(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 194 014 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
09.06.2010 Bulletin 2010/23

(21) Application number: **07828746.3**

(22) Date of filing: **28.09.2007**

(51) Int Cl.:
B66B 5/20 *(2006.01)*

(86) International application number:
PCT/JP2007/069005

(87) International publication number:
WO 2009/040934 (02.04.2009 Gazette 2009/14)

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK RS

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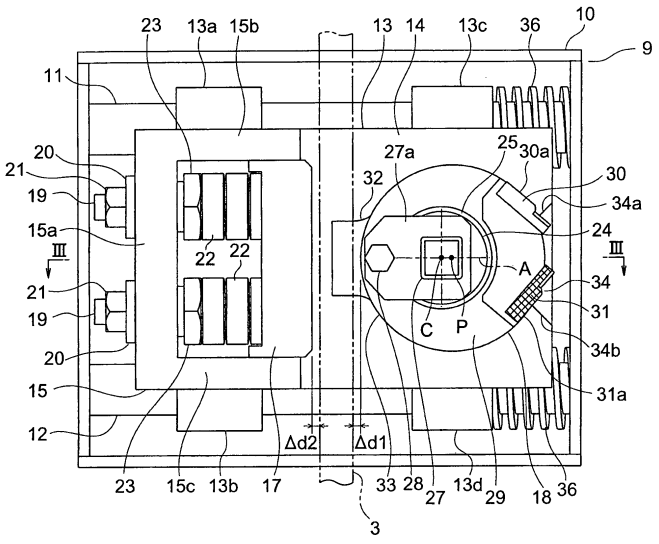
(54) SAFETY DEVICE FOR ELEVATOR

(57) In a safety device for an elevator, a receiving brake member and a rotatable brake member are disposed in a housing displaceable horizontally with respect to a guide rail. The guide rail is arranged between the receiving brake member and the rotatable brake member.

The rotatable brake member is rotatable vertically about a rotating shaft disposed in the housing. The guide rail is grasped between the receiving brake member and the rotatable brake member by vertical rotation about the rotating shaft. The rotatable brake member is provided with a rolling contact portion whose distance from the receiving brake member is continuously smaller even when the rotatable brake member rotates in anyone of upper and lower directions.

The rolling contact portion is configured along an outer peripheral surface of one cylinder having an axial line eccentric to a center line of the rotating shaft.

FIG. 2



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Description

Technical Field

[0001] The present invention relates to a safety device for an elevator, the safety device being capable of braking travel of a car in both of upper and lower directions.

Background Art

[0002] Up to now, there has been proposed an elevator apparatus having a wedge type emergency brake device which electrically conducts brake operation when an abnormality occurs in an elevator. In the conventional elevator apparatus, a wedge is displaced by an electromagnetic actuator, and sandwiched between a guide rail that guides a car and a support member disposed in the car to apply a braking force to the car (for example, refer to Patent Document 1).

[0003] Patent Document 1: WO 03/008317

Disclosure of the Invention

Problems to be solved by the Invention

[0004] However, an amount of displacement of the wedge in the vertical direction becomes larger because the braking force is applied to the car. As a result, a vertical dimension of the emergency brake device becomes larger. Further, there is required, for example, a plurality of parts for guiding the wedge while holding the wedge by a gripper, and the structure gets complicated. As a result, it takes time and labor to manufacture the emergency brake device.

[0005] The present invention has been made to solve the above-mentioned problems, and aims at providing a safety device for an elevator, the safety device being downsized and easily manufactured.

Means for solving the Problems

[0006] A safety device for an elevator according to the present invention includes: a housing that is supported by a car guided along a guide rail, and displaceable horizontally with respect to the guide rail; a receiving brake member disposed in the housing; and a rotatable brake member that is arranged at a distance from the receiving brake member so that the guide rail is interposed between the rotatable brake member and the receiving brake member, is vertically rotatable about a rotating shaft disposed in the housing, and grasps the guide rail in cooperation with the receiving brake member by the vertical rotation about the rotating shaft. The rotatable brake member includes a rolling contact portion whose distance from the receiving brake member is continuously smaller even when the rotatable brake member rotates in any one of upper and lower directions. The rolling contact portion is configured along an outer peripheral surface of one cylinder having an axial line eccentric to a center line of the rotating shaft.

Brief Description of the Drawings

[0007]

FIG. 1 is a configuration diagram illustrating an elevator apparatus according to Embodiment 1 of the present invention.
FIG. 2 is a configuration diagram illustrating an emergency stop device of FIG. 1.
FIG. 3 is a cross-sectional view taken along the line III-III of FIG. 2.
FIG. 4 is a configuration diagram illustrating a state in which a rolling contact portion of FIG. 2 is in contact with a car guide rail.
FIG. 5 is a cross-sectional view taken along the line V-V of FIG. 4.
FIG. 6 is a configuration diagram illustrating a state in which a car guide rail is grasped by the upper rotation of a rotatable brake member in FIG. 2.
FIG. 7 is a cross-sectional view taken along the line VII-VII of FIG. 6.
FIG. 8 is a schematic diagram for describing the displacement of the rotatable brake member in FIG. 2.
FIG. 9 is a schematic diagram illustrating an example in which a position of an axial line of a cylinder when the rotatable brake member is at a neutral position is different from that of the rotatable brake member in FIG. 2.
FIG. 10 is a configuration diagram illustrating an emergency stop device in a safety device for an elevator according to Embodiment 2 of the present invention.
FIG. 11 is a cross-sectional view taken along the line XI-XI of FIG. 10.

FIG. 12 is a main configuration diagram illustrating a state in which the rolling contact portion of a contact rotating body in FIG. 10 is in contact with the car guide rail.

FIG. 13 is a main configuration diagram illustrating a state in which an engagement pin is engaged with a lower portion of a rotated body by rotation of the contact rotating body in FIG. 12.

FIG. 14 is a main configuration diagram illustrating a state in which the car guide rail is grasped by the upper rotation of the contact rotating body and the rotated body.

Best Modes for carrying out the Invention

[0008] Hereinafter, preferred embodiments according to the present invention are described with reference to the drawings. Embodiment 1

FIG. 1 is a configuration diagram illustrating an elevator apparatus according to Embodiment 1 of the present invention. Referring to the figure, a car 1 and a counterweight (not shown) are suspended by a main rope 2. The main rope 2 is winded around a drive sheave of a hoisting machine. The drive sheave is rotated by a drive force of the hoisting machine. The car 1 and the counterweight go up and down within a hoistway by rotation of the drive sheave. Within the hoistway, there are located a pair of the car guide rails 3 for guiding the hoisting of the car 1, and a pair of counterweight guide rails (not shown) for guiding the hoisting of the counterweight.

[0009] The travel of the car 1 and the counterweight is controlled by a control panel 4 of the elevator. To the control panel 4, respective pieces of information are transmitted from the following: a car speed detecting sensor 5 for detecting a speed of the car 1; a door opening and closing detecting sensor 6 for detecting the open/close state of a doorway (not shown) of the car 1; and a main rope breakage detecting sensor 7 for detecting the presence or absence of breakage of the main rope 2. As the car speed detecting sensor 5, there is used, for example, an encoder, a resolver, or the like, which generates a signal corresponding to a rotating speed of the drive sheave. As the door opening and closing detecting sensor 6, there is used, for example, a position sensor or the like for detecting a position of a door that opens or closes the doorway of the car 1. As the main rope breakage detecting sensor 7, there is used, for example, a tension detector or the like for detecting a tension of the main rope 2.

[0010] In the control panel 4, there is provided a brake command unit 8 for detecting the presence or absence of abnormality of the elevator on the basis of the respective information from the car speed detecting sensor 5, the door opening and closing detecting sensor 6, and the main rope breakage detecting sensor 7. The brake command unit 8 outputs a brake command when detecting the occurrence of an abnormality of the elevator.

[0011] The brake command unit 8 includes a computer having an arithmetic processing unit (CPU and the like), a storage unit (ROM, RAM, hard disc, and the like), and a signal input/output unit. The function of the brake command unit 8 can be realized by arithmetic processing due to the computer.

[0012] The car 1 is provided with a pair of emergency stop devices 9 being a brake device for grasping the car guide rails 3 and braking the car 1. Each of the emergency stop devices 9 executes brake operation for braking the car 1 upon receiving a brake command from the brake command unit 8.

[0013] FIG. 2 is a configuration diagram illustrating the emergency stop device 9 in FIG. 1. Further, FIG. 3 is a cross-sectional view taken along a line III-III of FIG. 2. Referring to the figure, the car 1 is fitted with a mounting frame 10. The mounting frame 10 is fixed with an upper guide rod 11 and a lower guide rod 12 which are vertically located at a distance to each other. The upper guide rod 11 and the lower guide rod 12 are arranged in parallel to each other and horizontally.

[0014] A housing 13 is disposed inside of the mounting frame 10. Slide guides 13a to 13d are located above and below the housing 13. The upper guide rod 11 passes through the slide guides 13a and 13c. The lower guide rod 12 passes through the slide guides 13b and 13d. With this configuration, the housing 13 is slidable along the upper guide rod 11 and the lower guide rod 12 with respect to the mounting frame 10. That is, the housing 13 is displaceable horizontally with respect to the car 1 and the car guide rails 3.

[0015] The housing 13 includes a housing main body 14, a mounting guide portion 15 that projects from the housing main body 14 toward the car guide rails 3, and an adjusting bolt mounting portion 16 (FIG. 3) that projects from the housing main body 14 toward an opposite side of the car guide rails 3.

[0016] The mounting guide portion 15 is displaced from the car guide rails 3 in a displacement direction of the housing 13. Further, the mounting guide portion 15 has a holder 15a that extends vertically, and a pair of horizontal members 15b and 15c that extend from each of an upper end and a lower end of the holder 15a toward the car guide rails 3.

[0017] The housing 13 is provided with a receiving brake member 17 and a rotatable brake member 18 which horizontally face each other through an intermediation of the car guide rails 3. That is, the receiving brake member 17 and the rotatable brake member 18 are located at a distance to each other horizontally, and the car guide rails 3 are intervened between the receiving brake member 17 and the rotatable brake member 18 with gaps therebetween. The receiving brake member 17 and the rotatable brake member 18 are allowed to come in or out of contact with the car guide rails 3 by displacement of the housing 13 with respect to the mounting frame 10, respectively.

[0018] The receiving brake member 17 is arranged between the respective horizontal members 15b and 15c. The

receiving brake member 17 is guided along the respective horizontal members 15b and 15c. The receiving brake member 17 is fixed with a plurality of stepped bolts 19 (two in this example) that pass through the holder 15a. Each of the stepped bolts 19 is slidable horizontally with respect to the holder 15a. As a result, the receiving brake member 17 is displaceable horizontally with respect to the housing 13.

[0019] Plate springs (pushing elements) 22 and an adjusting screw (adjusting member) 23 through which each common stepped bolt 19 passes through are arranged between the receiving brake member 17 and the holder 15a (that is, an opposite side of the receiving brake member 17 to the car guide rails 3).

[0020] The plate springs 22 are displaced toward a direction along which the receiving brake member 17 approaches the holder 15a so as to be compressed to create an elastic repelling force.

As a result, the receiving brake member 17 is urged toward a direction approaching the car guide rails 3 (that is, a direction apart from the holder 15a). Each of the adjusting screws 23 is screwed with each screw hole (not shown) defined in the holder 15a. The adjusting screws 23 each adjust a position of the receiving brake member 17 relative to the holder 15a and a magnitude of the elastic repelling force of the plate springs 22 by adjusting the screwed amount with respect to the holder 15a.

[0021] Each of the stepped bolts 19 passes through a washer 20 and is engaged with a retaining nut 21. The washer 20 and the retaining nut 21 are engageable with the holder 15a. The displacement of the receiving brake member 17 in a direction approaching the car guide rails 3 are regulated by engagement of the washer 20 and the retaining nut 21 with the holder 15a. The engagement of the washer 20 and the retaining nut 21 with the holder 15a prevents the receiving brake member 17 from coming off from the holder 15a.

[0022] The rotatable brake member 18 is fitted to a spindle (rotating shaft) 24 fixed horizontally to the housing main body 14 through the intermediation of a bearing 25. In this example, the bearing 25 is a slide bearing. As a result, the rotatable brake member 18 is rotatable vertically (that is, clockwise or counterclockwise in FIG. 2) about the spindle 24. The spindle 24 has a through-hole 26 (FIG. 3) that passes through the spindle 24 along a center line C. A coupling rod 27 that couples the rotatable brake members 18 of the respective emergency stop devices 9 with each other passes through the through-hole 26.

[0023] The coupling rod 27 is arranged coaxially with the spindle 24. Further, the coupling rod 27 is provided with a fitting portion 27a fastened to the rotatable brake member 18 by a fitting bolt 28 while avoiding the spindle 24 and the bearing 25. As a result, the coupling rod 27 is rotatable about the spindle 24 integrally with the rotatable brake member 18. Accordingly, the rotating amount of the rotatable brake members 18 of the respective emergency stop devices 9 is identical with each other.

[0024] The rotatable brake member 18 rotates in a direction corresponding to a travel direction of the car 1 while coming in contact with the car guide rails 3 when the rotatable brake member 18 comes in contact with the car guide rails 3 at the time of traveling the car 1. That is, when the rotatable brake member 18 comes in contact with the car guide rails 3, the rotatable brake member 18 rotates upward (that is, clockwise about the spindle 24 in FIG. 2) while the car 1 is lowered, and the rotatable brake member 18 rotates downward (that is, counterclockwise about the spindle 24 in FIG. 2) while the car 1 is raised.

[0025] The shape of the rotatable brake member 18 is made so that a distance of the rotatable brake member 18 to the receiving brake member 17 becomes continuously smaller by vertical rotation about the spindle 24. As a result, the distance between the rotatable brake member 18 and the receiving brake member 17 is the largest before the rotatable brake member 18 rotates, and becomes continuously smaller as the rotating amount of the rotatable brake member 18 gets larger.

[0026] The position of the rotatable brake member 18 before rotation is at a neutral position where the brake operation of the emergency stop devices 9 is canceled. The rotatable brake member 18 grasps the car guide rails 3 in cooperation with the receiving brake member 17 by vertical rotation from the neutral position.

[0027] The rotatable brake member 18 includes a rotatable brake main body 29, and an upper brake shoe 30 and a lower brake shoe 31 (a pair of brake shoes) which are provided on the rotatable brake main body 29.

[0028] The rotatable brake main body 29 includes a rotation stopper portion 32 that projects toward a space defined between the car guide rails 3 and the housing main body 14, and the rolling contact portion 33 whose distance relative to the receiving brake member 17 become continuously smaller even when the rotatable brake member 18 rotates in both of upper and lower directions. The rotation stopper portion 32 and the rolling contact portion 33 are displaced from each other along the center line C of the spindle 24.

[0029] The displacement route of the rotation stopper portion 32 when the rotatable brake member 18 rotates deviates from a range of the car guide rails 3. Accordingly, there is no case in which the rotation stopper portion 3 comes in contact with the car guide rails 3. The rolling contact portion 33 is allowed to come in or out of contact with the car guide rails 3 by horizontal displacement of the housing 13 with respect to the car guide rails 3.

[0030] The housing main body 14 is provided with a rotation regulating portion 34 for regulating the respective upper and lower rotating amounts from the neutral position of the rotatable brake member 18. The rotation regulating portion 34 includes an upper stopper holder 34a for regulating the upper rotating amount of the rotatable brake member 18,

and a lower stopper holder 34b for regulating the lower rotating amount of the rotatable brake member 18. The upper rotation of the rotatable brake member 18 is prevented by allowing the rotation stopper portion 32 to abut against the upper stopper holder 34a. Further, the lower rotation of the rotatable brake member 18 is prevented by allowing the rotation stopper portion 32 to abut against the lower stopper holder 34b.

[0031] In this example, the respective positions of the upper stopper holder 34a and the lower stopper holder 34b are predetermined so that the upper rotating amount of the rotatable brake member 18 becomes larger than the lower rotating amount of the rotatable brake member 18. When the rotation regulating portion 34 abuts against the upper stopper holder 34a, the lower brake shoe 31 comes in contact with the car guide rails 3, and when the rotation regulating portion 34 abuts against the lower stopper holder 34b, the upper brake shoe 30 comes in contact with the car guide rails 3.

[0032] The rolling contact portion 33 is configured along an outer peripheral surface of one cylinder having an axial line P eccentric to the center line C of the spindle 24. The position of the axial line P is located on a side opposite to the car guide rails 3 with respect to the center line C of the spindle 24. Further, the axial line P intersects with a line that passes through the center line C of the spindle 24 and extends along a direction in which the housing 13 is displaced from the car guide rails 3 (that is, a normal to the car guide rails 3 that passes through the center line C) A.

[0033] The upper brake shoe 30 and the lower brake shoe 31 are arranged to sandwich the rolling contact portion 33 therebetween in the circumferential direction of the rotatable brake main body 29. Further, the upper brake shoe 30 and the lower brake shoe 31 are arranged on a side opposite to the car guide rails 3 with respect to a plane that includes the center line C of the spindle 24 and is parallel to the car guide rails 3.

[0034] The upper brake shoe 30 has a brake surface 30a (friction surface) being a plane, and the lower brake shoe 31 has a brake surface 31a (friction surface) being a plane. The brake surface 30a projects from an upper end of the rolling contact portion 33 by a given amount, and the brake surface 31a projects from a lower end of the rolling contact portion 33 by a given amount. The brake surface 30a of the upper brake shoe 30 comes in contact with the car guide rails 3 when the rotation regulating portion 34 abuts against the lower stopper holder 34a. The brake surface 31a of the lower brake shoe 31 comes in contact with the car guide rails 3 when the rotation regulating portion 34 abuts against the upper stopper holder 34b. That is, the respective positions (and the respective angles) of the upper brake shoe 30 and the lower brake shoe 31 in the rotatable brake member 18 are determined so that the rotating amount until the brake surface 31a comes in contact with the car guide rails 3 becomes larger than the rotating amount until the brake surface 30a comes in contact with the car guide rails 3 when the rotatable brake member 18 rotates from a neutral position.

[0035] The rolling contact portion 33 comes in contact with the car guide rails 3 by displacement of the rotatable brake member 18 toward the car guide rails 3.

[0036] When the rolling contact portion 33 comes in contact with the car guide rails 3 while the car 1 is lowered, the rotatable brake member 18 is attracted to the car guide rails 3, and rotates upward from the neutral position. When the rotatable brake member 18 rotates upward while the rolling contact portion 33 is in contact with the car guide rails 3, the housing 13 is displaced toward a direction along which the spindle 24 is apart from the car guide rails 3 (that is, a direction along which the receiving brake member 17 approaches the car guide rails 3). As a result, the receiving brake member 17 comes in contact with the car guide rails 3.

[0037] When the car 1 continues to be lowered even after the receiving brake member 17 has come in contact with the car guide rails 3, the rotational receiving brake member 3 further rotates. After that, when the brake surface 31a of the lower brake shoe 31 comes in contact with the car guide rails 3, the car guide rails 3 are grasped between the receiving brake member 17 and the rotatable brake member 18. In this situation, the rotation stopper portion 32 abuts against the upper stopper holder 34a.

[0038] When the rolling contact portion 33 comes in contact with the car guide rails 3 while the car 1 is raised, the rotatable brake member 18 is attracted to the car guide rails 3, and rotates downward from the neutral position. When the rotatable brake member 18 rotates downward while the rolling contact portion 33 is in contact with the car guide rails 3, the housing 13 is displaced toward a direction along which the spindle 24 is apart from the car guide rails 3 (that is, a direction along which the receiving brake member 17 approaches the car guide rails 3). As a result, the receiving brake member 17 comes in contact with the car guide rails 3.

[0039] When the car 1 continues to be raised even after the receiving brake member 17 has come in contact with the car guide rails 3, the rotational receiving brake member 3 further rotates. After that, when the brake surface 30a of the upper brake shoe 30 comes in contact with the car guide rails 3, the car guide rails 3 are grasped between the receiving brake member 17 and the rotatable brake member 18. In this situation, the rotation stopper portion 32 abuts against the lower stopper holder 34b.

[0040] In this example, a frictional coefficient μ between the rolling contact portion 33 and the car guide rails 3 are set to be larger than a ratio γ (=LY/LX) of a dimension LY between the axial line P of the rolling contact portion 33 and the center line C of the spindle 24 in the Y-axis direction (direction along the car guide rails 3) to a dimension LX between the rail contact point of the rotatable brake member 18 and the center line C in the X-axis direction (displacement direction of the housing 13) (that is, $\gamma<\mu$ is satisfied). With this arrangement, the frictional force of the rotatable brake member 18 against the pressing force can be made larger than a return rotating force caused by the pressing force of the rotatable

brake member 18 (load exerted in a direction opposite to a rotating direction during braking), and the rotatable brake member 18 can be more surely rotated. In order to reduce a value of the dimensional ratio γ, a radius R of a cylindrical surface of the rolling contact portion 33 may be increased. Further, in order to increase the frictional coefficient μ, a structure in which the car guide rails 3 are guided by an oilless guide to prevent adhesion of oil may be applied, or a large number of fine projections biting into the car guide rails 3 may be disposed on the rolling contact portion 33.

[0041] The mounting frame 10 is provided with a displacement drive mechanism 35 (FIG. 3) for displacing the housing 13 with respect to the mounting frame 10. The displacement drive mechanism 35 includes a plurality of urging springs (urging bodies) 36 that urge the housing 13 in a direction along which the rotatable brake member 18 comes in contact with the car guide rails 3, and a hold/release mechanism (holding means) 37 that is capable of regulating a displacement of the housing 13 against an urging force of the urging springs 36.

[0042] The urging springs 36 are disposed between the slide guides 13a and 13b and one end of the mounting frame 10 (at a right end thereof in FIG. 3). As the urging springs 36, for example, a coil spring is used. The slide guides 13a and 13b pass through each of the urging springs 36.

[0043] The hold/release mechanism 37 includes a gap allocation adjustment bolt 38 disposed in an adjustment bolt mounting portion 16, a holding lever 39 that can be displaced with respect to the mounting frame 10, and enageable with the gap allocation adjustment bolt 38, a thumbtack 40 that abuts against the holding lever 39, and an electromagnetic magnet 41 that displaces the thumbtack 40 to displace the holding lever 39.

[0044] The electromagnetic magnet 41 includes a stator core 42 that is fixed to the mounting frame 10, an electromagnetic coil 43 that is incorporated into the stator core 42, and a moving core 44 that can be displaced with respect to the stator core 42.

[0045] The thumbtack 40 is fixed to a center of the moving core 44. A leading end of the thumbtack 40 is screwed with a plurality of adjustment nuts 45 for finely adjusting a length of the thumbtack 40.

[0046] The holding lever 39 is displaceable between a retention position (FIG. 3) that regulates the displacement of the housing 13 and a cancel position (FIG. 5) that cancels the regulation of the housing 13 in a state where the rotatable brake member 18 is apart from the car guide rails 3. The holding lever 39 is rotatably fitted to the mounting frame 10. The holding lever 39 is displaced between the retention position and the cancel position by rotation of the mounting frame 10. One end of the holding lever 39 is abutted against a leading end of the thumbtack 40. Another end of the holding lever 39 is abutted against the gap allocation adjustment bolt 38.

[0047] The gap allocation adjustment bolt 38 is screwed with the adjustment bolt mounting portion 16. Further, the gap allocation adjustment bolt 38 is pushed horizontally toward another end of the holding lever 39 by urging of the respective urging springs 36. The gap dimensions Δd1 and Δd2 (FIG. 2) between each of the rotatable brake member 18 and the receiving brake member 17, and the car guide rails 3 when the holding lever 39 is at the retention position (that is, the displacement of the housing 13 is regulated) are adjusted by adjusting the screwing amount of the gap allocation adjustment bolt 38 to the adjustment bolt mounting portion 16.

[0048] The moving core 44 is adsorbed and held by the stator core 42 by exciting the electromagnetic magnet 41. The thumbtack 40 is held by adsorption of the moving core 44 due to the stator core 42 so as not to move with respect to the stator core 42. The holding lever 39 is abutted against the thumbtack 40 held to the stator core 42, thereby being held to the retention position. That is, the displacement of the holding lever 39 from the retention position to the cancel position is regulated by excitation of the electromagnetic magnet 41.

[0049] The retention force of the electromagnetic magnet 41 is set so as to overcome the urging force against the housing 13 of each of the urging springs 36. Accordingly, the receiving brake member 17 and the rotatable brake member 18 are held to be apart from the car guide rails 3 by excitation of the electromagnetic magnet 41 (FIG. 2 and FIG. 3).

[0050] Further, the regulation of the displacement of the holding lever 39 to the cancel position is canceled by eliminating the retention force by stopping the excitation of the electromagnetic magnet 41. The holding lever 39 is rotated while being pushed against the gap allocation adjustment bolt 38 due to the urging force of the respective urging springs 36 when the retention force of the electromagnetic magnet 41 is eliminated, and then displaced to the cancel position from the retentionposition. As a result, the housing 13 is displaced toward a direction along which the rotatable brake member 18 comes in contact with the car guide rails 3.

[0051] Subsequently, the operation is described. FIG. 4 is a configuration diagram illustrating a state in which the rolling contact portion 33 of FIG. 2 comes in contact with the car guide rails 3, and FIG. 5 is a cross-sectional view taken along a line V-V of FIG. 4. Further, FIG. 6 is a configuration diagram illustrating a state in which the car guide rails 3 are grasped due to the upper rotation of the rotatable brake member 18 of FIG. 2, and FIG. 7 is a cross-sectional view taken along a line VII-VII of FIG. 6.

[0052] In a normal state, the electromagnetic magnet 41 is excited under the control of the control panel 4, and as illustrated in FIG. 3, the moving core 44 is held to be adsorbed by the stator core 42. In this state, the holding lever 39 is held to the retention position (FIG. 3) by abutment with the thumbtack 40 to regulate the rotation toward the cancel position (clockwise rotation in FIG. 3). Further, in this state, the engagement of the gap allocation adjustment bolt 38 against the holding lever 39 allows each of the rotatable brake member 18 and the receiving brake member 17 to be

apart from the car guide rails 3 through the given gap dimensions Δd1 and Δd2.

[0053] When the abnormality of the elevator is detected by the brake command unit 8, a brake command is output from the brake command unit 8 to the respective emergency stop devices 9. When the displacement drive mechanism 35 of each emergency stop devices 9 receives the brake command, the energization of the electromagnetic coil 43 stops, and the retention force of the electromagnetic magnet 41 is eliminated. As a result, the holding lever 39 is rotated from the retention position (FIG. 3) to the cancel position (FIG. 5) by the urging force of the respective urging springs 36 while being pushed against the gap allocation adjustment bolt 38. In this situation, the thumbtack 40 is displaced while being abutted against the holding lever 39.

[0054] With the displacement of the holding lever 39 to the cancel position, the housing 13 is displaced in a direction along which the rotatable brake member 18 comes in contact with the car guide rails 3 (left direction in FIG. 2 and FIG. 3) by the urging force of the respective urging springs 36. As a result, as illustrated in FIGS. 4 and 5, the rotatable brake member 18 comes in contact with the car guide rails 3.

[0055] When the rotatable brake member 18 comes in contact with the car guide rails 3 while the car 1 is lowered, the rotatable brake member 18 is attracted to the car guide rails 3, and rotates upward. In this situation, the rotatable brake member 18 is rotated while the rolling contact portion 33 comes in contact with the car guide rails 3 by the urging force of the respective urging springs 36. As a result, the housing 13 is displaced in a direction along which the spindle 24 is apart from the car guide rails 3, and the receiving brake member 17 is displaced in a direction approaching the car guide rails 3. As a result, the gap allocation adjustment bolt 38 is apart from the holding lever 39.

[0056] After that, when the rotatable brake member 18 further rotates upward and the lower brake shoe 31 reaches the car guide rails 3, the car guide rails 3 are grasped between the lower brake shoe 31 and the receiving brake member 17 as illustrated in FIGS. 6 and 7. In this state, the plate springs 22 are contracted by the displacement of the receiving brake member 17 pushed toward the car guide rails 3, and an elastic repelling force that allows the receiving brake member 17 to be pushed toward the car guide rails 3 are generated. Further, the rotation stopper portion 32 is abutted against the upper stopper holder 34a, and the brake surface 31a of the lower brake shoe 31 comes in contact with the car guide rails 3. As a result, the grasp force of the car guide rails 3 is ensured, and the braking force is supplied to the car 1.

[0057] Meanwhile, when the rotatable brake member 18 comes in contact with the car guide rails 3 while the car 1 is lowered, the rotatable brake member 18 is attracted to the car guide rails 3, and rotates downward. In this situation, the rotatable brake member 18 is rotated while the rolling contact portion 33 comes in contact with the car guide rails 3 by the urging force of the respective urging springs 36. As a result, the housing 13 is displaced in a direction along which the spindle 24 is apart from the car guide rails 3, and the receiving brake member 17 is displaced in a direction approaching the car guide rails 3. As a result, the gap allocation adjustment bolt 38 is apart from the holding lever 39.

[0058] After that, when the rotatable brake member 18 further rotates upward and the upper brake shoe 30 reaches the car guide rails 3, the car guide rails 3 are grasped between the upper brake shoe 30 and the receiving brake member 17. In this state, the plate springs 22 are contracted by the displacement of the receiving brake member 17 pushed toward the car guide rails 3, and an elastic repelling force that allows the receiving brake member 17 to be pushed toward the car guide rails 3 are generated. Further, the rotation stopper portion 32 is abutted against the lower stopper holder 34b, and the brake surface 30a of the upper brake shoe 30 comes in contact with the car guide rails 3. As a result, the grasp force of the car guide rails 3 is ensured, and the braking force is supplied to the car 1.

[0059] In this example, the respective positions of the upper stopper holder 34a and the lower stopper holder 34b are preset so that the upper rotating amount of the rotatable brake member 18 is larger than the lower rotating amount of the rotatable brake member 18. Accordingly, the braking force when the lower brake shoe 31 comes in contact with the car guide rails 3 are larger than the braking force when the upper brake shoe 30 comes in contact with the car guide rails 3. That is, the braking force generated in the car 1 due to the operation of the emergency stop devices 9 when the car 1 is lowered is larger than that when the car 1 is raised.

[0060] In the above-mentioned safety device for an elevator, the rolling contact portion 33 disposed in the rotatable brake member 18 is configured along the outer peripheral surface of one cylinder having the axial line P eccentric with respect to the center line C of the spindle 24. Therefore, the shape of the rotatable brake member 18 can be simplified, and the processing of the rotatable brake member 18 can be facilitated. With the above-mentioned configuration, the emergency stop devices 9 can be easily manufactured. Further, the vertical travel amount of the rotatable brake member 18 relative to the car 1 can be reduced. Accordingly, the vertical dimension can be reduced, and the emergency stop devices 9 can be downsized.

[0061] Further, the axial line P of the rolling contact portion 33 intersects with a normal to the car guide rails 3 that pass through the center line C of the spindle 24, and is located on a side opposite to the car guide rails 3 with respect to the center line C of the spindle 24. Therefore, the rotatable brake member 18 can be further downsized.

[0062] That is, FIG. 8 is a schematic diagram for describing the displacement of the rotatable brake member 18 in FIG. 2. FIG. 9 is a schematic diagram illustrating an example in which the position of the axial line of the cylinder when the rotatable brake member is at the neutral position is different from that of the rotatable brake member 18 in FIG. 2. It is assumed that a point is S at which the rolling contact portion comes in contact with the car guide rail, and in an X-

Y coordinate system in which the center line C is a center thereof, the respective positions (initial positions) of the axial line P and the contact point S are P1 and S1 when the rotatable brake member is at the neutral position. Further, it is assumed that the respective positions of the axial line P and the contact point S are P2 and S2 when the rotatable brake member rotates downward (counterclockwise).

[0063] Further, it is assumed that a dimension between the axial line P of the rolling contact portion and the center line C of the spindle is r, and a radius of the cylinder of the rolling contact portion is R. Further, it is assumed that an angle θ (initial angle) is formed between a line connecting the initial position P1 and the center line C to each other and a + portion of the X axis. Further, it is assumed that an angle α (rotating angle from the initial position P1 to the position P2) is formed between a line connecting the position P2 and the center line C to each other and a line connecting the initial position P1 and the center line C to each other.

[0064] When it is assumed that a distance (parallel travel distance of the rotatable brake member) between the contact point S1 and the contact point S2 in the X-axis direction is L, the parallel travel distance L of the rotatable brake member is represented by Expression (1).

[0065]

$$L=r\{\cos\theta-\cos(\theta+\alpha)\}\ldots(1)$$

[0066] Further, it is assumed that a maximum friction angle is β at which an angle (friction angle) formed between a line connecting the center line C and the contact point S to each other and a - portion of the X axis becomes the largest while the axial line P travels from the initial position P1 to the position P2. Then, in the case where the initial angle θ is equal to or lower than 90°, and a total value ($\theta+\alpha$) of the initial angle θ and the rotating angle α is equal to or higher than 90°, the maximum friction angle β is represented by Expression (2).

[0067]

$$\beta=\tan^{-1}(r/R)\ldots(2)$$

[0068] In the case where the initial angle θ is lower than 90°, and the total value ($\theta+\alpha$) of the initial angle θ and the rotating angle α is lower than 90°, the maximum friction angle β is represented by Expression (3).

[0069]

$$\beta=\tan^{-1}[r\cdot\sin(\theta+\alpha)/\{R-r\cdot\cos(\theta+\alpha)\}]\ldots(3)$$

[0070] Further, in the case where the initial angle θ is higher than 90°, and the total value ($\theta+\alpha$) of the initial angle θ and the rotating angle α is higher than 90°, the maximum friction angle β is represented by Expression (4).

[0071]

$$\beta=\tan^{-1}[r\cdot\sin\theta/\{R-r\cdot\cos\theta\}]\ldots(4)$$

[0072] In FIG. 8, suffix "a" is attached to the initial angle θ, the rotating angle α, the dimension r, and the radius R. In FIG. 9, suffix "b" is attached to the initial angle θ, the rotating angle α, the dimension r, and the radius R, which distinguishes a case in which the initial position P1 of the axial line P is on the X-axis from a case in which the initial position P1 of the axial line P is at a position different from that on the X-axis.

[0073] In this example, it is assumed that the initial angle θ_a=0°, and the rotating angle α_a=140° in FIG. 8, and the initial angle θ_b=90°, and the rotating angle α_b=45° in FIG. 9. Then, for the purpose of making the parallel travel distance L identical between FIG. 8 and FIG. 9, a relationship of Expression (5) needs to be satisfied from Expression (1).

[0074]

$$r_a\{\cos(0°)-\cos(0°+140°)\}=r_b\{\cos(90°)-\cos(90°+45°)\}\ldots(5)$$

[0075] When Expression (5) is organized, $r_a=0.4r_b$ is satisfied.

[0076] Further, for the purpose of making the maximum friction angle β identical between FIG. 8 and FIG. 9, a relationship of Expression (6) needs to be satisfied from Expression (2).

[0077]

$$\tan^{-1}(r_a/R_a)=\tan^{-1}(r_b/R_b)\ldots(6)$$

[0078] When Expression (6) is organized, $r_a/R_a=r_b/R_b$ is satisfied. Accordingly, a relationship of $R_a=0.4\ R_b$ is derived from Expressions (5) and (6). That is, when the parallel travel distance L and the maximum friction angle β are identical, the radius R_a in FIG. 8 is 0.4 times as large as the radius R_b in FIG. 9.

[0079] From the fact described above, the position of the axial line P of the rolling contact portion 33 is arranged on the + portion of the X-axis in the X-Y coordinate system centered on the center line C, thereby enabling the rotatable brake member 18 to be downsized.

[0080] Further, the rotatable brake member 18 is rotatable about the center line C in both of the upper and lower directions. Therefore, when the initial position P1 of the axial line P deviates from the X-axis, there is a need to arrange the initial position P1 of the axial line P at two portions symmetrical with respect to the X-axis. With this arrangement, the rolling contact portion is configured by coupling the outer peripheral surfaces of two cylinders together, and becomes complicated.

[0081] In this example, the initial position P1 of the axial line P is arranged on the X-axis, and hence even when the rotatable brake member 18 rotates in both of the upper and lower directions, a shape along one cylinder having the common axial line P can be identical with the shape of the rolling contact portion. Accordingly, the shape of the rolling contact portion can be simplified, and the rotatable brake member 18 can be easily manufactured. Further, for example, a knurling process and a process of forming a plurality of fine protrusions can be easily conducted on the rolling contact portion 33. Thus, the friction coefficient of the rolling contact portion 33 can be easily improved.

[0082] Further, the rotatable brake member 18 includes the rotatable brake main body 29 with the rolling contact portion 33, and the upper brake shoe 30 and the lower brake shoe 31 which are disposed in the rotatable brake main body 29, and sandwich the rolling contact portion 33 therebetween in the circumferential direction of the rotatable brake main body 29. The upper brake shoe 30 and the lower brake shoe 31 are provided with the brake surface 30a and the brake surface 31a which come in contact with the car guide rails 3, respectively. Therefore, a contact area when the car guide rails 3 are grasped can be increased, and the abrasion of the car guide rails 3 and the rotatable brake member 18 can be suppressed. Further, it is possible to set an appropriate braking force against the car 1, and hence an impact against the car 1 when the emergency stop devices 9 operate can be reduced.

[0083] Further, the upper brake shoe 30 and the lower brake shoe 31 are placed on a side opposite to the car guide rails 3 with respect to a plane including the spindle 24 and parallel to the car guide rails 3. Therefore, the rotating amount of the rotatable brake member 18 until the upper brake shoe 30 and the lower brake shoe 31 come in contact with the car guide rails 3 can be increased, and the rotatable brake member 18 can be downsized.

[0084] Further, the housing 13 is displaced by the displacement drive mechanism 35 with respect to the car 1 in a direction along which the rotatable brake member 18 comes in or out of contact with the car guide rails 3. Therefore, the operation of bringing the rotatable brake member 18 in contact with the car guide rails 3 can be formed in a short time. As a result, the operating time of the emergency stop devices 9 can be reduced.

[0085] Further, the respective positions of the upper stopper holder 34a and the lower stopper holder 34b are preset so that the braking force when the lower brake shoe 31 comes in contact with the car guide rails 3 are larger than the braking force when the upper brake shoe 30 comes in contact with the car guide rails 3. Therefore, the braking force having a magnitude corresponding to the travel direction of the car 1 can be generated. That is, the braking force required for preventing a raising of the car 1 is smaller than the braking force required for preventing a lowering of the car 1 when the main rope 2 is ruptured, the raising being caused by imbalance of the car 1 side and the counterweight side. For that reason, the operation of the emergency stop devices 9 allows the braking force generated in the car 1 to differ between the raising operation and the lowering operation of the car 1. As a result, the impact on the car 1 when the emergency stop devices 9 operate can be further reduced, and the security can be improved.

[0086] Further, the gap between each of the receiving brake member 17 and the rotatable brake member 18 and each of the car guide rails 3 can be adjusted by the gap allocation adjustment bolt 38 in the normal state. Therefore, for example, the malfunction of the emergency stop devices 9 can be prevent from occurring by the oscillation of the car 1 due to the biased load. Further, the gaps between each of the receiving brake member 17 and the rotatable brake member 18 and the car guide rail 3 can be adjusted in a state where the emergency stop devices 9 are mounted on the car 1, respectively. Thus the installation operation of the emergency stop devices 9 can be performed.

[0087] In the above example, the housing 13 is advanced in parallel to the car 1 so that the rotatable brake member

18 is brought in contact with the car guide rails 3, and the rotatable brake member 18 is rotated by travel of the car 1 relative to the car guide rails 3. Alternatively, there may be provided a rotary drive device for directly rotating the rotatable brake member 18, and the rotatable brake member 18 is rotated by only a drive force of the rotary drive device without advancing the housing 13 in parallel.

Embodiment 2

[0088] FIG. 10 is a configuration diagram illustrating the emergency stop device 9 in a safety device for an elevator according to Embodiment 2 of the present invention. FIG. 11 is a cross-sectional view taken along the line XI-XI of FIG. 10. In the figures, the rotatable brake member 18 includes a contact rotating body 51 rotatable about the spindle 24, a rotated body 52 which is provided with the upper brake shoe 30 and the lower brake shoe 31 so as to be rotatable about the spindle 24, and an engagement pin (engagement member) 53 that is disposed in the contact rotating body 51 and engaged with the rotated body 52 when the rotating amount of the contact rotating body 51 reaches a given amount. The rotated body 52 is arranged between the contact rotating body 51 and the housing main body 14.

[0089] The housing main body 14 is provided with an upper rotation regulating portion 54 for regulating an upper rotating amount of the rotated body 52, and a lower rotation regulating portion 55 for regulating a lower rotating amount of the rotated body 52. The upper rotation regulating portion 54 and the lower rotation regulating portion 55 are arranged on a side opposite to the car guide rails 3 with respect to a plane including the center line C of the spindle 24 and parallel to the car guide rails 3.

[0090] The rotated body 52 includes a driven main body 56, an upper stopper portion 57 that projects from the upper portion of the driven main body 56, and a lower stopper portion 58 that projects from the lower portion of the driven main body 56.

[0091] The upper rotation of the rotated body 52 is prevented by abutting the upper stopper portion 57 against the upper rotation regulating portion 54. The lower rotation of the rotated body 52 is prevented by abutting the lower stopper portion 58 against the lower rotation regulating portion 55.

[0092] The upper brake shoe 30 is disposed on the upper portion of the rotated body 52, and the lower brake shoe 31 is disposed on the lower portion of the rotated body 52. The upper brake shoe 30 and the lower brake shoe 31 are arranged on a side of the car guide rails 3 with respect to a plane including the center line C of the spindle 24 and parallel to the car guide rails 3. In this example, before the rotated body 52 rotates, an inclined angle of the brake surface 30a of the upper brake shoe 30 to the car guide rails 3 are set to +45°, and an inclined angle of the brake surface 31a of the lower brake shoe 31 to the car guide rails 3 are set to -45°.

[0093] The car guide rails 3 are grasped between the lower brake shoe 31 and the receiving brake member 17 by the upper rotation (clockwise rotation in FIG. 10) of the rotated body 52, and grasped between the upper brake shoe 30 and the receiving brake member 17 by the lower rotation (counterclockwise rotation in FIG. 10) of the rotated body 52.

[0094] The contact rotating body 51 is provided with the same rolling contact portion 33 as in Embodiment 1, and an upper notch portion 59 and a lower notch portion 60 (a pair of notch portions) which are formed between ends of the rolling contact portion 33 in the circumferential direction of the contact rotating body 51.

[0095] The rolling contact portion 33 is configured along the outer peripheral surface of one cylinder having the axial line P eccentric to the center line C of the spindle 24. The position of the axial line P is located on a side opposite to the car guide rails 3 with respect to the center line C of the spindle 24. Further, the axial line P intersects with the normal A to the car guide rails 3 that pass through the center line C.

[0096] The upper notch portion 59 is continuous with the upper end of the rolling contact portion 33. The lower notch portion 60 is continuous with the lower end of the rolling contact portion 33. Further, the upper notch portion 59 and the lower notch portion 60 is a plane formed inside of the outer peripheral surface of the cylinder along the rolling contact portion 33 in the radial direction.

[0097] The contact rotating body 51 is capable of coming in or out of contact with the car guide rails 3 by displacement of the housing 13 with respect to the mounting frame 10. The car guide rails 3 are brought in or out of contact with the rolling contact portion 33 of the contact rotating body 51. When the rolling contact portion 33 is in contact with the car 1, the contact rotating body 51 rotates in a direction corresponding to the travel direction of the car 1. That is, when the rolling contact portion 33 comes in contact with the car guide rails 3, the contact rotating body 51 rotates upward while the car 1 is lowered, and the contact rotating body 51 rotates downward while the car 1 is raised.

[0098] The distance between the rolling contact portion 33 and the receiving brake member 17 is the maximum before the contact rotating body 51 rotates, and gets continuously smaller as the rotating amount of the contact rotating body 51 is larger. The position of the contact rotating body 51 before rotation corresponds to the neutral position where the brake operation of the emergency stop devices 9 is canceled.

[0099] The engagement pin 53 is arranged so as to be included in a plane including both of the center line C of the spindle 24 and the axial line P of the rolling contact portion 33. Further, the position of the engagement pin 53 corresponds to a side opposite to the center line C with respect to the axial line P. Further, the engagement pin 53 projects from the

contact rotating body 51 toward the housing main body 14.

[0100] When the contact rotating body 51 rotates downward from the neutral position by a given amount, the engagement pin 53 is engaged with the upper portion of the rotated body 52. After that, when the contact rotating body 51 further rotates, the rotated body 52 rotates together with the contact rotating body 51 while the engagement pin 53 is engaged with the rotated body 52. When the engagement pin 53 is engaged with the upper portion of the rotated body 52, because the upper notch portion 59 is provided to the contact rotating body 51, the contact rotating body 51 does not project from the upper brake shoe 30 toward the outside in the radial direction.

[0101] When the contact rotating body 51 rotates upward from the neutral position by a given amount, the engagement pin 53 is engaged with the lower portion of the rotated body 52. After that, when the contact rotating body 51 further rotates, the rotated body 52 rotates together with the contact rotating body 51 while the engagement pin 53 is engaged with the rotated body 52. When the engagement pin 53 is engaged with the lower portion of the rotated body 52, because the lower notch portion 60 is provided to the contact rotating body 51, the contact rotating body 51 does not project from the upper brake shoe 30 toward the outside in the radial direction.

[0102] The lower portion of the rotated body 52 is provided with a recess 61 for receiving the engagement pin 53. When the upper rotation of the contact rotating body 51 allows the engagement pin 53 to be engaged with the lower portion of the rotated body 52, the engagement pin 53 abuts against an inner surface of the recess 61. The upper rotating amount of the contact rotating body 51 until the engagement pin 53 is engaged with the lower portion of the rotated body 52 is determined according to a depth of the recess 61.

[0103] The recess 61 is formed in only the lower portion of the rotated body 52, but not formed in the upper portion of the rotated body 52. That is, the rotating amount of the contact rotating body 51 until the engagement pin 53 is engaged with the rotated body 52 when rotating downward is smaller than that when rotating upward. Other configurations are identical with those of Embodiment 1.

[0104] Then, the operation is described. As in Embodiment 1, when the housing 13 is displaced with respect to the mounting frame 10, the rolling contact portion 33 of the contact rotating body 51 comes in contact with the car guide rails 3.

[0105] FIG. 12 is a main configuration diagram illustrating a state in which the rolling contact portion 33 of the contact rotating body 51 in FIG. 10 is in contact with the car guide rails 3. FIG. 13 is a main configuration diagram illustrating a state in which the engagement pin 53 is engaged with the lower portion of the rotated body 52 by rotation of the contact rotating body 51 in FIG. 12.

FIG. 14 is a main configuration diagram illustrating a state in which the car guide rail 3 is grasped by the upper rotation of the contact rotating body 51 and the rotated body 52.

[0106] When the rolling contact portion 33 comes in contact with the car guide rails 3 while the car 1 is lowered (FIG. 12), the contact rotating body 51 is attracted by the car guide rails 3, and rotates upward. With this operation, the housing 13 is displaced in a direction along which the spindle 24 is apart from the car guide rails 3, and displaced in a direction along which the receiving brake member 17 approaches the car guide rails 3.

[0107] After that, when the contact rotating body 51 further rotates upward, and the rotating amount of the contact rotating body 51 reaches a given amount, the engagement pin 53 is engaged with the recess 61 formed in the lower portion of the rotated body 52 (FIG. 13). After that, when the contact rotating body 51 further rotates upward, the rotated body 52 rotates upward together with the contact rotating body 51 while the engagement pin 53 is engaged with the recess 61.

[0108] When the rotated body 52 rotates upward together with the contact rotating body 51, and the lower brake shoe 31 reaches the car guide rails 3 (FIG. 14), the car guide rails 3 are grasped between the lower brake shoe 31 and the receiving brake member 17. In this situation, the upper stopper portion 57 is abutted against the upper rotation regulating portion 54, and the brake surface 31a of the lower brake shoe 31 comes in contact with the car guide rails 3. As a result, the grasp force of the car guide rails 3 is ensured, and the braking force is applied to the car 1.

[0109] Meanwhile, when the rolling contact portion 33 comes in contact with the car guide rails 3 while the car 1 is raised, the contact rotating body 51 is attracted by the car guide rails 3, and rotates downward. With this operation, the housing 13 is displaced in a direction along which the spindle 24 is apart from the car guide rails 3, and displaced in a direction along which the receiving brake member 17 approaches the car guide rails 3.

[0110] After that, when the contact rotating body 51 further rotates downward, and the rotating amount of the contact rotating body 51 reaches a given amount, the engagement pin 53 is engaged with the upper portion of the rotated body 52. After that, the contact rotating body 51 further rotates downward, so that the rotated body 52 rotates downward together with the contact rotating body 51 while the engagement pin 53 is engaged with the upper portion of the rotated body 52.

[0111] When the rotated body 52 rotates downward together with the contact rotating body 51, and the upper brake shoe 30 reaches the car guide rails 3, the car guide rails 3 are grasped between the upper brake shoe 30 and the receiving brake member 17. In this situation, the lower stopper portion 58 is abutted against the lower rotation regulating portion 55, and the brake surface 30a of the upper brake shoe 30 comes in contact with the car guide rails 3. As a result, the grasp force of the car guide rails 3 is ensured, and the braking force is applied to the car 1.

[0112] The recess 61 is formed in the lower portion of the rotated body 52, and hence the rotating amount of the contact rotating body 51 until the engagement pin 53 is engaged with the rotated body 52 when rotating downward is lower than that when rotating upward. Accordingly, the braking force when the lower brake shoe 31 comes in contact with the car guide rails 3 are larger than the braking force when the upper brake shoe 30 comes in contact with the car guide rails 3. That is, the braking force generated in the car 1 through the operation of the emergency stop devices 9 when the car 1 is lowered is larger than that when the car 1 is raised.

[0113] In the above-mentioned safety device for an elevator, the contact rotating body 51 provided with the rolling contact portion 33, and the rotated body 52 provided with the upper brake shoe 30 and the lower brake shoe 31 are separated from each other. The contact rotating body 51 and the rotated body 52 are rotatable about the common spindle 24. The engagement pin 53 that is engaged with the rotated body 52 when the rotating amount of the contact rotating body 51 reaches a given amount is provided to the contact rotating body 51. With the above configuration, the contact rotating body 51 may have a substantially disc shape, and hence the shape of the contact rotating body 51 can be simplified. Accordingly, the process of the contact rotating body 51 can be facilitated. Further, there is no need to arrange the upper brake shoe 30 and the lower brake shoe 31 on an opposite side of the car guide rails 3 with respect to the spindle 24. Therefore, the upper brake shoe 30 and the lower brake shoe 31 can be arranged at positions apart from each other. Accordingly, the areas of the respective brake surfaces 30a and 31a of the upper brake shoe 30 and the lower brake shoe 31 can be increased. As a result, the contact area when the car guide rails 3 are grasped can be increased, and hence it is possible to set an appropriate braking force against the car 1. Accordingly, the impact on the car 1 when the emergency stop devices 9 operate can be reduced. Further, the vertical displacement amount of the contact rotating body 51 and the rotated body 52 with respect to the car 1 can be reduced, and hence the vertical dimension can be also reduced.

[0114] Further, the lower portion of the rotated body 52 is formed with the recess 61 engageable with the engagement pin 53, and hence the depth of the recess 61 is adjusted so that the rotating amount of the contact rotating body 51 until the engagement pin 53 is engaged with the rotated body 52 can be easily adjusted. Accordingly, the respective projecting amounts(projecting margins) of the upper brake shoe 30 and the lower brake shoe 31 are adjusted according to adjustment of the rotating amount of the rotated body 52. As a result, the braking force when the emergency stop devices 9 operate may be different from each other between the raising operation and the lowering operation of the car 1. Accordingly, the braking force when the car 1 is lowered can be larger than the braking force in the raising operation, the impact on the car 1 when the emergency stop devices 9 operates can be reduced, and the security can be improved.

[0115] Further, the engagement pin 53 provided to the contact rotating body 51 is engaged with the rotated body 52. Thus, the rotated body 52 rotates together with the contact rotating body 51. Therefore, even when the position of the engagement pin 53 relative to the contact rotating body 51 is adjusted, the rotating amount of the contact rotating body 51 until the engagement pin 53 is engaged with the rotated body 52 can be easily adjusted. Even with this configuration, the respective projecting amounts (projecting margins) of the upper brake shoe 30 and the lower brake shoe 31 are adjusted according to adjustment of the rotating amount of the rotated body 52. As a result, the braking force when the emergency stop devices 9 operate may be different from each other between the raising operation and the lowering operation of the car 1. Accordingly, the braking force when the car 1 is lowered can be larger than the braking force in the raising operation, the impact on the car 1 when the emergency stop devices 9 operates can be reduced, and the security can be improved.

[0116] In the above example, the housing 13 is advanced in parallel to the car 1 so that the contact rotating body 51 is brought in contact with the car guide rails 3, and the contact rotating body 51 is rotated by travel of the car 1 relative to the car guide rails 3. Alternatively, there may be provided a rotary drive device for directly rotating the contact rotating body 51, and the contact rotating body 51 is rotated by only a drive force of the rotary drive device without advancing the housing 13 in parallel. Even with this configuration, the rotated body 52 is rotated together with the contact rotating body 51 so that the upper brake shoe 30 and the lower brake shoe can be brought in contact with the car guide rails 3.

[0117] Further, the sensors in the above embodiments are not limited to the car speed detecting sensor 5, the door opening and closing detecting sensor 6, and the main rope breakage detecting sensor 7.

Claims

1. A safety device for an elevator, comprising:

a housing that is supported by a car guided along a guide rail, and displaceable horizontally with respect to the guide rail;
a receiving brake member disposed in the housing; and
a rotatable brake member that is arranged at a distance from the receiving brake member so that the guide rail is interposed between the rotatable brake member and the receiving brake member, is vertically rotatable about

a rotating shaft disposed in the housing, and grasps the guide rail in cooperation with the receiving brake member by the vertical rotation about the rotating shaft;

wherein the rotatable brake member comprises a rolling contact portion whose distance from the receiving brake member is continuously smaller even when the rotatable brake member rotates in any one of upper and lower directions, and
wherein the rolling contact portion is configured along an outer peripheral surface of one cylinder having an axial line eccentric to a center line of the rotating shaft.

2. A safety device for an elevator according to claim 1, wherein the axial line of the rolling contact portion intersects with a normal to the guide rail that passes through the center line of the rotating shaft, and is located on a side opposite to the guide rail with respect to the rotating shaft.

3. A safety device for an elevator according to claim 1,
wherein the rotatable brake member comprises : a rotatable brake main body provided with the rolling contact portion; and a pair of brake shoes that are disposed in the rotatable brake main body, and sandwiches the rolling contact portion therebetween in a circumferential direction of the rotatable brake main body, and
wherein each of the brake shoes has a brake surface that comes in contact with the guide rail when the guide rail is grasped between the receiving brake member and the rotatable brake member.

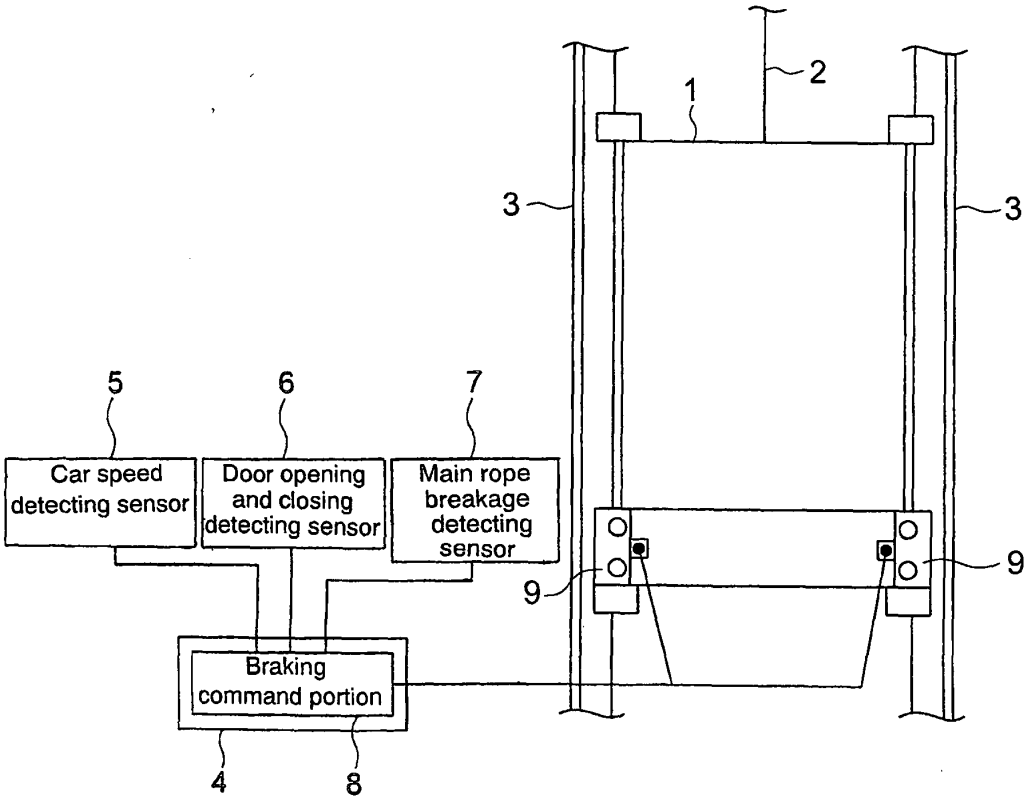
4. A safety device for an elevator according to claim 3, wherein each of the brake shoes is arranged on a side opposite to the guide rail with respect to a plane including the center line of the rotating shaft and parallel to the guide rail.

5. A safety device for an elevator according to claim 1, wherein the rotatable brake member comprises:

a contact rotating body provided with the rolling contact portion and rotatable about the rotating shaft;
a rotated body rotatable about the rotating shaft and provided with a pair of brake shoes each having a brake surface that comes in contact with the guide rail when the guide rail is grasped between the receiving brake member and the rotatable brake member; and
an engagement member provided to the contact rotating body and engaged with the rotated body when a rotating amount of the contact rotating body reaches a given amount.

6. A safety device for an elevator according to claim 1, further comprising: a displacement drive mechanism that displaces the housing with respect to the car in a direction along which the rotatable brake member comes in or out of contact with the guide rail.

FIG. 1


1
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7
Car speed detecting sensor
Door opening and closing detecting sensor
Main rope breakage detecting sensor
9
9
Braking command portion
4
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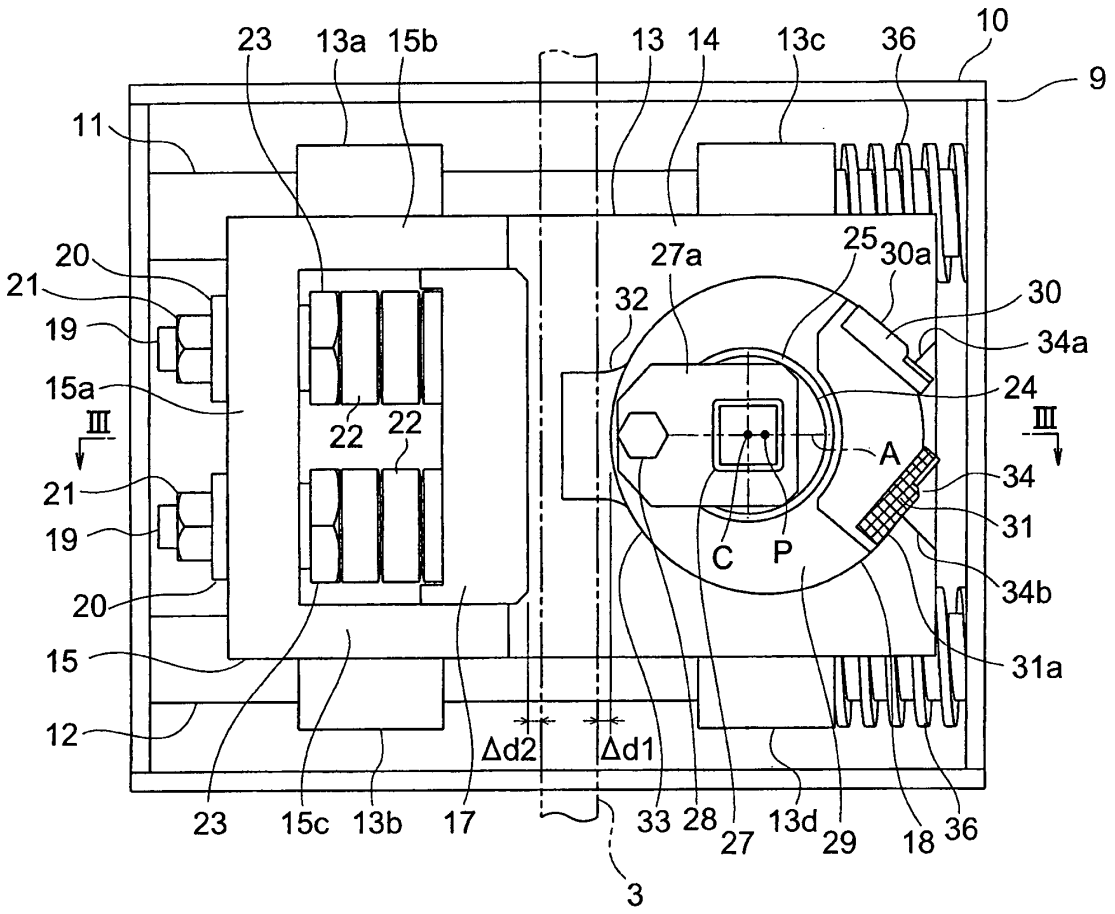
FIG. 2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27a
25
30a
32
30
34a
24
22
22
A
III
34
31
C
P
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FIG. 3

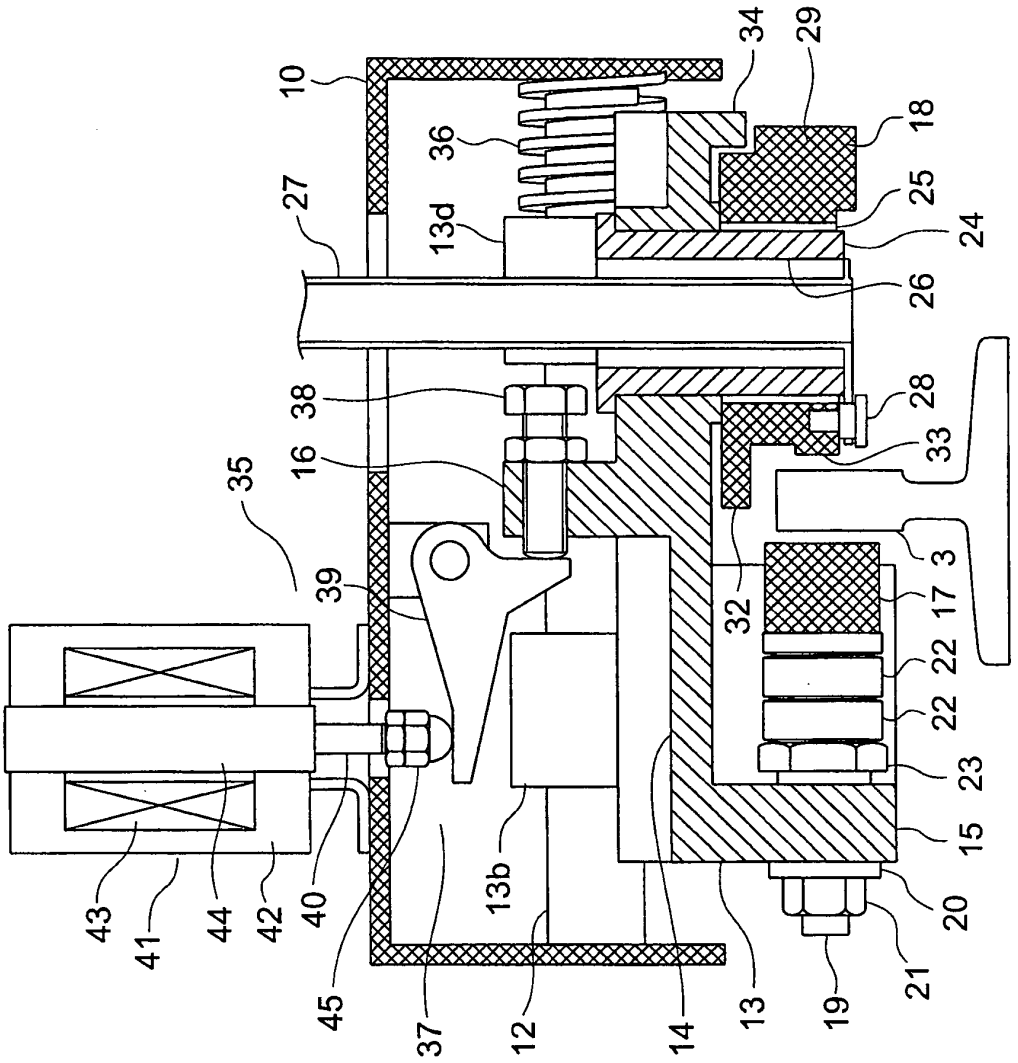
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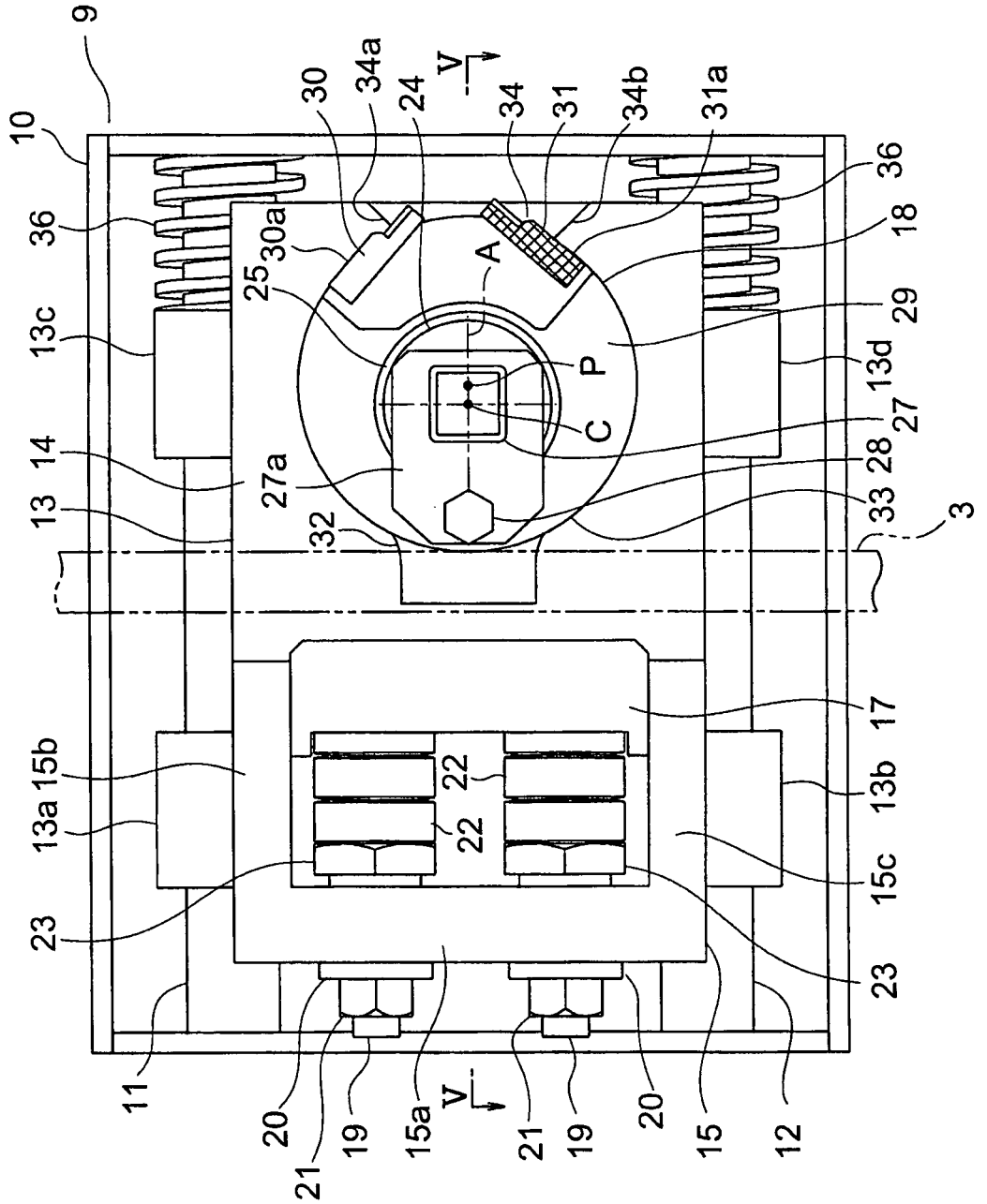
FIG. 4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34b
31a
30a
25
A
P
C
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28
33
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17
13b
15c
12
15

FIG. 5

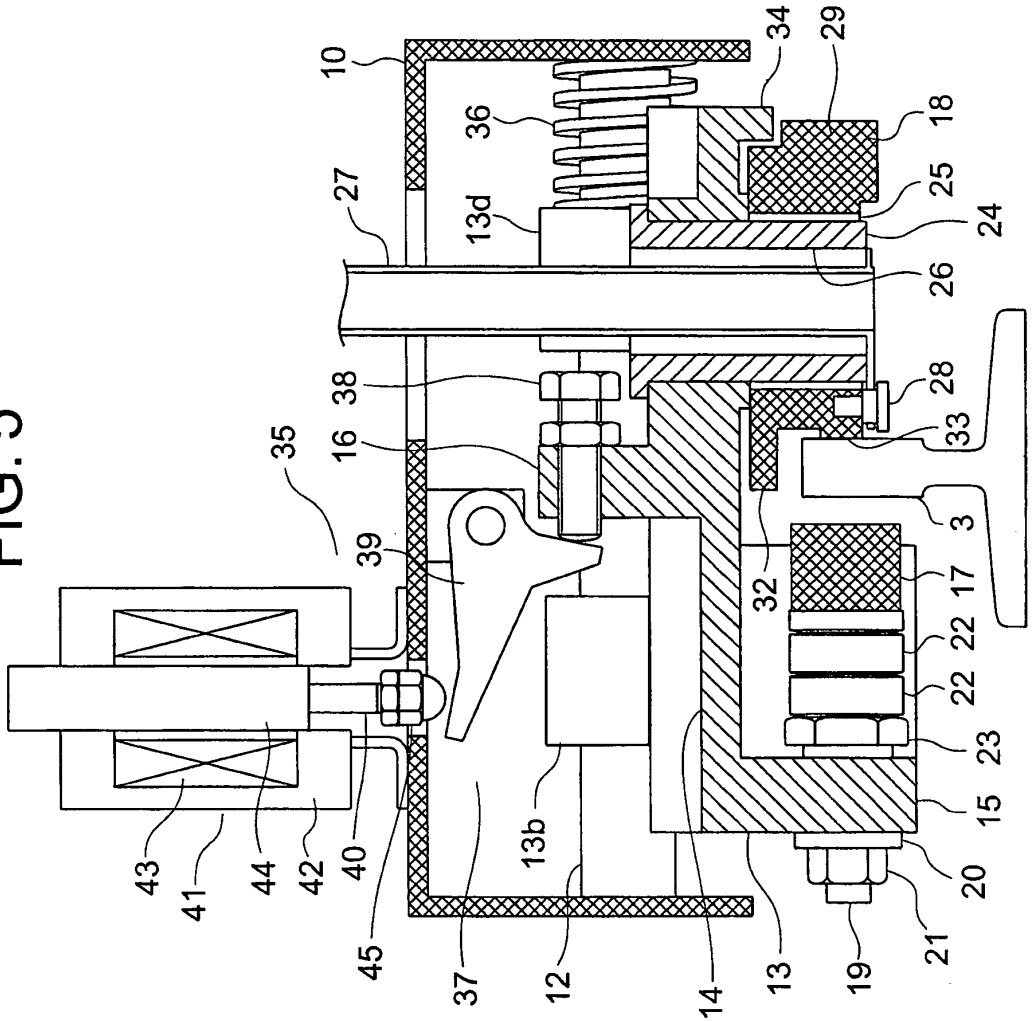
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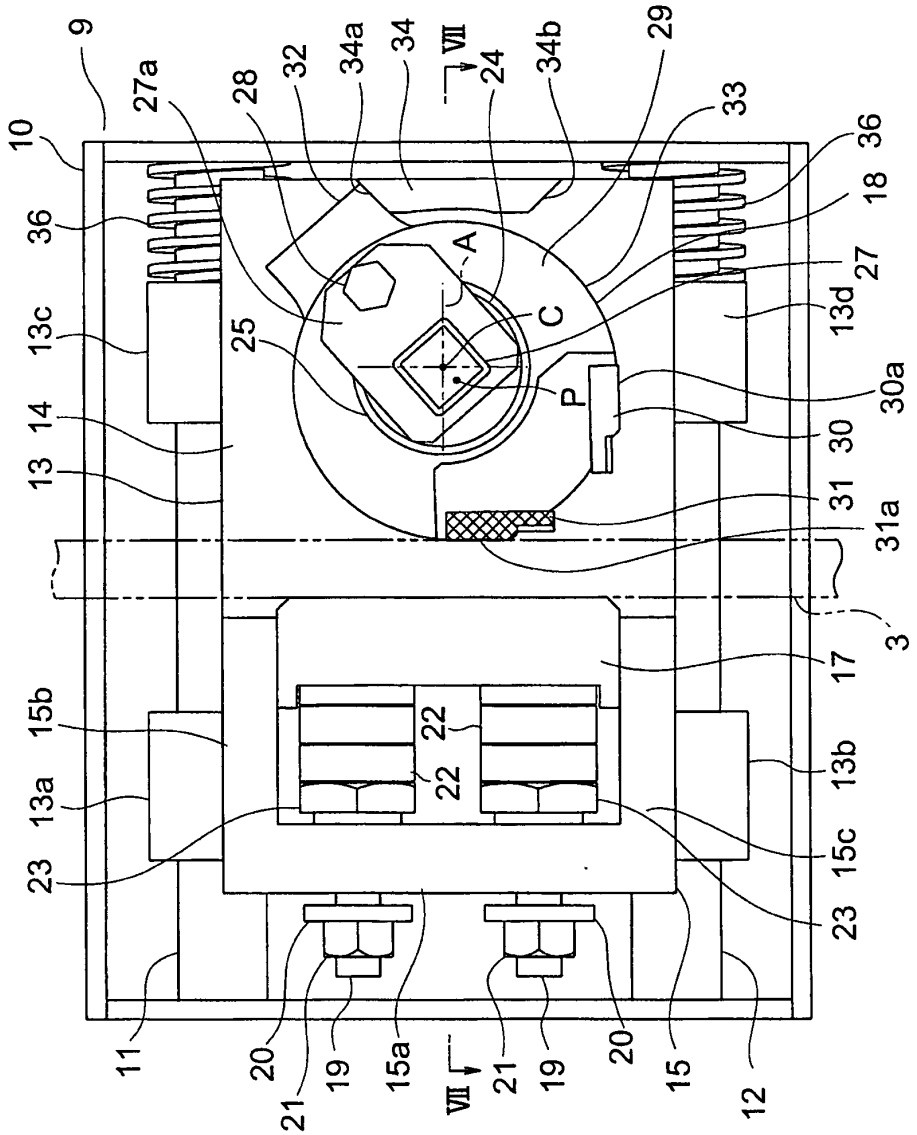
FIG. 6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30
13
31
31a
3
17
15b
22
22
13b
13a
15c
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23
11
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21
19
15a
VII
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FIG. 7

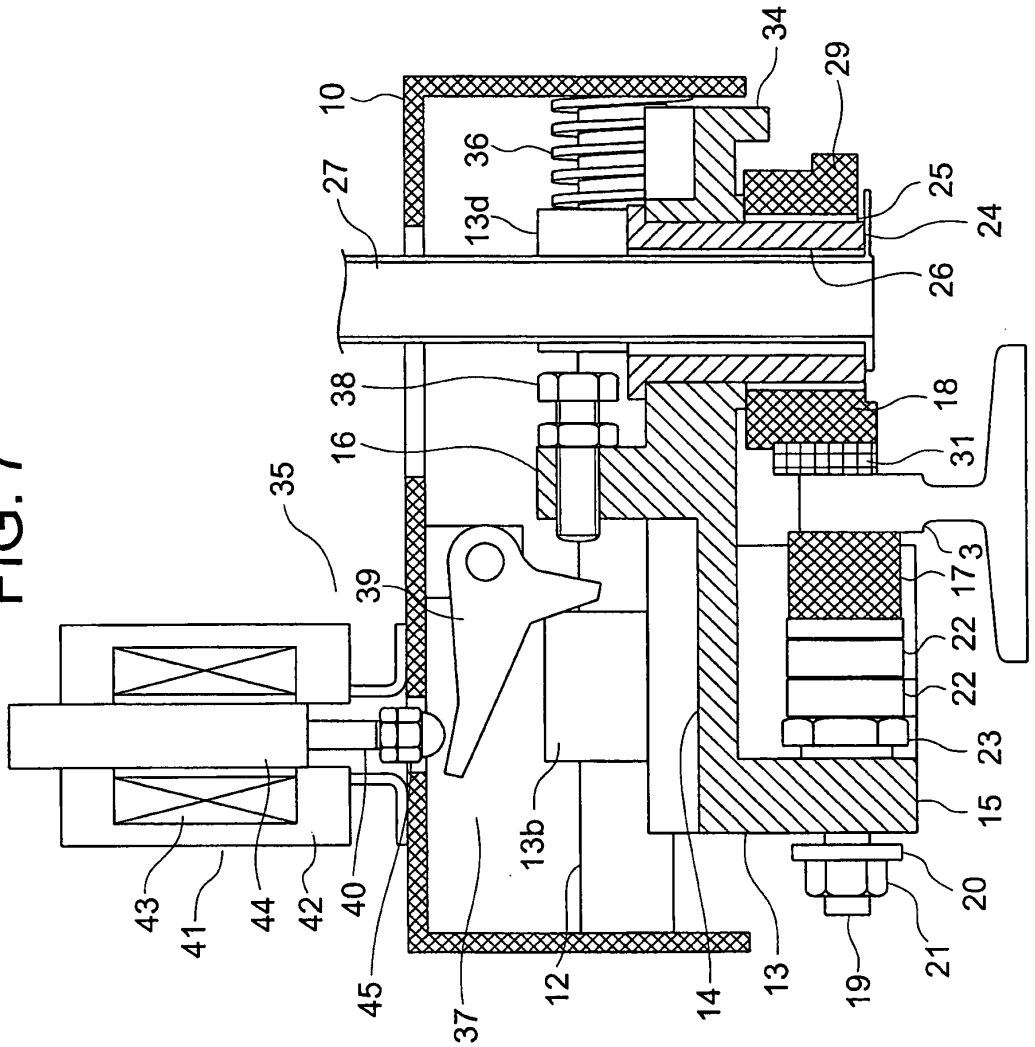
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FIG. 8

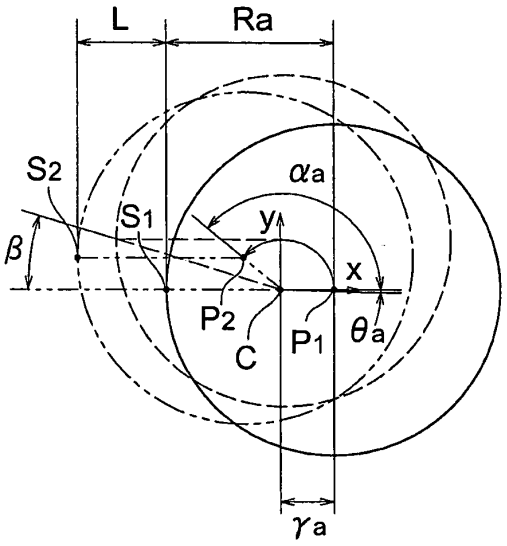


FIG. 9

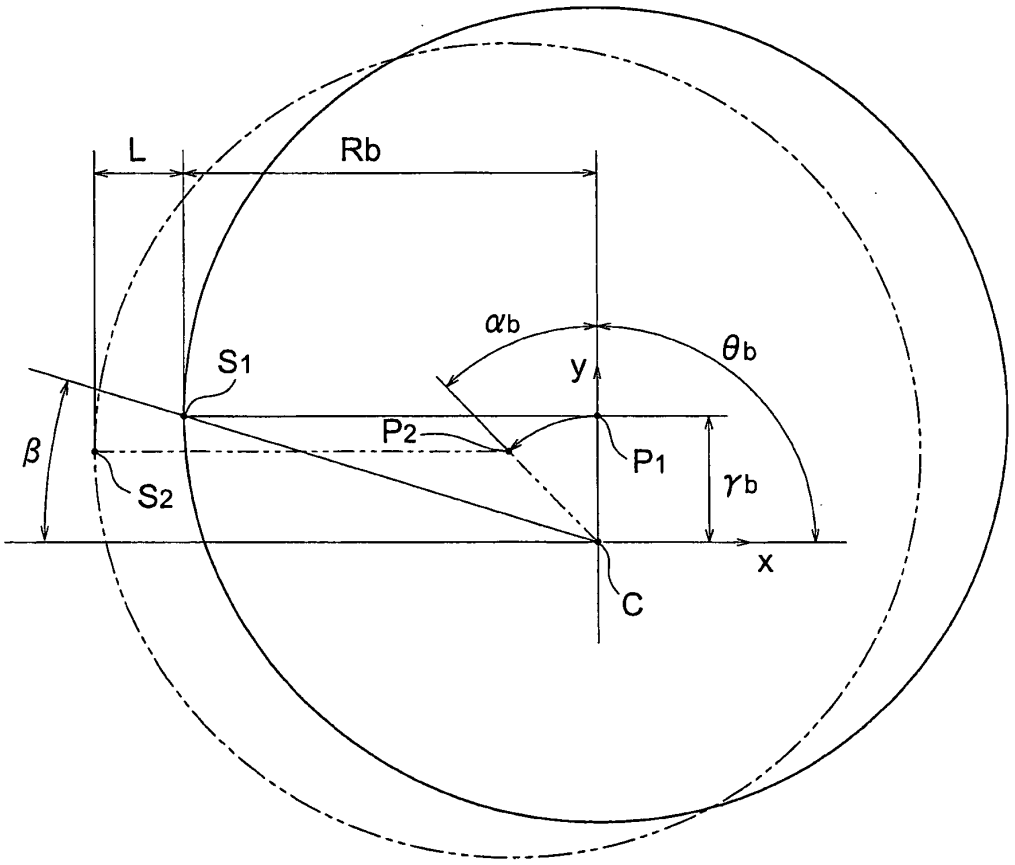
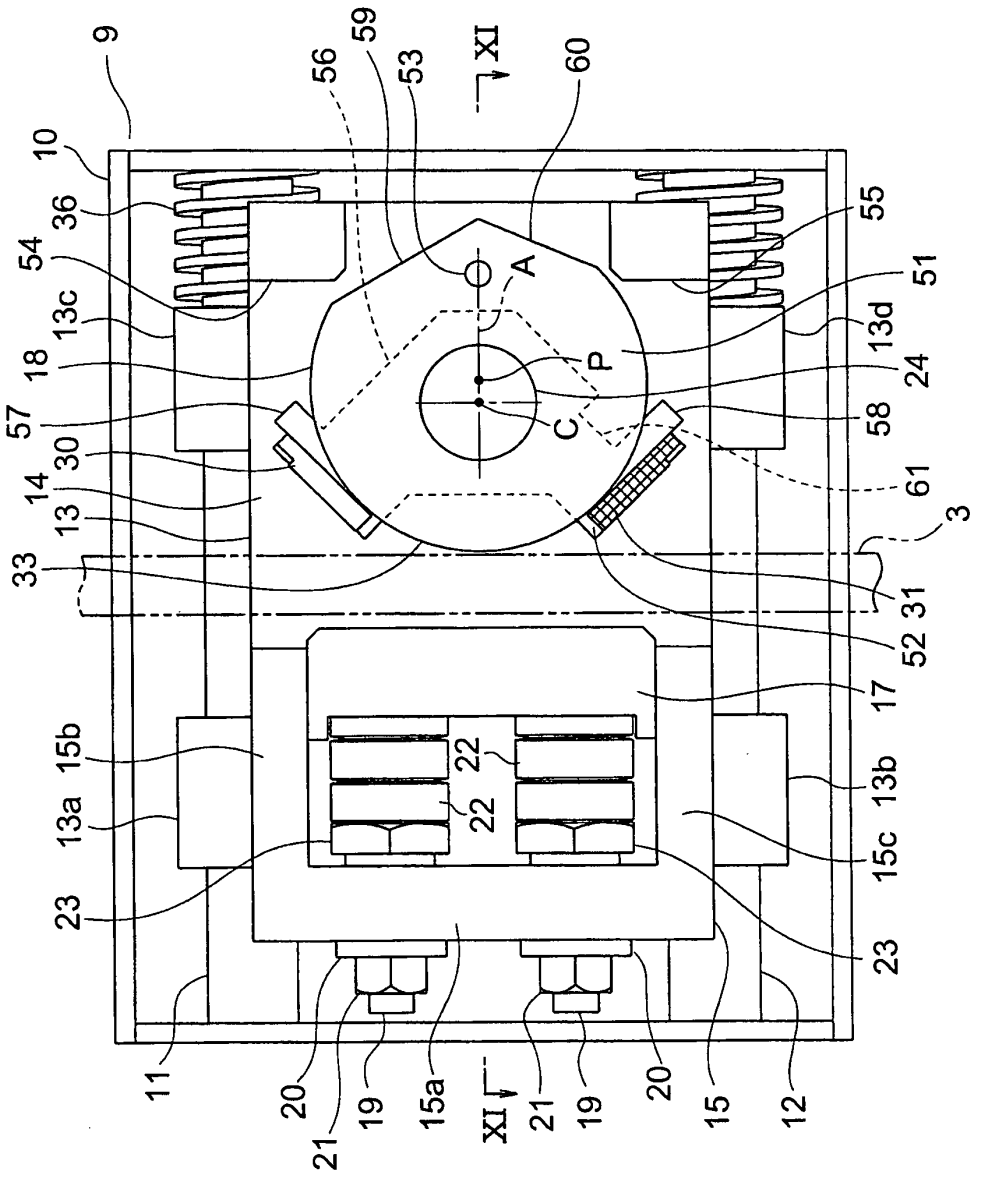


FIG. 10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XI
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13d
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3
31
52
17
13b
15c
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A
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FIG. 11

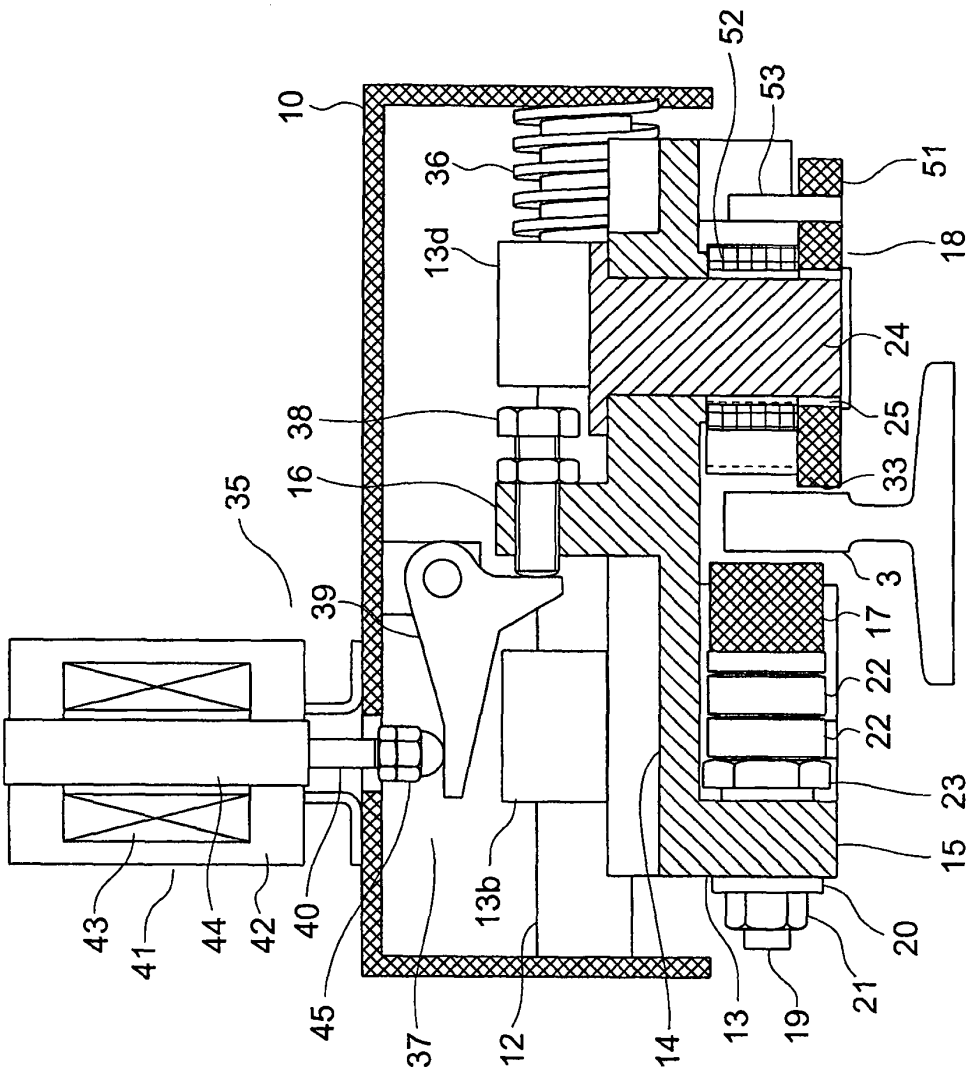
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FIG. 12

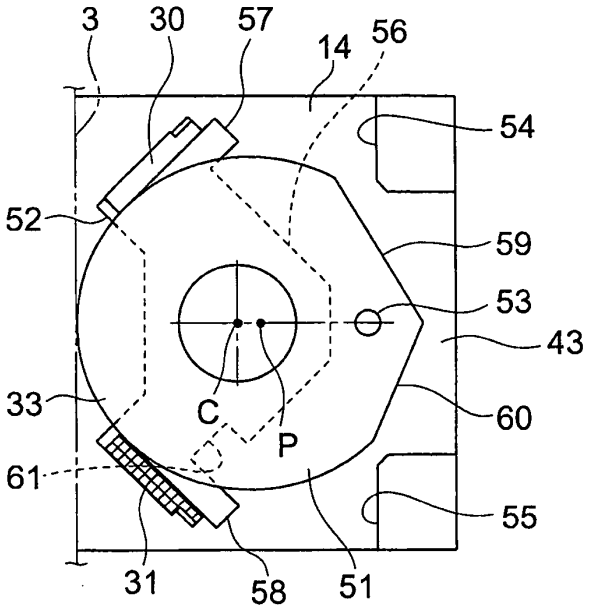
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FIG. 13

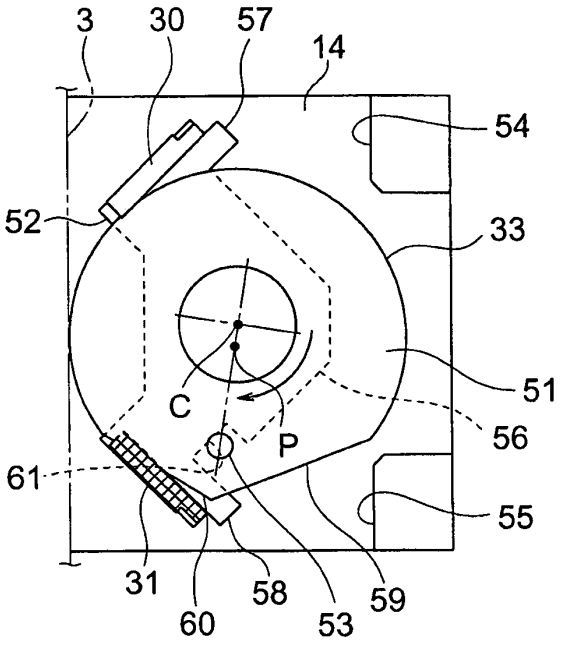
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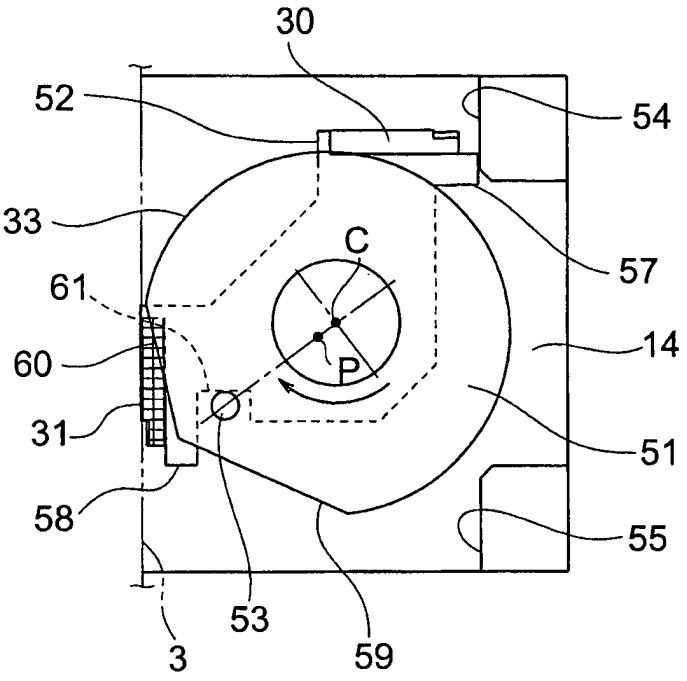
FIG. 14



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/069005

A. CLASSIFICATION OF SUBJECT MATTER
B66B5/20(2006.01)i

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)
B66B5/20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2008
Kokai Jitsuyo Shinan Koho 1971-2008 Toroku Jitsuyo Shinan Koho 1994-2008

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2006-347771 A (Inventio AG.), 28 December, 2006 (28.12.06), & US 2007/0007083 A1 & EP 1733992 A1 & KR 10-2006-0132506 A & CN 1880208 A	1-6
Y	US 6176350 B1 (AUTZUGSTECHNOLOGIE SCHLOSSER GMBH), 23 January, 2001 (23.01.01), & EP 0899231 A1	1-6

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 June, 2008 (16.06.08)	24 June, 2008 (24.06.08)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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Patent documents cited in the description

- WO 03008317 A **[0003]**