

Elevator system with elevator cars which can move vertically and horizontally

5 The invention relates to an elevator system with an elevator car which can move vertically and horizontally.

10 EP1693331A1 discloses an elevator system with vertical tracks which are formed by two car guide rails in each case, in which the vertical tracks extend between a lowermost stopping station and an uppermost stopping station and are each equipped with at least one separately controllable drive system. Each drive system comprises a flexible supporting means extending over
15 the entire length of the vertical tracks. This elevator system also includes a plurality of elevator cars which are movable and stoppable upward along the first vertical track and downward along the second vertical track by means of the drive systems. In this case, each
20 elevator car has a controllable coupling mechanism with which said elevator car can be coupled in an interlocking manner to the supporting means of a drive system assigned to the present vertical track thereof. An upper and a lower car transfer mechanism have the
25 task of taking over elevator cars which have arrived in the end regions of the vertical tracks and of displacing said elevator cars horizontally to the other vertical track where the elevator cars are introduced into the guide rails of the other vertical track.

30 In an elevator system designed in accordance with the teaching disclosed in EP1693331A1, all of the elevator cars are equipped with in each case four upper and four lower car supporting rollers which are mounted on
35 pivotable supporting structures in order to permit horizontal displacement of said elevator cars between two vertical tracks. When an elevator car has reached the uppermost position thereof, the four upper car

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supporting rollers thereof are pivoted, for the horizontal displacement, into a profile rail, which is arranged horizontally above the vertical tracks, such that the elevator car is supported and guided by the profile rail and the car supporting rollers. After an
5 elevator car has arrived in the lowermost position thereof, the lower car supporting rollers thereof are pivoted into a profile rail, which is arranged horizontally below the vertical tracks, so that the
10 elevator car is displaceable horizontally on said lower profile rail. In addition, in both end positions, a drive device (not illustrated in the drawing) is required to produce the horizontal movement of the elevator cars. Similarly, in order to permit the
15 horizontal displacement of the elevator cars, in the case of the disclosed elevator system having two vertical tracks, a total of eight end sections of car guide rails are arranged pivotably and are provided with controllable pivoting drives. When said end
20 sections are pivoted back into the guide positions thereof, the end sections have to be introduced again into the guide grooves, which have little play, of the guide shoes which are present on the elevator car which is not highly dimensionally stable. For an additional
25 vertical track, the number of car guide rails which can be pivoted away would be increased by eight.

The present invention is based on the object of providing an elevator system of the above-described
30 type, in which the horizontal displacement of the elevator cars can be realized with a smaller number of components to be moved and to be controlled and without accuracy problems, i.e. with both greater functional reliability and lower manufacturing and installation
35 costs.

To achieve this object, an elevator system according to the precharacterizing clause of claim 1 is developed by

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means of the characterizing features thereof. Claim 25 is directed toward a corresponding method for operating an elevator system according to the invention. The object is furthermore achieved by an elevator system
5 according to claim 27.

In the case of the elevator system according to the invention and according to the method according to the invention, an elevator car can move vertically and
10 horizontally, wherein vertical movements take place along a vertical track comprising a vertical guide rail, and horizontal movements are carried out with the aid of a car transfer mechanism, wherein the car transfer mechanism comprises a horizontal displacement
15 unit into which a vertical guide rail piece is integrated, said guide rail piece guiding the elevator car in the horizontal displacement unit, and wherein the horizontal displacement unit can be positioned in such a manner that the guide rail piece forms a section
20 of the vertical guide rail.

A substantial advantage of the elevator system according to the invention and of the method according to the invention is that the elevator car is displaced
25 horizontally without the guide shoes thereof having to leave the vertical guide rails and having to be introduced into other vertical guide rails. Accuracy problems are therefore avoided. Further advantages of the solution according to the invention consist in that
30 the horizontal displacement of the elevator car does not require the elevator cars to be equipped with lower and upper supporting rollers and that the horizontal displacement can be realized with a considerably smaller number of components to be moved and to be
35 controlled, this resulting in greater functional reliability of the elevator system and in lower manufacturing and installation costs.

Advantageous refinements and developments of the elevator system according to the invention and of the method according to the invention emerge from dependent claims 2 to 24 and 26, respectively.

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The elevator car advantageously has a brake mechanism with which said elevator car can be temporarily fixed to the guide rail piece integrated in the horizontal displacement unit of the car transfer mechanism.

10 With said fixing of the elevator car in the abovementioned horizontal displacement unit, an extremely simple transfer of the elevator car from the vertical track thereof into the horizontal displacement unit, and vice versa, can be realized.

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Advantageously, the brake mechanism of the elevator car can be activated and can be deactivated by a control mechanism, for example by the elevator controller. Activation or deactivation can be controlled, for
20 example, as a function of the detected presence of the elevator car on the guide rail piece integrated in the horizontal displacement unit.

The brake mechanism can advantageously also serve as a
25 catch brake for the elevator car. A brake of this type permits, for example, the elevator car to be braked in the event of it being detected that a permissible speed or a permissible acceleration is being exceeded. By means of a combination of the catch brake with the
30 brake mechanism required for fixing the elevator car during the horizontal displacement thereof, the total costs of the elevator system are considerably reduced.

The controllable brake mechanism may advantageously
35 also serve as a holding brake for the elevator car. A holding brake of this type fixes the elevator car on the vertical guide rail of the vertical track during a story stop, in order to avoid vertical displacements as

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a consequence of changes in load, and vertical oscillations.

5 The elevator system advantageously comprises two or more vertical tracks, wherein the elevator car is displaceable between said vertical tracks with the aid of the car transfer mechanism.

10 In the case of an elevator system of this type, the elevator car or a plurality of elevator cars can travel along a plurality of vertical tracks, wherein certain vertical tracks are preferably used for the upward trip and certain vertical tracks for the downward trip.

15 The vertical tracks are advantageously arranged offset with respect to each other parallel to a car wall of the at least one elevator car, said car wall having a car door. This solution permits elevator systems in which at least one elevator car can run in a plurality of vertical tracks arranged next to one another, 20 wherein the passengers enter and exit on the same side of the elevator cars on each story. This has the advantage that in each case only a single shaft door is required per vertical track and story.

25 The horizontal displacement unit of the car transfer mechanism is advantageously displaceable along horizontal guides which are arranged parallel to the car wall having a car door in a region of the elevator shaft which is not taken up by the vertically and 30 horizontally moving elevator car. An embodiment of this type is particularly expedient in particular in elevator configurations having a multiplicity of vertical tracks and/or long horizontal displacement paths.

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The at least one elevator car advantageously has two mutually opposite car walls each having a car door, and the vertical tracks are arranged offset with respect to

each other at right angles to said car walls. This embodiment which is suitable in particular for elevator systems having only two vertical tracks, a first vertical track is expediently used for upward trips and
5 a second vertical track for downward trips. It follows therefrom that, from each story, there is one entry vestibule for upward trips and one entry vestibule for downward trips, said entry vestibules being separated from one another by the elevator shaft. The advantage
10 of this embodiment is that a more orderly flow of traffic can be achieved by separating the waiting areas for upward trips from the waiting areas for downward trips.

15 An elevator system advantageously has a plurality of car transfer mechanisms which are arranged on different levels in such a manner that the guide rail pieces which are integrated in the horizontal displacement units thereof can form displaceable end sections or
20 intermediate sections of vertical guide rails of two or more vertical tracks. With an elevator system of this type, particularly high transport capacities can be achieved.

25 At least one vertical track is advantageously equipped with a car drive system which comprises a flexible supporting means which is movable and stoppable along the vertical track, wherein the elevator car has a controllable coupling mechanism with which the elevator
30 car can be coupled to or decoupled from the supporting means. A coupling or decoupling operation of this type takes place in each case after the elevator car has been fitted with the aid of a car transfer mechanism into the vertical track or before said elevator car is
35 displaced horizontally out of the vertical track by a car transfer mechanism.

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The supporting means and the coupling mechanism are advantageously designed in such a manner that the elevator car and the supporting means are coupled by means of interlocking engagement. Coupling by means of
5 interlocking engagement ensures a particularly reliable connection, but requires a supporting means which is equipped with certain interlocking elements, such as, for example, holes or bosses.

10 The supporting means and the coupling mechanism are advantageously designed in such a manner that the elevator car and the supporting means are coupled by means of frictional engagement. The effect achieved by this is that every point of the supporting means can be
15 used as a coupling point, and that the position of the supporting means does not need to be aligned with the car position prior to a coupling operation.

The drive system advantageously comprises a drive unit
20 with a speed-controllable electric motor, wherein the electric motor drives a driving pulley acting on the supporting means or a driving shaft which has an effective diameter of less than 100 mm, preferably of less than 80 mm. Such small effective diameters of the
25 driving pulley permit a transmission-free driving of the supporting means by electric motors which take up little installation space.

Each drive system advantageously comprises two flexible
30 supporting means arranged parallel. The functional reliability of the elevator system is increased by the use of in each case two supporting means acting redundantly on an elevator car.

35 Each drive system advantageously comprises an upper and a lower drive unit which can be controlled and regulated synchronously and jointly act on the at least one supporting means of the drive system. With said

measure, the traction capability and the functional reliability of the elevator system are increased.

5 The at least one supporting means of the drive system is advantageously designed as a flat belt, V-ribbed belt or toothed belt. Supporting means of this type have excellent traction properties and are particularly readily suitable for interaction with controllable coupling mechanisms.

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The coupling mechanism acting by means of frictional engagement advantageously comprises a clamping device which is movable out of the region of the drive belts in order to permit a horizontal transfer of the
15 elevator car.

Said drive system advantageously operates without a counterweight. The effect achieved by this is that the elevator cars which virtually always move in the same
20 traveling direction in a vertical track can be coupled to the drive system without a counterweight having to be brought beforehand into a certain starting position.

The drive system advantageously comprises a drive
25 regulator which, during a downward trip of an elevator car, feeds the energy generated into the mains or temporarily stores said energy in capacitors or in an accumulator for reuse. This measure makes it possible to prevent the absence of a counterweight from
30 resulting in increased energy consumption.

A vertical track is advantageously equipped with two or more drive systems arranged parallel to each other in order to be able to receive two or more elevator cars
35 simultaneously, wherein the elevator cars have two or more controllable coupling mechanisms with which the elevator cars can be coupled to a separately controllable drive system presently assigned thereto.

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One such refinement of the elevator system makes it possible to move two or more elevator cars simultaneously on the at least one vertical track without a story stop of one elevator car forcing the
5 synchronous stopping of the other elevator car(s).

A code scale with absolute encoding is advantageously arranged along a vertical track, each elevator car being assigned a code reading mechanism which
10 continuously reads information about the position of the elevator car from the code scale by means of detectors functioning in a contact-free manner. This mechanism supplies the elevator controller with the required information in order to have the current
15 positions and movement data of all the elevator cars of the elevator system available in every operating situation.

A rotary sensor is advantageously attached to the
20 elevator car and is driven by a friction wheel rolling along the vertical guide rail or along a guide rail section of a horizontal displacement unit, the rotary sensor supplying information about the present traveling speed to a monitor. This redundant
25 information about the current traveling speed of the elevator car serves to generally increase the functional reliability of the elevator system.

The monitor advantageously redundantly monitors the
30 traveling speed and/or the present acceleration of the elevator car with reference to the information transmitted by the rotary sensor and also by means of continuous differentiation of the travel path determined from the position information and, if it is
35 detected that a speed limit or acceleration limit is being exceeded, activates the controllable brake mechanism as a catch brake. In particular if the monitor is installed on the elevator car, said monitor

can activate the catch brake with the greatest possible reaction speed and functional reliability in the event of an emergency, with redundant activation by evaluation of the information from the code scale
5 contributing to a further increase in the functional reliability of the catch brake.

Exemplary embodiments of the invention are explained below with reference to the attached drawings.

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Figure 1A shows a front view of an elevator system according to the invention with two vertical tracks, two elevator cars and two car transfer mechanisms, wherein the vertical
15 tracks are arranged offset with respect to one another parallel to the car walls having the car doors.

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Figure 1B shows a side view of the elevator system according to figure 1.

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Figure 2A shows, on an enlarged scale, a horizontal displacement unit of the above-mentioned car transfer mechanisms in side view.

Figure 2B shows a front view of the horizontal displacement unit according to figure 3A.

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Figure 3A shows a side view of an elevator system according to the invention with three vertical tracks, two elevator cars and two car transfer mechanisms, wherein the vertical tracks are arranged offset with respect to one another at right angles to the car walls
35 having the car doors.

Figure 3B shows a front view of the elevator system according to figure 2A.

Figures 4-7 show a side view, a top view and two cross sections of a coupling mechanism which couples an elevator car to the supporting means in a frictionally engaged manner.

Figures 1A and 1B respectively show a front view and a side view of a first embodiment of the elevator system according to the invention which comprises two vertical tracks 3 arranged in an elevator shaft 2 and two elevator cars 4 traveling along said vertical tracks. The vertical tracks 3 are formed by two lengths in each case of vertical guide rails 5 fastened in the elevator shaft, and the elevator cars 4 are guided along said vertical guide rails by means of guide shoes 6, there being in each case two guide shoes on each side of the elevator cars. Each vertical track 3 is equipped with three car drive systems 7 having revolving supporting means 8. Each of the elevator cars 4 can be coupled to the supporting means 8 of in each case one car drive system in order to convey the elevator car along a vertical track, and can also be decoupled from said supporting means in order to displace the elevator car from one vertical track to another. For this purpose, each elevator car is equipped with three controllable coupling mechanisms 40, each of which is assigned to one of the three car drive systems 7. As a variant, each elevator car may also have just one single coupling mechanism which is brought in each case prior to the coupling operation into a position corresponding to the presently assigned car drive system by means of a controlled positioning device. The car drive systems and the coupling mechanisms required are described further on in this document.

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In this embodiment of the elevator system, the vertical tracks 3 are arranged offset with respect to one another parallel to the car walls 11 having the car

doors 10. During normal operation, one of the vertical tracks 3 serves as a track for the upward trip and the other as a track for the downward trip of the elevator cars, wherein each of the elevator cars, after reaching
5 a story level in the end region of a vertical track, executes a horizontal transfer to the other vertical track on which the elevator car can continue to move in the reverse traveling direction.

10 Three car transfer mechanisms 13, with the aid of which the elevator cars are displaceable between the vertical tracks 3, are illustrated in each case in regions of story stops 12. Each of the car transfer mechanisms comprises two horizontal guides 14, 15 which are fixed
15 to the door-side wall of the elevator shaft 2, and a horizontal displacement unit 16 which is displaceable along said horizontal guides. A horizontal displacement unit of this type comprises a frame structure 17 in which two vertical guide rail pieces 18 are fixed, said
20 guide rail pieces forming end sections or intermediate sections of the vertical guide rails 5 of the vertical tracks 3 when the horizontal displacement unit is positioned in a corresponding transit position. The frame structure 17 is designed in such a manner that
25 the elevator cars 4 can pass in the vertical direction through the horizontal displacement unit 16, which is in the correct transit position, or can stop in said horizontal displacement unit, the elevator cars being guided on the abovementioned guide rail pieces 18.

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The car transfer mechanisms 13 are equipped with a respective displacement drive (not illustrated here) which, controlled by means of an elevator controller, displaces the horizontal displacement units between the
35 vertical tracks 3 and positions said horizontal displacement units in defined transit positions in which the integrated guide rail pieces 18 are precisely aligned with the vertical guide rails 5 of the vertical

tracks. The horizontal displacement units may be empty during the displacement operation or loaded with an elevator car. The displacement drive may include, for example, a drive train, a toothed belt or a rack device
5 via which a preferably speed-controllable electric motor displaces the horizontal displacement units and positions them in a transit position required at that moment. Centering devices may expediently be present on the horizontal displacement units 16, said centering
10 devices fixing the horizontal displacement units precisely and rigidly in one of the transit positions, even when horizontal forces are in effect, for example with the aid of a centering wedge which engages in a controlled manner in a positionally fixed counterpiece.

15 Controllable brake mechanisms 20 are attached on both sides of the elevator cars 4, said brake mechanisms interacting with the vertical guide rails 5 and the guide rail pieces 18 of the horizontal displacement
20 units 16 in such a manner that the brake mechanisms brake or secure the elevator cars when said brake mechanisms are activated by a control mechanism. Said brake mechanisms 20 are used to secure the elevator cars 4 on the guide rail pieces 18 integrated in the
25 horizontal displacement units 16 while said elevator cars are being displaced between two vertical tracks 3. Said brake mechanisms 20 may advantageously also be used as catch devices which, in the event of the permissible car speed or the acceleration being
30 exceeded, act as safety brakes acting between the elevator cars 4 and vertical guide rails 5. Said brake mechanisms may also serve as holding brakes which, during story stops, prevent vertical oscillations and changes in the level of the elevator cars as a result
35 of changes in load. The brake mechanisms 20 customarily contain brake plates which are pressed against the vertical guide rails by means of controllable actuators. Various principles are suitable for

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realizing actuators of this type, for example lifting
spindles with torque-controllable drive motors,
hydraulic cylinders with pressure regulation, or
solenoids which, in the activated state, adhere to the
5 guide rails. In this case, the brake force generated is
preferably regulated as a function of the elevator car
deceleration measured by a deceleration sensor.

For safety reasons, controllable locking devices may be
10 attached to the horizontal displacement units 16, said
locking devices locking the transit of an elevator car
by means of the horizontal displacement units in the
downward direction and eliminating the risk of an
elevator car dropping out of a horizontal displacement
15 unit.

It can easily be seen that, in the embodiment of the
elevator system illustrated in figures 1A, 1B, in which
the vertical tracks are arranged offset with respect to
20 one another parallel to the car walls 11 having the car
doors 10, a plurality of vertical tracks 3 may also be
arranged next to one another. In this embodiment, entry
and exit take place at story stops 12 which may be
located on each story and may be assigned to each of
25 the vertical tracks. The horizontal guides 14, 15 of
the car transfer mechanisms 13 advantageously extend
here over the entire width of all of the vertical
tracks such that each elevator car can use each of the
vertical tracks 3. In the case of elevator systems
30 having a relatively large number of parallel vertical
tracks, it may be expedient to allow more than one
horizontal displacement unit 16 to operate on the same
horizontal guides 14, 15 of a car transfer mechanism 13
or to arrange two or more car transfer mechanisms
35 directly one above the other. Car transfer mechanisms
may also be present on any intermediate level of the
elevator system, said intermediate level not
necessarily having to be located in the region of a

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story stop. In combination with a correspondingly configured elevator controller, in an elevator system of this type elevator cars can change the vertical track thereof and, if appropriate, the traveling direction thereof via such car transfer mechanisms arranged on intermediate levels without having to complete a circuit via the end regions of the vertical tracks, or empty elevator cars can be called up from parallel vertical tracks without large detours and waiting times having to be accepted. One of the vertical tracks may advantageously be provided as a store or as a parking space for empty elevator cars. A car transfer mechanism 13 which is not arranged in an end region of the vertical tracks and has an empty horizontal displacement unit 16 is shown above the lowermost story stop. A car transfer mechanism of this type may be arranged on any intermediate level of the elevator system. Owing to roller-mounted horizontal displacement units 16 and controllable displacement drives, the car transfer mechanisms 13 are also suitable for horizontally displacing elevator cars which are occupied by passengers.

Since the vertical guide rails 5 of the vertical tracks 3 are interrupted in the regions of the car transfer mechanisms 13, the elevator controller ensures that each time before an elevator car enters such a region, the guide rail pieces 18 of a horizontal displacement unit 16 span the interruptions. If no horizontal displacement unit is available at the right time for a required spanning, the elevator car is stopped before reaching the interrupted region.

Figure 2A and figure 2B respectively show a side view and a front view of an above-described car transfer mechanism 13 together with the horizontal displacement unit 16 thereof in an enlarged illustration. To clarify the interaction of the horizontal displacement unit

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with the elevator cars 4, one such elevator car is indicated in a holding position in the horizontal displacement unit by means of ghost lines. An upper horizontal guide is denoted by 14 and a lower horizontal guide by 15, on which horizontal guides the horizontal displacement unit 16 can be displaced by a displacement drive 24 between the vertical tracks of the elevator system. The horizontal guides 14, 15 are fastened to the door-side wall 25 of the elevator shaft. The horizontal displacement unit 16 comprises a frame structure 17 with two vertically arranged side frames 26 and an upper longitudinal member 27 and a lower longitudinal member 28 which connect the two side frames 26 to each other. Four profiled, upper guide rollers 29 are fixed to the upper longitudinal member 27 and are used to guide the upper longitudinal member 27 in the vertical and horizontal direction on the upper horizontal guide 14.1. The lower longitudinal member 28 has four lower guide rollers 30 which guide the lower longitudinal member 28 in the horizontal direction on the lower horizontal guide 15. The vertically aligned guide rail pieces 18 already mentioned above are fixed to the inner sides of the two side frames 26. The two side frames 26 together with the upper and the lower longitudinal members 27, 28 form a U-shaped frame which permits the transit of elevator cars 4 between the two side frames 26, wherein the two guide rail pieces 18 form end sections or intermediate sections of the vertical guide rails of the vertical tracks of the elevator system when the horizontal displacement unit is positioned in a correct transit position. As likewise already mentioned, the elevator cars are equipped with controllable brake mechanisms 20 with which the elevator cars 4 can be secured on the abovementioned guide rail pieces 18 during a horizontal transfer between two vertical tracks.

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The displacement drive 24 is arranged above the horizontal displacement unit 16 and comprises a belt drive which is fastened on the upper horizontal guide, extends over the entire displacement distance and has a drive unit 32, a revolving displacement belt 33 and a deflecting belt pulley 34, wherein the lower strand of the displacement belt is connected to the upper longitudinal member 27 of the horizontal displacement unit.

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The drive units 32 of the horizontal displacement units 16 are preferably controlled by the central elevator controller which controls and monitors all of the elevator traffic.

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The horizontal displacement unit 16 illustrated is equipped with a centering device which is shown schematically by the reference number 35. The centering device 35 can fix the horizontal displacement unit, for example, in one of the transit positions precisely and such that it is capable of bearing a load by the rough positioning by means of the displacement drive 31 being followed by engagement of an electromagnetically controlled centering wedge in a notch on the upper horizontal guide 14.

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A controllable locking device is denoted by 36, said locking device locking the transit of an elevator car 4 by means of the horizontal displacement unit 16 in a downward direction and eliminating the risk of an elevator car dropping out of a horizontal displacement unit, for example should a brake mechanism fail. A locking device 36 of this type may comprise, for example, an electromagnetically controllable locking bolt which, controlled by the elevator controller, reaches out from at least one of the side frames 26 of the horizontal displacement unit 16 and engages under an elevator car fixed in the horizontal displacement

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unit for as long as said elevator car should not leave the horizontal displacement unit in the downward direction.

5 Figure 3A and figure 3B respectively show a side view and a front view of a second embodiment of the elevator system according to the invention, in which components acting in an identical manner are denoted by the reference numbers used in figures 1A and 1B. Where
10 required, the reference numbers for elements of the second embodiment are indicated by the index ".2".

The embodiment illustrated comprises two vertical tracks 3 each having two vertical guide rails 5, and
15 three elevator cars 4 traveling along said vertical tracks. In contrast to the above-described first embodiment, the vertical tracks 3 here are arranged offset with respect to one another at right angles to the car walls 11 having the car doors 10. The elevator
20 cars each have two mutually opposite car doors 10 which each correspond to shaft doors 9 provided on mutually opposite walls of the elevator shaft. In this second embodiment, the horizontal displacement units 16 of the car transfer mechanisms 13 are displaced along
25 horizontal guides 14, 15 which are respectively arranged below the lower ends and above the upper ends of the vertical tracks 3, for example on the floor and on the ceiling, respectively, of the elevator shaft 2. In said horizontal displacement units 16, the guide
30 rail pieces 18 which are integrated therein likewise permit an elevator car 4 to be received in order for said elevator car to be displaced between two vertical tracks 3. Horizontal displacement units which are installed on intermediate levels and permit transit of
35 the elevator cars are not provided in this embodiment. One advantage of this embodiment is that the story stops 12 and the entry vestibules for upward trips and downward trips are located separately from one another

on opposite sides of the elevator shaft, thus enabling more orderly flow of traffic to be achieved. A disadvantage of this embodiment is that only two vertical tracks can be arranged in such a manner that
5 it is possible to enter or leave the elevator cars traveling thereon from the story stops. However, it is also possible and expedient here to arrange at least one additional vertical track between the two vertical tracks adjacent to the shaft doors 9, it being possible
10 for the additional vertical track to serve as a store for elevator cars which are not currently in use and/or as a second track for the traveling direction presently having more traffic.

15 In this embodiment of the elevator system, the elevator cars 4 are driven by in each case two synchronously operating subsystems 7.2 of a respective car drive system, which subsystems are arranged on mutually opposite sides of the elevator cars, each subsystem 7.2
20 having two revolving supporting means 8. In total, there are six subsystems 7.2 which together form three car drive systems operating independently of one another, and each elevator car 4 is provided with a total of six coupling mechanisms 40, of which in each
25 case three interact with the left-hand and three with the right-hand subsystems 7.2 of the car drive systems. The arrangement of in each case two subsystems 7.2 on both sides has the advantage that the in each case two synchronously controlled and regulated subsystems
30 driving an elevator car do not generate a tilting moment which acts on the elevator car. However, the car drive systems could also be arranged only on one side of the elevator cars. The tilting moment generated by car drive systems which are arranged on one side and
35 acting on the elevator cars can be compensated for by the guide forces between the vertical guide rails and the guide shoes of the elevator cars.

In both embodiments, in order to move and position the elevator cars along the vertical tracks thereof, each vertical track is assigned car drive systems which are controllable independently from one another. Said car drive systems permit an asynchronous, i.e. non-coupled movement of a plurality of elevator cars along the same vertical track, which affords substantial advantages with regard to transport capacity and traveling times in comparison to elevator systems having a plurality of elevator cars driven by a single car drive system. For this purpose, the elevator cars can be coupled with the aid of controllable coupling mechanisms (described further below) to flexible supporting means of a car drive system, which supporting means are temporarily assigned to the elevators cars by the elevator controller. Of course, an elevator system according to the invention may also be provided with more than or with less than three car drive systems which are independent from one another.

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For safety reasons, each of the illustrated car drive systems 7 and 7.2 comprises at least two parallel, flexible supporting means 8 which are movable along the assigned vertical tracks and, preferably in the upper elevator region, loop around a driving pulley 41 and, in the lower region, loop around a deflecting pulley 42 or a second driving pulley. Each driving pulley 41 is driven by a drive unit 43 which preferably comprises a speed-controllable electric motor. The drive units 43, or the electric motors thereof, which are assigned in each case to one of the car drive systems 7 or 7.2 can be controlled and regulated independently of the other drive units associated with the same vertical track. The driving pulleys 41 have a small effective diameter of less than 100 mm, preferably an effective diameter of less than 80 mm, and the effect therefore achieved is that the required lifting forces can be generated in the supporting means 8 by electric motors having small

dimensions which preferably drive the driving pulleys directly without intermediate transmission. In this case, the motor shafts of the electric motors and the associated driving pulleys may form an integral unit.

5 The permissible loading of a car drive system may be increased by an upper and a lower drive unit each having a driving pulley being assigned in each case to one car drive system. An embodiment of this type is shown in figures 1A, 1B. The electric motors of drive

10 units of this type are controlled synchronously and are speed-controlled synchronously.

The driving or deflecting pulleys in the lower elevator region are equipped here with tensioning devices

15 (illustrated symbolically by means of arrows P) with which the required pretensioning of the supporting means is produced and deviations in the original lengths of the supporting means which are closed per se and operationally induced plastic changes in length in

20 the supporting means are compensated for. The required tensioning forces can preferably be produced using tensioning weights, gas-filled springs or metal springs.

25 The supporting means 8 illustrated in the elevator systems according to figures 1A, 1B, 3A, 3B are in the form of belts. The latter are preferably designed as toothed belts or as V-ribbed belts and reinforced with tensile reinforcements in the form of wire cables,

30 synthetic fiber cables or synthetic fiber tissues, and therefore said belts can convey an assigned elevator car 4 over a large number of stories without impermissible vertical oscillations occurring.

35 As already mentioned above, each elevator car 4 of the illustrated elevator system is equipped with controllable coupling mechanisms 40 which permit a respective elevator car 4 to be coupled to a

temporarily assigned car drive system 7 or to a subsystem 7.2 and, of course, also to be decoupled therefrom. A coupling mechanism of this type may have at least one controllably movable coupling element which interacts in an interlocking manner with openings or bosses present on the at least one supporting means of the assigned car drive system in order to produce a temporary connection between an elevator car and the supporting means. Although coupling mechanisms of this type ensure secure connections, they have the disadvantage that, prior to each coupling operation, the supporting means has to be brought into a position in which one of the openings or one of the bosses takes up a position corresponding to the movable coupling element of the car-side coupling mechanism. Prior to the decoupling, it is also expedient to relax the supporting means by means of appropriate activation of the drive unit after the elevator car is retained in a horizontal displacement unit in order to permit a load-free uncoupling of the interlocking connection and to avoid a sudden unloading of the relatively elastic supporting means.

On each elevator car, there are therefore expediently as many coupling mechanisms acting in a frictionally engaged manner as there are car drive systems 7 or subsystems 7.2 per vertical track. As a variant, each elevator car may also have just a single coupling mechanism which is brought in each case, prior to the coupling operation, by means of a controlled positioning device into a position corresponding to the car drive system presently assigned.

The coupling mechanisms 40 are preferably equipped with controllable clamping devices 45 with which in each case one of the coupling mechanisms of an elevator car can be connected in a frictionally engaged manner to at least one supporting means 8 of a temporarily assigned

car drive system 7 or of a subsystem 7.2. So that an elevator car 4 can be displaced horizontally when it is fixed to the guide rail pieces 18 of a horizontal displacement unit 16, the clamping devices 45 of the coupling mechanisms 40 thereof can be pulled back out of the region of the supporting means 8. Coupling mechanisms which act in a frictionally engaged manner have the advantage that the elevator cars can be coupled to the supporting means of a car drive system in every vertical position without any coupling elements of the supporting means having to be brought beforehand to a defined position in relation to the elevator car. In addition, it is not necessary to relax the supporting means prior to the uncoupling in the case of coupling mechanisms acting in a frictionally engaged manner.

An exemplary embodiment of a coupling mechanism 40 acting in a frictionally engaged manner is described below in conjunction with figures 4-7.

Figure 4 shows a side view and figure 5 a top view of a coupling mechanism 40. As illustrated schematically in figures 1A, 1B and 3A, 3B, a plurality of such coupling mechanisms are mounted on the upper sides of the elevator cars. Figures 6 and 7 respectively show cross sections through a clamping device 45 of the coupling mechanism and through a region of the coupling mechanism that is provided with a longitudinal guide which permits the coupling mechanism to be pulled back. The coupling mechanism 40 comprises a base plate 46 connected to the elevator car and a coupling part 47 which is displaceable on the base plate. The coupling part 47, in the region of the front end thereof, has a clamping device 45 which comprises a slot 49 through which the two supporting means 8 designed as belts are guided when the coupling part 47 takes up the extended position thereof. Two brake plates 50 are arranged in

the slot 49 of the clamping device 45, each of which brake plates is guided by means of a pressing piston 51 and can be pressed by the latter against the assigned supporting means 8. As illustrated in figure 6, the two pressing pistons 51 are arranged in respective cylinder bores 52 which are drilled in one of the arms of the clamping device 45 and are closed on one side by a sealing stopper 53. The pressure spaces present in the two cylinder bores 52 between the pressing pistons and the sealing stoppers 53 are connected to an oil-filled pressure cylinder bore 56 by a connecting bore 55. Oil from said pressure cylinder bore can be pressed into the abovementioned pressure spaces by displacement of a pressure-generating piston 57 in order, by means of the pressing pistons 51, to press the brake plates 50 against the supporting means 8 and therefore to couple the latter in a frictionally engaged manner to the coupling part 47 and therefore to the elevator car. In order to displace the pressure-generating piston 57, a lifting spindle 58 which is operated by an electric motor is mounted laterally on the coupling part 47 and, via a spring element 59 and the pressure-generating piston 57, generates the oil pressure required for the coupling. For uncoupling purposes, the spring element is relieved of load by the lifting spindle 58, and therefore the pressing pistons 51 are pulled back by restoring springs 60 and the brake plates 50 are therefore lifted off the supporting means 8. So that an elevator car can be displaced horizontally when it is fixed on the guide rail pieces of the horizontal displacement unit, the clamping device 45 of the coupling part 47 can be pulled back out of the region of the supporting means 8. For this purpose, the coupling part 47 is connected displaceably in the longitudinal direction to the base plate 46 thereof via a T-shaped longitudinal guide 62. In the coupling mechanism 40 illustrated in figures 4 to 7, the coupling part 47 and therefore the clamping device 45

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are pulled back and advanced by means of a further displacement lifting spindle 61 driven by an electric motor.

Patent claims

1. An elevator system with at least one elevator car (4) which moves vertically along a vertical track (3) comprising a vertical guide rail (5) and horizontally with the aid of a car transfer mechanism (13), wherein the vertical track (3) is equipped with a car drive system (7; 7.2) which comprises a flexible supporting means (8) which is movable and stoppable along the vertical track (3), and the elevator car (4) has a controllable coupling mechanism (40) with which the elevator car can be coupled to or decoupled from the supporting means, characterized in that the car transfer mechanism (13) comprises a horizontal displacement unit (16) into which a vertical guide rail piece (18) is integrated, said guide rail piece guiding the elevator car (4) in the horizontal displacement unit (16), the horizontal displacement unit being able to be positioned in such a manner that the guide rail piece (18) forms a section of the vertical guide rail (5), and the elevator car (4) has a brake mechanism (20) with which the elevator car can be temporarily fixed to the guide rail piece (18) integrated in the horizontal displacement unit (16).

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2. The elevator system as claimed in claim 1, characterized in that the brake mechanism (20) can be activated and can be deactivated by a control mechanism.

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3. The elevator system as claimed in claim 2, characterized in that the brake mechanism (20) also serves as a catch brake for the elevator car (4).

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4. The elevator system as claimed in claim 2, characterized in that the brake mechanism (20) also serves as a holding brake for the elevator car (4).

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5. The elevator system as claimed in one of the preceding claims, characterized in that said elevator system comprises two or more vertical tracks (3) and the elevator car (4) is displaceable between said
5 vertical tracks with the aid of the car transfer mechanism (13).

6. The elevator system as claimed in one of the preceding claims, characterized in that the vertical
10 tracks (3) are arranged offset with respect to each other parallel to a car wall (11) of the elevator car (4), said car wall having a car door (10).

7. The elevator system as claimed in one of the preceding claims, characterized in that the horizontal
15 displacement unit (16) of the car transfer mechanism (13) is displaceable along horizontal guides (14, 15) which are arranged parallel to a car wall having a car door (10) in a part of an elevator shaft which is not
20 taken up by the vertically and horizontally moving elevator car.

8. The elevator system as claimed in one of the preceding claims, characterized in that the elevator
25 car has two mutually opposite car walls (11) each having a car door (10) and the vertical tracks (3) are arranged offset with respect to each other at right angles to said car walls.

30 9. The elevator system as claimed in one of the preceding claims, characterized in that there is a plurality of car transfer mechanisms (13) which are arranged on different levels in such a manner that the guide rail pieces (18) which are integrated in the
35 horizontal displacement units (16) thereof can form displaceable end sections or intermediate sections of vertical guide rails (5) of two or more vertical tracks (3).

10. The elevator system as claimed in one of the preceding claims, characterized in that the supporting means (8) and the coupling mechanism are designed in
5 such a manner that the elevator car (4) and the supporting means are coupled by means of interlocking engagement.

11. The elevator system as claimed in one of the preceding claims, characterized in that the supporting
10 means and the coupling mechanism (40) are designed in such a manner that the elevator car (4) and the supporting means (8) are coupled by means of frictional engagement.

12. The elevator system as claimed in one of the preceding claims, characterized in that the drive system (7; 7.2) comprises a drive unit (43) with a speed-controllable electric motor, the electric motor
15 driving a driving pulley (41) acting on the supporting means or a driving shaft which has an effective diameter of less than 100 mm, preferably of less than 80 mm.

13. The elevator system as claimed in one of the preceding claims, characterized in that the drive system (7; 7.2) comprises two flexible supporting means
25 (8) arranged parallel.

14. The elevator system as claimed in one of the preceding claims, characterized in that the drive system (7; 7.2) comprises an upper and a lower drive unit (43) which can be controlled and regulated
30 synchronously and jointly act on the one or more supporting means (8) of the drive system.

15. The elevator system as claimed in one of the preceding claims, characterized in that the one or more

supporting means (8) of the drive system (7; 7.2) is or are designed as a wire cable, flat belt, V-ribbed belt or toothed belt.

5 16. The elevator system as claimed in one of the preceding claims, characterized in that the coupling mechanism (40) acting by means of frictional engagement comprises a clamping device (45) which is movable out of the region of the supporting means (8) in order to
10 permit a horizontal transfer of the elevator car (4).

17. The elevator system as claimed in one of the preceding claims, characterized in that the drive system (7; 7.2) operates without a counterweight.

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18. The elevator system as claimed in one of the preceding claims, characterized in that the drive system (7; 7.2) comprises a drive regulator which, during a downward trip of an elevator car (4), feeds
20 the energy generated into the mains or stores said energy in a capacitor or an accumulator.

19. The elevator system as claimed in one of the preceding claims, characterized in that a vertical
25 track (3) is equipped with two or more drive systems (7; 7.2) arranged parallel to each other so that two or more elevator cars (4) can move simultaneously along said vertical track, the elevator cars having two or more controllable coupling mechanisms (40) with which
30 the elevator cars can be coupled to a separately controllable drive system (7; 7.2) presently assigned thereto.

20. The elevator system as claimed in one of the preceding claims, characterized in that a code scale
35 with absolute encoding is arranged along a vertical track (3), each elevator car (4) being assigned a code reading mechanism which continuously reads information

about the position of the elevator car from the code scale by means of detectors functioning in a contact-free manner.

5 21. The elevator system as claimed in one of the preceding claims, characterized in that a rotary sensor is attached to the elevator car and is driven by a friction wheel rolling along the vertical guide rail (5) or along a guide rail section (18) of a horizontal
10 displacement unit (16), the rotary sensor supplying information about the present traveling speed to a monitor.

22. The elevator system as claimed in claim 23,
15 characterized in that the monitor redundantly monitors the traveling speed and/or the present acceleration of the elevator car (4) with reference to the information transmitted by the rotary sensor and also by means of continuous differentiation of the travel path
20 determined from the position information and, if it is detected that a speed limit or acceleration limit is being exceeded, activates the controllable brake mechanism (20) as a catch brake.

25 23. A method for operating an elevator system, in particular as claimed in one of the preceding claims, in which at least one elevator car (4) is moved along a vertical track (3) comprising a vertical guide rail (5) and is displaced horizontally with the aid of a car
30 transfer mechanism (13), wherein a controllable coupling mechanism (40) is used to couple the elevator car (4) to or to decouple said elevator car from a flexible supporting means (8) of a car drive system (7; 7.2), which supporting means is movable and stoppable
35 along the vertical track (3), characterized in that, for the horizontal displacement, the elevator car (4) is moved onto a guide rail piece (18) which is integrated in a horizontal displacement unit (16) of

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the car transfer mechanism (13) and, in a transfer position of the horizontal displacement unit (16), forms a horizontally displaceable section of the vertical guide rail (5) of the vertical track (3), the
5 elevator car (4) being fixed, by means of a brake mechanism (20) attached thereto, to the guide rail piece (18) integrated in the horizontal displacement unit (16).