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A Note on the Fathers of Escalators: Ames, Souder, Reno, Wheeler, Seeberger

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Abstract

Escalators (moving stairways) are machines which belong to the group of continuous conveying machines according to their principle of operation, but at the same time they are, together with elevators, classified as the machines for vertical transportation. In their historical evolution they have some points of contact, mostly because the manufactures of both equipment are the same; however, escalators differ substantially from elevators, which basic principles were formulated several centuries ago. The basic design employed has not varied from those patented more than a century ago. All relevant patents as a base for modern escalators have been developed in the second half of the 19th century. Individuals and engineers, who invented those first patents, are considered as fathers of escalators. In accordance with the sequence of inventions the key persons in the history of escalators are Nathan Ames, Leamon Souder, Jesse Reno, George Wheeler and Charles Seeberger. Brief notes from their life and work and their inventions are presented in chronological order.

Keywords

History of Machines, Escalators, Inventors, Patents

1. Background and Etymology of the Word Escalator

Material handling and conveying equipment is typically used for different purposes: moving loads and people in warehouse settings, such as large retail facilities, manufacturing centers and factories, storage facilities and other industrial settings, construction and mining sites, transportation yards, ports, department stores, buildings, etc. Usually, when we speak about such kind of equipment we consider lifting (hoisting) equipment and conveying equipment. Lifting equipment (mostly related to cranes, but including elevators as well) is a group of

machines intended for moving loads and people mainly in batches. Conveying equipment is a group of machines which move loads and people in a continuous flow (Zrnić & Hoffmann, 2012; Zrnić, Đorđević, & Gašić, 2024a).

Additionally, vertical transport devices are those whose primary use is to transport in a vertical direction (although as a side effect they may also transport in a horizontal direction and inclined direction). Vertical transportation systems include all kinds of transportation media within buildings, such as lifts, escalators, hydraulic hoists and passengers' conveyors etc. It may be considered the most important building services system for high-rise buildings (So & Chan, 1999).

More facts on vertical transportation, including elevators and escalators, can be found in various references, such as are for instance (Bangash & Bangash, 2007; Strakosch & Caporale, 2010).

Historical background and evolution of cranes and lifting mechanisms are well described in many references, such as are for instance (Seyhan, 2024; Paz, Ceccarelli, Otero, & Sanz, 2010) and even some reconstructions of ancient cranes are realized, such as for instance (Ceccarelli, 2020).

Theoretical background of conveying equipment, in the sense of operating principles with continuous movement, is connected to primary conveying machines, like screw conveyors, chain water elevators and bucket elevators, ropeways, etc., and date back to ancient times. Some references for further reading are (Zrnić, Đorđević, & Gašić, 2022; Zrnić, Đorđević, & Gašić, 2024b; Hoffmann & Zrnić, 2012).

Although knowledge of the principle of moving material on an inclined direction goes back to ancient times, the idea of moving the inclined plane to transport people was conceived at a relatively recent date. The idea of moving material on an inclined plane was implemented during the construction of the great pyramids of Giza in ancient Egypt, according to (La Grazia, 2024). A rudimentary track consisting of tree trunks was used to transfer stone cubes to construction sites. In its construction over 2 million stone cubes were laid on the tree trunks and slowly rolled upwards on the artificial earth bridges that surrounded the build site. That continuous use of rolling wheels beneath the transported weight became one of the basic principles behind today's escalators (Elevator History, 2024). Additionally, in Nguyen (2020), it is presented a theory based on the speculations that the ancient Egyptians did in fact invent escalators, elevators, travellators and semi-vehicles. In Kato (2020), they are presented several assumptions on ancient escalators. All of the mentioned theories lack evidences and are strongly under the question.

Generally, the simplest definition and explanation of escalator is "a power-driven set of stairs arranged like an endless belt that ascend or descend continuously" (Merriam-Webster, 2024). There are many other different definitions and explanations of escalators in literature and corresponding standards, which slightly differs according to the year of publishing. In Wright & Little (1921), an escalator is "moving apron type of elevator-conveyor set at an inclination corresponding to that of ordinary stairways, and used for conveying persons or freight

up or down". In Pennsylvania Code (1924), an escalator is a "moving continuous inclined stairway or runway used for raising or lowering persons". Finally, according to a relatively recent reference (Craighead, 2009), "An escalator is just a simple variation on the conveyer belt. A pair of rotating chain loops pulls a series of stairs in a constant cycle, moving a lot of people a short distance at a good speed". In specialized standards for escalators, such as (CEN EN 115:1995, 1995), we can find a definition which describes an elevator as a "power driven installation with endless moving stairway for the conveyance of passengers in the upward or downward direction". Escalator structure is presented in **Figure 1**.

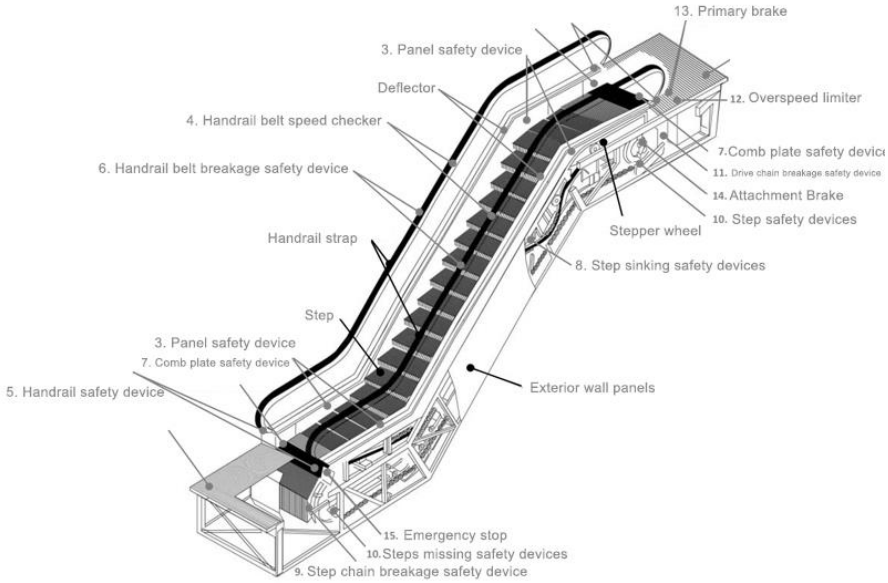


Figure 1. Escalator and its basic components (Dazen, 2024).

Escalator is a considered as a coined word, meaning stairs that can move (Zrnić, Đorđević, & Gašić, 2024a). However, several authors and historians have contributed their own differing interpretations of the source of the word "escalator", and there are also several unproved interpretations which can be found on the Internet. Originally, it was inventor Charles Seeberger who trademarked the word "escalator" in 1900, to coincide with his device's debut at the Exposition Universelle in Paris, France. According to his own account, in 1895, his legal counsel advised him to name his new invention, and he then set out to devise a title for it on his own. As evidenced in Seeberger's own handwritten documents, archived at the Otis Elevator Company headquarters in Farmington, Connecticut, the inventor consulted "a Latin lexicon" and "adopted as the root of the new word", "Scala"; as a prefix, "E" and as a suffix, "Tor" (De Fazio, 2007). Although it is a registered trade mark of the Otis Company, it has now become generic, because in 1950, the landmark case Haughton Elevator Co. v. Seeberger precipitated the end of Otis' reign over exclusive use of the word "escalator", and simultaneously created a cautionary study for companies and individuals interested in trademark retention (Folsom & Teply, 1980). The court determined that Otis Elevator failed to properly

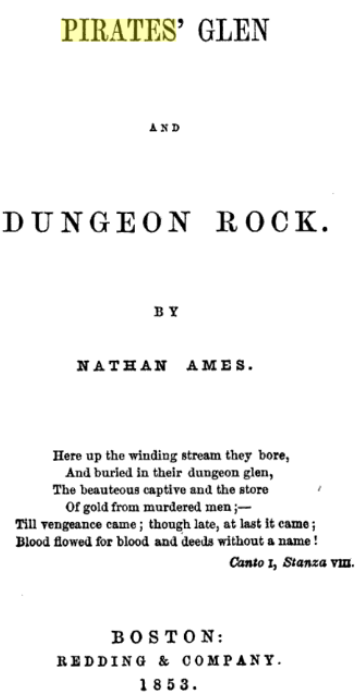
protect the mark and it had become recognized by the general public as the name for a moving stairway and not the source of the goods (i.e. the ESCALATOR of Otis Elevator) (Strutton, 2024). After this decision, the term "escalator" fell into the public domain and now anyone can freely use the term.

2. On the Fathers of Escalators and Their Inventions

In 1859, patent solicitor and writer Nathan Ames of Massachusetts held the first escalator patent in the United States for his "Revolving Stairs"—but the idea did not move beyond this stage.

2.1. Nathan Ames—Biographical Overview

Nathan Ames (1826, Roxbury, New Hampshire - 1865, Saugus, Massachusetts) was born as Nathan Eames, but it was officially changed to Nathan Ames in 1843 (Davis, 1895; Massachusetts, 1845). He worked to earn a living as a patent solicitor graduating from Harvard College in 1848, Phillips Academy at Andover. However, he was also known as an American poet known for his evocative and reflective poetry. His work often explores love, loss, and the complexities of human relationships. Also, he wrote poetry about local pirate legends. Ames published Pirates' Glen and Dungeon Rock in 1853, Figure 2 1853 (Ames, 1853). This book is an epic poem about the lives of pirates and their buried treasure. According to the authors' best knowledge no picture of Ames seems to exist.


PIRATES' GLEN

AND

DUNGEON ROCK.

BY

NATHAN AMES.

Here up the winding stream they bore,
And buried in their dungeon glen,
The beauteous captive and the store
Of gold from murdered men;—
Till vengeance came; though late, at last it came;
Blood flowed for blood and deeds without a name!
Canto I, *Stanza* VIII.

BOSTON:
REDDING & COMPANY.
1853.

Figure 2. Cover page of the Nathan Ames book published in 1853 (Ames, 1853).

2.2. Nathan Ames—Technical Contributions

Ames invented, claiming 11 patents aimed at making daily life easier. He also

patented machines for improvement in polishing leather during the time when Lynn's shoemaking industry was one of the largest in the world. Another one of his patents was for a polygraph, an early copying machine that operated by using pens connected by wires (Wells, 1856). Another patent he held was for an improved grater (United States. Congress. House, 1866). However, his most important invention is "revolving stairs", **Figure 3**. In the Specification of Letters Patent No. 25,076, dated August 9, 1859 Nathan Ames declared that he "invented a new and useful Improvement in Stairs, which he called Revolving Stairs".

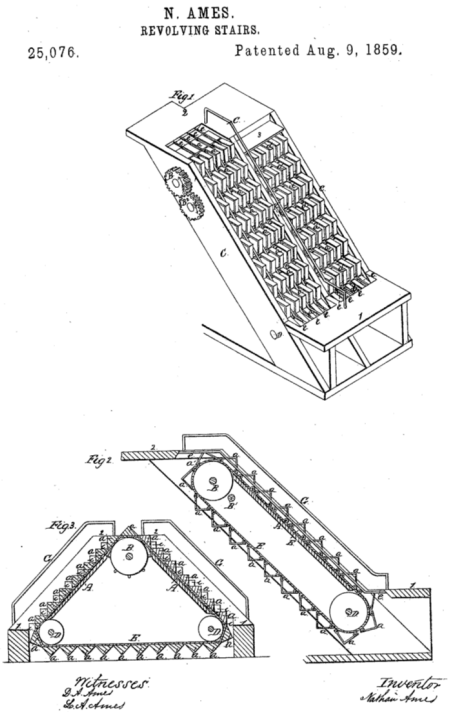


Figure 3. Illustration of the Nathan Ames patent—First escalator-like device: Revolving stairs (Ames, 1859).

Further, he explained that "**Figure 1** represents a perspective view of the double parallel arrangement of stair flights, the two flights being placed side by side, and moving in opposite directions. **Figure 2** represents a side sectional elevation of the double parallel arrangement. **Figure 3** represents a side sectional elevation of the triangular arrangement of a single, or continuous stair flight, in which the same object is attained as by the arrangement shown in **Figure 1**." He also stated that "The nature of his invention consists in arranging steps, or stairs, upon an inclined endless belt, chains, or ropes, or in attaching the stairs or steps together by links or joints so as to form an endless inclined flight of steps or stairs, which are placed on, over, or around, rollers, so that the stairs or steps shall serve as elevators, when motion is transmitted to the rollers. The object of the invention is to enable persons to ascend and descend from one story of a building to another, without exerting any muscular strength; the stairs being also capable of being used in the ordinary way, when desired".

His idea lacked details, he was not sure of possible power source (manual, steam or hydraulic) for his machine and it wasn't viable to use wood and chains for its creation. The impracticality of jumping on one side and jumping off on the other probably caused the demise of Ames's design (Strakosch & Caporale, 2010). Although Ames was ahead of his time, he patented the escalator long before the widespread availability of electricity and the lack of electrical distribution systems, as the first production electric motors didn't arrive until the 1870s (Cooper, 1998). It was also very unlikely that anyone would install a whole steam engine just to power an occasional stairway. In his view, the machine could benefit the sick or weak person within a household. This idea fully viable, but having in mind that there was no need for machines to move large numbers of people at that time, the previously mentioned facts prevent the realization of this patent and the first patented escalator was never built.

2.3. Leamon Griffith Souder—Biographical Overview

The second in a row after Ames is Leamon Griffith Souder who looked back at Nathan's creation before developing them further. Unfortunately, in contrast to the Ames, even on the internet pages and other sources, there is a complete lack of the information regarding Souder and his work and life. Even we couldn't find his picture. According to the scarce documentation provided in his patents we know that he was residing at the city of Philadelphia, in the county of Philadelphia and State of Pennsylvania. In Blitz (2016), we can also find that he was like Ames an amateur engineer.

2.4. Leamon Griffith Souder—Technical Contributions

In 1889, he patented the "Stairway", an escalator-type device that featured a "series of steps and links jointed to each other", **Figure 4** (Souder, 1889). In the description of his patent was declared that "this invention relates to means for access to the several floors of buildings, and has for its object the avoidance of the labor and fatigue involved in ascending ordinary stairways, and also the attendance requisite for operating a passenger-elevator. To these ends the invention consists in a series of steps and links jointed to each other, together with means for propelling the said steps. The stairs are propelled by an endless band or chain, passing over rollers and would be moved hydraulically or by propelling power." (Souder, 1889)

His patent remained unbuilt. However, the advantage of his patent in comparison to the Ames solution was that it was closer to the real engineering, as Souder described his invention in a manner that made it credible using the new technologies of the day.

The presented patent of the escalator-like device was the first of at least four escalator-style patents issued to Souder, including two for spiral designs (U. S. Patent Nos. 723,325 in 1903 and 792,623 in 1905), **Figure 5**.

The modern escalator, as we know it today, is a result of two inventions and extensive development.

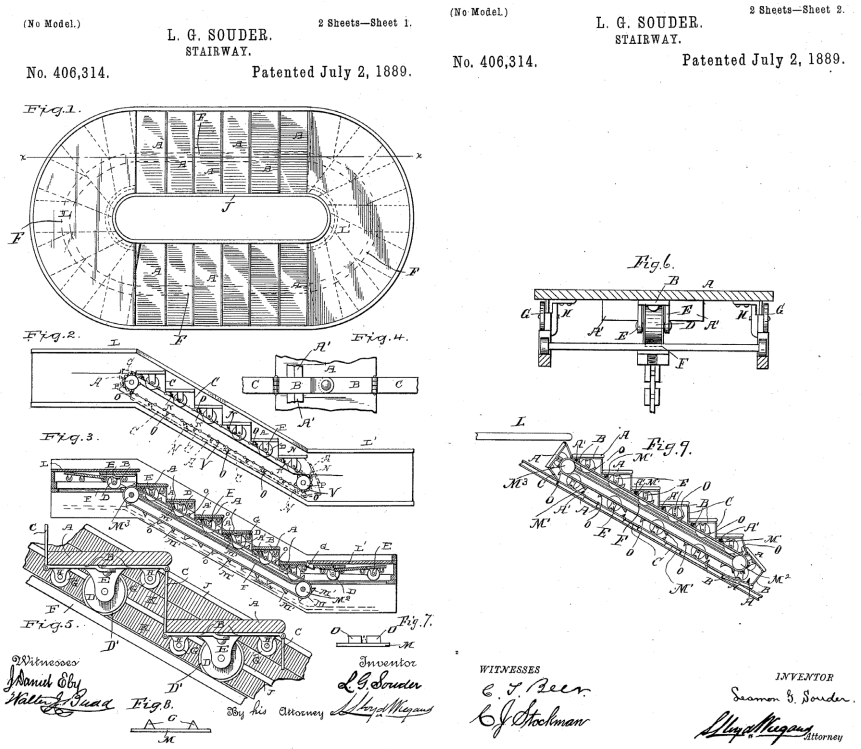


Figure 4. Illustration of the L. G. Souder patent—Moving stairway or elevator (Souder, 1889).

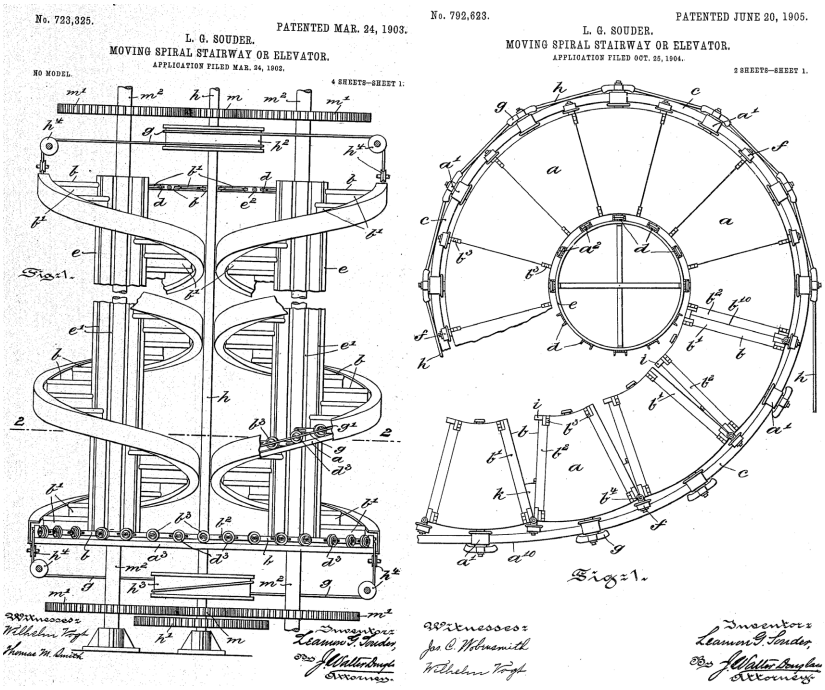


Figure 5. Illustration of the Leamon G. Souder later patents: Left—Moving stairway or elevator (Souder, 1903) and Right—Moving stairway or elevator (Souder, 1905).

2.5. Jesse Wilford Reno—Biographical Overview

The next in row of the fathers of escalators is Jesse Wilford Reno (1861-1947).

Regarding biographical information, Jesse Wilford Reno **Figure 6** (left), is certainly one of several individuals credited with the beginnings of the modern escalator. He was born in Fort Leavenworth, Kansas, as the son of Jesse L. Reno, famous career US Army officer who served in the Mexican-American War, in the Utah War, on the western frontier and as a Union General during the American Civil War, **Figure 6** (right). Reno family ties could be traced back to the French immigrants who came to the United States in 1700 and changed the spelling of their surname "Renault" to "Reno". Jesse Lee Reno is born in Wheeling, Virginia (now West Virginia). He was known as a "soldier's soldier" who fought alongside his men. General Reno was killed while commanding a corps at Fox's Gap during the Battle of South Mountain, at age 39 (by the way, city Reno in Nevada is named after General Jesse). His son Jesse was only one year old, and one of five children. He graduated engineering in 1883 (mining and later metallurgical engineering) at the Lehigh University. After graduating from Lehigh University in in Bethlehem, Pennsylvania, his engineering career took him to Colorado, then to Americus, Georgia, where he is credited with building the first electric railway in the southern U.S. Reno submitted his first patent application for a "new and useful endless conveyor or elevator" in 1891 and it became effective 15 months later. His spouse was Baroness Marie G. Snowman. He died at the age of 86 in Pelham Manor, Westchester County, New York and was buried in Oak Hill Cemetery in Washington (Find a Grave, 2011).

Figure 6. Jesse W Reno (Alchetron, 2023) and his father famous American general Jesse L Reno (Rushton-Smith, 2024).

2.6. Jesse Wilford Reno—Technical Contributions

In 1892, Reno's patent Endless conveyor or escalator became effective. In the patent was declared that "the object of this invention is in particular to provide a mechanical incline or slide conveyer to be used in place of elevators or stairways where large numbers of persons are to be transferred from one floor or level to

another, either upward or downward". Practically, he invented a conveyor belt set at an incline of 25 degrees. The planks of the conveyor belt were metal with a serrated surface, much like the steps of today's escalator. The design allowed for a smooth transition between the belt and the landings by combining serrated planks with a set of comb-like teeth at the top and bottom landings. A handrail that moved with the conveyor belt provided the passenger with an added sense of security, **Figure 7** (Strakosch & Caporale, 2010; Reno, 1892).

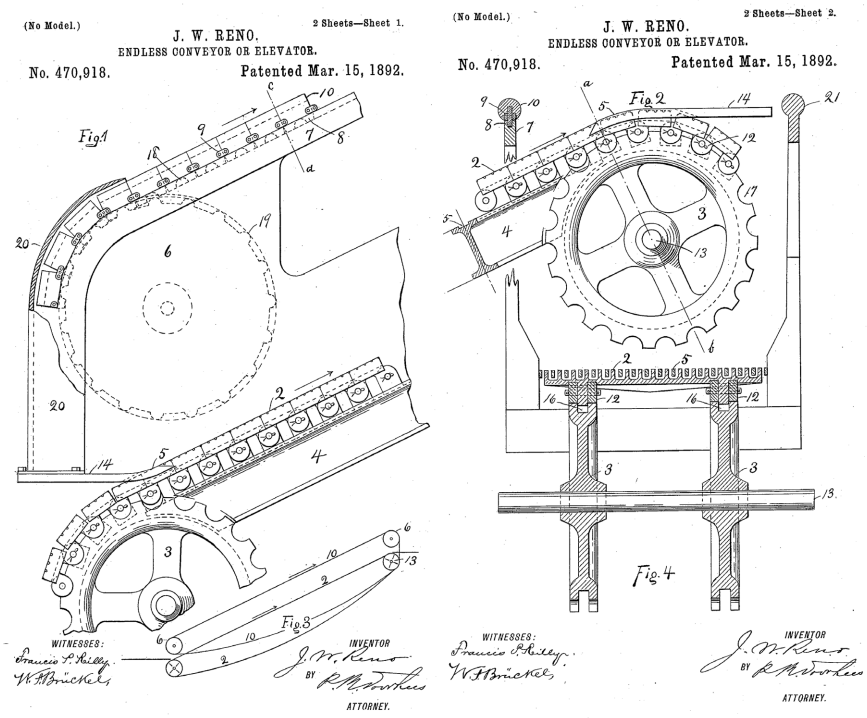


Figure 7. Illustration of Jesse W. Reno patent—Endless conveyor or escalator (Reno, 1892).

But Reno soon recognized that there are certain public spaces where elevators are not really the practical solution. Inspired by his predecessors' concepts, he produced the world's first working escalator and called it the "inclined elevator", which was officially accepted under this name as the Patent No. 637,526, dated November 1, 1899, **Figure 8** (Reno, 1899). He declared more precisely this patent that "his invention relates to inclined passenger elevators by means of which passengers are carried on a continuously-moving tread-surface or belt adapted to travel along an inclined track from one level to another, as from one floor in a building to another above or below it".

Reno built a model inclined elevator for installation as a novelty ride at the Old Iron Pier amusement park in Coney Island, New York for two weeks in 1896. This escalator, recognized by majority of sources as the first one ever built, was a little 6-foot stairway that lifted people onto the Coney Island Old Iron Pier. It has been estimated that as many of seventy-five thousand people lined up to ride the attraction, which carried them on a 25% incline and only went up 7 feet. The steps

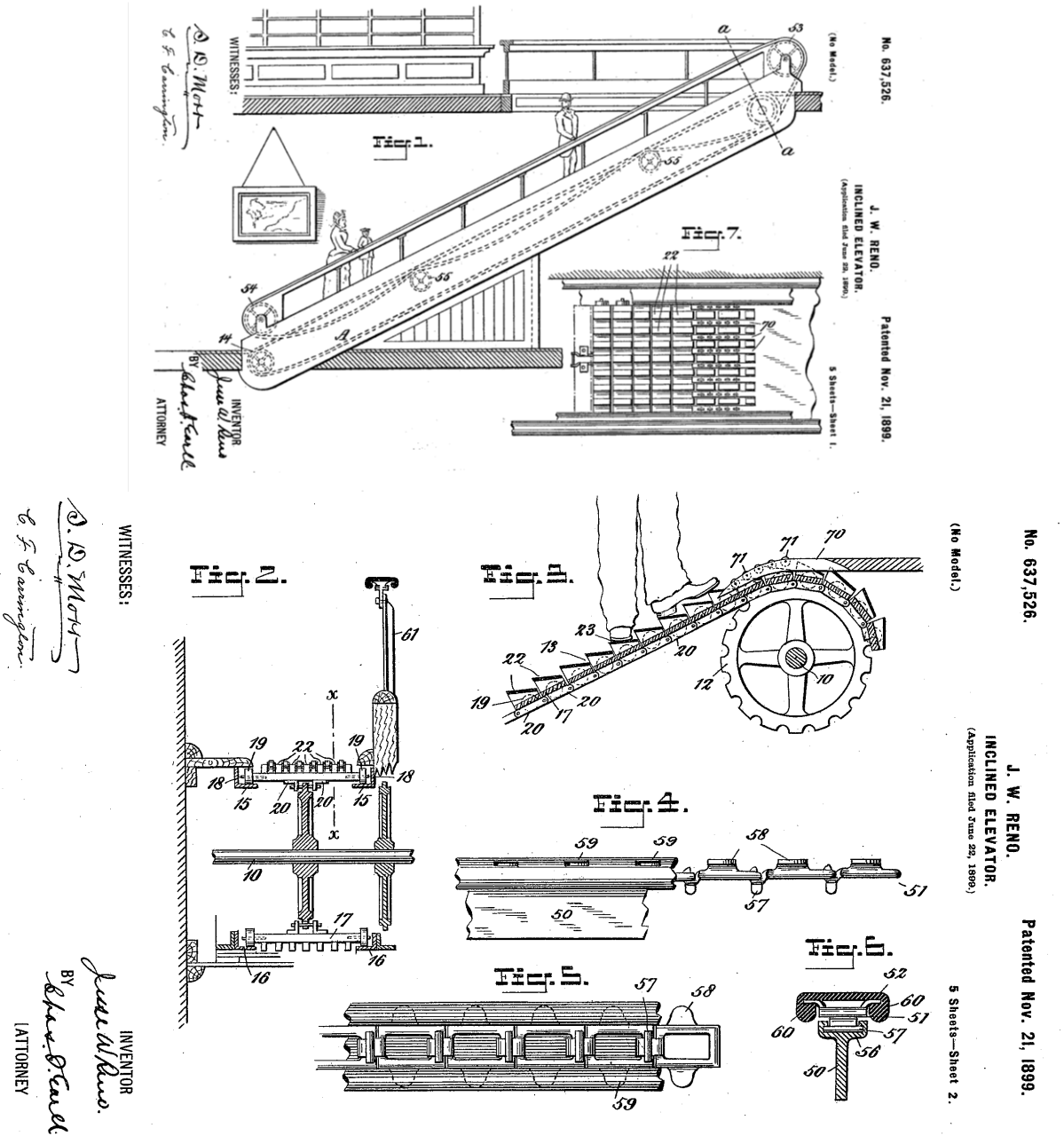


Figure 8. Illustration of Jesse W. Reno patent—Inclined elevator (Reno, 1899).

were made of wood, and they were very uncomfortable to stand on. It included the rubber handrails we have come to know and the teeth you see at the end of each side of an escalator today. But, at that time, it seemed superior to vertical elevators. At least, people were handled continuously and there was no necessity for the attendants, like as for elevators (Cooper, 1998). A few months later, the same model was installed on a trial basis for a month-long test on the Manhattan side of the Brooklyn Bridge. In the course of its operation, it carried 75,000 passengers. It was a sensation. In 1896, Reno developed plans for the building of the New York City subway, a double-decker underground system that could be

completed in three years. According to the report in the 1896 Street Railway Review (**Figure 9**), "A narrow incline of this kind has been given a practical test at the old iron pier, Coney Island, this fall, with the idea of demonstrating its practicality to the trustees of the Brooklyn Bridge, the officers of the elevated roads, and the Boston subway. The capacity of a single file elevator is 3,000 people per hour and by increasing the width the capacity can be correspondingly increased. The system is manifestly superior to vertical elevators for many places because people are handled by it continuously and without delay and no attendant is required" (Untapped Cities LLC, 2021).

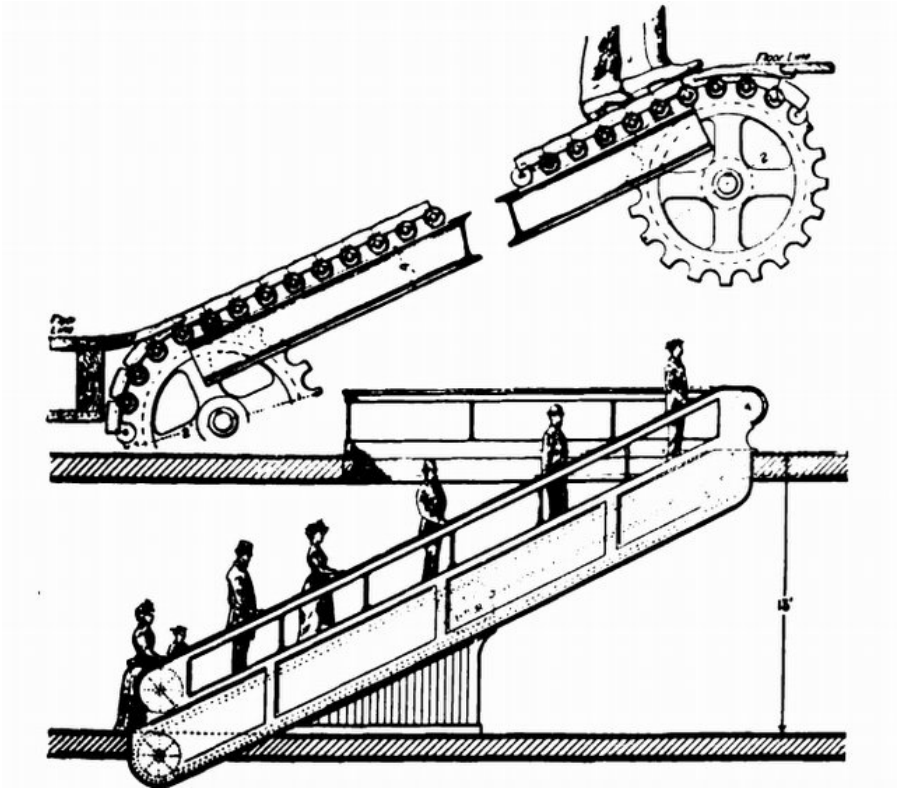


Figure 9. Plans for the inclined elevator from the 1896 (American Street Railway Association, 1896).

In 1896 Reno sold four escalators to the Siegal Cooper Department Store in New York, USA on the corner of 6th Avenue and 19th Street (Cooper, 1998). By 1898, the first retail application for the invention was established with the installation of an inclined elevator at the Bloomingdale Brothers store at Third Avenue and 59th Street in New York City, **Figure 10**.

This was the first retail application of the device in the US. Reno's inclined elevator was also on display at the Paris Exposition in 1900, where five Reno machines were commissioned. In the same year another was installed in London's Crystal Palace, passengers passing through a turnstile and paying a penny for the thrill of being conveyed from the ground floor to the gallery. The Crystal Palace machine was inclined at 25 degrees and was about 54 ft. long, with a vertical rise

of nearly 22 ft. It was located in the central transept and was powered by a 7.5 kW motor of American origin and driven at about 90 ft/min. Crystal Palace machine was almost certainly Reno's first British installation, **Figure 11** (Machorne, 2013). Based on these early successes, Reno married and moved to London where he founded the Reno Electric Stairways and Conveyors Company in 1902 and established a small production facility that was soon building machines for American subway systems and, eventually, a Spiral Moving Walkway for the London Tube transportation network (Hagley, 2023). He joined with William Henry Aston, holder of a patent for the flexible pallet coupling and chain, to create the pioneering mechanism that was exhibited for four years and installed on the London railway at his own cost, but never used by the public, probably due to safety

Figure 10. Early type of the Reno's escalator (Fenzel, 2021).

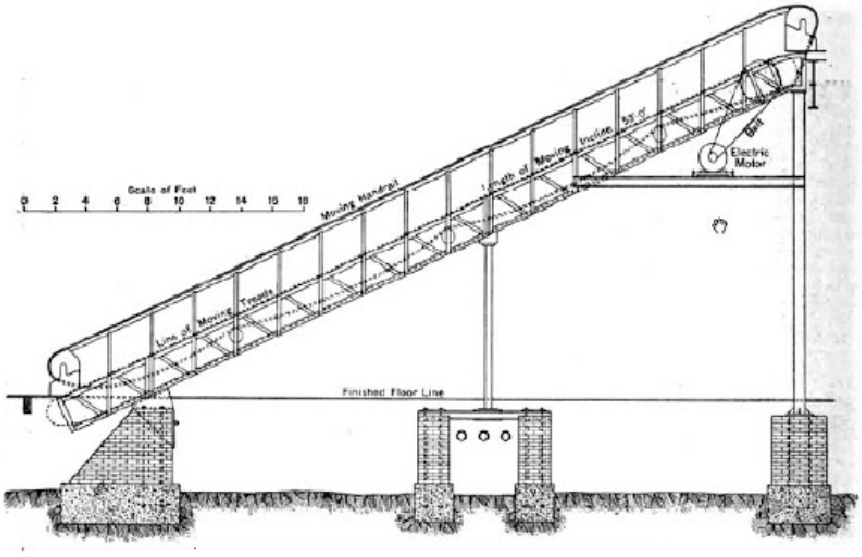


Figure 11. Reno's Crystal Palace machine (Machorne, 2013).

concerns (Elevator World, 2012). The remains a spiral escalator, **Figure 12**, was found buried at the bottom of a lift shaft at Holloway Road station in 1988. **Figure 12** was taken during station construction. Two workmen stand on adjacent "moving" stairways, encircling a central core like two helical coils. The escalator is located within a vertical shaft; a concrete platform hangs across the central core, supported by vertical iron girders (London Transport Museum, 2024). The old Reno escalator was a compact piece of equipment, and many are still in use.

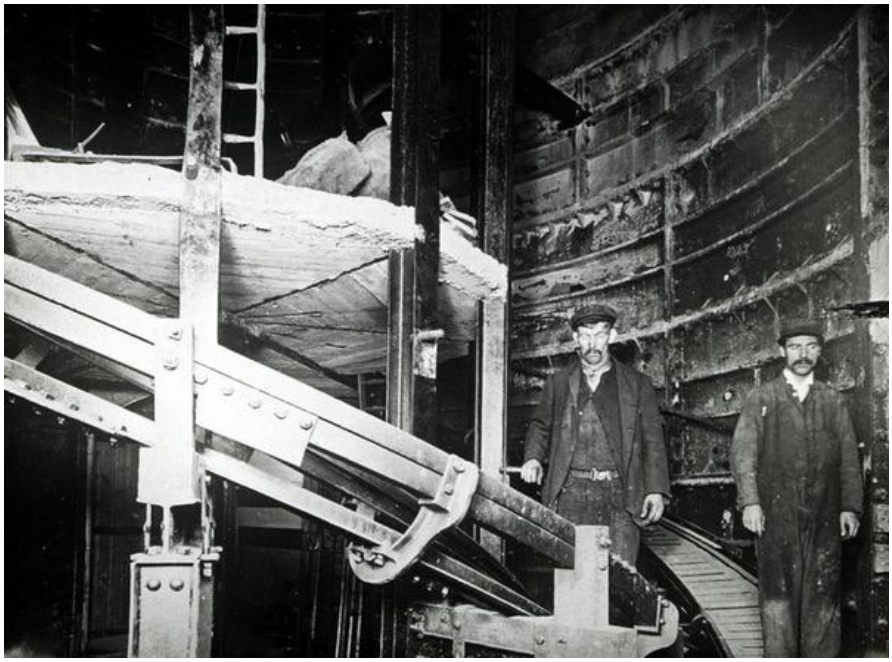


Figure 12. Spiral elevator/walkway built by Jesse Reno at Holloway Road Underground station, Piccadilly line, 1906 (London Transport Museum, 2024).

1892 was obviously a fruitful year for the escalator with two US patents being issued. A few months after Reno's patent was approved, George A. Wheeler from New York concurrently and independently patented his ideas for a practical escalator (Wheeler, 1892), though it was never built, **Figure 13**.

2.7. George A. Wheeler—Technical Contributions

However, regarding Wheeler biography we didn't find more facts about him. In his patent application we can find that "George A. Wheeler, of New York City, in the county and State of New York, have invented a new and useful Elevator, of which the following is a full, clear, and exact description" (Wheeler, 1892). Also, it is stated that "This invention relates to improvements in passenger-elevators preferably employed for stations on elevated railways, but also applicable to other locations, and has for its objects to provide a safe, capacious, and convenient device which will afford a stairway for travel as well as a continuously-movable elevator." His machine was a flat-step "inclined elevator" with a handrail. Accordingly, Wheeler's inclined elevator had flat steps and a triangular diverting

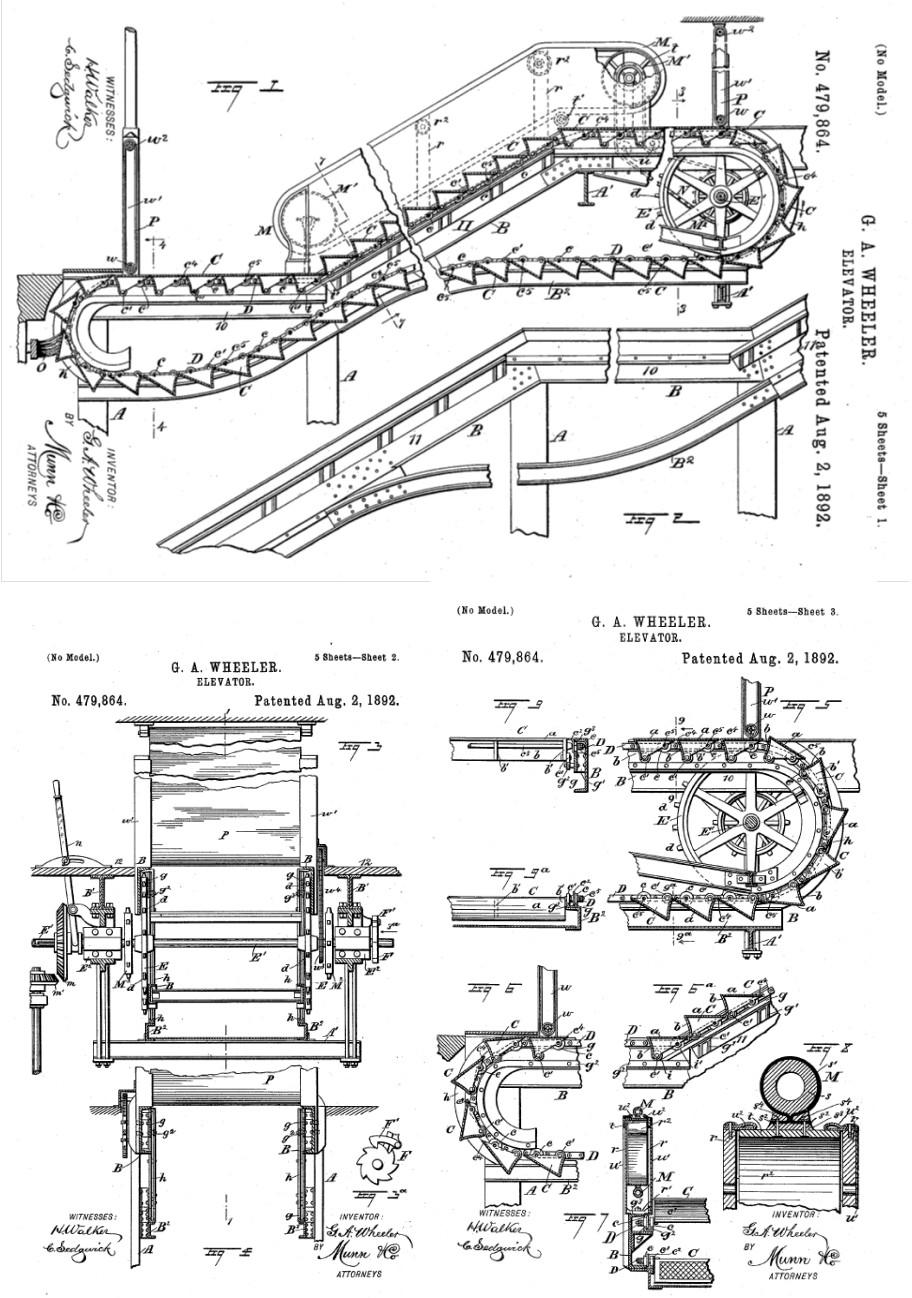


Figure 13. G. A. Wheeler, Elevator (Wheeler, 1892).

baffle, or "shunt", at the top and bottom, where people had to sidestep on and off the escalator, rather than straight off as we do today. This device was an improvement over the Reno in that it provided flat steps and a moving handrail (Kraus, 1962). Wheeler's patents were purchased by Charles Seeberger in 1899, who quickly struck a deal with elevator manufacturer Otis to produce moving staircases. Both the Reno and the Seeberger/Wheeler types of escalators were manufactured by Otis as separate products.

Some later patents are also associated with Wheeler, including moving spiral stairway, **Figure 14** (Wheeler, 1908).

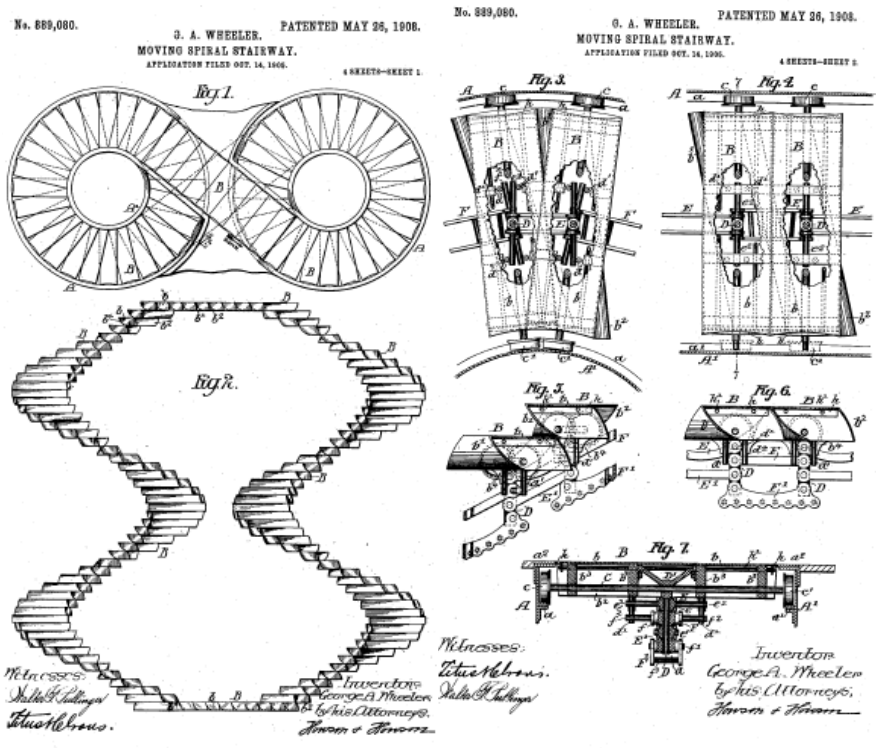


Figure 14. G. A. Wheeler, Moving Spiral Stairway (Wheeler, 1908).

Wheeler's patents were purchased by Charles Seeberger in 1899, who quickly come into contact with elevator manufacturer Otis to produce moving staircases. Registered as an "arbitrary word" on May 29, 1900, to Charles D. Seeberger, assigned to the Otis Elevator Company, and renewed May 29, 1930, in connection with "passenger elevators" (LexisNexis, 2024).

2.8. Charles D. Seeberger—Biographical Overview

Charles D. Seeberger (1857, Oskaloosa, Iowa - 1931, Oak Bluffs Highlands, Massachusetts), Figure 15, son of Anthony Seeberger and Jennie Cooper, was an American inventor and innovator, later well-known entrepreneur in the escalator industry. Charles married Emma Bridge Seeberger and they had two children. Seeberger was a Yale-trained engineer who obsessed over the prospect of a moving staircase while working in the family hardware store in Chicago (Schuler, 2008).

2.9. Charles D. Seeberger—Technical Contributions

He was the first one to realize that escalators need to be mass produced. Accordingly, having in mind that Seeberger had already been working on ideas of escalators of his own, however Seeberger wasn't satisfied with his own design, however, he preferred George Wheeler's "flat-step" design. So, he bought 50% of the Wheeler patent (interestingly, at that time, Wheeler couldn't raise any interest in his idea) in 1898 followed by a complete buyout. This coincides with the time when he decided to redesign Reno's model. In connection with the Otis Elevator

Company, Seeberger built the first commercially produced escalator based on his design in the Otis factory in 1899 and put such a model of the first "step" escalator on display at an exhibition in Paris in 1900 where it won an award. Looking more like a modern escalator than Reno's version and coming complete with steps, a truss, and a track system, this design really moved Paris. Reportedly a fee was charged to passengers who rode this escalator at the exhibit. After being shown in Paris the unit was returned to the United States and installed in Gimbel Brothers Philadelphia Store. This escalator gave service to Gimbels until 1939. Seeberger flat step escalators are presented in **Figure 16**. During 1900 another escalator was installed by Seeberger in a New York Store named "Simpson Crawford" and a third in the New York Elevated Railroad Station at 6th Avenue and 23rd Street. In 1902 the same man installed five escalators in R. H. Macy, New York. Four of these were in operation until about 1950. In the period from 1890 to 1911 Seeberger and Reno appear to have been the most active individuals in escalator development and Otis Elevator was the one Corporation involved (Kraus, 1962). In 1910,

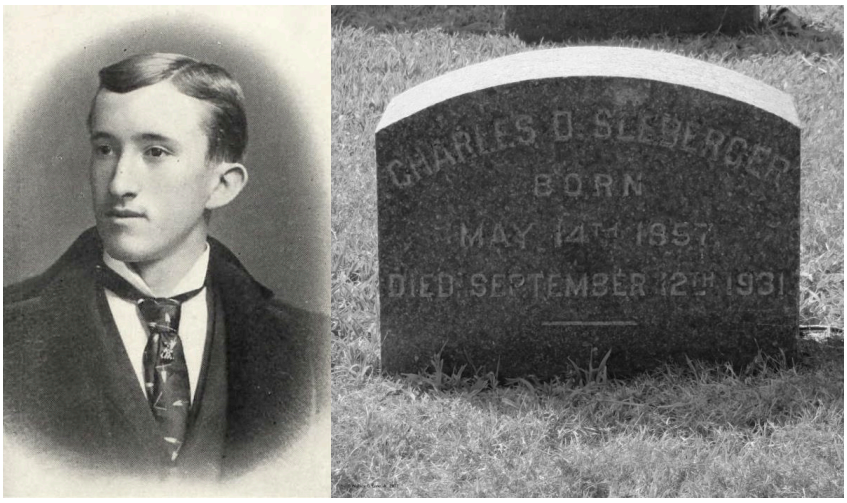


Figure 15. Charles David Seeberger in the young age and his grave at the Green-Wood Cemetery Brooklyn, Kings County, New York (Find a Grave, 2010).

Figure 16. "Seeberger" flat-step escalator and note barrier deflector (reproduced from Elevator World Magazine, January 1992) (Strakosch & Caporale, 2010).

Seeberger sold his design outright to Otis. Both the Reno and the Seeberger types of escalators were manufactured by Otis as separate products. The Otis Elevator Company began to manufacture escalators whose designs seem to have changed little over the subsequent century (Zrnić, Đorđević, & Gašić, 2024a).

3. Concluding Remarks

Escalators similar to elevators and different types of conveyors, originated in 19th century in the USA, taking several decades to become commercially viable. The value of escalators in vertical transportation is in providing a continuous flow of people, as contrasted with the batch approach of elevators. The invention of the escalator was ground-breaking. Early escalators were also known by a variety of names, including traveling staircase, inclined elevator, and magic stairway. The first step-type escalator made for public use was installed at the Paris Exhibition, where it won first prize. Before the escalator was invented, commerce and transportation were largely one-dimensional. The spread of the installation of escalators was slow at first, because there weren't many high-rise buildings at that time. Later, as more and more high-rises went up, the demand for escalators significantly increased. The real role of escalators is not so much that of labor savers but of space savers. They keep people moving in crowded places, where it is desirable to not have people congregating, possibly blocking passenger flow (Jarboe & O'Donohue, 2007).

The goal of this paper was to present the inventors of the escalators in 19th century. The common point for all of them is creativity. According to the reference (Ceccarelli, 2023), the creativity can be "understood as capacity and activity by which novel results, both for new inventions and problem solutions, can be achieved as based on very personal attitudes". In the same source it was mentioned that activities for innovation can be planned from different perspectives but require the following main features, among others (Ceccarelli, 2023): Technical novelty, which is the source of innovation as coming from new ideas and solutions in

solving problems or needs; Production feasibility, which refers to the product construction of the novelty at proper levels of manufacturing; Market exploitation, which is a successful offer to a large public for large implementation and usage. Ames, Souder, Reno, Wheeler and Seeberger are strongly connected to the before mentioned features.

For instance, Ames, who patented the first escalator, was without any formal engineering education, but his patent provided a completely new idea for moving people up and down. However, he never tried to build an escalator, probably due to the restrictions which seemed logical for the year of his invention. The same applies to Souder, also amateur engineer, who was the next one in a row of patenting moving stairways. The next one, Reno, had the formal engineering education, was also talented innovator with high level of creativity, he had his own patents, but at the same time he was associated with many practical engineering achievements. He recognized the drawbacks of elevators in public spaces and produced the world's first working escalator. Thus, he connected two innovative activities: technical novelty and productions feasibility and went beyond the achievements of his predecessors Ames and Souder. Also, he sold some of the escalators and can be associated with market exploitation. So, he united three main features of innovative activities. Wheeler, whose education background in engineering is unknown, improved the Reno's patents, but as he lacked practical skills to build the prototype and even go further to the production, he sold his modern solution to Seeberger. Finally, Seeberger, educated engineer, was inventor of several technical novelties, but at the same time very skilled entrepreneur. He recognized that there is potential for mass production of escalators and showed the understanding of market exploitation. Additionally, he understood the necessity of joining forces and connected to Otis Company, the giant manufacturer of escalator and elevators. It can be concluded that the formal engineering education helped both Reno and Seeberger to go beyond the patents and manufacture and sold the fruits of their creativity. Therefore, all five mentioned innovators in the field of escalators deserved to be called fathers of escalators.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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