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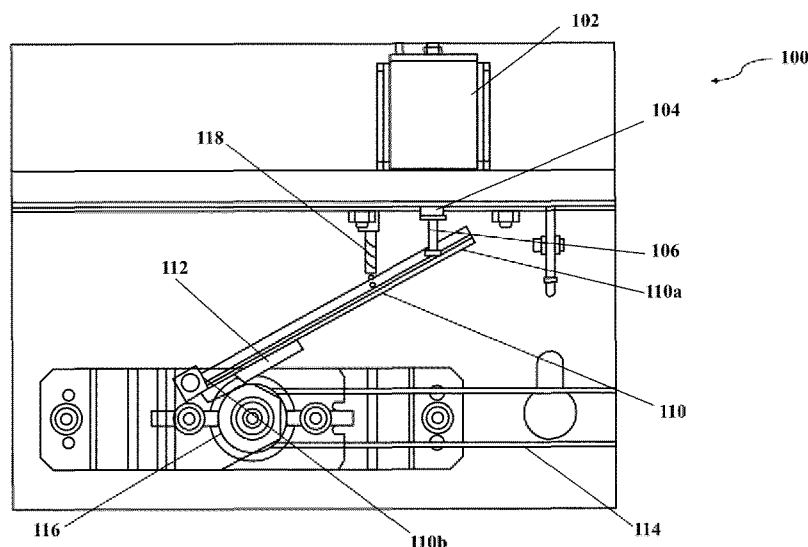


Figure 1A

(57) Abstract: A system for controlling an elevator car door having an elevator car door panel moving along a transom and the elevator car door panel being operatively coupled to a motor belt (114, 206, 316) capable of moving over a motor belt pulley (116, 208, 318) for opening and closing the elevator car door, the system comprising: a linear driving member (102, 302), provided on the transom, housing a plunger (104, 304) connected to one end of an elongated component (106, 310); a weight (306) placed upon the linear driving member (302) via a movable means (308) capable of applying a force on the plunger (304) such that the plunger (304) extrudes from the linear driving member (302); OR a spring (108) capable of applying a force on the plunger (104) such that the plunger (104) extrudes from the linear driving member (102); a lever arm (110, 202, 312) having a first end (110a, 202a, 312a) pivoted to a free end of the elongated component (106, 310) and a second end (110b, 202b, 312b) rotatably pivoted such that the second end (110b, 202b, 312b) of the lever

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arm (110, 202, 312) is located at a predefined distance from the motor belt pulley (116, 208, 318) and the lever arm (110, 202, 312) is further connected to a brake pad (112, 204, 314); wherein either due to the force applied on the plunger (104, 304) by the weight (306) or by the spring (108), a brake force is applied on the first end (110a, 202a, 312a) of the lever arm (110, 202, 312) through the free end of the elongated component (106, 310), and the lever arm (110, 202, 312) moves, such that the predefined distance is overcome, and the lever arm exerts an amplified brake force at the brake pad (112, 204, 314), wherein the brake force is used to brake the motor belt (114, 206, 316) in order to brake the movement of the elevator car door.

SYSTEM FOR CONTROLLING AN ELEVATOR CAR DOOR AND METHOD OF REFURBISHING THE ELEVATOR CAR DOOR

The present invention relates to a field of elevators, and particularly, it relates to a system for controlling an elevator car door. Furthermore, the present invention relates to a method for refurbishing the elevator car door.

Elevators are used very commonly by people as a mode of transport from one floor of a building to another, be it in multi-storey apartments, commercial complexes, hospitals, malls, restaurants, and the like. In conventional elevator systems, a door operating system driven by a linear induction motor is used. The door operating system driven by the linear induction motor and comprising a movable motor belt controls the opening and closing of doors during normal operation. However, there may be instances when power may shut off or the door operating system may malfunction while the elevator is at a floor level and the elevator is either closing or opening or is completely open. In such instances, the elevator car door may close with an uncontrollable speed and bang with a jamb. This can be particularly harmful for the passengers that may try to board or exit the elevator during such a situation as it may result in serious injuries. Further, the closing of the elevator car door with an uncontrollable speed may also damage the door operating system driven by the linear induction motor.

Elevator car door braking systems that overcome the inertia of the door movement and allow the door to close smoothly have been known to exist. Such systems generally employ a spring type electromagnetic brake that applies a frictional force on the movable motor belt by various means such as a brake shoe. However, such systems have certain limitations. For instance, since a frictional force to dampen the motion of the elevator car door is applied directly on the motor belt, it may result in wear and tear of the motor belt due to the contact of the brake shoe with the motor belt. Further, since the force required to dampen the motion of the elevator car door is relatively large, the electromagnet must be large enough to be capable of generating such a braking force.

Such an approach for elevator car door braking system is provided in JPH09242418A in which a spring type electromagnetic brake is arranged in a double-wing automatic door device for an

elevator car. When a power source of a door driving electric motor is cut off, an electromagnet in a spring type electromagnetic brake is released, and a brake shoe is pressed against a doorway frame by force of the spring, and the door moved by a weight is braked by frictional force.

5 Another alternative approach is provided in EP0841284A1 in which the elevator car door is driven by a linear motor and the movement of said elevator car door is synchronized by a cable extending over a first pulley having a contoured liner and a second pulley. The brake system is placed adjacent to the first pulley and includes a brake shoe attached to a solenoid. The solenoid includes a solenoid coil frame and a plunger having one end inserted into the solenoid coil frame and having
10 another end fixedly attached to the brake shoe. A spring is fitted over the plunger with one end of the spring pressing against the brake shoe and the other end of the spring pressing against the solenoid coil frame. During either a power failure or during the malfunction of the door operating control system, the solenoid becomes deactivated. In the deactivated mode, the solenoid coil frame releases the plunger. As the plunger is released, the spring expands and forces the brake shoe
15 forward against the pulley liner. The brake shoe contoured surface engages the contoured pulley liner and slows down the rotation of the pulley. As the rotation of the pulley is slowed down, the cable also is slowed down, thus slowing the movement of the elevator car door.

However, in both the approaches the braking force/the frictional force is applied directly on the
20 pulley contacting surface of the motor belt that moves about a pulley. This would, therefore, result in uneven wear and tear of the motor belt due to the contact of the brake shoe with the motor belt. Further, the solenoid or the electromagnet required would be large enough in order to be capable of applying a braking force on the motor belt so as to slow down the motion of the elevator car door.

25 There is therefore a need for a system with improved functionality that can apply enough braking force with a smaller linear driving member. Further, there is also a need for a system that can be incorporated with an existent elevator car door with minimal hardware incorporation.

Such needs may be met with the subject-matter of the independent claims. Advantageous embodiments are defined in the dependent claims and in the following specification.

According to a first aspect of the present invention, a system for controlling an elevator car door having an elevator car door panel moving along a transom and the elevator car door panel being
5 operatively coupled to a motor belt capable of moving over a motor belt pulley for opening and closing the elevator car door is disclosed. The system comprises a linear driving member, provided on the elevator transom, housing a plunger connected to one end of an elongated component. The system further comprises a weight placed upon the linear driving member via a movable means capable of applying a force on the plunger such that the plunger extrudes from the linear driving
10 member. Alternatively, the system may also comprise a spring capable of applying a force on the first end of the plunger such that the plunger extrudes from the linear driving member. The system further comprises a lever arm having a first end pivoted to a free end of the elongated component and a second end rotatably pivoted such that the second end of the lever arm is located at a predefined distance from the motor belt pulley. The lever arm is further connected to a brake pad.
15 Further, according to the first aspect of the present invention, either due to the force applied on the plunger by the weight or by the spring, a brake force is applied on the first end of the lever arm through the free end of the elongated component, and the lever arm moves, such that the predefined distance is overcome, and the lever arm exerts an amplified brake force at the brake pad that is used to brake the motor belt in order to brake the movement of the elevator car door.

20 According to a second aspect of the present invention, a method of refurbishing an elevator car door having an elevator car door panel moving along a transom and the elevator car door panel being operatively coupled to a motor belt capable of moving over a motor belt pulley for opening and closing the elevator car door is disclosed. The method comprises providing the system as
25 described in the first aspect of the present invention such that the lever arm is positioned in such a manner that the second end of the lever arm is rotatably pivoted at a predefined distance from the motor belt pulley. The lever arm is further connected to a brake pad, and the lever arm exerts an amplified brake force at the brake pad, such that the brake force is used to brake the motor belt in order to brake the movement of the elevator car door.

According to a third aspect of the present invention, a method for safely closing an elevator car door is disclosed. The elevator car door contains a system according to the first aspect of the invention. The method comprises removing electrical power from a linear driving member in case of a power drop, such that the lever arm exerts an amplified brake at the brake pad, such that the
5 brake force is used to brake the motor belt in order to brake the movement of the elevator car door. Ideas underlying embodiments of the present invention may be interpreted as being based, inter alia, on the following observations and recognitions.

The system proposed herein may be installed in new elevators or may be installed in conventional
10 elevators with minimal hardware inclusions. A conventional elevator car door comprises an elevator car door panel moving along a transom and the elevator car door panel operatively coupled to a motor belt capable of moving over a motor belt pulley in order to facilitate opening and closing of elevator car door. The motor belt may be a V-belt or a cog-belt made from different materials such as leather and reinforced rubber. The motor belt may either have a plain contact surface or
15 may have a contact surface of a special shape such as toothed and ribbed. The motor belt pulley may be fabricated from cast iron or mild steel or other suitable materials. The motor belt pulley or a second pulley, which is not driven by a motor, may contain a dedicated surface to be contacted by the brake pad, in order to brake or to align the brake pad.

20 The lever arm allows to magnify the force, which is applied at the one end of the elongated component, which is connected to the plunger, using the lever effect. A small force of the linear driving member can therefore press the brake pad strong enough to generate the required brake force or disengage the brake pad.

25 In a favorable embodiment of the system, the linear driving member comprises at least one of a solenoid or a pneumatic piston.

If the linear driving member is a solenoid, it further comprises a coil frame. The linear driving member houses a plunger having a first end and a second end. The second end of the plunger is
30 further connected to one end of an elongated component.

In a favorable embodiment of the system, the linear driving member is configured to perform at least one of: apply the brake force through the brake pad when an electrical power to the linear driving member is deactivated, and remove the applied brake force on the brake pad when the electrical power is activated.

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When electrical power is active, the plunger remains retracted within the linear driving member. The plunger is released from the linear driving member when the electrical power is deactivated or when the conventional elevator door operating system malfunctions, thereby applying a force on the first end of the lever arm connected at the free end of the elongated component whose one

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end is connected to the plunger.

In a favorable embodiment of the system, the lever arm is positioned with respect to the motor belt pulley in such a manner that a rotational axis of the lever arm is parallel to a rotational axis of the motor belt pulley.

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This allows the lever arm to be used as a force amplifier in such a manner that a brake force applied on the first end of the lever arm is amplified as it is transferred to the second end of the lever arm. In a favorable embodiment of the system, the brake pad is positioned nearer to the second end of the lever arm than the first end of the lever arm.

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The positioning of the brake pad nearer to the second end of the lever arm allows the amplified brake force to be applied on the motor belt through the brake pad. However, in another embodiment, the brake pad may also be placed at different positions between the first and second end of the lever arm.

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In a favorable embodiment of the system, the brake pad can be moved such that the motor belt is pressed between the brake pad and the motor belt pulley in order to cause the brake force.

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When electrical power to the elevator is active, the brake pad is not in contact with the motor belt. However, when the electrical power to the elevator is deactivated, due to the amplified brake force applied by the second end of the lever arm, the brake pad moves towards the motor belt in such a

manner that the motor belt becomes pressed between the motor belt pulley and the brake pad in order to brake the movement of the elevator car door.

In a favorable embodiment of the system, the brake pad comprises a friction material bound to its surface.

In one embodiment, the friction material comprises at least one of rubber, ethylene propylene diene monomer (EPDM) or polymer-based compounds. Such a friction material can be bound to the surface of the brake pad with glue that allows repetitive removal and reattachment of the friction material on the brake pad, thereby simplifying maintenance.

In a favorable embodiment of the system, the system further comprises an extension spring provided on the transom and configured to prevent deformation of the lever arm.

This allows to use also very strong linear driving members, which deliver more force than is required to lift the lever against the spring or the weight. The surplus force is then compensated by the extension spring. So, the extension spring works as a limiter for the movement upwards of the lever.

In a favorable embodiment of the system, the extension spring is further configured to restore the lever arm to its original position. The original position is a position of the lever arm in which the brake force is not exerted on the motor belt.

The extension spring provides support to the lever arm in such a manner that when the electrical power is deactivated and a force is applied on the first end of the lever arm by the plunger, the extension spring expands and allows a smooth motion of the lever arm. Further, when the electrical power becomes active, and the plunger retracts, the extension spring compresses to its original state, thereby allowing the lever arm to be restored smoothly to its original position without suffering any deformation. So the extension spring works as a damped limiter.

In a favorable embodiment of the present invention, the method further comprises performing by the linear driving member at least one of: applying the brake force through the brake pad when an electrical power to the linear driving member is deactivated and removing the applied brake force on the brake pad when the electrical power is activated.

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When electrical power is active, the plunger remains retracted within the linear driving member. The plunger is released from the linear driving member when the electrical power is deactivated or when the conventional elevator door operating system malfunctions, thereby applying a force on the first end of the lever arm connected at the free end of the elongated component whose one end is connected to the plunger.

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In a favorable embodiment of the present invention, the method further comprises positioning the lever arm with respect to the motor belt pulley in such a manner that a rotational axis of the lever arm is parallel to a rotational axis of the motor belt pulley.

This allows the lever arm to be used as a force amplifier in such a manner that a brake force applied on the first end of the lever arm is amplified as it is transferred to the second end of the lever arm.

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In the following, an embodiment of the system proposed herein will be described. The proposed system for controlling an elevator car door is incorporated in an elevator car door panel. The elevator car door panel comprises various existent components that are operatively coupled to a motor belt that is capable of moving over a motor belt pulley for facilitating opening and closing of the elevator car door.

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In one embodiment, the system for controlling an elevator car door comprises a linear driving member provided on the transom. In one embodiment, the linear driving member may be a solenoid comprising a coil frame. In another embodiment, the linear driving member may be a pneumatic piston, which is preferably controlled by a pneumatic switch. The linear driving member houses a plunger having a first end and a second end. The plunger remains retracted within the linear driving member when electrical power to elevator is active. The plunger is released from the linear driving member when the electrical power to the elevator is deactivated or when the conventional elevator door operating system malfunctions. The second end of the plunger is further connected to one end of an elongated component.

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The system further comprises a lever arm having a first end pivoted to a free end of the elongated component. The second end of the lever arm is rotatably pivoted at a predefined distance from the motor belt pulley such that a rotational axis of the lever arm is parallel to a rotational axis of the motor belt pulley. The lever arm is further connected to a brake pad in such a manner that the brake pad lies between the lever arm and the motor belt. However, when electrical power to the elevator car door is active, the brake pad is not in contact with the motor belt. Furthermore, according to one aspect of the invention, the brake pad is positioned nearer to the second end of the lever arm than the first end of the lever arm. However, the brake pad may also be placed at different positions between the first and second end of the lever arm. In one embodiment, the brake pad is fabricated from a friction material such as rubber, ethylene propylene diene monomer (EPDM) or polymer-based compounds.

In one embodiment, the system further comprises a spring capable of applying a force on the plunger in order to facilitate smooth linear motion of the plunger. The spring may be arranged in the system in accordance with one or more exemplary embodiments. For instance, according to one exemplary embodiment, the spring may be fitted around the plunger. According to another exemplary embodiment, the spring may be housed within the linear driving member. According to yet another exemplary embodiment, the spring may be placed adjacent to the linear driving member.

In another embodiment, the system further comprises a weight placed upon the linear driving member to apply a force on the plunger in order to facilitate smooth linear motion of the plunger.

During a power drop, or during a system malfunction, the plunger is released from the linear driving member. A force is applied on the first end of the plunger either by means of the spring or by the weight placed upon the linear driving member. The force applied on the first end of plunger is transferred to the first end of the lever arm pivoted at the free end of the elongated component. The force transferred to the first end of the lever arm acts as a brake force. Said brake force applied on the first end of the lever arm is transferred to the second end of the lever arm and since the lever arm acts as a force amplifier, said brake force is amplified. The amplified brake force is applied

on the motor belt via the brake pad, thereby damping the motion of the motor belt and allowing smooth motion of the elevator car door.

The system further can comprise an extension spring having a first end attached to the elevator door panel and a second end in contact with the lever arm. The extension spring is configured to restore or to help restore the lever arm to its original position, i.e., its position before the brake force was applied and prevent any deformation in the lever arm.

It shall be noted that possible features and advantages of embodiments of the invention are described herein partly with respect to a system for controlling an elevator car door and partly with respect to a method for refurbishing an elevator car door in order to incorporate the system for controlling the elevator car door. One skilled in the art will recognize that the features may be suitably transferred from one embodiment to another and features may be modified, adapted, combined and/or replaced, etc. in order to come to further embodiments of the invention.

In the following, advantageous embodiments of the invention will be described with reference to the enclosed drawings. However, neither the drawings nor the description shall be interpreted as limiting the invention.

Figures 1A and 1B show a side view of a system **100** for controlling an elevator car door before and after brake application respectively in accordance with an embodiment of the present disclosure;

Figure 2 shows a free body diagram **200** illustrating the working of a lever arm as a force amplifier in accordance with an embodiment of the present disclosure; and

Figure 3 shows a side view of a system **300** for controlling an elevator car door installed on a transom in accordance with an embodiment of the present disclosure.

The figures are only schematic and not to scale. Same reference signs refer to the same or similar features.

Figures 1A and 1B show a side view of a system **100** for controlling an elevator car door (herein after referred to as the “system **100**”) installed on a transom before and after brake application respectively in accordance with an embodiment of the present disclosure. In one embodiment, the system **100** may be installed in elevators with double doors or single door. In another embodiment, the system **100** may be installed in new elevators or may be installed in a conventional elevators with minimal hardware inclusions. It must be understood to a person skilled in the art that the system **100** may also be implemented in various environments, other than as shown in Fig. 1.

The system **100** comprises a linear driving member **102** housing a plunger **104** having a first end and a second end, a spring **108** capable of applying a force on the plunger **104**, an elongated component **106**, a lever arm **110** having a first end **110a** connected to a free end of the elongated component **106** and a second end **110b** rotatably pivoted at a predefined distance from a motor belt pulley **116**. The lever arm **110** is further connected to a brake pad **112** in such a manner that the brake pad lies between the lever arm **110** and a motor belt **114** capable of moving over the motor belt pulley **116** in order to facilitate opening and closing of the elevator car door. Further, a rotational axis of the lever arm **110** is parallel to a rotational axis of the motor belt pulley **116**. Furthermore, the brake pad **112** is positioned nearer to the second end **110b** of the lever arm **110** than the first end **110a** of the lever arm **110**. The system **100** further comprises an extension spring **118** having a first end attached to the transom and a second end in contact with the lever arm **110**. In the embodiment as depicted in figures 1A and 1B, the linear driving member **102** is taken to be a solenoid comprising a solenoid coil frame. It may however be understood that any other suitable means such as a pneumatic piston may be used as a linear driving member **102**.

As described above, the linear driving member **102** (herein after referred to as “solenoid **102**”) houses the plunger **104**. During a power-ON condition or in other words when electrical power to the elevator is active, the plunger **104** is in a retracted position within the solenoid **102** as shown in figure 1A and the extension spring **118** is in contact with the lever arm **110** in order to support the lever arm **110** in its current position. Further, when the electrical power to the elevator is active, the brake pad **112** is not in contact with the motor belt **114**, or in other words, is in a lifted-up state.

However, during a power outage, or due to a malfunction of the door operating system while the elevator is at a floor level, the solenoid **102** releases the plunger **104** as shown in figure 1B in

order to provide an emergency braking mechanism to prevent the elevator car door from closing with an uncontrollable speed. Further, as described above, the system **100** comprises a spring **108** that is capable of applying a force on the first end of the plunger **104** in order to allow smooth linear motion of the plunger **104**. In the exemplary embodiment, depicted in figure 1B, the spring **108** is fitted around the plunger **104**. However, it must be noted by a skilled person that the spring may be arranged in the system in accordance with one or more exemplary embodiments. For instance, according to another exemplary embodiment, the spring may be housed within the linear driving member **102** or arranged adjacent to the linear driving member **102**. In accordance, with the exemplary embodiment depicted in figures 1A and 1B, one end of the spring **108** is inserted into the solenoid **102** coil frame and a second end of the spring **108** is attached to the one end of the elongated component **106**. During the power outage or during the malfunction of the conventional door operating system, as the solenoid **102** releases the plunger **104**, the spring **108** expands allowing a smooth motion of the plunger **104** towards the elongated component **106**. The force applied by the plunger **104** on one end of the elongated component **106** is transferred to the first end **110a** of the lever arm **110** pivoted at the free end of the elongated component **106**. The lever arm **110** acts as a force amplifier as the rotational axis of the lever arm **110** is parallel to the rotational axis of the motor belt pulley **116** and therefore, magnifies the brake force as it is transferred from the first end **110a** of the lever arm **110** to its second end **110b**.

In accordance with another embodiment, the spring **108** may be housed within the linear driving member **102** with its one end connected to the first end of the plunger **104**. The second end of the plunger **104** is connected to one end of the elongated component **106**. During the power outage or during the malfunction of the conventional door operating system, the spring **108** applies a force on the first end of plunger **104** that is transferred to the first end of the lever arm **110** pivoted at the free end of the elongated component **106**. The lever arm **110** acts as a force amplifier as the rotational axis of the lever arm **110** is parallel to the rotational axis of the motor belt pulley **116** and therefore, magnifies the brake force as it is transferred from the first end **110a** of the lever arm **110** to its second end **110b**.

Further, the amplified brake force is applied to the motor belt **114** through the brake pad **112** that is placed between the lever arm **110** and the motor belt **114** that dampens the motion of the motor

belt **114**, thereby controlling the elevator car door. In such a situation, the brake pad **112** is in contact with the motor belt **114**.

The working of the lever arm **110** as a force amplifier is illustrated in figure 2 in accordance with an embodiment of the present invention. Figure 2 depicts an exemplary free body diagram **200** of the force applied (F_s) on the first end **202a** of the lever arm **202** and the force applied (N) by the brake pad **204** attached to the second end **202b** of the lever arm **202** on the motor belt **206**. The forces, F_s and N form a couple. As an exemplary embodiment, F_s is taken to be 15N and the perpendicular distance ($X1$) of F_s from the axis of rotation i.e., point A is taken to be 115.5mm. Similarly, the perpendicular distance ($X2$) of N from the axis of rotation i.e., point A is taken to be 21.5mm. Now, by applying the principle of moments, which states that anticlockwise moment is equal to the clockwise moment, i.e., $N \times X2 = F_s \times X1$, the force (N) applied by the brake pad **204** on the motor belt **206** is obtained to be 80.5N. Therefore, by using a lever **202** for a small magnitude of the applied force (F_s) a large braking force (N) can be obtained and is therefore, advantageous as it allows using a smaller sized solenoid, thereby reducing the bulkiness of the system **100** and making the system **100** space efficient. It must be noted by a skilled person that the values of F_s , $X1$, $X2$ and N as taken in figure 2 are exemplary and taken only for the sake of providing better understanding of the advantageous effect achieved through the use of the lever arm **110** and should not be construed as limiting to the scope of the invention.

Figure 3 shows a side view of a system **300** for controlling an elevator car door (herein after referred to as the “system **300**”) installed on a transom in accordance with an embodiment of the present disclosure. In one embodiment, the system **300** may be installed in elevators with double doors or single door. In another embodiment, the system **300** may be installed in new elevators or may be installed in a conventional elevator with minimal hardware inclusions. It must be understood to a person skilled in the art that the system **300** may also be implemented in various environments, other than as shown in Fig. 1.

The system **300** comprises a linear driving member **302** housing a plunger **304** having a first end and a second end, a weight **306** placed upon the linear driving member **302** by a movable means **308** and is capable of applying a force on the first end of the plunger **304**, an elongated component

310 with its one end connected to the second end of the plunger 304, a lever arm 312 having a first end 312a connected to a free end of the elongated component 310 and a second end 312b rotatably pivoted at a predefined distance from a motor belt pulley 318. The lever arm 312 is further connected to a brake pad 314 in such a manner that the brake pad 314 lies between the lever arm 110 and a motor belt 316 capable of moving over the motor belt pulley 318 in order to facilitate opening and closing of the elevator car door. Further, a rotational axis of the lever arm 312 is parallel to a rotational axis of the motor belt pulley 318. Furthermore, the brake pad 314 is positioned nearer to the second end 312b of the lever arm 312 than the first end 312a of the lever arm 312. The system 300 further comprises an extension spring 320 having a first end attached to the transom and a second end in contact with the lever arm 312. In the embodiment as depicted in figure 3, the linear driving member 302 is taken to be a solenoid comprising a solenoid coil frame. It may however be understood that any other suitable means such as a pneumatic piston may be used as a linear driving member 302.

As described above, the linear driving member 302 (herein after referred to as “solenoid 302”) houses a plunger 304. During a power-ON condition or in other words when electrical power to the elevator is active, the plunger is in a retracted position within the solenoid 302 as shown in figure 3 and the extension spring 320 is in contact with the lever arm 312 in order to support the lever arm 312 in its current position. Further, when the electrical power to the elevator is active, the brake pad 314 is not in contact with the motor belt, or in other words, is in a lifted-up state. However, during a power outage, or due to a malfunction of the door operating system while the elevator is at a floor level, the solenoid 302 releases the plunger 304 (not shown, similar to figure 1B) in order to provide an emergency braking mechanism to prevent the elevator car door from closing with an uncontrollable speed. Further, as described above, the system 300 comprises the weight 306 that is capable of applying a force on the first end of the plunger 304 by the movable means 308 in order to allow smooth linear motion of the plunger 304.

Since the second end of the plunger 304 is connected to one end of the elongated component 310, whose free end is further connected to the first end 312a of the lever arm 312, the force applied on the plunger 304 is transferred to the first end 312a of the lever arm 312 as a brake force. The lever arm 312 acts as a force amplifier as the rotational axis of the lever arm 312 is parallel to the

rotational axis of the motor belt pulley **318** and therefore, magnifies the brake force as it is transferred from the first end **312a** of the lever arm **312** to its second end **312b**.

Further, the amplified brake force is applied to the motor belt **316** through the brake pad **314** that is placed between the lever arm **312** and the motor belt **316** that dampens the motion of the motor belt **316**, thereby controlling the elevator car door. In such a situation, the brake pad **314** is in contact with the motor belt **316**.

The embodiment of the system **300** that uses the weight **306** to apply a force on the plunger **304** (as depicted in figure 3) offers additional advantages. For instance, the force applied on the plunger **304** by the weight **306** remains constant that allows for a desired braking force to be obtained conveniently.

A description of an embodiment with several components operatively coupled with each other does not imply that all such components are required. On the contrary, a variety of optional components are described to illustrate the wide variety of possible embodiments of the invention.

When a single device or article is described herein, it will be clear that more than one device/article (whether they cooperate) may be used in place of a single device/article. Similarly, where more than one device or article is described herein (whether they cooperate), it will be clear that a single device/article may be used in place of the more than one device or article or a different number of devices/articles may be used instead of the shown number of devices or programs. The functionality and/or the features of a device may be alternatively embodied by one or more other devices which are not explicitly described as having such functionality/features. Thus, other embodiments of the invention need not include the device itself.

Finally, the language used in the specification has been principally selected for readability and instructional purposes, and it may not have been selected to delineate or circumscribe the inventive subject matter. It is therefore intended that the scope of the invention be limited not by this detailed description, but rather by any claims that issue on an application based here on. Accordingly, the embodiments of the present invention are intended to be illustrative, but not limiting, of the scope of the invention, which is set forth in the following claims.

While various aspects and embodiments have been disclosed herein is related to elevators, aspects of this disclosure may also be applied in connection with other types of conveyance or transportation devices, such as a dumbwaiter, an escalator, a moving sidewalk, a wheelchair lift and
5 the like which will be apparent to those skilled in the art. The various aspects and embodiments disclosed herein are for purposes of illustration and are not intended to be limiting, with the true scope being indicated by the following claims.

We Claim:

1. A system for controlling an elevator car door having an elevator car door panel moving along a transom and the elevator car door panel being operatively coupled to a motor belt (114, 206, 316) capable of moving over a motor belt pulley (116, 208, 318) for opening and closing the elevator car door, the system comprising:
 - 5 a linear driving member (102, 302), provided on the transom, housing a plunger (104, 304) connected to one end of an elongated component (106, 310);
 - a weight (306) placed upon the linear driving member (302) via a movable means (308) capable of applying a force on the plunger (304) such that the plunger (304) extrudes from the linear driving member (302); OR
 - a spring (108) capable of applying a force on the plunger (104) such that the plunger (104) extrudes from the linear driving member (102);
 - a lever arm (110, 202, 312) having a first end (110a, 202a, 312a) pivoted to a free end of the elongated component (106, 310) and a second end (110b, 202b, 312b) rotatably pivoted, such that the second end (110b, 202b, 312b) of the lever arm (110, 202, 312) is located at a predefined distance from the motor belt pulley (116, 208, 318), and the lever arm (110, 202, 312) is further connected to a brake pad (112, 204, 314),
 - wherein either due to the force applied on the plunger (304, 104) by the weight (306) or by the spring (108), a brake force is applied on the first end (110a, 202a, 312a) of the lever arm (110, 202, 312) through the free end of the elongated component (106, 310), and the lever arm (110, 202, 312) moves, such that the predefined distance is overcome, and the lever arm (110, 202, 312) exerts an amplified brake force at the brake pad (112, 204, 314), wherein the brake force is used to brake the motor belt (114, 206, 316) in order to brake the movement of the elevator car door.
2. The system as claimed in claim 1, further comprising an extension spring (118, 320) provided on the transom and configured to prevent deformation of the lever arm (110, 202, 312)).
3. The system as claimed in claim 2, wherein the extension spring (118, 320) is further configured to restore the lever arm (110, 202, 312) to its original position, wherein in the original position the brake force is not exerted on the motor belt (114, 206, 316).

4. The system as claimed in claim 1, wherein the linear driving member (102, 302) comprises at least one of a solenoid or a pneumatic piston.
5. The system as claimed in claim 1, wherein the lever arm (110, 202, 312) can be positioned with respect to the motor belt pulley (116, 208, 318) in such a manner that a rotational axis of the lever arm (110, 202, 312) is parallel to a rotational axis of the motor belt pulley (116, 208, 318).
6. The system as claimed in claim 1, wherein the brake pad (112, 204, 314) comprises a friction material bound to its surface.
7. The system as claimed in claim 1, wherein the brake pad (112, 204, 314) is positioned nearer to the second end (110b, 202b, 312b) of the lever arm (110, 202, 312) than the first end (110a, 202a, 312a) of the lever arm (110, 202, 312).
8. The system as claimed in claim 1, wherein the brake pad (112, 204, 314) can be moved such that the motor belt (114, 206, 316) is pressed between the brake pad (112, 204, 314) and the motor belt pulley (116, 208, 318) in order to cause the brake force.
9. The system as claimed in claim 1, wherein the linear driving member (102, 302) is configured to perform at least one of:
 - apply the brake force through the brake pad (112, 204, 314) when an electrical power to the linear driving member (102, 302) is deactivated, and
 - remove the applied brake force on the brake pad (112, 204, 314) when the electrical power is activated.
10. A method for refurbishing an elevator car door having an elevator car door panel moving along a transom and the elevator car door panel being operatively coupled to a motor belt (114, 206, 316) capable of moving over a motor belt pulley (116, 208, 318) for opening and closing the elevator car door, the method comprising providing the system as claimed in claim 1, wherein:

the lever arm (110, 202, 312) is positioned such that the second end (110b, 202b, 312b) of the lever arm (110, 202, 312) is rotatably pivoted at a predefined distance from the motor belt pulley (116, 208, 318), and the lever arm (110, 202, 312) is further connected to a brake pad (112, 204, 314), and

the lever arm (110, 202, 312) exerts an amplified brake force at the brake pad (112, 204, 314), wherein the brake force is used to brake the motor belt (114, 206, 316) in order to brake the movement of the elevator car door.

11. The method as claimed in claim 10, further comprises performing by the linear driving member (102, 302) at least one of:

applying the brake force through the brake pad (112, 204, 314) when an electrical power to the linear driving member (102, 302) is deactivated, and

removing the applied brake force on the brake pad (112, 204, 314) when the electrical power is activated.

12. The method as claimed in claim 10, comprising positioning the lever arm (110, 202, 312) with respect to the motor belt pulley (116, 208, 318) in such a manner that a rotational axis of the lever arm (110, 202, 312) is parallel to a rotational axis of the motor belt pulley (116, 208, 318).

13. A method for safely closing an elevator car door, wherein the elevator car door contains a system according to one of the claims 1 – 9, the method comprising:

removing electrical power from a linear driving member (102, 302) in case of a power drop, such that the lever arm (110, 202, 312) exerts an amplified brake force at the brake pad (112, 204, 314), wherein the brake force is used to brake the motor belt (114, 206, 316) in order to brake the movement of the elevator car door.

1 / 4

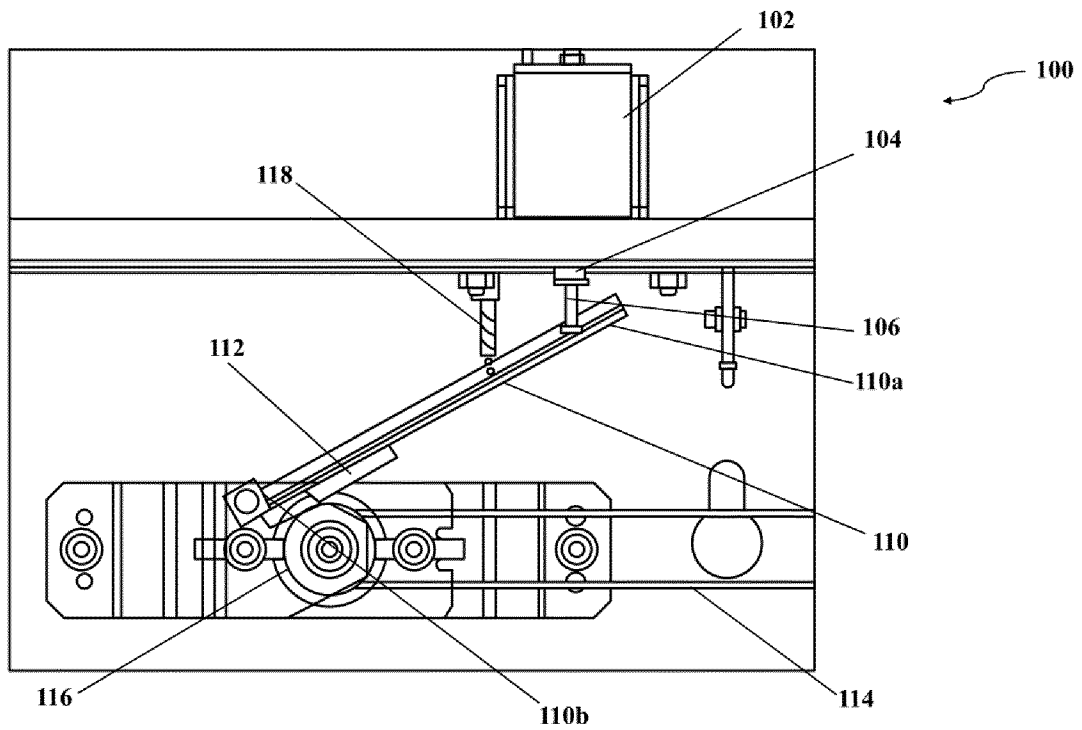


Figure 1A

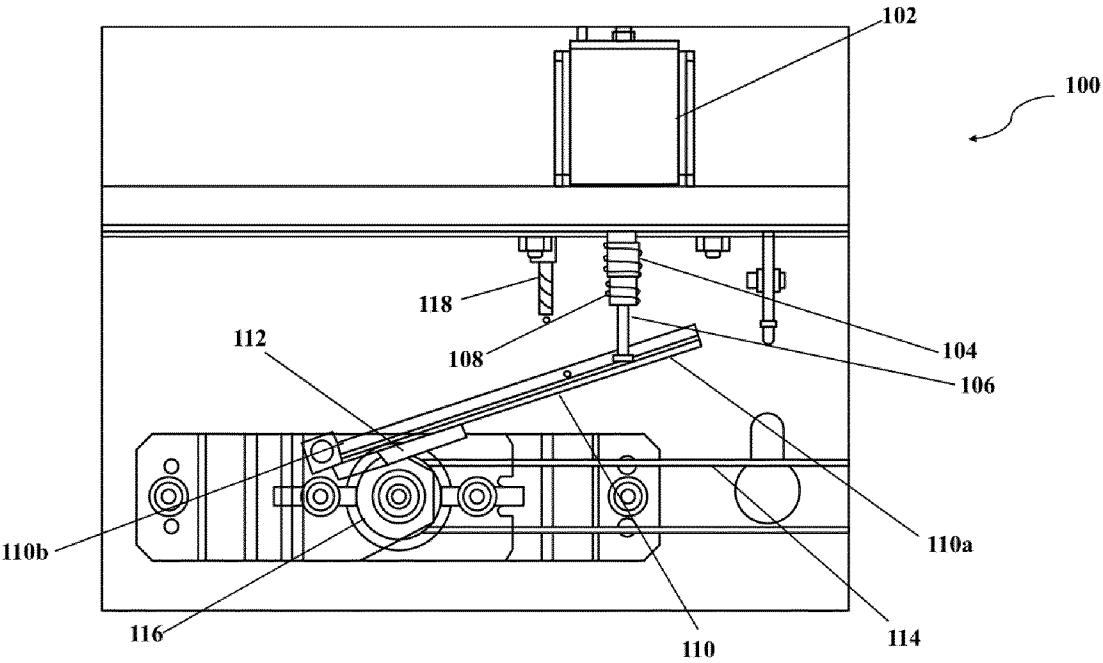


Figure 1B

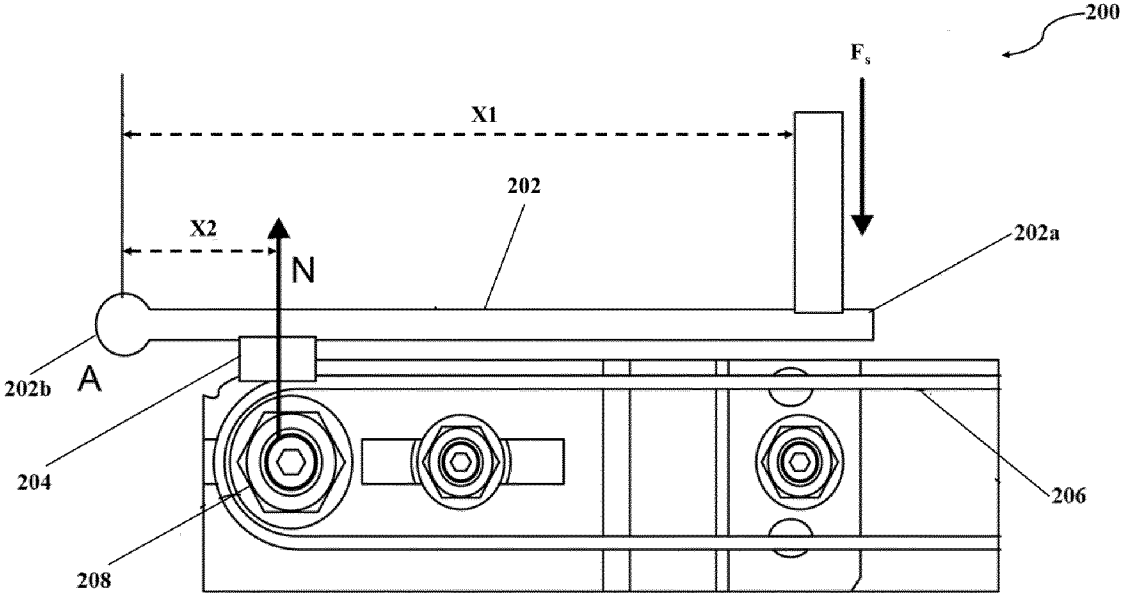


Figure 2

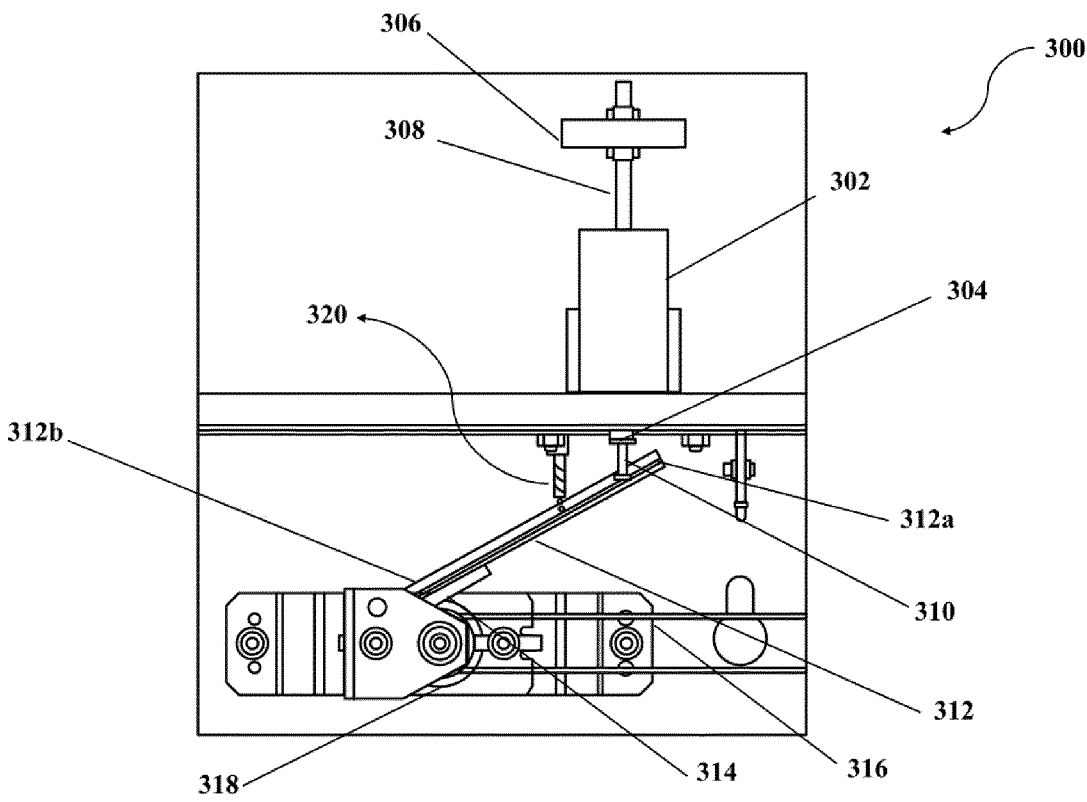


Figure 3

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2022/056590

A. CLASSIFICATION OF SUBJECT MATTER

INV. B66B13/02 B66B19/00 B66B13/08
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B66B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 841 284 A1 (OTIS ELEVATOR CO [US]) 13 May 1998 (1998-05-13) cited in the application column 2, line 26 - column 2, line 43; figures 1-3 -----	1-13
A	JP H09 242418 A (TOSHIBA CORP) 16 September 1997 (1997-09-16) cited in the application figures 1-6 -----	1-13
A	CN 201 458 475 U (LIANG YU) 12 May 2010 (2010-05-12) figure 1 -----	1-13
A	EP 0 927 697 A1 (OTIS ELEVATOR CO [US]) 7 July 1999 (1999-07-07) paragraph [0008] - paragraph [0009]; figures 1-4 -----	1-13



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of the actual completion of the international search

10 June 2022

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2022/056590

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