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Blinken at a Press Availability Press Statement Announcement of Visa Restrictions Against Cuban Officials Press Statement Additional Humanitarian Assistance for the People of Ukraine Ukrainian defenders battled on Saturday to contain Russian forces along several fronts, officials said, as the United States urged China to align itself with the West in opposing the invasion following an ill-tempered G20 meeting.Japan ruling party set for strong election showing after Abe killingJapanese voters went to the polls on Sunday for a parliamentary election that may give the ruling Liberal Democratic Party (LDP) a surge of support after the assassination of former Prime Minister Shinzo Abe, a dominant politician and power broker.undefined agoHSBC's global head of responsible investing is out after being suspended for downplaying the financial risks of climate change ... Netflix will try to run a 'Stranger Things' spinoff up that hill ... and Levi Strauss loves the lockdown effect on denim sales Vertical transport device For other uses, see Elevator (disambiguation). This article needs additional citations for verification. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed.Find sources: "Elevator" – news · newspapers · books · scholar · JSTOR (March 2020) (Learn how and when to remove this template message) Glass elevator in SKYCITY Metro, Auckland, New Zealand This elevator to the Alexanderplatz U-Bahn station in Berlin is built with glass walls and doors, exposing the inner workings. Interior of the elevator at the New Children's Hospital in Meilahti, Helsinki, Finland Outside of typical elevators, shown in an office building in Portland, Oregon Typical elevator doors An elevator (in North American English)[1] or lift (in Commonwealth English)[2] is a type of cable-assisted, hydraulic cylinder-assisted, or roller-track assisted machine that vertically transports people or freight between floors, levels, or decks of a building, vessel, or other structure. They are typically powered by electric motors that drive traction cables and counterweight systems such as a hoist, although some pump hydraulic fluid to raise a cylindrical piston like a jack. In agriculture and manufacturing, an elevator is any type of conveyor device used to lift materials in a continuous stream into bins or silos. Several types exist, such as the chain and bucket elevator, grain auger screw conveyor using the principle of Archimedes' screw, or the chain and paddles or forks of hay elevators. Languages other than English, such as Japanese, may refer to elevators by loanwords based on either elevator or lift. Due to wheelchair access laws, elevators are often a legal requirement in new multistory buildings, especially where wheelchair ramps are not possible. Some elevators can also travel horizontally in addition to the usual vertical motion.[3] History Pre-industrial era Elevator design by the German engineer Konrad Kyeser (1405) The earliest known reference to an elevator is in the works of the Roman architect Vitruvius, who reported that Archimedes (c. 287 BC – c. 212 BC) built his first elevator probably in 236 BC.[4] Sources from later periods mention elevators as cabs on a hemp rope, powered by people or animals. The Roman Colosseum, completed in AD 80, had roughly 25 elevators that were used for raising animals up to the floor. Each elevator could carry about 600 pounds (270 kg) (roughly the weight of two lions) 23 feet (7.0 m) up when powered by up to eight men.[5] In 1000, the Book of Secrets by Ibn Khalaf al-Muradi in Islamic Spain described the use of an elevator-like lifting device to raise a large battering ram to destroy a fortress.[6] In the 17th century, prototypes of elevators were installed in the palace buildings of England and France. Louis XV of France had a so-called 'flying chair' built for one of his mistresses at the Chateau de Versailles in 1743.[7] Ancient and medieval elevators used drive systems based on hoists and windlasses. The invention of a system based on the screw drive was perhaps the most important step in elevator technology since ancient times, leading to the creation of modern passenger elevators. The first screw-drive elevator was built by Ivan Kulibin and installed in the Winter Palace in 1793, although there may have been an earlier design by Leonardo da Vinci.[8] Several years later another of Kulibin's elevators was installed in the Arkhangelskoye near Moscow. Industrial era The development of elevators was led by the need for movement of raw materials, including coal and lumber, from hillsides. The technology developed by these industries and the introduction of steel beam construction worked together to provide the passenger and freight elevators in use today. Starting in coal mines, elevators in the mid-19th century operated with steam power, and were used for moving goods in bulk in mines and factories. These devices were soon applied to a diverse set of purposes. In 1823, Burton and Homer, two architects in London, built and operated a novel tourist attraction which they called the "ascending room", which elevated customers to a considerable height in the center of London, providing a panoramic view.[9] Early, crude steam-driven elevators were refined in the ensuing decade. In 1835, an innovative elevator, the Teagle, was developed by the company Frost and Stutt in England. It was belt-driven and used a counterweight for extra power.[10] In 1845, the Neapolitan architect Gaetano Genovese installed in the Royal Palace of Caserta the "Flying Chair", an elevator ahead of its time, covered with chestnut wood outside and with maple wood inside. It included a light, two benches and a hand-operated signal, and could be activated from the outside, without any effort by the occupants. Traction was controlled by a motor mechanic utilizing a system of toothed wheels. A safety system was designed to take effect if the cords broke, consisting of a beam pushed outwards by a steel spring. The hydraulic crane was invented by Sir William Armstrong in 1846, primarily for use at the Tyneside docks for loading cargo. They quickly supplanted the earlier steam-driven elevators, exploiting Pascal's law to provide much greater force. A water pump supplied a variable level of water pressure to a plunger encased inside a vertical cylinder, allowing the platform, carrying a heavy load, to be raised and lowered. Counterweights and balances were also used to increase lifting power. Elisha Otis demonstrating his safety system, at the New York Crystal Palace, 1853 Henry Waterman of New York is credited with inventing the "standing rope control" for an elevator in 1850.[11] In 1852, Elisha Otis introduced the safety elevator, which prevented the fall of the cab if the cable broke. He demonstrated it at the New York exposition in the Crystal Palace in a dramatic, death-defying presentation in 1854,[11][12] and the first such passenger elevator was installed at 488 Broadway in New York City on 23 March 1857. Elisha Otis's elevator patent drawing, 15 January 1861 The first elevator shaft preceded the first elevator by four years. Construction for Peter Cooper's Cooper Union Foundation building in New York began in 1853. An elevator shaft was included in the design because Cooper was confident that a safe passenger elevator would soon be invented.[13] The shaft was cylindrical because Cooper thought it was the most efficient design.[14] Otis later designed a special elevator for the building. Peter Ellis, an English architect, installed the first elevators that could be described as paternoster elevators in Oriel Chambers in Liverpool in 1868.[15] The Equitable Life Building, completed in 1870 in New York City, is thought to be the first office building with passenger elevators.[16] In 1872, James Wayland in the county of Hudson, An American Inventor, patented a novel method of securing elevator shafts with doors that are automatically opened and closed as the elevator car approaches and leaves them.[17] In 1874, J. W. Meaker patented a method permitting elevator doors to open and close safely.[18] The first electric elevator was built by Werner von Siemens in 1880 in Germany.[19] Inventor Anton Freissler further developed von Siemens' ideas and created a successful elevator enterprise in Austria-Hungary. The safety and speed of electric elevators were significantly enhanced by Frank Sprague, who added floor control, automatic operation, acceleration control, and further safety devices. His elevator ran faster and with larger loads than hydraulic or steam elevators. 584 of Sprague's elevators were installed before he sold his company to the Otis Elevator Company in 1895. Sprague also developed the idea and technology for multiple elevators in a single shaft. In 1882, when hydraulic power was a well established technology, a company later named the London Hydraulic Power Company was formed by Edward B. Ellington and others. It constructed a network of high-pressure mains on both sides of the Thames which ultimately extended 184 miles (296 km) and powered some 8,000 machines, predominantly elevators and cranes.[20] Schuyler Wheeler patented his electric elevator design in 1883.[21][22][23] In 1884, American Inventor D. Humphreys of Norfolk, Virginia patented an elevator with automatic doors that closed off the elevator shaft when the car was not being entered or exited.[24] In 1887, American Inventor Alexander Miles of Duluth, Minnesota patented an elevator with automatic doors that closed off the elevator shaft when the car was not being entered or exited. In 1891,American inventors, Joseph Kelly and William L. Woods, Co-patented a novel way to guard elevator shafts against accident, by way of hatches that would automatically open and close as the car passed through them.[25] The first elevator in India was installed at the Raj Bhavan in Calcutta (now Kolkata) by Otis in 1892.[26] By 1900, completely automated elevators were available, but passengers were reluctant to use them. Their adoption was aided by a 1945 elevator operator strike in New York City, and the addition of an emergency stop button, emergency telephone, and a soothing explanatory automated voice.[27] An inverter-controlled gearless drive system is applied in high-speed elevators worldwide. The Toshiba company continued research on thyristors for use in inverter control and dramatically enhanced their switching capacity, resulting in the development of insulated gate bipolar transistors (IGBTs) at the end of the 1980s. The IGBT realized increased switching frequency and reduced magnetic noise in the motor, eliminating the need for a filter circuit and allowing a more compact system. The IGBT also allowed the development of a small, highly integrated, highly sophisticated all-digital control device, consisting of a high-speed processor, specially customized gate arrays, and a circuit capable of controlling large currents of several kHz.[28] In 2000, the first vacuum elevator was offered commercially in Argentina.[29] Design Elevator machine room in an old building This section does not cite any sources. Please help improve this section by adding citations to reliable sources. Unsourced material may be challenged and removed. (March 2020) (Learn how and when to remove this template message) This section is missing information about elevators use guide rails: oil-lubricated guide shoes, roller guide shoes in high speed elevators or maglev shoes are used to follow the rail, high speed elevator vibration dampers, internal air pressure control and aerodynamic elevator cab and counterweight exterior, kone maxispace counterweightless elevator, outdoor and scenic elevator cab, elevator door belt and direct drive mechanism, elevator cab fan, elevator service mode and controls on cab roof, elevator roping Ratios/types/system/method, elevator capacity from 1 to over 40 people like in tokyo skytree, overweight protection. Please expand the section to include this information. Further details may exist on the talk page. (December 2020) Some people argue that elevators began as simple rope or chain hoists (see Traction elevators below). An elevator is essentially a platform that is either pulled or pushed up by a mechanical means. A modern-day elevator consists of a cab (also called a "cabin", "cage", "carriage" or "car") mounted on a platform within an enclosed space called a shaft or sometimes a "hoistway". In the past, elevator drive mechanisms were powered by steam and water hydraulic pistons or by hand. In a "traction" elevator, cars are pulled up by means of rolling steel ropes over a deeply grooved pulley, commonly called a sheave in the industry. The weight of the car is balanced by a counterweight. Sometimes two elevators are built so that their cars always move synchronously in opposite directions, and are each other's counterweight. The friction between the ropes and the pulley furnishes the traction which gives this type of elevator its name. Hydraulic elevators use the principles of hydraulics (in the sense of hydraulic power) to pressurise an above ground or in-ground piston to raise and lower the car (see Hydraulic elevators below). Roped hydraulics use a combination of both ropes and hydraulic power to raise and lower cars. Recent innovations include permanent magnet motors, machine room-less rail mounted gearless machines, and microprocessor controls. The technology used in new installations depends on a variety of factors. Hydraulic elevators are cheaper, but installing cylinders greater than a certain length becomes impractical for very-high lift hoistways. For buildings of much over seven floors, traction elevators must be employed instead. Hydraulic elevators are usually slower than traction elevators. Elevators are a candidate for mass customization. There are economies to be made from mass production of the components, but each building comes with its own requirements like different number of floors, dimensions of the well and usage patterns. Doors Cascading telescopic door configuration inside of an elevator A large "slab" door Elevator doors prevent riders from falling into, entering, or tampering with anything in the shaft. The most common configuration is to have two panels that meet in the middle, and slide open laterally. In a cascading telescopic configuration (potentially allowing wider entryways within limited space), the doors roll on independent tracks so that while open, they are tucked behind one another, and while closed, they form cascading layers on one side. This can be configured so that two sets of such cascading doors operate like the center opening doors described above, allowing for a very wide elevator cab. In less expensive installations the elevator can also use one large "slab" door: a single panel door the width of the doorway that opens to the left or right laterally. Some buildings have elevators with the single door on the shaftway, and double cascading doors on the cab. Machine room-less (MRL) elevators Kone EcoDisc. The entire drive system is in the hoistway. Elevators that do not require separate machine rooms are designed so that most of their power and control components fit within the hoistway (the shaft containing the elevator car), and a small cabinet houses the controller. The equipment is otherwise similar to that of a normal traction or hole-less hydraulic elevator. The world's first machine-room-less elevator, the Kone MonoSpace, was introduced in 1996, by Kone. Compared to traditional elevators, it: Required less space Used 70–80% less energy Used no hydraulic oil (assuming it replaced traditional hydraulic units) Had all components above ground (avoiding the environmental concern created by the hydraulic cylinder on direct hydraulic-type elevators being underground) Cost somewhat less than other systems, and significantly less than the hydraulic MRL elevator Could operate at faster speeds than hydraulics, but not normal traction units Its disadvantage was that it could be harder, and significantly more dangerous, to service and maintain. Other facts Noise level of 50–55 dBA (A-weighted decibels), lower than some but not all types of elevators Usually used for low-rise to mid-rise buildings National and local building codes did not address elevators without machine rooms. Residential MRL elevators are still not allowed by the ASME A17 code in the US. MRL elevators have been recognized in the 2005 supplement to the 2004 A17.1 Elevator Code. Today, some machine room-less hydraulic elevators by Otis and ThyssenKrupp exist. They do not involve the use of an underground piston or a machine room, mitigating environmental concerns; however, they are not allowed by codes in all parts of the United States.[30][31] Double-decker elevators Main article: Double-deck elevator Double-decker elevators are traction elevators with cars that have an upper and lower deck. Both decks, which can serve a floor at the same time, are usually driven by the same motor.[32] The system increases efficiency in high-rise buildings, and saves space so additional shafts and cars aren't required. In 2003, ThyssenKrupp invented a system called TWIN, with two elevator cars independently running in one shaft.[33] Traffic calculations Round-trip time calculations History In 1901 consulting engineer Charles G. Darrach (1846-1927) proposed the first formula to determine elevator service.[34] In 1908, Reginald P. Bolton published the first book devoted to this subject, ‘Elevator Service’.[35] The summation of his work was a massive fold-out chart (placed at the back of his book) that allowed users to determine the number of express and local elevators needed for a given building to meet a desired interval of service. In 1912, commercial engineer Edmund F. Tweedy and electrical engineer Arthur Williams co-authored a book titled ‘Commercial Engineering for Central Stations’.[36] He followed Bolton’s lead and developed a “Chart for determining the number and size of elevators required for office buildings of a given total occupied floor area”. In 1920, Howard B. Cook presented a paper titled “Passenger Elevator Service”.[37] This paper marked the first time a member of the elevator industry offered a mathematical means of determining elevator service. His formula determined the round trip time (RTT) by finding the single trip time, doubling it, and adding 10 seconds. In 1923, Bassett Jones published an article titled “The Probable Number of Stops Made by an Elevator”.[38] He based his equations on the theory of probabilities and found a reasonably accurate method of calculating the average stop count. The equation in this article assumed a consistent population on every floor. S = n { 1 − (n − 1 n) N } {\displaystyle S=n\{1-\left({\frac {n-1}{n}}\right)^{N}\}} He went on to write an updated version of his equations in 1926 which accounted for variable population on each floor.[39] Jones credited David Lindquist for the development of the equation but provides no indication as to when it was first proposed. S = n − { (P − P a P) N + (P − P b P) N + . . . + (P − P n P) N } {\displaystyle S=n-\{\left({\frac {P-P_{a}}{P}}\right)^{N}+\left({\frac {P-P_{b}}{P}}\right)^{N}+...+\left({\frac {P-P_{n}}{P}}\right)^{N}\}} Although the equations were there, elevator traffic analysis was still a very specialist task that could only be done by world experts. That was until 1967 when Strakosch wrote an eight step method for finding the efficiency of a system in “Vertical transportation: Elevators and Escalators”.[40] Uppeak calculations In 1975, Barney and Dos Santos developed and published the “Round Trip Time (RTT) formula”, which followed Strakosch's work.[41] This was the first formulized mathematical model and is the simplest form that is still used by traffic analyzers today. R T T = H t 1 + t 2 (S + 1) + 2 P t 3 {\displaystyle RTT=Ht_{1}+t_{2}(S+1)+2Pt_{3}} Modification and improvements have been made to this equation over the years, most significantly in 2000 when Peters published “Improvements to the Up Peak Round Trip Time Calculation”[42] which improved the accuracy of the flight time calculation, making allowances for short elevator journeys when the car doesn’t reach maximum rated speed or acceleration, and added the functionality of express zones. This equation is now referred to as the ‘Up peak Calculation’[43] as it uses the assumption that all the passengers are coming into the building from the ground floor (incoming traffic) and that there are no passengers travelling from a higher floor to the ground floor (outgoing traffic) and no passengers travelling from one internal floor to another (interfloor traffic). This model works well if a building is at its most busy first thing in the morning, however in more complicated elevator systems, this model doesn’t work. General analysis In 1990, Peters published a paper titled “Lift Traffic Analysis: Formulae for the General Case”[44] in which he developed a new formula which would account for mixed traffic patterns as well as accounting for passenger bunching using Poisson approximation. This new General Analysis equation enabled much more complex systems to be analyzed however the equations had now become so complex that it was almost impossible to do manually and it became necessary to use software to run the calculations. The GA formula was extended even further in 1996 to account for double deck elevators.[45] Simulations RTT calculations establish an elevator system's handling capacity by using a set of repeatable calculations which, for a given set of inputs, always produce the same answer. It works well for simple systems; but as systems get more complex, the calculations are harder to develop and implement. For very complex systems, the solution is to simulate the building.[46] Dispatcher-based simulation In this method, a virtual version of a building is created on a computer, modelling passengers and elevators as realistically as possible, and random numbers are used to model probability rather than mathematical equations and percentage probability. Dispatcher-based simulation has had major improvements over the years, but the principal remains the same. The most widely used simulator, Elevate, was first showcased in 1998 as Elevate Lite.[47] Although it is currently the most accurate method of modelling an elevator system, the method does have drawbacks. Unlike calculations, it doesn’t find a RTT value because it doesn’t run standard round trips; thus it doesn’t conform with standardized elevator-traffic analysis methodology, and can’t be used to find values such as average interval; instead, it is generally used to find the average waiting time. Monte Carlo simulation At the first Elevator and Escalator symposium in 2011, Al-Sharif proposed an alternative form of simulation[48] that modeled a car’s single round trip before restarting and running again. This method is still capable of modelling complex systems, and also conforms with standard methodology by producing an RTT value. The model was improved further in 2018 when Al-Sharif demonstrated a way to reintroduce a dispatcher-like function which can model destination control systems.[49] While this does successfully remove simulation's major drawback, it isn’t quite as accurate as dispatcher-based simulations due to its simplifications and non-continual nature. The Monte Carlo method also requires passenger count as an input, rather than passengers per second, in other methodologies. Types of hoist mechanisms Elevators can be rope dependent or rope-free.[50] There are at least four means of moving an elevator: Traction elevators This section needs additional citations for verification. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed. (March 2020) (Learn how and when to remove this template message)This section is missing information about winding drum elevators. Please expand the section to include this information. Further details may exist on the talk page. (December 2020) Steel ropes and an electric motor (machine) in the machine room. The machine has two brake calipers on top. Geared traction machines are driven by AC or DC electric motors. Geared machines use worm gears to control mechanical movement of elevator cars by "rolling" steel hoist ropes over a drive sheave which is attached to a gearbox driven by a high-speed motor. These machines are generally the best option for basement or overhead traction use for speeds up to 3 m/s (500 ft/min).[51] Historically, AC motors were used for single or double-speed elevator machines on the grounds of cost and lower usage applications where car speed and passenger comfort were less of an issue, but for higher speed, larger capacity elevators, the need for infinitely variable speed control over the traction machine becomes an issue. Therefore, DC machines powered by an AC/DC motor generator were the preferred solution. The MG set also typically powered the relay controller of the elevator, which has the added advantage of electrically isolating the elevators from the rest of a building's electrical system, thus eliminating the transient power spikes in the building's electrical supply caused by the motors starting and stopping (causing lighting to dim every time the elevators are used for example), as well as interference to other electrical equipment caused by the arcing of the relay contactors in the control system. The widespread availability of variable frequency AC drives has allowed AC motors to be used universally, bringing with it the advantages of the older motor-generator, DC-based systems, without the penalties in terms of efficiency and complexity. The older MG-based installations are gradually being replaced in older buildings due to their poor energy efficiency. Gearless traction machines are low-speed (low-RPM), high-torque electric motors powered either by AC or DC. In this case, the drive sheave is directly attached to the end of the motor. Gearless traction elevators can reach speeds of up to 20 m/s (4,000 ft/min), A brake is mounted between the motor and gearbox or between the motor and drive sheave or at the end of the drive sheave to hold the elevator stationary at a floor. This brake is usually an external drum type and is actuated by spring force and held open electrically; a power failure will cause the brake to engage and prevent the elevator from falling (see inherent safety and safety engineering). But it can also be some form of disc type like one or more calipers over a disc in one end of the motor shaft or drive sheave which is used in high speed, high rise and large capacity elevators with machine rooms (an exception is the Kone MonoSpace's EcoDisc which is not high speed, high rise and large capacity and is machine room less but it uses the same design as is a thinner version of a conventional gearless traction machine) for braking power, compactness and redundancy (assuming there's at least 2 calipers on the disc), or one or more disc brakes with a single caliper at one end of the motor shaft or drive sheave which is used in machine room less elevators for compactness, braking power, and redundancy (assuming there's 2 brakes or more). In each case, steel or kevlar cables are attached to a hitch plate on top of the cab or may be "underslung" below a cab, and then looped over the drive sheave to a counterweight attached to the opposite end of the cables which reduces the amount of power needed to move the cab. The counterweight is located in the hoist-way and is carried along a separate railway system; as the car goes up, the counterweight goes down, and vice versa. This action is powered by the traction machine which is directed by the controller, typically a relay logic or computerized device that directs starting, acceleration, deceleration and stopping of the elevator cab. The weight of the counterweight is typically equal to the weight of the elevator cab plus 40–50% of the capacity of the elevator. The grooves in the drive sheave are specially designed to prevent the cables from slipping. "Traction" is provided to the ropes by the grip of the grooves in the sheave, thereby the name. As the ropes age and the traction grooves wear, some traction is lost and the ropes must be replaced and the sheave repaired or replaced. Sheave and rope wear may be significantly reduced by ensuring that all ropes have equal tension, thus sharing the load evenly. Rope tension equalization may be achieved using a rope tension gauge, and is a simple way to extend the lifetime of the sheaves and ropes. Elevators with more than 30 m (98 ft) of travel have a system called compensation. This is a separate set of cables or a chain attached to the bottom of the counterweight and the bottom of the elevator cab. This makes it easier to control the elevator, as it compensates for the differing weight of cable between the hoist and the cab. If the elevator cab is at the top of the hoist-way, there is a short length of hoist cable above the car and a long length of compensating cable below the car and vice versa for the counterweight. If the compensation system uses cables, there will be an additional sheave in the pit below the elevator, to guide the cables. If the compensation system uses chains, the chain is guided by a bar mounted between the counterweight tracks. Regenerative drives Another energy-saving improvement is the regenerative drive,[52] which works analogously to regenerative braking in vehicles, using the elevator's electric motor as a generator to capture some of the gravitational potential energy of descent of a full cab (heavier than its counterweight) or ascent of an empty cab (lighter than its counterweight) and return it to the building's electrical system. Hydraulic elevators Pit of a hydraulic scenic elevator with metal grating on bottom. This elevator travels seven stories. Conventional hydraulic elevators. They use an underground hydraulic cylinder, are quite common for low level buildings with two to five floors (sometimes but seldom up to six to eight floors), and have speeds of up to 1 m/s (200 ft/min). Hole less hydraulic elevators were developed in the 1970s, and use a pair of above ground cylinders, which makes it practical for environmentally or cost sensitive buildings with two, three, or four floors. Roped hydraulic elevators use both above ground cylinders and a rope system, allowing the elevator to travel further than the piston has to move. The low mechanical complexity of hydraulic elevators in comparison to traction elevators makes them ideal for low rise, low traffic installations. They are less energy efficient as the pump works against gravity to push the car and its passengers upwards; this energy is lost when the car descends on its own weight. The high current draw of the pump when starting up also places higher demands on a building's electrical system. There are also environmental concerns should the lifting cylinder leak fluid into the ground,[53] hence the development of holeless hydraulic elevators, which also eliminate the need for a relatively deep hole in the bottom of the elevator shaft. Hydraulic elevators may use telescopic hydraulic cylinders.[citation needed] Electromagnetic propulsion Cable-free elevators using electromagnetic propulsion, capable of moving both vertically and horizontally, have been developed by German engineering firm Thyssen Krupp for use in high rise, high density buildings.[54][55] Climbing elevator This section does not cite any sources. Please help improve this section by adding citations to reliable sources. Unsourced material may be challenged and removed. (March 2020) (Learn how and when to remove this template message) A climbing elevator is a self-ascending elevator with its own propulsion. The propulsion can be done by an electric or a combustion engine. Climbing elevators are used in guyed masts or towers, in order to make easy access to parts of these constructions, such as flight safety lamps for maintenance. An example would be the moonlight towers in Austin, Texas, where the elevator holds only one person and equipment for maintenance. The Glasgow Tower — an observation tower in Glasgow, Scotland — also makes use of two climbing elevators. Temporary climbing elevators are commonly used in the construction of new high-rise buildings to move materials and personnel before the building's permanent elevator system is installed, at which point the climbing elevators are dismantled. Pneumatic elevator An elevator of this kind uses a vacuum on top of the cab and a valve on the top of the "shaft" to move the cab upwards and closes the valve in order to keep the cab at the same level. A diaphragm or a piston is used as a "brake", if there's a sudden increase in pressure above the cab. To go down, it opens the valve so that the air can pressurise the top of the "shaft", allowing the cab to go down by its own weight. This also means that in case of a power failure, the cab will automatically go down. The "shaft" is made of acrylic, and is always round due to the shape of the vacuum pump. To keep the air inside of the cab, rubber seals are used. Due to technical limitations, these elevators have a low capacity, they usually allow 1–3 passengers and up to 525 pounds (238 kg).[56] Controls Manual controls This section does not cite any sources. Please help improve this section by adding citations to reliable sources. Unsourced material may be challenged and removed. (March 2020) (Learn how and when to remove this template message) Otis 1920s controller, operational in a New York City apartment building In the first half of the twentieth century, almost all elevators had no automatic positioning of the floor on which the cab would stop. Some of the older freight elevators were controlled by switches operated by pulling on adjacent ropes. In general, most elevators before WWII were manually controlled by elevator operators using a rheostat connected to the motor. This rheostat (see picture) was enclosed within a cylindrical container about the size and shape of a cake. This was mounted upright or sideways on the cab wall and operated via a projecting handle, which was able to slide around the top half of the cylinder. The elevator motor was located at the top of the shaft or beside the bottom of the shaft. Pushing the handle forward would cause the cab to rise; backwards would make it sink. The harder the pressure, the faster the elevator would move. The handle also served as a dead man switch: if the operator let go of the handle, it would return to its upright position, causing the elevator cab to stop. In time, safety interlocks would ensure that the inner and outer doors were closed before the elevator was allowed to move. This lever would allow some control over the energy supplied to the motor and so enabled the elevator to be accurately positioned — if the operator was sufficiently skilled. More typically, the operator would have to "jog" the control, moving the cab in small increments until the elevator was reasonably close to the landing point. Then the operator would direct the outgoing and incoming passengers to "watch the step". Manual pushbutton elevator controls Automatic elevators began to appear as early as the 1920s,[citation needed] their development being hastened by striking elevator operators which brought large cities dependent on skyscrapers (and therefore their elevators) such as New York and Chicago to their knees. Self service elevators were not allowed in New York City until 1922. Prior to this, non-luxury buildings that could not afford an attendant were built as five-story walk ups. These electromechanical systems used relay logic circuits of increasing complexity to control the speed, position and door operation of an elevator or bank of elevators. The Otis Autotronic system of the early 1950s brought the earliest predictive systems which could anticipate traffic patterns within a building to deploy elevator movement in the most efficient manner. Relay-controlled elevator systems remained common until the 1980s; they were gradually replaced with solid-state systems, and microprocessor-based controls are now the industry standard. Most older, manually-operated elevators have been retrofitted with automatic or semi-automatic controls. Typical vintage freight elevator control station Typical passenger elevator control introduced by Dover in the early 1980s, and produced until the mid-2000s by ThyssenKrupp, common in the US Typical elevators floor buttons, produced by Schindler through the mid 1990s and first half of the 2000s, common in the US and Canada A digital floor indicator seen on some Schindler elevators in the 2000s and first half of the 2010s in the US and Canada An analog floor indicator from Dover, made in the 1970s or 1980s Using the emergency call button in an elevator. There is Braille text for visually impaired people and a button illuminates to alert a hearing impaired person that the alarm is ringing and the call is being placed. General controls Another photo of the typical elevator buttons from Mitsubishi Elepet Advance V A typical modern passenger elevator will have: Outside the elevator, buttons to go up or down (the bottom floor only has the up button, the top floor only has the down button, and every floor in between has both) Space to stand in, guardrails, seating cushion (luxury) Overload sensor – prevents the elevator from moving until excess load has been removed. It may trigger a voice prompt or buzzer alarm. This may also trigger a "full car" indicator, indicating the car's inability to accept more passengers until some are unloaded. Electric fans or air conditioning units to enhance circulation and comfort. A control panel with various buttons. In many countries, button text and icons are raised to allow blind users to operate the elevator; many have Braille text besides. Buttons include: Call buttons to choose a floor. Some of these may be key switches (to control access). In some elevators, such as those in some hotels, certain floors are inaccessible unless one swipes a security card or enters a passcode. Door open and door close buttons. The operation of the door open button is transparent, immediately opening and holding the door, typically until a timeout occurs and the door closes. The operation of the door close button is less transparent, and it often appears to do nothing, leading to frequent but incorrect[57] reports that the door close button is a placebo button: either not wired up at all, or inactive in normal service. On many older elevators, if one is present, the door close button is functional because the elevator is not ADA compliant and/or it doesn't have a fire service mode.[58][59][60][61] Working door open and door close buttons are required by code in many jurisdictions, including the United States, specifically for emergency operation: in independent mode, the door open and door close buttons are used to manually open or close the door.[57][62] Beyond this, programming varies significantly, with some door close buttons immediately closing the door, but in other cases being delayed by an overall timeout, so the door cannot be closed until a few seconds after opening. In this case (hastening normal closure), the door close button has no effect. However, the door close button will cause a hall call to be ignored (so the door won't reopen), and once the timeout has expired, the door close will immediately close the door, for example, to cancel a door open push. The minimum timeout for automatic door closing in the US is 5 seconds,[63] which is a noticeable delay if not over-ridden. An alarm button or switch, which passengers can use to warn the premises manager that they have been trapped in the elevator. A set of doors kept locked on each floor to prevent unintentional access into the elevator shaft by the unsuspecting individual. The door is unlocked and opened by a machine sitting on the roof of the car, which also drives the doors that travel with the car. Door controls are provided to close immediately or reopen the doors, although the button to close them immediately is often disabled during normal operations, especially on more recent elevators. Objects in the path of the moving doors will either be detected by sensors or physically activate a switch that reopens the doors. Otherwise, the doors will close after a preset time. Some elevators are configured to remain open at the floor until they are required to move again. Regulations often require doors to close after use to prevent smoke from entering the elevator shaft in event of fire. Elevators in high traffic buildings often have a "nudge" function (the Otis Autotronic system first introduced this feature)[citation needed] which will close the doors at a reduced speed, and sound a buzzer if the "door open" button is being deliberately held down, or if the door sensors have been blocked for too long a time. A stop switch (not allowed under British regulations[citation needed]) to halt the elevator while in motion and often used to hold an elevator open while freight is loaded. Keeping an elevator stopped for too long may set off an alarm. Unless local codes require otherwise, this will most likely be a key switch. Some elevators may have one or more of the following: An elevator telephone, which can be used (in addition to the alarm) by a trapped passenger to call for help. This may consist of a transceiver, or simply a button. This feature is often required by local regulations. Hold button: This button delays the door closing timer, useful for loading freight and hospital beds. Call cancellation: A destination floor may be deselected by double clicking. Access restriction by key switches, RFID reader, code keypad, hotel room card, etc. One or more additional sets of doors. This is primarily used to serve different floor plans: on each floor only one set of doors opens. For example, in an elevated crosswalk setup, the front doors may open on the street level, and the rear doors open on the crosswalk level. This is also common in garages, rail stations, and airports. Alternatively, both doors may open on a given floor. This is sometimes timed so that one side opens first for getting off, and then the other side opens for getting on, to improve boarding/exiting speed. This is particularly useful when passengers have luggage or carts, as at an airport, due to reduced manoeuvrability. Dual door open and door close buttons, in an elevator with two sets of doors, found on a ThyssenKrupp elevator from the 2010s In case of dual doors, there may be two sets of door open and door close buttons, with one pair controlling the front doors, from the perspective of the console, typically denoted and >|||

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