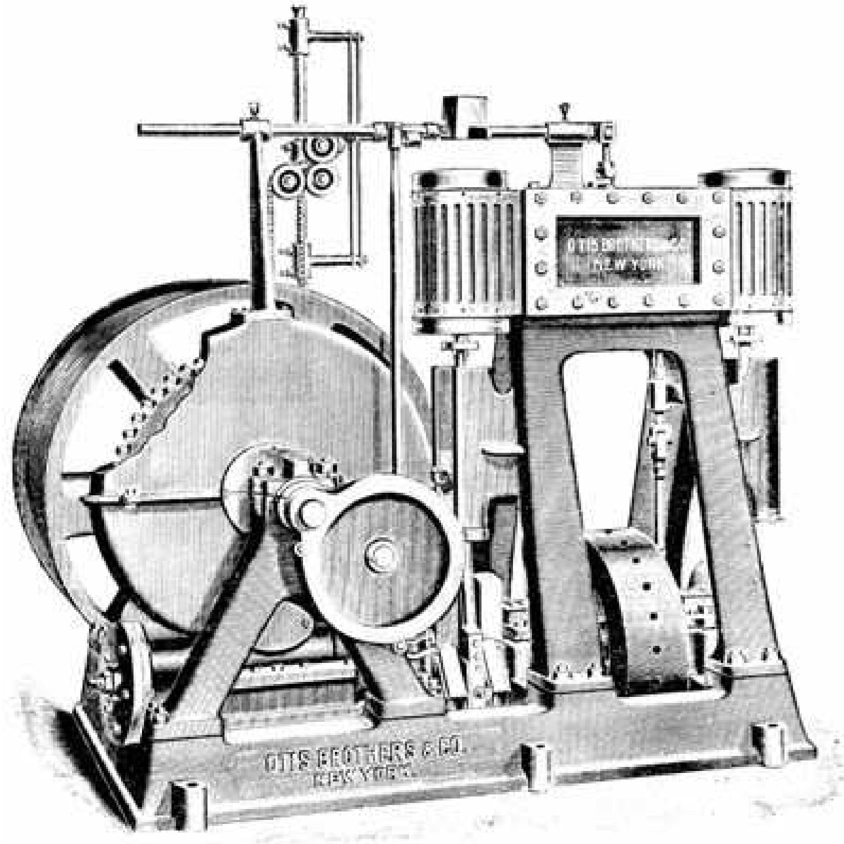
"…In the decade following the Civil War, tall buildings had just begun to emerge; and, although the skylines of the world's great cities were still dominated by church spires, there was increasing activity in the development of elevator apparatus adapted to the transportation of people as well as of merchandise. Operators of hotels and stores gradually became aware of the commercial advantages to be gained by elevating their patrons even one or two floors above the ground, by machinery. The steam engine formed the foundation of the early elevator industry, but as building heights increased it was gradually replaced by hydraulic, and ultimately by electrical, systems…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

“…The progression from an elevator machine powered by the line shafting of a mill to one in which the power source was independent would appear a simple and direct one. Nevertheless, it was about forty years after the introduction of the powered elevator before it became common to couple elevator machines directly to separate engines. The multiple belt and pulley transmission system was at first retained, but it soon became evident that a more satisfactory service resulted from stopping and reversing the engine itself, using a single fixed belt to connect the engine and winding mechanism. Interestingly, the same pattern was followed forty years later when the first attempts were made to apply the electric motor to elevator drive…”

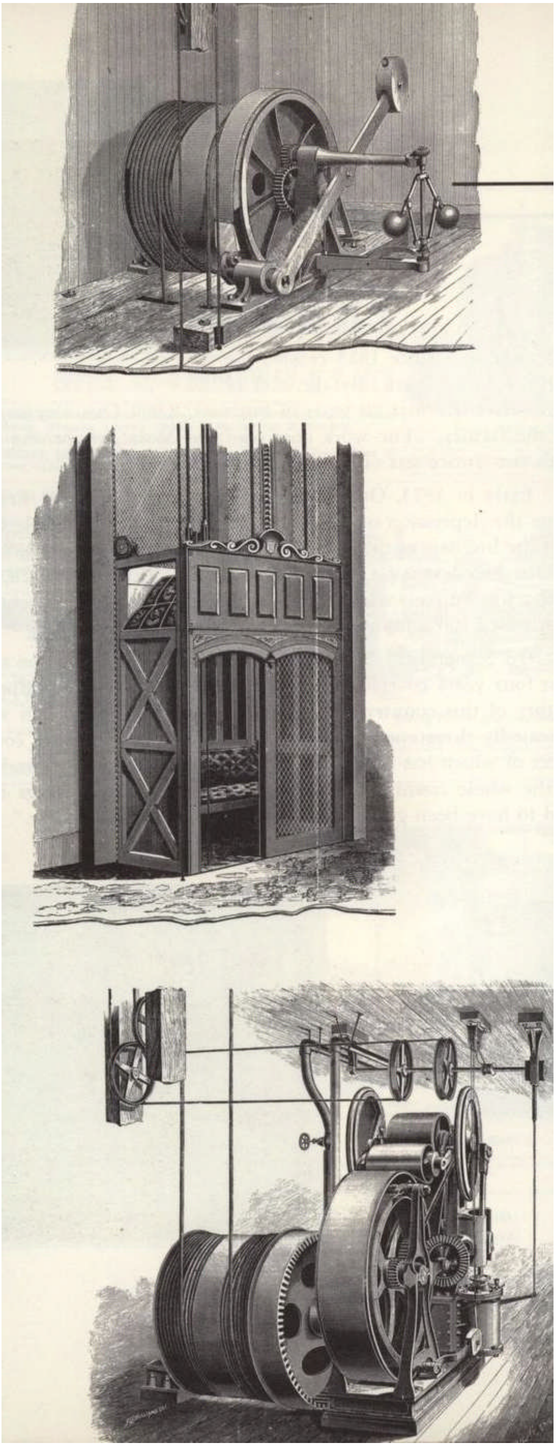
RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*





<u>Left</u>: caption: “In the typical steam elevator machine two vertical cylinders were situated either above or below the crankshaft, and a small pulley was keyed to the crankshaft. In a light-duty machine, the power was transmitted by flatbelt from the small pulley to a larger one mounted directly on the drum. In heavy-duty machines, spur gearing was interposed between the large secondary pulley and the winding drum.”

<u>Right</u>: caption: “Several manufacturers built steam machines in which a gear on the drum shaft meshed directly with a worm on the crankshaft. This arrangement eliminated the belt, and, since the drum could not drive the engine through the worm gearing, no brake was necessary for holding the load.”



"…By 1870 the steam elevator machine had attained its ultimate form, which, except for a number of minor refinements, was to remain unchanged until the type became completely obsolete toward the end of the century. By the last quarter of the century, a continuous series of improvements in the valving, control systems, and safety features of the steam machine had made possible an elevator able to compete with the subsequently appearing hydraulic systems for freight and low-rise passenger service insofar as smoothness, control, and lifting power were concerned. However, steam machinery began to fail in this competition as the increasing height of buildings rapidly extended the demands of speed and length of rise…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

Left: caption: "Components of the steam passenger elevator at the time of its peak development and use (1876)"

"…The limitation in rise constituted the most serious shortcoming of the steam elevator, an inherent defect that did not exist in the various hydraulic systems. Since the only practical way in which the power of a steam engine could be applied to the haulage of elevator cables was through a rotational system, the cables invariably were wound on a drum. The travel or rise of the car was therefore limited by the cable capacity of the winding drum. As building heights increased, drums became necessarily longer and larger until they grew so cumbersome as to impose a serious limitation upon further upward growth. A drum machine rarely could be used for a lift of more than 150 feet. Another organic difficulty existing in drum machines was the dangerous possibility of the car - or the counterweight, whose cables often wound on the drum - being drawn past the normal top limit and into the upper supporting works. Only safety stops could prevent such an occurrence if the operator failed to stop the car at the top or bottom of the shaft, and even these were not always effective. Hydraulic machines were not susceptible to this danger, the piston or plunger being arrested by the ends of the cylinder at the extremes of travel…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

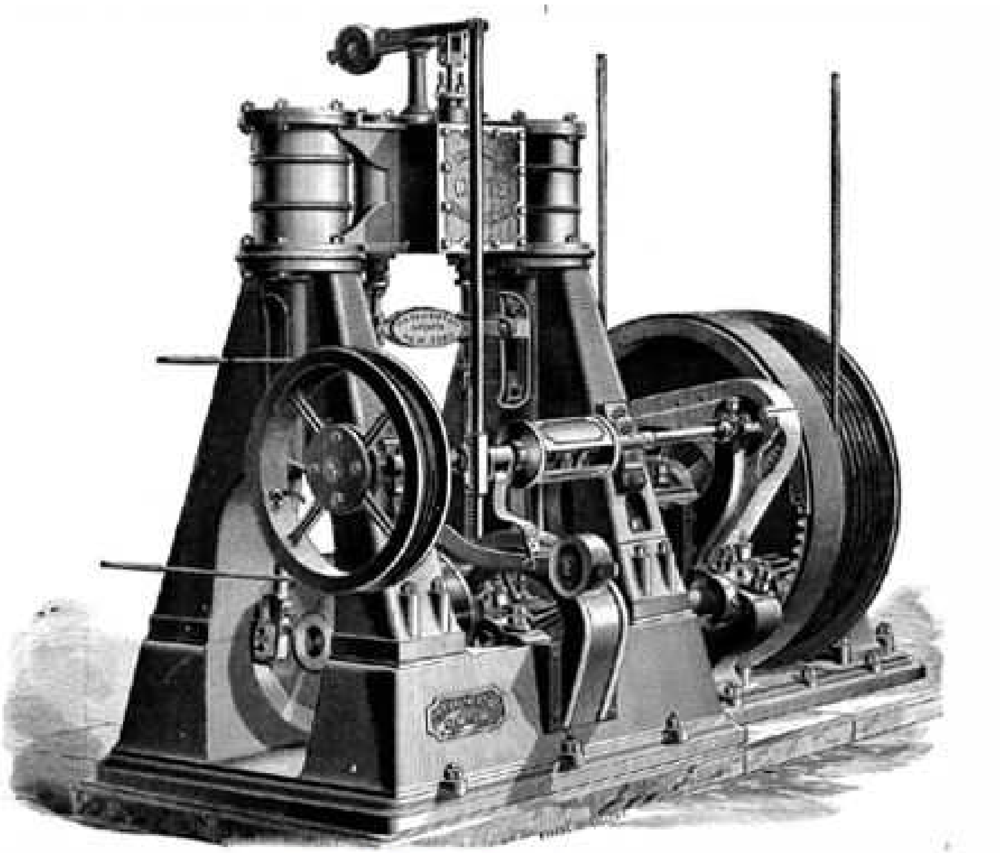
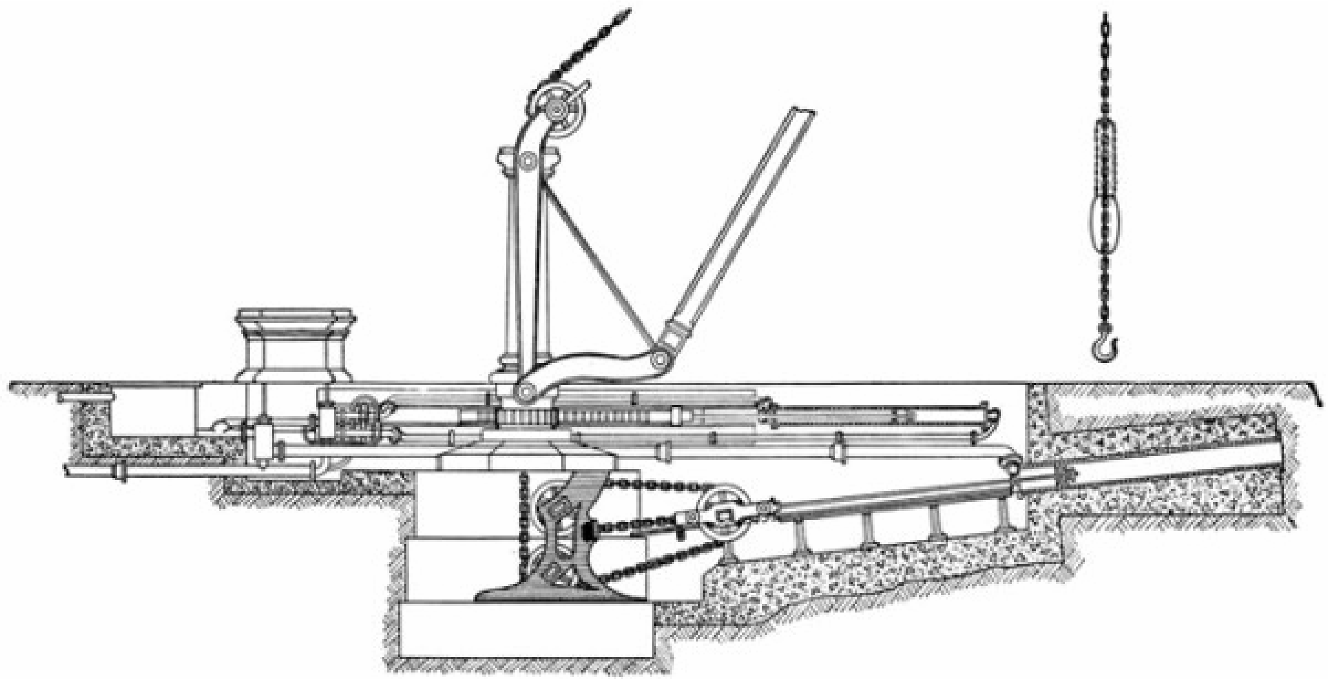


Fig. 2.—THE OTIS STEAM PASSENGER ELEVATOR ENGINE

Standard of the Industry

“…The rope-geared hydraulic elevator, which was eventually to become known as the ‘Standard of the Industry,’ is generally thought to have evolved directly from an invention of the English engineer Sir William Armstrong (1810-1900) of ordnance fame. In 1846 he developed a water-powered crane, utilizing the hydraulic head available from a reservoir on a hill 200-feet above. The system was not basically different from the simple hydraulic press so well known at the time. Water, admitted to a horizontal cylinder, displaced a piston and rod to which a sheave was attached. Around the sheave passed a loop of chain, one end of which was fixed, the other running over guide sheaves and terminating at the crane arm with a lifting hook. As the piston was pressed into the cylinder, the free end of the chain was drawn up at triple the piston speed, raising the load. The effect was simply that of a 3-to-1 tackle, with the effort and load elements reversed. Simple valves controlled admission and exhaust of the water…”

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*



"…The success of this system initiated a sizable industry in England, and the hydraulic crane, with many modifications, was in common use there for many years. Such cranes were introduced in the United States in about 1867 but never became popular; they did, however, have a profound influence on the elevator art, forming the basis of the third generic type to achieve widespread use in this country. The ease of translation from the Armstrong crane to an elevator system could hardly have been more evident, only two alterations of consequence being necessary in the passage. A guided platform or car was substituted for the hook; and the control valves were connected to a stationary endless rope that was acc-essible to an operator on the car…"

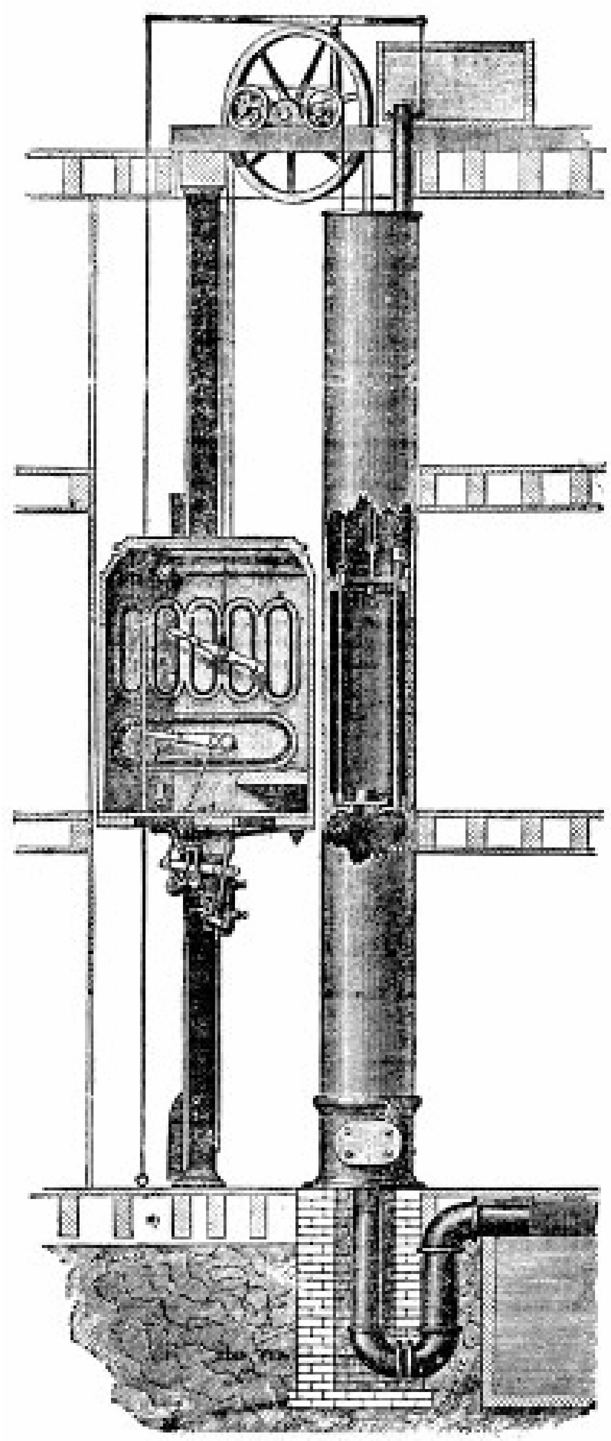
RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

<u>Above</u>: caption: "Armstrong's Hydraulic Crane. The main cylinder was inclined, permitting gravity to assist in overhauling the hook. The small cylinder rotated the crane."

Hydro-Atmospheric

"…The rope-geared hydraulic system appeared in mature form in about 1876. However, before it had become the 'standard elevator' through a process of refinement, another system was introduced which merits notice if for no other reason than that its popularity for some years seems re-markable in view of its preposterously unsafe design. Patented by Cyrus W. Baldwin of Boston in January 1870, this system was termed the Hydro-Atmospheric Elevator, but more commonly known as the water-balance elevator…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*



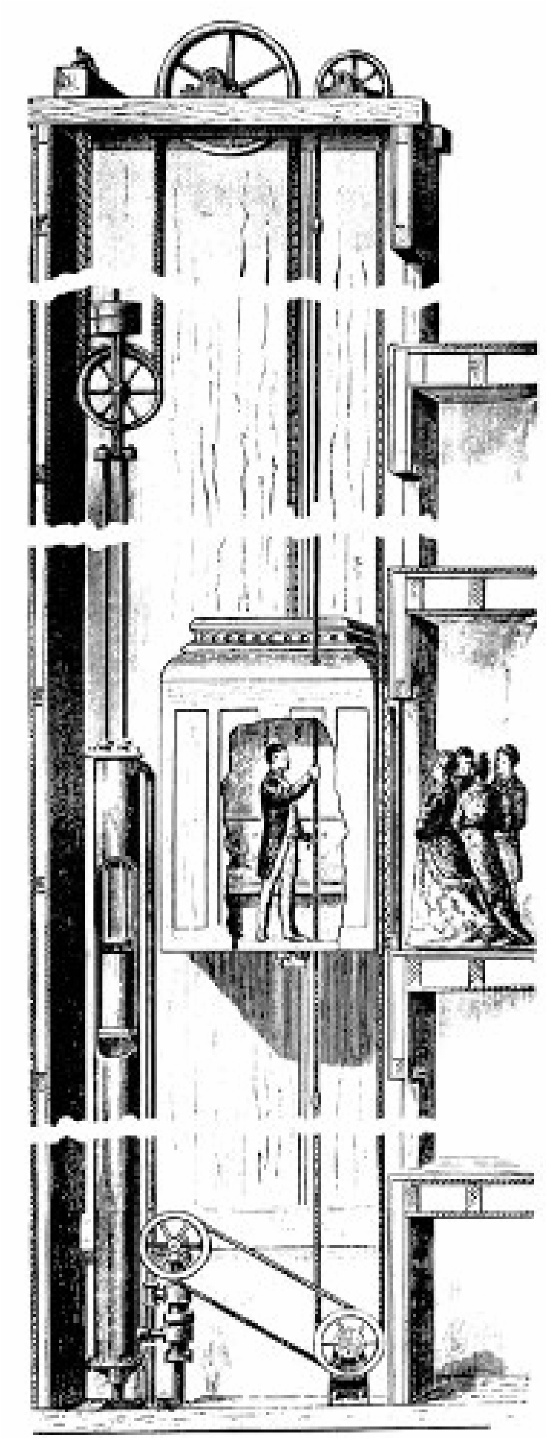
"…It employed water not under pressure but simply as mass under the influence of gravity. The elevator car's supporting cables ran over sheaves at the top of the shaft to a large iron bucket, which traveled in a closed tube or well adjacent to and the same length as the shaft. To raise the car, the operator caused a valve to open, filling the bucket with water from a roof tank. When the weight of water was sufficient to over-balance the loaded car, the bucket descended, raising the car. On its ascent the car was stopped at intermediate floors by a strong brake that gripped the guides. Upon reaching the top, the operator was able to open a valve in the bucket, now at the bottom of its travel, and discharge its contents into a basement tank, to be pumped back to the roof. No longer counterbalanced, the car could descend, its speed controlled solely by the brake…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

Left: caption: "Final development of the Baldwin-Hale water balance elevator, 1873. The brake, kept applied by powerful springs, was released only by steady pressure on a lever. There were two additional controls - the continuous rope that opened the cistern valve to fill the bucket, and a second lever to open the valve of the bucket to empty it."

"…The great popularity of this novel system apparently was due to its smooth operation, high speed, simplicity, and economy of operation. Managed by a skillful operator, it was capable of speeds far greater than other systems could then achieve - up to a frightening 1,800 feet per minute. In addition to the element of potential danger from careless operation or failure of the brake, the Baldwin system was extremely expensive to install as a result of the second shaft, which of course was required to be more or less watertight. Much of the water-balance elevator's development and refinement was done by William E. Hale of Chicago, who also made most of the installations. The system has, therefore, come to bear his name more commonly than Baldwin's. The popularity of the water-balance system waned after only a few years, being eclipsed by more rational systems. Hale eventually abandoned it and became the western agent for Otis - by this time prominent in the field - and subsequently was influential in development of the hydraulic elevator…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*



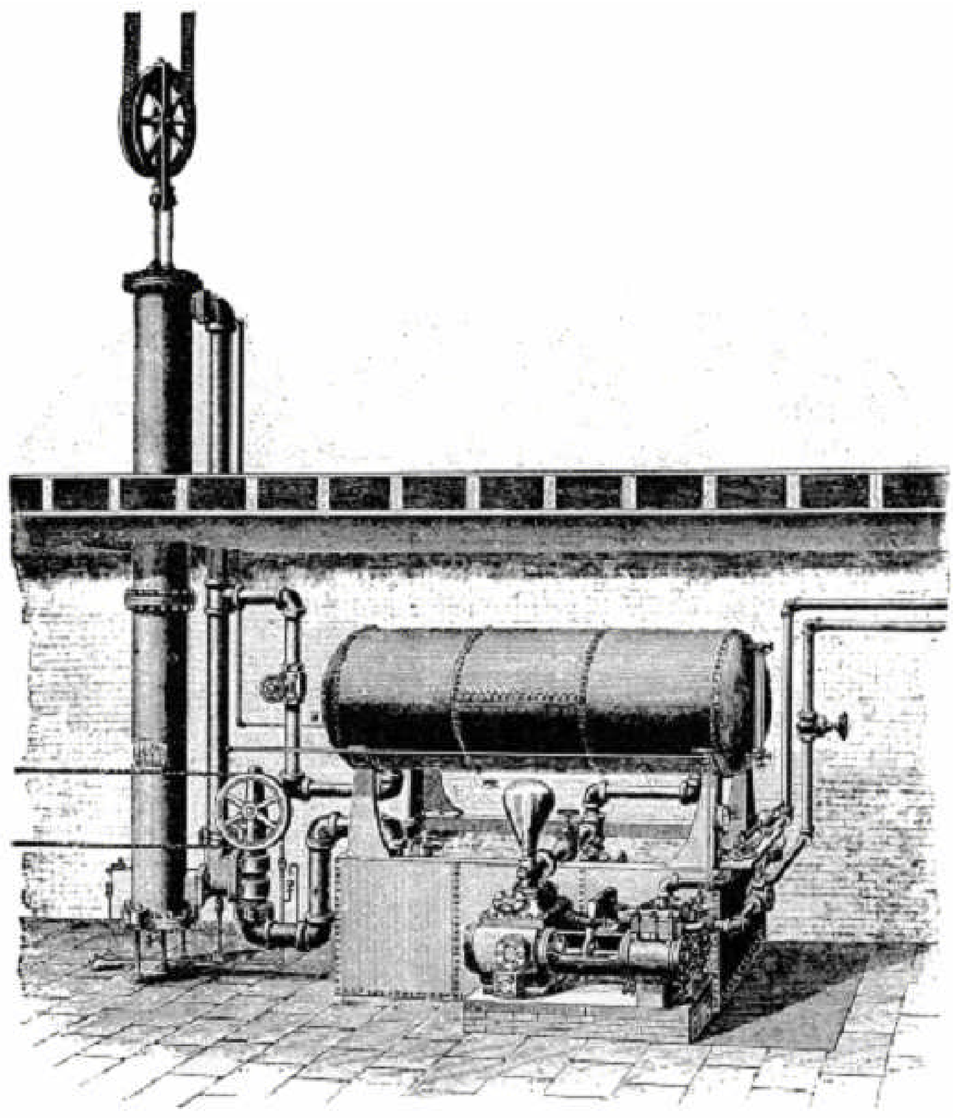
"…The rope-geared system of hydraulic elevator operation was so basically simple that by 1880 it had been embraced by virtually all manufacturers. However, for years most builders continued to maintain a line of steam and belt driven machines for freight service. Inspired by the rapid increase of taller and taller buildings, there was a concentrated effort, heightened by severe competition, to refine the basic system…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

Left: caption: "Vertical cylinder, rope-geared hydraulic elevator with 2:1 gear ratio and rope control (about 1880). For higher rises and speeds, ratios of up to 10:1 were used, and the endless rope was replaced by a lever."

"…By the late 1880's a vast number of improvements in detail had appeared, and this form of elevator was considered to be almost without defect. It was safe. Absence of a drum enabled the car to be carried by a number of cables rather than by one or two, and rendered overtravel impossible. It was fast. Control devices had received probably the most attention by engineers and were as perfect and sensitive as was possible with mechanical means. Cars with lever control could be run at the high speeds required for high buildings, yet they could be stopped with a smoothness and precision unattainable earlier with systems in which the valves were controlled by an endless rope, worked by the operator. It was almost completely silent, and when the cylinder was placed vertically in a well near the shaft, practically no valuable floor space was occupied. But most important, the length of rise was unlimited because no drum was used. As greater rises were required, the multiplication of the ropes and sheaves was simply increased, raising the piston-car travel ratio and permitting the cylinder to remain of manageable length. The ratio was often as high as 10 or 12 to 1, the car moving 10 or 12-feet to the piston's 1…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*



"…In addition to its principal advantages, the hydraulic elevator could be operated directly from municipal water mains in the many cities where there was sufficient pressure, thus eliminating a large investment in tanks, pumps and boilers…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

Left: caption: "In the various hydraulic systems, a pump was required if pressure from water mains was insufficient to operate the elevator directly. There was either a gravity tank on the roof or a pressure tank in the basement."

A Matter of Trust

"…European elevator development - notwithstanding the number of American rope-geared hydraulic machines sold in Europe in the ten years or so preceding the Paris fair of 1889 - was confined mainly to variations on the direct plunger type, which was first used in English factories in the 1830's. The plunger elevator, an even closer derivative of the hydraulic press than Armstrong's crane, was nothing more than a platform on the upper end of a vertical plunger that rose from a cylinder as water was forced in. There were two reasons for this European practice. The first and most apparent was the rarity of tall buildings. The drilling of a well to receive the cylinder was thus a matter of little difficulty. This well had to be equivalent in depth to the elevator rise. The second reason was an innate European distrust of cable-hung elevator systems in any form…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

A Promising Future

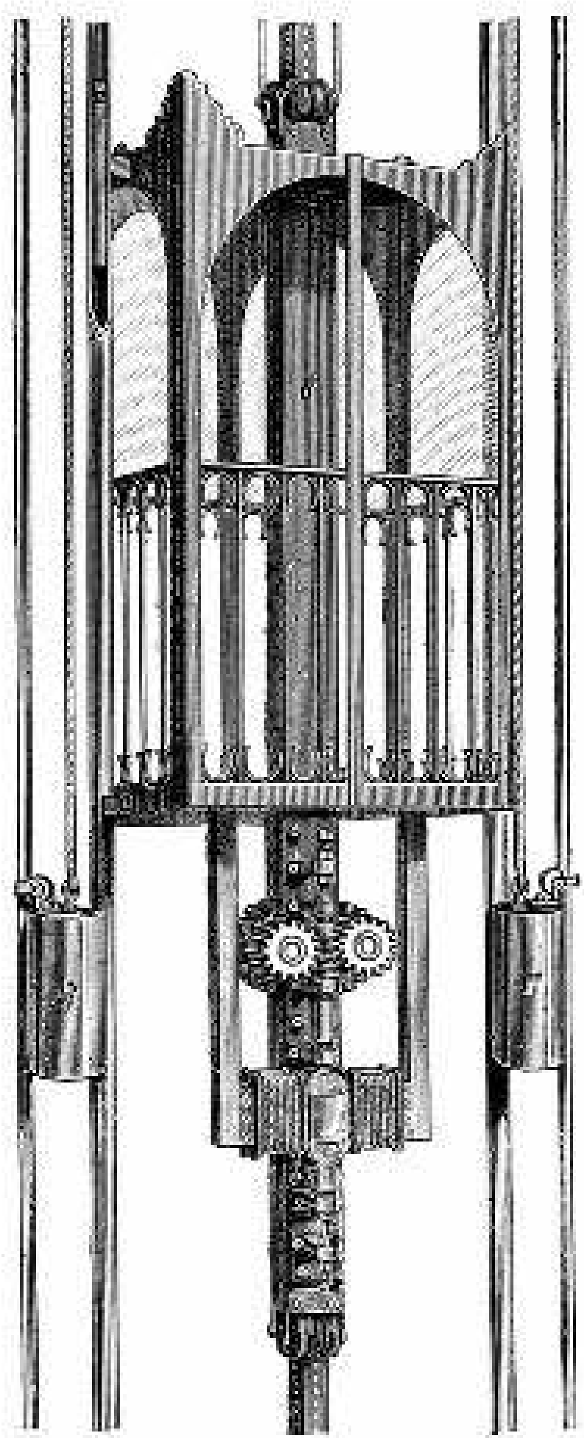
"…At the time the Eiffel Tower elevators were under consideration, water under pressure was, from a practical standpoint, the only agent capable of fulfilling the power and control requirements of this particularly severe service. Steam, as previously mentioned, had already been found wanting in several respects. Electricity, on the other hand, seemed to hold promise for almost every field of human endeavor. By 1888 the electric motor had behind it a ten or fifteen-year history of active development. Frank J. Sprague had already placed in successful operation a sizable electric trolley-car system, and was manufacturing motors of up to twenty horsepower in commercial quantity. Lighting generators were being produced in sizes far greater. There were, nevertheless, many obstacles preventing the translation of this progress into machinery capable of hauling large groups of people a vertical distance of 1,000-feet with unquestionable dependability…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

"…The first application of electricity to elevator propulsion was an experiment of the distinguished German electrician Werner von Siemens, who, in 1880, constructed a car that successfully climbed a rack by means of a motor and worm gearing beneath its deck - again, the characteristic European distrust of cable suspension. However, the effect of this success on subsequent development was negligible. Significant use of electricity in this field occurred somewhat later, and in a manner parallel to that by which steam was first applied to the elevator - the driving of mechanical (belt driven) elevator machines by individual motors. Slightly later came another application of the 'conversion' type. This was the simple substitution of electrically driven pumps for steam pumps in hydraulic installations. It will be recalled that pumps were necessary in cases where water main pressure was insufficient to operate the elevator directly…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

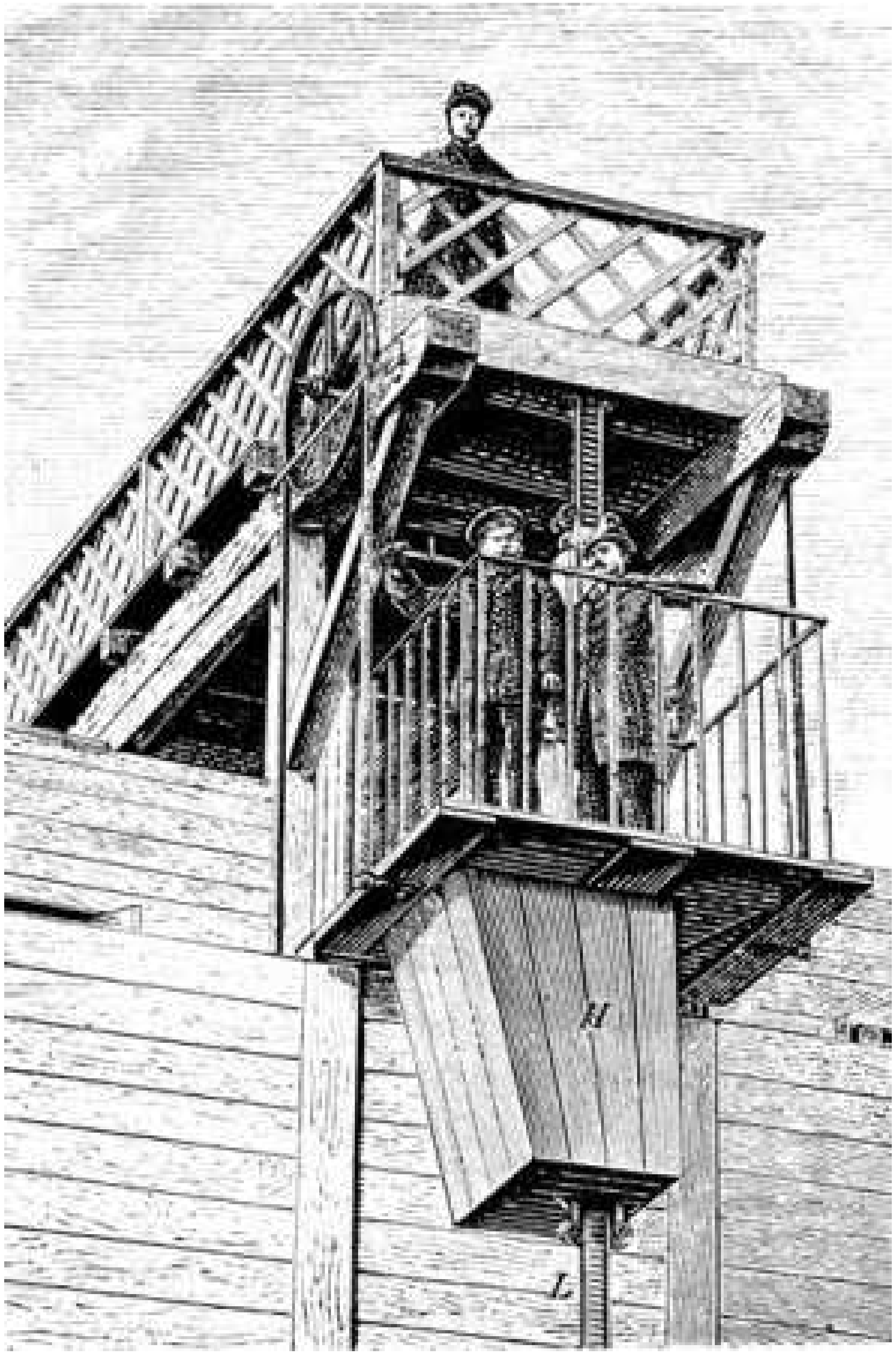
Left: Werner von Siemens



"…In both of these cases the operational demands on the motor were of course identical to those on the prime movers which they replaced; no reversal of direction was necessary, the speed was constant, and the load was nearly constant. Furthermore, the load could be applied to the motor gradually through automatic relief valves on the pump and in the mechanical machines by slippage as the belt was shifted from the loose to the fast pulleys. The ultimate simplicity in control resulted from permitting the motor to run continuously, drawing current only in proportion to its loading. The direct-current motor of the 1880's was easily capable of such service, and it was widely used in this way…"

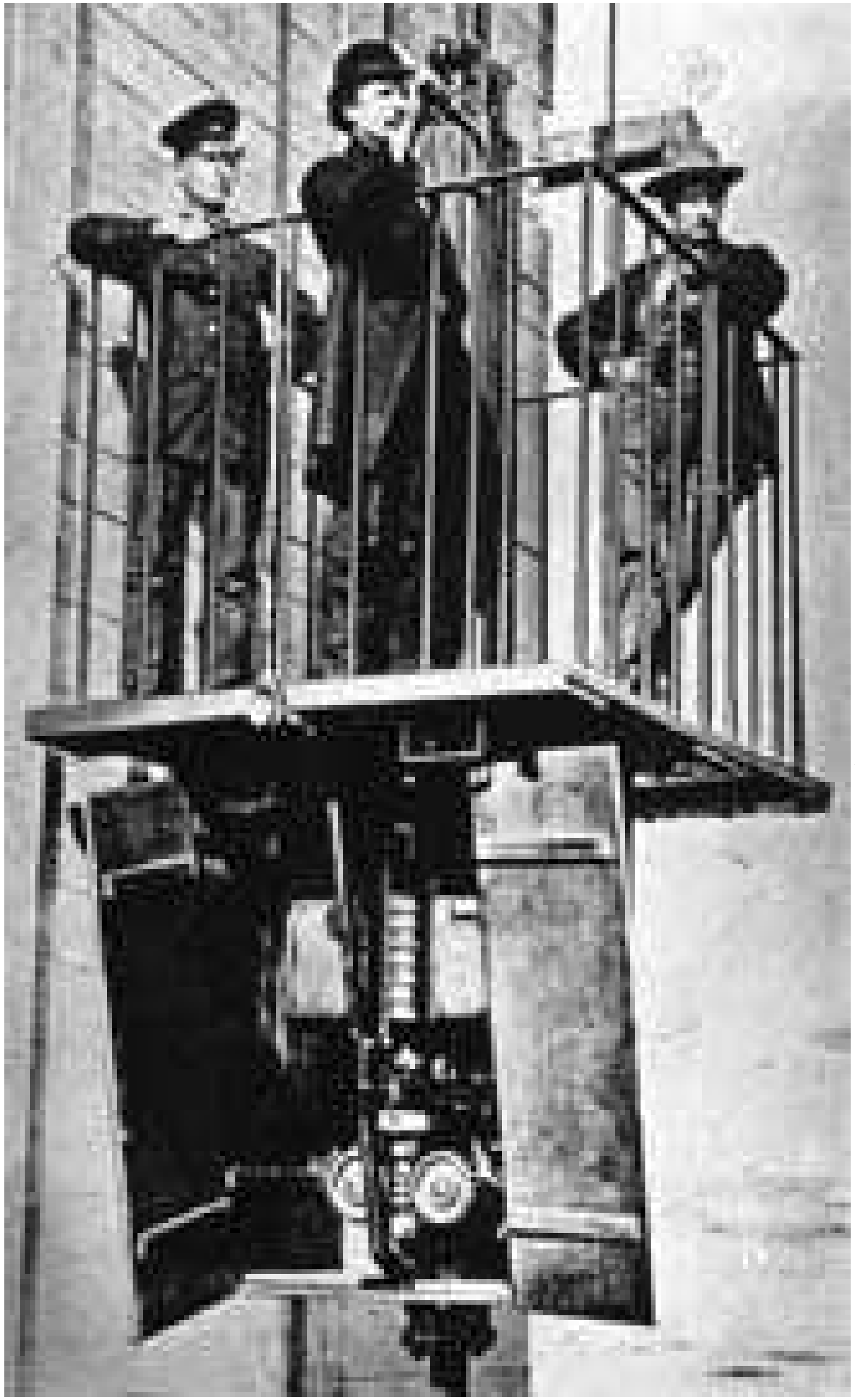
RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

Left: caption: "Motor and drive mechanism of Siemens' elevator"



"I've just heard that the electric elevator is running well! It's a big draw for the exhibition!"
Werner von Siemens
RE: excerpt from a letter to his brother Carl. In April 1880, the organizers of the *Mannheim Pfalzgau Trade & Agricultural Exhibition* asked whether Siemens could build an "electric elevator" for their exhibition. Werner von Siemens accepted the commission and work commenced shortly afterwards. However, it took longer than planned thus the exhibition opened in July 1880 without its main attraction. It wasn't until the end of August 1880 that the elevator was in operation. There was enormous interest in the elevator; from September to mid-November 1880, over eight-thousand people tried out the new means of vertical transportation, while at the same time enjoyed the view of Mannheim. As a result, there were numerous enquiries about elevators of this kind (many hotels wanted to provide their guests with the convenience of this new technology).
<u>Left</u>: caption: "Siemens' electric rack-climbing elevator of 1880"


DER ERSTE ELEKTRISCHE AUFZUG DER WELT
• ERBAUT VON WERNER VON SIEMENS •
AUSGESTELLT AUF DER PFALZGAUAUSSTELLUNG
ZU MANNHEIM • IM JAHRE 1880



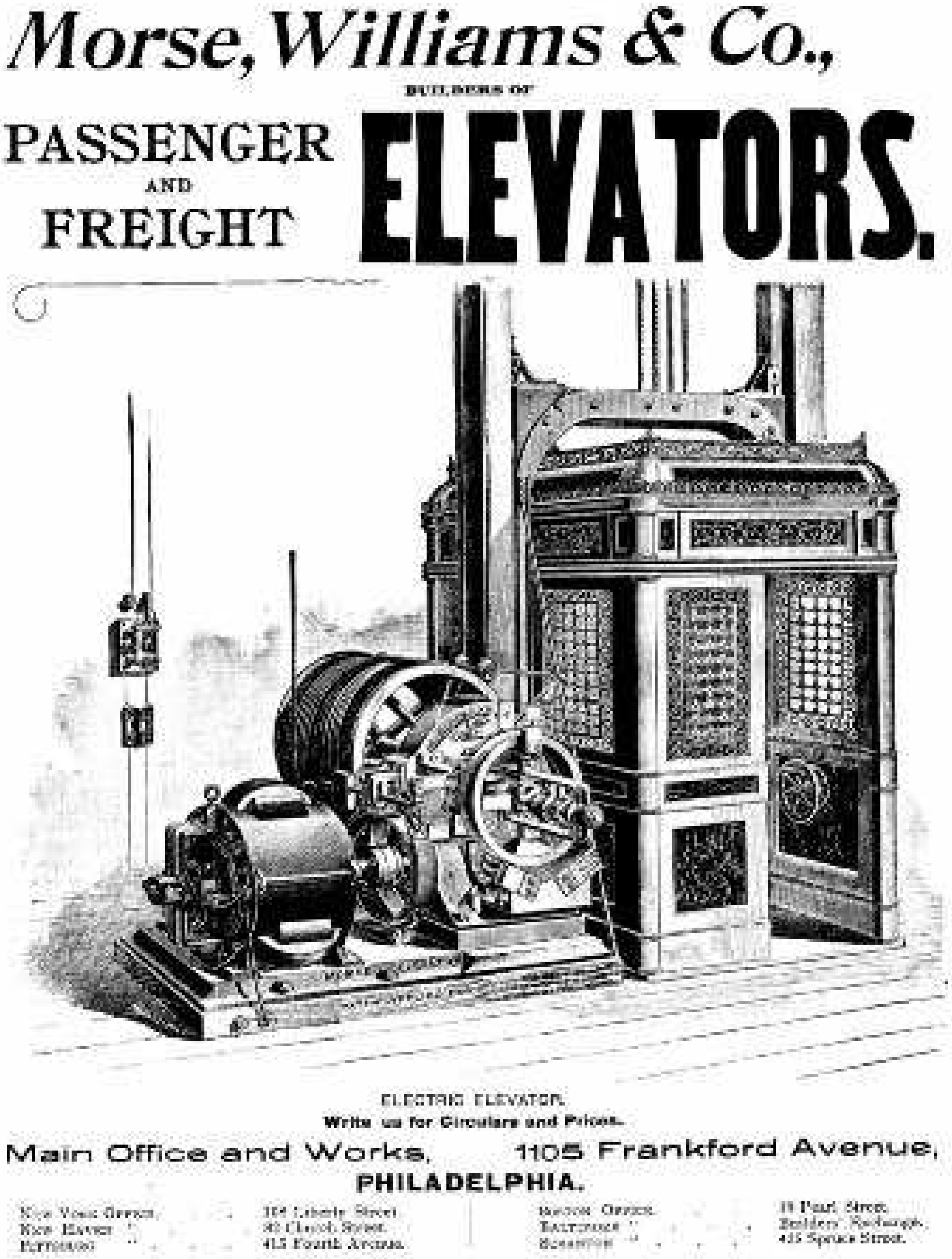
"…Adaptation of the motor to the direct drive of an elevator machine was quite another matter, the difficulties being largely those of control. At this time the only practical means of starting a motor under load was by introducing resistance into the circuit and cutting it out in a series of steps as the speed picked up; precisely the method used to start traction motors. In the early attempts to couple the motor directly to the winding drum through worm gearing, this 'notching up' was transmitted to the car as a jerking motion, disagreeable to passengers and hard on machinery. Furthermore, the controller contacts had a short life because of the arcing which resulted from heavy starting currents. In all, such systems were unsatisfactory and generally unreliable, and were held in disfavor by both elevator experts and owners…"

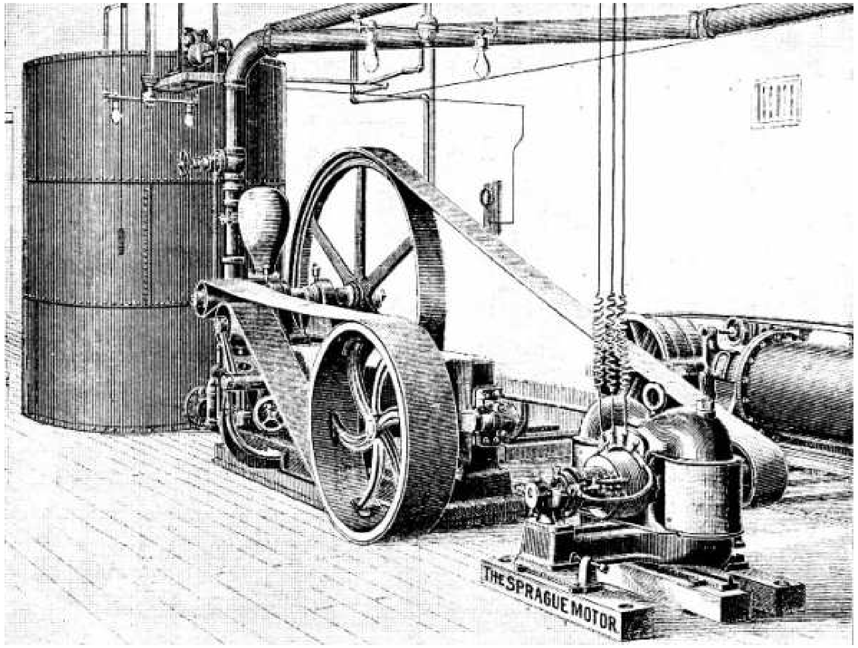
RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

Left: caption: "First electric elevator at the Industrial Exposition at Mannheim"

"…There was, moreover, little inducement to overcome the problem of control and other minor problems because of a more serious difficulty which had persisted since the days of steam. This was the matter of the drum and its attendant limitations. The motor's action being rotatory, the winding drum was the only practical way in which to apply its motive power to hoisting. This single fact shut electricity almost completely out of any large-scale elevator business until after the turn of the century. True, there was a certain amount of development, after about 1887, of the electric worm-drive drum machine for slow-speed, low-rise service. But the first installation of this type that was considered practically successful - in that it was in continuous use for a long period - was not made until 1889, the year in which the Eiffel Tower was completed…"

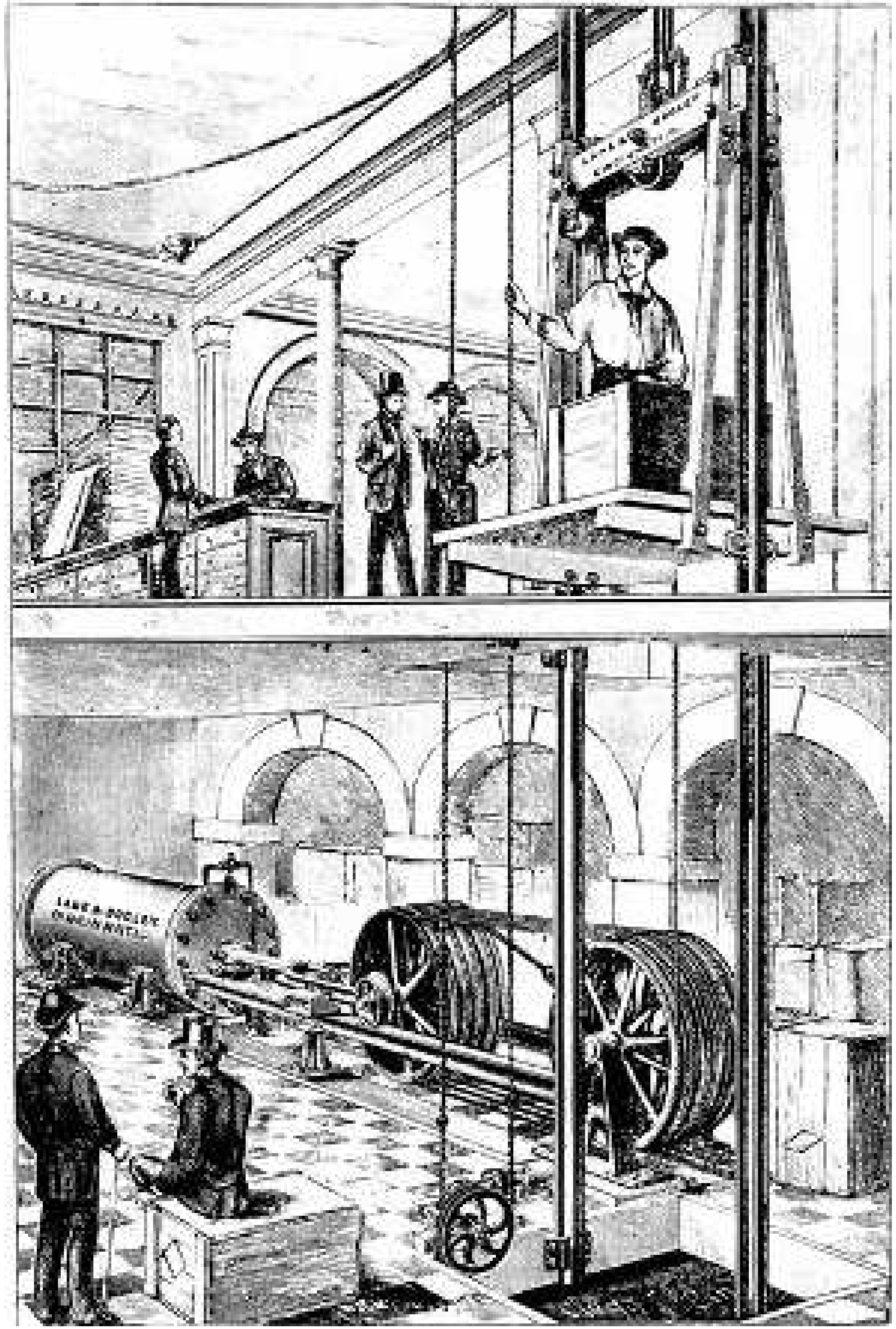
RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*





Above: caption: "The first widespread use of electricity in the elevator field was to drive belt-type mechanical machines and the pumps of hydraulic systems, as shown"

Left: caption: "The electric elevator in its earliest commercial form (1891), with the motor connected directly to the load. By this time, incandescent lighting circuits in large cities were sufficiently extensive to make such installations practical. However, capacity and lift were severely limited by weaknesses of the control system and the necessity of using a drum."

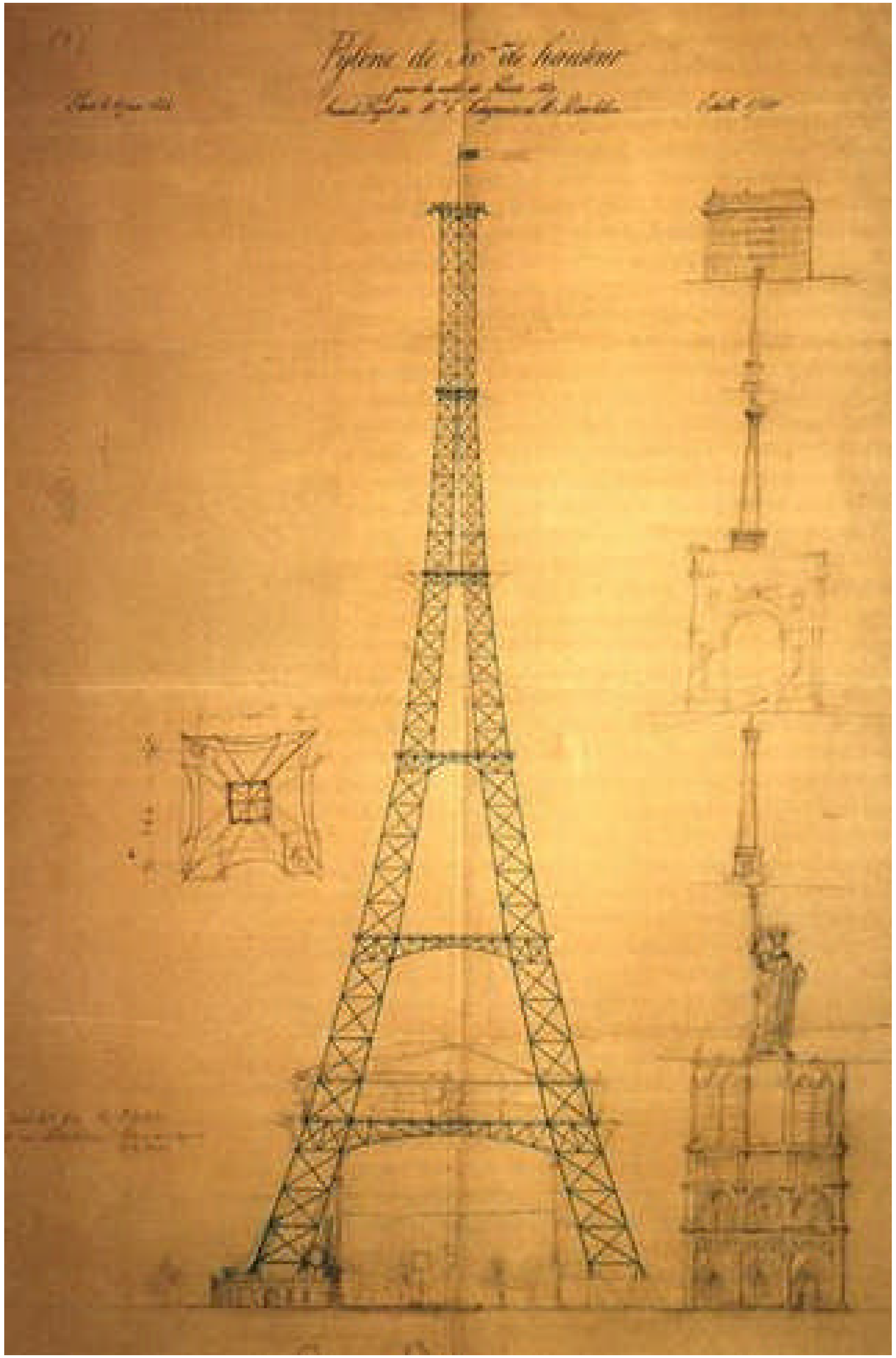


"…Pertinent is the one nearly successful attempt which was made to approach the high-rise problem electrically. In 1888, Charles R. Pratt, an elevator engineer of Montclair, New Jersey, invented a machine based on the horizontal cylinder rope-geared hydraulic elevator, in which the two sets of sheaves were drawn apart by a screw and traveling nut. The screw was revolved directly by a Sprague motor, the system being known as the Sprague-Pratt. While a number of installations were made, the machine was subject to several serious mechanical faults and passed out of use around 1900. Generally, electricity as a practical workable power for elevators seemed to hold little promise in 1888…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

Left: caption: "Rope-geared hydraulic freight elevator using a horizontal cylinder (ca. 1883)"

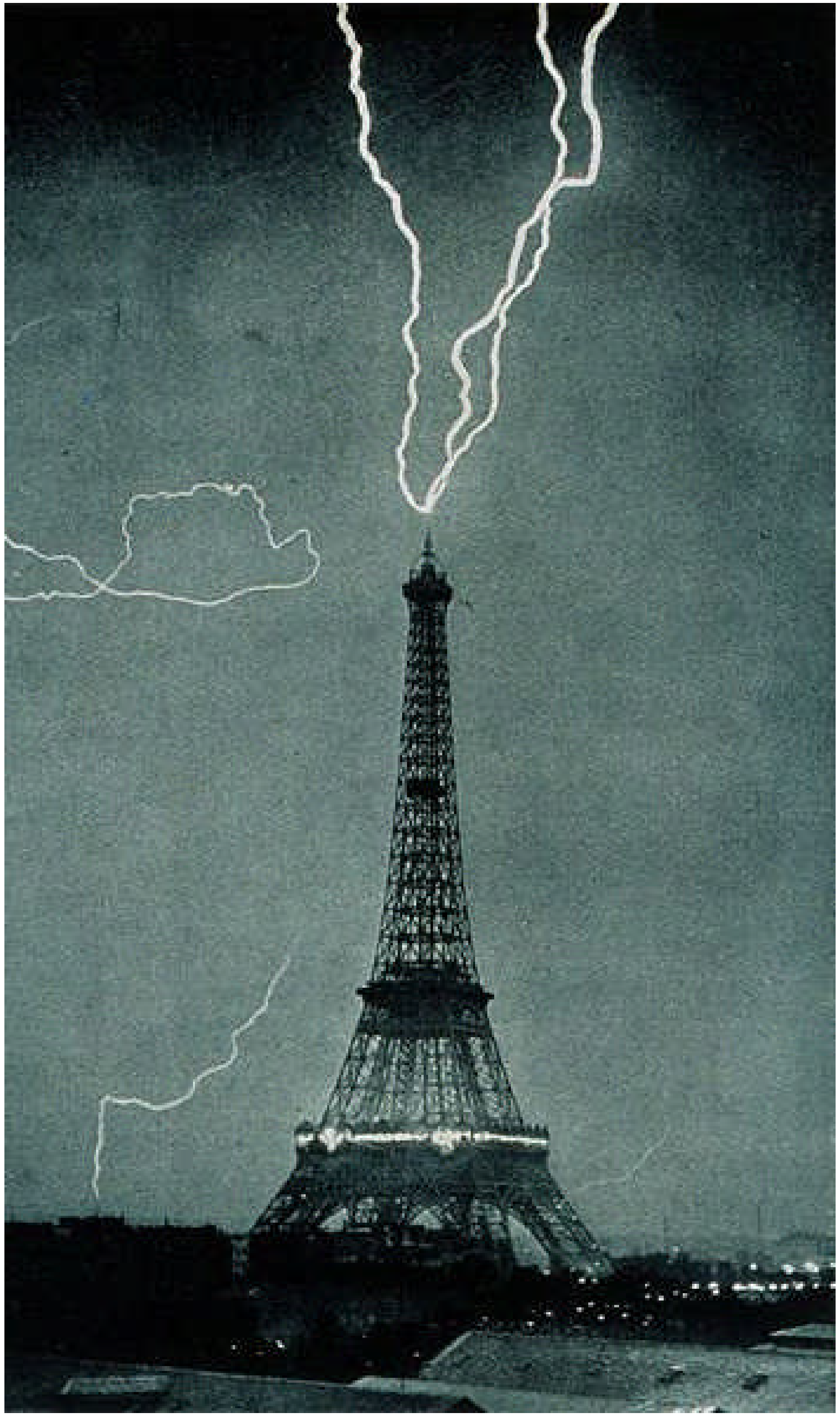
Raison d’etre



"…A great part of the Eiffel Tower's worth and its 'raison d'etre' lay in the overwhelming visual power by which it was to symbolize to a world audience the scientific, artistic, and, above all, the technical achievements of the French Republic. Another consideration, in Eiffel's opinion, was its great potential value as a scientific observatory. At its summit grand experiments and observations would be possible in such fields as meteorology and astronomy. In this respect it was welcomed as a tremendous improvement over the balloon and steam winch that had been featured in this service at the 1878 Paris exposition. Experiments were also to be conducted on the electrical illumination of cities from great heights. The great strategic value of the Tower as an observation post also was recognized. But from the beginning, sight was never lost of the structure's great value as an unprecedented public attraction, and its systematic exploitation in this manner played a part in its planning, second perhaps only to the basic design…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

Left: drawing by *Koechlin* and *Nougier* emphasizing the tower's great height



"…The conveyance of multitudes of visitors to the Tower's first or main platform and a somewhat lesser number to the summit was a technical problem whose seriousness Eiffel must certainly have been aware of at the project's onset. While a few visitors could be expected to walk to the first or possibly second stage, 377-feet above the ground, the main means of transport obviously had to be elevators. Indeed, the two aspects of the Tower with which the Exposition commissioners were most deeply concerned were the adequate grounding of lightning and the provision of a reliable system of elevators, which they insisted be unconditionally safe…"

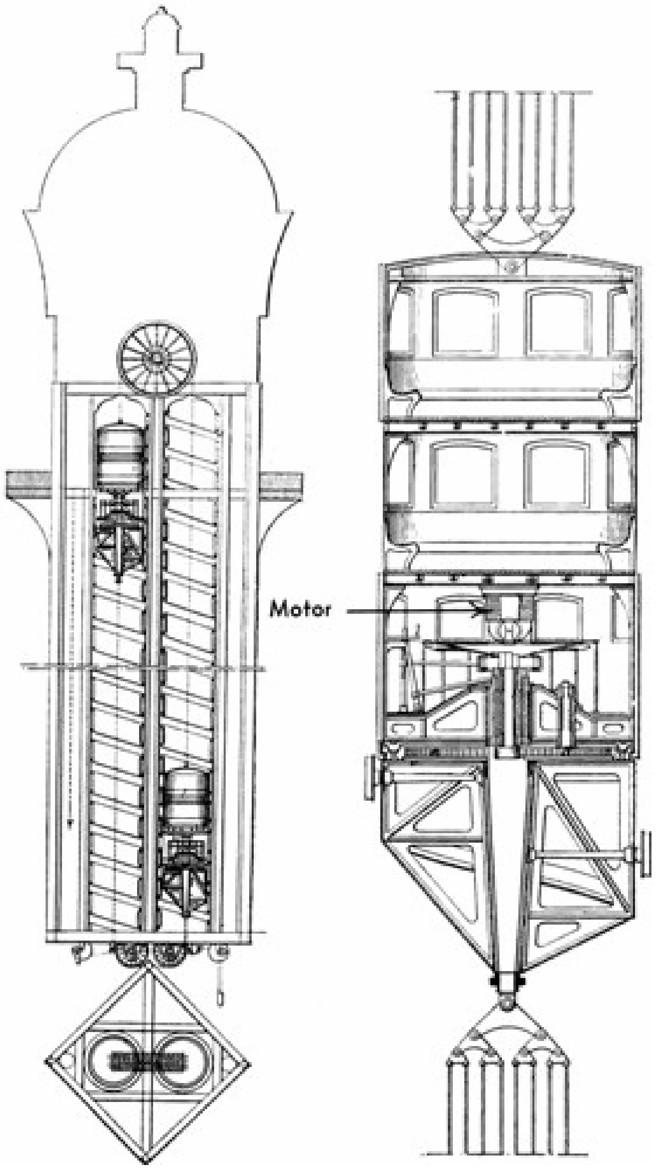
RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

Left: on average, the Eiffel Tower is struck by lightning 100x each year

All Screwed Up

"…To study the elevator problem, Eiffel retained a man named Backmann who was considered an expert on the subject. Apparently Backmann originally was to design the complete system, but he was to prove inadequate to the task. As his few schemes are studied it becomes increasingly difficult to imagine by what qualifications he was regarded as either an elevator expert or designer by Eiffel and the Commission. His proposals appear, with one exception, to have been decidedly retrogressive, and, further, to incorporate the most undesirable features of those earlier systems he chose to borrow from. Nothing has been discovered regarding his work, if any, on elevators for the lower section of the Tower. Realizing the difficulty of this aspect of the problem, he may not have attempted its solution, and confined his work to the upper half where the structure permitted a straight, vertical run…"

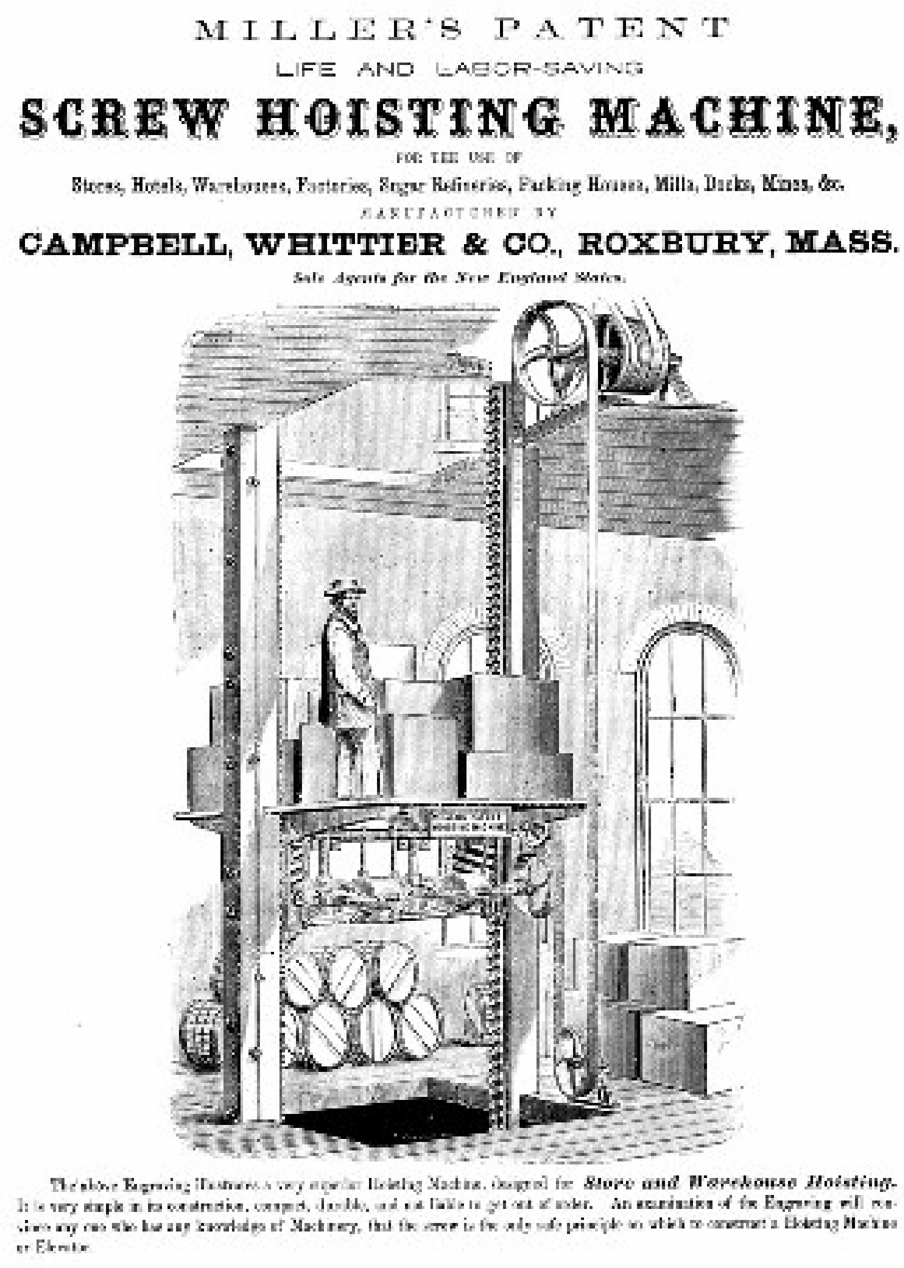
RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*



"…The Backmann design for the upper elevators was based upon a principle which had been attractive to many inventors in the mid-19th century period of elevator development - that of 'screwing the car up' by means of a threaded element and a nut, either of which might be rotated and the other remain stationary. The analogy to a nut and bolt made the scheme an obvious one at that early time, but its inherent complexity soon became equally evident and it never achieved practical success. Backmann projected two cylindrical cars that traveled in parallel shafts and balanced one another from opposite ends of common cables that passed over a sheave in the upperworks. Around the inside of each shaft extended a spiral track upon which ran rollers attached to revolving frames underneath the cars. When the frames were made to revolve, the rollers, running around the track, would raise or lower one car, the other traveling in the opposite direction…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

Left: caption: "Backmann's proposed helicoidal elevator for the upper section of the Eiffel Tower. The cars were to be self-powered by electric motors."



"…In the plan as first presented, a ground-based steam engine drove the frames and rollers through an endless fly rope - traveling at high speed presumably to permit it to be of small diameter and still transmit a reasonable amount of power - which engaged pulleys on the cars. The design was remarkably similar to that of the Miller Patent Screw Hoisting Machine, which had had a brief life in the United States around 1865. The Miller system used a flat belt rather than a rope. This plan was quickly rejected, probably because of anticipated difficulties with the rope transmission…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

Left: caption: "Advertisement for the Miller screw-hoisting machine, about 1867"

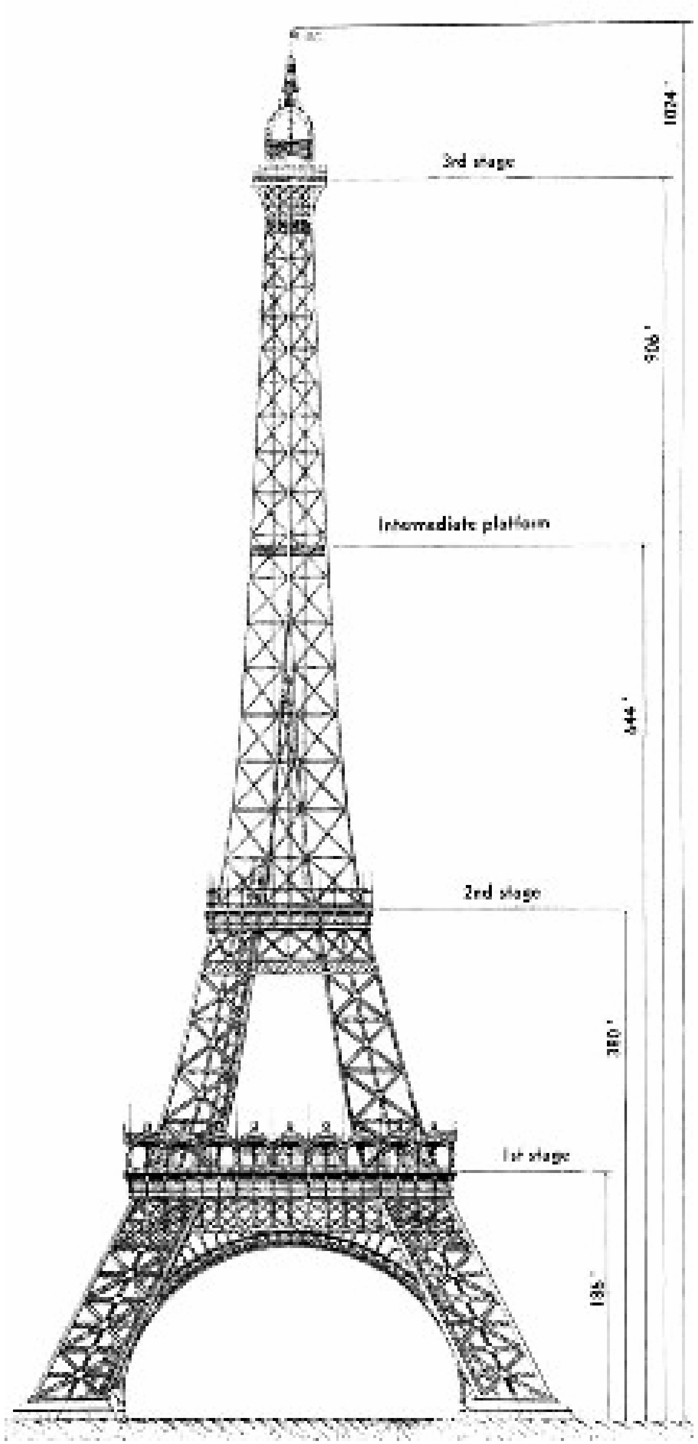
"…Backmann's second proposal, actually approved by the Commission, incorporated the only - although highly significant - innovation evident in his designs. For the rope transmission, electric motors were substituted, one in each car to drive the roller frame directly. With this modification, the plan does not seem quite as unreasonable, and would probably have worked. However, it would certainly have lacked the necessary durability and would have been extremely expensive. The Commission discarded the whole scheme about the middle of 1888, giving two reasons for its action: (1) the novelty of the system and the attendant possibility of stoppages which might seriously interrupt the 'exploitation of the Tower,' and (2) fear that the rollers running around the tracks would cause excessive noise and vibration. Both reasons seem quite incredible when the Backmann system is compared to one of those actually used - the Roux, which obviously must have been subject to identical failings, and on a far greater scale. More likely there existed an unspoken distrust of electric propulsion. That the Backmann system should have been given serious consideration at all reflects the uncertainty surrounding the entire matter of providing elevator service of such unusual nature. Had the Eiffel Tower been erected only 15 years later, the situation would have been simply one of selection. As it was, Eiffel and the commissioners were governed not by what they wanted but largely by what was available…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

North, South, East & West

"…The curvature of the Tower's legs imposed a problem unique in elevator design, and it caused great annoyance to Eiffel, the fair's Commission, and all others concerned. Since a vertical shaftway anywhere within the open area beneath the first platform was esthetically unthinkable, the elevators could be placed only in the inclined legs. The problem of reaching the first platform was not serious. The legs were wide enough and their curvature so slight in this lower portion as to permit them to contain a straight run of track, and the service could have been designed along the lines of an ordinary inclined railway. It was estimated that the great majority of visitors would go only to this level, attracted by the several international restaurants, bars and other features located there. Two elevators to operate only that far were contracted for with no difficulty - one to be placed in the east leg and one in the west…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*



"…To transport people to the second platform was an altogether different problem. Since there was to be a single run from the ground, it would have been necessary to form the elevator guides either with a constant curvature, approximating that of the legs, or with a series of straight chords connected by short segmental curves of small radius. Eiffel planned initially to use the first method, but the second was adopted ultimately, probably as being the simpler because only two straight lengths of run were found to be necessary…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

<u>Left</u>: caption: "Various levels of the Eiffel Tower"

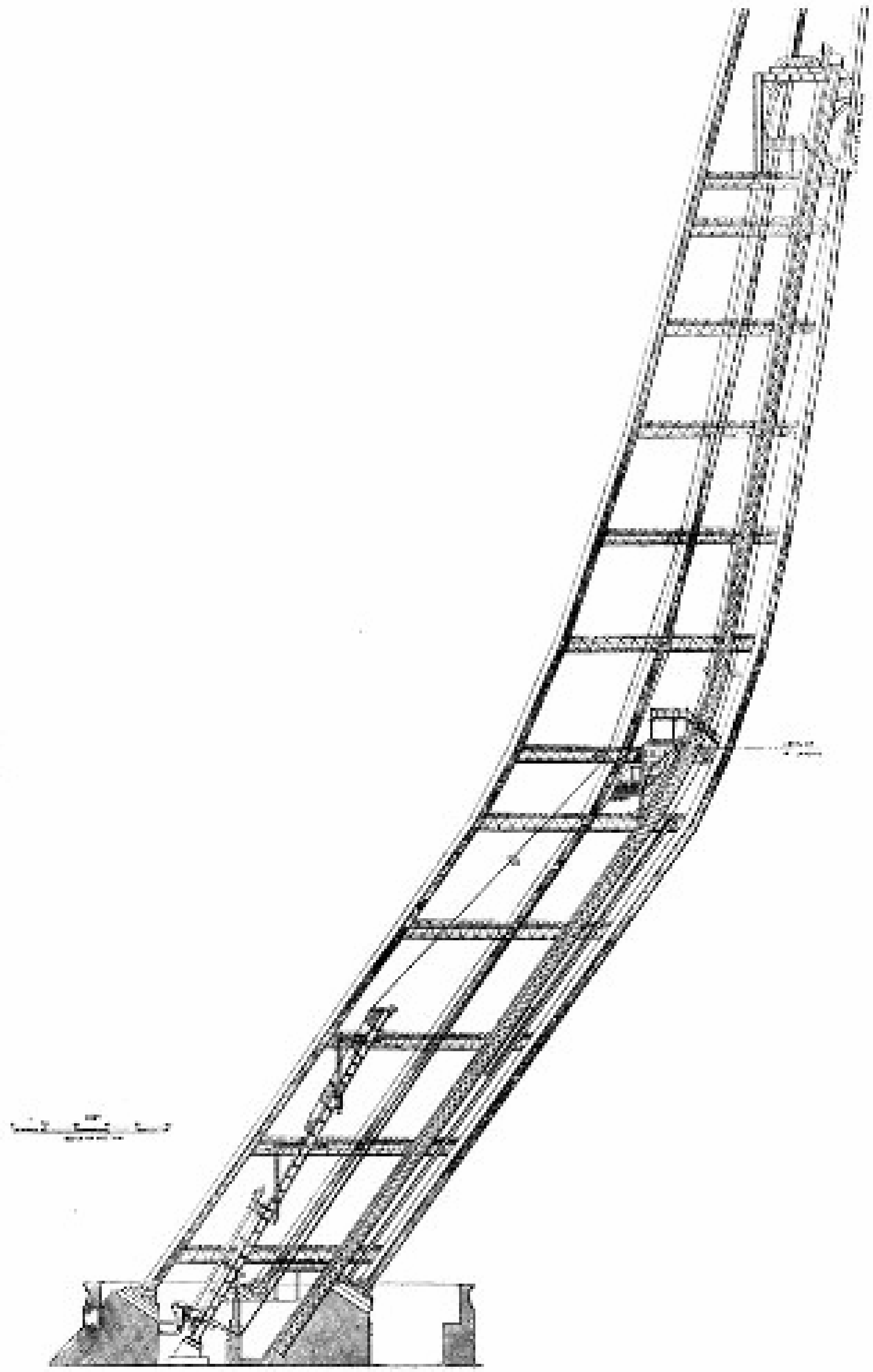
Otis Ascenseur Cie

"…Bids were invited for two elevators on this basis - one each for the north and south legs. Here the unprecedented character of the matter became evident - there was not a firm in France willing to undertake the work. The American Elevator Company, the European branch of Otis Brothers & Company, did submit a proposal through its Paris office, Otis Ascenseur Cie, but the Commission was compelled to reject it because a clause in the fair's charter prohibited the use of any foreign material in the construction of the Tower. Furthermore, there was a strong prejudice against foreign contractors, which, because of the general background of disfavor surrounding the project during its early stages, was an element worth serious consideration by the Commission. The bidding time was extended, and many attempts were made to attract a native design but none was forthcoming…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

"…As time grew short, it became imperative to resolve the matter, and the Commission, in desperation, awarded the contract to Otis in July 1887 for the amount of $22,500. A curious footnote to the affair appeared much later in the form of a published interview with W. Frank Hall, Otis' Paris representative: 'Yes,' said Mr. Hall, 'this is the first elevator of its kind. Our people for thirty-eight years have been doing this work, and have constructed thousands of elevators vertically, and many on an incline, but never one to strike a radius of 160 feet for a distance of over 50 feet. It has required a great amount of preparatory study and we have worked on it for three years.' 'That was before you got the contract?' 'Quite so, but we knew that, although the French authorities were very reluctant to give away this piece of work, they would be bound to come to us, and so we were preparing for them.' Such supreme confidence must have rapidly evaporated as events progressed. Despite the invaluable advertising to be derived from an installation of such distinction, Otis would probably have defaulted had they foreseen the difficulties which preceded completion of the work…"

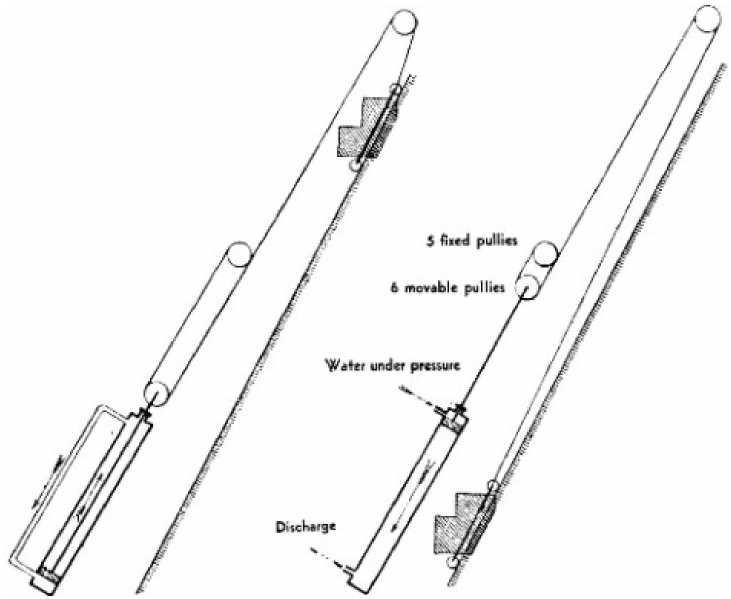
RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

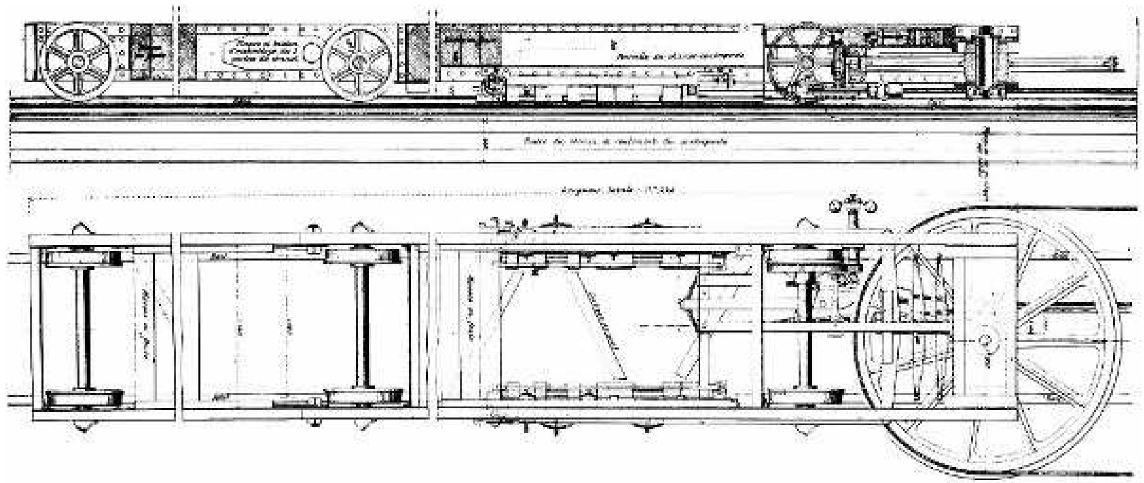


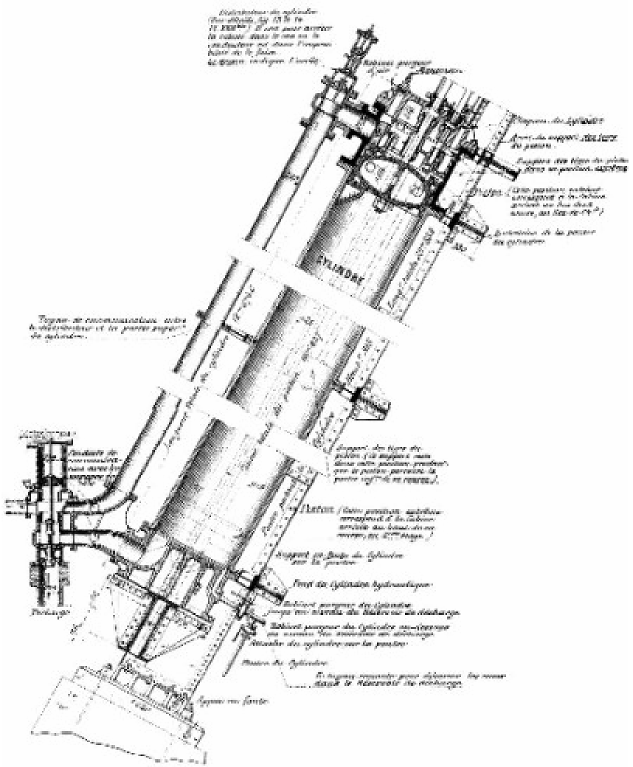
"…The proposed system was based fundamentally upon Otis' standard hydraulic elevator, but it was recognizable only in basic operating principle. Tracks of regular rail section replaced the guides because of the incline, and the double-decked cabin ran on small flanged wheels. This much of the apparatus was really not unlike that of an ordinary inclined railway. Motive power was provided by the customary hydraulic cylinder, set on an angle roughly equal to the incline of the lower section of run. Balancing the cabin's dead weight was a counterpoise carriage loaded with pig iron that traveled on a second set of rails beneath the main track. Like the driving system, the counterweight was rope-geared, 3 to 1, so that its travel was about 125 feet to the cabin's 377 feet…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

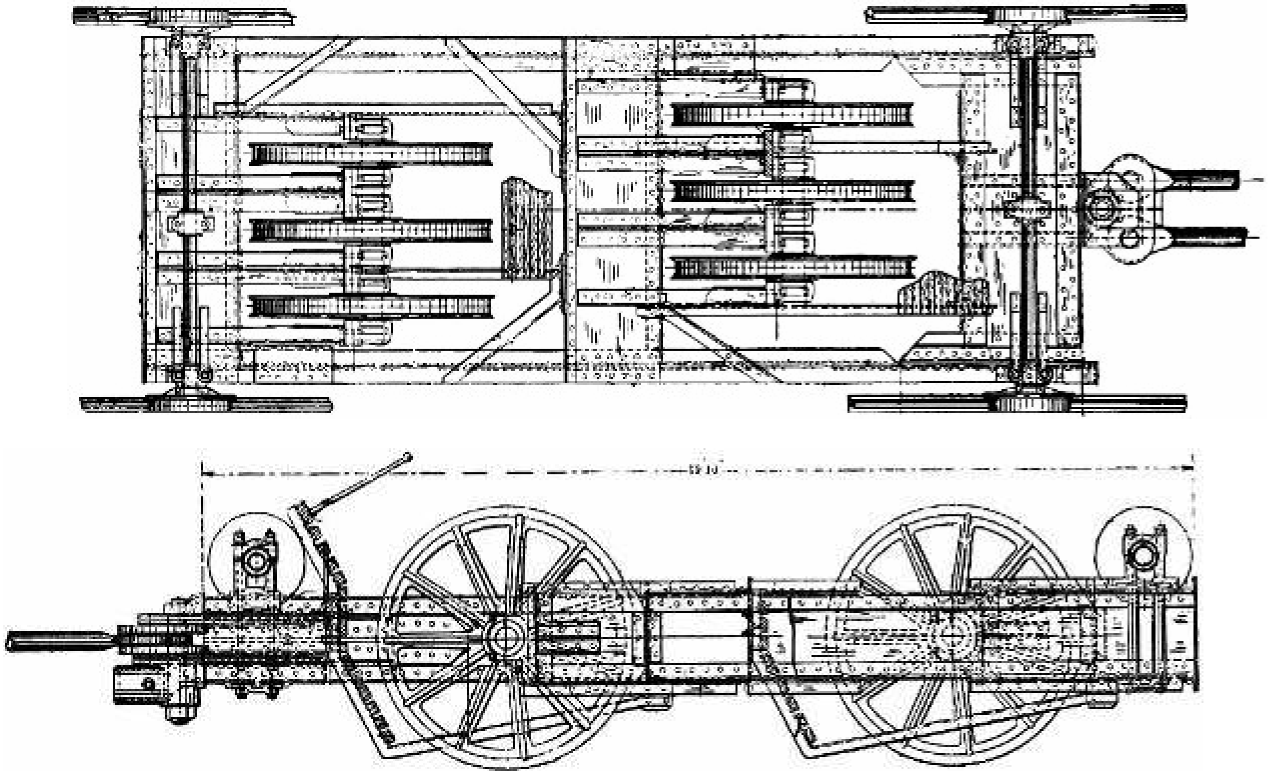
Left: caption: "General arrangement ofOtis elevator system in Eiffel Tower"







<u>Above</u>: caption: "Details of the counterweight carriage in the Otis system"
<u>Upper Left</u>: caption: "Schematic diagram of the rigging of the Otis system"
<u>Lower Left</u>: caption: "Section through the Otis power cylinder"



"…Everything about the system was on a scale far heavier than found in the normal elevator of the type. The cylinder, of 38-inch bore, was 36-feet long. Rather than a simple nest of pulleys, the piston rods pulled a large guided carriage or 'chariot' bearing six movable sheaves. Corresponding were five stationary sheaves, the whole reeved to form an immense 12-purchase tackle. The car, attached to the free ends of the cables, was hauled up as the piston drew the two sheave assemblies apart…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

Above: caption: "Plan and section of the Otis system's movable pulley assembly, or chariot. Piston rods are at left"

"…In examining the system, it is difficult to determine what single element in its design might have caused such a problem as to have been beyond the engineering ability of a French firm, and to have caused such concern to a large, well-established American organization of Otis' wide elevator and inclined railway experience. Indeed, when the French system - which served the first platform from the east and west legs - is examined, it appears curious that a national technology capable of producing a machine at such a level of complexity should have been unable to deal easily with the entire matter. This can be plausibly explained only on the basis of Europe's previously mentioned lack of experience with rope-geared and other cable-hung elevator systems. The difficulty attending Otis' work, usually true in the case of all innovations, lay unquestionably in the multitudes of details - many of them, of course, invisible when only the successfully working end product is observed…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

"…More than a matter of detail was the Commission's demand for perfect safety, which precipitated a situation typical of many confronting Otis during the entire work. Otis had wished to coordinate the entire design process through Mr. Hall, with technical matters handled by mail. Nevertheless, at Eiffel's insistence, and with some inconvenience, in 1888 the company dispatched the project's engineer, Thomas E. Brown, Jr., to Paris for a direct consultation. Mild conflict over minor details ensued, but a gross difference of opinion arose ultimately between the American and French engineers over the safety of the system. The disagreement threatened to halt the entire project. In common with all elevators in which the car hangs by cables, the prime consideration here was a means of arresting the cabin should the cables fail…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

“…As originally presented to Eiffel, the plans indicated an elaborate modification of the standard Otis safety device - itself a direct derivative of E.G. Otis’ original. If any one of the six hoisting cables broke or stretched unduly, or if their tension slackened for any reason, powerful leaf springs were released causing brake shoes to grip the rails. The essential feature of the design was the car’s arrest by friction between its grippers and the rails so that the stopping action was gradual, not sudden as in the elevator safety. During proof trials of the safety, made prior to the fair’s opening by cutting away a set of temporary hoisting cables, the cabin would fall about 10-feet before being halted…”

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

"…Although highly efficient and of unquestionable security, this safety device was considered an insufficient safeguard by Eiffel, who, speaking in the name of the Commission, demanded the application of a device known as the rack and pinion safety that was used to some extent on European cog railways. The commissioners not only considered this system more reliable but felt that one of its features was a necessity: a device that permitted the car to be lowered by hand, even after failure of all the hoisting cables. The serious shortcomings of the rack and pinion were its great noisiness and the limitation it imposed on hoisting speed. Both disadvantages were due to the constant engagement of a pinion on the car with a continuous rack set between the rails. The meeting ended in an impasse, with Brown unwilling to approve the objectionable apparatus and able only to return to New York and lay the matter before his company. While Eiffel's attitude in the matter may appear highly unreasonable, it must be said that during a subsequent meeting between Brown and Koechlin, the French engineer implied that a mutual antagonism had arisen between the Tower's creator and the Commission. Thus, since his own judgment must have had little influence with the commissioners at that time, Eiffel was compelled to specify what he well knew were excessive safety provisions…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

"…This decision placed Otis Brothers in a decidedly uncomfortable position, at the mercy of the Commission. W.E. Hale, promoter of the water balance elevator - who by then had a strong voice in Otis' affairs - expressed the seriousness of the matter in a letter to the company's president, Charles R. Otis, following receipt of Brown's report on the Paris conference. Referring to the controversial cogwheel, Hale wrote: '...if this must be arranged so that the car is affected in its operation by constant contact with the rack and pinion...so as to communicate the noise and jar, and unpleasant motion which such an arrangement always produces, I should favor giving up the whole matter rather than allying ourselves with any such abortion...we would be the laughing stock of the world, for putting up such a contrivance.' This difficult situation apparently was the product of a somewhat general contract phrased in terms of service to be provided rather than of specific equipment to be used. This is not unusual, but it did leave open to later dispute such ambiguous clauses as 'adequate safety devices are to be provided.'…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

“…Although faced with the loss not only of all previously expended design work but also of an advertisement of inter-national consequence, the company apparently concurred with Hale and so advised Paris. Unfortunately, there are no Otis records to reveal the subsequent transactions, but we may assume that Otis’ threat of withdrawal prevailed, coupled as it was with Eiffel’s confidence in the American equipment. The system went into operation as originally designed, free of the odious rack and pinion…”

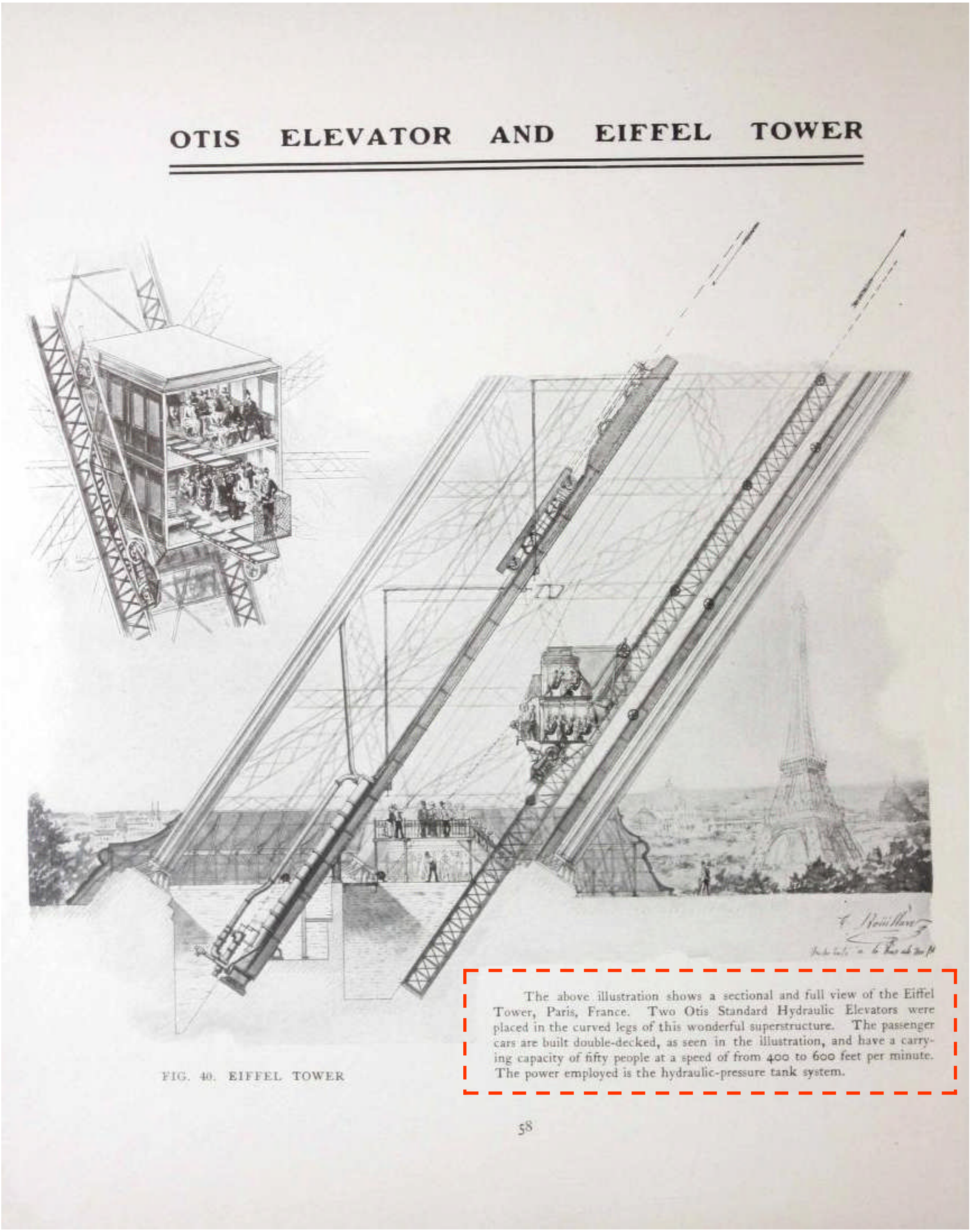
RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

"…That, unfortunately, was not the final disagreement. Before the fair's opening in May 1889, the relationship was strained so drastically that a mutually satisfactory conclusion to the project must indeed have seemed hopeless. The numerous minor structural modifications of the Tower legs found necessary as construction progressed had necessitated certain equivalent alteration to the Otis design insofar as its dependency upon the framework was affected. Consequently, work on the machinery was set back by some months. Eiffel was informed that although everything was guaranteed to be in full operation by opening day on May 1, the contractual deadline of January 1 could not possibly be met. Eiffel, now unquestionably acting on his own volition, responded by cable, refusing all payment. Charles Otis' reply, a classic of indignation, disclosed to Eiffel the jeopardy in which his impetuosity had placed the success of the entire project: 'After all else we have borne and suffered and achieved in your behalf, we regard this as a trifle too much; and we do not hesitate to declare, in the strongest terms possible to the English language, that we will not put up with it...and, if there is to be War, under the existing circumstances, propose that at least part of it shall be fought on American ground. If Mr. Eiffel shall, on the contrary, treat us as we believe we are entitled to be treated, under the circumstances, and his confidence in our integrity to serve him well shall be restored in season to admit of the completion of this work at the time wanted, well and good; but it must be done at once...otherwise we shall ship no more work from this side, and Mr. Eiffel must charge to himself the consequences of his own acts.'…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

"…This message apparently had the desired effect and the matter was somehow resolved, as the machinery was in full operation when the Exposition opened. The installation must have had immense promotional value for Otis Brothers, particularly in its contrast to the somewhat anomalous French system. This contrast evidently was visible to the technically unsophisticated as well as to visiting engineers. Several newspapers reported that the Otis elevators were one of the best American exhibits at the fair. In spite of their large overall scale and the complication of the basic pattern imposed by the unique situation, the Otis elevators performed well and justified the original judgment and confidence which had prompted Eiffel to fight for their installation. Aside from the obvious advantage of simplicity when compared to the French machines, their operation was relatively quiet, and fast…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*



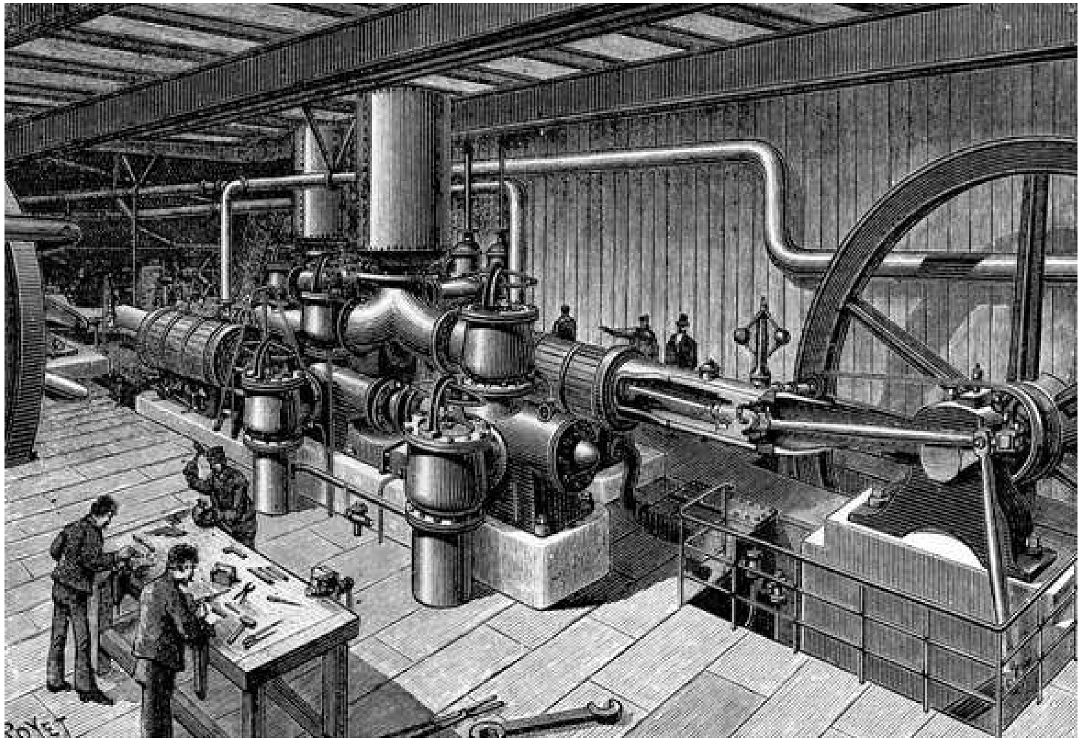
OTIS ELEVATOR AND EIFFEL TOWER

The above illustration shows a sectional and full view of the Eiffel Tower, Paris, France. Two Otis Standard Hydraulic Elevators were placed in the curved legs of this wonderful superstructure. The passenger cars are built double-decked, as seen in the illustration, and have a carrying capacity of fifty people at a speed of from 400 to 600 feet per minute. The power employed is the hydraulic-pressure tank system.

FIG. 40. EIFFEL TOWER

58

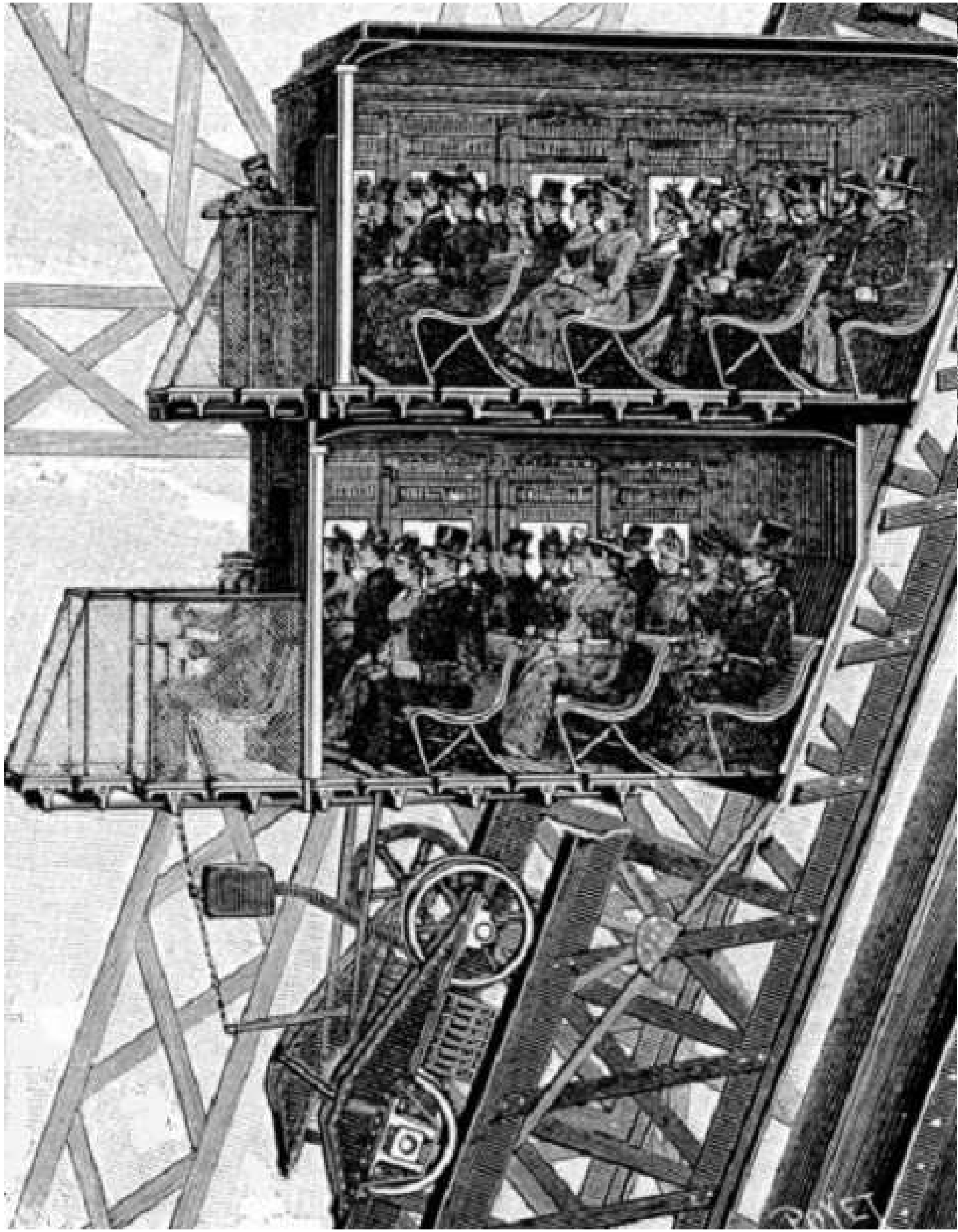
<u>Left</u>: caption: "The above illustration shows a sectional and full view of the Eiffel Tower, Paris, France. Two Otis Standard Hydraulic Elevators were placed in the curved legs of this wonderful superstructure. The passenger cars are built double-decked, as seen in the illustration, and have a carrying capacity of fifty people at a speed of from 400 to 600-feet per minute. The power employed is the hydraulic-pressure tank system." (excerpt from an *Otis Elevator Company* brochure, ca. 1905)

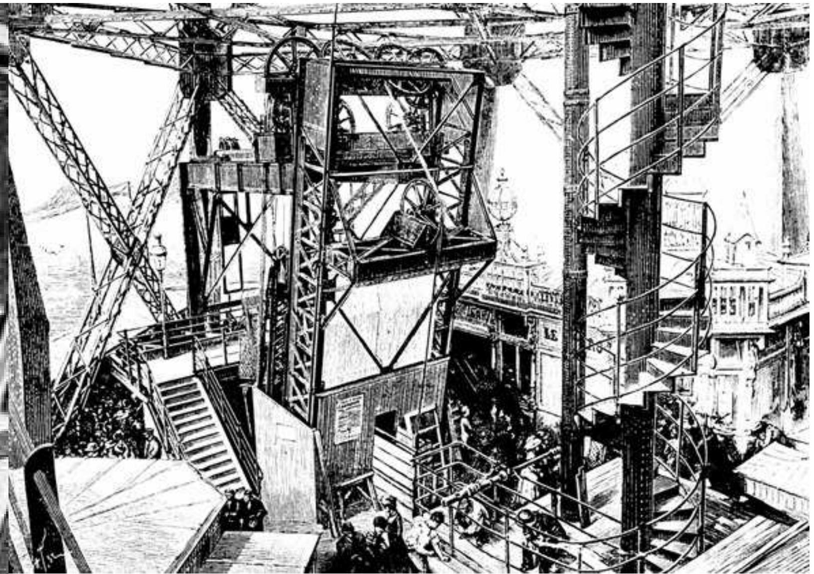


"…The double car, traveling at 400-feet per minute, carried forty persons, all seated because of the change of inclination. The main valve or distributor that controlled the flow of water to and from the driving cylinder was operated from the car by cables. The hydraulic head necessary to produce pressure within the cylinder was obtained from a large open reservoir on the second platform. After being exhausted from the cylinder, the water was pumped back up by two Girard pumps in the engine room at the base of the Tower's south leg…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

Above: caption: "The French Girard pumps that supplied the Otis and Roux systems"





Above: caption: "Upperworks and passenger platforms of the Otis system at second level"
Left: caption: "Section through cabin of the Otis elevator. Note the pivoted floor-sections. As the car traveled, these floor-sections were leveled by the operator to compensate for the change of inclination; however, they were soon removed because they interfered with the loading and unloading of passengers."

The Otis System

Negative effect

Weight of cabin: 23,900 lb. × sin 78°9′ (incline of upper run)	23,390 lb.		
Live load: 40 persons @150 lb. = 6,000 × sin 78°9′	5,872		
	———	— 29,262 lb.	

Positive effect

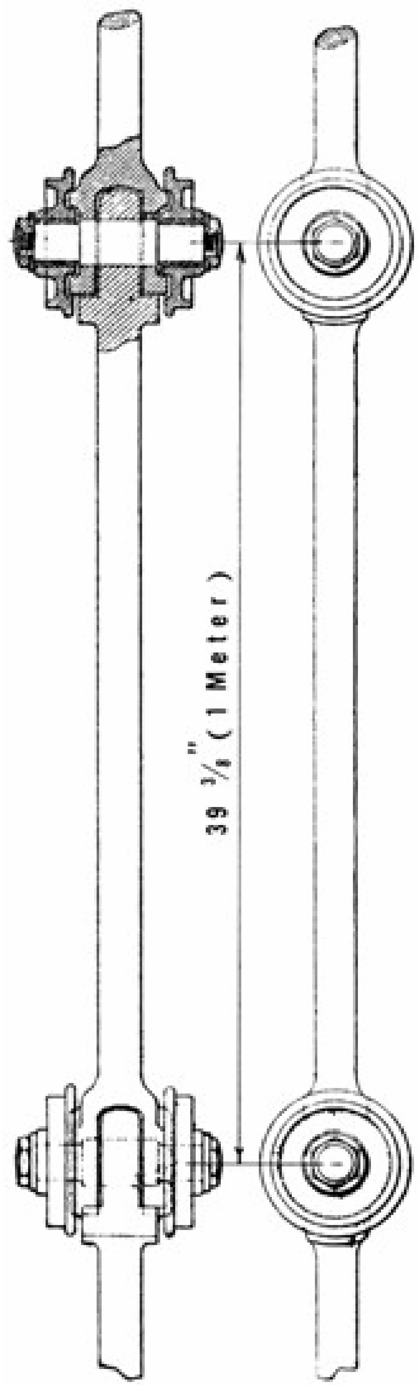
Counterweight: $\dfrac{55{,}000 \times \sin 54°35′ \text{ (incline of lower run)}}{3 \text{ (rope gear ratio)}}$	14,940 lb.	
Weight of piston and chariot: $\dfrac{33{,}060 \times \sin 54°35′}{12 \text{ (ratio)}}$	2,245	
Power: $\dfrac{156 \text{ p.s.i.} \times 1{,}134 \text{ sq. in. (piston area)}}{12 \text{ (ratio)}}$	14,742	31,927 lb.

Excess to overcome friction 2,665 lb.

Saving Face

"…There can be little doubt that the French elevators placed in the east and west piers to carry visitors to the first stage of the Tower had the important secondary function of saving face. That an engineer of Eiffel's mechanical perception would have permitted their use, unless compelled to do so by the Exposition Commission, is unthinkable. Whatever the attitudes of the commissioners may have been, it must be said - recalling the Backmann system - that they did not fear innovation. The machinery installed by the firm of Roux, Combaluzier and Lepape was novel in every respect, but it was a product of misguided ingenuity and set no precedent. The system, never duplicated, was conceived, born, lived a brief and not overly creditable life, and died, entirely within the Tower…"

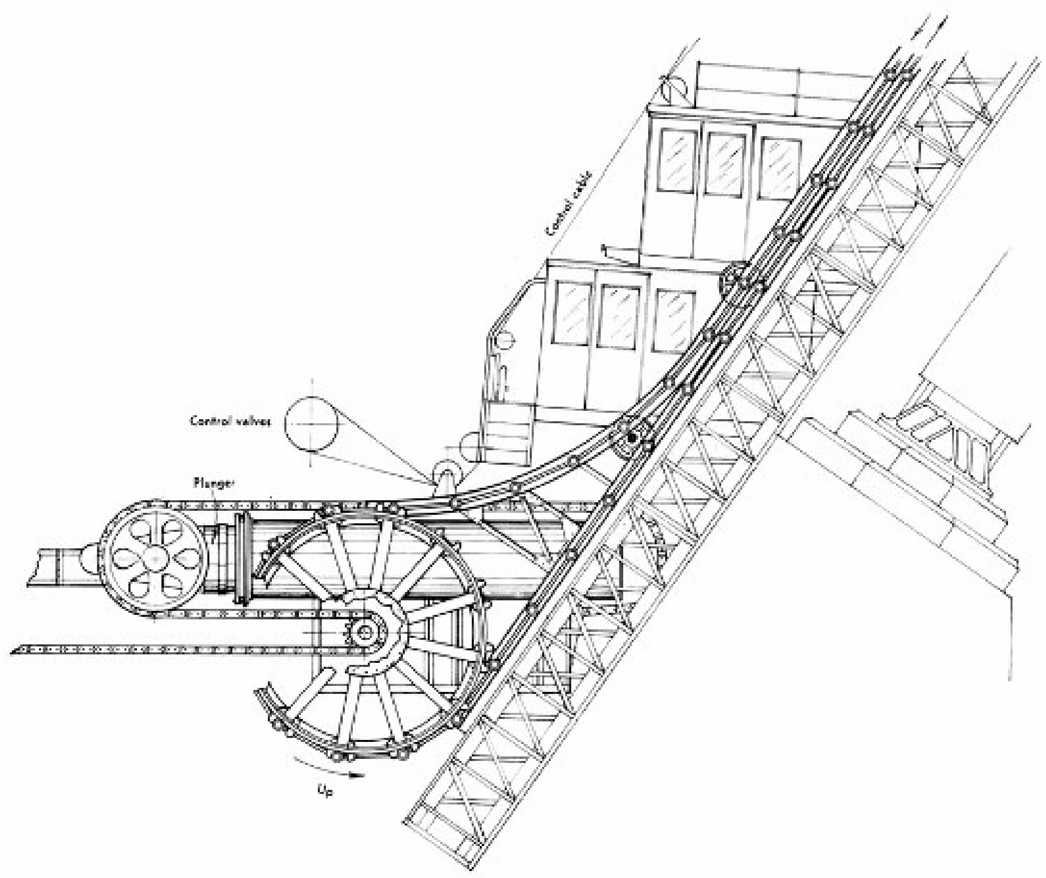
RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

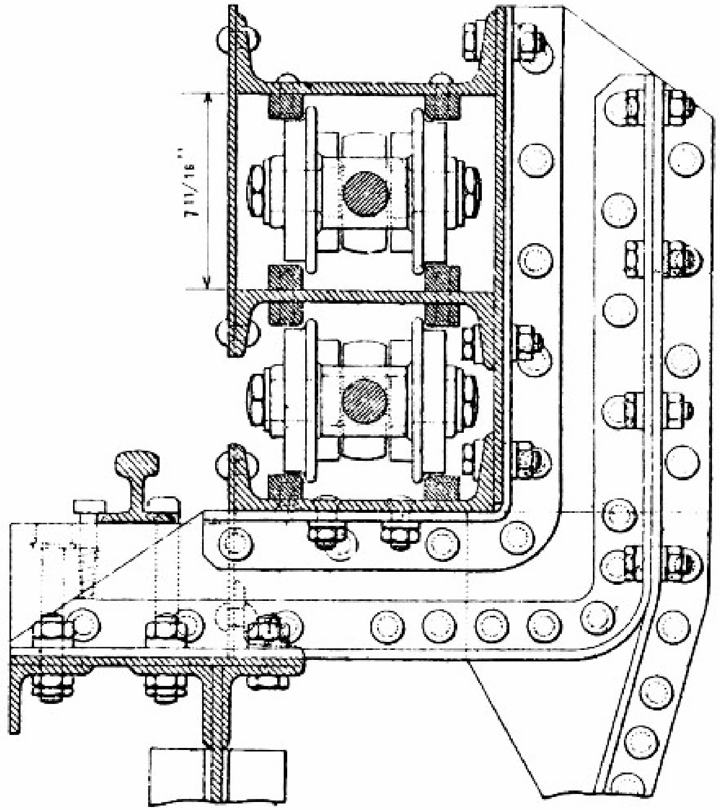


"…The basis of the French system was an endless chain of short, rigid, articulated links, to one point of which the car was attached. As the chain moved, the car was raised or lowered. Recalling the European distrust of suspended elevators, it is interesting to note that the car was pushed up by the links below, not drawn by those above, thus the active links were in compression. To prevent buckling of the column, the chain was enclosed in a conduit. Excessive friction was prevented by a pair of small rollers at each of the knuckle joints between the links. The system was, in fact, a duplicate one, with a chain on either side of the car. At the bottom of the run the chains passed around huge sprocket wheels, 12.80 feet in diameter, with pockets on their peripheries to engage the joints. Smaller wheels at the top guided the chains. If by some motive force the wheel were turned counterclockwise, the lower half of the chain would be driven upward, carrying the car with it. Slots on the inside faces of the lower guide trunks permitted passage of the connection between the car and chain. Lead weights on certain links of the chains' upper or return sections counterbalanced most of the car's dead weight…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

<u>Left</u>: caption: "Detail of links in the Roux system"





<u>Left</u>: caption: “General arrangement of the Roux Combaluzier and Lepape elevator”
<u>Right</u>: caption: “Section of guide trunks in the Roux system”

"…Two horizontal cylinders rotated the driving sprockets through a mechanism whose effect was similar to the rope-gearing of the standard hydraulic elevator, but which might be described as chain gearing. The cylinders were of the pushing rather than the pulling type used in the Otis system; that is, the pressure was introduced behind the plungers, driving them out. To the ends of the plungers were fixed smooth-faced sheaves, over which were looped heavy quadruple-link pitch chains, one end of each being solidly attached to the machine base. The free ends ran under the cylinder and made another half-wrap around small sprockets keyed to the main drive shaft. As the plungers were forced outward, the free ends of the chain moved in the opposite direction, at twice the velocity and linear displacement of the plungers. The drive sprockets were thereby revolved, driving up the car. Descent was made simply by permitting the cylinders to exhaust, the car dropping of its own weight. The overall gear or ratio of the system was the multiplication due to the double purchase of the plunger sheaves times the ratio of the chain and drive sprocket diameters: 2(12.80/1.97) or about 13:1. To drive the car 218-feet to the first platform of the Tower the plungers traveled only about 16.5-feet…"

RE: excerpt from ***Elevator Systems of the Eiffel Tower 1889***

"…To penetrate the inventive rationale behind this strange machine is not difficult. Aware of the fundamental dictum of absolute safety before all else, the Roux engineers turned logically to the safest known elevator type - the direct plunger. This type of elevator, being well suited to low rises, formed the main body of European practice at the time, and in this fact lay the further attraction of a system firmly based on tradition. Since the piers between the ground and first platform could accommodate a straight, although inclined run, the solution might obviously have been to use an inclined, direct plunger. The only difficulty would have been that of drilling a 220-foot, inclined well for the cylinder. While a difficult problem, it would not have been insurmountable. What then was the reason for using a design vastly more complex? The only reasonable answer that presents itself is that the designers, working in a period before the Otis bid had been accepted, were attempting to evolve an apparatus capable of the complete service to the second platform. The use of a rigid direct plunger thus precluded, it became necessary to transpose the basic idea in order to adapt it to the curvature of the Tower leg, and at the same time retain its inherent quality of safety. Continuing the conceptual sequence, the idea of a plunger made in some manner flexible apparently suggested itself, becoming the heart of the Roux machines…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

"…Here then was a design exhibiting strange contrast. It was on the one hand completely novel, devised expressly for this trying service; yet on the other hand it was derived from and fundamentally based on a thoroughly traditional system. If nothing else, it was safe beyond question. In Eiffel's own words, the Roux lifts 'not only were safe, but appeared safe; a most desirable feature in lifts traveling to such heights and carrying the general public.'…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

<u>Left</u>: caption: "Roux, Combaluzier & Lepape machinery and cabin at the Tower's base"

"…The system's shortcomings could hardly be more evident. Friction resulting from the more than 320 joints in the flexible pistons, each carrying two rollers, plus that from the pitch chains must have been immense. The noise created by such multiplicity of parts can only be imagined. Capacity was equivalent to that of the Otis system. About one-hundred people could be carried in the double-deck cabin, some standing. The speed, however, was only 200-feet per minute, understandably low. If it had been the initial intention of the designers to operate their cars to the second platform, they must shortly have become aware of the impracticability of this plan, caused by an inherent characteristic of the apparatus. As long as the compressive force acted along the longitudinal axis of the links, there was no lateral resultant and the only load on the small rollers was that due to the dead weight of the link itself. However, if a curve had been introduced in the guide channels to increase the incline of the upper run, as done by Otis, the force on those links traversing the bend would have been eccentric - assuming the car to be in the upper section, above the bend. The difference between the two sections (based upon the Otis system) was 78°9' minus 54°35', or 23°34', the tangent of which equals 0.436. Forty-three percent of the unbalanced weight of the car and load would then have borne upon the, say, twelve sets of rollers on the curve. The immense frictional load thus added to the entire system would certainly have made it dismally inefficient, if not actually unworkable…"

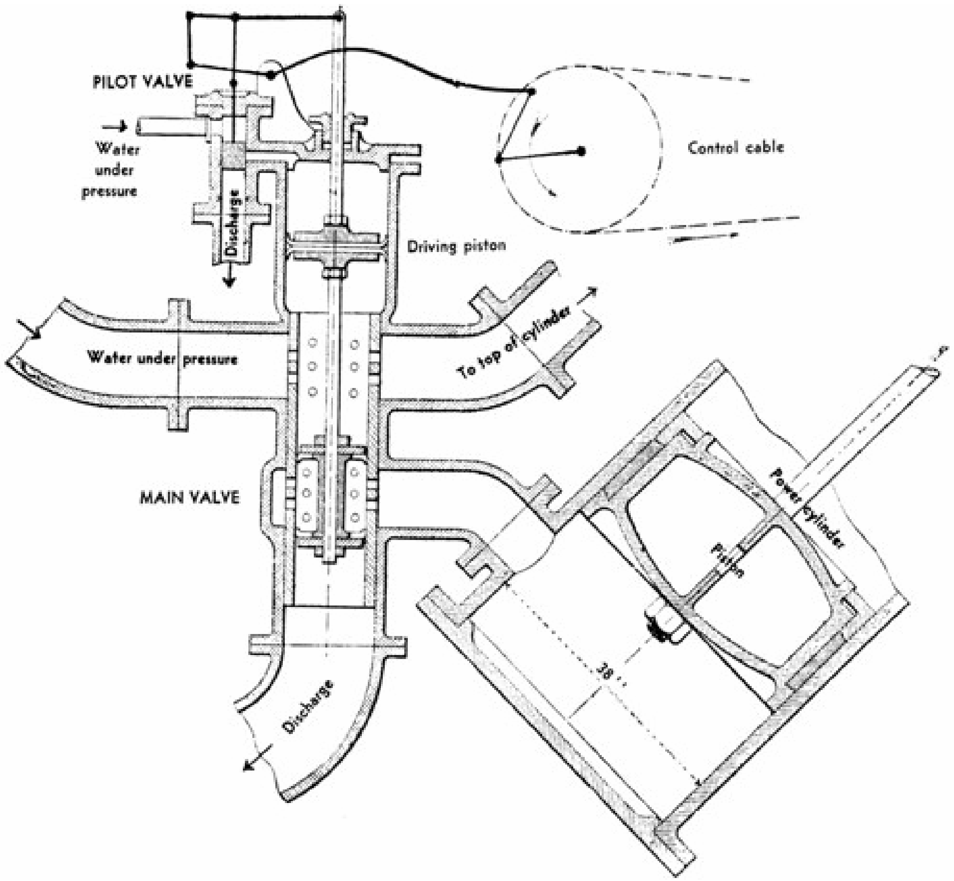
RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

"…In spite of Eiffel's public remarks regarding the safety of the Roux machinery, in private he did not trouble to conceal his doubts. Otis' representative, Hall, discussing this toward the end of Brown's previously mentioned report, probably presented a fairly accurate picture of the situation. His comments were based on conversations with Eiffel and Koechlin: 'Mr. Gibson, Mr. Hanning (who were other Otis employees) and myself came to the unanimous conclusion that Mr. Eiffel had been forced to order those other machines, from outside parties, against his own judgment: and that he was very much in doubt as to their being a practical success - and was, therefore, all the more anxious to put in our machines (which he did have faith in)...and if the others ate up coal in proportions greatly in excess of ours, he would have it to say...'Gentlemen, these are my choice of elevators, those are yours &c.' There was a published interview...in which Eiffel stated...that he was to meet some American gentlemen the following day, who were to provide him with elevators - grand elevators, I think he said...'…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

"…The Roux and the Otis systems both drew their water supply from the same tanks; also, each system used similar distributing valves operated from the cars. Although no reports have been found of actual controlled tests comparing the efficiencies of the Otis and Roux systems, a general quantitative comparison may be made from the balance figures given for each, where it is seen that 2,665 pounds of excess tractive effort were allowed to overcome the friction of the Otis machinery against 13,856 pounds for the Roux…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*



<u>Left</u>: caption: "The Otis distributor, with valves shown in motionless, neutral position. Since the main valve at all times was subjected to the full operating pressure, it was necessary to drive this valve with a servo piston. The control cable operated only the servo piston's valve."

The Roux System

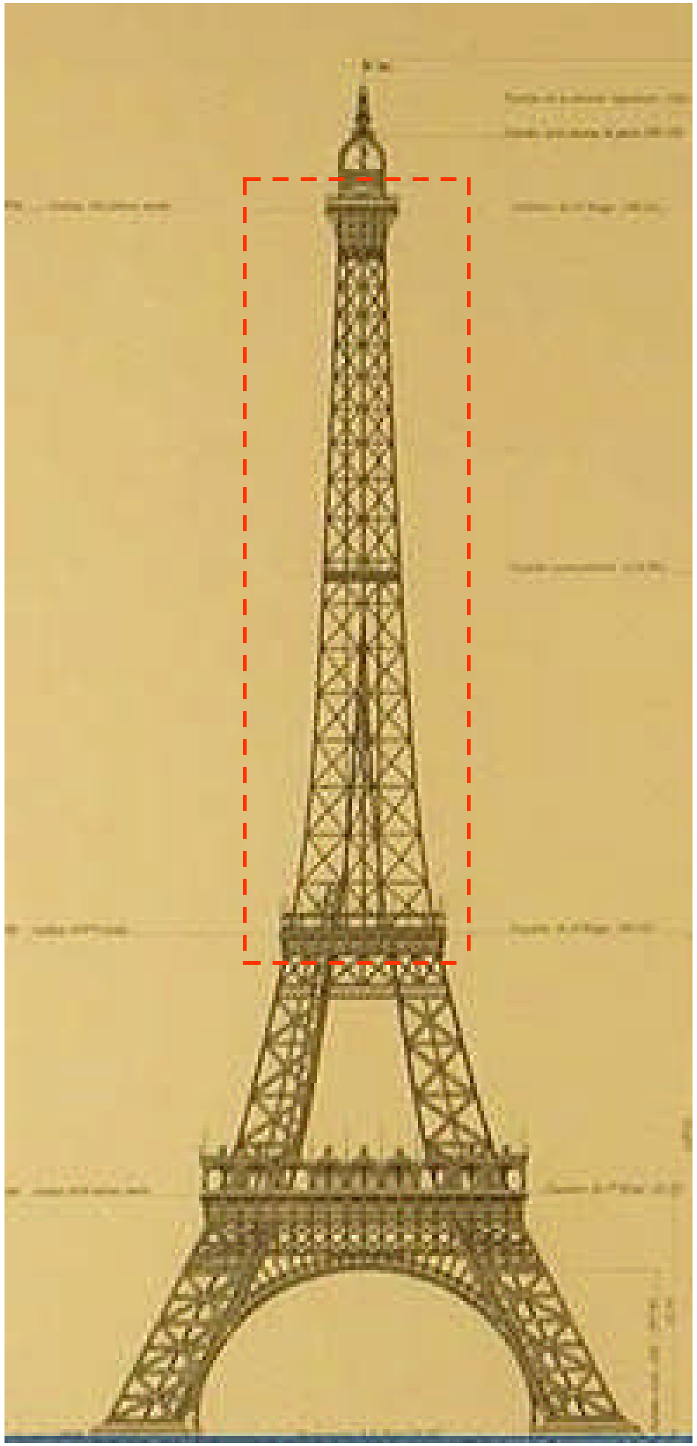
Negative effect

Weight of cabin: 14,100 × sin 54°35′	11,500 lb.	
Live load: 100 persons @150 lb. = 15,000 × sin 54°35′	12,200	
		— 23,720 lb.

Positive effect

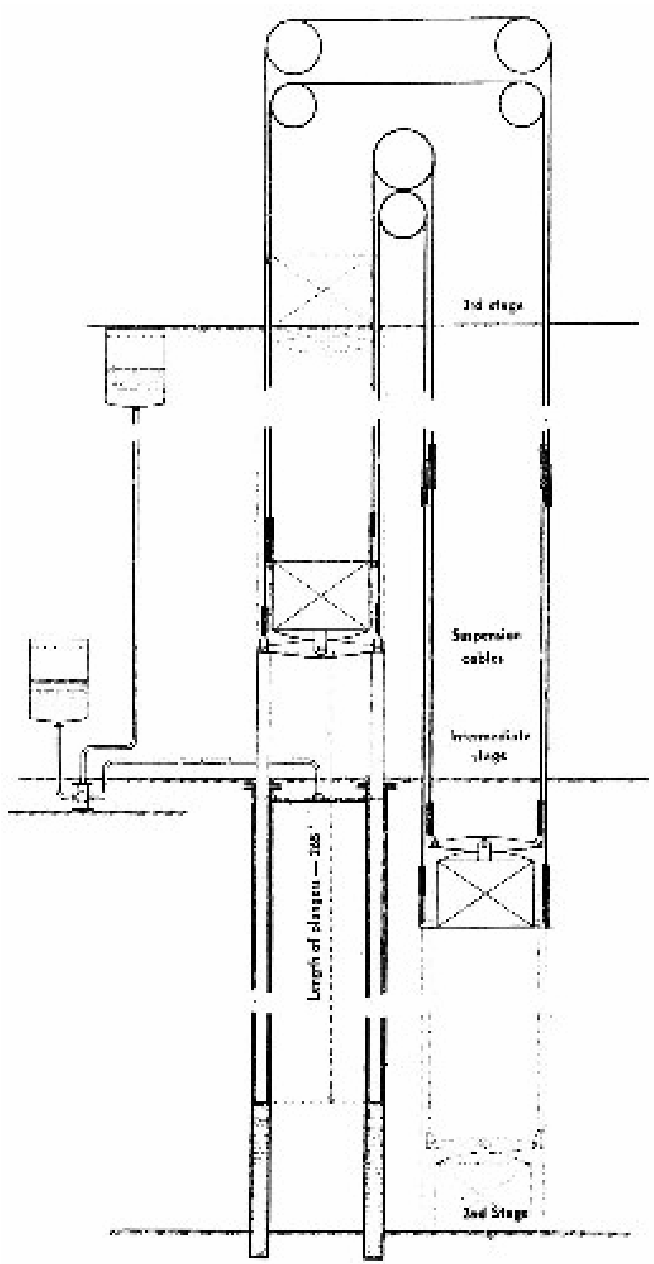
Counterweight: 6,600 × sin 54°35′	5,380	
Power: $\dfrac{156 \text{ p.s.i.} \times 2 \text{ (pistons)} \times 1{,}341.5 \text{ sq. in. (piston area)}}{13 \text{ (ratio)}}$	32,196	37,576 lb.
Excess to overcome friction		13,856 lb.

Edoux



"…The section of the Tower presenting the least difficulty to elevator installation was that above the juncture of the four legs - from the second platform to the third, or observation, enclosure. There was no question that French equipment could perform this service. The run being perfectly straight and vertical, the only unusual demand upon contemporary elevator technology was the length of rise – 525-feet…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*



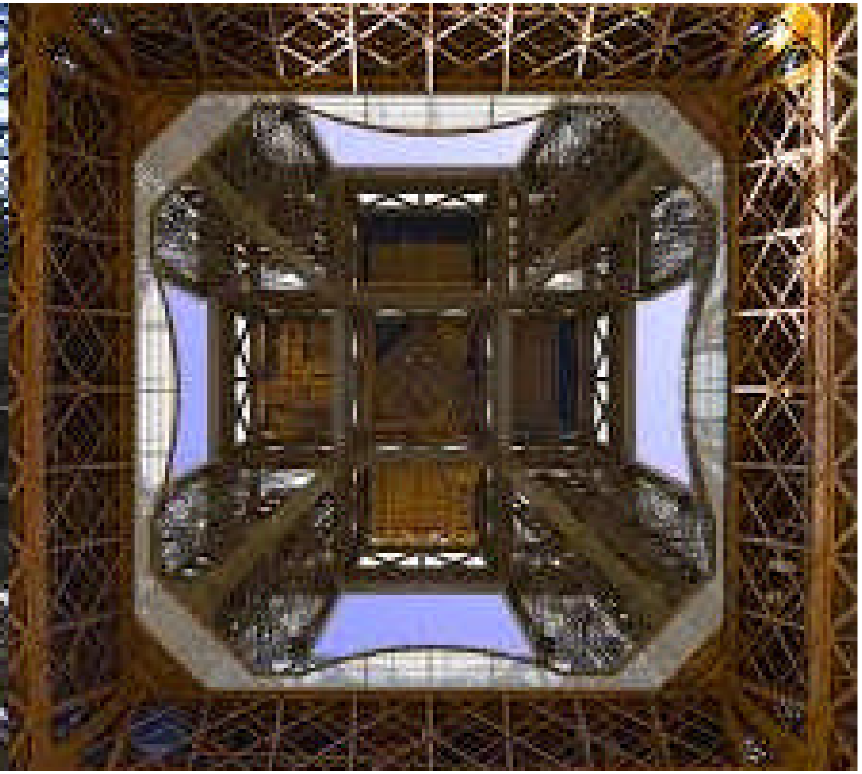
"…The system ultimately selected appealed to the Commission largely because of a similar one that had been installed in one tower of the famous Trocadero and which had been operating successfully for ten years. It was the direct plunger system of Leon Edoux, and was, for the time, far more rationally contrived than Backmann's helicoidal system. Edoux, an old schoolmate of Eiffel's, had built thousands of elevators in France and was possibly the country's most successful inventor and manufacturer in the field. It is likely that he did not attempt to obtain the contract for the elevator equipment in the Tower legs, as his experience was based almost entirely on plunger systems, a type, as we have seen, not readily adaptable to that situation. What is puzzling was the failure of the Commission's members to recognize sooner Edoux's obvious ability to provide equipment for the upper run. It may have been due to their inexplicable confidence in Backmann…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

Left: caption: "Schematic diagram of the Edoux system"

"…The direct plunger elevator was the only type in which European practice was in advance of American practice at this time. Not until the beginning of the 20th century, when hydraulic systems were forced into competition with electrical systems, was the direct plunger elevator improved in America to the extent of being practically capable of high rises and speeds. Another reason for its early disfavor in the United States was the necessity for drilling an expensive plunger well equal in length to the rise…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*



"…As mentioned, the most serious problem confronting Edoux was the extremely high rise of 525-feet. The Trocadero elevator, then the highest plunger machine in the world, traveled only about 230-feet. A secondary difficulty was the esthetic undesirability of permitting a plunger cylinder to project downward a distance equal to such a rise, which would have carried it directly into the center of the open area beneath the first platform…"

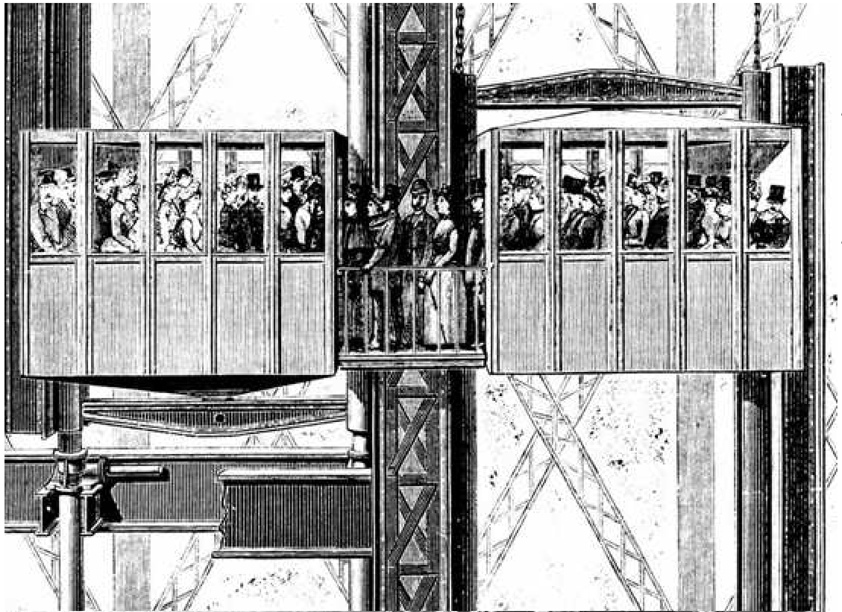
RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*
Left: view from ground of open area at First Platform Level
Right: view from ground looking up through First Platform Level to underside of Second Platform Level

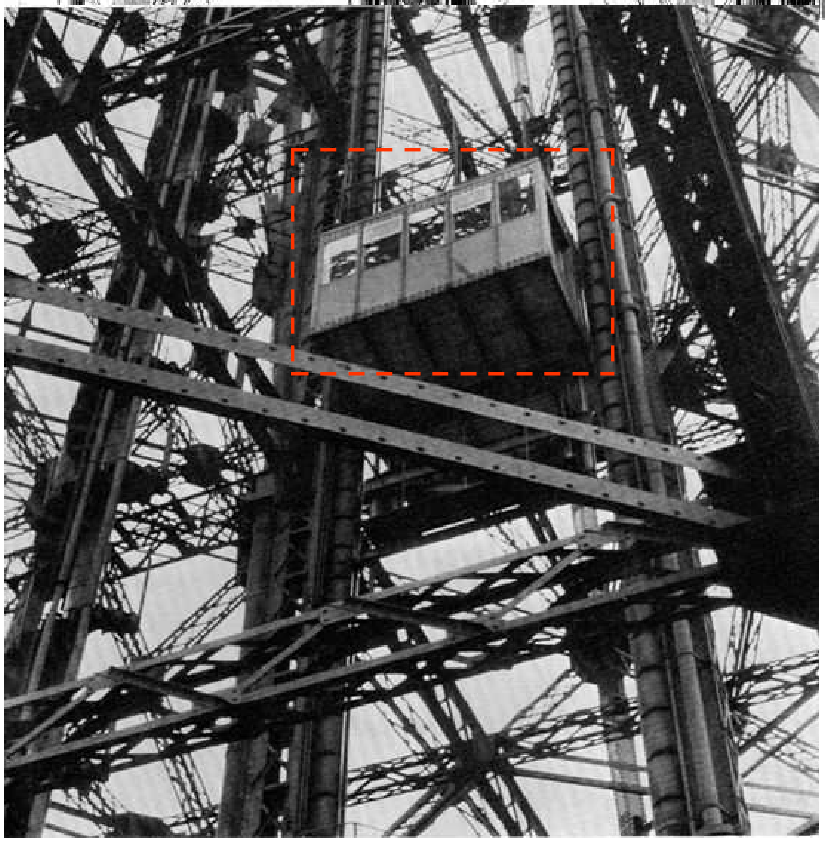
"…Both problems were met by an ingenious modification of the basic system. The run was divided into two equal sections, each of 262-feet, and two cars were used. One operated from the bottom of the run at the second platform level to an intermediate platform half-way up, while the other operated from this point to the observation platform near the top of the Tower. The two sections were of course parallel, but offset. A central guide, on the Tower's centerline, running the entire 525-feet served both cars, with shorter guides on either side - one for the upper and one for the lower run. Thus, each car traveled only half the total distance. The two cars were connected, as in the Backmann system, by steel cables running over sheaves at the top, balancing each other and eliminating the need for counterweights. Two driving rams were used. By being placed beneath the upper car, their cylinders extended downward only the 262-feet to the second platform and so did not project beyond the confines of the system itself. In making the upward or downward trip, the passengers had to change from one car to the other at the intermediate platform, where the two met and parted. This transfer was the only undesirable feature of what was, on the whole, a thoroughly efficient and well designed work of elevator engineering…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

"…In operation, water was admitted to the two cylinders from a tank on the third platform. The resultant hydraulic head was sufficient to force out the rams and raise the upper car. As the rams and car rose, the rising water level in the cylinders caused a progressive reduction of the available head. This negative effect was further heightened by the fact that, as the rams moved upward, less and less of their length was buoyed by the water within the cylinders, increasing their effective weight. These two factors were, however, exactly compensated for by the lengthening of the cables on the other side of the pulleys as the lower car descended…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*



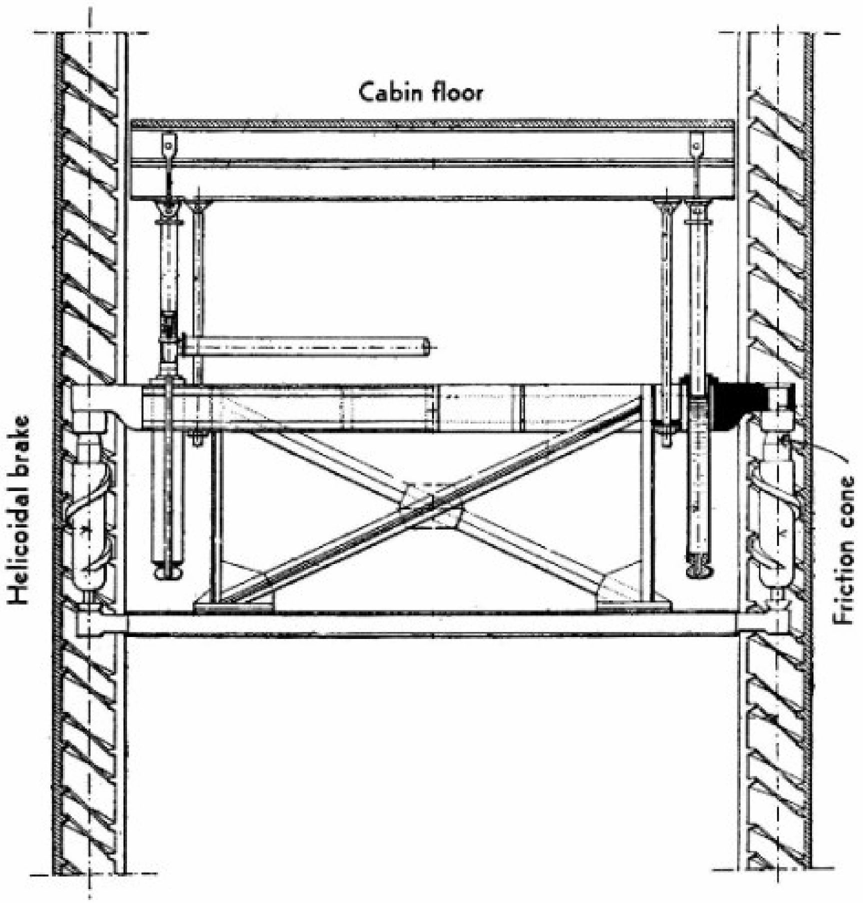


"…Perfect balance of the system's dead load for any position of the cabins was, therefore, a quality inherent in its design. However, there were two extreme conditions of live loading which required consideration: the lower car full and the upper empty, or vice versa. To permit the upper car to descend under the first condition, the plungers were made sufficiently heavy, by the addition of cast iron at their lower ends, to overbalance the weight of a capacity load in the lower car. The second condition demanded simply that the system be powerful enough to lift the unbalanced weight of the plungers plus the weight of passengers in the upper car…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

<u>Top</u>: caption: "Passengers changing cars on Edoux elevator at intermediate platform"

<u>Bottom</u>: caption: "Present-day view of the lower Edoux Elevator"



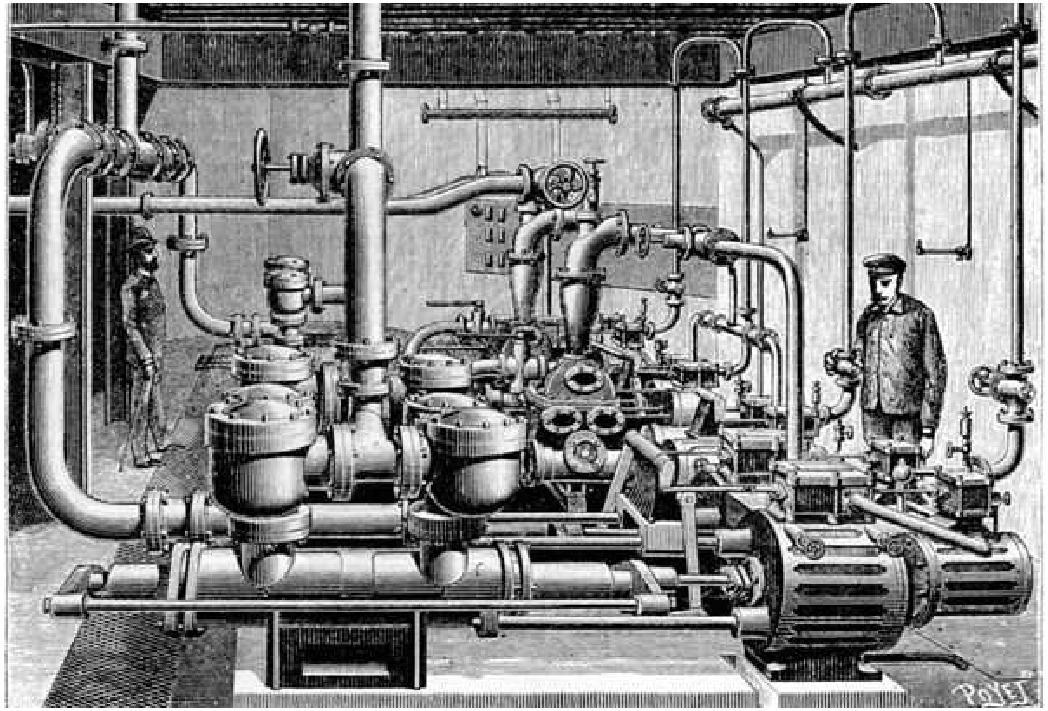
"…As in the other systems, safety was a matter of prime importance. In this case, the element of risk lay in the possibility of the suspended car falling. The upper car, resting on the rams, was virtually free of such danger. Here again the influence of Backmann was felt - a brake of his design was applied. It was, true to form, a throw-back, similar safety devices having proven unsuccessful much earlier. Attached to the lower car were two helically threaded vert-ical rollers, working within the hollow guides. Corresponding helical ribs in the guides rotated the rollers as the car mo-ved. If the car speed exceeded a set limit, the increased resistance offered by the apparatus drove the rollers up into friction cups, slowing or stopping the car…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

<u>Upper Right</u>: caption: "Vertical section through lower (suspended) Edoux car, showing Back-mann helicoidal safety brake"

"…The device was considered ineffectual by Edoux and Eiffel, who were aware that the ultimate safety of the system resulted from the use of supporting cables far heavier than necessary. There were four such cables, with a total sectional area of 15.5 square inches. The total maximum load to which the cables might be subjected was about 47,000 pounds, producing a stress of about 3,000 pounds per square inch compared to a breaking stress of 140,000 pounds per square inch - a safety factor of forty-six…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*



"…A curiosity in connection with the Edoux system was the use of Worthington (American) pumps to carry the water exhausted from the cylinders back to the supply tanks. No record has been found that might explain why this particular exception was made to the 'foreign materials' stipulation. This exception is even more strange in view of Otis' futile request for the same pumps and the fact that any number of native machines must have been available. It is possible that Edoux's personal influence was sufficient to overcome the authority of the regulation…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

Above: caption: "Worthington tandem compound steam pumps, at base of the Tower's south pier, supplied water for the Edoux system. The tank was at 896-feet, but suction was taken from the top of the cylinders at 643-feet; therefore, the pumps worked against a head of only about 250-feet."

The Edoux System

Negative effect

Unbalanced weight of plungers (necessary to raise full lower car and weight of cables on lower side)	42,330lb	
Live load: 60 persons @150 lb.	9,000	— 51,330 lb.

Positive effect

Power: 227.5 p.s.i. × 2 (plungers) × 124 sq. in. (plunger area)	56,420lb.	
Excess to overcome friction		5,090 lb.

Turn of the Century

"…In 1900, after the customary eleven-year period, Paris again prepared for an international exposition, about five years too early to take advantage of the great progress made by the electric elevator. When the Roux machines, the weakest element in the Eiffel Tower system, were replaced at this time, it was by other hydraulics. Built by the well known French engineering organization of Fives-Lilles, the new machines were the ultimate in power, control, and general excellence of operation. As in the Otis system, the cars ran all the way to the second platform…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

Left: caption: "The Roux-Combaluzier elevators were replaced by two hydraulic press elevators built by Fives-lillies. Each consisted of two cabins with a 50-person capacity."

"…The Fives-Lilles equipment reflected the advance of European elevator engineering in this short time. The machines were rope-geared and incorporated the elegant feature of self-leveling cabins which compensated for the varying track inclination…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

<u>Left</u>: caption: "Roux Elevator Eiffel Tower, Paris Exhibition, 1900"

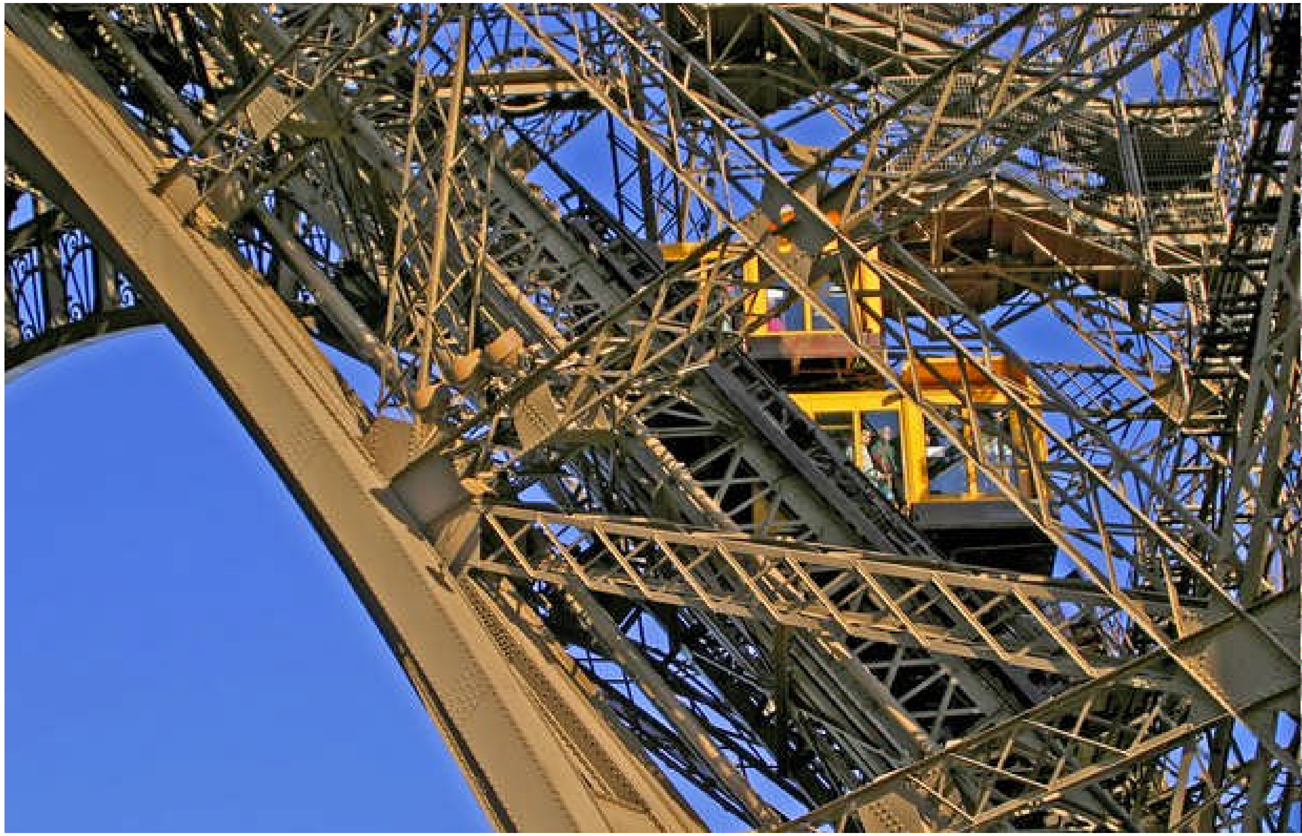
Opened on April 14th 1900 by French President *Emile Loubet*, the *Paris International Exposition* of 1900 spread out across the *Siene River* and covered a much wider area than did its 1889 predecessor. In its two-hundred and twelve day run, it welcomed over fifty-million visitors. The Exposition was also seen by French officials as an opportunity to revitalize the Eiffel Tower's declining public appeal. To that end, several plans were suggested modifying the great edifice. One of the most noteworthy was submitted by the tower's original architect: *Stephen Sauvestre.* His bold idea was to add two lateral towers (left) in order that additional elevators to the Second Platform Level could be installed. Alas, the scheme was never realized nor were any of the others save for the elevator equipment modernization.

"…For the 1900 fair, the Otis elevator in the south pier was also removed and a wide stairway to the first platform built in its place. In 1912, twenty-five years after Backmann's startling proposal to use electricity for his system, the remaining Otis elevator was replaced by a small electric one. This innovation was reluctantly introduced solely for the purpose of accommodating visitors in the winter when the hydraulic systems were shut down due to freezing weather. The electric elevator had a short life, being removed in 1922 when the number of winter visitors increased far beyond its capacity. However, the two hydraulic systems were modified to operate in freezing temperatures - presumably by the simple expedient of adding an anti-freezing chemical to the water - and operation was placed on a year-round basis…"

RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*

"…Today the two Fives-Lilles hydraulic systems re-main in full use; and visitors reach the Tower's summit by Edoux's elevator, which is all that remains of the original installation…"

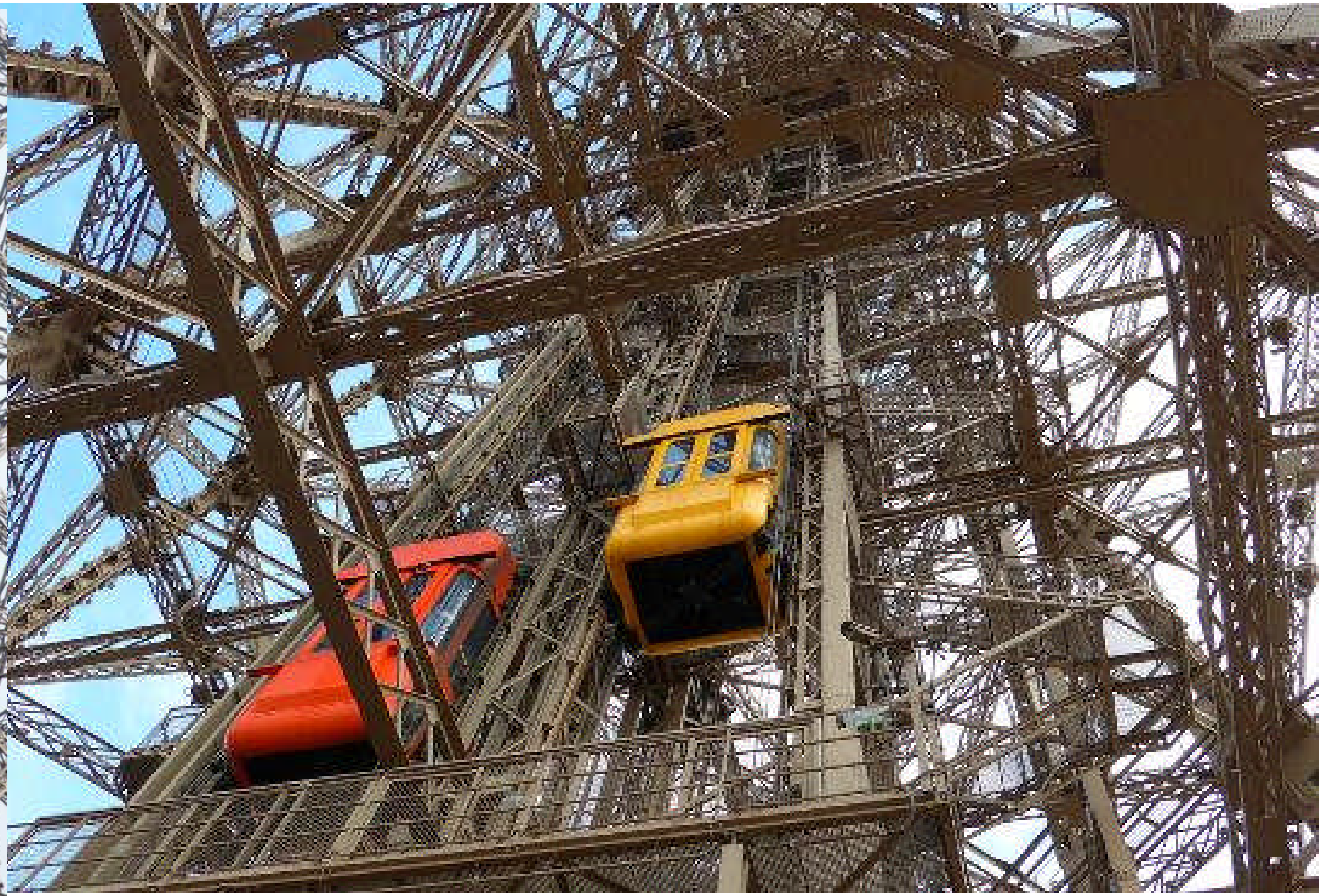
RE: excerpt from *Elevator Systems of the Eiffel Tower 1889*




Viva la Otis

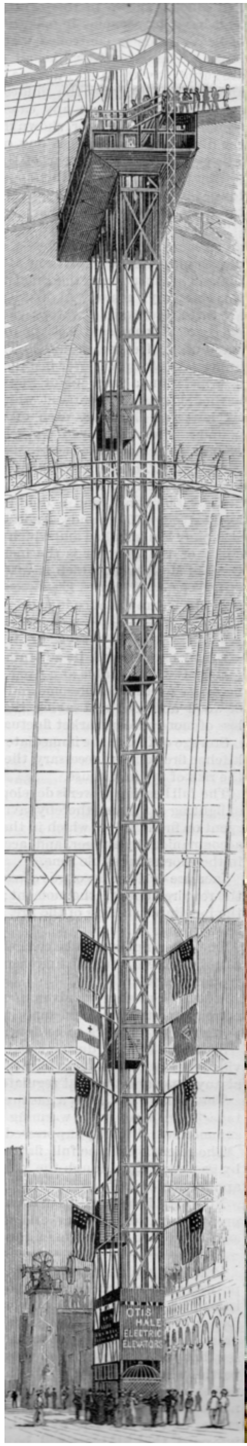
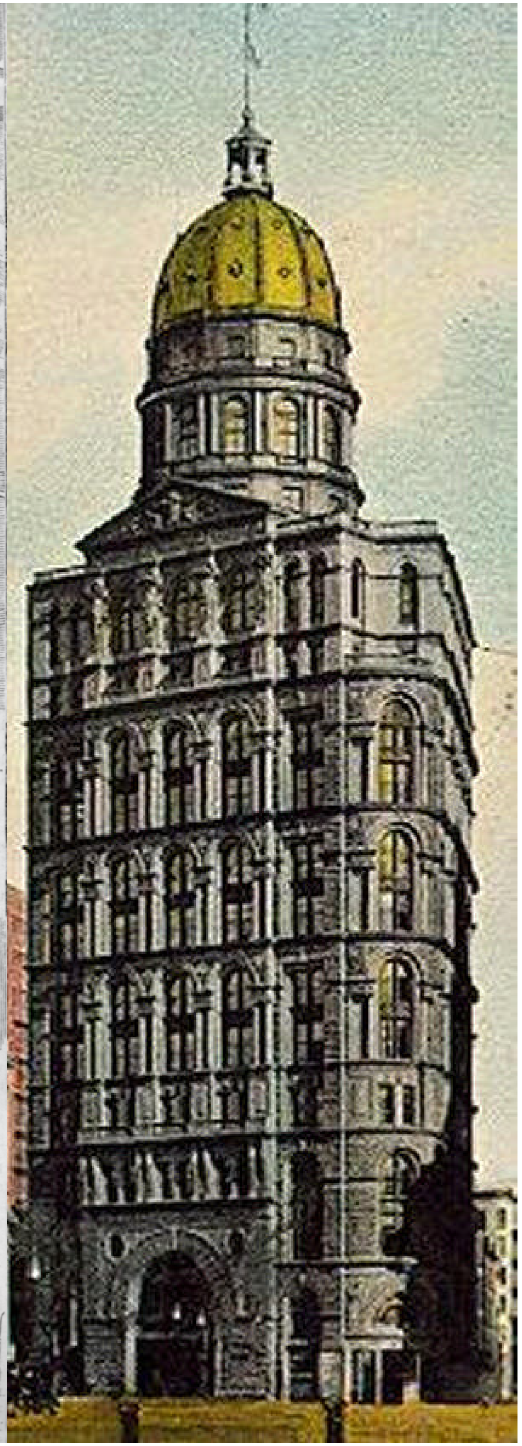
"While four Otis elevators have plied the Eiffel Tower since 1889, they typically don't last longer than a decade. Heavy use and exposure to the elements take a toll on the cars. But the latest designs from Otis should run much longer. Called Duolift, they're designed for easy maintenance. Each car's framework is machine-welded stainless steel, with modular exterior panels composed of an aluminum-plastic composite sandwich. Workers can replace both inside and outside sheathing without dismounting the entire elevator. The Duolift cars, which took three weeks to install, are reciprocally balanced, with each elevator serving as its counterpart's counterweight. Each car can carry twenty-two people and has four observation windows."

***Popular Mechanics*, October 1994**

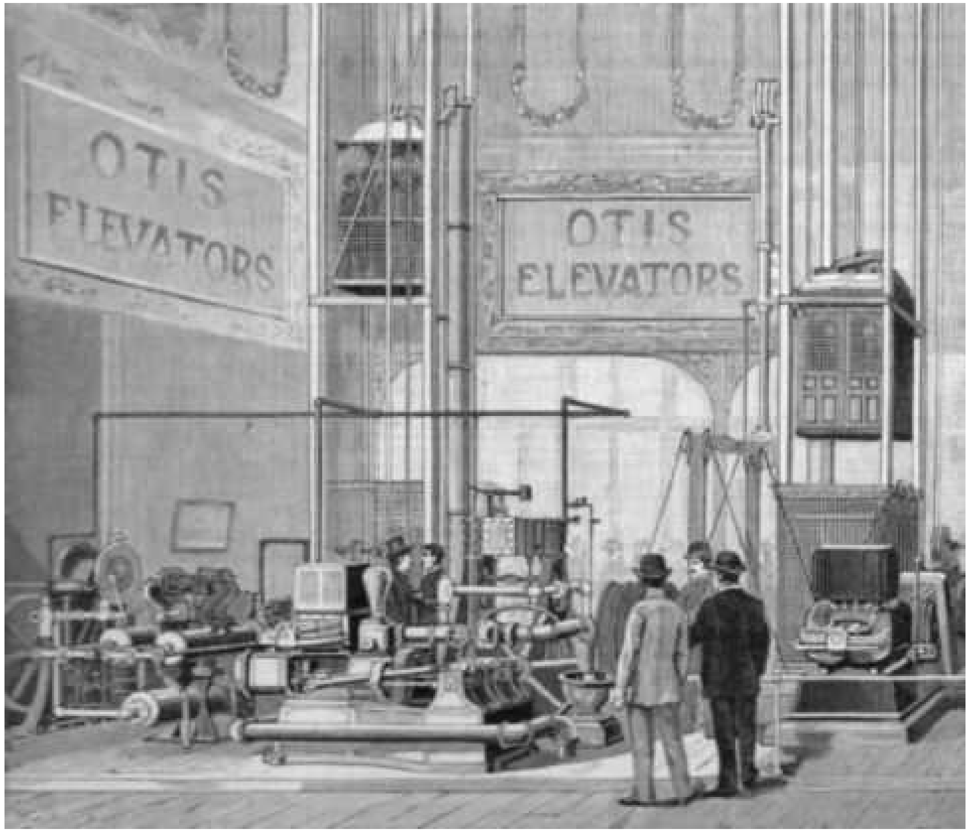


Power for all the elevators initially came from steam systems; electricity did not replace them until about 1912. That was also the year that the Otis elevators ceased to serve the *Eiffel Tower*. One was replaced by a staircase to the first Platform Level and the other by a small electric elevator that could function in the winter, when hydraulic systems were shut down. For decades, Otis was not associated with the tower, but when the company did return, it was in a big way. It happened in the early 1980s, by which time two key changes had occurred: the tower was in need of major renovation, including all of its elevators and Otis was no longer viewed as a "foreign" company, having established significant operations in France (Otis absorbed the French company whose lifts had served the tower since 1889). The new elevators included one inclined from the ground to the First and Second Platform Level/s and two Duo-lifts (from the Second Platform Level to the top of the tower. The two Duo-lifts elevators consist of two cabs connected by hoist ropes and suspended over a gearless machine. As one cab goes up, the other goes down. The run covered 524.9-feet, the longest open-air run in the world. The elevators consist of two cabins counter-weighting one another; one going up and the other down. When the two Duo-lifts were put into service, forty people could both ascend and descend simultaneously. Then, in 2001, Otis fulfilled the contract to modernize the Duo-lifts, a process that had to be accomplished at night, when they were not in use. The job consumed 6K hours and involved the transport of eight-tons of components to the top of the tower.

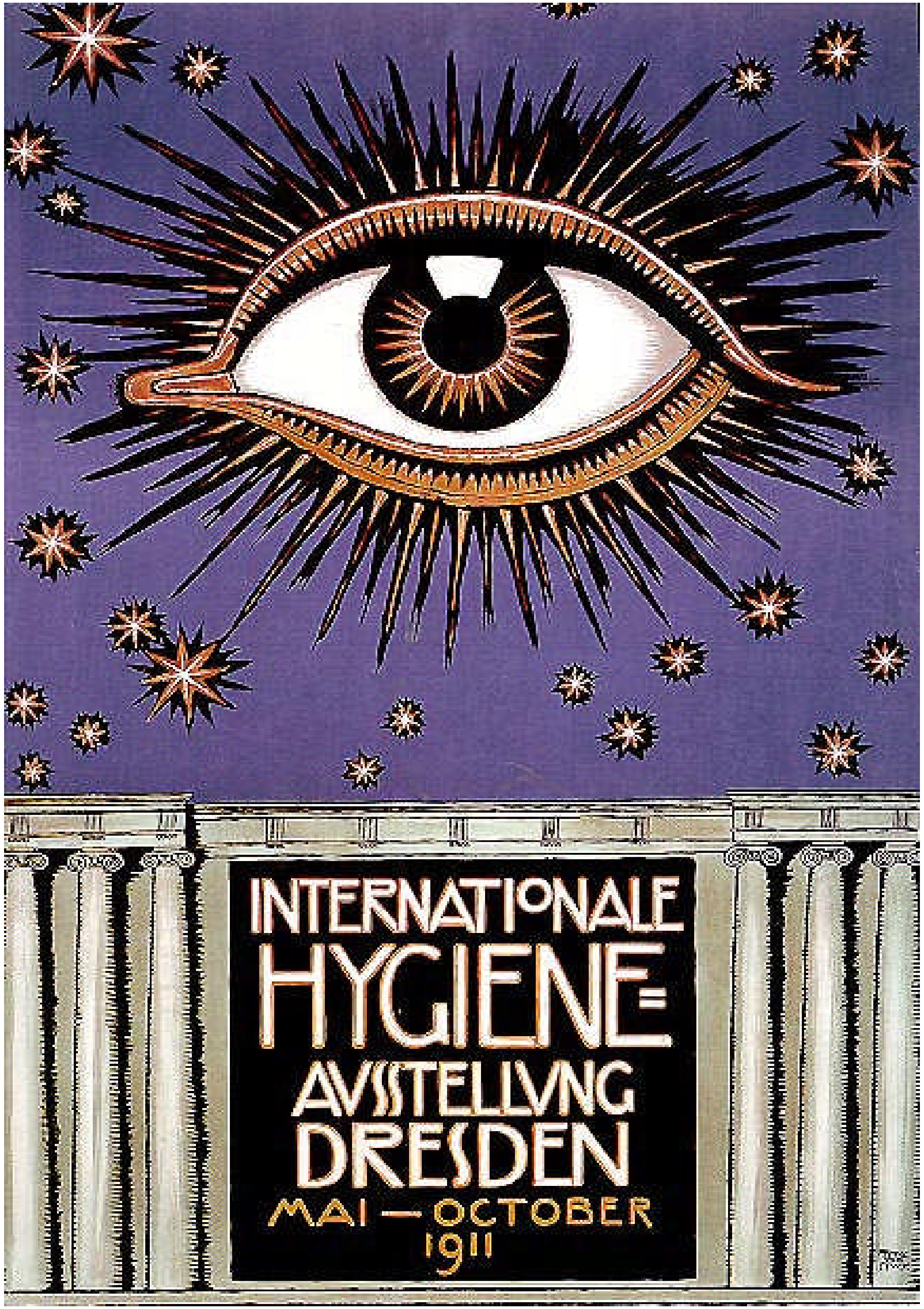
Reaching New Heights

The front page of *Scientific American* magazine for the October 28th 1893 issue presented the Otis elevator on exhibit at the *Columbian Exposition* of 1893, held in Chicago's *Jackson Park*. Otis was one of a dozen manufacturers displaying their products to the public. It was one of the largest and most sensational industrial displays. Their demonstration "Otis-Hale Electric Elevator" (constructed in the center of the *Manufactures and Liberal Arts Hall*), rose 185-feet from the ground (far left). At the time, the tallest skyscraper in the world was the *New York World Building* (a.k.a. "Pulitzer Building") on New York City's famous *Park Row* - recently finished in 1890 and 349-feet high (near left). The tallest buildings of the 1880s weren't nearly as tall as the Columbian Otis elevator, so the ride to the top provided the thrill-of-a-lifetime for many fairgoers. The Otis elevator used a *Westinghouse* brake system.

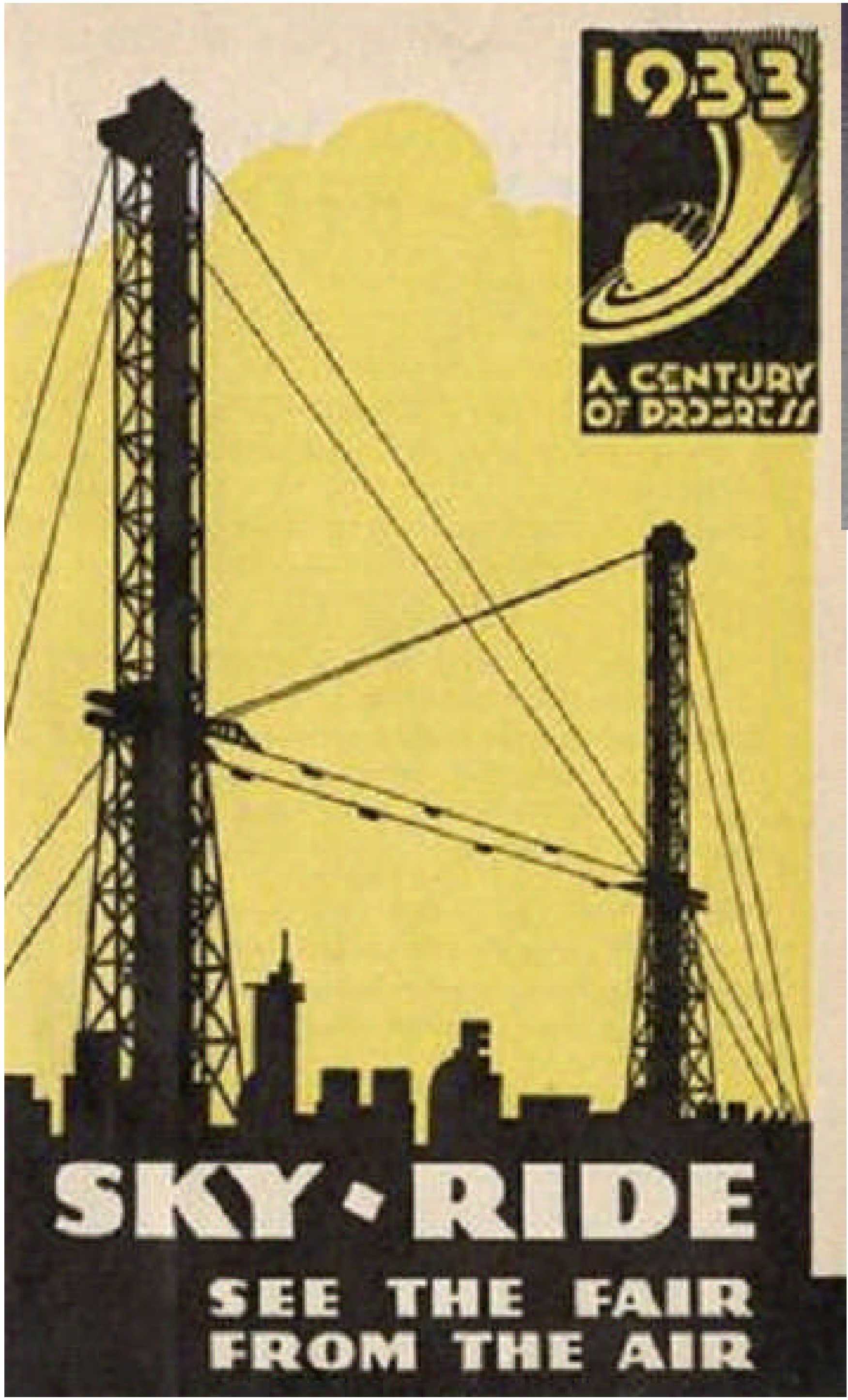


Otis Brothers not only exhibited elevators at the 1893 *Columbian Exposition*, but also had many elevators in actual use throughout the fair. For example, in the *Manufactures and Liberal Arts Building* there were four electric elevators (left) that carried fair-goers to the roof promenade.



At the 1911 *Internationale Hygiene Exhibition* held in Dresden, Germany (original poster at left), Otis was awarded the Golden Medal for Elevator Exhibits. The Otis elevator unit on display was of the 0-H type direct-current, 220 volts, push-button control. As the name of the show suggests, the exhibition was mainly devoted to hygiene and the associated sciences.

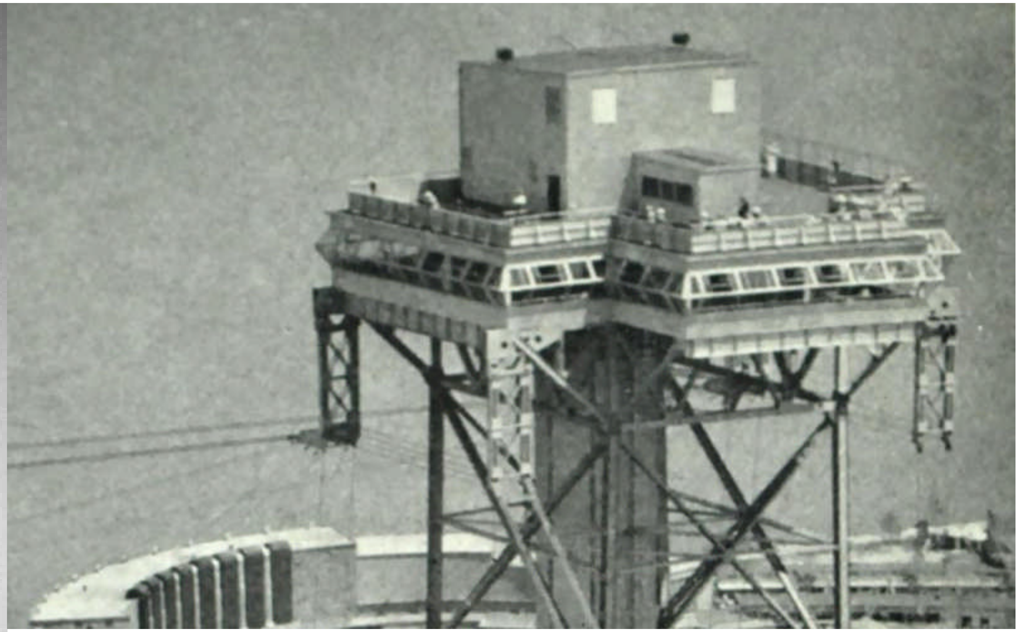
The Towering Sky-Ride



"…Two towers stand like giant sentinels, 1,850-feet apart, seeming to guard the Hall of Science on the Mainland, and the Hall of Social Science across the Lagoon - support of the spectacular Sky-Ride, great thrill feature of A Century of Progress…striking example of the progress of science even in thrill makers, is this suspension bridge principle applied to an entertainment feature - and perhaps the near solution of some problems of overhead transportation…"

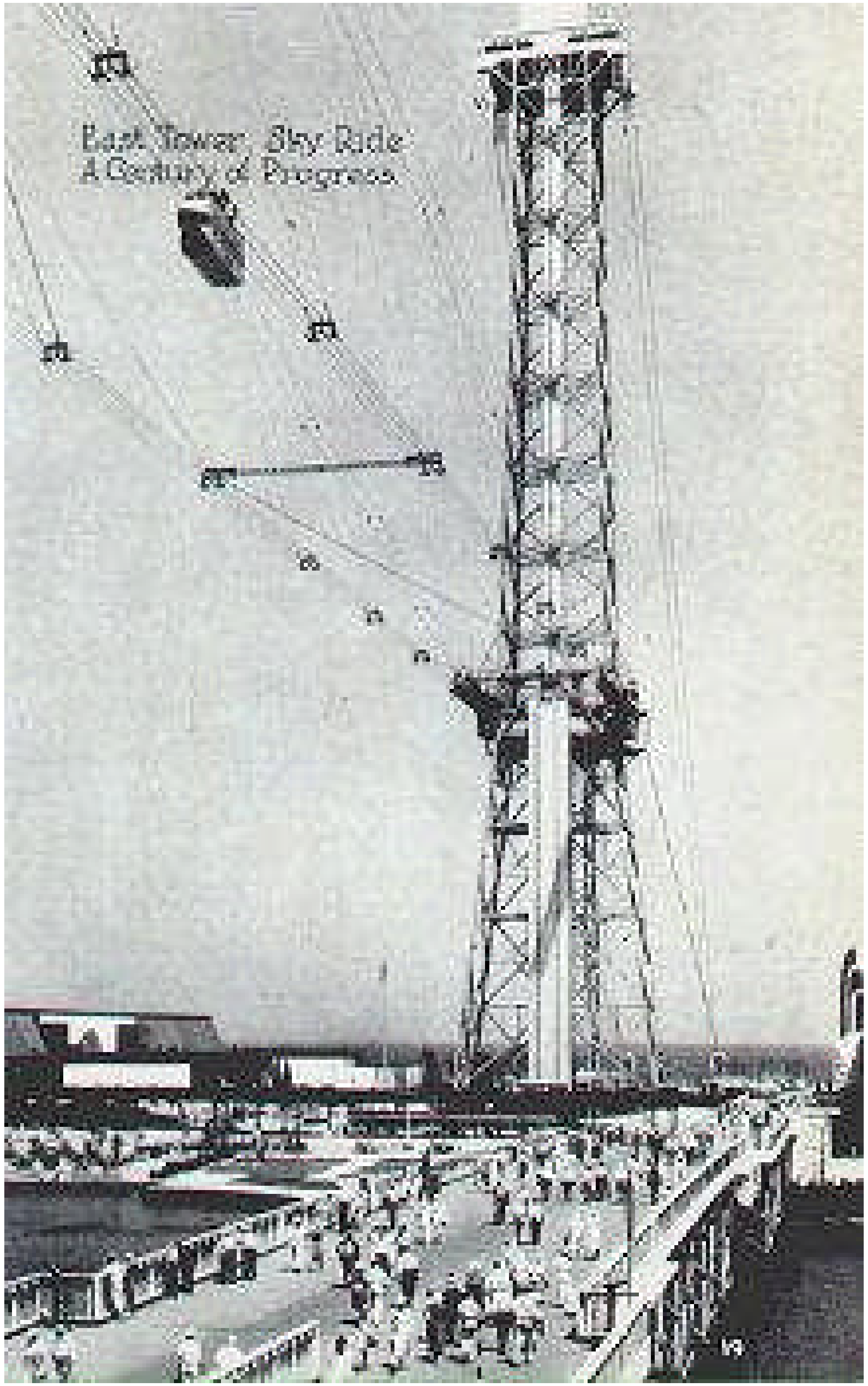
RE: excerpt from *The Official Guide Book of the Fair, 1933*

<u>Above</u>: caption: "Vista of 200 ft. level West Tower of Spectacular Sky-Ride. Showing pass-enger rocket cars."

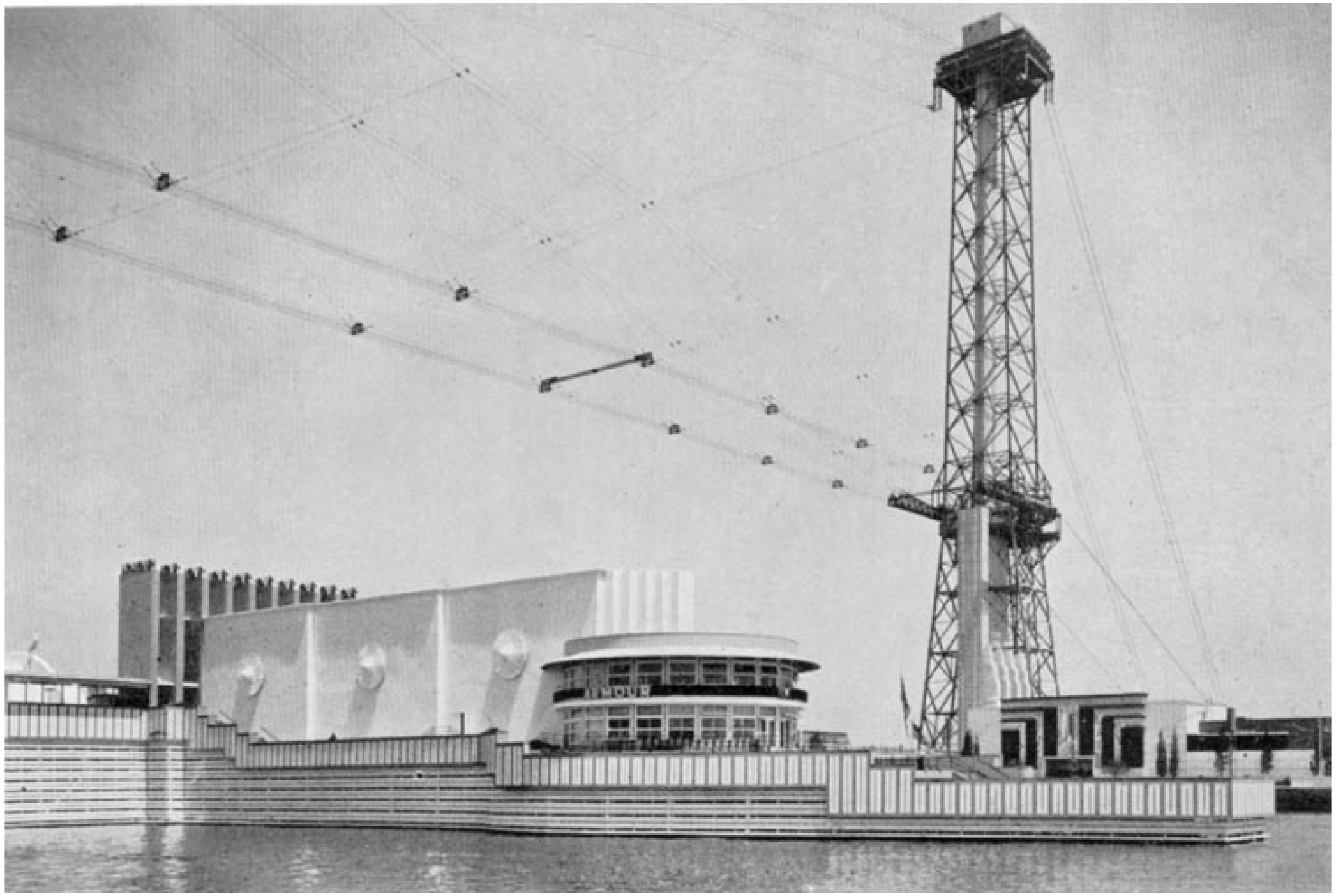


"…They are higher than any building in Chicago, these two strong steel towers, imbedded deep in cement. Six hundred and twenty-eight feet they rise into the skies, with observation floors atop them. If you stand in one of these observation rooms at night and look down, you gaze upon a magic city that seems to float in a vast pool of light. From the towers, great searchlights sweep the sky, the lake, and over the great city to the west, to clash with other massive beams of light…"

RE: excerpt from *The Official Guide Book of the Fair, 1933*

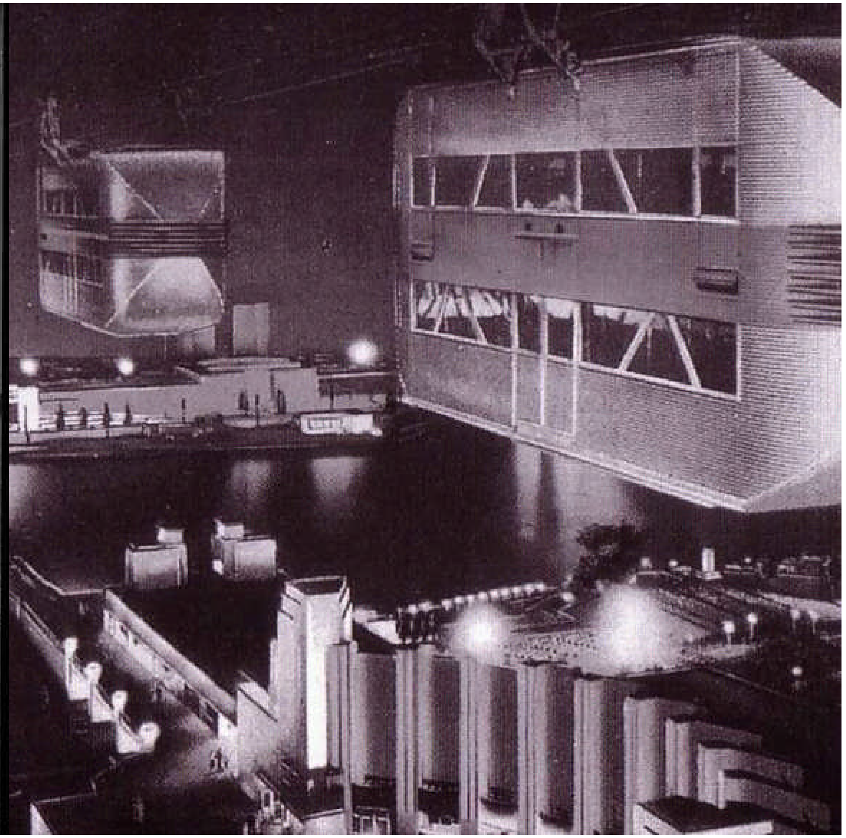


The *Sky-Ride* consisted of two towers, each 628-feet high, spaced 1,850-feet apart. Fair goers could take a trip across from one tower to the other at the 210-foot level, or take the elevator farther up to the observation decks at the top of the tower (there were two decks per tower). Steel cable overhead tracks connected the towers at the 210-foot level giving an unmatched observation ride in twelve double-decked "rocket cars" suspended beneath the rails (each car emitted steam intended to resemble a "tail" or rocket exhaust, as it traveled across the wires). The cars were so constructed as to give an unobstructed view in all directions. An endless traction cable drew them across the span, the ride taking about four minutes. At night, lights were focused on the cars as they traveled between the towers, and lights were also attached to the bottom of the elevators. The Sky-Ride cost $1.75 million to erect.



"…Sky Ride mainland tower is near the south end of the Avenue of Flags. The spectacular steel web towers of the Sky Ride, rising 628-feet in the air, are the highest man-made structures west of the Atlantic coast. At their tops are observation platforms from which is obtained a matchless view of the Exposition spread out below you like a brilliantly colored map, with the lake on one side and on the other the miles of buildings of Chicago. At night the scene is an incredible spectacle of colored light and movement…"

RE: excerpt from *The Official Guide Book of the Fair, 1934*

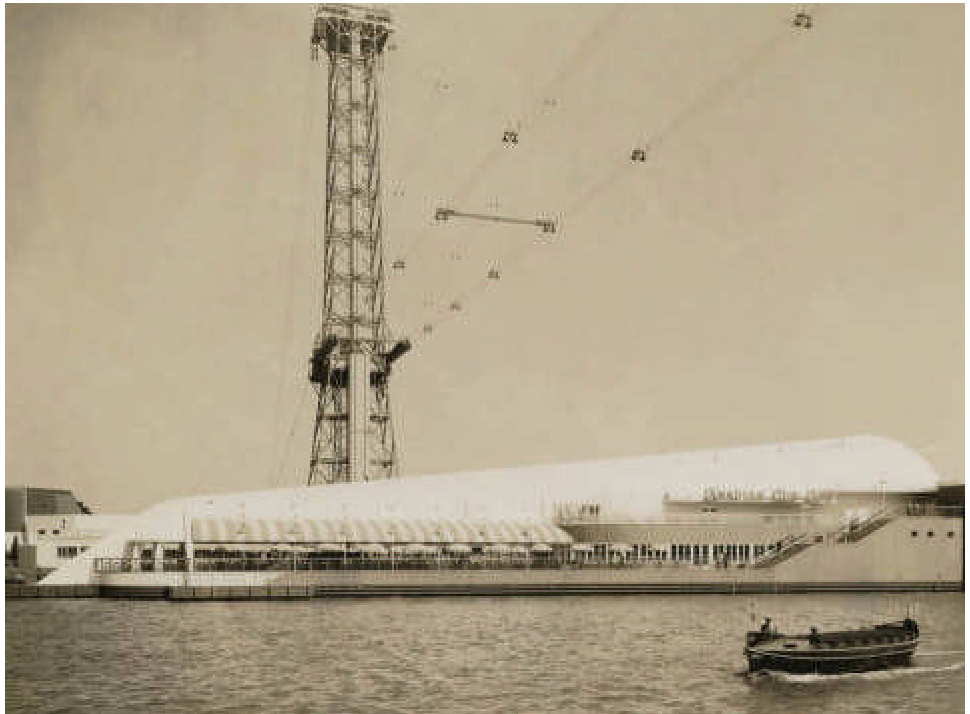


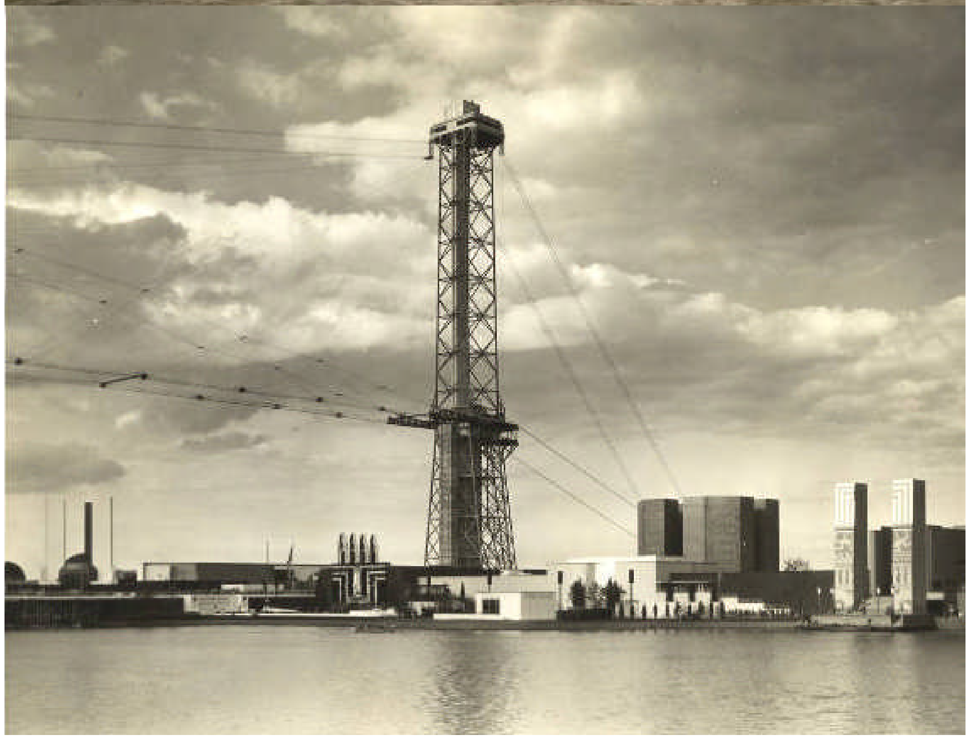
"…In the day, look down, and it is a pattern of many hues, like a gigantic, gay rug, or a vast garden of colorful flowers. Far to the south you look upon Indiana, and to the north upon Wisconsin, to the west, Chicago and Illinois, and eastward across the lake you can see Michigan. Airplanes, and dirigibles may pass, as cars do on the ground, and clouds may swirl about you. You are standing a hundred feet higher than the observation level of Washington monument…"

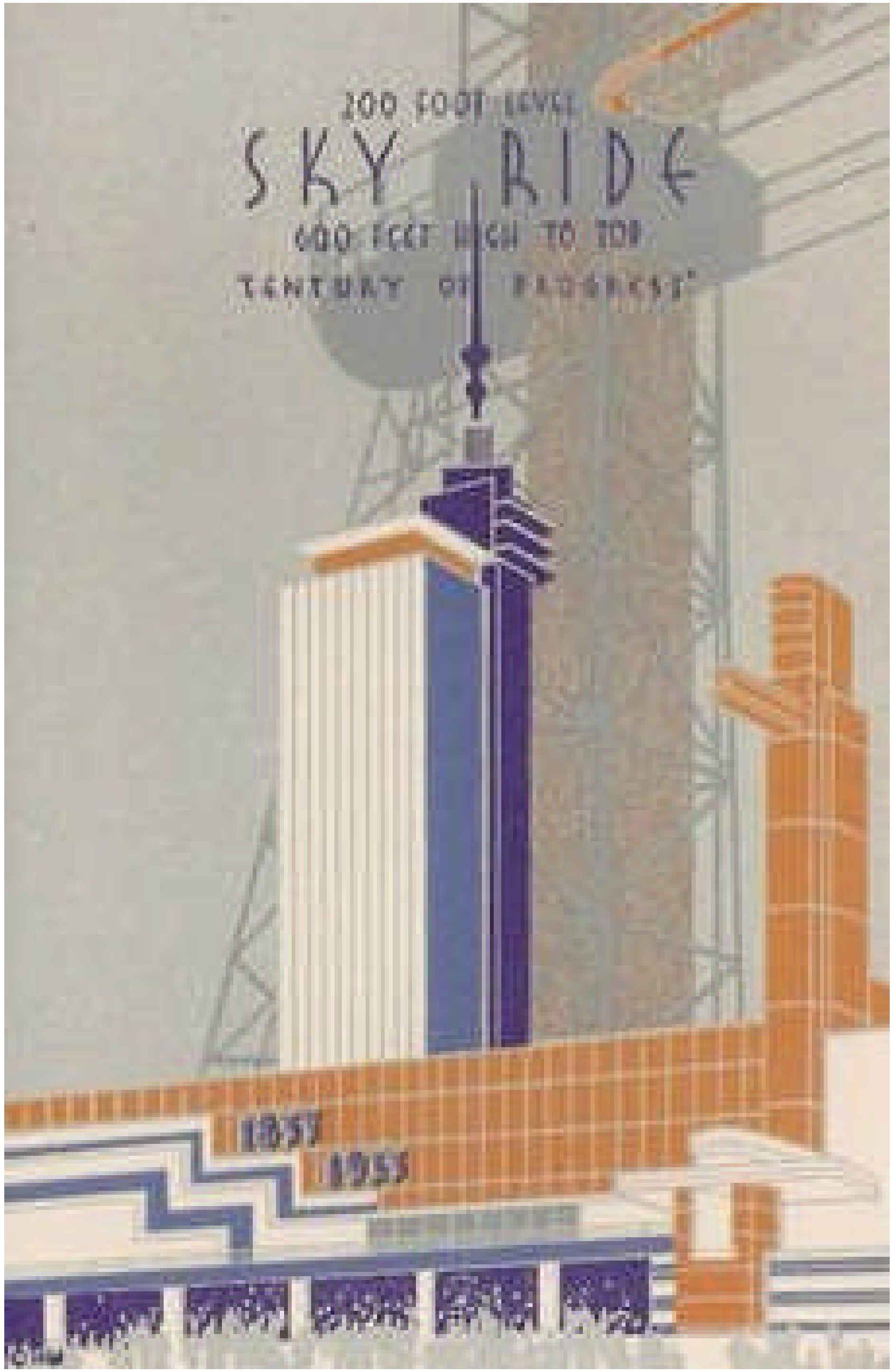
RE: excerpt from *The Official Guide Book of the Fair, 1933*

"…Aerial cable track of the Sky Ride crosses the lagoons at the 210-foot level for a trip between the towers, which are 1,850 feet apart. In the boat-shaped observation cars the ride is a thrilling novelty, enjoyed in perfect safety…"

RE: excerpt from *The Official Guide Book of the Fair, 1934*



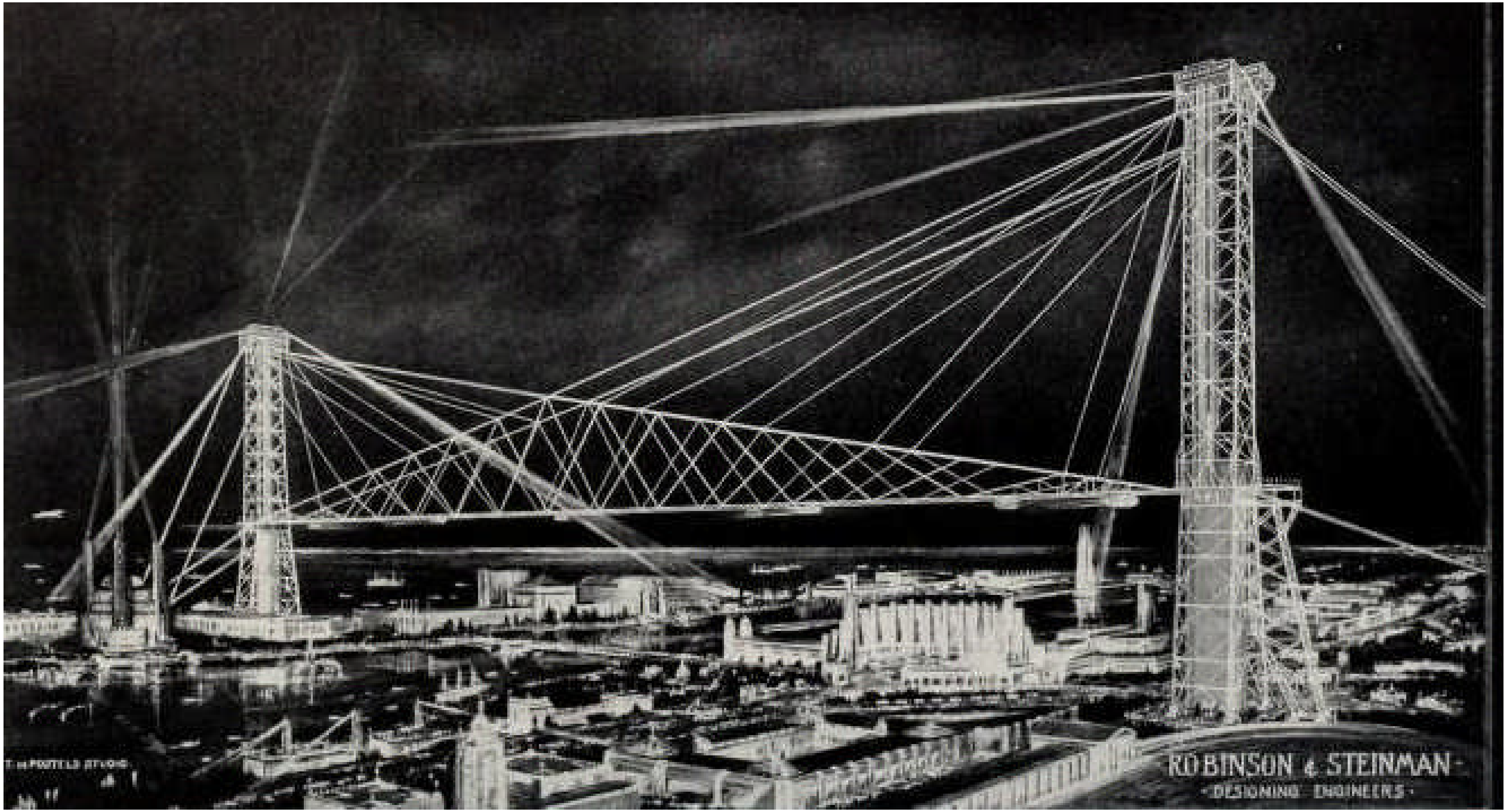




"…On a 200-foot level the rocket cars offer you a beautiful and thrilling ride across the lagoon. These cars are suspended from a cableway which has a breaking strength of 220,000 pounds per square inch of cross section. Only one span in the world, that of the George Washington bridge across the Hudson River just above New York City, exceeds the Sky-Ride cableway in length. The towers and rocket cars can handle 5,000 visitors an hour…"

RE: excerpt from *The Official Guide Book of the Fair, 1933*


PANORAMA OF
A CENTURY OF
PROGRESS



"…The Sky-Ride was built by five great companies, Otis Elevator Company, Mississippi Valley Structural Steel Company, John A. Roebling's Sons Company, Inland Steel Company, and Great Lakes Dredge and Dock Company and is an appropriate expression of their faith in the future of American industry…"

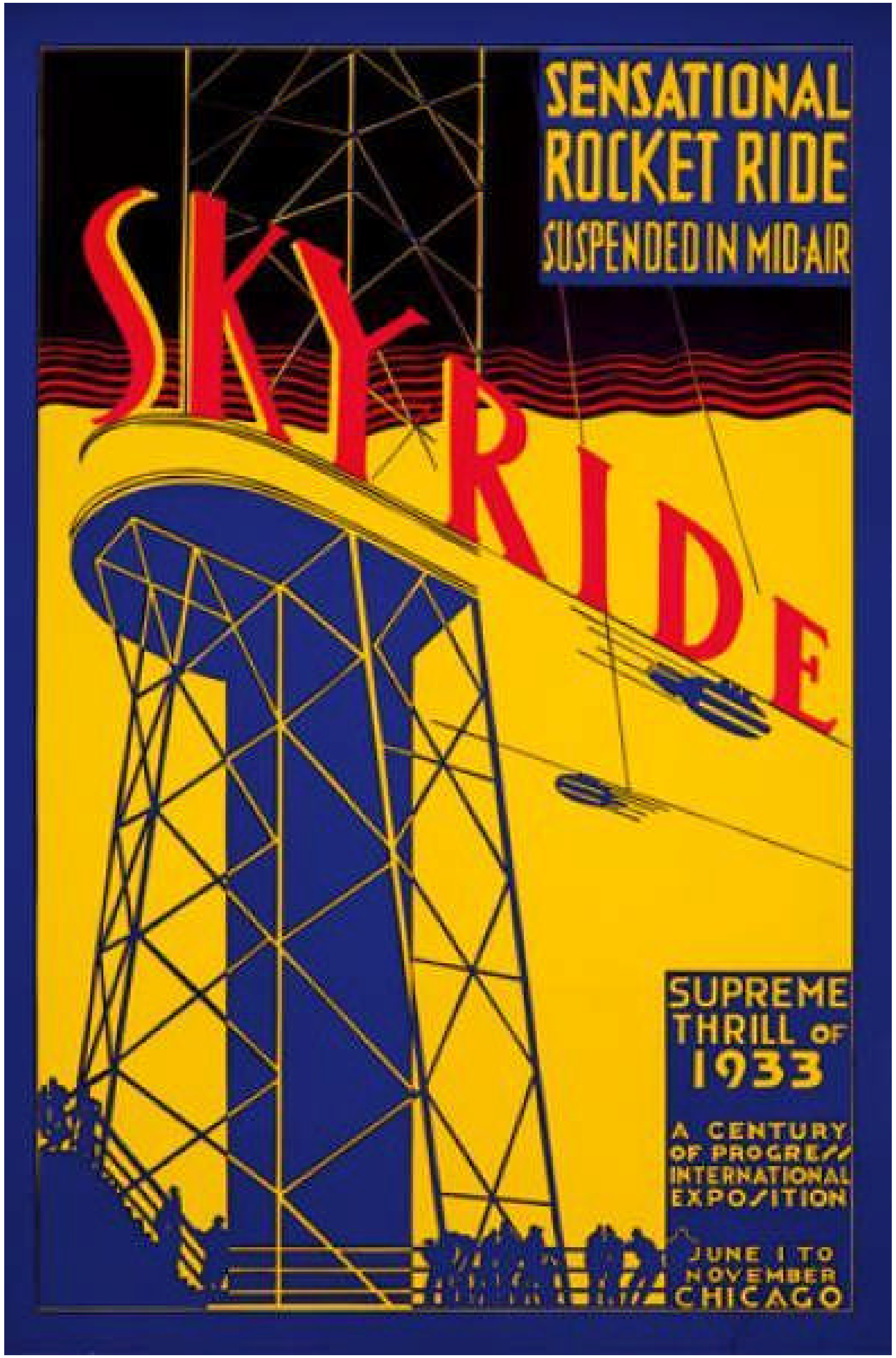
RE: excerpt from *The Official Guide Book of the Fair, 1933*

Science Finds, Industry Applies, Man Adapts

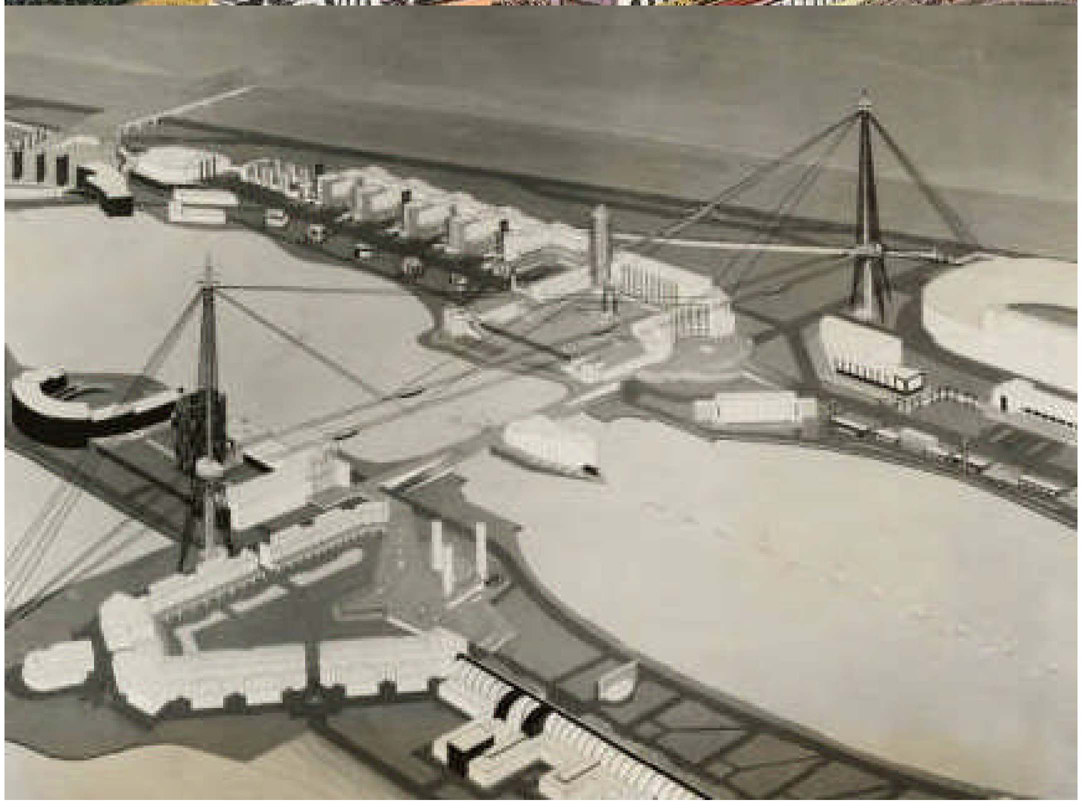
"…The Sky Ride is one of the outstanding engineering works of the century. The network of steel cables connecting them is one of the world's longest suspension bridges, equal in length to the Ambassador Bridge at Detroit connecting the United States and Canada. During the 1933 Exposition 2,616,389 persons went up the towers and crossed in the observation cars…"

RE: excerpt from *The Official Guide Book of the Fair, 1934*

<u>Left</u>: caption: "A painting of a Sky Ride Rocket Car shows full capacity at the Century of Progress International Exposition (1933). The Century of Progress was the World's Fair held in Chicago to celebrate the city's centennial with a focus on technological innovation and a theme of 'Science Finds, Industry Applies, Man Adapts.'"

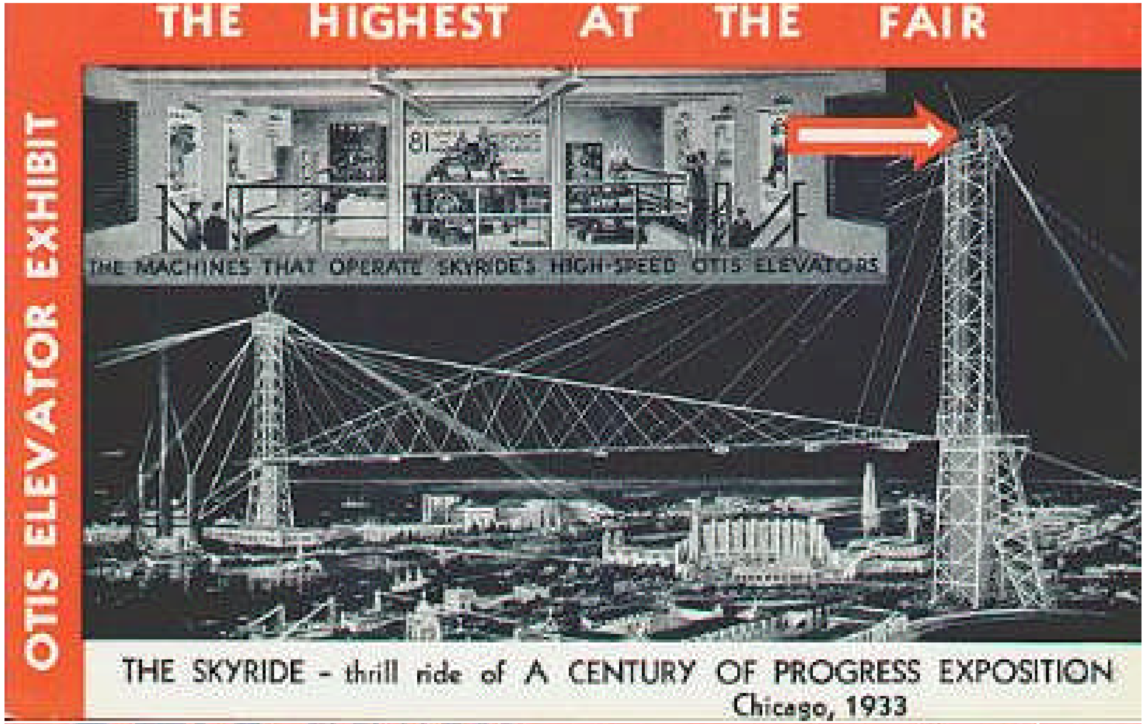


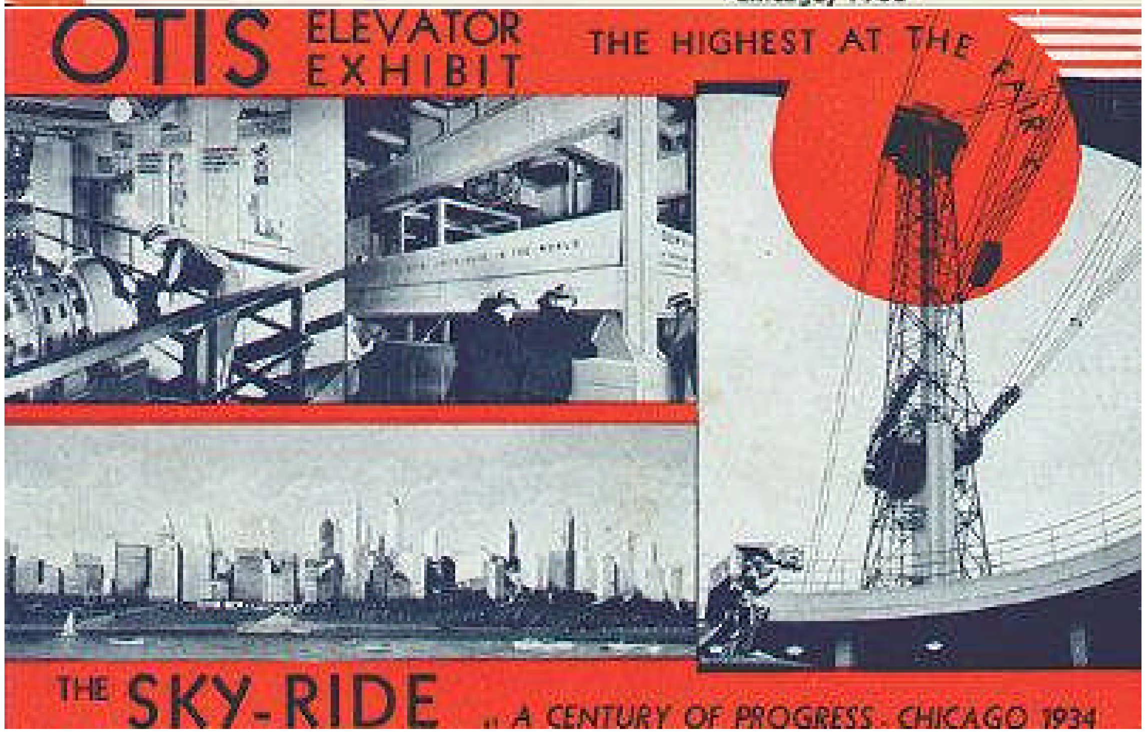
The *Sky-Ride* was a Transporter Bridge (a.k.a. "aerial tramway") designed by *Robinson & Steinman* and built for the *1933/34 Chicago Universal Exhibition* whose motto was: "A Century of Progress." The Sky-Ride was built in just six months by a consortium of five companies: *Great Lakes Dredge and Dock Company*, *Inland Steel*, *John Roebling's Sons*, *Mississippi Valley Structural Steel* and the *Otis Elevator Company*. To the despair of the fair's architects and planners, this "attraction" became the symbol of the exhibition. More common in Europe, only two Transporter Bridges were ever built in the U.S. (the *Aerial Lift Bridge* in Duluth, MN., in 1905, and the Sky-Ride. Due to capacity constraints, the Duluth bridge was converted from a Transporter Bridge to a more conventional vertical lift bridge (with a raisable through truss span) in 1930.



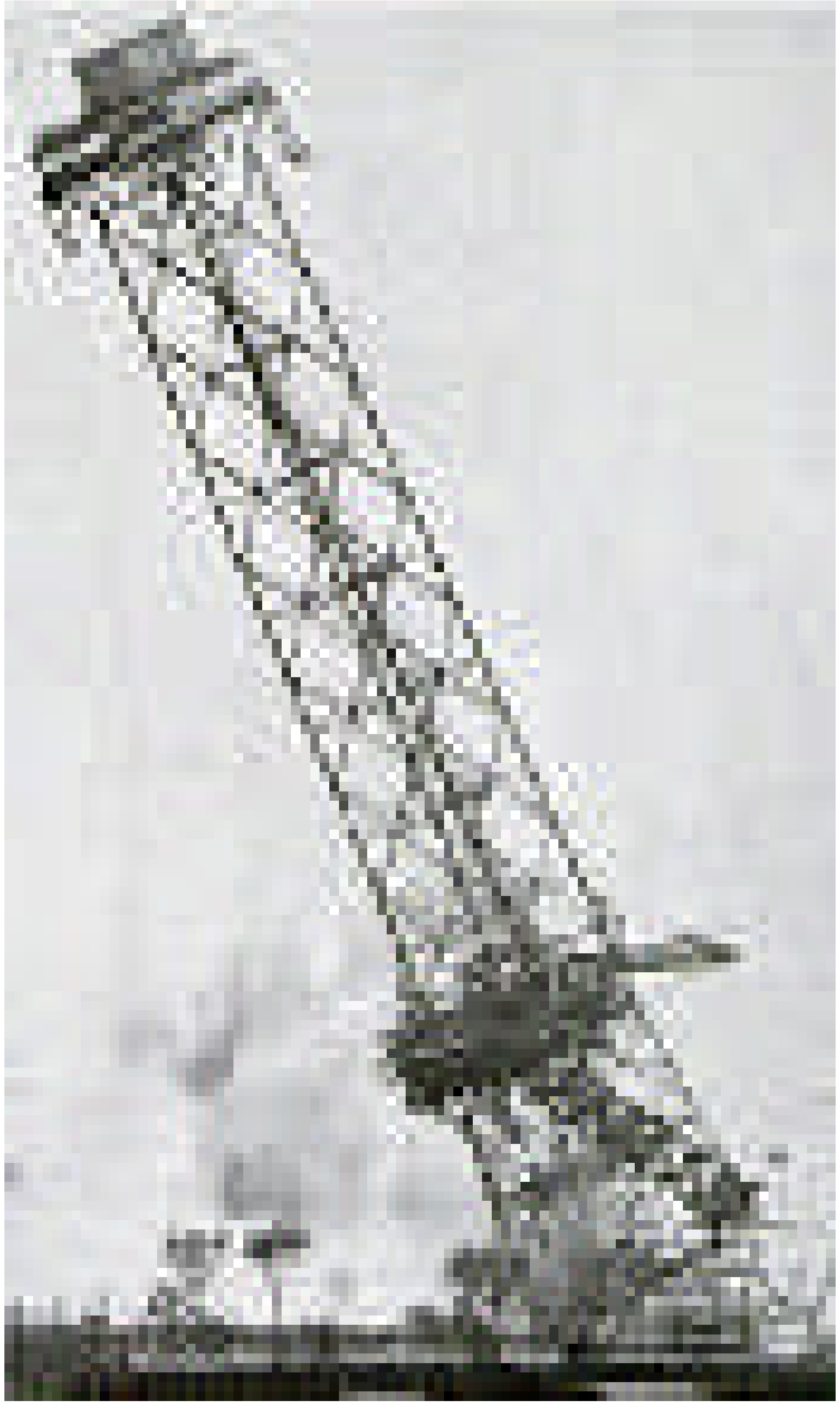
"This structure will mark the opening of a new era in bridge designing. It is much cheaper to erect; it can be built faster; it will enable us to build longer spans, and it will be just as practical as the standard-type bridge now generally used. It demonstrates for the first time that steel is most efficient when it is in tension, and the cables used have four times the strength of steel members. These are the highest towers in the world in which welding is employed exclusively in the fabrication, and this use, to date, is the most important advance in the development of welding processes. The span is 1,850-feet long and it would require only more time and material to make one ten times as long – in other words, more than three miles."

***Dr. D.B. Steinman,* Robinson & Steinman, Consulting Engineers**





The trip to the top/s of the two towers took less than one minute in the Otis Automatic High-Speed Elevators. The eight *Sky-Ride* elevators (four to each tower - two to the 200-foot level and two to the top) carried six million passengers in five-and-a-half months in 1933 - a new record for intensive elevator service. The low rise car's speed was 500 fpm, capacity thirty. The high rise car's speed was 700 fpm, capacity twenty. An *Otis Elevator Exhibit* was at the top of each tower. Once there, fair visitors could observe the elevator machinery in operation.



"Intense heat was employed by wrecking engineers in toppling the 3,000,000-pound east tower of the 'Skyride,' a major attraction of Chicago's Century of Progress…thermite generated a temperature of more than 5,000 degrees about the two legs, melting the ten-foot sections almost instantly, causing the tower to tip and then crash…"

***Popular Mechanics,* November, 1935**

RE: the *Sky-Ride* was demolished at the conclusion of the fair. The west tower was brought down using 120 pounds of dynamite while the east tower was toppled on August 29th 1935 using 1,500 pounds of thermite charges (to melt ten-foot sections near the bottom of two of the legs).

A CENTURY OF PROGRESS
EXPOSITION-1934
SEE CHICAGO

Part 7

Through the Years

Post-War

An Otis passenger elevator is part of the *Karapiro Hydro-Electric Station* (one-hundred miles south of Auckland, New Zealand) on the *Waikato River*. Otis installed the fully automatic elevator in 1946 during construction of the power station on the Waikato, New Zealand's longest river at two-hundred and twenty miles. At the time, Otis operated in New Zealand under the name "Waygood-Otis."

Left: 1951 travel/publicity poster for New Zealand with caption: "Karapiro Hydro-Electric Station"

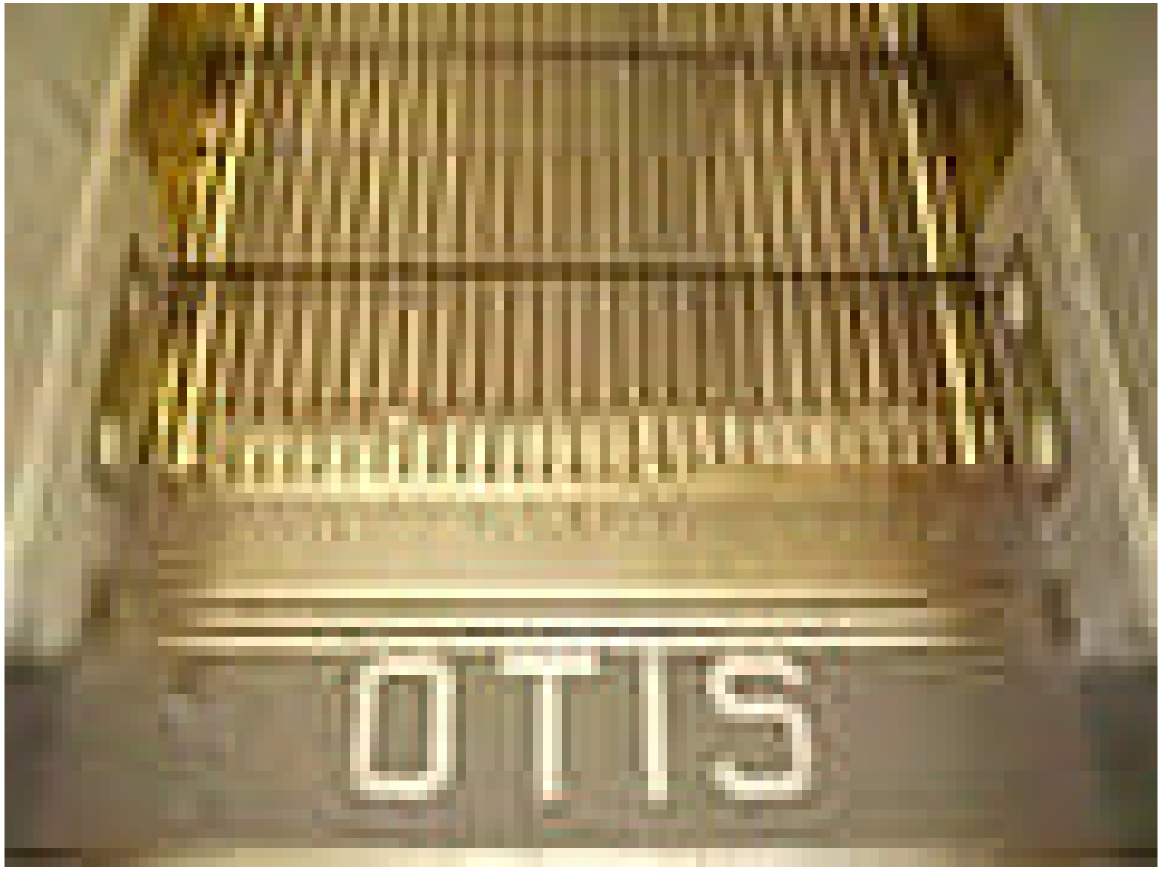
Also in 1946, Otis introduced the first illuminated escalator. The balustrades glowed with a soft, translucent light; an effect designed by *Eleanor Le Maire*. Understanding the merchandising value, the *Rike-Kumler Department Store* in Dayton, Ohio (above), was the first to have this type of escalator installed to transport shoppers from the basement to the sixth floor. Rike-Kumler was so pleased that they increased their original order from twelve to fourteen (to lure customers to the seventh floor).

Left: caption: "You know the answer. It's something 'extra' at a fair price. In a store, shopping convenience may be the extra. Or, patrons may be drawn by simple things like friendliness and trusted good taste. Customers for Otis escalators are the same way. Like shoppers in stores, they try to buy important things wisely, from sellers they trust. Certainly, vertical transportation is a major purchase. It can boost a store's sales. Yet mistakes may cut traffic capacity, and they're very costly to correct. Otis has solved many problems to make an escalator installation as painless as possible. Special features help craftsmen of different trades cooperate. This cuts installation time and cost. We interfere very little with shopping activities, and we get our work done promptly. Most important, an Otis customer can count on good performance, day after day, for years and decades…" (ca. 1949 Otis ad)

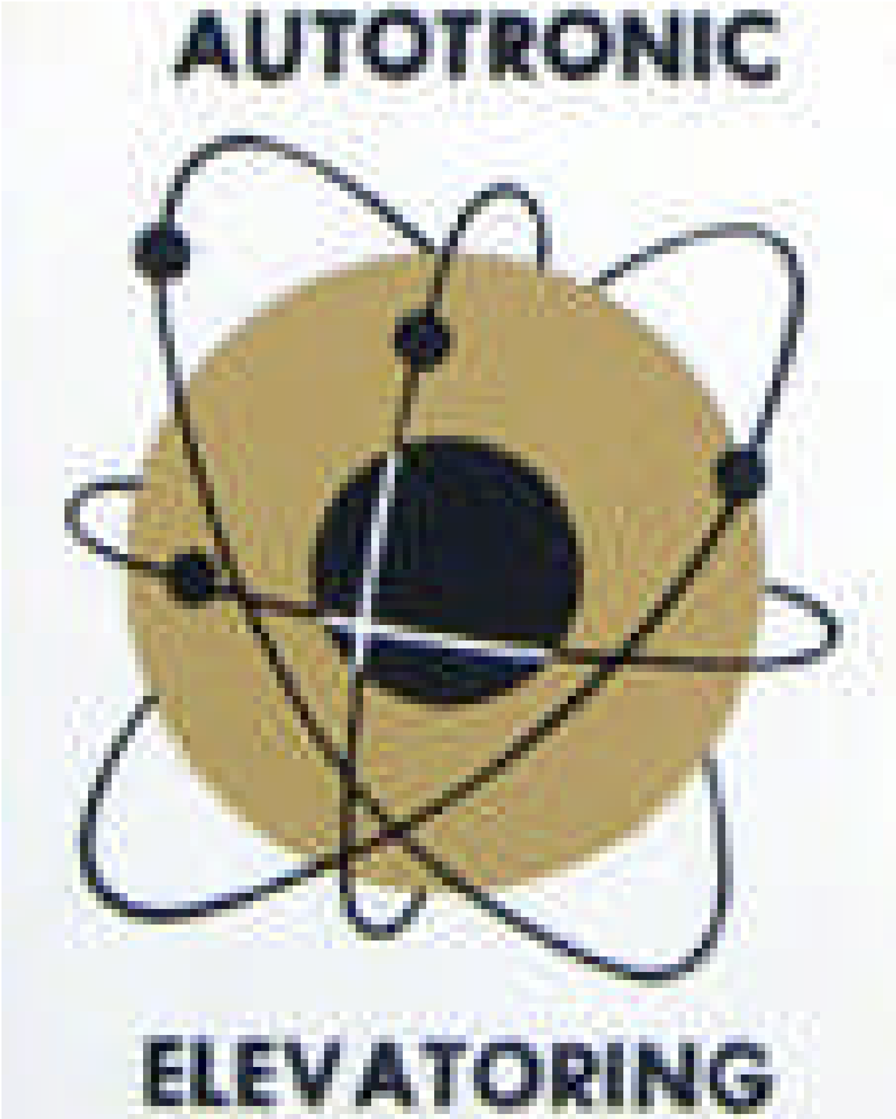
In 1947, Otis installed the first escalator in the Republic of Colombia - in the *Compania Colombiana de Seguros Building* in Bogota (left). The escalator ran at right angles to the stairway, a peculiar installation necessitated by the construction of the building, which also had four gearless and two geared Otis *Signal Control* elevators.

The Last Word in Escalator Design

Left: caption: "HERE NOW – the first Escalator designed especially for the medium-sized and smaller building. The result of many years' research, this new escalator has all the time-tested features of earlier models, plus a wealth of post-war design features…It is truly the last word in Escalator design. Capable of carrying 5,000 people an hour, it handles more persons per dollar investment than any other moving stairway. Wide enough to comfortably carry an adult and child in one step, it is the ideal size for most stores, stations, plants, banks and other public buildings. Yet for all its spaciousness , it requires less space and structural work than narrower moving stairways. Best of all there has been no compromise with quality, in eye-appeal, in safety, in the inherent ruggedness that makes for long life and low upkeep, it is the equal of any Escalator we ever built. And remember, only Otis makes Escalators." (1947 Otis ad)

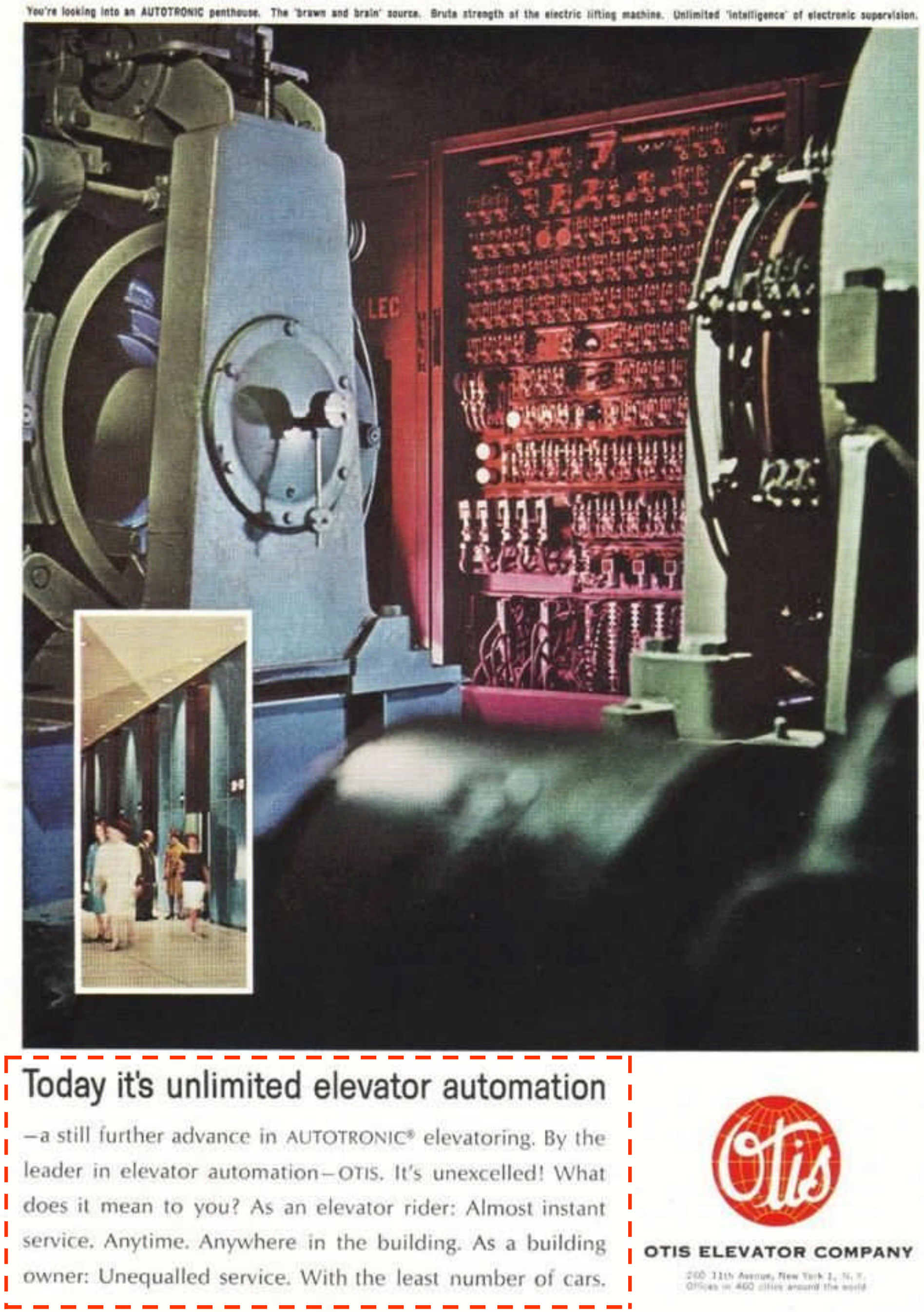

OTIS

Autotronic Elevatoring



In the late 1930s, elevator operators began to be displaced by rudimentary automation and push buttons. Passengers did not embrace the new systems as enthusiastically as building owners (who enjoyed saving the expense of an operator). By 1948, Otis had introduced the *Autotronic e*levator, one that was not only operatorless, but capable of launching itself to wherever it was needed, based on time of day and anticipated traffic patterns.

<u>Left</u>: caption: "'How would my tenants react to operatorless elevators?' This question is uppermost in the minds of building managers who are concerned with today's spiraling operational costs. Why not ask your tenants? Otis AUTOTRONIC elevators give tenants a sprightly feeling of independence. Riders simply step into the car and press buttons for the floors they want. Everything else is completely automatic. We've found that tenants like the idea of self-service elevators. They push buttons for each other. They tell new riders what to do. Everybody's friendlier. Tenants quickly accustom themselves to automatic door closing. The Otis Electronic Elevator Door inspires confidence with its 'electronic politeness.' A two-way communication system in the car keeps the riders from feeling alone. Employees feel more independent, especially when making interfloor trips. We'll be glad to help you explain Otis AUTOTRONIC elevatoring to your tenants. Call any of our 27 offices."
(1955 Otis ad)

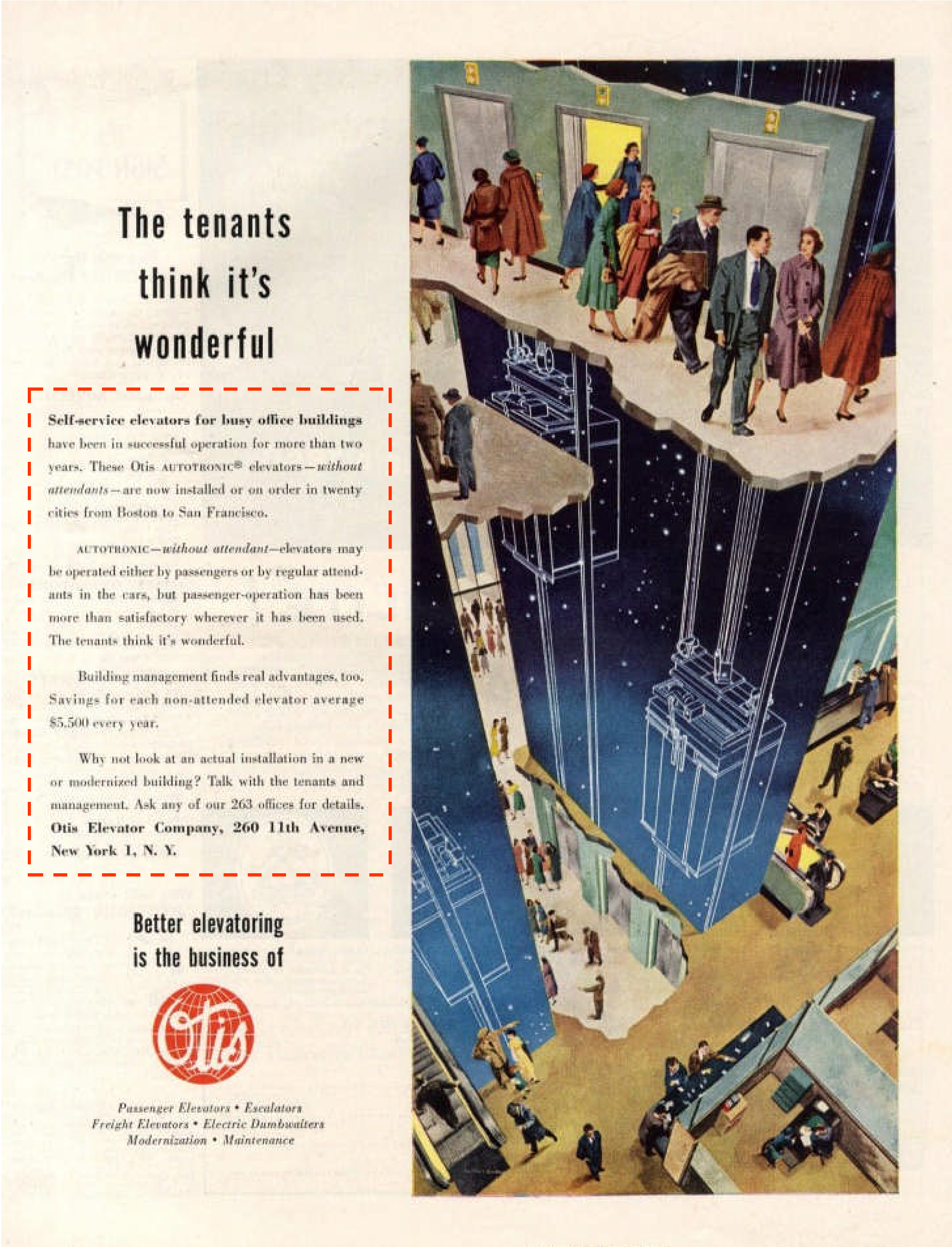


<u>Left</u>: caption: "Today it's unlimited elevator automation – a still further advance in AUTOTRONIC elevatoring. By the leader in elevator automation – OTIS. It's unexcelled! What does it mean for you? As an elevator rider: Almost instant service. Anytime. Anywhere in the building. As a building owner: Unequalled service. With the least number of cars."
(1962 Otis ad)

Autotronic – *Without Attendant* - Elevatoring

***Autotronic* elevators proved highly successful; as both money-savers (for building owners) and time-savers for (occupants and visitors). The first Autotronic system was installed in the *Atlantic Refining Building* in Dallas, Texas, in 1950. In a letter to Otis, the building's chief engineer said the new elevators allowed the 130K square-foot building to be emptied in less than ten minutes.**

<u>Left</u>: caption: "Otis Autotronic - Without Attendant - Elevator, 1950." New Orleans' *California Company Building* opened in October 1950, featuring four of the new attendant-less elevators. The Auttronic elevators were programmed so that when one ascended from the first floor, an elevator on the top floor would simultaneously descend to replace it.



<u>Left</u>: caption: "Self-service elevators for busy office buildings have been in successful operation for more than two years. These Otis AUTOTRONIC elevators – *without attendant* – are now installed or on order in twenty cities from Boston to San Francisco. AUTOTRONIC – *without attendant* – elevators may be operated either by passengers or by regular attendants in the cars, but passenger-operation has been more than satisfactory wherever it has been used. The tenants think it's wonderful. Building management finds real advantages, too. Savings for each non-attended elevator average $5,500 every year. Why not look at an actual installation in a new or modernized building?"
(1952 Otis ad)

<u>Left</u>: caption: "Autotronic – WITHOUT ATTENDANT – Elevatoring offers, as an optional feature, a completely automatic supervisory system. When it is in operation, the starter does not have to change the traffic programs manually. The completely automatic supervisory system is kept aware of every traffic change during a busy building's day – by the traffic itself! Passenger calls and waiting time data are recorded continuously. A change in the traffic pattern is detected automatically. Is the traffic Balanced UP-DOWN, Heavier-DOWN, Heavier-UP, DOWN-peak, UP-peak, Light-INTERMITTENT? When this question is answered, the automatic program selector puts a corresponding traffic program into operation immediately. Autotronic – WITHOUT ATTENDANT – Elevatoring has an 'automatic elevator operator' on duty in each car every minute of the day. This saves up to $7,000 a car, each year. Six automatic programs operate the cars as a coordinated group. Diversified traffic can be handled in large, or small, office buildings, hotels and hospitals."
(1953 Otis ad)

The Zone of Detection

This advertisement from the mid-1950s high-lights an additional feature of the *Autotronic* elevator: the *Otis Electronic Elevator Door*.

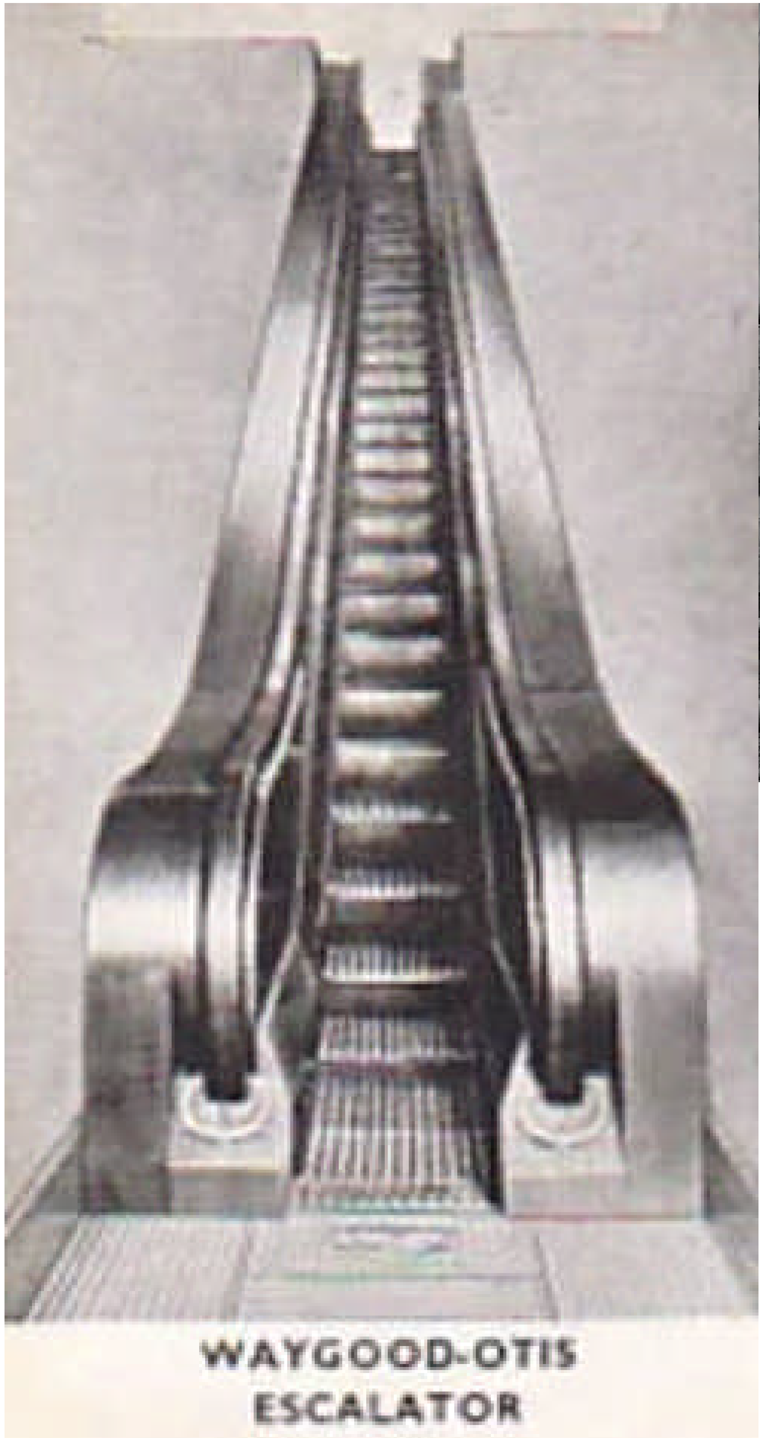
<u>Left</u>: caption: "Passengers quickly discover why they like the Otis Electronic Elevator Door. It's the invisible electronic zone of detection that extends in front of the leading edges of both car and hoistway doors up to shoulder height – *as shown in phantom above*. It inspires passenger confidence. Whenever this *electronic zone* de-tects a person's presence in the doorway, the doors politely reverse before they can touch the passenger. But if there is no chance of pass-enger interference, the doors close promptly after each stop. This *zone of detection* prevents unnecessary delays. If a talkative passenger ling-ers overlong in the doorway, a buzzer sounds and the doors slowly, firmly - but politely nudge the passenger out of the doorway so that the car can proceed on its way. The Otis Electronic Elevator Door is the crowning achievement in the field of the operatorless elevator. Its successful development insured the ability of operatorless elevators to move great masses of people in busy buildings with the greatest degree of safety…"

The passenger is seldom aware of door movement

Otis vertical transportation systems were an essential part of many landmark buildings, including the *United Nations Headquarters* in NYC (1948). It had a total of thirty-three Otis elevators and fourteen Otis escalators installed in the three main buildings.

The Gearless Machine Assembly section of Otis' former Yonkers, NY factory was usually a bustling, busy place during a routine working day. Down its neat and orderly aisles passed many of the high-speed elevators of the world in the late 1940s. To make a time-exposure photograph for the July 1949 employee publication: *the Otis Bulletin* (June 1948 issue, at left), all work was stopped, overhead cranes moved out of the way and the electric trucks were chased off the floor.

Down Under



The *Waygood-Otis* factory in Sydney, Australia, was in production in 1953. The British firm *Waygood* was bought by Otis in the late 1800s and became "Waygood-Otis." By 1926, Waygood-Otis had installed twenty-eight gearless elevators in a Sydney department store. Australia's first escalators were installed in Melbourne in 1932.

Above: caption: "Waygood-Otis Escalators"

WAYGOOD-OTIS LIFTS

NEW OFFICES FOR MESSRS. THE ASSOCIATED NEWSPAPERS, LIMITED

MESSRS. H. O. ELLIS & CLARKE, FF.R.I.B.A., ARCHITECTS

EQUIPPED WITH 2 PASSENGER & 1 GOODS WAYGOOD-OTIS LIFTS

HEAD OFFICE & WORKS:
FALMOUTH ROAD, S.E.1.

TELEPHONE:
HOP 5644 (DAY & NIGHT)

BRANCHES IN ALL
PRINCIPAL CITIES

Fitted with four WAYGOOD-OTIS Electric Passenger Lifts, arranged with Patent Micro Self-levelling Apparatus.

WAYGOOD-OTIS LTD.

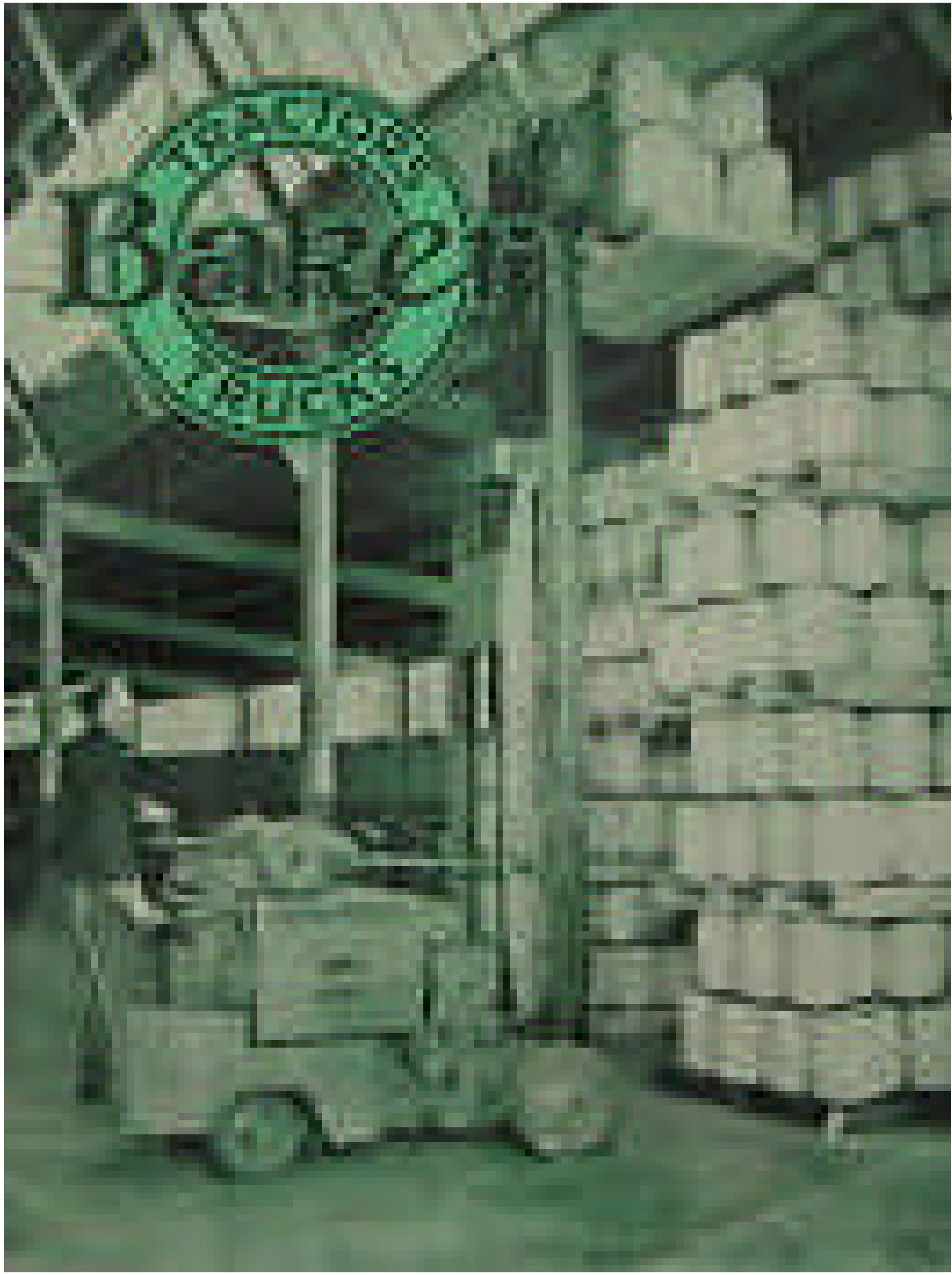
54 & 55 Fetter Lane, London, E.C.4.
62 & 63 Lionel Street, Birmingham.

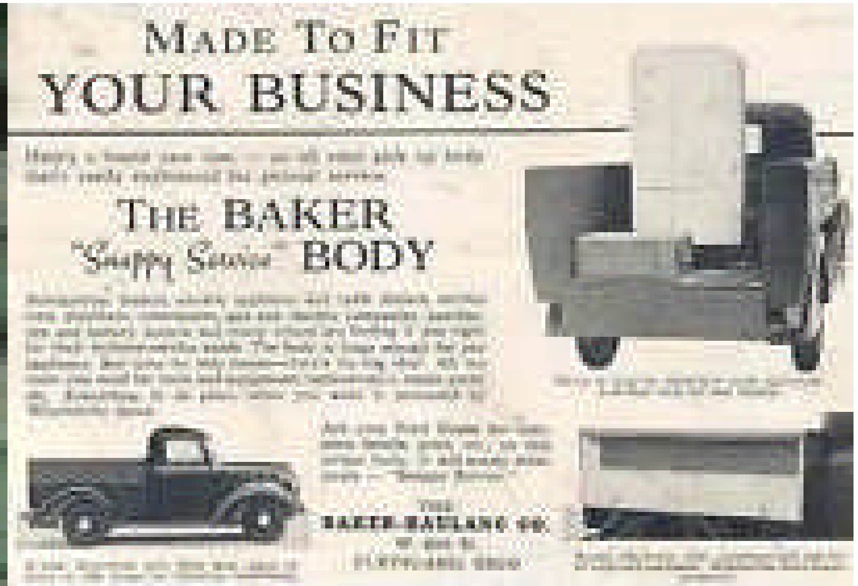
Telephones: Holborn 2001, Central 307

And principal Provincial Cities and Abroad.


WAYGOOD-OTIS

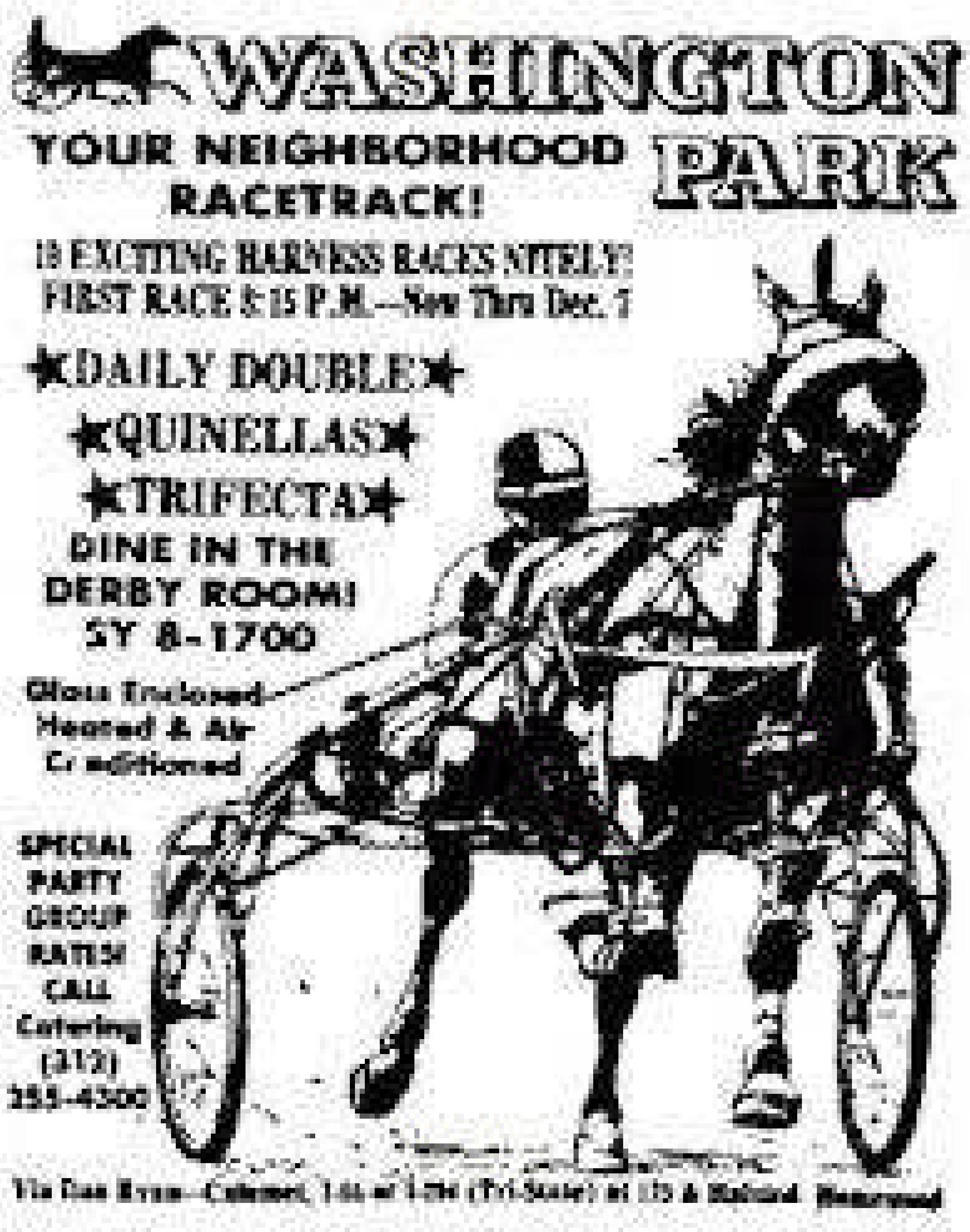
Diversification





In 1954 (in line with top management's vision of Otis as a short-distance mover), Otis acquired the *Baker-Raulang Company* of Cleveland, Ohio, which made forklifts and short-haul industrial trucks (1938 Ford Baker-Raulang Pickup Truck ad above). *Baker* remained part of Otis from 1954 to 1975 (forklift ad at left).

<u>Above</u>: caption: “The new gas-powered BAKER TIGER Series is an all new breed of cat. It’s designed to obsolete 20% of your present truck fleet. Four TIGERS wile out-perform, out-run and out-maneuver any other five comparable fork lift trucks. When your serviceman checks the design and construction of this Tiger truck, he’ll immediately recognize the built-in accessibility features which cut this Tiger’s down-time as much as 97%. He’ll purr like a kitten in a catnip patch. Now blend in other TIGER features like low profile for greater safety and stability…instant response from baker’s new ‘Tiger Torque’ transmission…cross-braced masts to reduce distortion from off-center loading…faster, smoother travel and lift speeds. Baker Division - Otis Elevator Company, Cleveland Ohio.”



With a rise of 33-feet 6-inches and a top-to-bottom length of 67-feet the escalator in the *Washington Park Race Track* in Homewood, Ill. (above), was, in 1955, the largest of the Otis 32R series ever installed (the average department store escalator runs about 30-feet in length).

__Left__: ***Tsutenkaku*** **(a/k/a "Tower To Heaven") in Osaka, Japan, contains a circular shaft housing a round elevator cab designed and built by** ***Toyo-Otis*** **in 1956. The round cab installed in Tsutenkaku was the first outside the U.S. Toyo-Otis designed a translucent plastic ceiling for the car, studded with artificial jewels to give riders the effect of a miniature constellation overhead. The tower is 340-feet high.**

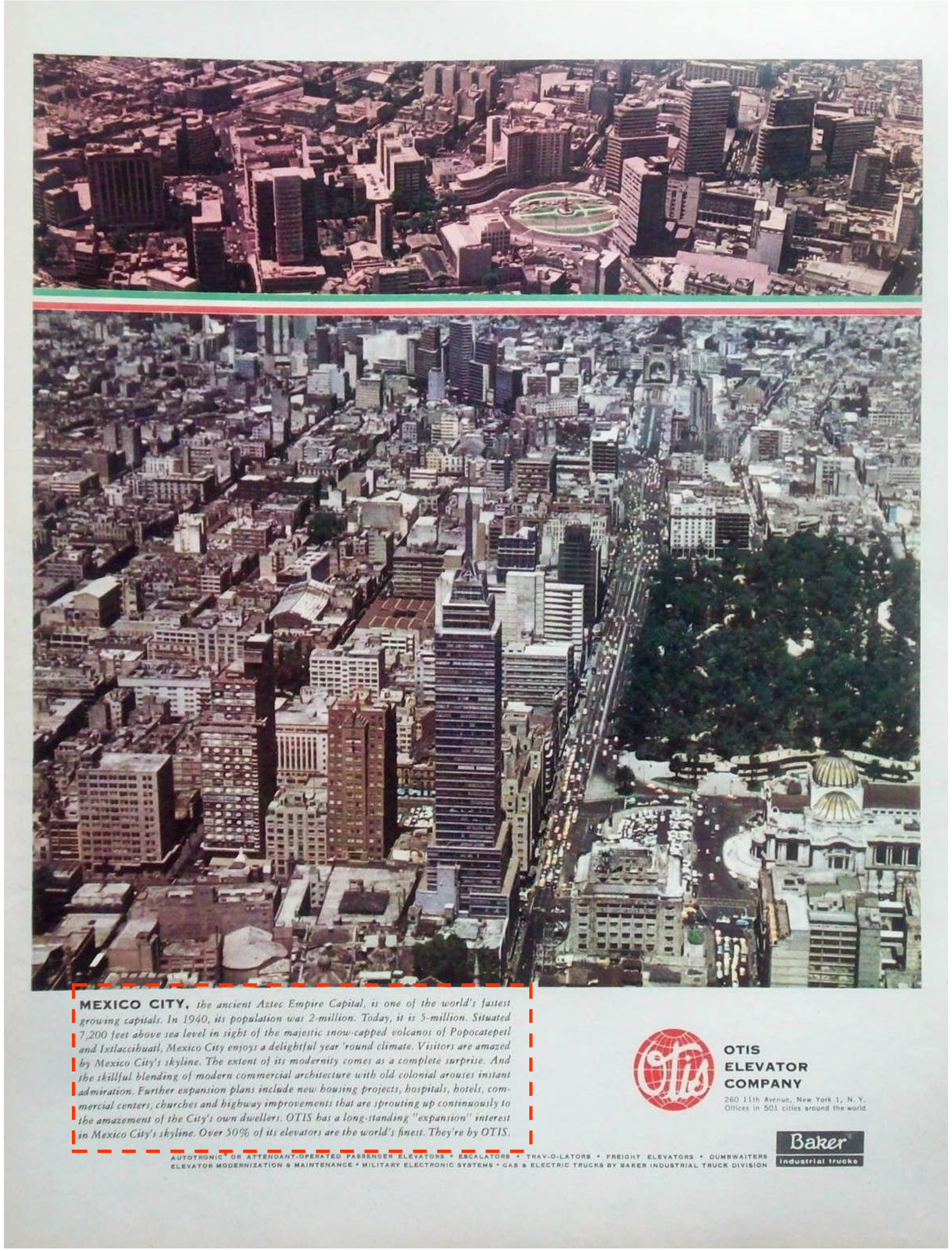
Otis Street

"This is to inform you that the Senate of Berlin passed the resolution for the new street name, Otis Strasse, leading from the 'Seidelstrasse' to the 'S' Bahn railway line Berlin-Velten under date of July 19th, 1956."

RE: letter from the Berlin Senate, District Board of Reinickendorf, to the management of *Flohr-Otis*, dated August 9th 1956. Berlin's "Otistrasse" joined other streets identified with the Otis company. Manila, capital of the Philippines, also has an "Otis Street." This avenue commemorates a relative of *Elisha Graves Otis*, General *Elwell S. Otis*, who was commander of the U.S. Military Forces in the Philippines at one time. Rochester, N.Y., also has an Otis Street, as does Washington, D.C.

Above: *Otisstrasse U-Bahn Station*. The station is close to the *Otistrasse* thus, it was renamed in honor of Otis' long-time presence in Berlin.

<u>Left</u>: the *Pirelli Building* in Milan, Italy, is home to Italy's largest maker of tires and other rubber products. Completed in 1960, it was described by Otis' employee publication; *the Otis Bulletin*, as: "the newest addition to Milan's tradition of architectural leadership." Milan is Italy's second largest city and was one of the important industrial targets for Allied bombers during WWII. In 1943, an air-raid destroyed Pirelli's Milan offices (located near the city's Central Station) in an area known as the *Brusada*. Rebuilding the Brusada and establishing its headquarters there would crown Pirelli's post-war comeback and bring the company back to where it had its start in 1872. The Pirelli Building - at thirty floors (407-feet) dominates Milan's ancient towers and rooftops, making it the highest in Milan and it still ranks among the highest office buildings in Europe. *Stiglar-Otis* supplied the building's twelve elevators.



<u>Left</u>: caption: "MEXICO CITY, the ancient Aztec Empire Capital, is one of the world's fastest growing capitals. In 1940, its population was 2-million. Today, it is 5-million. Situated 7,200 feet above sea level in sight of the magestic snow-capped volcanoes of Popocatepetl and Ixtlaccbuatl, Mexico City enjoys a delightful year 'round climate. Visitors are amazed by Mexico City's skyline. The extent of its modernity comes as a surprise. And the skillful blending of modern commercial architecture with old colonial arouses instant admiration. Further expansion plans include new housing projects, hospitals, hotels, commercial centers, churches and highway improvements that are sprouting up continuously to the amazement of the City's own dwellers. OTIS has a long-standing 'expansion' interest in Mexico City's skyline. Over 50% of its elevators are the world's finest. They're by OTIS."
(1960 Otis ad)

__Left__: **construction of the 772-foot *FM Tower* in Johannesburg, South Africa, was completed in 1962. At the time, it was the tallest man-made structure in Africa. The tower, designed principally to support FM antennae to broadcast microwave signals, featured an Otis South Africa elevator that carried tower visitors up 585-feet to the lowest observation level. Today, the FM Tower is known as the *Sentech Tower* and broadcasts radio and television signals.**

__Above__: **also in the 1960s, two Otis elevators were used to transport miners and carloads of iron ore deep within the *Thabazimbi Mine* in South Africa. The elevators were side-by-side in a single elliptically shaped hoistway. The passenger elevator was rated at 1,050 pounds while the freight elevator could carry a full load of 40K pounds and traveled at 100 fpm.**

Speed-Park

"Theater-goers in New York's Times Square are have something new to talk about: a garage that can park or unpark 27 cars in 10 minutes with only one attendant on duty. It's all done by push button and it works this way: Drive up in your car onto a receiving platform, get out, and you're handed a key. (It's your receipt, keeps anyone else from handling the car). The lone attendant then presses a button and automation goes to work. Before you've left the building, long fingers have reached under the car and transferred it to an elevator that deposits it in its designated pigeonhole. Getting it back is just the reverse. The insertion of your key sends the elevator to your car's stall to bring it down. Speed-Park garage holds 270 cars. Two special Otis elevators handle the chores."

***Popular Science*, July 1963**

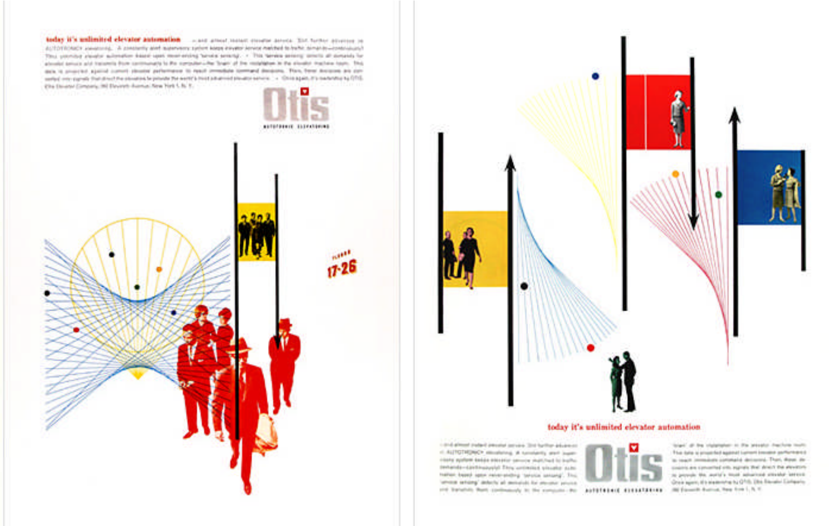
<u>Above</u>: caption (left-to-right): "No attendant jockeys your car in this automatic garage / Key is inserted in control panel / Elevator retrieves car from stall"

Left: caption: "Automation of the Speed-Park System eliminates car jockeys. Parking fee is electronically computed and recorded. The motorist leaves his car in the driveway lobby. All with no dented fenders. Otis Elevator Company cooperated in the development of the revolutionary Speed-Park System. Otis manufactures, installs and maintains Speed-Park."
(1962 Otis Ad)

As the Imagination Fancies

Left: caption: "a great new escalator challenges the imagination, It is the ESCAL-AIRE, by OTIS. Created for tradition-breaking hotel and office building lobbies and shopping center malls. Visualize balustrades that are crystal clear. Light. Airy. Or intriguingly translucent. Tinted. Textured. Sparkling. With handrail colors picked from a rainbow. The new ESCAL-AIRE can be designed to vanish into its setting. Or be subtly inspiring. Or boldly scintillating. As the imagination fancies. The premiere of the ESCAL-AIRE? In the NEW YORK HILTON at Rockefeller Center and SAN FRANCISCO HILTON Hotels."

RE: in 1962, Otis introduced the "Escal-aire." The shortest-rise *Escal-Aire* escalator on record was 5-feet 6¾-inches. It was installed at the *Kahler Plaza Inn* in Orlando, FL in 1976.



<u>Above</u>: "Today it's unlimited elevator information" (1964 Otis ad)

<u>Left</u>: caption: "In the pavilions illustrated: ELEVATORS that herald space age living. ESCAL-AIRE and TRAVL-AIRE transportation that opens up a new universe of materials and colors. Again, leadership by OTIS!" (1964 Otis ad for their elevators and escalators at the 1964/65 New York World's Fair

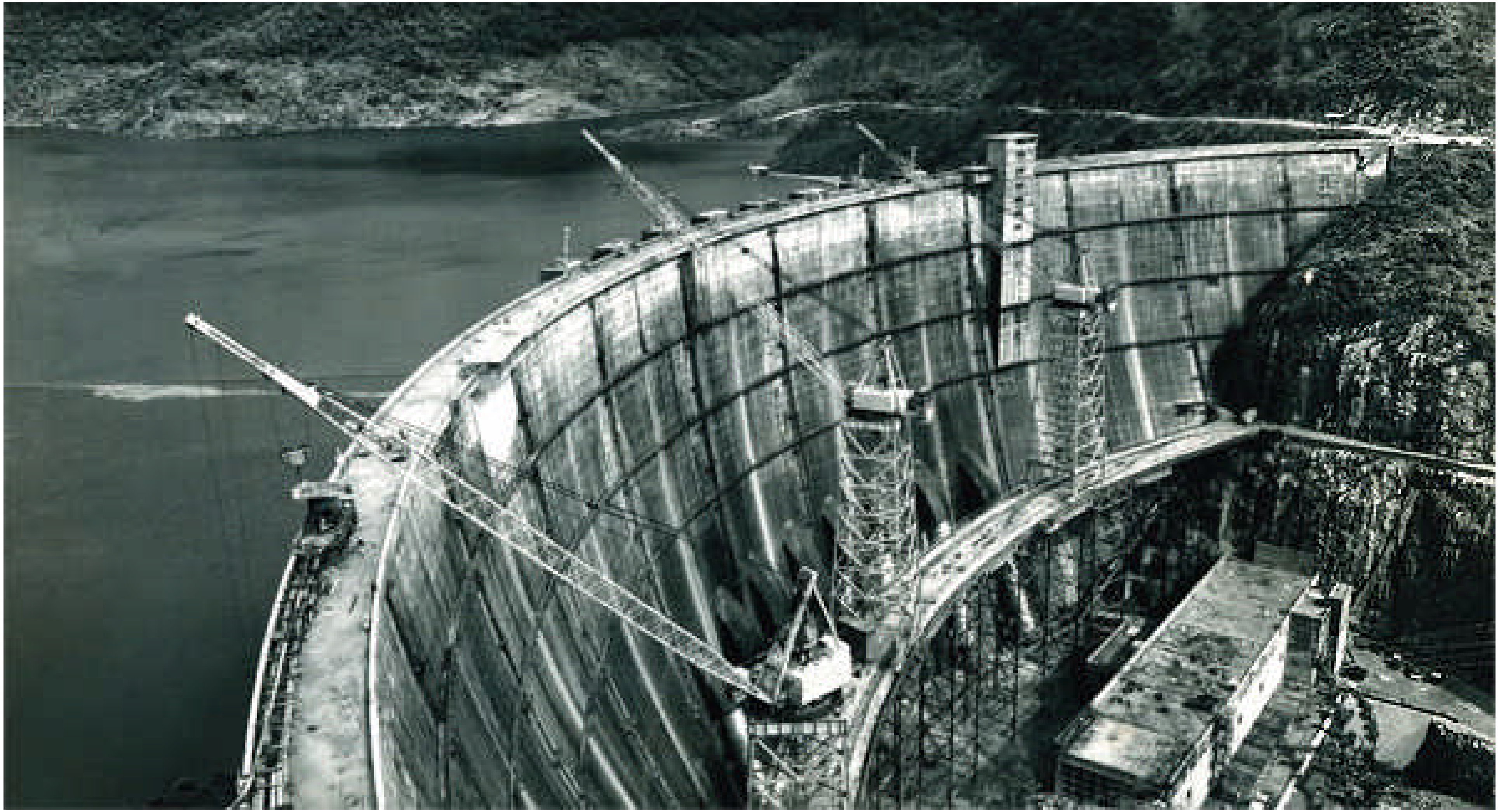

OTIS
ESCAL-AIRE

The *Frankfurt Intercontinental Hotel* (highlighted above) - the largest hotel in Germany when it opened in June 1963, was equipped with Otis equipment: four *Autotronic* passenger elevators, two service elevators and one freight elevator. The hotel is in the heart of Frankfurt's main business district, facing the *River Main*. The Otis escalator facility in Stadthagen, Germany, was constructed in a twelve-month period in 1963 and 1964 on what was once a potato field. The factory, then known as the "Flohr-Otis Plant," encompassed an interior area of 140K square feet. On June 26th 1964, the new manufacturing plant became operational.

ASCINTER

OTIS

Also in 1964, Otis announced the merger of the French companies *Ascenseurs-Otis* and *Ascinter,* with the combined firms to be known as "Ascinter-Otis." The merger represented a major step forward for Otis and the French elevator industry and marked the latest in a series of steps that began in 1884 when Otis in France was established.



Above: about two-hundred and sixty miles northwest of Bangkok, Thailand, a crew of 4K men built a huge new dam and power plant known as the "Yanhee Multipurpose Project." The $100 million undertaking included two Otis passenger elevators for maintenance purposes. When the dam was completed in 1964, it was the largest of its kind in Southeast Asia.

***Allied Bronze Division*, well-known for its metal sculpture fabrication, was an Otis division from 1967 to 1980, supplying balustrades for escalators. Allied worked magic with metals as well as escalator components. Among its projects in the 1970s was a bronze-clad spiral staircase at *Salomon Brothers* in NYC; the metal and glass storefront railings and entrances in the atrium of the *Citicorp Center*, also in NYC (above L&R) and the huge reproduction in the *John Hancock Tower* in Boston of the *Declaration of Independence* (on a single panel of stainless steel).**

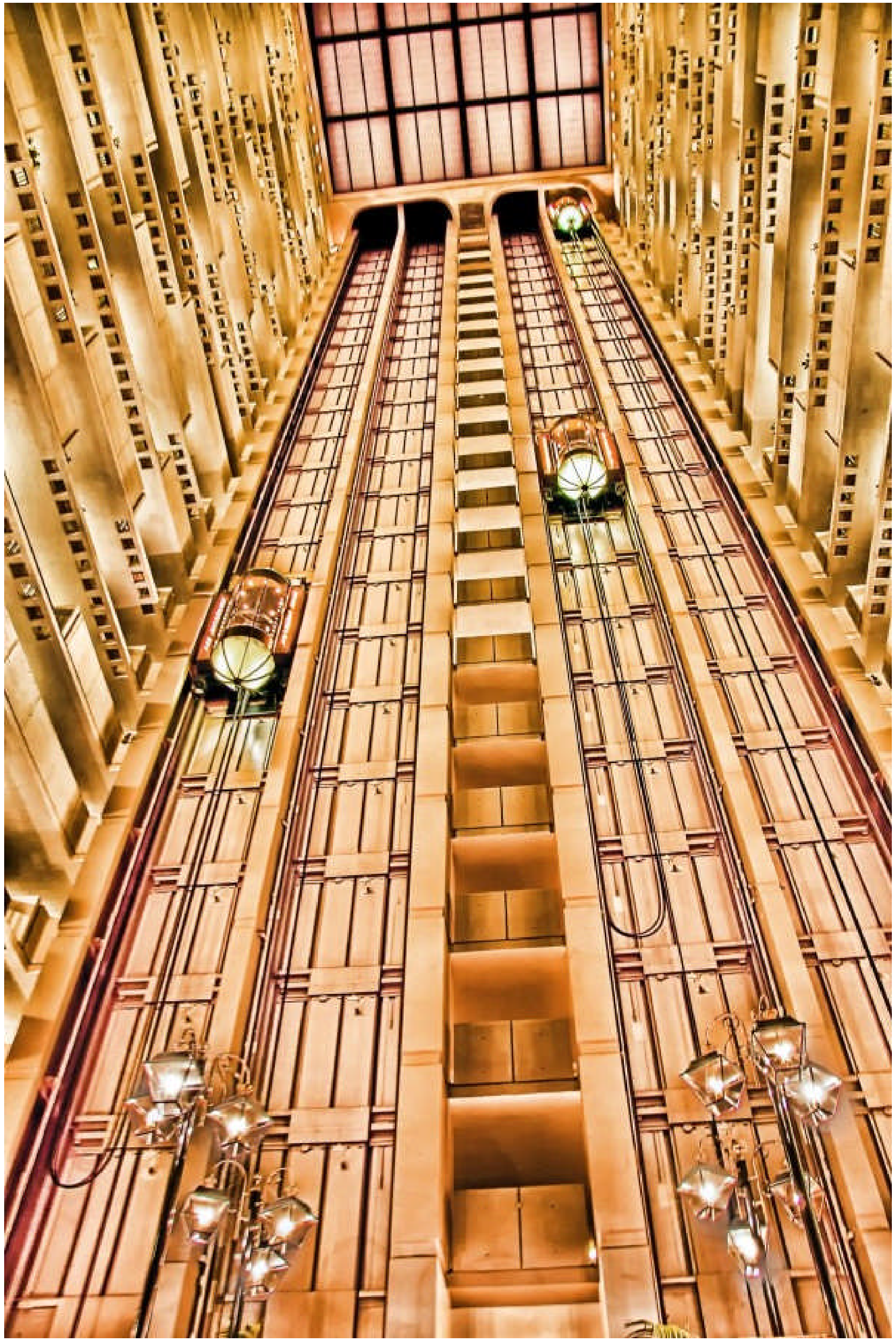
<u>V</u>ery <u>I</u>mportant <u>P</u>assengers

<u>**Left**</u>**: caption: "Electronic detectors with peripheral vision make VIP elevator doors safer than all others. And more respectful. They're exclusive with the world's most sophisticated elevatoring system. At no extra cost."**
(1967 Otis ad)

<u>Left</u>: in April 1968, *Nippon-Otis* completed installation of thirty-five elevators and eight escalators in what was to become Japan’s first skyscraper; the 512-foot *Kasumigaseki Building* in Tokyo. The Otis units included nine elevators with a speed of 1K fpm (considered the most advanced elevators at the time of their installation). The thirty-six floor Kasumigaseki Building was the first modern high-rise building in post-WWII Japan.

At Home Everywhere

<u>Left</u>: caption: "Otis Elevator Company is a true multinational company. We make elevators in twenty different countries…sell, install, and maintain them anywhere in the world. In Brazil, for example, our elevators are designed to fit that country's unique requirements. And we manufacture them there using our own locally made components that are engineered to work together, not just fit together like a jigsaw puzzle. So our customers get more elevator, and a better elevator, for their money. Anywhere in the world, customers find it easy to do business with Otis. Because Otis knows the world. Things like trade balances, tariffs, currency conversion as well as local building codes, electrical requirements, safety regulations and building traffic patterns. Because each of our offices in 118 countries is staffed by nationals, we're not 'foreigners' in any country. And that's what multinational really means….being at home everywhere." (1972 Otis ad)



In 1974, Otis "dewdrop-shaped" Transparent Elevators (a/k/a "Observation Elevator") were scaling the heights of the new *Sofitel Hotel* at Sevres, France (a suburb of Paris). The Sofitel was the first in France to have this style cab. The elevator was manufactured by *Otis France* which, in 1974 was known as *Ascinter-Otis*. Installation of other dewdrop-shaped elevators began shortly thereafter in other parts of Europe.

Left: the *Sheraton Hotel Downtown Nashville* has similar style observation elevators

The Sky Pod's the Limit

"Visitors to the Sky Pod atop Toronto's 1,815-ft. CN Tower will have a dramatic ride up – with a view. Four Otis elevators on the outside of the tower will lift passengers 1,126-ft. in one minute. The elevators can carry 2,000 people an hour."

Popular Science, **November 1975**

<u>Above L&R</u>: in 1975, an Otis glass-walled elevator was installed in Boston's historic *Symphony Hall* - home of the *Boston Pops* and *Symphony Orchestra/s*, The Otis elevator operated in a rectangular stairwell and blended-in well with the hall's classical interior design. It was used to transport patrons to the second and third gallery levels.

<u>Left</u>: a similar Otis "see-through" style (Glass) elevator

Consolidation

OTIS

United Technologies

On July 7th 1976, the *Otis Elevator Company* merged with *United Technologies Corp.* (UTC) as a wholly owned subsidiary. This transaction followed a special meeting in NYC of Otis shareholders, who granted approval of the merger. UTC had purchased a major share of Otis in October 1975 (an exchange of Otis shares of stock for UTC shares resulted in the completion of the merger). Otis is United Technologies' most global division. Its +60K employees speak so many languages and local dialects that other UTC operations have, at times, used them as a translation agency. For example, how do you say "air conditioner" in Aymara? Somewhere in the world, an Otis employee will know.

“It started with Ascinter in 1964, making Otis a prevailing force in the French elevator market and turning it into the biggest Otis operation outside the U.S.”

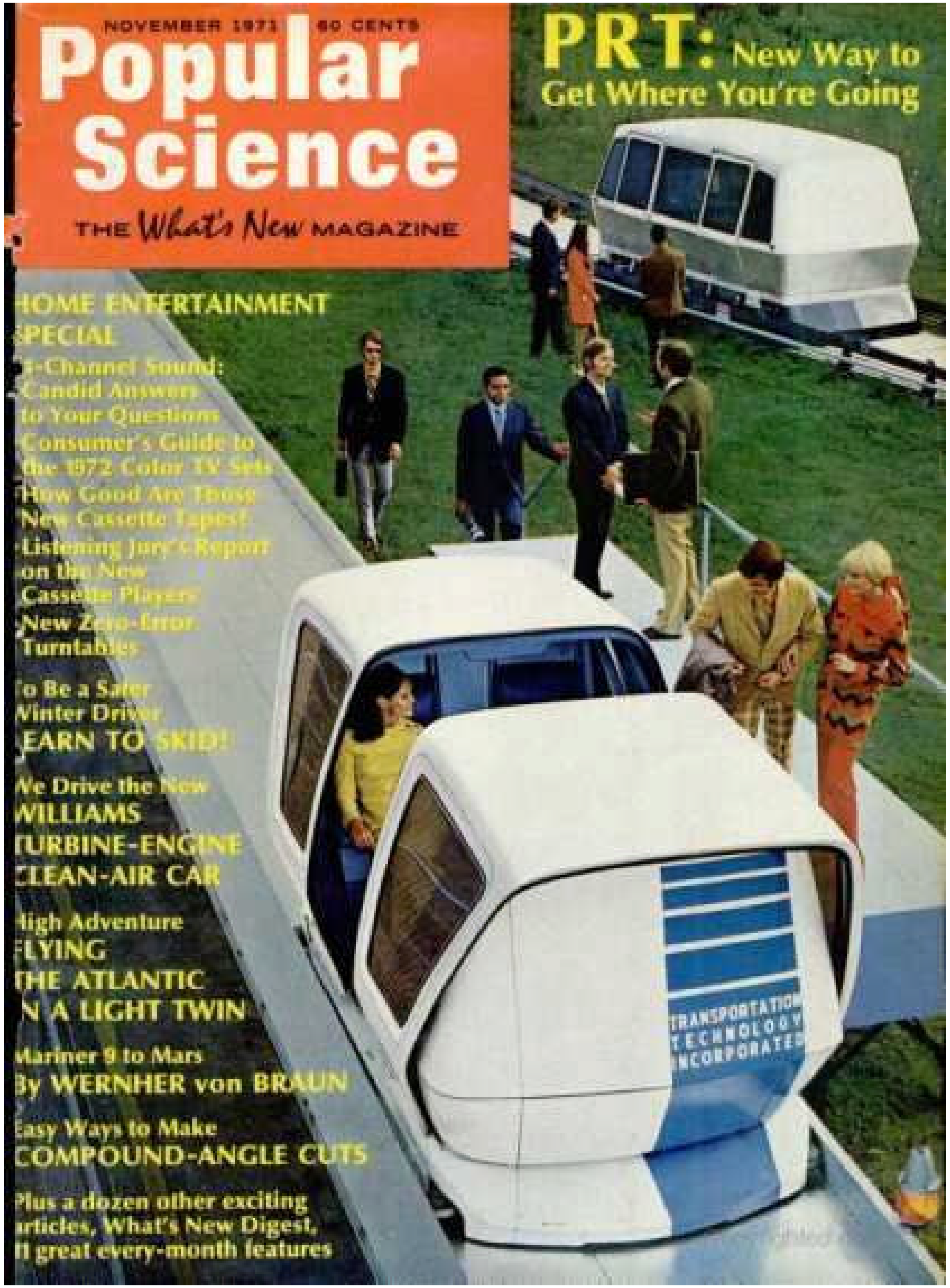
***Hubert Faure*, former *Otis Elevator Company* President**

RE: the history of Otis has been described as a history of remarkably successful acquisitions, involving scores of companies from every part of the world. That pattern, begun in Europe in the 1960s, has been repeated elsewhere in the world. Non-U.S. sales drove elevator and escalator growth in the latter decades of the 20th Century as global trade grew along with a movement of populations from rural to urban environments, where there was a growing market for vertical transportation. Otis’ ability to satisfy these needs rested on a basic decision to grow through the acquisition of smaller local companies that understood the culture, demands and business practices of their particular markets. Otis led the way by merging with *Ascinter*, a small elevator company formed by the merger of three smaller concerns in 1960 and 1962, at a time when the European elevator market was ripe for consolidation. Other mergers followed: in Germany, Portugal, Austria, Scandinavia, Switzerland and Spain - a total of thirty by 1970. In 2000, Otis’ largest-ever acquisition occurred in Korea when *LG-Otis* – a joint venture with *LG Elec-Tronics,* was formed.

"…Otis was founded by Elisha Graves Otis, who invented the safety brake in 1853, and who is therefore usually thought of, in the simplistic way of historical innovation accreditation, as the inventor of the elevator. Mechanical hoists go back at least as far as Archimedes, and many men, not all of them employed by Otis, did their part to make the elevator work. Otis, having absorbed or outlasted all its native rivals, and gone through one of the first-ever hostile takeovers (by United Technologies, in 1976), is the last big American elevator company. Its major global competitors are Schindler, Thyssen-Krupp, Kone, and Mitsubishi - Swiss, German, Finnish, and Japanese. The action is overseas. Otis does about eighty per cent of its business outside the United States, especially in the high-rise boomtowns of the Gulf states and in China…"

***The New Yorker*, April 2008**

Hovair



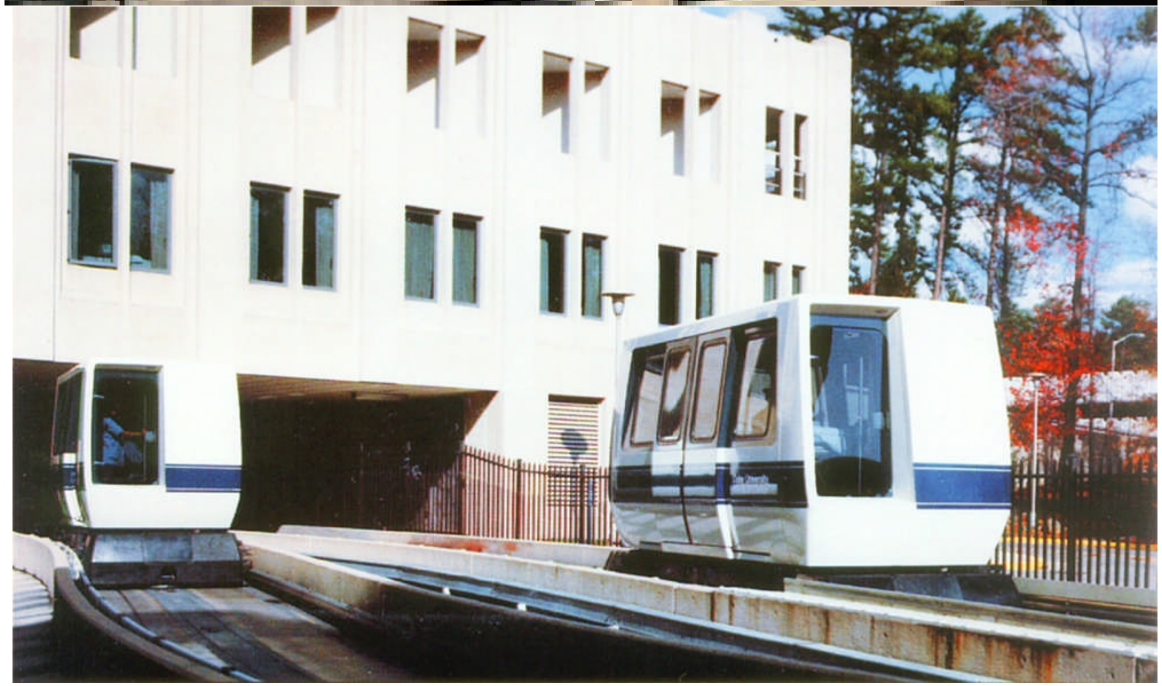
"If you look at the cover of our November 1971 issue you'll see a prototype for a system of Personal Rapid Transit (PRT), designed by Transportation Technology, Inc., an affiliate of Otis Elevator Company. Now TTI has been selected to supply the hardware for what may be the world's first full-scale PRT system in Nancy, France…The wheel-less vehicles will float on airpads an inch above the guideway and will be propelled by linear induction motors…" 996

***Popular Science,* May 1974**

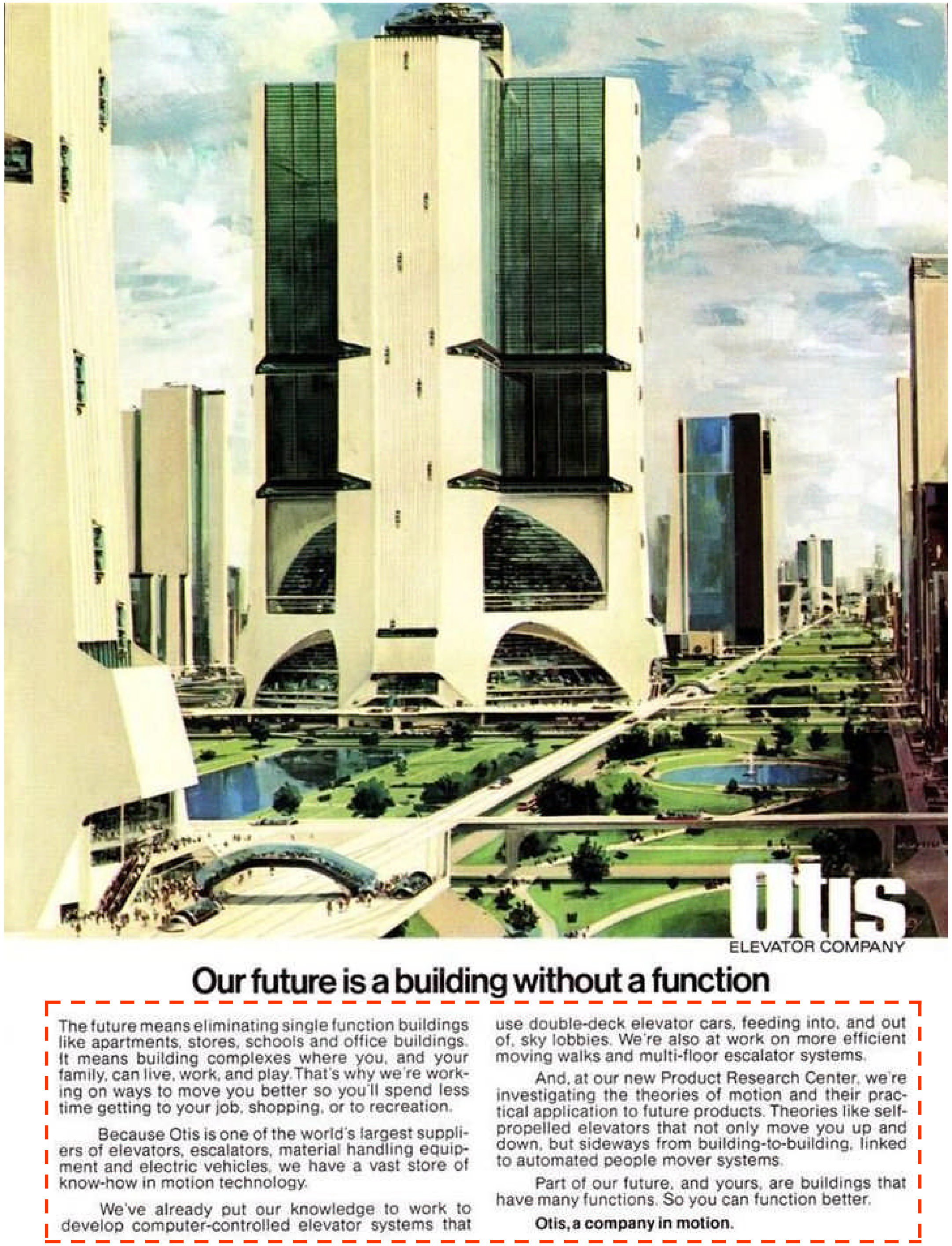
"Passengers and cargo will ride vibration-free when Duke University begins running air-suspension vehicles…Cars will travel at 25 mph over a 1,200-ft. two-lane guideway. Otis Elevator is designing the system for Duke's medical center."

***Popular Science,* April 1976**

RE: a "Hovertrain" is a type of high-speed train that replaces conventional steel wheels with hovercraft lift pads and the conventional railway bed with a paved road-like surface (known as the track or "guideway"). The concept's aim was to eliminate rolling resistance thus allowing for high-performance while, at the same time, simplifying infrastructure requirements. Hovertrains were developed for *Personal Rapid Transit* (PRT) systems which were a hot topic in the late 1960s and early 1970s. PRT (a/k/a "Podcar") is a public transport mode featuring small automated vehicles operating on a network of specially built guide ways. PRT is a type of *Automated Guideway Transit* (AGT), a class of system which also includes larger vehicles all the way to small subway systems. The Hovertrain's ability to float over small imperfections and debris on the rails was a practical advantage, although it competed with the *Maglev* concept that had the same advantage (ultimately, Maglev won the competition). The only Hovertain to see commercial service was the Otis *Hovair* system. Originally developed at *General Motors* as an AGT system, GM was forced to divest the design as part of an anti-trust ruling. The design eventually ended up at Otis which later replaced its linear motor with a cable-pull and sold the resulting design for "people mover" installations around the world (i.e. airports).

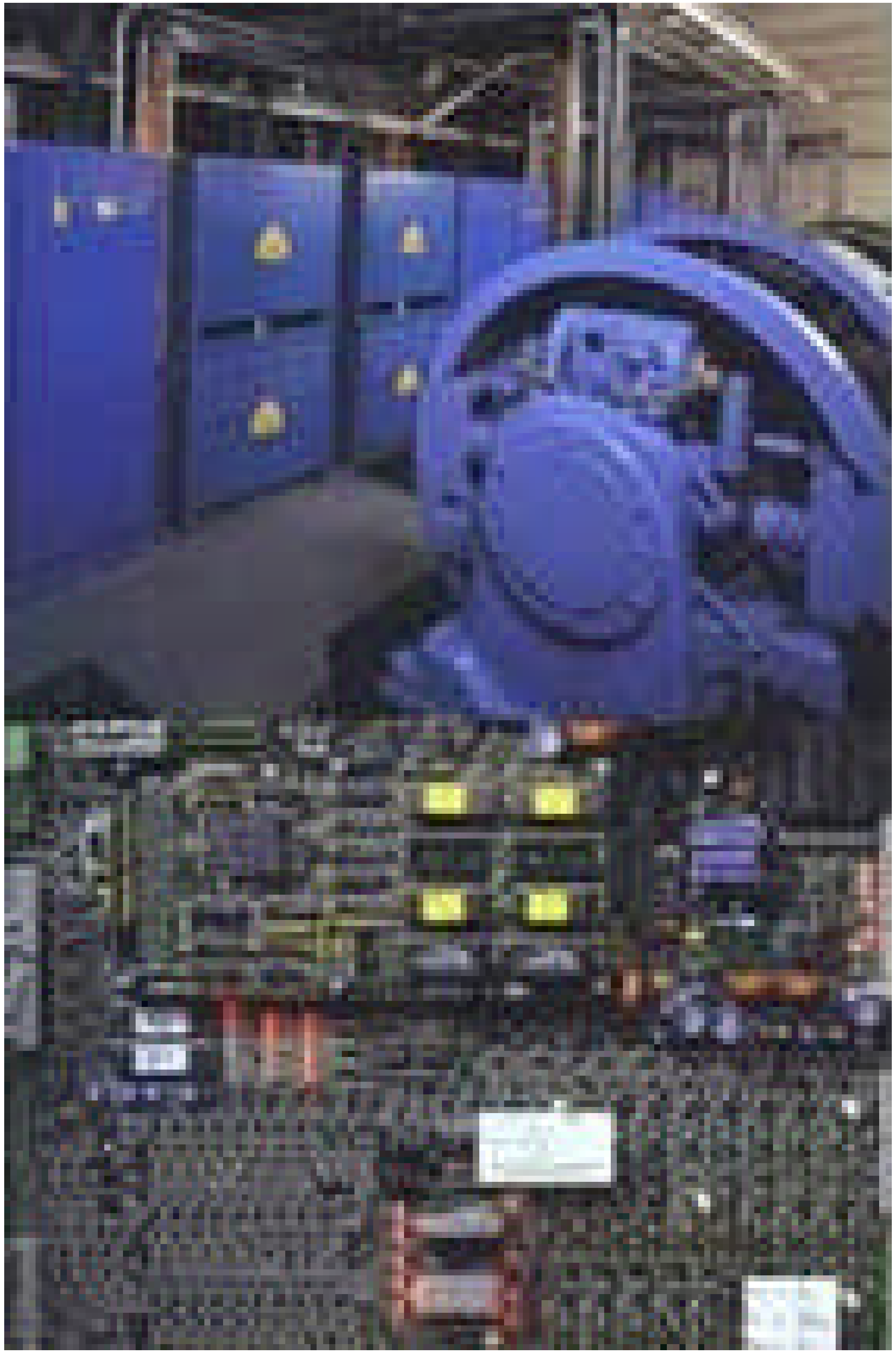
A Company in Motion



<u>Left</u>: caption: "The future means eliminating single function buildings like apartments, stores, schools and office buildings. It means building complexes where you and your family can live, work, and play. That's why we're working on ways to move you better so you'll spend less time getting to your job, shopping, or to recreation. Because Otis is one of the world's largest suppliers of elevators, escalators, material handling equipment and electric vehicles, we have a vast store of know-how in motion technology. We've already put our knowledge to work to develop computer-controlled elevator systems that use double-deck elevator cars, feeding into, and out of, sky lobbies. We're also at work on more efficient moving walks and multi-floor escalator systems. And, at our new Product Research Center, we're investigating the theories of motion and their practical application to future products. Theories like self-propelled elevators that not only move you up and down, but sideways from building-to-building, linked to automated people mover systems. Part of our future, and yours, are buildings that have many functions. So you can function better. Otis, a company in motion"
(1974 Otis ad)

<u>Left</u>: caption: "It's a future group of specialty clinics surrounding an established general hospital, designed to provide complete services for preventive medicine as well as treatment of accidents and diseases. They're high-rise because inner city hospitals are limited in the amount of land available near existing facilities. We envision patients moving – in climate-controlled mobile units equipped with the latest life-support systems – on automated guideways from surgery to recovery units and on to recuperation areas. When the first such high-rise health care complex is built, Otis will combine modern elevators, escalators and moving walks with computer-controlled supply systems and horizontal transporting systems. All designed with the comfort and safety of the patient uppermost in mind. Because we're concerned with people, Otis research is working on ideas to help the next generation live longer and better in our urban centers. Otis, a company in motion." (1975 Otis ad)

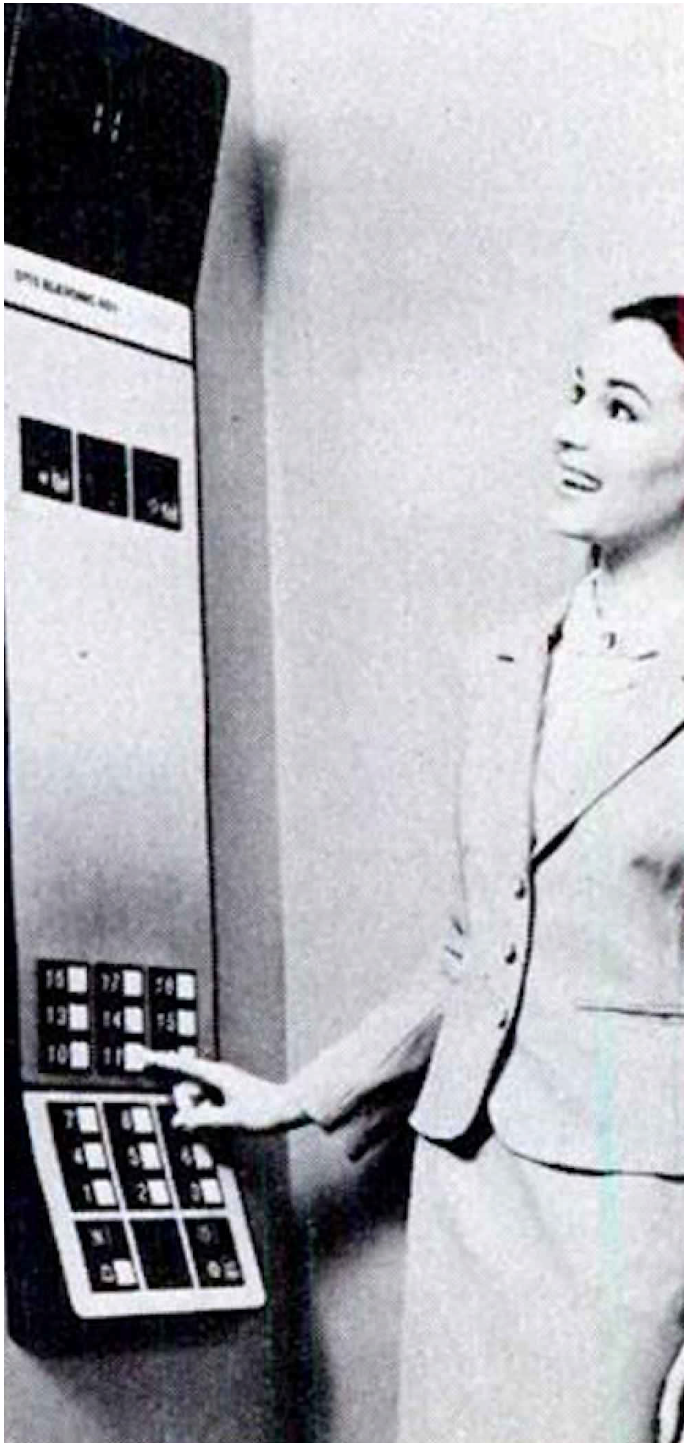
Since the merger trend began in the early 1960s, there have been joint ventures in both China and Russia to open up emerging markets. A four-page Russian language advertisement, which appeared in 1978, highlighted the importance of the invention of elevators and described the first agreement between an American elevator company; Otis, and a Soviet organization. Among the installations appearing in the ad was Moscow's *International Trade Center* (above), where Otis installed twenty-seven elevators and four escalators for the thirteen-story hotel (left) and the twenty-seven-story administration building (right). China is considered the largest elevator and escalator new equipment market in the world. In 2002, Otis joint-ventured with *Suzhou Jiangnan Elevator Group Co. Ltd.* To form the *Jiangnan Express Elevator Company,* based in Suzhou. Otis' had six other previous joint ventures in China.



To enhance the quality and reliability of its elevators, Otis has steadily applied break-throughs in computer tech-nology. Beginning in 1979 with its *Elevonic 101* system, Otis has increasingly employed the power of microprocessors to control every aspect of elev-ator operation.

<u>Left</u>: caption: "The Elevonic 411M control system, designed for mid- and high-rise elevator upgrades, replaces the traditional analog sel-ector with a digitally-controlled, primary velocity transducer. The result: A vastly superior experience in every possible degree."

What Next, Talking Elevators?



"'Good morning, watch your step.' The Elevonic 401, Otis elevator's latest model, can greet you, say whether its going up or down, announce floors and safety messages. The 401 uses a form of computerized speech synthesis and has a 111-word vocabulary."

Popular Science, **August 1981**

RE: it was the first elevator control system with synthesized speech as an option, information display and security systems. It was also the first elevator system equipped with weight sensors to put full cars in express mode. The *Elevonic 401* dispatched cars in response to variants in building traffic as they occurred. The 401 was later succeeded by the Otis *Elevonic 411* and *Elevonic 411M* (high-rise modernization) in 1990.

"…Riding elevators, even when you are supposed to be paying attention, for the purpose of writing about them, is a pretty banal enterprise…Otis has conducted research to find out whether people might better enjoy their time in elevators if it were more of an experience - if it would somehow help to emphasize that they're in an elevator, hurtling up and down a shaft. Otis found, to little surprise, that people would rather be distracted from that fact. Even elevator music, designed to put passengers at ease, is now so closely associated with elevators that it is no longer widely used…"

***The New Yorker*, April 2008**

<u>Above</u>: in 1985, Otis introduced the *REM* monitoring system. The REM system uses sensors, monitors, circuits, hardware and software to collect and analyze information on three-hundred and twenty-five elevator functions. If it detects a serious problem, mechanics are given precise information about the problem and are then dispatched with the proper tools and parts necessary to make repairs. The system also allows for a round-the-clock voice link between the elevator and the Otis service center.

Otis' *eService* combines *REM* data with technicians' reports to give customers access to information about their elevators and/or escalators directly over the Internet. Internet monitoring through eService helps customers to better manage their buildings by giving them access to reports showing trends in uptime, service call types and technicians' documentation – anytime, anywhere. Centralized communications services such as the *OTISLINE* center create vital links among elevator service professionals, building managers and the equipment itself. These telecom services can wirelessly contact emergency technicians, immediately notifying them of a problem and its location. The centralized communications hub features a 24-hour service network available to customers regardless of location. With one call, a problem can be identified, mechanic dispatched and replacement parts located and expedited to the site.

<u>Left</u>: on Sept. 16th 1988, the ***U.S. Postal Service*** **(USPS) issued an elevator stamp. Artist** ***Lou Nolan*** **based the design on illustrations of Otis' famous "Birdcage" elevator cabs. The 5.3-cent stamp was intended for nonprofit third-class mailers who presort to the carrier route. The elevator stamp was the 39th in the transportation series issued by the USPS.**

An Unusual Elevator

“Nippon Otis Elevator Co., a partly owned subsidiary of Otis Elevator of the United States, has installed two unusual elevators – the first linear-motor elevators in the world – in the Tokyo area. One is in the company’s employee dormitory; a window in the back wall of the cab allows employees to view their company’s advanced technology…”

***Popular Science,* February 1991**

"…Like a conventional rope elevator, a linear motor elevator has wire ropes running from the cab over sheaves at the top of the shaft to a counterweight. But a conventional elevator is operated by a traction machine at the top of a shaft. In the new design, a tubular linear induction motor incorporated in the counterweight drives itself up and down the hoistway, lifting and lowering the cab as it goes. In this type of motor, the secondary member - analogous to the rotor of a rotary motor - is a solid iron column, wrapped with aluminum, that runs the length of the shaft. The primary member - analogous to a stator - consists of meter-long iron bars arranged in a circle and held together by tubular iron rings. The primary member fits around the secondary member like a sleeve. When an alternating current is applied to the motor's primary member, it generates a magnetic flux, inducing current flow on the surface of the secondary member. The flow of this current pulls the primary member along the column…"

***Popular Science,* February 1991**

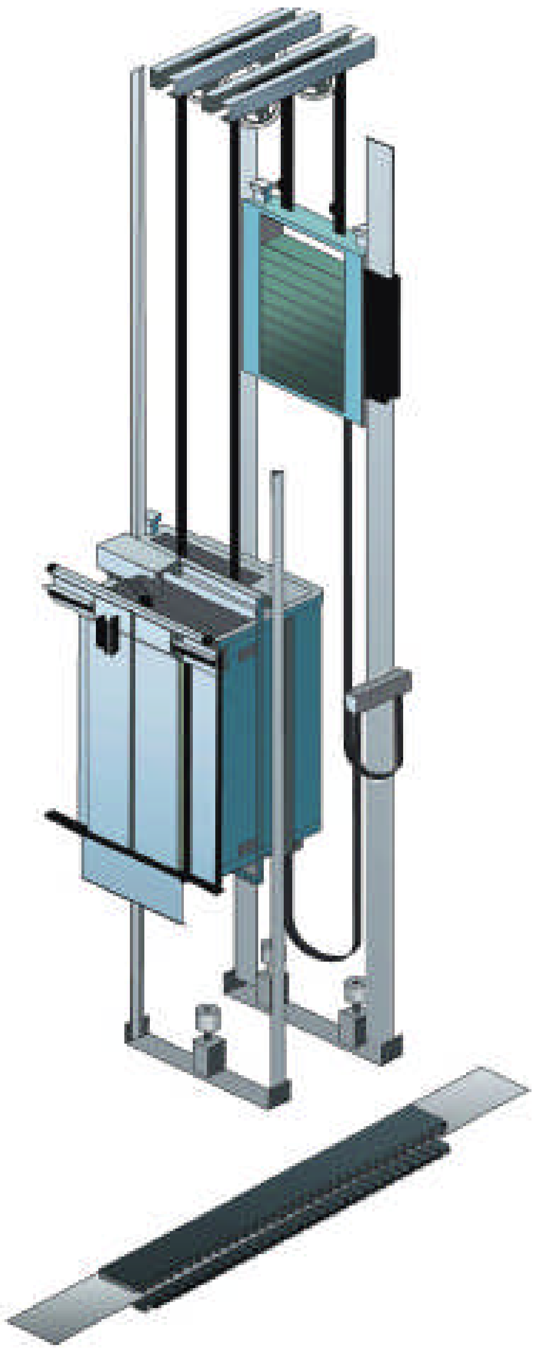
<u>Above</u>: caption: "Otis Linear-Motor"

"…Norihiko Fujisawa, a manager in the research division of Nippon Otis Elevator, says that eliminating the motor rooms needed for conventional rope and hydraulic elevators will mean lower installation costs. Also, with far fewer moving parts, linear-motor elevators will require less maintenance. Future versions of the elevator may do away with ropes entirely, simply incorporating the motor into the cab. 'Technologically, it is possible now,' Fujisawa says. 'The problem is with building codes.'"

***Popular Science,* February 1991**

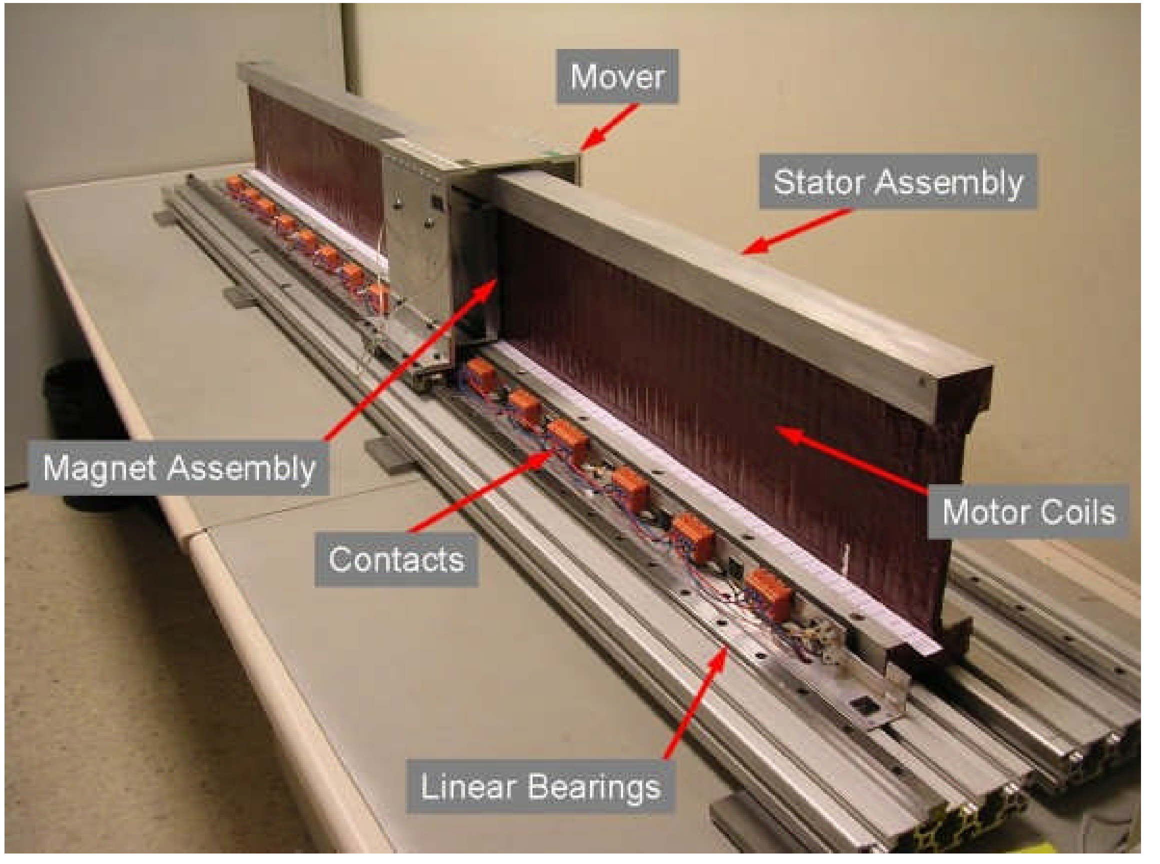
RE: making only incremental steps in development was characteristic of the elevator industry during the early 1990's with respect to both its key technology: hoisting, and key driver: space efficiency. The main developments that had recently taken place were the computerization of control systems and subsequent rapid improvement in group control performance. On the hoisting side, frequency converters were launched (following the replacement of motor-generator sets by static converters). There had been some attempts towards a more radical hoisting paradigm-shift over the years (i.e. using linear motors in the hoistway). This would have been particularly interesting in the case of high-rise buildings where required building space for elevators is significant.

In 1990, the “Skylinear” elevator (a linear-motor based product) was marketed in Japan exclusively (it was intended to be marketed worldwide, eventually). Skylinear utilized a hoisting concept that operated with a linear induction motor whereby the hoisting machine was located in the counter-weight. Thus, it was intended for use with ordinary rope suspension and the target market was residential housing, not skyscrapers. Electric components like frequency converters and batteries for the emergency drive were located in a small room next to the shaft. This initiative started a patenting boom in the industry and by the end of 1995, there were about one-hundred and fifty new patents concerning linear motors in elevators. It’s interesting to note that many of the patents applied for were by construction companies, not elevator companies. The Skylinear solution was based on a tubular linear motor resulting in force balance and better efficiency (the design was patented).



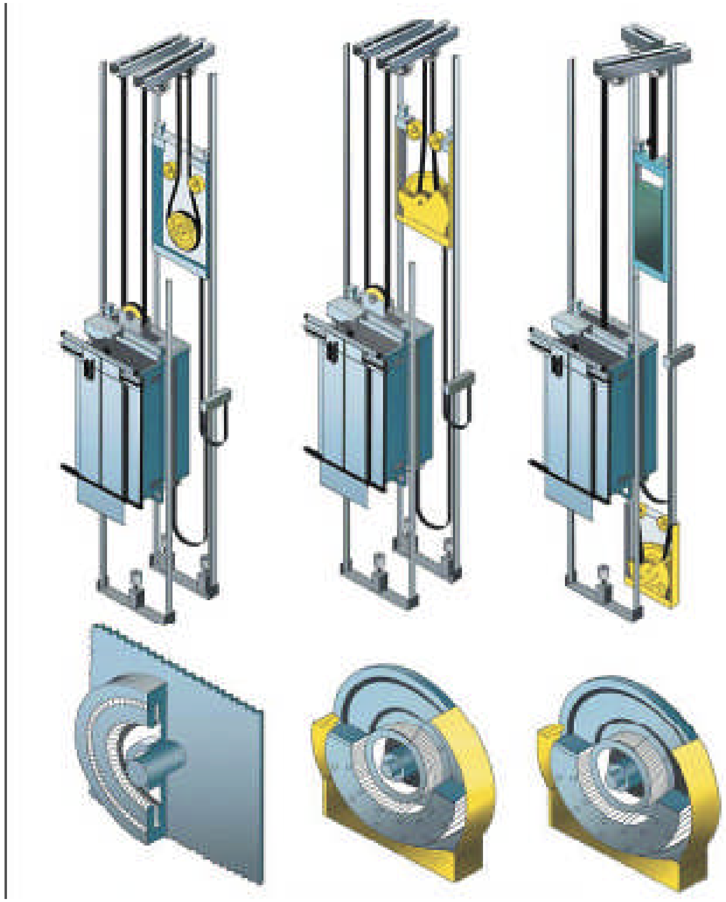
The older alternative (using a flat linear motor) had been patented in the early 1970s. The idea was to use the guide rail of the counterweight as the secondary part and locate the primary part (i.e. the stator winding) into the counterweight (see diagram at left). The benefit was the integration the secondary part into the ordinary guide rail structure, thus allowing unlimited hoisting height (since the secondary part did not pass the stator winding as it did in the tubular version). Thus, *Skylinear* limited the structure height to just twenty-five meters. Many of the major technical problems were solved and patents filed, but in 1992, the cost level remained the biggest stumbling block. The main issue was the strong interdependence of the building height and the production cost since the motor was as tall as the hoistway. As a side-effect of the linear motor studies, a new idea emerged in late 1992. In essence it was a combination of friction drive and rotating machine, but was located in the counterweight (a kind of motorized traction sheave).

<u>Left</u>: caption: “A ‘conventional’ linear motor elevator”



The benefit was, essentially, the same as for linear-motor hoisting (i.e. no machine room required), but now at significantly lower cost since the correlation between building height and cost was no longer applicable. By the beginning of 1993, it was realized that if a motor flat enough to be located in the counterweight could be built, it would be possible to launch an entirely new elevator type. This would then provide the cost level of a traditional friction drive with the benefit of space efficiency offered by a linear motor drive.

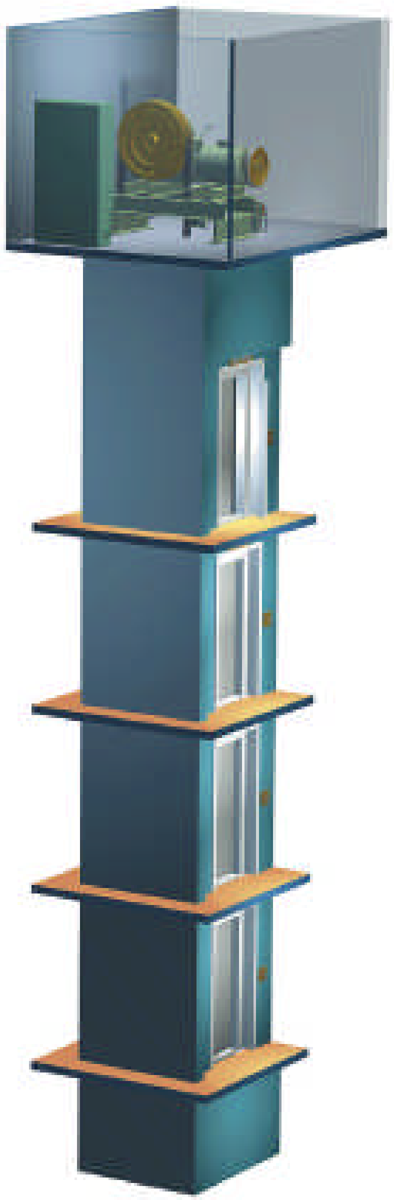
<u>Above</u>: caption: "Model of a Linear Motor"



As a result, plans to develop the linear-motor were cancelled and the whole of 1993 was spent developing the flat-rotating motor type. The point of departure in design was the traditional cylindrical induction motor with outside rotor. However, the thickness of the motor was a problem as the endings of the windings required too much space making the counterweight thicker than in standard elevators, which was not acceptable. An initial condition was that the elevator must fit in the standard shaft. The design was therefore changed to an axial type in which the main air-gap flux is parallel with the shaft direction. This structure is known as "disc-motor" or "pancake-motor." In fact, the idea was not new. Faraday's first electric motors were of this type (the cylinder form appeared later). However, they were not commonly used since its design and manufacture was more difficult compared to radial-gap motors. Typical applications for this motor type have been industrial robots and vehicle wheels with integrated motors.

Left: caption: "Development phases of the flat-rotating motor"

Efficiency of the low-revving induction motor (operating at about 40-70%) was problematic as was cooling the heat which was generated in the middle of the motor. Therefore, the induction motor was abandoned. Another attempt focused on a reluctance motor, where the secondary part consists only of massive iron rendering rotor losses insignificant. However, the power factor was only 0.3 in low rpm resulting in a high stator current and even lower total efficiency than that of the induction motor. The most viable solution appeared to be a synchronous motor with rare-earth permanent magnets (PMSM). A new manufacturer in Finland: *Outokumpu Magnets Corp*., could supply the required magnets. Finland-based *Kone* and Outokumpu established a partnership that provided various magnets for prototype motors. The efficiency of the motor was now excellent since no magnetizing power was necessary. The drawback was the high cost of material. However, this was mitigated by savings in other elevator parts. Thus, the introduction of high-energy permanent magnets not only paved the way for battery-drive portable tools and laptops, but also changed the face of elevator technology.



"…an elevator with a gearless machine located in the hoistway and where the extension of the machine shaft intersected the profile of the elevator car…"

RE: excerpt from Kone's patent application. The next step was to develop all components for a working elevator system. The new elevator type was first named "Greenstar," but later renamed "Monospace." By mid 1994, a full scale prototype of the *MonoSpace* elevator was ready in the research center in Hyvinkaa, Finland. Internal calculations proved that the product was viable in terms of performance, cost and reliability. Though there were still some technical hurdles, by the end of 1995, all the most relevant patents had been granted. The benefits of MonoSpace for customers were obvious: no machine room was required, reduced construction costs and lower energy bills. Test marketing began late in 1995, when the first elevators were delivered to customers as pilots. The Netherlands was selected as the country in which the tests were to take place. It was an appropriate choice considering the fact that buildings in Holland are generally low and there was a clear need for a machine-room-less (MRL) elevator given that certain types of buildings (even with only two floors) require an elevator by code. In such cases, the relative cost of a machine room is significant.

<u>Left</u>: caption: "MonoSpace Elevator"

During test marketing, nearly all customer groups contacted claimed *MonoSpace* to be a great innovation and were in agreement on its benefits. Novelty of the concept remained the main concern and the uncertain reactions of authorities in various EU countries yet to be contacted. Code compliance initiatives continued and MonoSpace was released in Europe country-by-country. The official product launch took place in Brussels, Belgium in March 1996. New production facilities for "EcoDisc" motors were needed thus *Kone* established a new factory in 1997 with a capacity of 5K units per year (which was doubled in 1998 and expanded further in 1999). Now, *Ecodisc* flat-rotating-motor machines account for over 90% of Kone's sales. The license was also sold to *Toshiba*, who started to sell standard elevators based on the machine manufactured by Kone (Toshiba sold the MonoSpace elevators under the "Spacel" brand in Japan). The mid-rise product came onto the market in 1998 (under the name "MiniSpace") and a high-rise product ("Alta") was launched in 2000. "MaxiSpace" is a traction elevator without the counterweight.

<u>Top</u>: caption: "First EcoDisc prototype"

<u>Bottom</u>: caption: "MXo6 Machine"

<u>Above L&R</u>: the *Cathedral of Milan* has 135 spires and, in one of them, an Otis elevator. What began in 1997 as an Otis modernization project in preparation for the Vatican's *2000 Jubilee* became a new prestige elevator, installed inside a spire of Italy's largest and most intricate example of *Gothic Architecture* (the new elevator replaced an Otis unit installed in 1961). It's used primarily to take visitors to the cathedral's roof for a fantastic view of the city through a forest of spires and 2,245 white marble statues.

"...we succeeded in achieving the goal of modernizing the safety and operation systems of the elevator, while preserving its initial appearance as it was installed almost a century ago."

RE: excerpt from a 1998 article appearing in the *Zardoya-Otis* quarterly employee magazine: *Boletin Informativo.* The *Royal Palace of Madrid* (above) is a towering structure with two-hundred and fifty years of history. The palace was built on the site of a former *Alcazar* that burned down in 1734. In 1903, three *Stigler-Otis* elevators, known as: the *Damas Elevator*, the *Carlos III Elevator* and the *Elevator of the King,* were installed. The latter is the only one that was kept in its original condition. Three more were subsequently installed. In the 1990s, Zardoya-Otis modernized the six Otis elevators in the palace which included preserving the "Elevator of the King."

<u>Above L&R</u>: a windswept hilltop in California's *Santa Monica Mountains* is home to the *J. Paul Getty Center*, one of the world's largest private museums. Each year, thousands of people visit the center, transported from a parking area below by the Otis *Hovair* system; a state-of-the-art people-mover system installed in 1998. The Otis system uses pollution-free, noiseless electronic motors to propel two shuttle trains on a cushion of air along a curved line that follows the hill-side's jagged contours up a 209-foot vertical rise.

Moving Sidewalks

“…While long distances to the farthest gates will remain a fact of airport life, moving walkways and the tram system will mean that, except during maintenance periods, the only travelers taking a half-mile walk in the new terminal will be those who want the exercise.…The smaller West Concourse, which will have eight jet gates and twenty-five commuter-plane gates, will be linked to the main East Concourse by a tunnel equipped with moving walkways. All of the terminal's moving walkways will be 56 inches wide - 16 inches wider than those in the existing terminals and thus designed to allow baggage-carrying walkers to pass with ease…”

***The Blade*, January 2001**

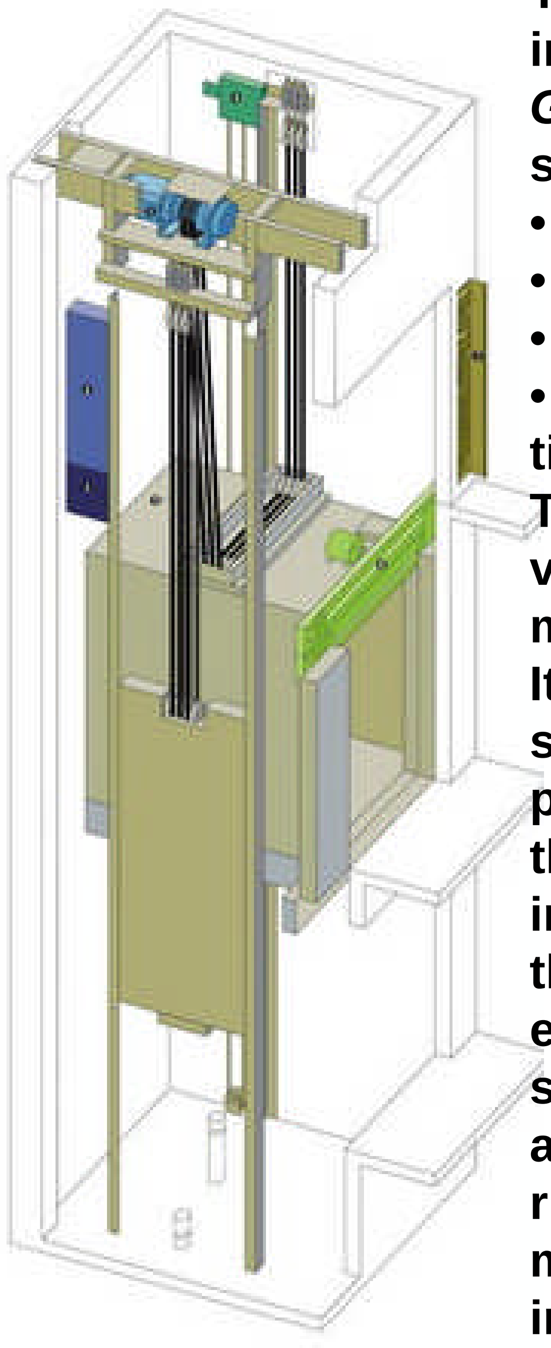
RE: ***Midfield Passenger Terminal*** **at** ***Detroit Metropolitan-Wayne County Airport***

Left: caption: “Dan Misuraca of Otis Elevator works on a moving walkway in the midfield terminal at Detroit”

Into the New Millennium

"…From one incarnation to the other, the basic principles - car, sheave, rope, safety - remain the same. With the exception of a few quantum leaps - steel cable, electricity, microprocessing - elevator advancements have been subtle and incremental. On the twenty-fifth floor, we came across evidence of one: spools of flat, rubbery-looking cable. In recent years, Otis has introduced flat hoist belts, made of polyurethane threaded with steel, which are lighter, stronger, and more energy-efficient than the old steel ropes. (Otis gave its employees gifts of belts made out of the cable.) The flat cables have made possible much smaller machines, facilitating the proliferation of what are called, rather inelegantly, 'machineroomless' elevators. A machine the size of a marmot, rather than of a moose, can be installed in the shaft, rather than in a room of its own, freeing up space for architects and landlords. This is what passes for cutting edge…"

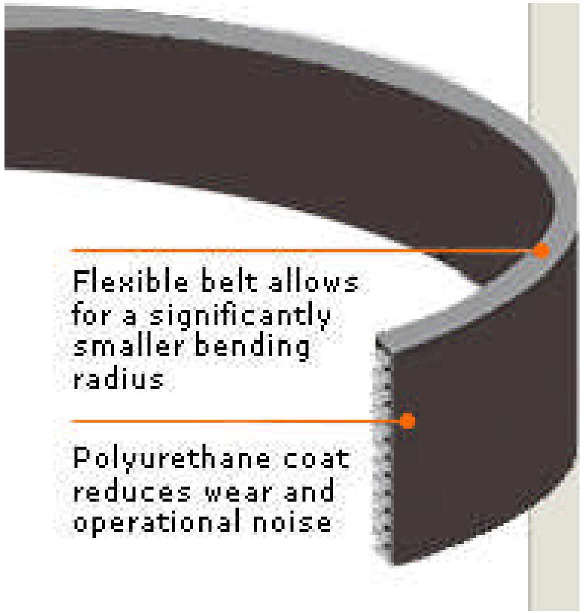
***The New Yorker*, April 2008**.



The new millennium marked a significant new product introduction for Otis, developed in a totally new way: the *Gen2* elevator system (left). Otis designed the Gen2 system to meet strict criteria, including:

- Universal design
- Cost-effective
- Space-saving, reliable and safe
- Available on the market in half the usual development time (eighteen months instead of three years)

The resulting Gen2 system; the product of a global development effort that tapped Otis resources worldwide, meets all of these essentials requirements and then some. It's the first elevator to use flat belt technology in place of steel cables to lift the elevator car. These revolutionary flat, polyurethane-coated steel belts have a lifespan two to three times that of traditional wire rope. This technical innovation means the Gen2 system requires a machine that is only one-quarter the size of traditional technologies, eliminating the need for a separate machine room thereby saving significant amounts of space. The unique flat belts and permanently sealed bearings require no oil or lubrication, making the system environment-friendly. Furthermore, its energy-efficient gearless design results in lower long-term operating costs for the end-user.



__Above__: caption: “Just 3-mm thick, yet stronger than conventional steel cables. It lasts up to three times longer. The flat, coated-steel belt eliminates the metal-to-metal effect of conventional systems. Coupled with a smooth-surface crowned machine sheave, the result is exceptionally quiet operation and superior ride comfort. Furthermore, the flexible flat belt enables a more compact, energy-efficient machine, which can be contained in the hoist-way.”

__Left__: caption: “Otis Gen2 Elevator System”


OTIS

The *Pulse* system continuously monitors and ensures the integrity of *Gen2* flat, coated-steel belts. This first-of-its-kind system provides greater safety through its immediate, automatic reporting of belt status. Conventional wire rope inspection relies on periodic visual examination of the hoist ropes, which requires taking the elevator out-of-service. These manual inspections require a visual examination of the ropes for broken exterior strands. Time consuming and disruptive to building operations, it can also leave broken interior strands undetected due to human error. The Pulse system's automatic 24/7/365 monitoring and reporting eliminates the need for downtime while significantly enhancing the quality and reliability of the inspection process.

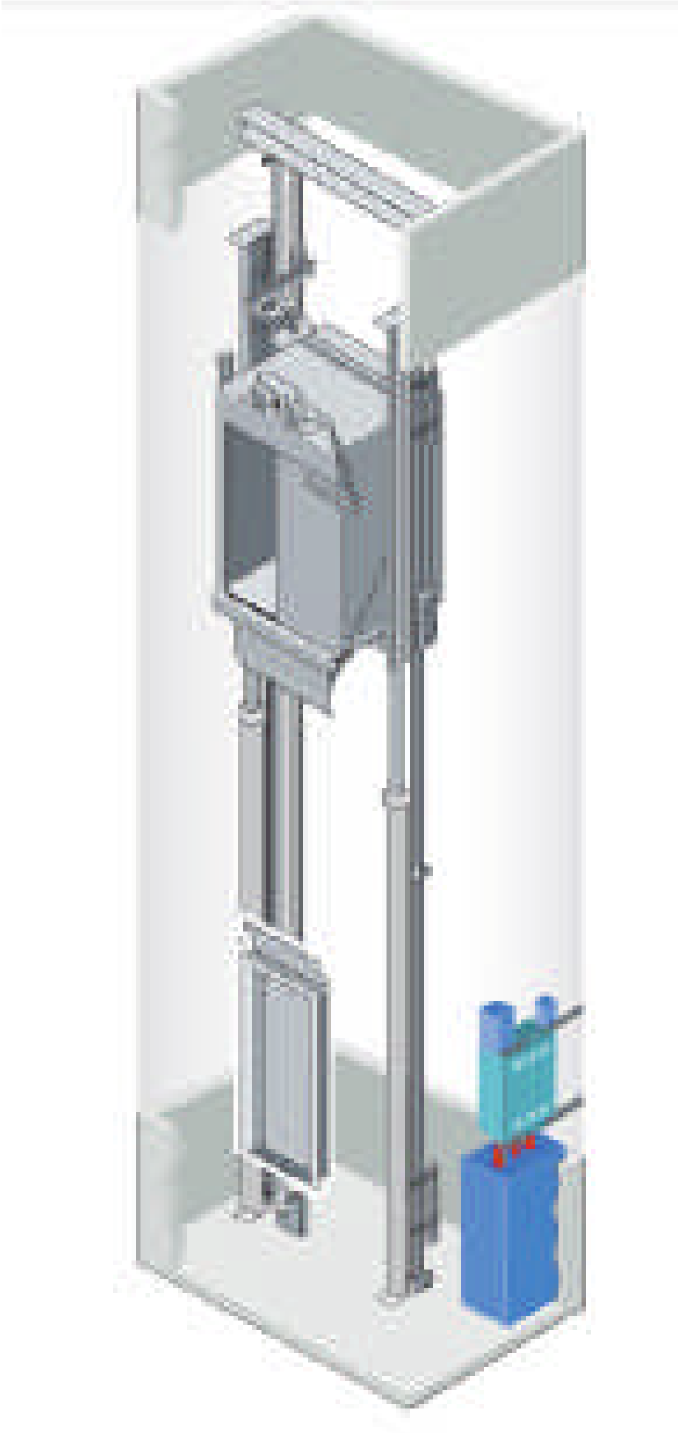
<u>**Above**</u>**: the *Pulse* system works by monitoring the electrical resistance of each cord inside of the *Gen2* coated-steel belts. Conducting pins penetrate the belt's coating to make electrical contact with each cord. When wear is detected, an alert is given more than a year in advance of when belts need to be replaced, allowing for convenient maintenance scheduling. On elevators equipped with *REM*, the system can remotely report belt wear and system faults for rapid response. On systems without REM, LED lights on the unit alert maintenance personnel of the need for belt replacement.**

GeN2® Mod

Gen2Mod **offers all of Gen2's advantages to existing elevator installations including:**

- **Improved performance and reliability**
- **Updated aesthetics**
- **Green Technology**
- **Enhanced Safety**
- **Minimal disruption**

Conventional elevators use wire ropes. This requires a larger bending radius, resulting in a larger sheave of at least 30-inches in diameter. Gen2Mod's polyurethane-coated steel belts are stronger and more flexible, with a smaller bending radius allowing for a 70% smaller machine and increased durability and efficiency. Otis' *ReGen* drive requires less cooling and captures wasted energy for reuse increasing efficiency by up to 60%. The system's sealed bearings and coated steel belts never require lubrication. The *Elevonic* controller's microprocessor technology enhances reliability and advanced wiring ensures reliable communication throughout the system. The *Closed Loop Door Operator* provides consistent performance, reduces noise while ensuring passenger safety. LED light fixtures provide contemporary, modern aesthetics while saving energy. Gen2Mod systems have experienced a reduction of 50% in "call-backs" and feature superior, vibration-less performance. In *Sleep Mode*, lights and fan shut down when there is no demand, increasing energy efficiency. Gen2's internal brake eliminates the need to add separate rope grippers to comply with the latest building code requirements. As an option, if the building loses power, *Automatic Return Operation* returns the elevator to the nearest landing and opens the doors. When combined with Otis' *Elite* service, expert and timely diagnostics, analysis and resolution is provided.



Otis applied the strength of its worldwide engineering resources and created the *HydroFit* system (left), an innovative holeless hydraulic elevator system that, like *Gen2*, eliminated the need for a machine room. All critical components are contained in the hoistway while retaining the same hoistway width and depth, pit depth and overhead clearance as a conventional hydraulic system. The self-contained, compact system – able to fit in a standard hydraulic hoistway – eliminates the need for a machine room which requires HVAC, lighting and fire protection. To further reduce coordination with numerous trades on the jobsite, hall call buttons are mounted in the door jamb. Hydrofit elevators use LED lighting and a sleep mode shuts down the lights and fan when the elevator is idle. Annually, the energy used by a Hydrofit system is roughly half that of a conventional hydraulic system. Being domestically produced, lead-times are minimized for delivery and installation.

All Safe, Gentlemen, All Safe

The New York Times

That Daring Young Man in His Elevator Machine

The New York Times

Celebrating Effort to Make The Elevator A Dull Ride

Going up: 150 years of advances in elevators

<u>Above</u>: Otis celebrated the company's 150th Anniversary in 2003. NYC's *Hammerstein Theater* was the site of a dramatic reenactment of Elisha Graves Otis' demonstration of the first safety elevator, which took place at the *Crystal Palace* during the first World's Fair in NYC in 1854. The reenactment was covered widely by both print and visual media.

"Mr. Burger, please raise the hoist," said Otis, sporting a black top hat, black beard and frock coat …

"Mr. White, please cut the rope." (The only rope suspending the platform above the gathered crowd.)

The raised platform on which our Otis' founder stood jerked downward about an inch, then stopped with the startling bang as the safety "dogs" locked into position.

"All safe, gentlemen, all safe," Otis announced to loud applause.

RE: 2003 reenactment. In Washington, D.C. Otis partnered with UTC and the *National Building Museum* to mount an exhibition celebrating the history of elevators, escalators and moving walkways entitled: "Up, Down and Across." Special customer events were held in Korea, Japan, Russia, France, Belgium and across North America. By the time of the tercentenary in 2003, Otis was the world's largest vertical transportation company with operations worldwide. Quite an accomplishment considering the fact that in just seventy-two hours, elevators move the equivalent of the entire world's population. Sixty-one thousand employees and 1.2 million installations later, Otis elevators could be found in half of the world's twenty tallest buildings. In 1930, Otis was maintaining 10,081 units worldwide. By 2014, that number had reached 1.7 million.

"One-hundred and fifty years ago, Elisha Graves Otis cut the rope of an elevator and launched both a company and an industry. In doing so, he gave birth to the modern metropolis, enabling builders and architects around the world to turn dreams into reality. This conference celebrates not only Mr. Otis' historic innovation but also the achievements of thousands of Otis employees, whose dedication and esprit de corps have fueled the fire of our company for one-hundred and fifty years."

***Ari Bousbib*, President - Otis Elevator Company**

RE: Otis executives from thirty-seven countries convened in NYC for the *Otis 2003 Leadership Conference*. The three-day event honored both a century-and-a-half of Otis history and charted the course of the company's next 150 years.

<u>Left</u>: 1905 Otis ad (+50 years)

In April 2003, Otis acquired *Amtech Elevator Services* from San Francisco-based *ABM Industries*. At the time, Amtech was the largest independent service provider for elevators and escalators in the U.S., with an extensive portfolio of customers, including universities, airports, hotels, casinos, condominiums, convention centers, office buildings, hospitals, manufacturing facilities and arenas. The acquisition enabled Otis to expand its elevator and escalator maintenance, repair and modernization operations in the U.S.[1041]

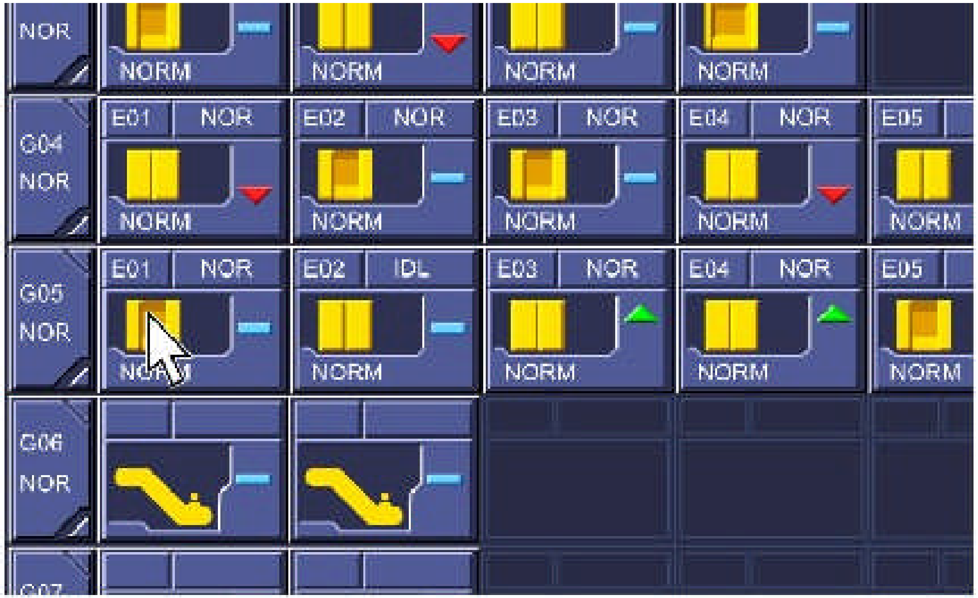
NextStep

“Otis Elevator wants to take the stress out of moving stairs, Its new escalator, aptly named NextStep, integrates a series of safety features. Most notably, each step and its side skirt move in unison. A spokesman for the Farmington, Conn., company says this minimizes the risk of trapping shoelaces and clothing. A second flap step forms at the entry and exit points to smooth the stair-to-landing transition.”

***Popular Mechanics,* June 2003**

RE: the development of the “guarded step” directly confronted a major source of escalator safety concerns and comprehensively resolved it. It reduced accidents by including deeper combplate teeth thereby minimizing the possibility of items becoming caught as the step meshes into the floorplate. Doubling the number of cleats on the step riser meant that the gaps between the cleats were reduced by 50%, minimizing the risk of entrapment between the steps. The step nose was rounded (with a 4mm radius) minimizing the risk of injury, scrapes and/or cuts in the event of a passenger slip or fall. Two flat steps at the entry and exit along with under-step lighting and yellow combs helped ease passenger transition between the moving step and the landing. The handrail entry module was designed to virtually eliminate the risk of entrapment. Firstly, its design acts as a deflector and, secondly, by the addition of a tightly fitting rubber collar. A stop switch is triggered if an object is pushed against this collar as a further safety measure. An aluminum step link and sealed self-lubricating bearings replaced the conventional step chain, steel-on-steel pivots resulting in chain stretch causing step-to-step gap increases. The lateral guidance system running in the center of the escalator minimized step movement thus improving step-to-side-gap consistency.

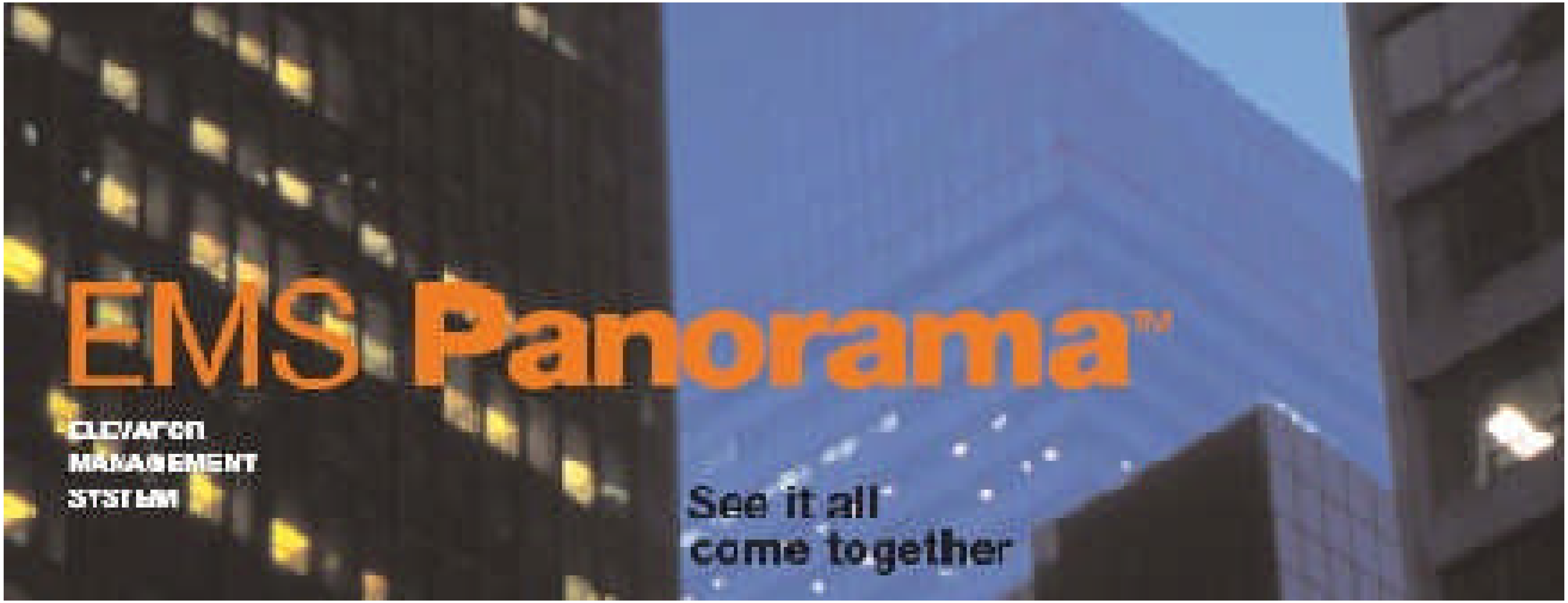

<u>Above L&R</u>: the elimination of the "catchment risk" between the moving stair and the fixed base interior trim was achieved by the patented "Guarded Step." With this innovation, garments, shoelaces etc. cannot be drawn-in. Passenger falls on conventional escalators often resulted in painful injuries due to the sharp edge/s of treads. With *NextStep,* such injury was very effectively eliminated. The tread was "defused" by rounding the front edge. Sub-step lighting, deeper comb plate teeth (at landing platform) further increased passenger safety. Polyurethane drive-belts significantly decreased vibration resulting in improved ride comfort. In addition, the new drive-machine is much more compact and can be accommodated within the framework of the escalator. NextStep reduced by 15% the standard escalators dimensions allowing for flexibly when fitted into existing openings (i.e. when replacing old escalators). Stainless steel (with non-slip coating) and/or aluminum floor plates are available and long-lasting LED lights are mounted below the Handrail.



<u>Above</u>: *EMS Panorama* allows users to monitor the status of up to 64 groups or 512 units of elevators, escalators, and moving walkways. The system provides access to real-time operational information about:

- **Equipment status**
- **Performance**
- **Traffic patterns**
- **Floor accessibility**
- **Operating conditions**
- **Security status**
- **Equipment events**
- **Alarms**

The system is available with new and existing Otis installations. It can also be used to upgrade or retrofit an existing Otis EMS system.



In 2004, Otis launched the *EMS Panorama* system. EMS (*Elevator Management System*) Panorama is a web-based management application that enables building personnel to securely monitor, control and report on elevators, escalators and moving walkways from virtually any location using a computer with a standard Internet browser. The system can display the equipment status for a single building or an entire airport, college campus or medical center. Because EMS Panorama offers comprehensive, real-time data to building managers, they are able to respond quickly to passengers' needs and make informed decisions about equipment operations with greater assurance.

Smart Elevators

"…The other was the 'destination dispatch' system that the Marriott introduced, a few years ago, becoming the first hotel in North America to do so. Such 'smart elevators' have now been installed in a dozen buildings in New York, among them the headquarters of the Times, of Hearst, and of the News Corporation. Destination dispatch assigns passengers to an elevator according to which floors they're going to, in an attempt to send each car to as few floors as possible. You enter your floor number at a central control panel in the lobby and are told which elevator to take. With destination dispatch, the wait in the lobby may be longer, but the trip is shorter. And the waiting may not grate as much, because you know which car is yours. In Japan, the light over your prospective elevator lights up ('arrival immediate prediction lantern,' in the vulgate of vertical transportation), even if the elevator isn't there yet, to account for what the Japanese call 'psychological waiting time.' It's like a nod of acknowledgment from a busy bartender…"

***The New Yorker*, April 2008**

"'We'll wait ten to fifteen minutes for a train, without complaining. But wait thirty seconds for an elevator and the world's coming to an end. Which means, really, that we've done a good job. We deliver short waits. But why are we held to a different standard?"

***Rick Pulling*, Head of High-Rise Operations – *Otis Elevator Co.* (2008)**

In 1937, Otis introduced *Peak Period Control* to automatically schedule elevator service during high-demand periods. It helped reduce the waiting time on any given floor by co-ordinating the movement of the building's elevators. Peak-hour traffic in a busy high-rise often means long waits, a scramble for each arriving elevator, overcrowded cars and too many stops. Otis' *Compass Destination Management* system answered these challenges by using passengers' actual destination information to instantly assign each passenger to the most appropriate car. Instead of using standard hall call buttons, passengers input the specific floor they want to travel to before they enter the elevator. The system assigns passengers traveling to nearby floors to the same car. This minimizes the number of stops and significantly reduces car crowding as well as passenger waiting and travel times. In the past, destination management systems focused on the task of moving people vertically by using intelligent elevator dispatching. Otis' Compass Destination Management system facilitates moving people horizontally – from the lobby to their desired floor.

"…Smart elevators are strange elevators, because there is no control panel in the car; the elevator knows where you are going. People tend to find it unnerving to ride in an elevator with no buttons; they feel as if they had been kidnapped by a Bond villain. Helplessness may exacerbate claustrophobia. In the old system - board elevator, press button - you have an illusion of control; elevator manufacturers have sought to trick the passengers into thinking they're driving the conveyance. In most elevators, at least in any built or installed since the early nineties, the door-close button doesn't work. It is there mainly to make you think it works (it does work if, say, a fireman needs to take control. But you need a key, and a fire, to do that). Once you know this, it can be illuminating to watch people compulsively press the door-close button. That the door eventually closes reinforces their belief in the button's power. It's a little like prayer. Elevator design is rooted in deception - to disguise not only the bare fact of the box hanging by ropes but also the tethering of tenants to a system over which they have no command. The biggest drawback of destination dispatch, besides the anxiety of novelty, is that once you are in an elevator you cannot change your mind. To amend your floor choice, you must disembark, and start again. Elevator mind-changing - the sudden lunge for the unlit button - is rare enough; still, the option is nice. Also, when you get used to this system, you get into an elevator with buttons and forget to press one. But sometimes that happens anyway…"

***The New Yorker*, April 2008**


Please enter
destination
floor.
1
2
3
5
6
9
*

"…Destination dispatch, strictly speaking, was introduced eighteen years ago, by Schindler, the Swiss conglomerate, but a version of it was developed in the thirties, by the A.B. See Elevator Company, founded by the noted anti-feminist A.B. See ('If the world had had to depend on the inventive and constructive ability of women, we should still be sleeping on the plains'). Without the microprocessor, however, it was hard to implement. Schindler's version, the Miconic 10, was developed by an engineer named Joris Schroeder, who has written dense essays about his 'passenger-second minimizing cost-of-service algorithm.' Schindler claims that its system is up to thirty per cent more efficient than standard elevators. The other big manufacturers have come out with similar systems and make similar claims. In each, every bank of elevators has its own group-dispatch logic - which elevator picks up whom, and so on…The first American building to use smart elevators, the Ameritech building, in Indianapolis, hired mimes to help people navigate the system. They are still rare enough so that the Marriott has an attendant on hand to assist bewildered guests…"

***The New Yorker*, April 2008**

"…go see 7 World Trade Center, a two-year-old building, of unspectacular height (fifty-two stories, seven hundred and fifty feet)…'it's the most advanced system going.' The elevators were Otis - Larry Silverstein, the building's developer, is a longtime Otis man - and their destination-dispatch system is integrated with the security system; it reads your I.D. card at a turnstile and assigns you to an elevator. 'The next phase of this is face-recognition biometrics'…"

***The New Yorker*, April 2008**

<u>Left</u>: 7 WTC

"…One of the first buildings ever to use Otis' Compass Destination Management, 7 WTC has kiosks in the lobby where passengers select the floor they're going to. Sophisticated routing allows the elevator to save time and energy transporting people to and from their destination. At first it's confusing. Then, you realize it's more efficient. 'You'll arrive three minutes earlier,' says Randy Wilcox, president of Otis North and South America. 'It's about efficiency rather than speed today.'…"

***NY Daily News,* December 2nd 2011**

"…In the early days, you'd have an operator in each car and a licensed attendant, or dispatcher, in the lobby, who would tell people where to go. The operator typically was a woman and the dispatcher a man, and he tended to know the name, face, and status of each tenant. He could assign elevators to contiguous floors and tell the gals when to leave and direct the boss to an empty, momentarily private elevator…When systems converted to automatic, in the middle of the last century, and operators and dispatchers disappeared, that central logician was lost, and lobbies descended into randomness…"

***The New Yorker*, April 2008**

Elevonic Class

Otis' *Elevonic Class* of gearless elevators has redefined elevator performance, safety and comfort:

- **<u>Intelligent Dispatching</u> - efficient dispatching is key to performance. The *Elevonic RSR PLUS* system, with its algorithm of bonuses and penalties, consistently delivers the shortest waiting times with the minimum number of elevators.**
- **<u>Precise Performance</u> - the smooth ride of the Elevonic Class is achieved by multiple closed-loop systems which constantly monitor a car's performance, measuring every aspect against predetermined standards and correcting the slightest deviation within milliseconds.**
- **<u>Safety Precautions</u> - recent innovations include a high-tech alloy wedge face for the safety brake shoe which has exceptional temperature, strength and friction characteristics for improved braking performance and reliability. Moreover the *LAMBDA 3D* entrance-protection system anticipates passenger entry with an innovative hallway beam projection system preventing doors from coming into contact with passengers. Using fifty-six infrared emitters and detectors, it creates an invisible safety net across the elevator entrance and also extends into the hallway. The microprocessor controller continually scans for interrupted beams and reopens the door without coming into contact with the passenger.**
- **<u>Energy Efficiency</u> - the Elevonic Class uses ACVF regenerative equipment wherever possible to return energy to a building's electrical grid for re-use. The gearless Elevonic AC machines further conserve power by reducing initial starting currents, improving train-drive efficiencies and eliminating carbon brushes.**
- **<u>Comfort</u> - smooth acceleration and deceleration with an absolute minimum of vibration and noise defines the Elevonic Class ride**
- **<u>Intelligent Door</u> – bearing in mind that door problems account for about 40% of all service calls, Otis' *High Performance Linear Induction Motor* (HPLIM) door system, significantly reduces the number of moving parts resulting in more dependable and safe operation**

The Way to Green

OTIS

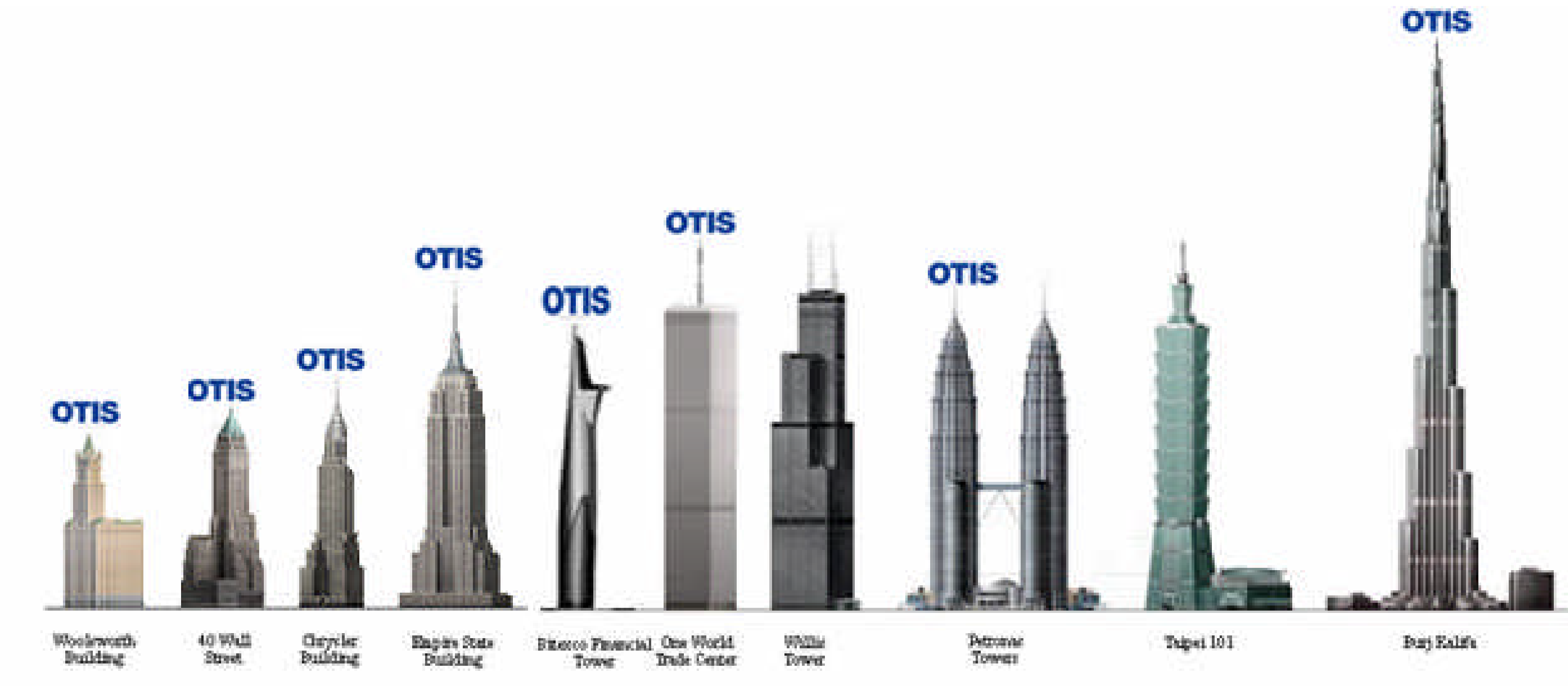
THE WAY TO GREEN™

"Winning new projects in South Korea, Germany, Brazil, China and Russia demonstrates Otis' commitment to providing energy-efficient solutions for sustainable development worldwide. As the industry leader, our continued focus on innovation is reflected in our products and services, which ensure efficient and reliable transportation for all passengers."

Didier Michaud-Daniel*, President - *Otis Elevator Company

RE: in October 2011, Otis announced at the 2011 *Greenbuild International Conference* that it had won several significant contracts that would solidify the company's commitment to providing sustainable solutions for its customers. These new projects were reinforced by the success of Otis' "The Way To Green" initiative; a global environmental program that spans every aspect of the multinational company's worldwide operations - from design and manufacturing to end-of-life product recycling. The most substantial of the new contracts involved supplying and installing seven-hundred energy-efficient elevators for a large-scale social housing reconstruction project in Jiangsu, China. Under the contract, Otis installed the company's energy-efficient *ReGen* drive technology. As of October 2011, Otis had sold more than 230K *Gen2* elevators since the product's launch in 2000, making it the fastest-selling elevator product in the company's long history.

Skyrise



<u>Above</u>: over the past one-hundred years, Otis has provided elevators to eight of the ten world's tallest buildings. *Skyrise* is Otis' premiere high-speed elevator system, designed and engineered for the world's most prestigious skyscrapers and high-rise residential and commercial buildings. Based on standards set by *Verein Deutscher Ingeniure* (VDI). Skyrise systems achieved an overall "A" energy-efficiency class rating, resulting in total energy savings up to 50%. *ReGen* drives deliver substantial energy savings while helping to meet or exceed worldwide standards. Permanent magnet synchronous machines are 40% smaller, and when paired with Otis' drive technology and control system, which are 50% smaller than traditional high-rise control systems, they allow for a smaller machine room.

Red Dragon Rising

"It is exciting for us to take on another project of such magnitude here in China and it will be the largest single contract for a commercial building for Otis. Innovation is at the core of what we do and this project requires a number of advanced technologies, including our super high-rise cap-abilities as well as best-in-class energy saving technology. We will continue bringing superior products to the China market, to meet the needs brought along by fast economic growth."

Tom Vining*, President of *Otis China Area

On June 3rd 2013, Otis announced the award of the *Goldin Finance 117* contract for 255 units in China's northern metropolis of Tianjin. Goldin Finance 117 (left) will have the honor of being the tallest building in all of the North China region at a height of about 600-meters (117 floors) when completed in 2016. The four elevator unit types being used in the project include *Elevonic*, *Skyrise* and the energy-efficient *GeN2-MRL* elevators and Otis *LINK* escalators. Goldin Finance 117 will have fifty double-deck units installed. The double-deck elevators will be able to save up to 40% of the space required by traditional elevators.

"Every city wants an iconic tower…Very few high-rise jobs are money makers. You give 'em away for the maintenance contract"

***James Fortune,* Elevator Consultant**

Riding High

“Wang Xiuli is a lift attendant. For the past five years, all she has had to do is to sit on a wooden chair and press buttons in an elevator of a 10-story office block built in the 1990s. It's grating on her nerves and gives her headaches. The good and bad news (for her) is the job that pays around 1,000 yuan ($163) a month won't last long. It is rare to see a lift attendant these days in the United States and Europe. Mostly they are retained for nostalgic customer service reasons in grand department stores and hotels. In the third- and fourth-tier cities of China, there are still many like Wang to be seen but, as more advanced automated elevators replace the old ones and fill the thousands of new buildings springing up, their days, like their buttons, are numbered. The upside is that many more lift personnel jobs will be created as business steadily increases for elevator and escalator manufacturers currently riding high on the continuing construction boom…”

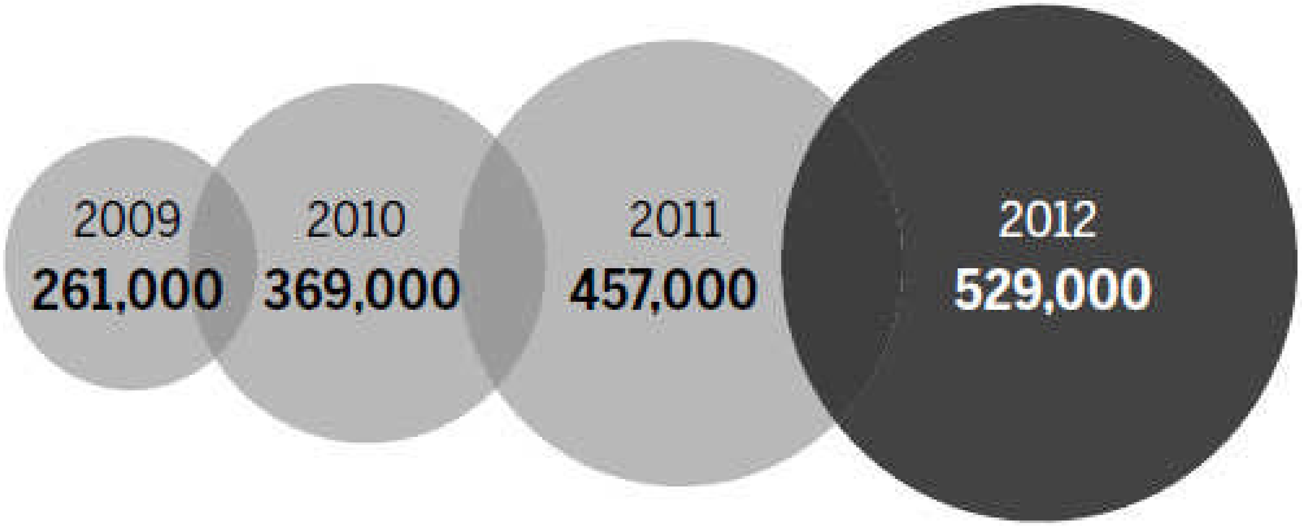
***China Daily*, February 10th 2013**

"A large amount of infrastructure construction is needed during the urbanization process. As a result, more and more elevators and escalators will be installed in public places such as office buildings, commercial shopping centers, airports, railway stations and residential areas. The market is growing much faster than we expected. Before, no one thought we would produce 60,000 units last year. Now we are trying to reach the next goal of 100,000 units."

***Li Shoulin*, Head of the *China Elevator Association* (2013)**

RE: in the first decade of the 21st Century (thanks to China's economic development and increased demand for construction projects), the elevator market in the country has grown rapidly. In 2012 (as compared with sluggish sales in the U.S. and Europe), the elevator and escalator market in China recorded sales of about 529K units; an annual increase of 15.8%. Although growth slowed slightly from 24% in 2011, according to the *China Elevator Association* (CEA), China still ranked first in the world for the amount of new elevators installed. Foreign elevator brands account for 80% of the Chinese market – the world's largest elevator market. China's urban population is expected to swell to 1 billion by 2025, when the country is expected to have as many as 221 cities, ten of them with +10-million population. As cities get bigger, so do the buildings resulting in more growth potential for elevator companies.

SALES VOLUME OF ELEVATORS AND ESCALATORS IN CHINA



"If China's urban population maintains an increase of one percentage point each year, about fifteen million rural residents will enter cities. That population will increase demand for urban infrastructure and thus the demand for elevators and escalators during the process of social transformation. We chose Chongqing as our second production base in line with the government's long-term policy to develop the interior and western areas rather than just the coastal cities. We want to be a service-oriented company instead of just a manufacturer or an equipment installation company. We expect profits to be maintained in the coming years, but we have to be more competent."

***Alan Cheung*, President – *Xizi-Otis Elevator Co. Ltd*.**

RE: Otis has concluded that China's urbanization level (as of 2013) is at 51%. Even so, it still has a long way to go to achieve the 80% urbanization level of Western Europe and the U.S. In anticipation of the growing market, Otis opened a new factory in Chongqing (in September 2012) to expand into central and western China. The plant – with a capacity of 15K units annually, will produce Otis' *Gen2* line of MRL elevators. Another growth factor in China's elevator market arises from the demand for repair and maintenance services. *Xizi-Otis* (Otis' largest subsidiary) will continue to invest in the after-sales sector, expanding its repair and maintenance service staff by 30%.

"It is growing faster than the average market in the world. We have never seen economic development at such a scale and such a pace anywhere in history; every time I go China, I am fascinated."

***Pedro Baranda*, President – *Otis Elevator Company* (2013)**

<u>Above</u>: caption "An employee of Xizi-Otis Elevator Co. Ltd. assembles an escalator"

<u>Left</u>: caption: "Xizi-Otis's Chongqing factory"

“China is the largest market for elevator consumption in the world - about 60% of the elevators sold in the world are sold in China. And there is an even higher proportion of elevators made in the world being made in China; it becomes an export hub. Today, China hosts the highest number of Otis employees in the world - more than 13,000. It is a fundamental source of talent for us. Talent flow in the best indicator of future cash flows; good recruiting and good training in China are going be fundamental for our success in China. Otis must continue to grow the service to keep those elevators running in a safe and reliable way. Investment in service is one of the key areas for Otis for the next ten years. Being close to the customer, with the best people and innovative products, is the recipe for success.”

***Pedro Baranda*, President – *Otis Elevator Company* (2013)**

RE: Otis, which installed its first elevator in China in 1907, has been trying to stand out in China by going beyond production to emphasize innovation by establishing a “high-rise center of excellence” in Shanghai. About one-hundred engineers from around the world work at the facility. Otis has also set-up a scholarship program to enable employees to further their education. The Spanish-born Baranda, who started his career with Otis in 1993 as a research engineer, became Otis’ president in February 2012, Baranda has visited China seven times, aiming to better understand the market and oversee the company's 13K Chinese employees based in Shanghai, Chongqing, Guangzhou and Hangzhou.

Innovation Thrusts

"The spark of innovation can be difficult to manage. We have a more structured process, even though some people might think processes are kind of a straitjacket for innovation. But in our case, they're for guiding the thought process. We decide where to focus on innovation, and we call them our innovation thrusts, which are based on what we're hearing from customers, architects, consultants, general contractors – everyone in our industry. We want to know what is going to be important for their business five to ten years out. Sometimes they don't know, but you can sense what's going to be important for them. At any given time we have five or six innovation thrusts. Once you have those, then you structure the process around those themes, and you guide the sparks in areas where they would have a big impact…"

Pedro Baranda*, President – *Otis Elevator Company

RE: excerpt from a July 2013 *New York Times* interview entitled: "Pedro Baranda of Otis Elevator, on the Push for Innovation"

<u>Left</u>: caption: "Pedro Baranda, president of the Otis Elevator Company, says that 'If you want to develop leaders and not followers, one of the key things you have to learn to do is delegate.'"

"…Then we do two things. We bring together teams of people from around the world, because I believe that diversity is fundamental in the thought process. I really appreciate the importance of diversity as a catalyst for creation and inn-ovation. It matters not just in product development and technology - I think it happens in many other aspects of the enterprise. But for innovation, it's fundamental. We also have an internal Web page where people can post their ideas about innovations. We have 62,000 employees, and they can vote on the ideas - thumb up or thumb down - or build on them. It also helps you to see people who have this innovative spirit. Those are the people we want to invite to meetings to develop ideas…"

Pedro Baranda*, President – *Otis Elevator Company

RE: excerpt from a July 2013 *New York Times* interview entitled: "Pedro Baranda of Otis Elevator, on the Push for Innovation"

Testing Towers

"…You can get a fair sense of the perils of an elevator shaft by watching an elevator rush up and down one, its counter-weight flying by, like the blade on a guillotine. The elevator companies I talked to wouldn't let me ride on top of a car or get into a hoistway; just to see a machine room, I was required to sign a release and don a hard hat, safety glasses, and steel-toed boots. For a good look at the innards, I had to leave New York, city of elevators, and drive up to Otis's testing center, in Bristol, Connecticut…"

***The New Yorker*, April 2008**

"…The Otis test tower rises twenty-eight stories above an office park, at the base of a wooded ridge. It's the only tall building for miles around. Its hazy-day gray color and near-windowlessness suggest a top-secret military installation, a bat tower, or the monolith from '2001: A Space Odyssey.' In one way, it's the most over-elevatored building in the world; all it is, really, is elevators - twelve test hoistways, plus a regular elevator. That one gets busy. The wait can be as long as thirteen minutes…"

***The New Yorker*, April 2008**

RE: Bristol, CT, is home to the Otis' testing tower (left). Otis needed a place to test their newest ideas to remain an elevator industry leader. The Bristol testing tower, at 383-feet, allows Otis to develop and test all of its elevator systems and their components. The facility has a quality control and product testing lab, along with thirteen test elevator shafts. Since the elevator market differs around the world, the Bristol facility has three high, four mid-level, and six low elevator shafts to accommodate these differences. A wide range of systems needed for elevator oper-ation/s can be tested at Bristol including cables, belts and hydraulic systems as well as systems in development.

"…Our first stop, on the ground floor, was the so-called 'drop car,' a rudimentary elevator platform stacked with dozens of hundred-and-fifty-pound lead plates. The Otis engineers use it to test overspeed stopping - free-fall prevention. The drop car shares a hoistway with another half-elevator, from which a tester can examine the performance of safety brake shoes. Piles of them were on the floor, like discarded lobster claws. It takes just a couple of feet for the brakes to engage. Over several weeks, the drop car lurches down the hoistway, from the top of the building to the ground, in mini-free-fall intervals that make the notion of an eighty-floor drop seem both ludicrous and newly horrifying…"

***The New Yorker*, April 2008**

"…Inside the tower is not what anyone would expect. It's home to an Otis Elevator testing and research center, and it's where they make sure anyone around the world who steps into one of their millions of elevators remains safe. At the top of their list are fighting off natural elements such as dust, sand, fog, heat, cold air and earthquakes. Every screw, belt, morsel of metal, machine or piece of equipment is put to the test in the facility where men and women wear white coats, construction hats, goggles and special shoes. It looks more like a hospital for machine parts than a test center. There isn't a spec of dust on the floor…"

NY Daily News, **December 2nd 2011**

<u>Left</u>: caption: "The 29-story testing tower is the tallest building for miles"

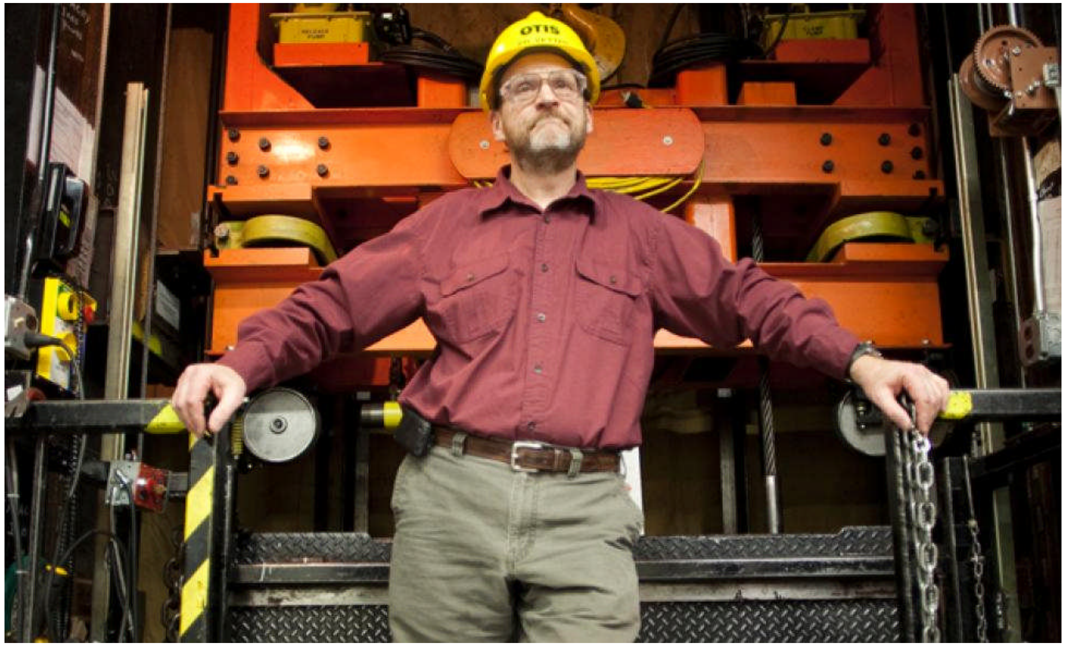

OTIS

The Engineer's Playground

"…All through the building, you could hear the clicking and whirring of elevators. We rode up to the twenty-eighth floor, a single vast room, with various hoistway openings in the floor, like crevasses. Men in hard hats were futzing with a control panel. 'We're interpreting the data before we proceed,' one of them said. In a corner was the 70T, a fourteen-ton turbine of steel about the size of a VW Beetle, capable of hauling seventy tons at fifty feet a second. In another corner there was a full-sized working replica of the 'Improved Hoisting Apparatus,' a suspended wooden platform that looked a bit like a gallows, which Elisha Otis had debuted at the Crystal Palace, in 1854, to demonstrate his new brake…We rode downstairs, to an immaculate warehouse space called the Quality Assurance Center – 'The engineer's playground,' Pulling called it - where Otis components were subjected to wear-and-tear tests. Kiln-like machines exposed parts to heavy doses of heat, dust, and salt fog. Hoist belts underwent twenty years of jerking and pulling in a few months…"

***The New Yorker*, April 2008**.

We Have to Be



"The fact that people have no idea how an elevator works is the best testament to how well we do our job. We're all about safety. We have to be."

Ed Yetter **(left), Manager for Product Process and Quality -** ***Bristol Testing Tower***

<u>Above & Left</u>: Otis operates the world's tallest elevator test tower in Shibayama, Japan. This test tower stands 505-feet above ground and 89-feet below ground. Mimic worst-case operating conditions and ones that simulate the rough ride Otis products might have during the journey from manufacturing facilities to installation sites around the world.


DANGER
DO NOT ENTER
TEST IN PROGRESS

Going Verde

Also in 2013, *Otis Brazil* inaugurated its first "Verde" (Green) plant in South America. Located in Sao Bernardo do Campo (in Greater Sao Paulo). The new plant covers more than 20K square-meters and produces Otis' most efficient elevator system: the *Gen2* (with *ReGen* drive). With this new facility, Otis Brazil's production capacity increased by 50%. The new facility was designed and built to minimize environmental impacts using the U.S. Green Building Council's LEED (*Leadership in Energy and Environmental Design*) criteria. The new plant uses natural energy and a highly efficient building system to help reduce power consumption and reuse water in its operations. The new plant also has an elevator testing tower 47-meters high (highlighted, above left), a modern center for technical training and a four-hundred square-meter product showroom. The plant is part of Otis' continuing investment in its Brazil operations which total over $30 million. Throughout Brazil, Otis has thirty-one branches and approximately two-thousand employees (as of 2013).

Expanding Markets

“We are extremely delighted with the Hyderabad Metro Rail win. This win affirms our position as a major vertical transportation supplier to Metro systems worldwide. Our experience with the Taipei Metro System, Shanghai Metro Line 6, Singapore East-West metro line, Tianjin Subway, Beijing South Railway station etc. will all help in delivering the best solutions for this prestigious project.”

Patrick Blethon*, President - *Otis Pacific Asia Area

RE: on April 23rd 2013, *Otis Elevator Company India Limited* announced that it had been awarded the elevators & escalators contract for the *Hyderabad Metro Rail Project* by *L&T Metro Rail* (Hyderabad) *Limited* (LTMRHL). Otis was contracted to supply and install a total of 670 elevators and escalators for the project. Of the total units, 260 *Gen2 Premier* elevator and 410 units of the *520 NPE* model escalator will be installed in over sixty-six metro stations, workshops and other buildings. To date, it was the largest single contract in the history of the Indian elevator industry.

“Otis is very pleased with this strategic acquisition, which is part of the company’s long-term commitment to invest and expand its operations in the fast-growing Colombian market, now one of the most promising in Latin America. IEI and Lucky have been Otis’ strategic partners for years. As employees in our global organization, they now have direct access to Otis’ innovative new equipment and service technologies and can deliver these enhanced solutions to our customers.”

Luis Molina*, Regional Vice President - *Otis Latin America

RE: on July 3rd 2013, Otis announced the acquisition of its independent distributors: *International Elevator Inc*. (IEI) and *Lucky Global Elevators S.A*. (Lucky), both based in Bogota, Colombia. The acquisition allows Otis to focus on new equipment, maintenance, repair and modernization of elevators in the third most populated country in Latin America (which also has the fourth highest GDP in the region). The acquisition also supports the growth of the infrastructure and civil construction sector in Colombia, which is rapidly expanding.

"With the ongoing massive activity on the ground, the Kingdom's construction industry is growing rapidly, we are honored to be a part of these structures and look forward to being present to anticipate needs and exceed expectations for technology and services"

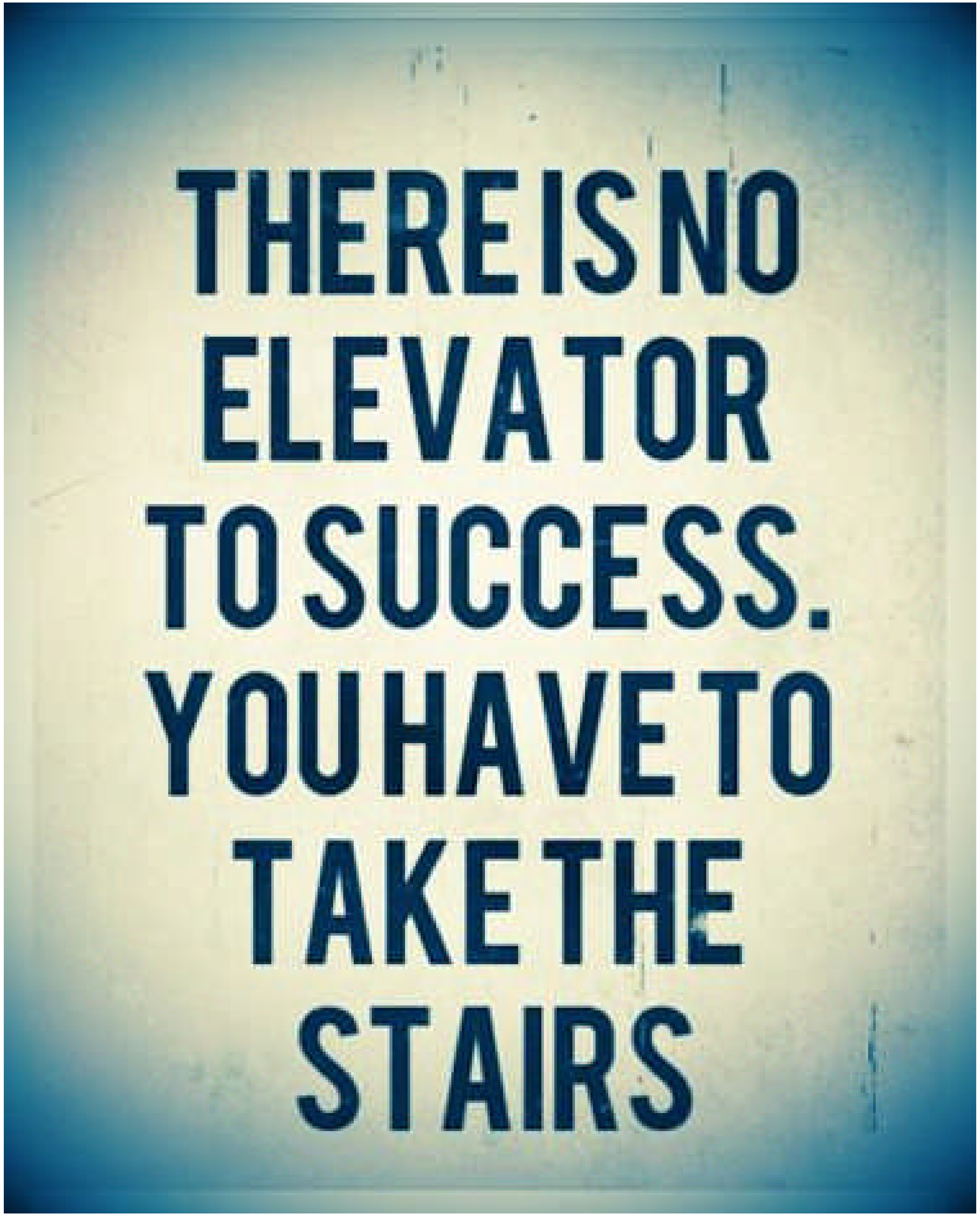
Rick Pulling*, Director of Key Projects and World Sales - *Otis Elevator Company

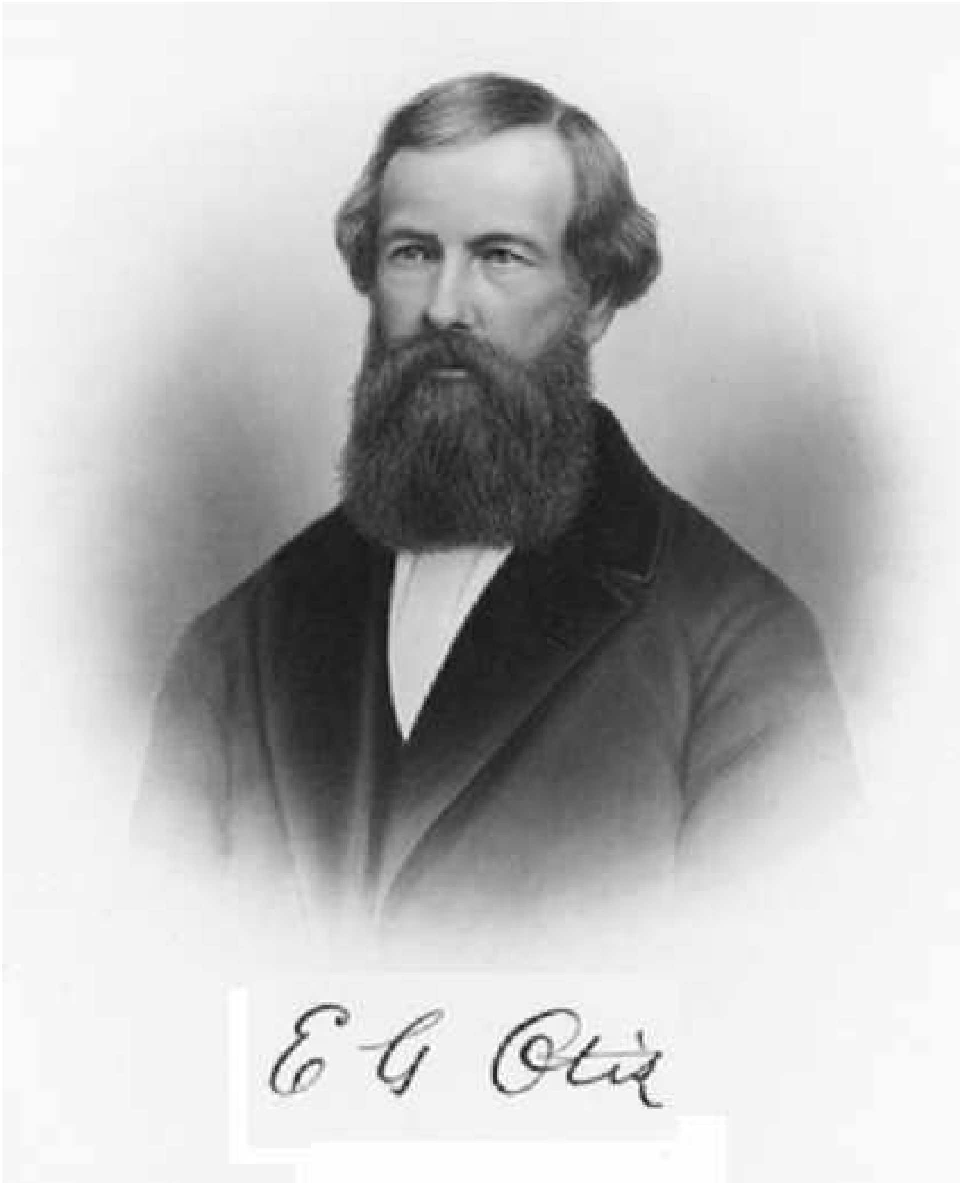
RE: in 2013, Otis celebrated its 160th year of operations. In both 2012 and 2013, Otis won six contracts to supply and install elevators and escalators in different buildings in the *King Abdullah Financial District* in Riyadh, Saudi Arabia. *Otis Saudi Arabia*, installed its first Otis elevator in the kingdom 1974, at the palace of *King Abdulaziz Bin Saud*. 2013 was the 30th anniversary of the installation of elevators at the *King Khalid International Airport* in Riyadh (1983) and the 20th anniversary of the installation of elevators at the *Ministry of Municipal and Rural Affairs* (1993). As well as Saudi Arabia, Otis was/is active in marketing to other Gulf states where there is a growing, active market for their products. By 2013, Otis' +60K employees were active in over two-hundred countries around the world.


OTIS
OTIS
TEDA CENTER

On the Home Front

Back home, Otis' 423K square-foot Florence, South Carolina plant began operations in mid-2013. This new facility united Otis' manufacturing, engineering, contract logistics and field support expertise for the first time in a single U.S. location thus enabling Otis to enhance customer support and product development efforts. *Gen2* and *HydroFit* MRL elevators are manufactured in Florence using sophisticated equipment for streamlined production. The facility also produces state-of-the-art controllers with energy-conserving *ReGen* drives and features a 150-foot test tower (above) for developing and testing the latest Otis elevator technologies. The Florence facility reflects Otis' *Way to Green* initiatives; from high-efficiency HVAC and lighting systems to product designs that eliminate painting and welding processes.


THERE IS NO
ELEVATOR
TO SUCCESS.
YOU HAVE TO
TAKE THE
STAIRS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