History of the Elevator

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In the early 19th century, hydraulic plunger elevators were used in some European factories. In this type, later used to some extent in the United States and more extensively elsewhere, the car is mounted on a hollow steel plunger that drops into a cylinder sunk into the ground. Water forced into the cylinder under pressure raises the plunger and car In early installations the main valve controlling the flow of water was operated by hand by means of ropes running vertically through the car; lever control and pilot valves regulating acceleration and deceleration were later improvements.

A forerunner of the modern traction elevator was in use in Great Britain in 1835. In this case the hoisting rope passed over a belt-driven sheave, or pulley, to a counterweight traveling in guides. The downward pull of the two weights held the rope tight against its sheave, creating sufficient adhesive friction, or traction, between the two so that the turning sheave pulled the rope along.

Power Elevators

The history of power elevators in the U.S. began in 1850, when a crude freight hoist operating between two adjacent floors was installed in a New York City building. In 1853, at the New York Crystal Palace exposition, the American inventor and manufacturer Elisha Otis exhibited an elevator equipped with a device called a safety to stop the fall of the car if the hoisting rope broke. In this event a spring would operate two pawls on the car, forcing them into engagement with racks at the sides of the shafts so as to support the car. This invention gave impetus to elevator construction. Three years later the first passenger elevator in the U.S., designed by Otis, was in a New York City store.

In these early elevators, a steam engine was connected by belt and gears to a revolving drum on which the hoisting rope was wound. In 1859 an elevator raised and lowered by a vertical screw was installed in the Fifth Avenue Hotel in York City. In the 1870s the rope-geared hydraulic elevator was introduced.

The plunger was replaced in this type by a relatively short piston moving in a cylinder that was mounted, either vertically or horizontally, within the building; the effective length of the stroke of the piston was multiplied by a system of ropes and sheaves. Because of its smoother operation and greater efficiency, the hydraulic elevator generally replaced the type with a rope wound on a revolving drum.

Electric Elevators

The electric motor was introduced in elevator construction in 1880 by the German inventor Werner von Siemens. His car, carrying the motor below, climbed its shaft by means of revolving pinion gears that engaged racks at the sides of the shaft. An electric elevator was constructed in Baltimore, Maryland, in 1887, operated by an electric motor turning a revolving drum on which the hoisting rope was wound. Within the next 12 years, electric elevators with worm gearing connecting the motor and drum came into general use except in tall buildings.

In the drum elevator the length of the hoisting rope, and therefore the height to which the car can rise, are limited by the size of the drum; space limitations and manufacturing difficulties prevented the use of the drum mechanism in skyscrapers. The advantages of the electric elevator, however, including efficiency, relatively low installation costs, and virtually constant speed regardless of the load, spurred inventors to search for a way of using electric motive power in skyscrapers. Counterweights creating traction on electrically driven sheaves solved the problem. Since the introduction of electric motive power for elevators, various improvements have been made in motors and methods of control.

At first, single-speed motors only were used. Because a second, lower speed was desirable to facilitate leveling the car with landings, low-speed auxiliary motors were introduced, but later several systems were devised for varying speed by varying the voltage supplied to the hoisting motor. In recent years devices for automatic leveling of cars at landings are commonly used. Originally the motor switch and the brakes were operated mechanically from the car by of hand ropes.

Soon electromagnets, were introduced to throw the motor switch and to release a spring brake. Push-button control was an early development, later supplemented by elaborate signal systems. Safety devices have been highly developed. In 1878 Charles Otis (1835-1927), a son of the inventor of the original car safety, introduced a similar mechanism connected to a speed governor that applied the safety if the car was traveling at a dangerous speed, whether or not the rope broke. In later car safeties, clamps were used to grip the guide rails so as to bring the car to a stop.

Today so-called governors control a series of devices to slow down the car if it is speeding only slightly, to shut off the motor and apply an electromagnetic brake if the car continues to accelerate, and then to apply the mechanical safety if the speed becomes dangerous. Terminal switches independent of other controlling mechanisms stop the car at the upper and lower limits of travel. For low-speed cars, spring bumpers are provided at the bottom of the hoistway; high-speed cars are buffered by pistons fitting into oil-filled cylinders. Electric circuits, completed by contact points in hoistway doors on various floors and in car gates, permit operation only when gates and doors are closed.

The great advances in electronic systems during World War II resulted in many changes in elevator design and installation. Computing equipment was developed for compiling automatically information that vastly improved the operational efficiency of elevators in large buildings. The equipment, which became available in 1948, made possible the solution of such scheduling problems as morning and evening peak loads and traffic balance and the elimination of operators. The use of automatic programming equipment eventually eliminated the need for starters at the ground level of large commercial buildings, and thus the operation of elevators became completely automatic. Automatic elevators are now generally employed in all types of buildings. The World Trade Center in New York City, with its two 110-story towers, had 244 elevators with carrying capacities of up to 4536 kg (10,000 lb) and speeds of up to 488 m (1600 ft) per min. The 110-story Sears-Roebuck Building in Chicago has 109 elevators up to 549 m (1800 ft) per min.

Machinery

In machinery, device for transporting people or goods from one level to another. The term is applied to the enclosed structures as well as the open platforms used to provide vertical transportation in buildings, large ships, and mines; it is also applied to devices consisting of a continuous belt or chain with attached buckets for handling bulk materials. Simple hoists were used from ancient times. From about the middle of the 19th cent., power elevators, often steam-operated, were used for conveying materials in factories, mines, and warehouses. In 1853 the American inventor Elisha G. Otis demonstrated a freight elevator equipped with a safety device to prevent falling in case a supporting cable should break.

This increased public confidence in such devices and served as an impetus to the industry. Otis established a company for manufacturing elevators and patented (1861) a steam elevator. After the introduction by Sir William Armstrong of the hydraulic crane (1846), the hydraulic principle was applied to the elevator, and in the early 1870s hydraulic machines began to replace the steam-powered elevator.

The hydraulic elevator is supported by a heavy piston. As improvement of design made increased speed of movement possible, various safety devices, such as speed governors, were developed. Toward the end of the 19th cent., electric elevators came into use, and operation by electric motor gradually became the chief method. Later improved safety devices were added, and automatic and partly automatic elevators were introduced. Increase in speed of operation and improvement in general design also characterize the more modern elevators.

Gearless electric elevators

In 1903, Otis introduced the design that would become the standard in the elevator industry. The gearless traction electric elevator could be employed in buildings of any height and operated at much higher speeds than steam-powered elevators. The first ones were installed in the Beaver Building in New York City, and the Majestic Building in Chicago. This design has proven so durable that even now, 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 feet per minute. In a gearless traction machine, 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 ends 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. The grooved sheave in this traditional gearless system is quite large, from 0.6 to 1.2 meters (2–4 ft) in diameter.

The electric motor that runs it must be powerful enough to turn this large drive sheave at 50–200 revolutions per minute 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.

To reduce the load on the motor, the counterweight 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.

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Hydraulic elevators

Hydraulic elevators are used extensively in buildings up to five or six stories high. These elevators — which can operate at speeds up to 46 meters (150 ft) per minute — 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.

Machine roomless elevators

This revolutionary elevator system is based on the first major breakthrough in lifting technology in nearly 100 years. Designed initially for buildings between 2 and 20 stories, this system employs a smaller sheave than conventional geared and gearless elevators. The reduced sheave size, together with a redesigned motor, allows the machine to be mounted within the hoistway itself — eliminating the need for a bulky machine room on the roof. Otis' machine roomless elevator features unique, flat polyurethane-coated steel belts instead of the heavy woven steel cables that have been the industry standard since the 1800s. The belts are about 30 mm wide (1 inch) and only 3 mm (0.1 inch) thick, yet they are as strong as woven steel cables while being far more durable and flexible. The thinness of the belts makes for a smaller winding sheave, reducing the space required for the machine in the hoistway.

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These elevators typically operate at speeds greater than 500 feet per minute. In a gearless traction machine, six to eight lengths of wire cable, known as hoisting ropes, are attached to the around the drive sheave in special grooves. The other ends 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. The grooved sheave in this traditional gearless system is quite large, from 0.6 to 1.2 meters (2–4 ft) in diameter.

The electric motor that runs it must be powerful enough to turn this large drive sheave at 50–200 revolutions per minute 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.

To reduce the load on the motor, the counterweight 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.

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As the name implies, 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 38 to 152 meters (125-500 ft) per minute and carry loads of up to 13,600 kilograms (30,000 lb). An electrically controlled brake between the motor and the reduction unit stops the elevator, holding the car at the desired floor level.

Hydraulic elevators

Hydraulic elevators are used extensively in buildings up to five or six stories high. These elevators — which can operate at speeds up to 46 meters (150 ft) per minute — 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.

Machine roomless elevators

This revolutionary elevator system is based on the first major breakthrough in lifting technology in nearly 100 years. Designed initially for buildings between 2 and 20 stories, this system employs a smaller sheave than conventional geared and gearless elevators. The reduced sheave size, together with a redesigned motor, allows the machine to be mounted within the hoistway itself — eliminating the need for a bulky machine room on the roof. Otis' machine roomless elevator features unique, flat polyurethane-coated steel belts instead of the heavy woven steel cables that have been the industry standard since the 1800s. The belts are about 30 mm wide (1 inch) and only 3 mm (0.1 inch) thick, yet they are as strong as woven steel cables while being far more durable and flexible. The thinness of the belts makes for a smaller winding sheave, reducing the space required for the machine in the hoistway.

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In the early 19th century, hydraulic plunger elevators were used in some European factories. In this type, later used to some extent in the United States and more extensively elsewhere, the car is mounted on a hollow steel plunger that drops into a cylinder sunk into the ground. Water forced into the cylinder under pressure raises the plunger and car In early installations the main valve controlling the flow of water was operated by hand by means of ropes running vertically through the car; lever control and pilot valves regulating acceleration and deceleration were later improvements.

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In these early elevators, a steam engine was connected by belt and gears to a revolving drum on which the hoisting rope was wound. In 1859 an elevator raised and lowered by a vertical screw was installed in the Fifth Avenue Hotel in York City. In the 1870s the rope-geared hydraulic elevator was introduced.

The plunger was replaced in this type by a relatively short piston moving in a cylinder that was mounted, either vertically or horizontally, within the building; the effective length of the stroke of the piston was multiplied by a system of ropes and sheaves. Because of its smoother operation and greater efficiency, the hydraulic elevator generally replaced the type with a rope wound on a revolving drum.

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In the drum elevator the length of the hoisting rope, and therefore the height to which the car can rise, are limited by the size of the drum; space limitations and manufacturing difficulties prevented the use of the drum mechanism in skyscrapers. The advantages of the electric elevator, however, including efficiency, relatively low installation costs, and virtually constant speed regardless of the load, spurred inventors to search for a way of using electric motive power in skyscrapers. Counterweights creating traction on electrically driven sheaves solved the problem. Since the introduction of electric motive power for elevators, various improvements have been made in motors and methods of control.

At first, single-speed motors only were used. Because a second, lower speed was desirable to facilitate leveling the car with landings, low-speed auxiliary motors were introduced, but later several systems were devised for varying speed by varying the voltage supplied to the hoisting motor. In recent years devices for automatic leveling of cars at landings are commonly used. Originally the motor switch and the brakes were operated mechanically from the car by of hand ropes.

Soon electromagnets, were introduced to throw the motor switch and to release a spring brake. Pushbutton control was an early development, later supplemented by elaborate signal systems. Safety devices have been highly developed. In 1878 Charles Otis (1835-1927), a son of the inventor of the original car safety, introduced a similar mechanism connected to a speed governor that applied the safety if the car was traveling at a dangerous speed, whether or not the rope broke. In later car safeties, clamps were used to grip the guide rails so as to bring the car to a stop.

Today so-called governors control a series of devices to slow down the car if it is speeding only slightly, to shut off the motor and apply an electromagnetic brake if the car continues to accelerate, and then to apply the mechanical safety if the speed becomes dangerous. Terminal switches independent of other controlling mechanisms stop the car at the upper and lower limits of travel. For low-speed cars, spring bumpers are provided at the bottom of the hoistway; high-speed cars are buffered by pistons fitting into oil-filled cylinders. Electric circuits, completed by contact points in hoistway doors on various floors and in car gates, permit operation only when gates and doors are closed.

The great advances in electronic systems during World War II resulted in many changes in elevator design and installation. Computing equipment was developed for compiling automatically information that vastly improved the operational efficiency of elevators in large buildings. The equipment, which became available in 1948, made possible the solution of such scheduling problems as morning and evening peak loads and traffic balance and the elimination of operators. The use of automatic programming equipment eventually eliminated the need for starters at the ground level of large commercial buildings, and thus the operation of elevators became completely automatic. Automatic elevators are now generally employed in all types of buildings. The World Trade Center in New York City, with its two 110-story towers, had 244 elevators with carrying capacities of up to 4536 kg (10,000 lb) and speeds of up to 488 m (1600 ft) per min. The 110-story Sears-Roebuck Building in Chicago has 109 elevators up to 549 m (1800 ft) per min.

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The 1857 Haughwout Building, a hulking structure just five stories tall, is modeled after the 16th-century Sansovino library near St. Mark's Square in Venice. But beneath the historically backward, if elegant, facade was something quite revolutionary. The owner of a store selling fine China, E.V. Haughwout, hired one Elisha Graves Otis of Yonkers, N.Y., to install what became the first passenger elevator in the United States. In this modest five-story structure is hidden the invention that would make the city possible.

Machinery

In machinery, device for transporting people or goods from one level to another. The term is applied to the enclosed structures as well as the open platforms used to provide vertical transportation in buildings, large ships, and mines; it is also applied to devices consisting of a continuous belt or chain with attached buckets for handling bulk materials. Simple hoists were used from ancient times. From about the middle of the 19th cent., power elevators, often steam-operated, were used for conveying materials in factories, mines, and warehouses. In 1853 the American inventor Elisha G. Otis demonstrated a freight elevator equipped with a safety device to prevent falling in case a supporting cable should break.

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The hydraulic elevator is supported by a heavy piston. As improvement of design made increased speed of movement possible, various safety devices, such as speed governors, were developed. Toward the end of the 19th cent., electric elevators came into use, and operation by electric motor gradually became the chief method. Later improved safety devices were added, and automatic and partly automatic elevators were introduced. Increase in speed of operation and improvement in general design also characterize the more modern elevators.

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Today so-called governors control a series of devices to slow down the car if it is speeding only slightly, to shut off the motor and apply an electromagnetic brake if the car continues to accelerate, and then to apply the mechanical safety if the speed becomes dangerous. Terminal switches independent of other controlling mechanisms stop the car at the upper and lower limits of travel. For low-speed cars, spring bumpers are provided at the bottom of the hoistway; high-speed cars are buffered by pistons fitting into oil-filled cylinders. Electric circuits, completed by contact points in hoistway doors on various floors and in car gates, permit operation only when gates and doors are closed.

The great advances in electronic systems during World War II resulted in many changes in elevator design and installation. Computing equipment was developed for compiling automatically information that vastly improved the operational efficiency of elevators in large buildings. The equipment, which became available in 1948, made possible the solution of such scheduling problems as morning and evening peak loads and traffic balance and the elimination of operators. The use of automatic programming equipment eventually eliminated the need for starters at the ground level of large commercial buildings, and thus the operation of elevators became completely automatic. Automatic elevators are now generally employed in all types of buildings. The World Trade Center in New York City, with its two 110-story towers, had 244 elevators with carrying capacities of up to 4536 kg (10,000 lb) and speeds of up to 488 m (1600 ft) per min. The 110-story Sears-Roebuck Building in Chicago has 109 elevators up to 549 m (1800 ft) per min.

Elisha Otis

New York's skyline represents the physical revolution of the 20th century, leading the transformation of cities from horizontal, walking communities, where church steeples dominated the skyline, to dense conglomerations of skyscrapers. The characteristic image of the jagged-Peaked skyline that we all know as shorthand for "city" was made possible by Otis' elevator. Patent No. 31,128, granted by the U.S. Patent Office on Jan. 15,1861, and on view at the University of Hartford, is for an "improved hoisting apparatus." This simple contraption, which sounds like it might be of modest help, was in fact one of the most revolutionary inventions of the past two centuries. Down on Broadway in Manhattan.

The 1857 Haughwout Building, a hulking structure just five stories tall, is modeled after the 16th-century Sansovino library near St. Mark's Square in Venice. But beneath the historically backward, if elegant, facade was something quite revolutionary. The owner of a store selling fine China, E.V. Haughwout, hired one Elisha Graves Otis of Yonkers, N.Y., to install what became the first passenger elevator in the United States. In this modest five-story structure is hidden the invention that would make the city possible.

Machinery

In machinery, device for transporting people or goods from one level to another. The term is applied to the enclosed structures as well as the open platforms used to provide vertical transportation in buildings, large ships, and mines; it is also applied to devices consisting of a continuous belt or chain with attached buckets for handling bulk materials. Simple hoists were used from ancient times. From about the middle of the 19th cent., power elevators, often steam-operated, were used for conveying materials in factories, mines, and warehouses. In 1853 the American inventor Elisha G. Otis demonstrated a freight elevator equipped with a safety device to prevent falling in case a supporting cable should break.

This increased public confidence in such devices and served as an impetus to the industry. Otis established a company for manufacturing elevators and patented (1861) a steam elevator. After the introduction by Sir William Armstrong of the hydraulic crane (1846), the hydraulic principle was applied to the elevator, and in the early 1870s hydraulic machines began to replace the steam-powered elevator.

The hydraulic elevator is supported by a heavy piston. As improvement of design made increased speed of movement possible, various safety devices, such as speed governors, were developed. Toward the end of the 19th cent., electric elevators came into use, and operation by electric motor gradually became the chief method. Later improved safety devices were added, and automatic and partly automatic elevators were introduced. Increase in speed of operation and improvement in general design also characterize the more modern elevators.

Gearless elevators

In 1903, Otis introduced the design that would become the standard in the elevator industry. The gearless traction electric elevator could be employed in buildings of any height and operated at much higher speeds than steam-powered elevators. The first ones were installed in the Beaver Building in New York City, and the Majestic Building in Chicago. This design has proven so durable that even now, 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 feet per minute. In a gearless traction machine, six to eight lengths of wire cable, known as hoisting ropes, are attached to the around the drive sheave in special grooves. The other ends 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. The grooved sheave in this traditional gearless system is quite large, from 0.6 to 1.2 meters (2–4 ft) in diameter.

The electric motor that runs it must be powerful enough to turn this large drive sheave at 50–200 revolutions per minute 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.

To reduce the load on the motor, the counterweight 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.

Geared traction elevators

As the name implies, 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 38 to 152 meters (125-500 ft) per minute and carry loads of up to 13,600 kilograms (30,000 lb). An electrically controlled brake between the motor and the reduction unit stops the elevator, holding the car at the desired floor level.

Hydraulic elevators

Hydraulic elevators are used extensively in buildings up to five or six stories high. These elevators — which can operate at speeds up to 46 meters (150 ft) per minute — 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.

Machine roomless elevators

This revolutionary elevator system is based on the first major breakthrough in lifting technology in nearly 100 years. Designed initially for buildings between 2 and 20 stories, this system employs a smaller sheave than conventional geared and gearless elevators. The reduced sheave size, together with a redesigned motor, allows the machine to be mounted within the hoistway itself — eliminating the need for a bulky machine room on the roof. Otis' machine roomless elevator features unique, flat polyurethane-coated steel belts instead of the heavy woven steel cables that have been the industry standard since the 1800s. The belts are about 30 mm wide (1 inch) and only 3 mm (0.1 inch) thick, yet they are as strong as woven steel cables while being far more durable and flexible. The thinness of the belts makes for a smaller winding sheave, reducing the space required for the machine in the hoistway.