

Clutch for coupling a car door of an elevator car with a landing door of an elevator system

- 5 The invention is related to a clutch for coupling a car door of an elevator car with a landing door of an elevator system in accordance with the preamble of claim 1.

A conventional elevator system comprises two different sets of doors, i. e. car doors and landing doors. In general, each car of the elevator system includes at least one car door.

- 10 Within each landing zone of the elevator system, at least one landing door is installed. Each landing door is located such that, when the car is stopped within the corresponding landing zone, the landing door is adjacent to a car door so that the interior of the elevator is accessible through the landing door and the car door provided that both doors are open. Under normal conditions, the landing doors are kept closed whenever the car is not
- 15 present in the related landing zones. Instead of having actuators for each of the landing doors, a particular landing door can be coupled with the car door by means of a clutch which is arranged at the car door. If access to the elevator car through a particular landing door and a particular car door is desired, the elevator car is moved into the landing zone corresponding to that landing door and stopped. In addition, the car door is mechanically
- 20 coupled with the landing door by means of the clutch when the car enters the landing zone. Afterwards, the landing door and the car door can be opened or closed by means of an actuator that is linked to the car door. Prior to moving the car to another landing door, the clutch is released, thereby uncoupling the car door and the landing door.

- 25 In general, the clutch is arranged at the car door and comprises at least one coupling element, which is movable with respect to the car door between a first position and a second position such that the coupling element engages with the landing door, when the elevator car is within a landing zone and the coupling element is moved towards the second position, thereby establishing the coupling of the car door with the landing door.
- 30 For uncoupling the car door and the landing door, the coupling element is moved towards the first position.

- For actuating the clutch, two different concepts are known. In a first concept, the clutch is linked to the actuator which drives the car door. Thus, the coupling element of the clutch
- 35 and the car door are simultaneously driven by means of a single actuator. In a second concept, two actuators are provided, one of said actuators being dedicated for driving the

clutch and the other actuator being dedicated for driving the car door. The latter concept is advantageous in that it allows more freedom in the timing and synchronization of movement of the coupling element since the actuation of the clutch is independent of the actuator which drives the car door.

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In EP 0 676 360 A1, a clutch for coupling a car door of an elevator car with a landing door of an elevator system is disclosed. The car door is movable with respect to the elevator car by means of a first actuator. The clutch comprises a coupling element and a second actuator. The coupling element is movable with respect to the car door between a first
10 position and a second position by means of a second actuator such that the coupling element engages with the landing door, when the elevator car is within a landing zone and the coupling element is moved towards the second position, thereby establishing the coupling of the car door with the landing door. In particular, the coupling element consists of two vanes which are connected by means of a movable linkage. By means of the
15 second actuator, the vanes are movable with respect to each other for establishing a mechanical contact of the vanes with rollers, which rotate about horizontal axles disposed at the top of the landing door, and which provide rotationally stiff coupling. As second actuator, a solenoid acting on an armature against the bias of a spring is used. The armature is arranged in parallel with respect to the vanes and in a sliding contact with one
20 of the vanes. By activating the solenoid, the armature can be moved, thereby causing a movement of the vanes perpendicular to the direction of movement of the armature so that the distance between the vanes is changed. In order to control the movement of the vanes, a bias is applied on the vanes by means of a compressed spring being connected with both vanes. This clutch has several disadvantages. The sliding contact between the
25 armature and one of the vanes is subjected to wear, thus limiting the lifetime and the reliability of operation of the clutch. In addition, the actual position of the vanes is influenced by the balance of at least four forces, i.e. the forces being provided by the solenoid and two springs and the friction between the armature and one of the vanes. Thus, it is difficult to control the motion of the vanes precisely and to ensure a given
30 accuracy of control over a long time. In addition, due to the bias of the springs, the operation of the second actuator is not very efficient since the force generated by means of the solenoid must compensate the spring forces.

In FR 2827266, a clutch for coupling a car door of an elevator car with a landing door of
35 an elevator system is disclosed, the clutch being independently driven by means of a DC

motor whereas the car door is opened or closed by means of a separate actuator. The force provided by the DC motor is transmitted to movable parts of the clutch by means of a gear or a screw drive. Due to friction in the gear or in the screw drive, a major part of the energy provided by the DC motor is lost. Thus, the efficiency of the clutch is reduced.

- 5 Furthermore, if electric power is not available for driving the DC motor, it is difficult to operate the gear or the screw drive and, thus, it becomes difficult to actuate any component of the clutch. This is disadvantageous during the installation of the clutch in the elevator system. In the case of a power failure during operation of the elevator system, it may be necessary to manually operate the clutch. It is difficult or even impossible to
10 exercise this task, depending on the friction in the gear or the screw drive.

In view of the disadvantages of known clutches, it is the objective of the invention to provide a clutch which can be independently actuated by means of a separate actuator with high efficiency and with high precision.

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This objective is achieved by means of a clutch in accordance with claim 1.

Advantageous embodiments are defined in the dependent claims.

- 20 The clutch is designed for coupling a car door of an elevator car with a landing door of an elevator system, wherein the car door is movable with respect to the elevator car by means of a first actuator. The clutch comprises at least one coupling element and a second actuator. The coupling element is movable with respect to the car door between a first position and a second position by means of the second actuator such that the
25 coupling element engages with the landing door, when the elevator car is within a landing zone and the coupling element is moved towards the second position, thereby establishing the coupling of the car door with the landing door.

According to the invention, the second actuator is a linear motor.

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In this context, the term "linear motor" designates any motor comprising a motor primary and a motor secondary, wherein the motor primary and/or the motor secondary are movable in one dimension with respect to each other under the influence of a traveling magnetic field provided by the motor primary and acting on the motor secondary.

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The use of a linear motor in accordance with the invention has several advantages.

- Linear motors usually provide a high force density since the distance between the motor primary and the motor secondary primary can be kept small. Therefore, optimized linear motors provide a high efficiency. In addition, in the clutch in accordance with the invention, the coupling element can be directly coupled with the linear motor. Thus, the coupling element of the clutch can be directly actuated by means of the linear motor. Consequently, components such as a gear or a screw drive are not necessary for coupling the linear motor with the coupling element. Thus, the coupling element can be actuated with low friction. Therefore, the clutch in accordance with the invention can be efficiently actuated. In addition, the second actuator does not require much space.
 - The position and the motion of the movable parts of a linear motor and the force provided by the linear motor can be precisely controlled on the basis of known technologies. Therefore, any movement of the coupling element of the clutch in accordance with the invention can be controlled with high precision. On this basis, the clutch can be operated with high reliability and with low noise.
 - If electric power is not supplied, the motor primary and the motor secondary of the linear motor can be easily moved with respect to each other with low friction, for example by hand. This makes it easier to install the motor during the assembly of the clutch and simplifies manual operation of the clutch during power failure.
- 25 In one embodiment of the invention, the motor primary is arranged at the car door and the motor secondary is arranged for force transmission to the coupling element. Alternatively, the motor secondary may be arranged at the car door and the motor primary may be arranged for force transmission to the coupling element.
- 30 In another embodiment of the invention, the motor secondary is linked to the coupling element by means of a first pivot and the motor primary is rotatable about a second pivot being stationary with respect to the car door. Alternatively, the motor primary may be linked to the coupling element by means of a first pivot and the motor secondary may be rotatable about a second pivot being stationary with respect to the car door. In particular,
- 35 the coupling element may comprise two vanes which are connected by means of a

movable linkage such that the vanes are movable with respect to each other for establishing a mechanical contact of the vanes with the landing door. In each case, the first pivot may be arranged at the linkage or at one of the vanes. On this basis, it is possible to establish a connection between the linear motor and the coupling element, which connection is resistant to wear and, therefore, long-lived.

In the following, preferred embodiments of the invention are described in conjunction with the accompanying drawings, in which:

Fig. 1 is a view of a clutch in accordance with the invention;

Fig. 2 is a view of the clutch of Fig. 1, taken in a different perspective, the clutch being arranged at a car door and the car being located in a landing zone at a landing door;

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Fig. 3 is a view of the clutch of Fig. 2 taken on the line III-III;

Fig. 4 is a view of the clutch of Fig. 2, taken in a different perspective, the clutch not being engaged with the landing door, and

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Fig. 5 is a view of the clutch in accordance with Fig. 4, the clutch being engaged with the landing door.

In Fig. 1-5, a clutch 10 for coupling a car door of an elevator car with a landing door of an elevator system is shown.

Referring to Fig. 1 and 2, the clutch 10 comprises a support 11. At support 11, all movable parts of the clutch 10 are arranged:

- 30 – a coupling element 20 which consists of two vanes 21, 22 being arranged in parallel and a linkage 25 connecting both vanes 21 and 22,
- a linear motor 40 which comprises a motor primary 41 and a motor secondary 42,
- a clamp 43 for connecting the motor primary 41 pivotally about a pivot 46 with support 11 and

- a lever 28, one end of which is connected with the motor secondary 42 pivotally about pivot 45 and another end being connected with linkage 25.

The linkage 25 comprises a first connecting element 26 and a second connecting element 27. The first connecting element 26 is connected with support 11 pivotally about a pivot 26'. In addition, the first connecting element 26 is connected with the vanes 21 and 22 pivotally about pivots 26'' and 26''', respectively. The second connecting element 27 is connected with support 11 pivotally about a pivot 27'. In addition, the second connecting element 27 is connected with the vanes 21 and 22 pivotally about pivots 27'' and 27''', respectively.

The linkage 25 is arranged such that the vanes 21 and 22 and the connecting elements 26 and 27 form a parallelogram. The connecting elements 26 and 27 can synchronously rotate about the pivots 26' and 27', respectively, thereby keeping the vanes 21 and 22 in parallel and changing the distance between the vanes 21 and 22.

The lever 28 is rigidly coupled to the connecting element 27.

As indicated in Fig. 1 and 2, the pivots 26', 26'', 26''', 27', 27'', 27''', 45 and 46 are arranged in parallel. All pivots may be provided with a wear resistant bearing.

By means of a control unit (not shown), the linear motor 40 can be actuated, thus leading to a linear movement of the motor secondary 42 with respect to the motor primary 41, as indicated by an arrow 47 in Fig. 2. Since the motor secondary 42 is connected with the lever 28 at the first pivot 45, the connecting elements 26 and 27 can be turned around the pivots 26' and 27', respectively, by actuating the linear motor 40. In addition, since the motor primary 41 is pivotally connected with the support 11, the motor primary 41 is turned around the pivot 46 upon an actuation of the linear motor 40, as indicated by an arrow 48 in Fig. 2.

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The support 11 is provided with holes 12. Fastening means 13 may be passed through these holes in order to fix the clutch 20 at a car door.

Referring now to Fig. 3, the clutch 10 is fixed at a car door 1 of an elevator car. The clutch 10 is arranged such that the vanes 21 and 22 are aligned parallel to the direction in which

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the elevator car can be moved during operation of the elevator. Said direction of motion of the elevator car is indicated by an arrow 7 in Fig. 2, 4 and 5. The car door 1 is arranged essentially parallel to the direction of motion of the car, too.

- 5 For causing the car door 1 to open or close, an actuator 2 is provided (as schematically represented in Fig. 3). An arrow 3 in Fig. 3 indicates the opening direction.

In the situation shown in Fig. 2 and 3, the elevator car is arriving in a landing zone at a landing door 5, which is arranged essentially parallel to the direction of motion of the car.

- 10 Both the car door 1 and the landing door are closed.

For enabling the car door 1 to be coupled with the landing door 5, the landing door 5 comprises two rollers 31 and 32 facing the car door 1. The rollers 31 and 32 are arranged at a distance with respect to each other. The coupling element 20 has been passed
15 between the rollers 31 and 32 upon arrival of the elevator car in the landing zone. The distance between the rollers 31 and 32 is chosen such that both of the following conditions are fulfilled:

- By actuating the linear motor 40, the coupling element 20 can be moved with respect
20 to the car door 1 to a first position, such that the vanes 21 and 22 do not touch the rollers 31 and 32 (Fig. 2, 3 and 4). Under these circumstances, the coupling element 20 is not engaged with the landing door 5. Thus, the car door 1 is not coupled with the landing door 5.
 - 25 – By actuating the linear motor 40, the coupling element 20 can be moved with respect to the car door 1 to a second position, such that the vanes 21 and 22 touch the rollers 31 and 32 (Fig. 5). Under these circumstances, the coupling element 20 is engaged with the landing door 5. Thus, the car door 1 is coupled with the landing door 5.
- 30 Thus, by actuating the linear motor 40, the car door 1 can be caused to couple or to uncouple with the landing door 5.

Fig. 4 and 5 show the clutch 20 for two different situations. According to Fig. 4, the motor secondary 42 is arranged with respect to the motor primary 41 such that the coupling
35 element 20 does not touch the rollers 31 and 32. Thus, a coupling of the car door 1 with

the landing door 5 is not established. By moving the motor secondary 42 towards the coupling element 20 and, thereby, turning the motor primary 41 around the pivot 46, the vanes 21 and 22 are moved within a plane parallel to the direction 7 of motion of the elevator car and the distance between the vanes 21 and 22 increases, thus causing the
5 coupling element 20 to touch the rollers (Fig. 5). In the latter case, a coupling of the car door 1 with the landing door 5 is established.

The roller 32 may be provided with an axis of rotation which can be shifted within certain limits in the horizontal direction as indicated by an arrow in Fig. 4 and 5, thus causing the
10 distance between the rollers 31 and 32 to change. In this case, a lateral shift of the roller 32 can be achieved by means of the linear motor 20, when a coupling of the car door 1 with the landing door 5 is established. This shift can be used for controlling a mechanism for locking and/or unlocking the landing door 5. Similarly, a mechanism for locking and/or unlocking the car door 1 can be coupled to the clutch, the mechanism being actuated by
15 the linear motor 40.

If a coupling of the car door 1 with the landing door 5 is established, the landing door can be opened or closed by means of the actuator 2.

20 The linear motor 40 is a tubular linear motor. The motor primary 41 comprises windings for providing a traveling magnetic field. The motor secondary 42 is a tube in which are disposed permanent magnets of circular section, for example made of Neodymium-Iron-Boron magnetic material. Such a tubular linear motor is a simple, low cost, low noise and highly reliable device to drive the clutch. Its motion and force can be precisely controlled,
25 in contrast for example to a simple solenoid which would lack those features.

Of course, linear motors of another kind are appropriate for actuating the clutch.

The clutch 10 may be modified within the scope of the invention. Instead of connecting the
30 linear motor 40 with the linkage 25, the linear motor 40 may be connected with one of the vanes 21 or 22. Furthermore, the motor secondary may 42 be pivotally connected with the support 11 and the motor primary 41 may be connected with the coupling element 20.

Claims

1. Clutch (10) for coupling a car door (1) of an elevator car with a landing door (5) of an
5 elevator system,
wherein the car door (1) is movable with respect to the elevator car by means of a
first actuator (2),
the clutch (10) comprising at least one coupling element (20) and a second actuator,
wherein the coupling element (20) is movable with respect to the car door (1)
10 between a first position and a second position by means of the second actuator
such that the coupling element (20) engages with the landing door (5), when the
elevator car is within a landing zone and the coupling element is moved towards the
second position, thereby establishing the coupling of the car door (1) with the
landing door (5),
15 characterized in that
the second actuator is a linear motor (40).
2. The clutch in accordance with claim 1, wherein
the linear motor (40) comprises a motor primary (41) and a motor secondary (42)
20 and
the motor primary (41) is arranged at the car door (1) and
the motor secondary (42) is arranged for force transmission to the coupling element
(20).
- 25 3. The clutch in accordance with claim 1, wherein
the linear motor (40) comprises a motor primary (41) and a motor secondary (42)
and
the motor secondary (42) is arranged at the car door (1) and
the motor primary (41) is arranged for force transmission to the coupling element
30 (20).
4. The clutch in accordance with claim 2, wherein
the motor secondary (42) is linked to the coupling element (20) by means of a first
pivot (45) and the motor primary (41) is rotatable about a second pivot (46) being
35 stationary with respect to the car door (1).

5. The clutch in accordance with claim 3, wherein the motor primary (41) is linked to the coupling element (20) by means of a first pivot (45) and the motor secondary (42) is rotatable about a second pivot (46) being stationary with respect to the car door (1).

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6. The clutch in accordance with one of claims 1-5, wherein the coupling element (20) comprises two vanes (21, 22) which are connected by means of a movable linkage (25) such that the vanes (21, 22) are movable with respect to each other for establishing a mechanical contact of the vanes (21, 22) with the landing door (5).

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7. The clutch in accordance with claim 6, when appended to claims 4 or claim 5, wherein the first pivot (45) is arranged at the linkage (25) or at one of the vanes (21, 22).

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