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(54) **ELEVATOR CAR DOOR LOCKING APPARATUS**

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Description

[Technical Field]

[0001] The present invention relates to an apparatus to mechanically lock the door of an elevator car outside the landing zone, the unlocking zone, independent of the hoistway door motion. Automatic elevator doors are opened by the door drive usually located on the elevator car. In case the car stops between floors, e.g. due to a power failure, passengers force the car doors manually to open. A car door locking apparatus is applied in order to prevent the car doors from being manually opened.

[Background Art]

[0002] An elevator car door locking apparatus according to the preamble of claim 1 is already known e.g. from JP-A-10045360.

[0003] Conventional mechanical car door locking apparatuses are operated by contact between a roller on the car and ramps mounted in the elevator hoistway at each floor. This had the disadvantage that the roller contacted the ramp of each floor during car travel, causing part wear and noise.

[0004] A solution for this problem is to secure a clearance between the roller and the ramp during car travel by adding a manual handle to manually provide this clearance between the ramp and the roller as described in Patent US 3659677, Patent GB 1047977 or Patent GB 1265989. The disadvantage of this solution is that the doors are no longer automatically operated, but manual operation is required to unlock a door locking mechanism even at a landing.

[0005] Another solution was found in including some electrical actuator to keep clearance between the roller and the ramp during car travel as described in Patent DE 598407, Patent GB 2206331 or Patent EP 0426057. The disadvantage of electrical actuators is that power is required for locking operation.

[0006] In view of this, to keep the clearance between the roller and the ramp during car travel, it has been proposed to use the motion of a coupling drive mechanism between the car doors and hoistway doors as described in Patent EP 0709334.

[0007] As shown in Fig. 28, the conventional door locking apparatus disclosed in Patent EP 0709334 has the lock 31, the ramp 30 at each floor in the hoistway, and the link device 32 for actuating the lock 31. The lock 31 and the link device 32 are mounted to the overhead support beam 36. The link device 32 has the actuation lever 33. With the car positioned at a floor, the actuation lever 33 infringes with the ramp 30 through the roller 34. The actuation lever 33 is rotatably mounted to the link device 32 through the movable pivot 35. The door coupling portion 38 is mounted to the hanger plate 37, with the coupling element 40 coupled to the vane 39 of the door coupling portion 38.

[0008] The motion of the hanger plate 37 is transferred to the link device 32 via the vane 39 and the coupling element 40 before the door reaches its closed position, actuating the lock 31 by the drive force of the door actuating mechanism.

[0009] In the conventional car door locking apparatus according to Patent EP 0709334, the actuation of the lock 31 is dependent on the door drive. This involves a disadvantage that modification of the existing door drive coupling mechanism is necessary to add the additional function of the car door locking.

[Disclosure of the Invention]

[0010] An object of this invention is to provide a mechanical car door locking apparatus, automatically operated by the door drive but independent of the door drive coupling mechanism.

[0011] This invention relates to an elevator car door locking apparatus for locking a sliding door of a car of an elevator when the car is outside a landing zone, including: a ramp mounted in a hoistway at each landing position; and a locking mechanism portion mounted on the car. The locking mechanism portion includes: a static latch which moves along with the door; a first cam which moves along with the door; and a lever mechanism mounted to the car. The lever mechanism includes: a slider rod whose one end is mounted to the car so as to be pivotable around a first hinge point, the slider rod being adapted to assume a locked position where the slider rod extends horizontally in a door opening direction and an unlocked position where the slider rod has been pivoted upward from the locked position by a predetermined angle; a latch arranged integrally with the slider rod such that the latch can engage with the static latch when the slider rod is in the locked position and that the latch does not engage with the static latch when the slider rod is in the unlocked position; a slider arranged so as to move along the slider rod; a first roller arranged below a position between the first hinge point and the slider and adapted to be rotatable around a second hinge point; a first lever mounted such that its one end is pivotable around the first hinge point and its other end is pivotable around the second hinge point, the first lever being suspended between the first and second hinge points; a second lever mounted such that its one end is pivotable around the second hinge point and its other end is mounted to the slider so as to be pivotable around a third hinge point, the second lever being suspended between the second and third hinge points; and a second roller mounted to the slider so as to be rotatable around the third hinge point. When, with the car positioned outside the landing zone, motion of the first cam moving along with opening motion of the door is transferred to the first roller, the slider moves in conjunction with motion of the first cam along the slider rod in a door opening direction to keep the slider rod in the locked position, and the static latch moving along with the opening motion of the door engages with the latch,

disabling opening operation of the door. Further, when, with the car positioned inside the landing zone, motion of the first cam moving along with opening motion of the door is transferred to the first roller, the slider moves in conjunction with motion of the first cam along the slider rod in a door opening direction to cause the second roller to infringe with the ramp, and subsequent motion of the first cam causes the slider rod to pivot from the locked position to the unlocked position with a result that the static latch passes the latch without engaging with the latch, enabling opening operation of the door.

[0012] The locking apparatus according to this invention is totally independent of the drive mechanism of the hoistway doors, whereby any type of hoistway door coupling mechanism can be applied. Furthermore, a mechanical lever mechanism with no electrically operated actuator is adopted, whereby no electrical power is required to effect locking operation.

[Brief Description of the Drawings]

[0013]

Fig. 1 is a schematic view schematically showing an elevator car door locking apparatus according to Embodiment 1 of this invention in the state where a car is at a landing with a closed door.

Fig. 2 is a front view showing the elevator car door locking apparatus according to Embodiment 1 of this invention in the state where the car is at a landing with a closed door.

Fig. 3 is a side view showing the elevator car door locking apparatus according to Embodiment 1 of this invention in the state where the car is at a landing with a closed door.

Fig. 4 is a perspective view showing the elevator car door locking apparatus according to Embodiment 1 of this invention to explain how a ramp is mounted.

Fig. 5 is a side view showing the elevator car door locking apparatus according to Embodiment 1 of this invention to explain how the ramp is mounted.

Fig. 6 is a front view for explaining how the ramp is mounted in the elevator car door locking apparatus according to Embodiment 1 of this invention.

Fig. 7 is a schematic view schematically showing the elevator car door locking apparatus according to Embodiment 1 of this invention in the state where a car door is partly opened inside an unlocking zone until a roller touches the ramp.

Fig. 8 is a front view showing the elevator car door locking apparatus according to Embodiment 1 of this invention in the state where the elevator door is partly opened inside the unlocking zone until the roller touches the ramp.

Fig. 9 is a side view showing the elevator car door locking apparatus according to Embodiment 1 of this invention in the state where the car door is partly opened inside the unlocking zone until the roller touches the ramp.

Fig. 10 is a schematic view schematically showing the elevator car door locking apparatus according to Embodiment 1 of this invention in the state where the car door is partly opened inside the unlocking zone with unlocked latch.

Fig. 11 is a front view showing the elevator car door locking apparatus according to Embodiment 1 of this invention in the state where the car door is partly opened inside the unlocking zone with unlocked latch.

Fig. 12 is a schematic view schematically showing the elevator car door locking apparatus according to Embodiment 1 of this invention in the state where the car door is partly opened outside the unlocking zone.

Fig. 13 is a front view showing the elevator car door locking apparatus according to Embodiment 1 of this invention in the state where the car door is partly opened outside the unlocking zone.

Fig. 14 is an enlarged view of a portion A of Fig. 13.

Fig. 15 is a side view showing the elevator car door locking apparatus according to Embodiment 1 of this invention in the state where the car door is partly opened outside the unlocking zone.

Fig. 16 is a front view showing an elevator car door locking apparatus according to Embodiment 2 of this invention in a default position.

Fig. 17 is a side view showing the elevator car door locking apparatus according to Embodiment 2 of this invention in the default position.

Fig. 18 is a front view showing the elevator car door locking apparatus according to Embodiment 2 of this invention in a state where the car door is partly opened outside the unlocking zone.

Fig. 19 is a side view showing the elevator car door locking apparatus according to Embodiment 2 of this invention in the state where the car door is partly opened outside the unlocking zone.

Fig. 20 is a front view showing an elevator car door locking apparatus according to Embodiment 3 of this invention during door closing motion.

Fig. 21 is an enlarged view of a portion B of Fig. 20.

Fig. 22 is a side view showing the elevator car door locking apparatus according to Embodiment 3 of this invention during door closing motion.

Fig. 23 is a front view showing the elevator car door locking apparatus according to Embodiment 3 of this invention to explain a cam mounting structure.

Fig. 24 is a side view showing the elevator car door locking apparatus according to Embodiment 3 of this invention to explain the cam mounting structure.

Fig. 25 is a schematic view schematically showing an elevator car door locking apparatus according to Embodiment 4 of this invention.

Fig. 26 is a schematic view schematically showing an elevator car door locking apparatus according to Embodiment 5 of this invention.

Fig. 27 is a schematic view schematically showing an elevator car door locking apparatus according to Embodiment 6 of this invention.

Fig. 28 is a structural view schematically showing a conventional elevator car door locking apparatus.

[Best Mode for carrying out the Invention]

[0014] The basic concept and operation of this invention will hereinafter be explained by the aid of an application embodiment by referring to the drawings.

[Embodiment 1]

[0015] Figure 1 shows the basic concept of the locking apparatus of this invention. The locking apparatus can be divided into three groups of parts: the parts mounted to the door hanger 10; the parts mounted to the car support frame (not shown); and the parts mounted static in the hoistway (not shown). The parts mounted to the door hanger 10 are a static latch 16 and a first cam 9. A ramp 1 is mounted at each landing static in the hoistway. The ramp 1 is positioned next to the door entrance. Further, by positioning the ramp 1 behind the jamb of the door frame, appearance is not negatively influenced even in case of glass doors or a glass hoistway.

[0016] A lever mechanism 25 is mounted to the car support frame, and has a first hinge point 15 static on the car support frame. This lever mechanism 25 is basically composed of three levers. Two levers, a first lever 11 and a slider rod 3, are hinge-connected to the first hinge point 15. A first roller 7 is mounted to the opposite end of the first lever 11 on the first hinge 15 side at a second hinge point 8. A slider 4 is moved along a slider rod 3. The second roller 5 is mounted to the slider 4 at a third hinge point 17. One end of the remaining second lever 6 is hinge-connected to the second hinge point 8, and the opposite side is hinge-connected to the third hinge point 17. A latch 2 is mounted to the slider rod 3.

[0017] Here, the specific construction of the locking apparatus is described based on Figs. 2 through 6. Figs. 2 and 3 show a state in which the car is at a landing with the door closed.

[0018] Though not shown, the door hanger 10 is mounted to a door rail disposed on an upper outer wall of the car entrance so as to free to move in the door opening and closing direction. Further, a bracket 19 is mounted to the door hanger 10, and a cam bracket 18 is mounted to the door hanger 10 so as to be positioned below the bracket 19.

[0019] The static latch 16 is mounted on top of the bracket 19. Further, although not shown, shims are applied in between the static latch 16 and the bracket 19, making it possible to easily adjust the height of the static latch 16 for proper locking distance. The first cam 9 has a pair of inclined parts 9a and 9c, and a flat part 9b connecting between the pair of inclined parts 9a and 9c. The first cam 9 is mounted on top of the cam bracket 18, with the inclined part 9a facing the direction of door opening and the flat part 9b being horizontal. Further, shims 24 are applied between the first cam 9 and the cam bracket 18, enabling easy adjustment of the height of the first cam 9. Further, slots 18a are provided in the cam bracket 18 for easy adjustment of the horizontal position of the first cam 9.

[0020] A hinge block 12 is hinge-connected at the first hinge point 15. The slider rod 3 and the latch 2 are mounted to the hinge block 12. The slider 4 rests in default position where the slider 4 contacts the hinge block 12. In this default position the latch 2 and the slider rod 3 are at a horizontal position, and a clearance (standard set gap) is present between the ramp 1 and the second roller 5 mounted to the slider 4. In this way, no contact noise of second roller 5 and the ramp 1 will occur during car travel when the slider 4 is at the default position. When the slider 4 is at the default position, a first cam 9 is mounted such that the first roller 7 just contacts the inclined part 9a of the first cam 9. A switch contact 14 is mounted to the latch 2 and contacts a switch 13 if the latch is in horizontal position as shown. The shown switch contact 14 and the switch 13 are just an example. Other types of safety switches can be applied in a similar way.

[0021] A ramp bracket 27 is fastened onto a landing door frame (not shown) with bolts passed through slots 27a. The ramp 1 is fastened onto the ramp bracket 27 with bolts passed through slots 27b. The shape of the ramp bracket 27 depends of course on the landing door frame shape and is not limited to the design shown in Figs. 4 through 6. Further, the position of the ramp 1 can be adjusted in two directions corresponding to the longitudinal directions of the elongated slots 27a, 27b formed in the ramp bracket 27, that is, in the direction parallel to the door motion for adjusting the gap between the first roller 7 and the ramp 1 and in the direction perpendicular to the door motion for adjusting the clearance between static parts in the hoistway and the parts moving along with the car during car travel. Further, the vertical position of the ramp 1 can be adjusted if necessary by providing shims between the ramp bracket 27 and the landing door frame.

[0022] First, the operation of the locking apparatus of this invention inside the unlocking zone (inside the landing zone) is described.

[0023] Figs. 7 though 9 show the locking apparatus when the door is partly opened inside the unlocking zone until the second roller 5 touches the ramp 1. In this case, the door is opened over a distance equal to the default gap between the second roller 5 and the ramp 1 in the case of a closed door. The first cam 9 moves together with the door in the rightward direction as seen in Figs. 7 and 8 and pushes against the first roller 7. Consequently the hinge-connected first lever 11 has to rotate counterclockwise as seen in Figs. 7 and 8. This rotation of the first lever 11 moves the second hinge point 8. The second lever 6 shares the same second hinge point 8. Due to the fixed length of the second lever 6, the other hinge

point of the second lever 6, the third hinge point 17, has to move as well. The slider 4 sharing the same third hinge point 17 is pressed on by the second lever 6 with a force F_R. The vertical component of the force F_R, a force F_{RV}, creates a counterclockwise torque around the first hinge point 15 which is equal to F_{RV} multiplied by the distance between the third hinge point 17 and the first hinge point 15. A gravity force F_{COM} of the whole lever mechanism 25 creates a clockwise torque around the first hinge point 15 which is equal to F_{COM} multiplied by the horizontal distance between the center of mass (COM) of the lever mechanism 25 and the first hinge point 15. The mass and COM of the lever mechanism 25 are arranged such that the clockwise torque is greater than the counterclockwise torque. Thus, instead of the latch 2 rotation, the slider 4 with the attached second roller 5 will move along the slider rod 3 towards the ramp 1 until the second roller 5 contacts the ramp 1. That is, the latch 2 and the slider rod 3 are held in their locked positions until the second roller 5 contacts the ramp 1.

[0024] Here, as shown in Fig. 8, the slider 4 is moved away from the hinge block 12. Further, no clearance remains between the second roller 5 and the ramp 1.

[0025] Figs. 10 and 11 show the locking apparatus when the car door is partly opened inside the unlocking zone with the latch unlocked position.

[0026] The second roller 5 comes into contact with the ramp 1, preventing further horizontal motion of the third hinge point 17. If the inclined part 9a of the first cam 9 continues to push against the first roller 7 during continued door opening motion, the first lever 11 continues to rotate until the first roller 7 rides onto the flat part 9b on the top of the first cam 9 from the inclined part 9a. Due to the construction of the lever mechanism 25, the third hinge point 17 has no other option than to move upward. The slider 4, sharing the same third hinge point 17, is forced to move upward as well. The slider rod 3 is hinge-connected to the hinge point 15 static positioned on the car support frame. Accordingly, upward motion of the slider 4 results in counterclockwise rotation of the slider rod 3 around the first hinge point 15. The latch 2 linked to the slider rod 3 will rotate counterclockwise as well. As a result, the latch 2 and the slider rod 3 rotate upward by a predetermined angle from the locked position to the unlocked position so that the static latch 16 can pass the latch 2.

[0027] At this time, as shown in Fig. 11, the switch contact 14 no longer contacts the switch 13.

[0028] The first roller 7 remains on the flat portion 9b of the first cam 9 until the static latch 16 and the bracket 19 have passed the latch 2 sufficiently to prevent infringements between those parts. That is, the latch 2 and the slider rod 3 are held in the unlocked position. Then, as the first roller 7 moves to the inclined part 9c via the flat part 9b, the latch 2 and the slider rod 3 are returned to the locked position from the unlocked position.

[0029] Next, operation of the locking apparatus of this invention outside the unlocking zone (outside the landing zone) is described.

[0030] Figs. 12 through 15 shows a state when the door is partly opened outside the unlocking zone. In this state, for example, passengers open the door manually in between floors.

[0031] As shown in Figs. 10 and 11, with the car door positioned inside the unlocking zone, the second roller 5 contacts the ramp 1 during continued door opening motion, causing the third hinge point 17 to move upward.

[0032] However, when, as shown in Figs. 12 through 15, the car door is outside the unlocking zone, the ramp 1 does not exist, so the third hinge point 17 does not move upward during the continued door opening motion. In that case the slider 4 will continue to move due to the horizontal component of the force F_R, a force F_{RH}, along the slider rod 3 until the static latch 16 hooks behind the latch 2. That is, the latch 2 and the slider rod 3 are held in their locked positions. Because the static latch 16 is mounted to the door hanger 10, the door hanger 10 can not continue to open further once the static latch 16 thus hooks behind the latch 2.

[Embodiment 2]

[0033] Referring to Figs. 16 through 19, the bracket 22 has a horizontal flange 22a and a vertical flange 22b and is mounted on top of the slider 4. A bracket 21 has a first flange 21a and a second flange 21b that are horizontally bent at two different levels, and is mounted to a lever assembly support plate 26. The first flange 21a nearest to the lever assembly support plate 26 is at the same horizontal level as the horizontal flange 22a. Further, as shown in Fig. 16, in the default position with the slider 4 positioned nearest to the hinge block 12, only a negligible horizontal gap is present between the first flange 21a and the horizontal flange 22a. Further, the vertical flange 22b is positioned between the first flange 21a and the second flange 21b.

[0034] When the door is opened with the slider 4 positioned in the default position, the first roller 7 is pushed upward along the inclined part 9a of the first cam 9. This first roller 7 motion creates a force for rotating the latch 2 counterclockwise around the first hinge point 15 as seen in Fig. 16. When the latch 2 starts to rotate due to this force, the horizontal flange 22a of the bracket 22 infringes almost directly with the first flange 21a. The reaction force created by the horizontal flange 22a infringing with the first flange 21a acts on the bracket 22, moving the slider 4 along the slider rod 3 in the rightward direction as seen in Fig. 16. In case the slider 4 sticks to the slider rod 3 due to some cause, the above-mentioned reaction force acts to release the slider 4 from the slider rod 3 so that the slider 4 is able to move without rotating the latch 2. Here, the first flange 21a and the horizontal flange 22a constitute slider motion generating means.

[0035] Then, the slider 4 moves along the slider rod 3 to the default latch position shown in Figs. 18 and 19. In this default latch position, the vertical flange 22b is posi-

tioned directly below the second flange 21b, and there is a small vertical gap between the flanges 21b and 22b. Here, this default latch position corresponds to the last part of the slider 4 motion path until the static latch 16 infringes with the latch 2 from its fully closed position. The second flange 21b and the vertical flange 22b constitute pivot stopping means.

[0036] Note that, otherwise, Embodiment 2 is of the same construction as Embodiment 1 described above.

[0037] In normal door opening operation inside the unlocking zone, the second roller 5 infringes with the ramp 1 before the vertical flange 22b reaches the second flange 21b. The latch 2 can thus rotate to unlock.

[0038] Further, when the door is opened outside the unlocking zone, the vertical flange 22b moves underneath the second flange 21b. From that moment the latch 2 rotation is restricted due to the infringement between the vertical flange 22b and the second flange 21b. Then, the static latch 16 moves until it hooks behind the latch 2, preventing further door opening operation. The worst case installation and car inclination conditions are considered in setting the gap between the flanges 21b and 22b.

[Embodiment 3]

[0039] Referring to Figs. 20 through 24, the first cam 9 is mounted on top of the cam bracket 18. Further, a second cam 20 is mounted on top of the first cam 9. Shims 24 are applied in between the first cam 9 and the cam bracket 18 to adjust the vertical positions of the first and second cams 9 and 20 simultaneously. The combination of the first and second cams 9 and 20 is such that the lever mechanism 25 does not get clamped between the first and second cams 9 and 20 during door motion.

[0040] Note that, otherwise, Embodiment 3 is of the same construction as Embodiment 2 described above.

[0041] During door closing motion, the first roller 7 rides onto the flat part 9b of the first cam 9 from the inclined part 9c thereof, pivoting the slider rod 3 from the locked position to the unlocked position. The first roller 7 then moves along the flat part 9b so the slider rod 3 is held in the unlocked position. When the first roller 7 reaches the inclined part 9a, the latch 2 and the slider rod 3 rotate clockwise around the first hinge point 15 by their own weights. The first roller 7 thus moves downward along the inclined part 9a, causing the slider 4 to move along the slider rod 3 towards the hinge block 12. Then the slider 4 returns to the default position where it is positioned near the hinge block 12 and the latch 2 and the slider rod 3 are at their horizontal positions (unlocked positions).

[0042] In case the latch 2 and the slider rod 3 do not return to their default positions by rotating clockwise around the first hinge point 15 due to their own weights, an extended part of the roller shaft member 23 contacts an inclined part 20a of the second cam 20. Then, continued door closing motion forces the extended part of the roller shaft member 23 to move downward along the inclined part 20a, causing the second hinge point 8 to move down. The first and second levers 11 and 6 sharing the same second hinge point 8 have to move together. Further, the second lever 6 and the slider 4 share the same third hinge point 17. Accordingly, the motion of the second lever 6 forces the slider 4 to return to its default position. Consequently the slider rod 3, and thus the linked latch 2 as well, rotate clockwise around the first hinge point 15 during the last part of the door closing motion path, returning to their horizontal positions (locked positions).

[0043] As described above, according to Embodiment 3, the slider 4 can be reliably returned to its default position in the state where the door is closed.

[Embodiment 4]

[0044] In Embodiment 4, as shown in Fig. 25, the length of the flat part 9b of a first cam 9A is such that the flat part 9b contacts the first roller 7 during the whole door motion path from a time the static latch 16 passes the latch 2 until the door is fully opened.

[0045] Note that, otherwise, Embodiment 4 is of the same construction as Embodiment 1 described above.

[0046] Referring to Fig. 25, the locking apparatus with the door fully opened is indicated by dotted lines while the locking apparatus with the door fully closed is indicated by solid lines.

[0047] As described above, the first roller 7 is in contact with the flat part 9b of the first cam 9A during the whole door motion path until the door is really closed from its fully opened state, thereby maintaining the state (unlocked position) with the slider rod 3 having been rotated counterclockwise around the first hinge point 15 by a predetermined angle. The switch 13 is opened at this time, making it possible to achieve extended lifetime of the switch 13.

[0048] Further, the contact between the first roller 7 and the first cam 9A is kept by the gravity force or by the gravity force plus the spring force. Therefore, the contact between the first roller 7 and the first cam 9A can be maintained by means of an inexpensive structure.

[Embodiment 5]

[0049] In Embodiment 5, as shown in Fig. 26, the flat part 9b of the first cam 9A and the flat part 20b of a second cam 20A have such lengths that they contact the first roller 7 during the whole door motion path from a time the static latch 16 passes the latch 2 until the door is fully opened.

[0050] Note that, otherwise, Embodiment 5 is of the same construction as Embodiment 3 described above.

[0051] Referring to Fig. 26, the locking apparatus with the door fully opened is indicated by dotted lines while the locking apparatus with the door fully closed is indicated by solid lines.

[0052] As described above, the first roller 7 is positioned between the flat part 9b of the first cam 9A and the flat part 20b of the second cam 20A during the whole door motion path until the door is really closed from its fully opened state, thereby maintaining the state (unlocked position) with the slider rod 3 having been rotated counterclockwise around the first hinge point 15 by a predetermined angle. The switch 13 is opened at this time, making it possible to achieve extended lifetime of the switch 13.

[0053] Further, the first roller 7 is positioned between the flat parts 9b and 20b due to the shape relation of the first and second cams 9A and 20A, whereby the unlocked position of the slider rod 3 can be reliably maintained even during shock motion of the car. Thus closure of the switch 13 during shock motion of the car can be prevented as well.

[0054] Note that the shape relation of the first and second cams 9A and 20A is not limited to the one shown in Fig. 26 but may be any other shape relation.

[Embodiment 6]

[0055] In Embodiment 6, as shown in Fig. 27, the shape of the first cam 9 is such that the first cam 9 does not contact the first roller 7 during the end of the door closing path.

[0056] Note that, otherwise, Embodiment 6 is of the same construction as Embodiment 1 described above.

[0057] Referring to Fig. 27, the locking apparatus with the door fully opened is indicated by dotted lines while the locking apparatus with the door fully closed is indicated by solid lines.

[0058] In Embodiment 6, the shape of the first cam 9 is such that the first cam 9 does not contact the first roller 7 during the end of the door closing path, that is, when the slider 4 is in its default position. Adjustment of the horizontal position of the first cam 9 is thus not required, and the installation of the first cam 9 is simplified.

[0059] Needless to say, the present invention is not restricted to Embodiments 1 through 6 described above but may accommodate further modifications within the scope of the claims.

[0060] The advantages achievable by this invention as described include the following:

No electrical power requirement to operate the lock;

- Easy to install at the job-site;
- Low maintenance needs;
- Independent of the hoistway door drive;
- Mounted inside the car door header and next to the entrance, in other words, behind the jamb of the door frame, preventing a negative effect on the appearance even in case of glass doors or a glass hoistway.

[0061] A relatively simple lever mechanism is applied without any electrically operated actuators, so the locking operation is independent of the presence of electrical power.

[0062] Installation on the job-site is very simple. Most installation jobs can be performed in the factory where the work environment is much better than at the job-site. The parts mounted to the car support frame and the parts mounted to the door hanger 10 can all be installed in the factory. The ramp bracket 27 can be installed to the landing door frame in the factory as well. The ramp 1 can easily be installed at the job-site.

[0063] At the job-site, only a few possible part position adjustments remain. These are the following. It may be necessary to adjust the second roller 5 position in the direction perpendicular to the door motion to keep sufficient clearance to the static parts in the hoistway. In this case, this can be simply arranged by adding or removing shims behind the second roller 5 mounting.

[0064] It might be necessary to adjust the position of the first cam 9, 9A parallel to the door motion after door centering. This can be simply effected by the slots 18a in the cam bracket 18. Further, it might be necessary to adjust the position of the ramp 1 in the direction parallel to the door motion to modify the gap between the second roller 5 and the ramp 1. This can be simply effected by installing one ramp 1 at a proper position and using this ramp position as the plumb line for the positioning of the ramps at all landings.

[0065] Maintenance needs are low. In this locking apparatus, only lubrication of the bearings and periodical visual checks of the locking operation are necessary.

[0066] In this locking apparatus, any type of hoistway door coupling mechanism can be applied, because this car door locking apparatus is totally independent of the drive mechanism of the hoistway doors. This is an advantage because in many cases the hoistway door coupling mechanism is part of a certified hoistway door locking apparatus. Modifications to the hoistway door locking apparatus may require new certification.

Claims

1. An elevator car door locking apparatus for locking a sliding door of a car of an elevator when the car is outside a landing zone, comprising:

a ramp (1) mounted in a hoistway at each landing position; and
a locking mechanism portion mounted on the car, comprising

a static latch (16) which moves along with the door;
a first cam (9, 9A) which moves along with the door; and
a lever mechanism (25) mounted to the car;

the lever mechanism (25) comprises:

a slider rod (3) whose one end is mounted to the car so as to be pivotable around a first hinge point (15), the slider rod (3) being adapted to assume a locked position where the slider rod (3) extends horizontally in a door opening direction and an unlocked position where the slider rod (3) has been pivoted upward from the locked position by a predetermined angle;
a latch (2) arranged integrally with the slider rod such that the latch (2) can engage with the static latch (16) when the slider rod (3) is in the locked position and that the latch (2) does not engage with the static latch (16) when the slider rod (3) is in the unlocked position;

the elevator car door locking apparatus being **characterized in that**:
the locking mechanism portion comprises:

a slider (4) arranged so as to move along the slider rod (3);
a first roller (7) arranged below a position between the first hinge point (15) and the slider (4) and adapted to be rotatable around a second hinge point (8);
a first lever (11) mounted such that its one end is pivotable around the first hinge point (15) and its other end is pivotable around the second hinge point (8), the first lever (11) being suspended between the first and second hinge points (15, 8);
a second lever (6) mounted such that its one end is pivotable around the second hinge point (8) and its other end is mounted to the slider so as to be pivotable around a third hinge point (17), the second lever (6) being suspended between the second and third hinge points (8, 17); and
a second roller (5) mounted to the slider (4) so as to be rotatable around the third hinge point (17);

when, with the car positioned outside the landing zone, motion of the first cam (9, 9A) translating along with opening motion of the door is transferred to the first roller (7), the slider (4) moves in conjunction with motion of the first cam (9, 9A) along the slider rod (3) in a door opening direction to keep the slider rod (3) in the locked position, and the static latch (16) moving along with the opening motion of the door engages with the latch (2), disabling opening operation of the door; and
when, with the car positioned inside the landing zone, motion of the first cam (9, 9A) moving along with opening motion of the door is transferred to the first roller (7), the slider (4) moves in conjunction with motion of the first cam (9, 9A) along the slider rod (3) in a door opening direction to cause the second roller (5) to infringe with the ramp (1), and subsequent motion of the first cam (9, 9A) causes the slider rod (3) to pivot from the locked position to the unlocked position with a result that the static latch (16) passes the latch (2) without engaging with the latch (2), enabling opening operation of the door.

2. An elevator car door locking apparatus according to claim 1, **characterized in that** the second roller (5) does not contact the ramp (1) when the door is fully closed.

3. An elevator car door locking apparatus according to claim 1, **characterized in that** the first cam (9) is adapted to cause the slider rod (3) to pivot to the unlocked position only when, with the car positioned inside the landing zone, the static latch (16) has to pass the latch (2) without engaging with the latch (2).

4. An elevator car door locking apparatus according to claim 1, **characterized in that** when the car is inside the landing zone, the first cam (9A) is adapted to keep the slider rod (3) in the unlocked position during a whole motion path of the door from a time the static latch (16) passes the latch (2) until the door is fully opened.

5. An elevator car door locking apparatus according to claim 1, **characterized in that** in the lever mechanism (25), a drive force for moving the slider (4) along the slider rod (3) is greater than a pivoting force with which the slider rod (3) is pivoted from the locked position to the unlocked position.

6. An elevator car door locking apparatus according to claim 1, **characterized in that** the ramp (1) is positioned next to an entrance behind a jamb of a hoistway door frame.

7. An elevator car door locking apparatus according to claim 1, **characterized in that** the elevator car door locking apparatus comprises a second cam (20, 20A) which moves along with the door, the second cam (20) being adapted to operate in cooperation with the first roller (7) during a last part of a motion path of closing operation of the door to generate a drive force for causing the slider rod 3 to pivot from the unlocked position to the locked position.

8. An elevator car door locking apparatus according to claim 7, **characterized in that** a shaft member (23) of the first roller (7) is extended so as to contact the

second cam, the shaft member (23) being adapted to move in conjunction with motion of the second cam (20) while in contact with the second cam to generate a drive force for causing the slider rod (3) to pivot from the unlocked position to the locked position.

9. An elevator car door locking apparatus according to claim 1, **characterized in that** the lever mechanism (25) comprises slider motion generating means (21a, 22a) for converting, at start of closing operation of the door, a pivoting force with which the slider rod (3) is pivoted from the locked position to the unlocked position into motion of the slider (4) along the slider rod (3).

10. An elevator car door locking apparatus according to claim 1, **characterized in that** the lever mechanism (25) comprises pivot stopping means (21b, 22b) for stopping pivoting operation of the slider rod (3) from the locked position to the unlocked position during a final part of a motion path of the slider (4) until the static latch (16) moves to a position of the latch (2) from a fully closed position when the car is outside the landing zone.

Patentansprüche

1. Vorrichtung zur Verriegelung von Aufzugstüren zum Verriegeln einer Schiebetüre einer Kabine eines Aufzugs, wenn sich die Kabine außerhalb eines Etagenhaltebereichs befindet, mit:

einer Auflauffläche (1) die in einem Aufzugsschacht an jeder Etagenhalteposition angebracht ist; und
einem an der Kabine angebrachten Verriegelungsmechanismus-Abschnitt, der aufweist:

eine feststehende Sperre (16), die sich zusammen mit der Türe bewegt;
einen ersten Mitnehmer (9, 9A), der sich zusammen mit der Türe bewegt; und
einen Hebelmechanismus (25), der an der Kabine angebracht ist;

wobei der Hebelmechanismus (25) aufweist:

eine Schiebestange (3), deren eines Ende derart an der Kabine angebracht ist, dass sie um einen ersten Anlenkpunkt (15) schwenkbar ist, wobei die Schiebestange (3) derart ausgelegt ist, dass sie eine verriegelte Position, in der sich die Schiebestange (3) horizontal in einer Türöffnungsrichtung erstreckt, und eine entriegelte Position einnehmen kann, in der die Schiebestange (3) von der verriegelten Position um einen vorbestimmten Winkel nach oben geschwenkt wurde;
eine Sperre (2) die derart integral mit der Schiebestange angeordnet ist, dass die Sperre (2) mit der feststehenden Sperre (16) in Eingriff kommen kann, wenn die Schiebestange (3) in der verriegelten Position ist, und die Sperre (2) nicht mit der feststehenden Sperre (16) in Eingriff kommt, wenn die Schiebestange (3) in der entriegelten Position ist;

wobei die Vorrichtung zur Verriegelung von Aufzugstüren
dadurch gekennzeichnet ist, dass der Verriegelungsmechanismus aufweist:

einen Schieber (4), der derart angeordnet ist, dass er sich entlang der Schiebestange (3) bewegt;
eine erste Rolle (7), die unterhalb einer Position zwischen dem ersten Anlenkpunkt (15) und dem Schieber (4) angeordnet ist, und derart ausgelegt ist, dass sie um einen zweiten Anlenkpunkt (8) drehbar ist;
einen ersten Hebel (11), der derart angebracht ist, dass sein eines Ende um den ersten Anlenkpunkt (15) schwenkbar ist, und sein anderes Ende um den zweiten Anlenkpunkt (8) schwenkbar ist, wobei der erste Hebel (11) zwischen dem ersten und zweiten Anlenkpunkt (15, 8) aufgehängt ist;
einen zweiten Hebel (6), der derart angebracht ist, dass sein eines Ende um den zweiten Anlenkpunkt (8) schwenkbar ist, und sein anderes Ende an dem Schieber derart angeracht ist, dass es um einen dritten Anlenkpunkt (17) schwenkbar ist, wobei der zweite Hebel (6) zwischen dem zweiten und dritten Anlenkpunkt (8, 17) aufgehängt ist; und
eine zweite Rolle (5), die derart an dem Schieber (4) angebracht ist, dass sie um den dritten Anlenkpunkt (17) drehbar ist; wobei

sich der Schieber (4), bei außerhalb des Etagenhaltebereichs positionierter Kabine, falls Bewegung des ersten Mitnehmers (9, 9A), der sich zusammen mit Öffnungsbewegung der Türe verschiebt, auf die erste Rolle (7) übertragen wird, zusammen mit Bewegung des ersten Mitnehmers (9, 9A) entlang der Schiebestange (3) in einer Türöffnungs-Richtung derart bewegt, dass die Schiebestange (3) in der verriegelten Position gehalten wird, und die feststehende Sperre (16), die sich zusammen mit der Öff-

nungsbewegung der Türe bewegt, mit der Sperre (2) in Eingriff kommt, wodurch Öffnungsbetrieb der Türe deaktiviert ist; und
sich der Schieber (4), bei innerhalb des Etagenhaltebereichs positionierter Kabine, falls Bewegung des ersten Mitnehmers (9, 9A), der sich zusammen mit Öffnungsbewegung der Türe bewegt, auf die erste Rolle (7) übertragen wird, zusammen mit Bewegung des ersten Mitnehmers (9, 9A) entlang der Schiebestange (3) in einer TüröffnungsRichtung derart bewegt, dass die zweite Rolle (5) dazu veranlasst wird, mit der Auflauffläche (1) in Eingriff zu kommen, und darauffolgende Bewegung des ersten Mitnehmers (9, 9A) die Schiebestange (3) dazu veranlasst, von der verriegelten Position zur nicht verriegelten Position zu schwenken, mit einem Ergebnis, dass die feststehende Sperre (16) die Sperre (2) passiert, ohne mit der Sperre (2) in Eingriff zu kommen, wodurch Öffnungsbetrieb der Türe freigegeben ist.

2. Vorrichtung zur Verriegelung von Aufzugstüren nach Anspruch 1, **dadurch gekennzeichnet, dass** die zweite Rolle (5) die Auflauffläche (1) nicht kontaktiert, wenn die Türe vollständig geschlossen ist.

3. Vorrichtung zur Verriegelung von Aufzugstüren nach Anspruch 1, **dadurch gekennzeichnet, dass** der erste Mitnehmer (9) derart ausgelegt ist, dass er die Schiebestange (3) dazu veranlasst, bei innerhalb des Etagenhaltebereichs positionierter Kabine, nur dann in die nicht verriegelte Position zu schwenken, falls die feststehende Sperre (16) die Sperre (2) passieren muss, ohne mit der Sperre (2) in Eingriff zu kommen.

4. Vorrichtung zur Verriegelung von Aufzugstüren nach Anspruch 1, **dadurch gekennzeichnet, dass** der erste Mitnehmer (9A) ausgelegt ist, die Schiebestange (3), falls sich die Kabine innerhalb des Etagenhaltebereichs befindet, während eines gesamten Bewegungspfads der Türe, von einem Zeitpunkt, an dem die feststehende Sperre (16) die Sperre (2) passiert, bis die Türe vollständig geöffnet ist, in der nicht verriegelten Position zu halten.

5. Vorrichtung zur Verriegelung von Aufzugstüren nach Anspruch 1, **dadurch gekennzeichnet, dass** in dem Hebelmechanismus (25) eine Triebkraft, um den Schieber (4) entlang der Schiebestange (3) zu bewegen, größer als eine Schwenkkraft ist, mit der die Schiebestange (3) von der verriegelten Position zur nicht verriegelten Position geschwenkt wird.

6. Vorrichtung zur Verriegelung von Aufzugstüren nach Anspruch 1, **dadurch gekennzeichnet, dass** die Auflauffläche (1) neben einem Eingang hinter einem Türpfosten eines Aufzugsschacht-Türrahmens angeordnet ist.

7. Vorrichtung zur Verriegelung von Aufzugstüren nach Anspruch 1, **dadurch gekennzeichnet, dass** die Vorrichtung zur Verriegelung von Aufzugstüren einen zweiten Mitnehmer (20, 20A) aufweist, der sich zusammen mit der Türe bewegt, wobei der zweite Mitnehmer (20) derart ausgelegt ist, dass er, während des letzten Teils eines Bewegungspfades eines Schließbetriebs der Türe, zusammen mit der ersten Rolle (7) wirkt, um eine Triebkraft zu erzeugen, um die Schiebestange (3) dazu zu veranlassen, von der nicht verriegelten Position zur verriegelten Position zu schwenken.

8. Vorrichtung zur Verriegelung von Aufzugstüren nach Anspruch 7, **dadurch gekennzeichnet, dass** ein Achsenelement (23) der ersten Rolle (7) derart verlängert ist, dass es den zweiten Mitnehmer kontaktiert, wobei das Achsenelement (23) derart ausgelegt ist, dass es sich zusammen mit Bewegung des zweiten Mitnehmers (20) bewegt, während es mit dem zweiten Mitnehmer in Kontakt ist, um eine Triebkraft zu erzeugen, um die Schiebestange (3) dazu zu veranlassen, von der nicht verriegelten Position zur verriegelten Position zu schwenken.

9. Vorrichtung zur Verriegelung von Aufzugstüren nach Anspruch 1, **dadurch gekennzeichnet, dass** der Hebelmechanismus (25) eine Schieberbewegungs-Erzeugungseinrichtung (21a, 22a) aufweist, um bei Beginn eines Schließbetriebs der Türe eine Schwenkkraft, mit der die Schiebestange (3) von der verriegelten Position zu der nicht verriegelten Position geschwenkt wird, in Bewegung des Schiebers (4) entlang der Schiebestange (3) umzuwandeln.

10. Vorrichtung zur Verriegelung von Aufzugstüren nach Anspruch 1, **dadurch gekennzeichnet, dass** der Hebelmechanismus (25) eine Schwenkbewegungsstoppeinrichtung (21b, 22b) aufweist, um, während eines finalen Teils eines Bewegungspfades des Schiebers (4), bis sich die feststehende Sperre (16) von einer vollständig geschlossenen Position zu einer Position der Sperre (2) bewegt, Schwenkbetrieb der Schiebestange (3) von der verriegelten Position zu der nicht verriegelten Position zu stoppen, wenn sich die Kabine außerhalb des Etagenhaltebereichs befindet.

Revendications

1. Appareil de verrouillage de porte de cabine d'ascenseur pour verrouiller une porte coulissante d'une cabine d'un ascenseur lorsque la cabine est à l'extérieur d'une zone de palier, comprenant :

une rampe (1) montée dans une cage d'ascenseur à chaque position de palier ; et
une portion de mécanisme de verrouillage montée sur la cabine, comprenant :

un verrou statique (16) qui se déplace en même temps que la porte ;
une première came (9, 9A) qui se déplace en même temps que la porte ; et
un mécanisme à levier (25) monté sur la cabine ;

le mécanisme à levier (25) comprenant :

une tige de coulisseau (3) dont une extrémité est montée sur la cabine de manière à pouvoir être pivotée autour d'un premier point d'articulation (15), la tige de coulisseau (3) étant adaptée pour prendre une position verrouillée, dans laquelle la tige de coulisseau (3) s'étend horizontalement dans une direction d'ouverture de porte, et une position déverrouillée, dans laquelle la tige de coulisseau (3) a été pivotée d'un angle prédéterminé vers le haut à partir de la position verrouillée ;
un verrou (2) disposé en un seul tenant avec la tige de coulisseau de façon à ce que le verrou (2) puisse venir en engagement avec le verrou statique (16) lorsque la tige de coulisseau (3) est dans la position verrouillée et que le verrou (2) ne vienne pas en engagement avec le verrou statique (16) lorsque la tige de coulisseau (3) est dans la position déverrouillée ;

l'appareil de verrouillage de porte de cabine d'ascenseur étant **caractérisé en ce que** :

la portion de mécanisme de verrouillage comprend :

un coulisseau (4) agencé de manière à se déplacer le long de la tige de coulisseau (3) ;
un premier rouleau (7) agencé au-dessous d'une position entre le premier point d'articulation (15) et le coulisseau (4) et adapté pour pouvoir être tourné autour d'un deuxième point d'articulation (8) ;
un premier levier (11) monté de façon à ce que son une extrémité puisse être pivotée autour du premier point d'articulation (15) et que son autre extrémité puisse être pivotée autour du deuxième point d'articulation (8), le premier levier (11) étant suspendu entre les premier et deuxième points d'articulation (15, 8) ;
un deuxième levier (6) monté de façon à ce que son une extrémité puisse être pivotée autour du deuxième point d'articulation (8) et que son autre extrémité soit montée sur le coulisseau de façon à ce qu'elle puisse être pivotée autour d'un troisième point d'articulation (17), le deuxième levier (6) étant suspendu entre les deuxième et troisième points d'articulation (8, 17) ; et
un deuxième rouleau (5) monté sur le coulisseau (4) de manière à pouvoir tourner autour du troisième point d'articulation (17) ;

lorsque, la cabine étant positionnée à l'extérieur de la zone de palier, le mouvement de la première came (9, 9A) se déplaçant en translation en même temps que le mouvement d'ouverture de la porte est transféré au premier rouleau (7), le coulisseau (4) se déplace en conjonction avec le mouvement de la première came (9, 9A) le long de la tige de coulisseau (3) dans une direction d'ouverture de porte pour maintenir la tige de coulisseau (3) dans la position verrouillée, et le verrou statique (16) se déplaçant en même temps que le mouvement d'ouverture de la porte vient en engagement avec le verrou (2), désactivant l'opération d'ouverture de la porte ; et
lorsque, la cabine étant positionnée à l'intérieur de la zone de palier, le mouvement de la première came (9, 9A) se déplaçant en même temps que le mouvement d'ouverture de la porte est transféré au premier rouleau (7), le coulisseau (4) se déplace en conjonction avec le mouvement de la première came (9, 9A) le long de la tige de coulisseau (3) dans une direction d'ouverture de porte pour amener le deuxième rouleau (5) à empiéter sur la rampe (1), et le mouvement suivant de la première came (9, 9A) amène la tige de coulisseau (3) à pivoter depuis la position verrouillée jusqu'à la position déverrouillée avec pour résultat que le verrou statique (16) passe devant le verrou (2) sans venir en engagement avec le verrou (2), activant l'opération d'ouverture de la porte.

2. Appareil de verrouillage de porte de cabine d'ascenseur selon la revendication 1, **caractérisé en ce que** le deuxième rouleau (5) n'est pas au contact de la rampe (1) lorsque la porte est complètement fermée.

3. Appareil de verrouillage de porte de cabine d'ascenseur selon la revendication 1, **caractérisé en ce que** la première came (9) est adaptée pour amener la tige de coulisseau (3) à ne pivoter jusqu'à la position déverrouillée que lorsque, la cabine étant positionnée à l'intérieur de la zone de palier, le verrou statique (16) doit passer devant le verrou (2) sans venir en engagement avec le verrou (2).

4. Appareil de verrouillage de porte de cabine d'ascenseur selon la revendication 1, **caractérisé en ce que** lorsque la cabine est à l'intérieur de la zone de palier la première came (9A) est adaptée pour maintenir la tige de coulisseau (3) dans la position déverrouillée pendant un trajet de mouvement complet de la porte depuis un moment où le verrou statique (16) passe devant le verrou (2) jusqu'à ce que la porte soit complètement ouverte.

5. Appareil de verrouillage de porte de cabine d'ascenseur selon la revendication 1, **caractérisé en ce que** dans le mécanisme à levier (25), une force d'entraînement pour déplacer le coulisseau (4) le long de la tige de coulisseau (3) est plus grande qu'une force de pivotement avec laquelle la tige de coulisseau (3) est pivotée de la position verrouillée à la position déverrouillée.

6. Appareil de verrouillage de porte de cabine d'ascenseur selon la revendication 1, **caractérisé en ce que** la rampe (1) est positionnée à proximité d'une entrée à l'arrière d'un montant d'armature de porte de cage d'ascenseur.

7. Appareil de verrouillage de porte de cabine d'ascenseur selon la revendication 1, **caractérisé en ce que** l'appareil de verrouillage de porte de cabine d'ascenseur comprend une deuxième came (20, 20A) qui se déplace en même temps que la porte, la deuxième came (20) étant adaptée pour opérer en coopération avec le premier rouleau (7) pendant une dernière partie d'une trajectoire de mouvement d'opération de fermeture de la porte pour générer une force d'entraînement pour amener la tige de coulisseau (3) à pivoter de la position déverrouillée à la position verrouillée.

8. Appareil de verrouillage de porte de cabine d'ascenseur selon la revendication 7, **caractérisé en ce qu'**un élément d'arbre (23) du premier rouleau (7) s'étend de manière à être au contact de la deuxième came, l'élément d'arbre (23) étant adapté pour se déplacer en conjonction avec le mouvement de la deuxième came (20) tout en étant au contact de la deuxième came pour générer une force d'entraînement pour amener la tige de coulisseau (3) à pivoter de la position déverrouillée à la position verrouillée.

9. Appareil de verrouillage de porte de cabine d'ascenseur selon la revendication 1, **caractérisé en ce que** le mécanisme à levier (25) comprend des moyens (21a, 22a) de génération de mouvement de coulisseau pour convertir, au démarrage de l'opération de fermeture de la porte, une force de pivotement avec laquelle la tige de coulisseau (3) est pivotée de la position verrouillée à la position déverrouillée en un mouvement du coulisseau (4) le long de la tige de coulisseau (3).

10. Appareil de verrouillage de porte de cabine d'ascenseur selon la revendication 1, **caractérisé en ce que** le mécanisme à levier (25) comprend des moyens (21b, 22b) d'arrêt de pivotement pour arrêter l'opération de pivotement de la tige de coulisseau (3) de la position verrouillée à la position déverrouillée pendant une partie finale d'une trajectoire de mouvement du coulisseau (4) jusqu'à ce que le verrou statique (16) se déplace dans une position du verrou (2) à partir d'une position complètement fermée lorsque la cabine est à l'extérieur de la zone de palier.

FIG. 1

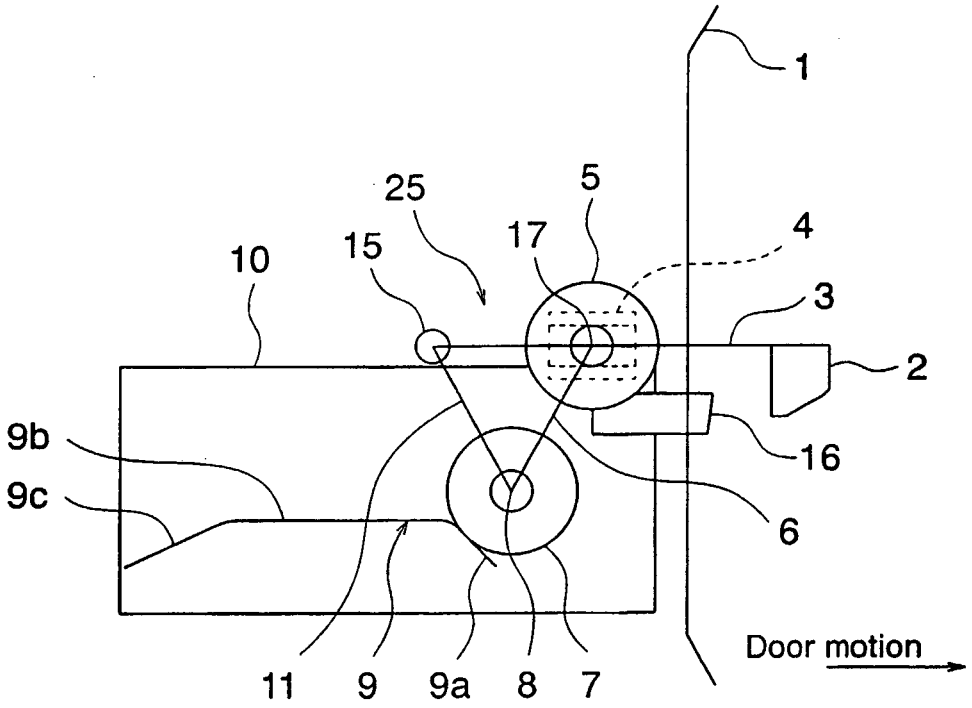


FIG. 2

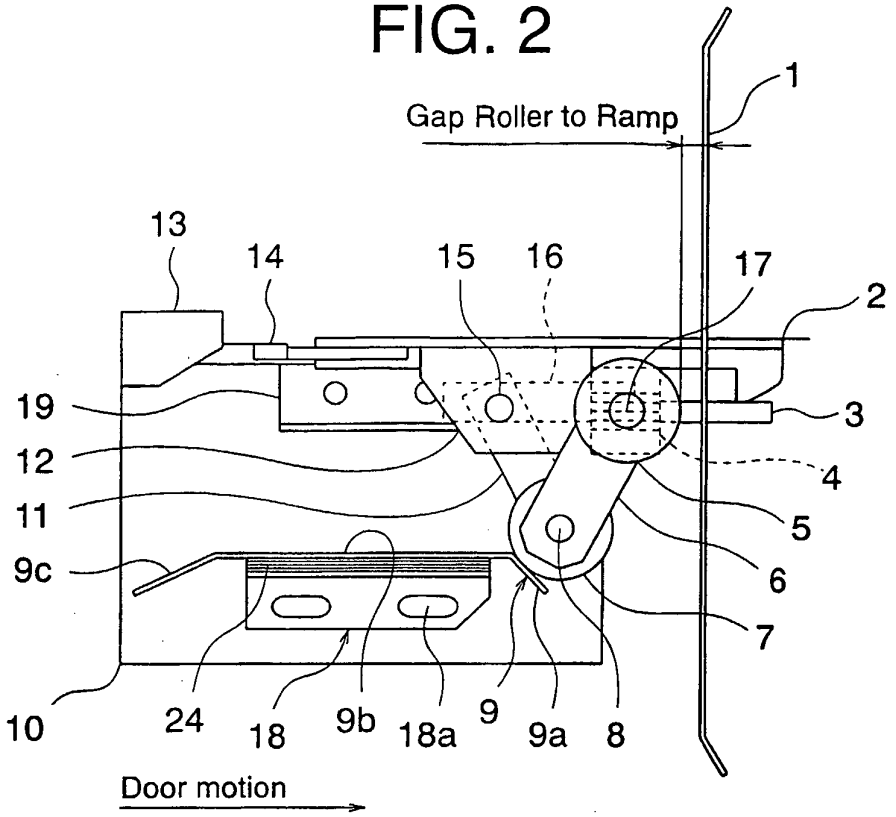

1
Gap Roller to Ramp
13
14
15
16
17
2
19
3
12
4
11
5
9c
6
7
10
24
18
9b
18a
9
9a
8
Door motion

FIG. 3

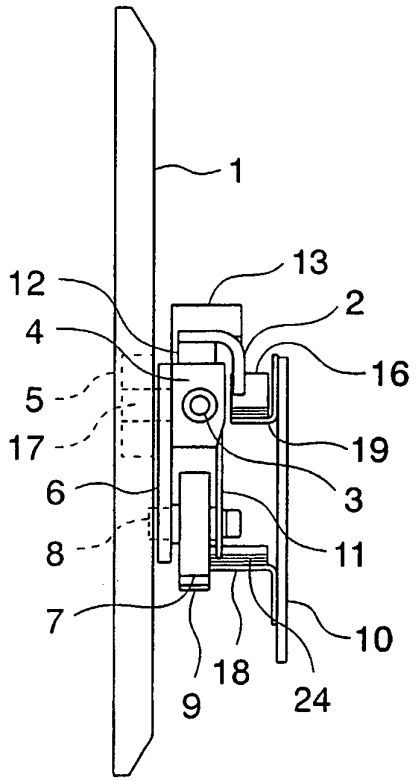

1
13
12
2
4
16
5
17
19
6
3
8
11
7
10
18
9
24

FIG. 4

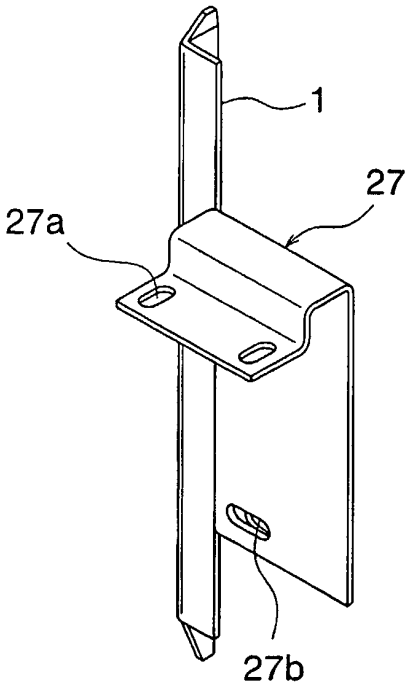


FIG. 5

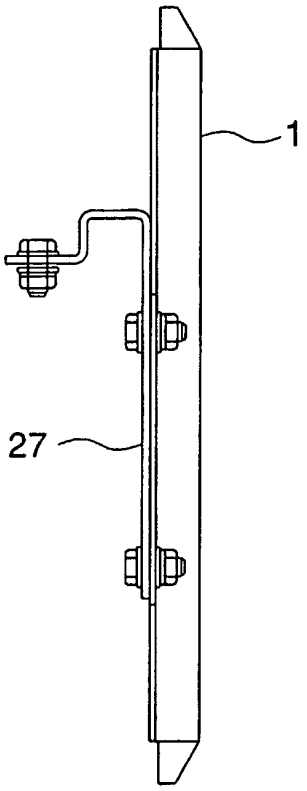


FIG. 6

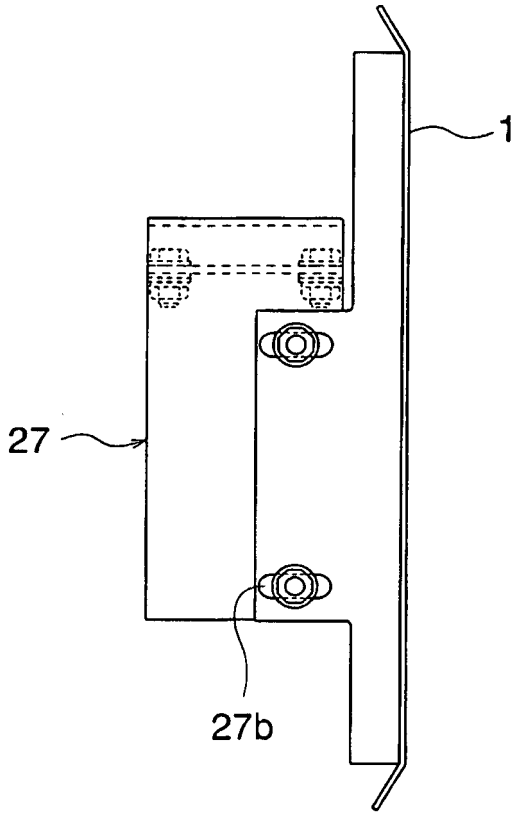


FIG. 7

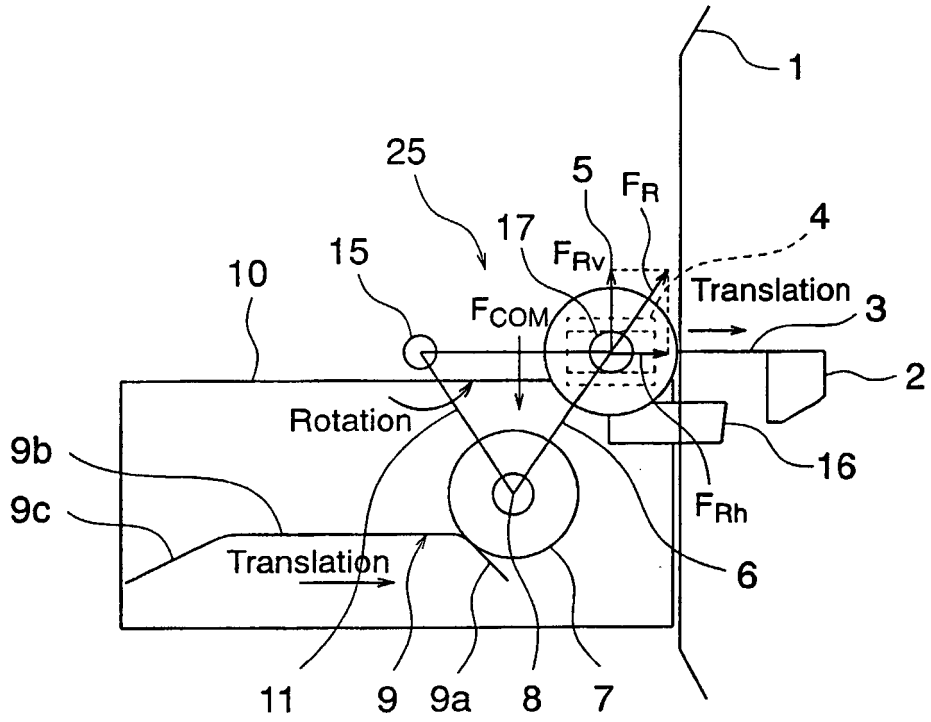

1
25
5
F_R
4
17
15
F_{Rv}
10
Translation
3
F_{COM}
2
Rotation
16
9b
9c
F_{Rh}
Translation
6
11
9
9a
8
7

FIG. 8

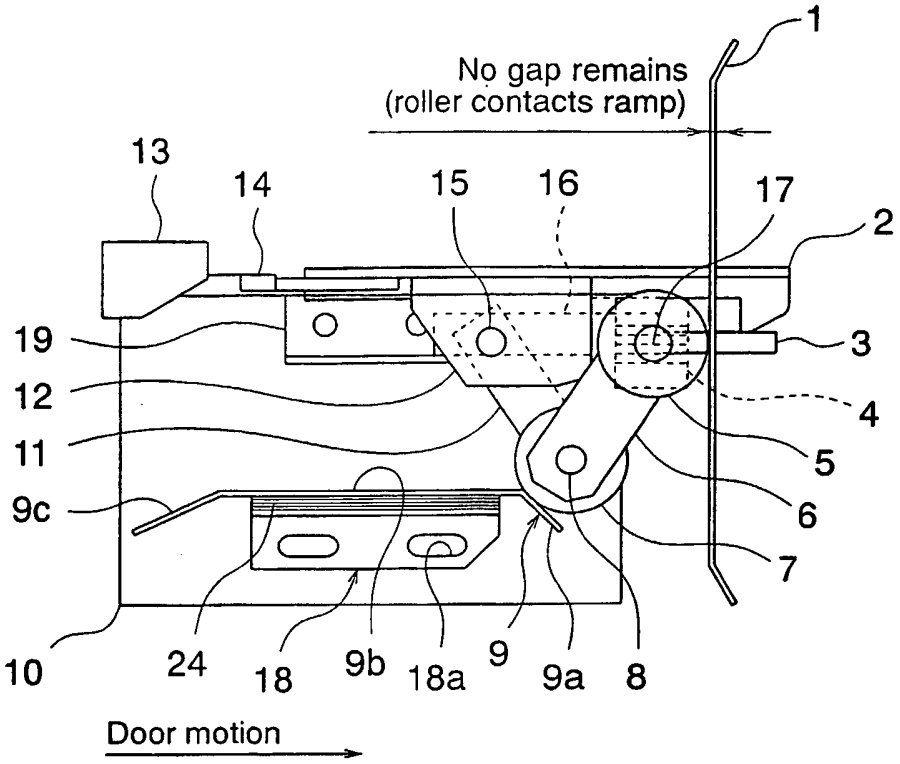

1
No gap remains
(roller contacts ramp)
13
14
15
16
17
2
19
3
12
4
11
5
9c
6
7
10
24
18
9b
18a
9
9a
8
Door motion

FIG. 9

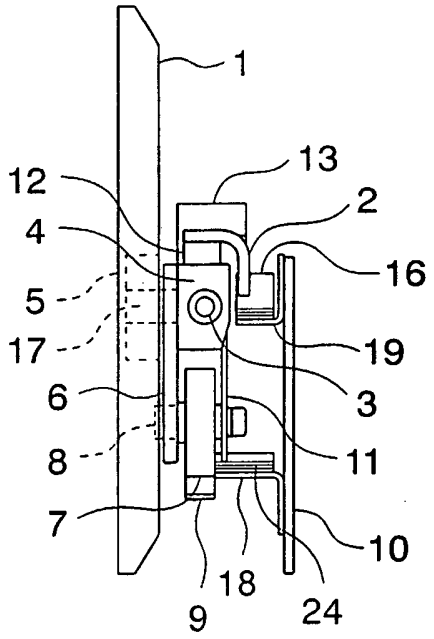

1
13
12
2
4
16
5
17
19
6
3
8
11
7
10
18
9
24

FIG. 10

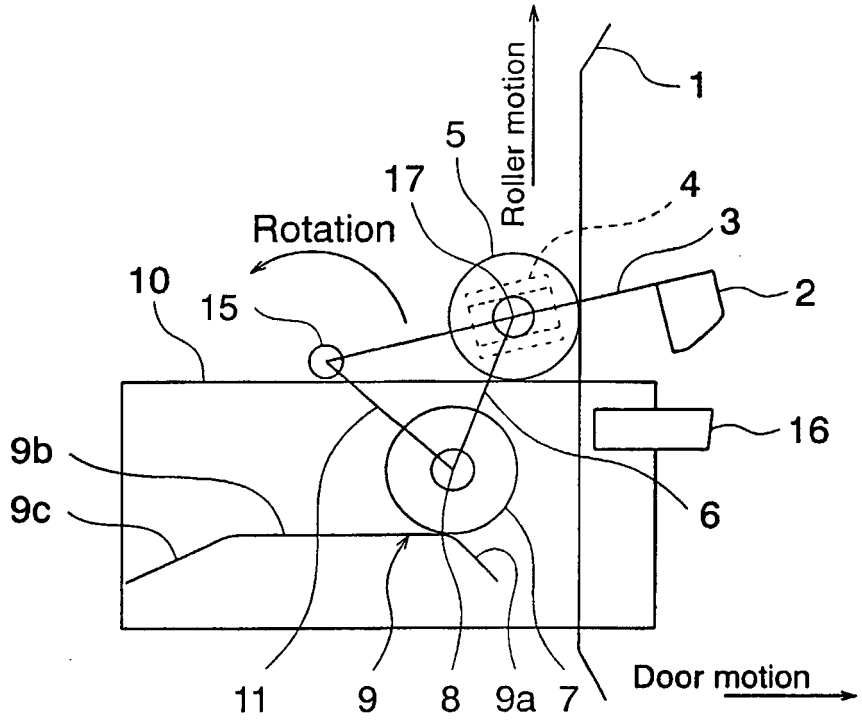

Roller motion
1
5
17
4
3
Rotation
10
15
2
16
9b
9c
6
11
9
8
9a
7
Door motion

FIG. 11

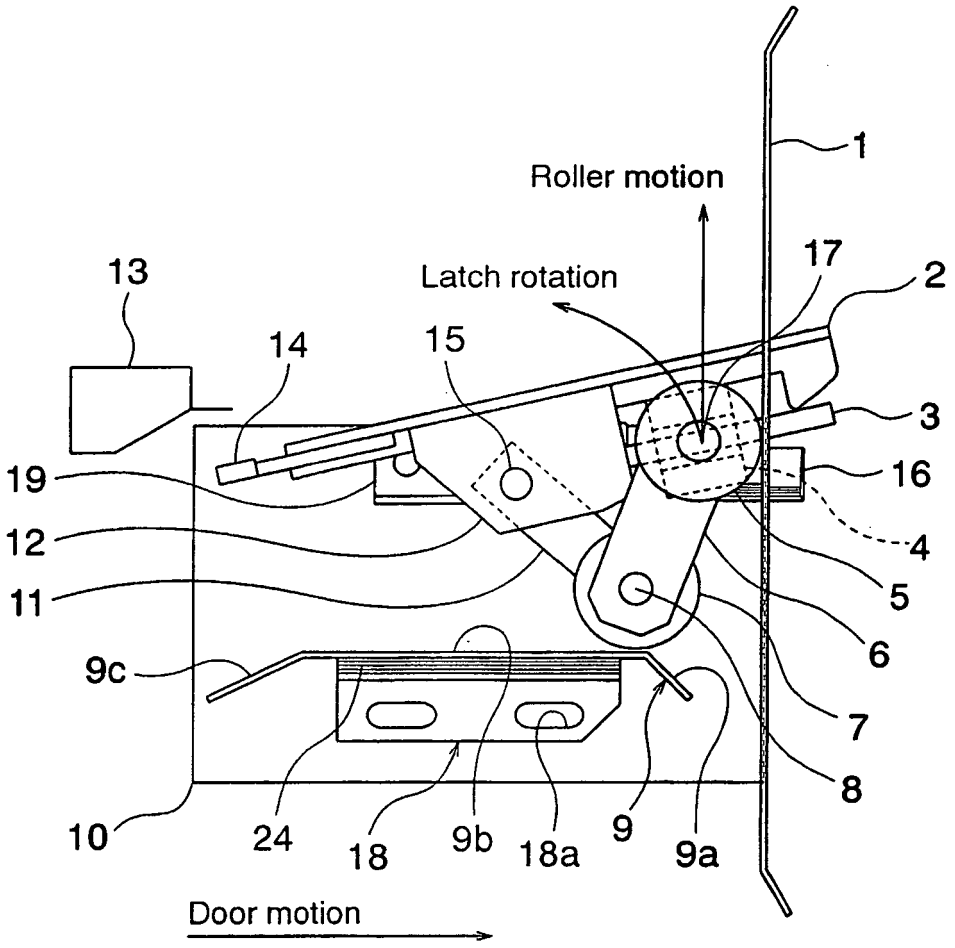

1
Roller motion
17
2
13
Latch rotation
14
15
3
19
16
12
4
11
5
6
9c
7
8
10
24
18
9b
18a
9
9a
Door motion

FIG. 12

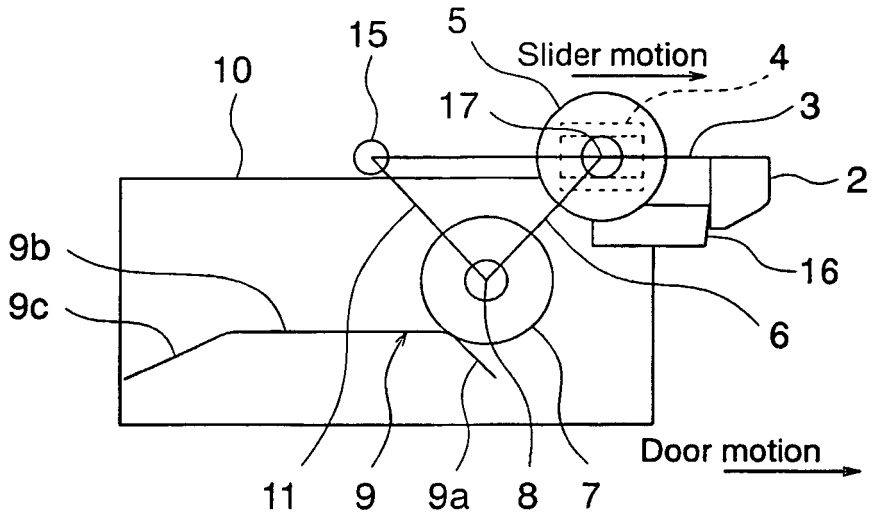

15
5
Slider motion
4
10
17
3
2
9b
9c
16
6
Door motion
11
9
9a
8
7

FIG. 13

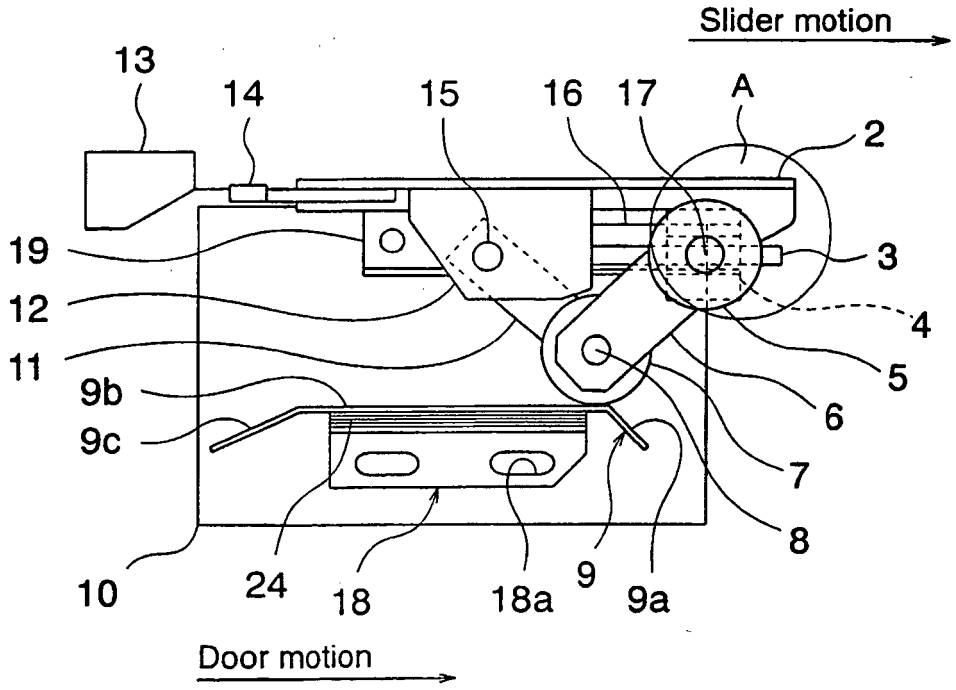

Slider motion
13
14
15
16
17
A
2
19
3
12
4
11
5
9b
6
9c
7
8
10
24
18
18a
9
9a
Door motion

FIG. 14

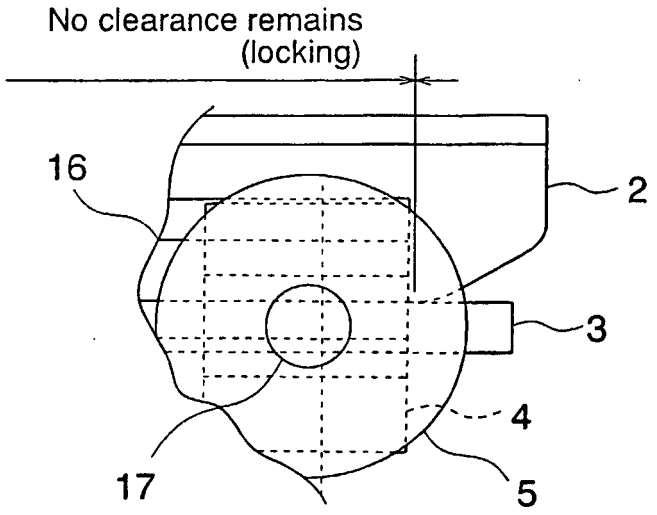

No clearance remains
(locking)
16
2
3
4
17
5

FIG. 15

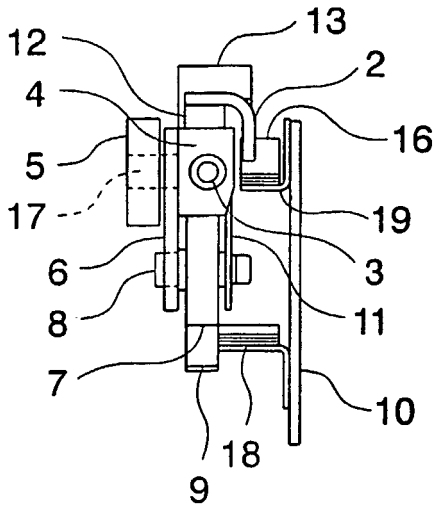

12
13
4
2
16
5
17
19
6
3
8
11
7
10
18
9

FIG. 16

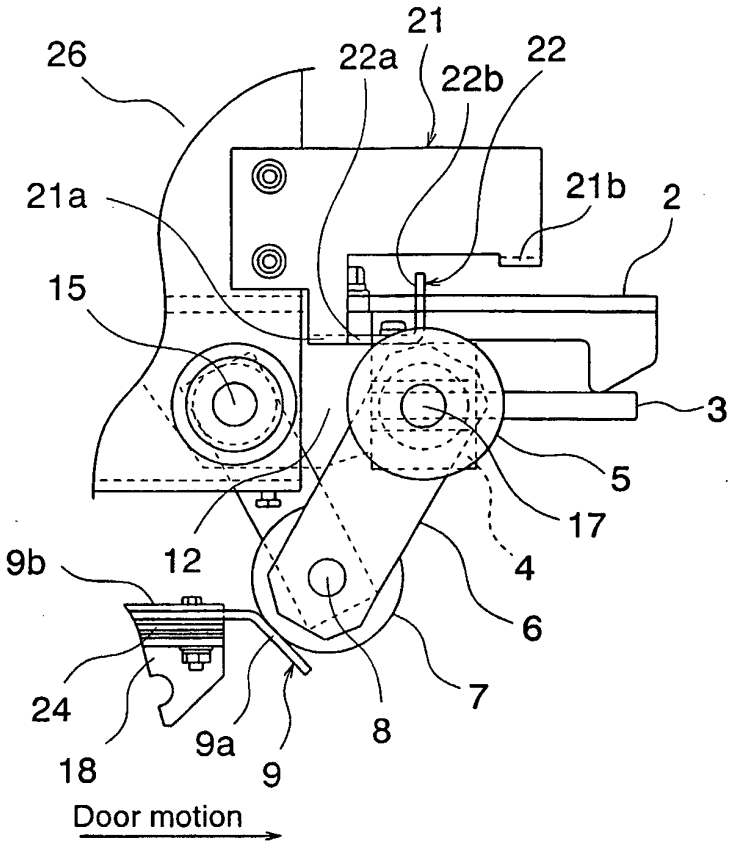

26
21
22a
22b
22
21a
21b
2
15
3
5
17
12
4
9b
6
7
24
9a
8
18
9
Door motion

FIG. 17

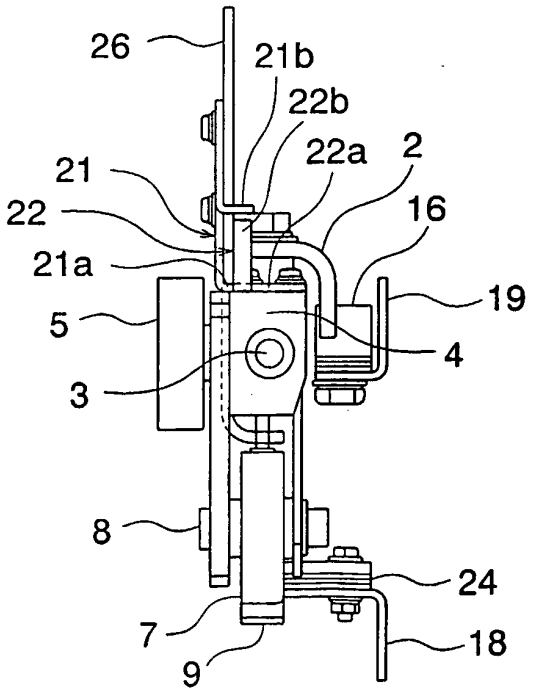

26
21b
22b
22a
2
21
22
16
21a
19
5
4
3
8
24
7
18
9

FIG. 18

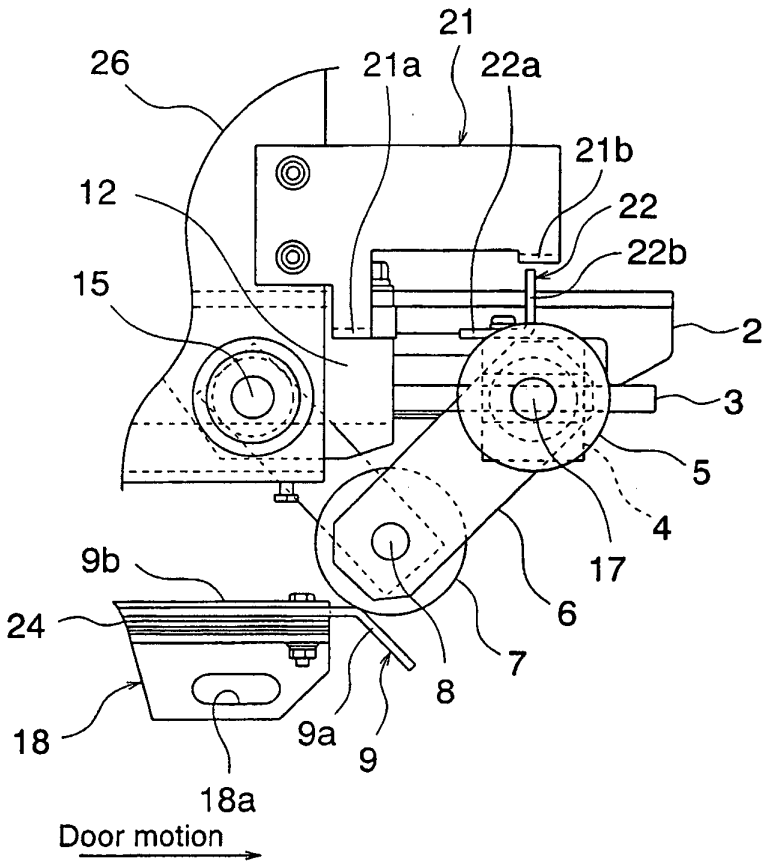

21
26
21a
22a
21b
12
22
22b
15
2
3
5
4
17
6
9b
24
7
8
18
9a
9
18a
Door motion

FIG. 19

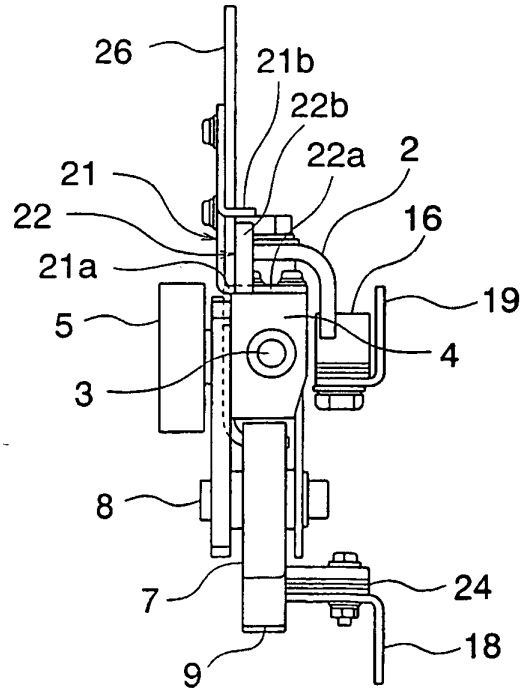

26
21b
22b
22a
2
21
22
16
21a
19
5
4
3
8
7
24
9
18

FIG. 20

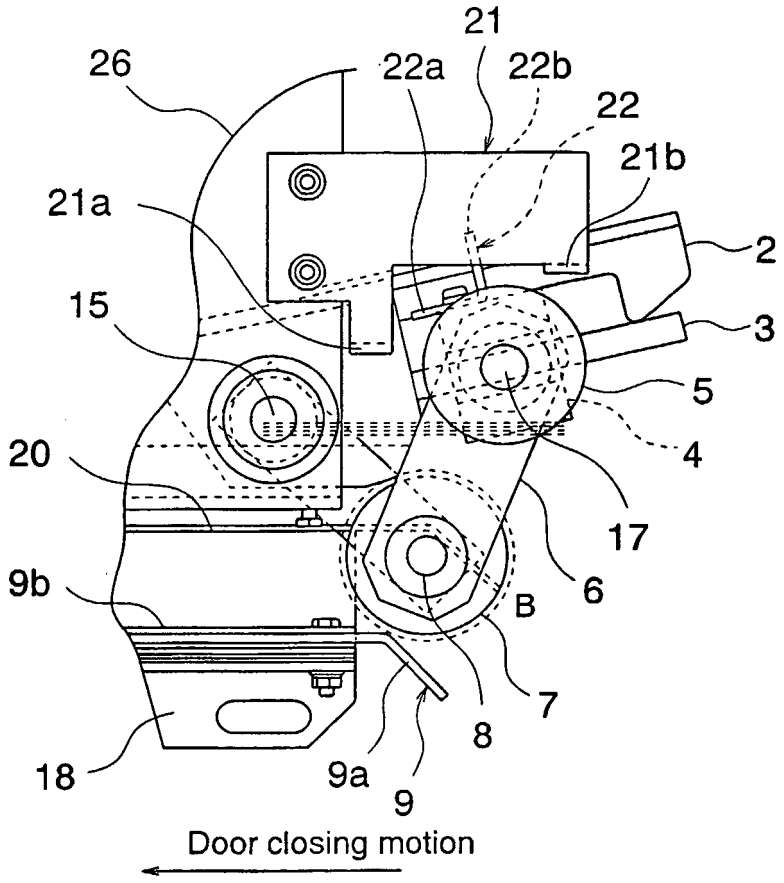

21
26
22a
22b
22
21b
21a
2
15
3
5
4
20
17
6
9b
B
7
8
18
9a
9
Door closing motion

FIG. 21

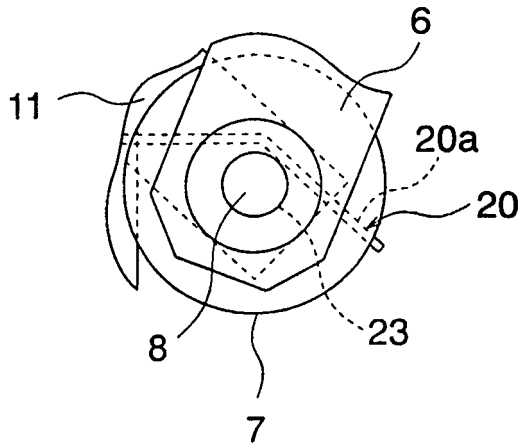

6
11
20a
20
8
23
7

FIG. 22

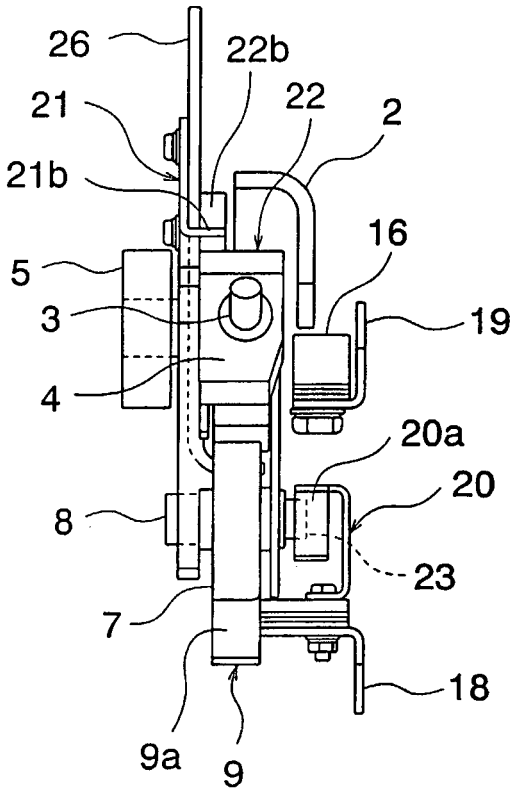


FIG. 23

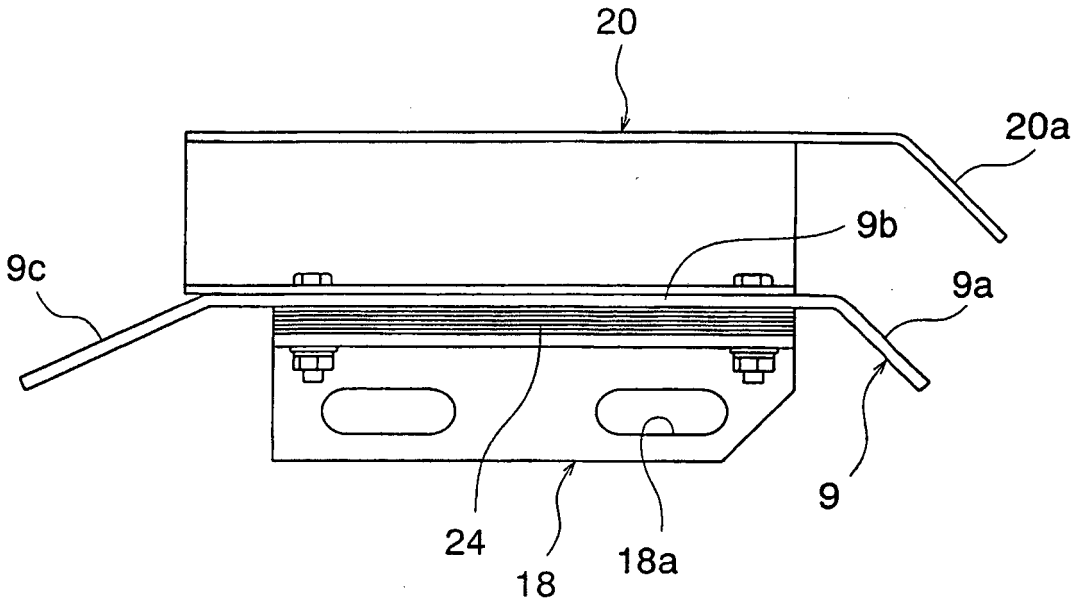


FIG. 24

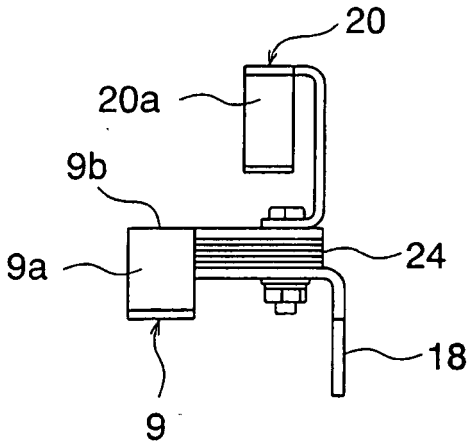


FIG. 25

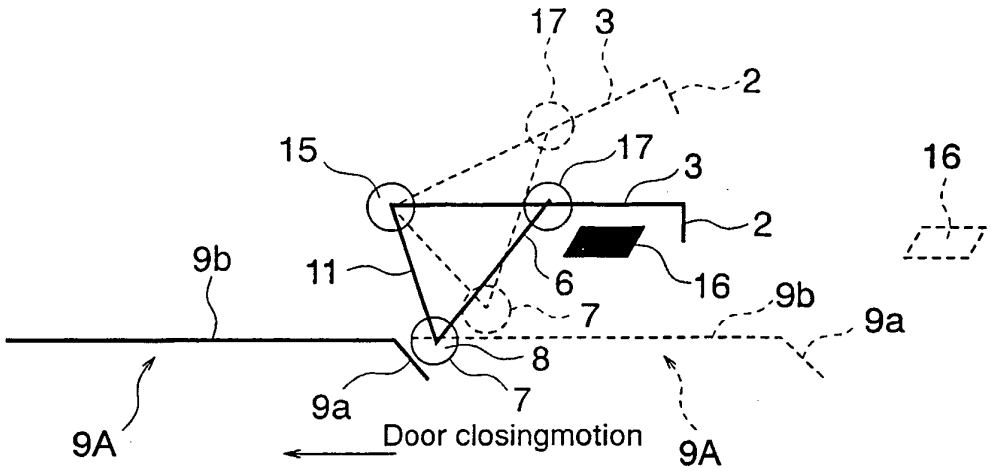


FIG. 26

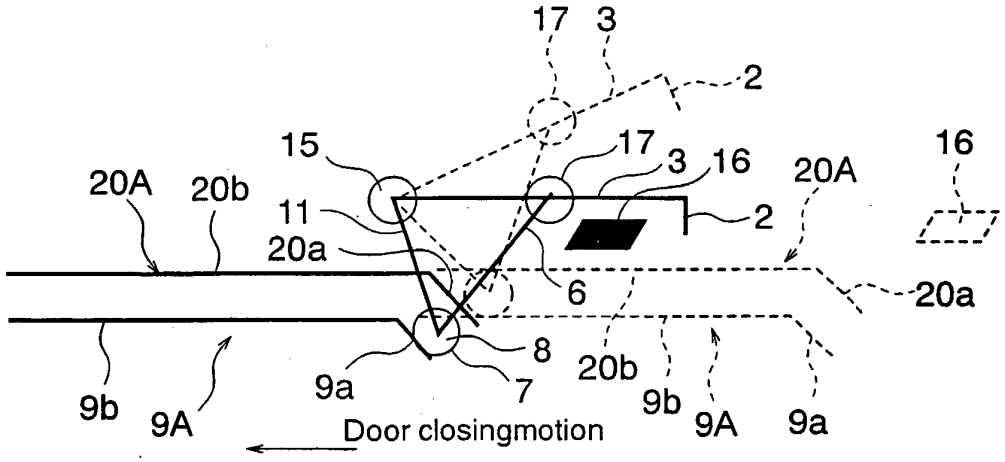


FIG. 27

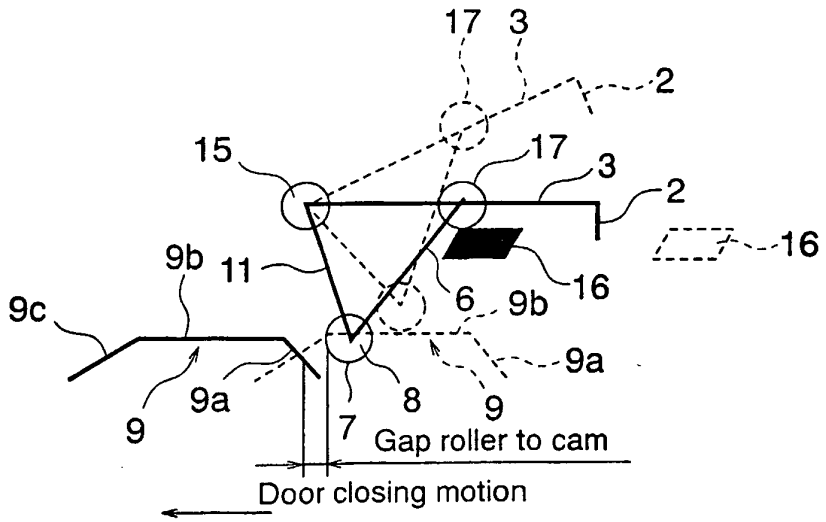
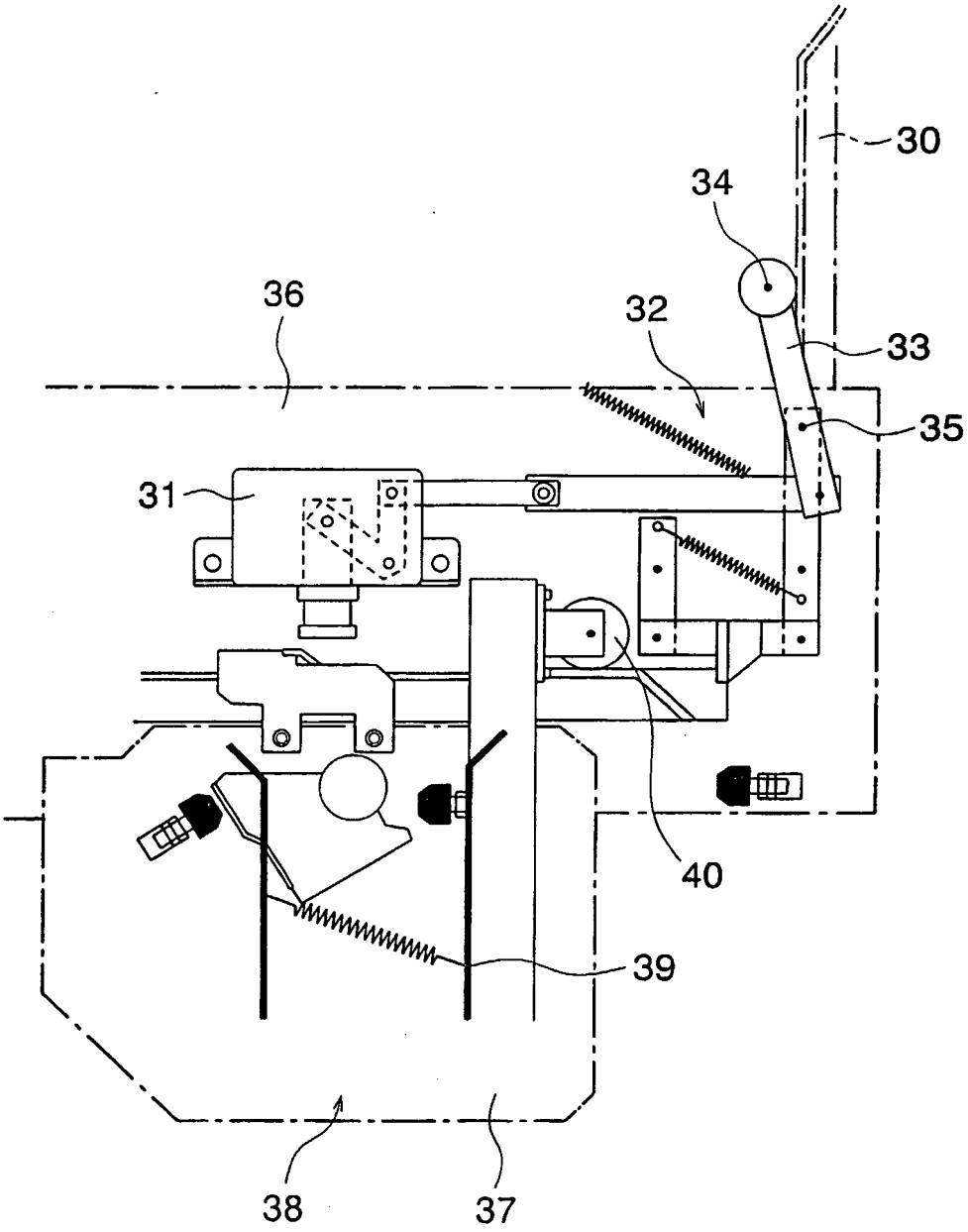


FIG. 28



REFERENCES CITED IN THE DESCRIPTION

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