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

(11) **EP 2 112 116 A1**

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

(43) Date of publication:
28.10.2009 Bulletin 2009/44

(21) Application number: **07714231.3**

(22) Date of filing: **15.02.2007**

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

(86) International application number:
PCT/JP2007/052701

(87) International publication number:
WO 2008/099487 (21.08.2008 Gazette 2008/34)

(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 NL PL PT RO SE SI SK TR

(71) Applicant: **Mitsubishi Electric Corporation**
Chiyoda-ku
Tokyo 100-8310 (JP)

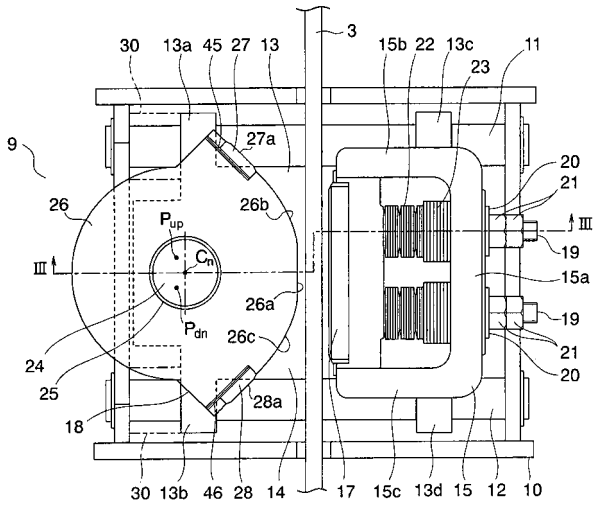
(72) Inventors:
- **MARUYAMA, Naoyuki**
  Tokyo 100-8310 (JP)
- **ANDO, Eiji**
  Tokyo 100-8310 (JP)
- **KIGAWA, Hiroshi**
  Tokyo 100-8310 (JP)
- **YUMURA, Takashi**
  Tokyo 100-8310 (JP)
- **OKADA, Mineo**
  Tokyo 100-8310 (JP)

(74) Representative: **HOFFMANN EITLE**
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

(54) SAFETY DEVICE FOR ELEVATOR

(57) In an elevator safety apparatus, a bearing rail stopper and a pivoting rail stopper are disposed in a housing that is displaceable horizontally relative to a car. A guide rail that guides the car is disposed between the bearing rail stopper and the pivoting rail stopper. A distance between the bearing rail stopper and the pivoting rail stopper is reduced by vertical pivoting of the pivoting rail stopper. The housing can be displaced by a displacement driving mechanism in a direction in which the pivoting rail stopper contacts or separates from the guide rail. The guide rail can be gripped between the pivoting rail stopper and the bearing rail stopper by the pivoting rail stopper being pivoted in a direction that corresponds to a direction of movement of the car while contacting the guide rail.

FIG. 2



EP 2 112 116 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to an elevator safety apparatus that can brake running of a car in either vertical direction.

BACKGROUND ART

[0002] Conventionally, elevator apparatuses have been proposed that include a wedge-type emergency stop device in which braking is activated electrically if an elevator abnormality has occurred. In these conventional elevator apparatuses, a braking force is applied to a car by displacing a wedge using an electromagnetic actuator to engage the wedge between a guide rail that guides the car and a bracket that is disposed on the car (see Patent Literature 1, for example).

[0003] Conventionally, elevator safety apparatuses have also been proposed that perform the car braking action by combining actions of a pair of electromagnets to pivot a pivoting member vertically. A top braking shoe and a bottom braking shoe are disposed on the pivoting member. A guide rail that guides the car is gripped between the bottom braking shoe and a fixed shoe by upward pivoting of the pivoting member, and is gripped between the top braking shoe and the fixed shoe by downward pivoting of the pivoting member. The car is braked by the guide rail being gripped between either the top braking shoe or the bottom braking shoe and the fixed shoe (see Patent Literature 2, for example).

[0004]

[Patent Literature 1]
W02004/083091
[Patent Literature 2]
European Patent Application Publication No. 1460020 (Specification)

DISCLOSURE OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0005] However, in the elevator apparatus that is disclosed in Patent Literature 1, a plurality of emergency stop devices that perform a braking action individually either in an upward direction or in a downward direction must be mounted to the car. Consequently, in order to perform a braking action on the car in either vertical direction, the emergency stop device as a whole is enlarged.

[0006] In the elevator safety apparatus that is disclosed in Patent Literature 2, because a pair of electromagnets must be used in order to pivot the pivoting member, the drive portion is also enlarged.

[0007] The present invention aims to solve the above problems and an object of the present invention is to provide an elevator safety apparatus that can achieve reductions in size, and that can perform a car braking action in either vertical direction more reliably and in a shorter amount of time.

MEANS FOR SOLVING THE PROBLEM

[0008] In order to achieve the above object, according to one aspect of the present invention, there is provided an elevator safety apparatus characterized in including: a housing that is supported by a car that is guided by a guide rail, and that is displaceable horizontally relative to the car; a bearing rail stopper that is disposed on the housing; a pivoting rail stopper that is disposed on the housing such that the guide rail is disposed between the pivoting rail stopper and the bearing rail stopper, and that can be pivoted vertically such that a distance to the bearing rail stopper is reduced by the vertical pivoting; and a displacement driving mechanism that displaces the housing relative to the car in a direction in which the pivoting rail stopper separates from and contacts with the guide rail, the guide rail being gripped between the pivoting rail stopper and the bearing rail stopper by the pivoting rail stopper being pivoted in a direction that corresponds to a direction of movement of the car while contacting the guide rail.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

Figure 1 is a structural diagram that shows an elevator apparatus according to Embodiment 1 of the present invention;
Figure 2 is a structural diagram that shows an emergency stopping apparatus from Figure 1;
Figure 3 is a cross section that has been taken along line III - III in Figure 2;
Figure 4 is a side elevation of the emergency stopping apparatus in Figure 2;
Figure 5 is a structural diagram that shows a state in which a central contacting surface of a pivoting rail stopper from Figure 2 contacts a car guide rail;
Figure 6 is a cross section that has been taken along line VI - VI in Figure 5;
Figure 7 is a structural diagram that shows a state in which a lower frictional surface of the pivoting rail stopper from Figure 2 contacts the car guide rail;
Figure 8 is a cross section that has been taken along line VIII - VIII in Figure 7;
Figure 9 is a structural diagram that shows an emergency stopping apparatus according to Embodiment 2 of the present invention;
Figure 10 is a cross section that has been taken along line X - X in Figure 9;
Figure 11 is a cross section that has been taken along line XI - XI in Figure 9;
Figure 12 is a structural diagram that shows a state

in which a central contacting surface of a pivoting rail stopper from Figure 9 contacts a car guide rail;
Figure 13 is a cross section that has been taken along line XIII - XIII in Figure 12;
Figure 14 is a structural diagram that shows a state in which a lower frictional surface of the pivoting rail stopper from Figure 9 contacts the car guide rail; and
Figure 15 is a cross section that has been taken along line XV - XV in Figure 14.

BEST MODE FOR CARRYING OUT THE INVENTION

[0010] Preferred embodiments of the present invention will now be explained with reference to the drawings.

Embodiment 1

[0011] Figure 1 is a structural diagram that shows an elevator apparatus according to Embodiment 1 of the present invention. In the figure, a car 1 and a counterweight (not shown) are suspended by a main rope 2. The main rope 2 is wound around a drive sheave of a hoisting machine. The drive sheave is rotated by a driving force from the hoisting machine. The car 1 and the counterweight are raised and lowered inside a hoistway by the rotation of the drive sheave. A pair of car guide rails 3 that guide raising and lowering of the car 1, and a pair of counterweight guide rails (not shown) that guide raising and lowering of the counterweight are installed in the hoistway.

[0012] The raising and lowering of the car 1 and the counterweight are controlled by an elevator control board 4. Respective information from a car speed detecting sensor 5 that detects speed of the car 1, a door opening and closing detecting sensor 6 that detects whether a doorway (not shown) of the car 1 is open or closed, and a main rope breakage detecting sensor 7 that detects presence or absence of a breakage in the main rope 2 is sent to the control board 4. An encoder, or a resolver, etc., that generates a signal that corresponds to rotational speed of the drive sheave, for example, can be used as the car speed detecting sensor 5. A position sensor, etc., that detects the position of a door that opens and closes the doorway of the car 1, for example, can be used as the door opening and closing detecting sensor 6. A tension detector, etc., that detects tension of the main rope 2, for example, can be used as the main rope breakage detecting sensor 7.

[0013] A braking command portion 8 that detects presence or absence of an elevator abnormality based on 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 is disposed on the control board 4. The braking command portion 8 outputs a braking command if the occurrence of an elevator abnormality is detected.

[0014] The braking command portion 8 includes a computer that has: an arithmetic processing portion (a CPU, etc.), a storage portion (ROM, RAM, hard disk, etc.), and a signal input-output portion. The functions of the braking command portion 8 can be implemented by arithmetic processing by the computer.

[0015] A pair of emergency stopping apparatuses 9 that constitute a braking apparatus that brakes the car 1 by gripping the car guide rail 3 are mounted to the car 1. Each of the emergency stopping apparatuses 9 performs a braking action that brakes the car 1 when a braking command is received from the braking command portion 8.

[0016] Figure 2 is a structural diagram that shows an emergency stopping apparatus 9 from Figure 1. Figure 3 is a cross section that has been taken along line III - III in Figure 2. In addition, Figure 4 is a side elevation of the emergency stopping apparatus 9 in Figure 2. In the figure, a mounting frame 10 is mounted to the car 1. An upper guide rod 11 and a lower guide rod 12 that are disposed so as to be spaced apart from each other vertically are mounted onto the mounting frame 10. The upper guide rod 11 and the lower guide rod 12 are disposed horizontally so as to be parallel to each other.

[0017] A housing 13 is disposed inside the mounting frame 10. Sliding guides 13a through 13d are disposed above and below the housing 13. The upper guide rod 11 passes through the sliding guides 13a and 13c. The lower guide rod 12 passes through the sliding guides 13b and 13d. Thus, the housing 13 is slidable relative to the mounting frame 10 along the upper guide rod 11 and the lower guide rod 12. In other words, the housing 13 is displaceable horizontally relative to the car 1.

[0018] The housing 13 has: a housing main body 14; a mounting guide portion 15 that projects from the housing main body 14 toward the car guide rail 3; and an adjusting bolt mount portion 16 that projects from the housing main body 14 away from the car guide rail 3.

[0019] The mounting guide portion 15 is disposed in a position that is offset relative to the car guide rail 3 in a direction of displacement of the housing 13. The mounting guide portion 15 has: a bearing portion 15a that extends vertically; and a pair of horizontal portions 15b and 15c that extend toward the car guide rail 3 from an upper end portion and a lower end portion, respectively, of the bearing portion 15a.

[0020] A bearing rail stopper 17 and a pivoting rail stopper 18 that face each other from opposite sides of the car guide rail 3 in a horizontal direction are disposed on the housing 13. In other words, the car guide rail 3 is disposed between a bearing rail stopper 17 and a pivoting rail stopper 18 that are disposed on a common housing 13. Thus, the bearing rail stopper 17 and the pivoting rail stopper 18 are displaced together with the housing 13. The bearing rail stopper 17 and the pivoting rail stopper 18 are both able to contact with and separate from the car guide rail 3 by displacement of the housing 13 relative to the mounting frame 10.

[0021] The bearing rail stopper 17 is disposed between each of the horizontal portions 15b and 15c. The bearing

rail stopper 17 is guided along each of the horizontal portions 15b and 15c. A plurality of (in this example, two) shoulder bolts 19 that pass through the bearing portion 15a are fixed to the bearing rail stopper 17. Each of the shoulder bolts 19 is slidable horizontally relative to the bearing portion 15a. The bearing rail stopper 17 is thereby displaceable horizontally relative to the housing 13.

[0022] Pressing elements 22 and adjusting elements 23 through which the respective common shoulder bolts 19 are passed are disposed between the bearing rail stopper 17 and the bearing portion 15a (i.e., on an opposite side of the bearing rail stopper 17 from the car guide rail 3).

[0023] The pressing elements 22 have a plurality of disk springs, for example. The pressing elements 22 force the bearing rail stopper 17 toward the car guide rail 3 (i.e., away from the bearing portion 15a) using elastic resilience due to the disk springs being compressed. The adjusting elements 23 adjust the magnitude of the elastic resilience of the pressing elements 22. In this example, the adjusting elements 23 have a plurality of spacers that are stacked on each other. Adjustment of the magnitude of the elastic resilience of the pressing elements 22 is performed by the adjusting the number of spacers.

[0024] Each of the shoulder bolts 19 is passed through a washer 20, and is screwed into a positioning nut 21. The washers 20 and the positioning nuts 21 can be engaged with the bearing portion 15a. Displacement of the bearing rail stopper 17 toward the car guide rail 3 is restricted by the engagement of the washers 20 and the positioning nuts 21 with the bearing portion 15a. Adjustment of the position of the bearing rail stopper 17 in a horizontal direction relative to the housing 13 is performed by adjusting an amount of thread engagement of the positioning nuts 21 on the shoulder bolts 19.

[0025] When the bearing rail stopper 17 is displaced toward the bearing portion 15a, the pressing elements 22 generate even larger elastic resilience in opposition to the displacement of the bearing rail stopper 17.

[0026] The pivoting rail stopper 18 is mounted by means of a bearing 25 to a horizontal shaft (a main shaft) 24 that is fixed to the housing main body 14. In this example, the bearing 25 is a sliding bearing. The pivoting rail stopper 18 is thereby pivotable vertically around the main shaft 24. If the pivoting rail stopper 18 contacts the car guide rail 3 while the car 1 is moving, it is pivoted in a direction that that corresponds to the direction of movement of the car 1 while contacting the car guide rail 3. Specifically, when the pivoting rail stopper 18 contacts the car guide rail 3, the pivoting rail stopper 18 is pivoted upward if the car 1 is descending, and the pivoting rail stopper 18 is pivoted downward if the car 1 is ascending.

[0027] The pivoting rail stopper 18 has a shape in which a distance to the bearing rail stopper 17 is reduced continuously by the vertical pivoting. In other words, the distance between the pivoting rail stopper 18 and the bearing rail stopper 17 is greatest before pivoting of the pivoting rail stopper 18, and is reduced continuously as the amount of pivoting of the pivoting rail stopper 18 increases.

[0028] The pivoting rail stopper 18 has: a pivoting rail stopper main body 26; and an upper braking shoe 27 and a lower braking shoe 28 (a pair of braking shoes) that are disposed on the pivoting rail stopper main body 26.

[0029] A rail contacting surface that the car guide rail 3 can contact is disposed on an outer circumferential portion of the pivoting rail stopper main body 26 near the car guide rail 3. The rail contacting surface has: a central contacting surface 26a; an upper contacting curved surface (an upper curved surface portion) 26b that is a curved surface that is contiguous with an upper end portion of the central contacting surface 26a; and a lower contacting curved surface (a lower curved surface portion) 26c that is a curved surface that is contiguous with a lower end portion of the central contacting surface 26a.

[0030] In this example, the central contacting surface 26a is a flat surface that is perpendicular to a straight line in a radial direction that passes through a pivoting center Cn of the pivoting rail stopper 18. The upper contacting curved surface 26b is a cylindrical surface that is centered around a position Pup that is offset upward from the pivoting center Cn. In addition, the lower contacting curved surface 26c is a cylindrical surface that is centered around a position Pdn that is offset downward from the pivoting center Cn. Moreover, the center Pup of the upper contacting curved surface 26b is positioned near the Y-axis in a second quadrant of X - Y coordinates that are centered around the center Cn, and the center Pdn of the lower contacting curved surface 26c is positioned near the Y-axis in a third quadrant.

[0031] In this example, a coefficient of friction μ between the car guide rail 3 and each of the contacting curved surfaces 26b and 26c is set so as to be greater than a ratio γ (= LY/LX) between dimensions in a Y-axis direction LY between the respective centers Pup and Pdn of each of the contacting curved surfaces 26b and 26c and the pivoting center Cn and a dimension in the X-axis direction LX between a rail contacting point of the pivoting rail stopper 18 and the center of rotation Cn (i.e., such that $\gamma < \mu$). Frictional force relative to the pressing force from the pivoting rail stopper 18 can thereby be made greater than return torque due to the pressing force from the pivoting rail stopper 18 (a load that acts in an opposite direction from the direction the pivoting rail stopper 18 should be pivoted during braking), enabling the pivoting rail stopper 18 to be pivoted more reliably. In order to reduce the value of the dimensional ratio γ, radius R of the cylindrical surfaces of each of the contacting curved surfaces 26b and 26c should be increased. Methods for increasing the coefficient of friction μ include using a construction in which oil adhesion is prevented by guiding the car guide rail 3 using an oilless guide or disposing a large number of minute lugs that bite into the car guide rail 3 on each of the contacting curved surfaces 26b and 26c, etc.

[0032] The upper braking shoe 27 is disposed so as

to be adjacent to an upper end of the upper contacting curved surface 26b. An upper frictional surface (an upper flat surface portion) 27a that is a flat surface is disposed on the upper braking shoe 27. A portion of the upper braking shoe 27 on which the upper frictional surface 27a is disposed projects beyond the upper end of the upper contacting curved surface 26b by a predetermined amount.

[0033] A spacer 45 that can adjust the amount of protrusion of the upper braking shoe 27 from the rail contacting surface is disposed between a back surface of the upper braking shoe 27 and the pivoting rail stopper main body 26. Adjustment of the amount of protrusion of the upper braking shoe 27 is performed by adjusting the thickness of the spacer 45.

[0034] The lower braking shoe 28 is disposed so as to be adjacent to a lower end of the lower contacting curved surface 26c. A lower frictional surface (a lower flat surface portion) 28a that is a flat surface is disposed on the lower braking shoe 28. A portion of the lower braking shoe 28 on which the lower frictional surface 28a is disposed projects beyond the lower end of the lower contacting curved surface 26c by a predetermined amount.

[0035] A spacer 46 that can adjust the amount of protrusion of the lower braking shoe 28 from the rail contacting surface is disposed between a back surface of the lower braking shoe 28 and the pivoting rail stopper main body 26. Adjustment of the amount of protrusion of the lower braking shoe 28 is performed by adjusting the thickness of the spacer 46. In this example, the respective amount of protrusion of the upper braking shoe 27 and the lower braking shoe 28 from the rail contacting surface is approximately identical.

[0036] The central contacting surface 26a contacts the car guide rail 3 due to displacement of the pivoting rail stopper 18 toward the car guide rail 3.

[0037] If the central contacting surface 26a contacts the car guide rail 3 when the car 1 is descending, the pivoting rail stopper 18 is pulled by the car guide rail 3 so as to be pivoted upward. As the pivoting rail stopper 18 is pivoted upward while placing the lower contacting curved surface 26c in contact with the car guide rail 3, the housing 13 is displaced in a direction in which the main shaft 24 moves away from the car guide rail 3 (i.e., a direction in which the bearing rail stopper 17 approaches the car guide rail 3). When the upper frictional surface 27a of the upper braking shoe 27 contacts the car guide rail 3, the car guide rail 3 is gripped between the upper braking shoe 27 and the bearing rail stopper 17.

[0038] If the central contacting surface 26a contacts the car guide rail 3 when the car 1 is ascending, the pivoting rail stopper 18 is pulled by the car guide rail 3 so as to be pivoted downward. As the pivoting rail stopper 18 is pivoted downward while placing the upper contacting curved surface 26b in contact with the car guide rail 3, the housing 13 is displaced in a direction in which the main shaft 24 moves away from the car guide rail 3 (i.e., a direction in which the bearing rail stopper 17 approaches the car guide rail 3). When the lower frictional surface 28a of the lower braking shoe 28 contacts the car guide rail 3, the car guide rail 3 is gripped between the lower braking shoe 28 and the bearing rail stopper 17.

[0039] A displacement driving mechanism 29 that displaces the housing 13 relative to the mounting frame 10 is disposed on the mounting frame 10 (Figures 3 and 4). The displacement driving mechanism 29 has: a plurality of forcing springs (a forcing body) 30 that force the housing 13 in a direction in which the pivoting rail stopper 18 contacts the car guide rail 3; and a holding and releasing mechanism (a holding means) 31 that can restrict the displacement of the housing 13 in opposition to the spring forces from the forcing springs 30.

[0040] The forcing springs 30 are disposed between the sliding guides 13a and 13b and one end portion of the mounting frame 10 (left end portion in Figure 2). Coil springs, for example, can be used for the forcing springs 30. The sliding guides 13a and 13b are passed through the respective forcing springs 30.

[0041] The holding and releasing mechanism 31 has: a gap distribution adjusting bolt 41 that is disposed on the adjusting bolt mount portion 16; a holding lever 32 that is displaceable relative to the mounting frame 10, and that can engage with the gap distribution adjusting bolt 41; a pushing pin 33 that is placed in contact with the holding lever 32; and an electromagnet 34 that displaces the pushing pin 33 to displace the holding lever 32.

[0042] The pushing pin 33 and the electromagnet 34 are disposed on an opposite side of the mounting frame 10 from the housing 13. The electromagnet 34 has: a fixed core (a first core) 36 that is fixed to the mounting frame 10; an electromagnetic coil 37 that is installed in the fixed core 36; and a movable core (a second core) 38 that is displaceable relative to the fixed core 36.

[0043] The pushing pin 33 is fixed centrally on the movable core 38. The pushing pin 33 passes centrally through the fixed core 36. A plurality of adjusting nuts 39 are screwed onto the pushing pin 33. Magnitude of a gap between the movable core 38 and the fixed core 36 can be set to a predetermined value by adjusting positions of the adjusting nuts 39.

[0044] The holding lever 32 is displaceable between a holding position that restricts displacement of the housing 13 in a state in which the pivoting rail stopper 18 is separated from the car guide rail 3 (Figure 3), and a releasing position that releases restriction of the housing 13 (Figure 6). A lever mounting member is fixed to the fixed core 36. One end portion of the holding lever 32 is pivotably mounted to the lever mounting member by means of a pivoting support pin 40. A second end portion of the holding lever 32 is placed in contact with the gap distribution adjusting bolt 41. The holding lever 32 is displaced between the holding position and the releasing position by pivoting around the pivoting support pin 40.

[0045] The gap distribution adjusting bolt 41 is screwed into the adjusting bolt mount portion 16 of the housing 13. The gap distribution adjusting bolt 41 is pressed hor-

izontally against the second end portion of the holding lever 32 by the forces from the respective forcing springs 30. Gap dimensions between the car guide rail 3 and the pivoting rail stopper 18 and between the car guide rail 3 and the bearing rail stopper 17 when the holding lever 32 is in the holding position (i.e., when displacement of the housing 13 is being restricted) (Figures 2 and 3) can be adjusted by adjusting an amount of thread engagement of the gap distribution adjusting bolt 41 in the adjusting bolt mount portion 16.

[0046] The movable core 38 is attracted to the fixed core 36 when the electromagnet 34 is excited. The pushing pin 33 is held by the attraction of the movable core 38 by the fixed core 36 so as not to move relative to the fixed core 36. The holding lever 32 is held in the holding position by being placed in contact with the pushing pin 33 that is held against the fixed core 36. In other words, displacement of the holding lever 32 from the holding position to the releasing position is restricted by excitation of the electromagnet 34.

[0047] Holding force from the electromagnet 34 is set so as to overcome the spring forces from the respective forcing springs 30 on the housing 42. Consequently, the bearing rail stopper 17 and the pivoting rail stopper 18 are held away from the car guide rail 3 by the excitation of the electromagnet 34 (Figures 2 and 3).

[0048] Restriction of the displacement of the holding lever 32 to the releasing position is released by loss of the holding force due to stopping of the excitation of the electromagnet 34. If the holding force from the electromagnet 34 is lost, the holding lever 32 is pivoted by the respective forces from the forcing springs 30 while being pushed onto the housing 13 by means of the gap distribution adjusting bolt 41, and is displaced from the holding position to the releasing position. The housing 13 is thereby displaced in a direction in which the pivoting rail stopper 18 contacts the car guide rail 3.

[0049] Moreover, the gap distribution adjusting bolt 41 constitutes a housing position adjusting means that can adjust the horizontal position of the housing 13 relative to the car guide rail 3. A rail stopper interval adjusting means that can adjust a distance between the pivoting center Cn of the pivoting rail stopper 18 and the bearing rail stopper 17 includes the shoulder bolts 19 and the positioning nuts 21.

[0050] Next, operation will be explained. Figure 5 is a structural diagram that shows a state in which the central contacting surface 26a of the pivoting rail stopper 18 from Figure 2 contacts the car guide rail 3, and Figure 6 is a cross section that has been taken along line VI - VI in Figure 5. Figure 7 is a structural diagram that shows a state in which the lower frictional surface 28a of the pivoting rail stopper 18 from Figure 2 contacts the car guide rail 3, and Figure 8 is a cross section that has been taken along line VIII - VIII in Figure 7.

[0051] During normal operation, as shown in Figures 2 and 3, the electromagnet 34 is excited by control from the control board 4 so as to keep the movable core 38 attracted to the fixed core 36. Here, the holding lever 32 is held in the holding position by coming into contact with the pushing pin 33 (Figure 3), and pivoting to the releasing position (pivoting in a clockwise direction in Figure 3) is restricted. Here also, both the pivoting rail stopper 18 and the bearing rail stopper 17 are separated from the car guide rail 3 by a predetermined gap by engagement of the gap distribution adjusting bolt with the holding lever 32.

[0052] If an elevator abnormality is detected by the braking command portion 8, a braking command is output from the braking command portion 8 to each of the emergency stopping apparatuses 9. When the displacement driving mechanism 29 of each of the emergency stopping apparatuses 9 receives the braking command, the passage of electric current to the electromagnetic coil 37 is stopped, and the holding force from the electromagnet 34 is lost. The holding lever 32 is thereby pivoted from the holding position (Figure 3) to the releasing position (Figure 6) while being pushed by the housing 13 by the forces from the respective forcing springs 30. Here, the pushing pin 33 is displaced while being placed in contact with the holding lever 32. The movable core 38 is displaced away from the fixed core 36. The displacement of the pushing pin 33 and the movable core 38 is performed until the adjusting nuts 39 are placed in contact with the fixed core 36.

[0053] Together with the displacement of the holding lever 32 to the releasing position, the housing 13 is displaced in a direction in which the pivoting rail stopper 18 contacts the car guide rail 3 (to the right in Figure 3) by the respective forces from the forcing springs 30. Thus, the pivoting rail stopper 18 contacts the car guide rail 3, as shown in Figures 5 and 6.

[0054] If the pivoting rail stopper 18 contacts the car guide rail 3 when the car 1 is descending, the pivoting rail stopper 18 is pulled by the car guide rail 3 so as to be pivoted upward. Here, the lower contacting curved surface 26c contacts the car guide rail 3 due to the respective forces from the forcing springs 30 as the pivoting rail stopper 18 is pivoted. The housing 13 is thereby displaced in a direction in which the main shaft 24 separates from the car guide rail 3, and the bearing rail stopper 17 is displaced toward the car guide rail 3. Moreover, here, the gap distribution adjusting bolt 41 is separated from the holding lever 32 due to the displacement of the housing 13.

[0055] As the pivoting rail stopper 18 is subsequently pivoted further upward and the lower braking shoe 28 reaches the car guide rail 3, the car guide rail 3 is gripped between the lower braking shoe 28 and the bearing rail stopper 17, as shown in Figures 7 and 8. Here, the pressing elements 22 are compressed by the displacement of the bearing rail stopper 17 that is pushed by the car guide rail 3, generating elastic resilience that presses the bearing rail stopper 17 against the car guide rail 3. The lower frictional surface 28a of the lower braking shoe 28 also contacts the car guide rail 3. The gripping force on the

car guide rail 3 is thereby ensured, imparting a braking force to the car 1.

[0056] On the other hand, if the pivoting rail stopper 18 contacts the car guide rail 3 when the car 1 is ascending, the pivoting rail stopper 18 is pulled by the car guide rail 3 so as to be pivoted downward. Here, the upper contacting curved surface 26b contacts the car guide rail 3 due to the respective forces from the forcing springs 30 as the pivoting rail stopper 18 is pivoted. The housing 13 is thereby displaced in a direction in which the main shaft 24 separates from the car guide rail 3, and the bearing rail stopper 17 is displaced toward the car guide rail 3. Moreover, here, the gap distribution adjusting bolt 41 is separated from the holding lever 32 due to the displacement of the housing 13.

[0057] As the pivoting rail stopper 18 is subsequently pivoted further downward and the upper braking shoe 27 reaches the car guide rail 3, the car guide rail 3 is gripped between the upper braking shoe 27 and the bearing rail stopper 17. Here, the pressing elements 22 are compressed by the bearing rail stopper 17 that is pushed by the car guide rail 3, generating elastic resilience that presses the bearing rail stopper 17 against the car guide rail 3. The upper frictional surface 27a of the upper braking shoe 27 also contacts the car guide rail 3. The gripping force on the car guide rail 3 is thereby ensured, imparting a braking force to the car 1.

[0058] In an elevator safety apparatus of this kind, because a bearing rail stopper 17 and a pivoting rail stopper 18 are disposed on a housing 13 in which a distance to the bearing rail stopper 17 is reduced by vertical pivoting, and a displacement driving mechanism 29 that displaces the housing 13 in a direction in which the pivoting rail stopper 18 contacts and separates from a car guide rail 3 is disposed on a mounting frame 10, movement of a car 1 can be braked in either vertical direction by the action of the common displacement driving mechanism 29. Thus, it is no longer necessary to dispose separate driving mechanisms that brake movement of the car 1 in each vertical direction, enabling reductions in the size of the emergency stopping apparatus 9 to be achieved.

[0059] Because the displacement driving mechanism 29 has: forcing springs 30 that force the housing 13 in a direction in which the pivoting rail stopper 18 contacts the car guide rail 3; and a holding and releasing mechanism 31 that can restrict the displacement of the housing 13 in opposition to the spring force from the forcing springs 30, the housing 13 can be displaced by a simple configuration. Even if the holding force on the housing 13 is lost due to failure of the holding and releasing mechanism 31, the housing 13 can be displaced in a direction in which the pivoting rail stopper 18 contacts the car guide rail 3 by the force from the forcing springs 30, enabling the braking action of the car 1 to be performed more reliably.

[0060] Because the holding and releasing mechanism 31 has an electromagnet 34 that restricts the displacement of the housing 13 by excitation, and performs release of the restriction of the housing 13 by stopping excitation, a braking action can be performed in a short amount of time.

[0061] Because the bearing rail stopper 17 and the pivoting rail stopper 18 are displaced together with the housing 13, the construction for mounting the bearing rail stopper 17 and the pivoting rail stopper 18 onto the housing 13 can be simplified.

[0062] Because a gap distribution adjusting bolt 41 that can adjust a horizontal position of the housing 13 relative to the car guide rail 3, and a rail stopper interval adjusting means that can adjust a distance between a pivoting center Cn of the pivoting rail stopper 18 and the bearing rail stopper 17 (shoulder bolts 19 and positioning nuts 21) are disposed on the housing 13, respective gap dimensions between the pivoting rail stopper 18 and the car guide rail 3 and between the bearing rail stopper 17 and the car guide rail 3 when the displacement of the housing 13 is being restricted by the displacement driving mechanism 29 can be adjusted easily. Thus, adjustment of the gap dimensions can be performed after mounting the emergency stopping apparatuses 9 to the car 1, enabling time spent on installation work to be reduced. Malfunctions due to the mounting frame 10 being inclined, etc., can also be prevented.

[0063] Because either the upper contacting curved surface 26b or the lower contacting curved surface 26c contacts the car guide rail 3 when the pivoting rail stopper 18 is pivoted while contacting the car guide rail 3, and either the upper frictional surface 27a or the lower frictional surface 28a contacts the car guide rail 3 when the car guide rail 3 is gripped between the pivoting rail stopper 18 and the bearing rail stopper 17, contact of the pivoting rail stopper 18 with the car guide rail 3 during pivoting of the pivoting rail stopper 18 can be made to be point contact or line contact, enabling abrasion of the pivoting rail stopper 18 to be reduced. Extension of service life can thereby be achieved, enabling the number of braking actions to be increased.

[0064] Because positions of an upper braking shoe 27 and a lower braking shoe 28 relative to a pivoting rail stopper main body 26 are adjustable by adjustment of thicknesses of spacers 45 and 46, if gripping force on the car guide rail 3 has been reduced by abrasion, etc., of the upper braking shoe 27 and the lower braking shoe 28, for example, the gripping force can be restored by adjusting the positions of the upper braking shoe 27 and the lower braking shoe 28.

[0065] Because pressing elements 22 that press the bearing rail stopper 17 against the car guide rail 3 are disposed between the bearing rail stopper 17 and the housing 13, gripping force on the car guide rail 3 can be generated more reliably. Thus, braking force can be applied to the car 1 more reliably.

[0066] Because presence or absence of an elevator abnormality is detected by a braking command portion 8 based on respective information from a car speed detecting sensor 5, a door opening and closing detecting

sensor 6, and a main rope breakage detecting sensor 7, and braking action of the emergency stopping apparatuses 9 is performed on detection of an abnormality by the braking command portion 8, a braking force can be applied to the car 1 more reliably and in a shorter amount of time if an abnormality occurs in the speed of the car 1, if the car 1 moves with the doorway of the car 1 open, or if the main rope 2 breaks.

[0067] Moreover, in the above example, respective amounts of protrusion of the upper braking shoe 27 and the lower braking shoe 28 from the pivoting rail stopper main body 26 are approximately identical, but the amount of protrusion of the upper braking shoe 27 may also be made less than the amount of protrusion of the lower braking shoe 28. The braking force required to stop the ascending car 1 when balance between the car 1 and the counterweight is uneven may be smaller than the braking force required to stop the descending car 1 if the main rope 2 breaks. Consequently, the braking force required during the ascent of the car 2 can be made smaller than the braking force required during the descent of the car 1 by making the amount of protrusion of the upper braking shoe 27 less than the amount of protrusion of the lower braking shoe 28, enabling a braking force that corresponds to the direction of movement of the car 1 to be applied to the car 1.

[0068] In the above example, the rail contacting surface of the pivoting rail stopper 18 is constituted by a flat surface 26a, and cylindrical surfaces 26b and 26c that are centered around positions Pup and Pdn that are respectively offset upward and downward from a pivoting center Cn, but the rail contacting surface is not limited to this shape, and may also be shaped such that the main shaft 24 separates from the car guide rail 3 continuously as the pivoting rail stopper 18 is pivoted while contacting the car guide rail 3.

Embodiment 2

[0069] Figure 9 is a structural diagram that shows an emergency stopping apparatus 9 according to Embodiment 2 of the present invention. Figure 10 is a cross section that has been taken along line X - X in Figure 9, and Figure 11 is a cross section that has been taken along line XI - XI in Figure 9. In the figures, a housing 13 has: a housing main body 51; and an upper mounting guide portion 52 and a lower mounting guide portion 53 that are disposed on the housing main body 51, and that are arranged so as to be spaced apart from each other in a vertical direction.

[0070] The upper mounting guide portion 52 and the lower mounting guide portion 53 project toward a car guide rail 3 from the housing main body 51. The upper mounting guide portion 52 has: a horizontal portion; and a bearing portion that extends downward from an end portion of the horizontal portion at an opposite end from the car guide rail 3. The lower mounting guide portion 53 has: a horizontal portion; and a bearing portion that extends upward from an end portion of the horizontal portion at an opposite end from the car guide rail 3.

[0071] A bearing rail stopper 17 is disposed between the upper mounting guide portion 52 and the lower mounting guide portion 53. The bearing rail stopper 17 is guided relative to the housing 13 along the respective horizontal portions of the upper mounting guide portion 52 and the lower mounting guide portion 53.

[0072] A plurality of (in this example, two) shoulder bolts 19 that are disposed horizontally are fixed to the bearing rail stopper 17. Each of the shoulder bolts 19 extends toward a back surface of the bearing rail stopper 17. Each of the shoulder bolts 19 passes through a common backing plate (a restricting portion) 54 that is disposed between the upper mounting guide portion 52 and the lower mounting guide portion 53.

[0073] A plurality of (in this example, two) pressing force adjusting bolts (adjusting elements) 55 through which the respective shoulder bolts 19 pass are screwed into the backing plate 54. The pressing force adjusting bolts 55 are slidable horizontally relative to the shoulder bolts 19.

[0074] Pressing elements 22 through which the shoulder bolts 19 are passed are respectively disposed between the bearing rail stopper 17 and the respective pressing force adjusting bolts 55 (i.e., on an opposite side of the bearing rail stopper 17 from the car guide rail 3). The pressing elements 22 have a plurality of disk springs, for example. The pressing elements 22 force the bearing rail stopper 17 away from the backing plate 54 using elastic resilience due to the disk springs being compressed.

[0075] The pressing force adjusting bolts 55 adjust the magnitude of the elastic resilience of the pressing elements 22. Adjustment of the elastic resilience of the pressing elements 22 is performed by the adjusting an amount of thread engagement of the pressing force adjusting bolts 55 in the backing plate 54.

[0076] Each of the shoulder bolts 19 is passed through a washer 20, and is screwed into a positioning nut 21. Displacement of the bearing rail stopper 17 away from the backing plate 54 is restricted by the engagement of the washers 20 and the positioning nuts 21 with the backing plate 54. Adjustment of the position of the bearing rail stopper 17 relative to the backing plate 54 is performed by adjusting an amount of thread engagement of the positioning nuts 21 on the shoulder bolts 19.

[0077] The bearing rail stopper 17 is displaceable relative to the housing 13 together with each of the shoulder bolts 19, the washers 20, the positioning nuts 21, the pressing elements 22, the backing plate 54, and the pressing force adjusting bolts 55. When the bearing rail stopper 17 is displaced toward the backing plate 54, the pressing elements 22 generates even larger elastic resilience in opposition to the displacement of the bearing rail stopper 17.

[0078] A plurality of (in this example, two) forcing springs 68 are disposed so as to be compressed between

the bearing portion of the upper mounting guide portion 52 and the bearing rail stopper 17 and between the bearing portion of the lower mounting guide portion 53 and the bearing rail stopper 17, respectively. In other words, the bearing rail stopper 17 is forced horizontally away from each of the bearing portions of the upper mounting guide portion 52 and the lower mounting guide portion 53 by the respective forcing springs 68.

[0079] A gap adjusting bolt 56 that passes horizontally through the backing plate 54 is screwed into a portion of the backing plate 54 between each of the shoulder bolts 19. A locknut 57 for preventing displacement of the gap adjusting bolt 56 relative to the backing plate 54 is screwed onto the gap adjusting bolt 56.

[0080] A lever passage aperture 58 is disposed on the housing main body 51. A holding lever 59 that is engaged with the gap adjusting bolt 56 is passed through the lever passage aperture 58. The bearing rail stopper 17 is displaced relative to the housing 13 while the gap adjusting bolt 56 is engaged with the holding lever 59. A distance between the holding lever 59 and the backing plate 54 is adjusted by adjusting the amount of thread engagement of the gap adjusting bolt 56 in the backing plate 54. The distance between the bearing rail stopper 17 and the pivoting center Cn can thereby be adjusted.

[0081] An electromagnet 60 is disposed on a portion of the housing 13 on an opposite side from the car guide rail 3. The electromagnet 60 has: a fixed core (a first core) 61 that is fixed to the housing 13; an electromagnetic coil 62 that is installed in the fixed core 61; and a movable core (a second core) 63 that is displaceable relative to the fixed core 61. The fixed core 61 and the movable core 63 can be attracted to each other by passing an electric current to the electromagnetic coil 62 (i.e., excitation of the electromagnet 60), and can be separated from each other in the direction of displacement of the housing 13 by stopping the passage of electric current to the electromagnetic coil 62.

[0082] A lever mounting member is fixed to the fixed core 61. One end portion of the holding lever 59 is pivotably mounted to the lever mounting member by means of a pivoting support pin 64. An end portion of the gap adjusting bolt 56 near the bearing rail stopper 17 is pressed against a second end portion of the holding lever 59.

[0083] A pushing pin 65 that is disposed horizontally is fixed centrally on the movable core 63. The pushing pin 65 passes centrally through the fixed core 61. An adjusting nut 66 that restricts displacement of the fixed core 61 away from the movable core 63 is screwed onto the pushing pin 65. Magnitude of a gap between the movable core 63 and the fixed core 61 can be set to a predetermined value by adjusting a position of the adjusting nut 66 relative to the pushing pin 65.

[0084] An intermediate portion of the holding lever 59 can be placed in contact with a tip end portion of the pushing pin 65. A gap distribution adjusting bolt (a housing position adjusting means) 67 that can be placed in contact with an intermediate portion of the holding lever 59 is mounted to the mounting frame 10.

[0085] The respective intermediate portions of the holding lever 59 are placed in contact with the pushing pin 65 and the gap distribution adjusting bolt 67 when the fixed core 61 and the movable core 63 are attracted to each other. Both the bearing rail stopper 17 and the pivoting rail stopper 18 are thereby held away from the car guide rail 3. Specifically, when the fixed core 61 and the movable core 63 are attracted to each other, displacement of the bearing rail stopper 17 toward the car guide rail 3 is restricted by the pushing pin 65 stopping the pivoting of the holding lever 59, and displacement of the pivoting rail stopper 18 toward the car guide rail 3 is restricted by the gap distribution adjusting bolt 67 stopping displacement of the housing 13.

[0086] A position at which displacement of the housing 13 is restricted by the gap distribution adjusting bolt 67 can be adjusted by adjusting an amount of thread engagement of the gap distribution adjusting bolt 67 in the mounting frame 10. In other words, gap dimensions between the car guide rail 3 and the pivoting rail stopper 18 and between the car guide rail 3 and the bearing rail stopper 17 (Figures 9 and 10) can be adjusted by adjusting the amount of thread engagement of the gap distribution adjusting bolt 67 in the mounting frame 10.

[0087] The housing 13 is displaced to the right in Figure 10 by spring forces from each of the forcing springs 30 and 68 when the fixed core 61 and the movable core 63 are separated from each other, pivoting the holding lever 59 counterclockwise in Figure 10. In other words, the housing 13 and the holding lever 59 are displaced when the fixed core 61 and the movable core 63 are separated from each other such that the bearing rail stopper 17 and the pivoting rail stopper 18 are displaced toward each other. Thus, the bearing rail stopper 17 and the pivoting rail stopper 18 each contact the car guide rail 3.

[0088] A plurality of (in this example, two) center of gravity adjusting apertures 69 are disposed on the pivoting rail stopper main body 26. The center of gravity of the pivoting rail stopper 18 is thereby aligned with the pivoting center Cn. In this example, the center Pup of the upper contacting curved surface 26b is positioned near the Y-axis in a first quadrant of X - Y coordinates that are centered around the pivoting center Cn, and the center Pdn of the lower contacting curved surface 26c is positioned near the Y-axis in a fourth quadrant. In addition, a bearing 25 between the pivoting rail stopper 18 and the main shaft 24 is a rolling bearing.

[0089] Moreover, a displacement driving mechanism 29 includes the respective forcing springs 30 and a holding and releasing mechanism (a holding means). The holding and releasing mechanism (the holding means) includes the holding lever 59, the electromagnet 60, the pushing pin 65, and the gap distribution adjusting bolt 67. In addition, a rail stopper interval adjusting means that adjusts a distance between the pivoting center Cn of the pivoting rail stopper 18 and the bearing rail stopper

17 includes the backing plate 54, the gap adjusting bolt 56, the locknut 57, and the respective forcing springs 68. The rest of the configuration is similar to that of Embodiment 1.

[0090] Next, operation will be explained. Figure 12 is a structural diagram that shows a state in which the central contacting surface 26a of the pivoting rail stopper 18 from Figure 9 contacts the car guide rail 3, and Figure 13 is a cross section that has been taken along line XIII - XIII in Figure 12. Figure 14 is a structural diagram that shows a state in which the lower frictional surface 28a of the pivoting rail stopper 18 from Figure 9 contacts the car guide rail 3, and Figure 15 is a cross section that has been taken along line XV - XV in Figure 14.

[0091] During normal operation, as shown in Figures 9 and 10, the electromagnet 60 is excited by control from the control board 4 such that the fixed core 61 and the movable core 63 are attracted to each other. Here, displacement of the bearing rail stopper 17 toward the car guide rail 3 (displacement to the left in Figure 10) is restricted by the holding lever 59, and displacement of the pivoting rail stopper 18 toward the car guide rail 3 (displacement to the right in Figure 10) is restricted by the gap distribution adjusting bolt 67. Both the pivoting rail stopper 18 and the bearing rail stopper 17 are thereby separated from the car guide rail 3 by a predetermined gap.

[0092] If the displacement driving mechanism 29 of each of the emergency stopping apparatuses 9 receives a braking command, the passage of electric current to the electromagnetic coil 62 is stopped, and the holding force from the electromagnet 60 is lost. When the holding force from the electromagnet 60 is lost, the fixed core 61 and the movable core 63 are displaced away from each other by the forces from the forcing springs 30 and 68. The housing 13 is thereby displaced together with the fixed core 61, displacing the pivoting rail stopper 18 toward the car guide rail 3 (to the right in Figure 10). Here, the holding lever 59 is also pivoted counterclockwise in Figure 10, displacing the bearing rail stopper 17 toward the car guide rail 3.

[0093] As shown in Figures 12 and 13, the bearing rail stopper 17 and the pivoting rail stopper 18 subsequently contact the car guide rail 3. The bearing rail stopper 17 is subsequently pressed onto the car guide rail 3 by the forces from the respective forcing springs 68, and the pivoting rail stopper 18 is pressed onto the car guide rail 3 by the forces from the respective forcing springs 30. Moreover, the forces from the forcing springs 30 and 68 are set such that these pressing forces balance each other.

[0094] Next, if the car 1 is descending, the pivoting rail stopper 18 is pulled by the car guide rail 3 so as to be pivoted upward. Here, the lower contacting curved surface 26c of the pivoting rail stopper 18 is pivoted while contacting the car guide rail 3 due to the respective forces from the forcing springs 30. The housing 13 is thereby displaced in a direction in which the main shaft 24 separates from the car guide rail 3 (to the left in Figure 12).

[0095] As the pivoting rail stopper 18 is subsequently pivoted further, and the housing 13 is displaced in a direction in which the main shaft 24 separates from the car guide rail 3, each of the bearing portions of the upper mounting guide portion 52 and the lower mounting guide portion 53 engages with the backing plate 54, further compressing the pressing elements 22.

[0096] As the lower braking shoe 28 reaches the car guide rail 3, the car guide rail 3 is gripped between the lower braking shoe 28 and the bearing rail stopper 17 (Figures 14 and 15). Here, the pressing elements 22 are compressed by the displacement of the bearing rail stopper 17 that is pushed by the car guide rail 3, generating elastic resilience that presses the bearing rail stopper 17 against the car guide rail 3. The lower frictional surface 28a of the lower braking shoe 28 also contacts the car guide rail 3. The gripping force on the car guide rail 3 is thereby ensured, imparting a braking force to the car 1.

[0097] On the other hand, if the pivoting rail stopper 18 contacts the car guide rail 3 when the car 1 is ascending, the pivoting rail stopper 18 is pulled by the car guide rail 3 so as to be pivoted downward. Here, the upper contacting curved surface 26b of the pivoting rail stopper 18 is pivoted while contacting the car guide rail 3 due to the respective forces from the forcing springs 30. The housing 13 is thereby displaced in a direction in which the main shaft 24 separates from the car guide rail 3.

[0098] As the pivoting rail stopper 18 is subsequently pivoted further, and the housing 13 is displaced in a direction in which the main shaft 24 separates from the car guide rail 3, each of the bearing portions of the upper mounting guide portion 52 and the lower mounting guide portion 53 engages with the backing plate 54, further compressing the pressing elements 22.

[0099] As the upper braking shoe 27 subsequently reaches the car guide rail 3, the car guide rail 3 is gripped between the upper braking shoe 27 and the bearing rail stopper 17. Here, the pressing elements 22 are compressed by the displacement of the bearing rail stopper 17 that is pushed by the car guide rail 3, generating elastic resilience that presses the bearing rail stopper 17 against the car guide rail 3. The upper frictional surface 27a of the upper braking shoe 27 also contacts the car guide rail 3. The gripping force on the car guide rail 3 is thereby ensured, imparting a braking force to the car 1.

[0100] In an elevator safety apparatus of this kind, because a bearing rail stopper 17 is displaced in a reverse direction to a direction in which a housing 13 is displaced, distances between a car guide rail 3 and a bearing rail stopper 17 and between the car guide rail 3 and a pivoting rail stopper 18 can be widened during normal operation, further enabling prevention of malfunction as a result of the car 1 inclining.

[0101] Because adjustment of elastic resilience of pressing elements 22 is performed by adjusting an amount of thread engagement of pressing force adjusting bolts 55 in a backing plate 54, pressing force from the

bearing rail stopper 17 onto the car guide rail 3 can be adjusted easily.

[0102] Because a center of gravity of the pivoting rail stopper 18 is aligned with a pivoting center Cn of the pivoting rail stopper 18, pivoting of the pivoting rail stopper 18 can be prevented even if rocking, etc., of the car 1 arises, for example.

[0103] Moreover, in the above example, the center of gravity of the pivoting rail stopper 18 is aligned with the pivoting center Cn of the pivoting rail stopper 18, but the center of gravity of the pivoting rail stopper 18 may also be positioned below the pivoting center Cn on the Y-axis. Pivoting of the pivoting rail stopper 18 that occurs due to rocking, etc., of the car 1 can also be prevented in this manner.

[0104] In the above example, the pressing force adjusting bolts 55 are screwed into the backing plate 54, but may also be screwed into a back surface of the bearing rail stopper 17.

In addition, sensors 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. An elevator safety apparatus **characterized in** comprising:

   a housing that is supported by a car that is guided by a guide rail, and that is displaceable horizontally relative to the car;
   a bearing rail stopper that is disposed on the housing;
   a pivoting rail stopper that is disposed on the housing such that the guide rail is disposed between the pivoting rail stopper and the bearing rail stopper, and that can be pivoted vertically such that a distance to the bearing rail stopper is reduced by the vertical pivoting; and
   a displacement driving mechanism that displaces the housing relative to the car in a direction in which the pivoting rail stopper separates from and contacts with the guide rail,
   the guide rail being gripped between the pivoting rail stopper and the bearing rail stopper by the pivoting rail stopper being pivoted in a direction that corresponds to a direction of movement of the car while contacting the guide rail.

2. An elevator safety apparatus according to Claim 1, **characterized in that** the displacement driving mechanism comprises: a forcing body that forces the housing in a direction in which the pivoting rail stopper contacts the guide rail; and a holding means that can restrict displacement of the housing in opposition to force from the forcing body.

3. An elevator safety apparatus according to Claim 2, **characterized in that** the holding means comprises an electromagnet that restricts displacement of the housing by excitation, and that performs release of the restriction by stopping the excitation.

4. An elevator safety apparatus according to Claim 1, **characterized in that** the bearing rail stopper and the pivoting rail stopper are displaced together with the housing.

5. An elevator safety apparatus according to Claim 1, **characterized in that** the bearing rail stopper is displaceable relative to the housing, the pivoting rail stopper can be displaced together with the housing, and the displacement driving mechanism displaces the bearing rail stopper in a reverse direction to a direction in which the housing is displaced.

6. An elevator safety apparatus according to Claim 1, **characterized in that** the displacement driving mechanism comprises: a housing position adjusting means that can adjust a position of the housing relative to the guide rail; and a rail stopper interval adjusting means that can adjust a distance between a pivoting center of the pivoting rail stopper and the bearing rail stopper.

7. An elevator safety apparatus according to Claim 1, **characterized in that:**

   a rail contacting surface that includes a curved surface portion, and flat surface portions that are adjacent to an upper end and a lower end of the rail contacting surface are disposed on the pivoting rail stopper; and
   the curved surface portion contacts the guide rail when the pivoting rail stopper is pivoted while contacting the guide rail, and the flat surface portion contacts the guide rail when the guide rail is gripped between the pivoting rail stopper and the bearing rail stopper.

8. An elevator safety apparatus according to Claim 1, **characterized in that:**

   the pivoting rail stopper comprises a pivoting rail stopper main body; and a pair of braking shoes that are disposed on the pivoting rail stopper main body, and that contact the guide rail when the guide rail is gripped between the pivoting rail stopper and the bearing rail stopper; and
   a position of each of the braking shoes relative to the pivoting rail stopper main body is adjustable.

9. An elevator safety apparatus according to Claim 1, **characterized in that** a center of gravity of the piv-

oting rail stopper is aligned with a pivoting center of the pivoting rail stopper.

10. An elevator safety apparatus according to Claim 1, **characterized in** further comprising a pressing element that presses the bearing rail stopper against the guide rail when the guide rail is gripped between the bearing rail stopper and the pivoting rail stopper.

11. An elevator safety apparatus according to Claim 10, **characterized in that** the pressing element and an adjusting element are disposed so as to overlap with each other between the bearing rail stopper and a restricting portion by which displacement away from the bearing rail stopper is restricted; and
the adjusting element is a pressing force adjusting bolt that adjusts a pressing force from the pressing element by adjusting an amount of thread engagement relative to at least one of the bearing rail stopper and the restricting portion.

12. An elevator safety apparatus according to Claim 1, **characterized in** further comprising a determining portion that detects presence or absence of an elevator abnormality and outputs a braking command based on at least one of a car speed detecting portion that detects speed of the car, a door opening and closing detecting portion that detects whether a doorway of the car is open or closed, and a main rope breakage detecting portion that detects presence or absence of a breakage of a main rope that suspends the car, and
the displacement driving mechanism displaces the housing in a direction in which the pivoting rail stopper contacts the guide rail due to receiving the braking command.

FIG. 1

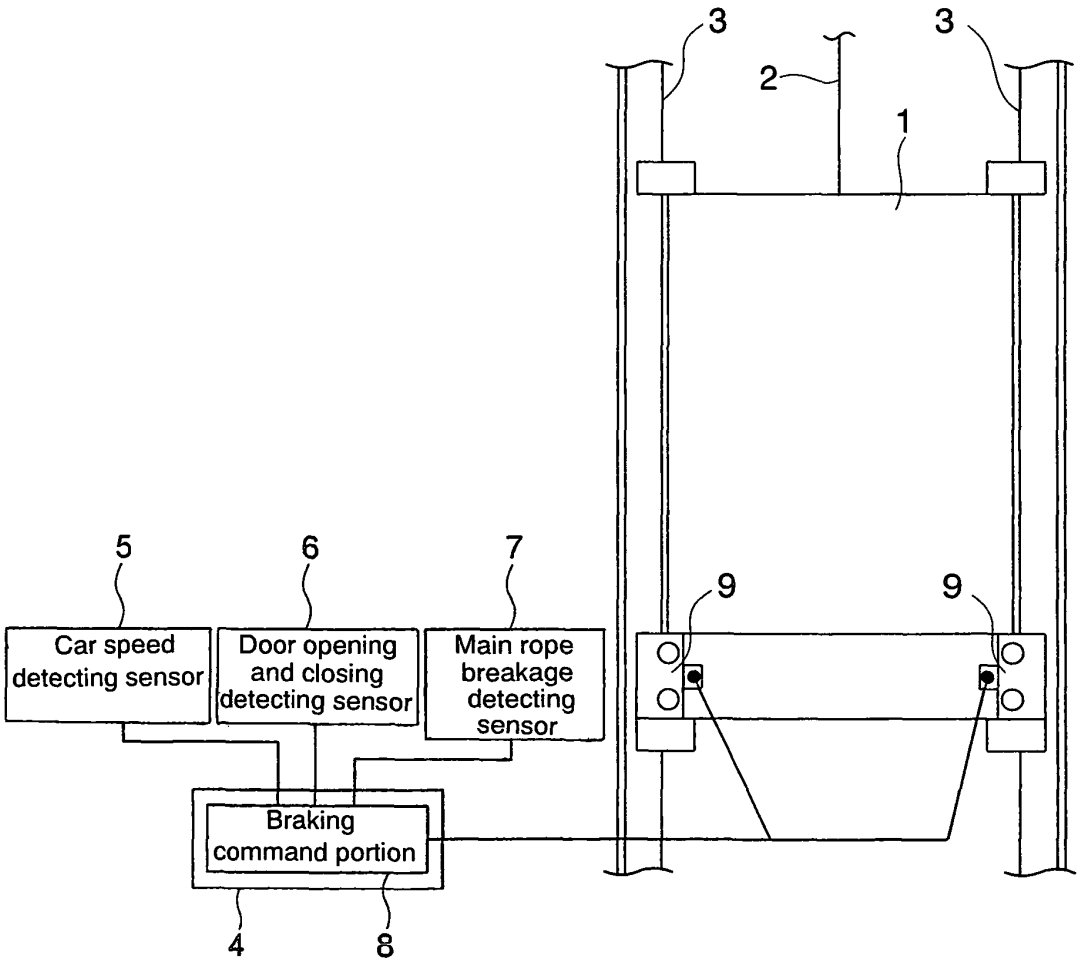

3
2
3
1
5
6
7
9
9
Car speed detecting sensor
Door opening and closing detecting sensor
Main rope breakage detecting sensor
Braking command portion
4
8

FIG. 2

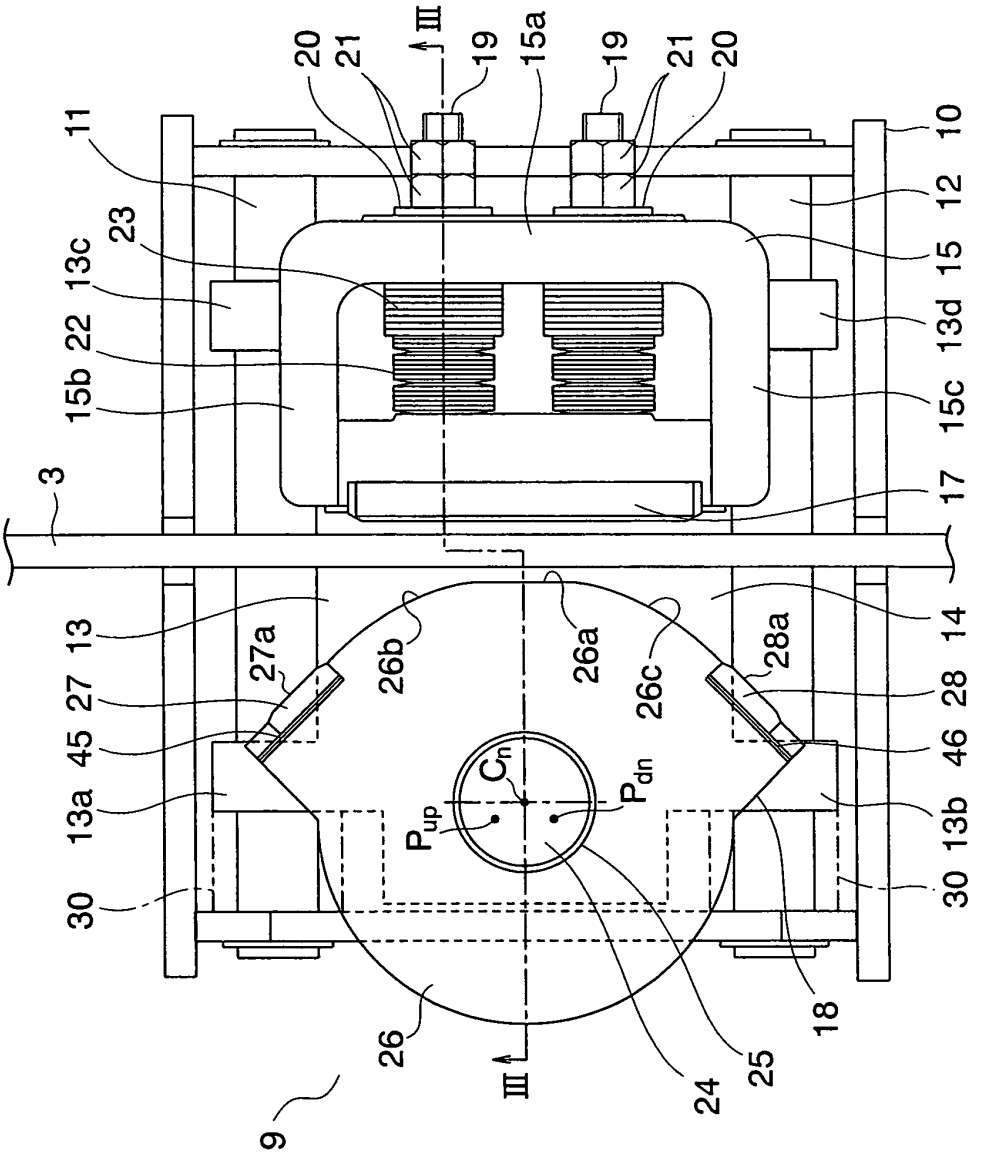

III
20
21
19
15a
19
21
20
11
10
12
23
13c
15
13d
22
15b
15c
3
17
13
14
27a
26b
26a
26c
28a
27
28
45
46
13a
13b
30
30
C_n
P_{up}
P_{dn}
26
III
18
24
25
9

FIG. 3

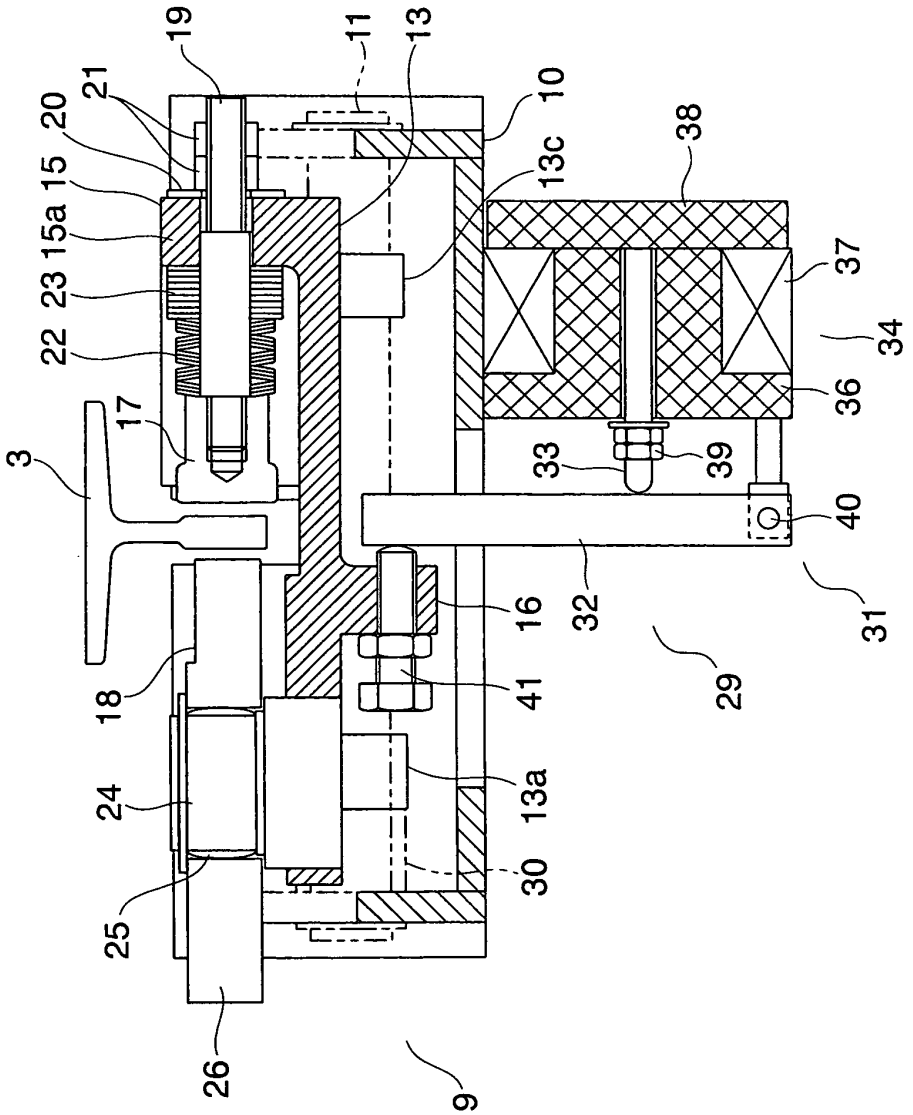

19
11
13
21
10
20
38
13c
15
15a
37
23
34
22
36
17
33
39
3
40
32
16
31
18
41
29
24
13a
30
25
26
9

FIG. 4

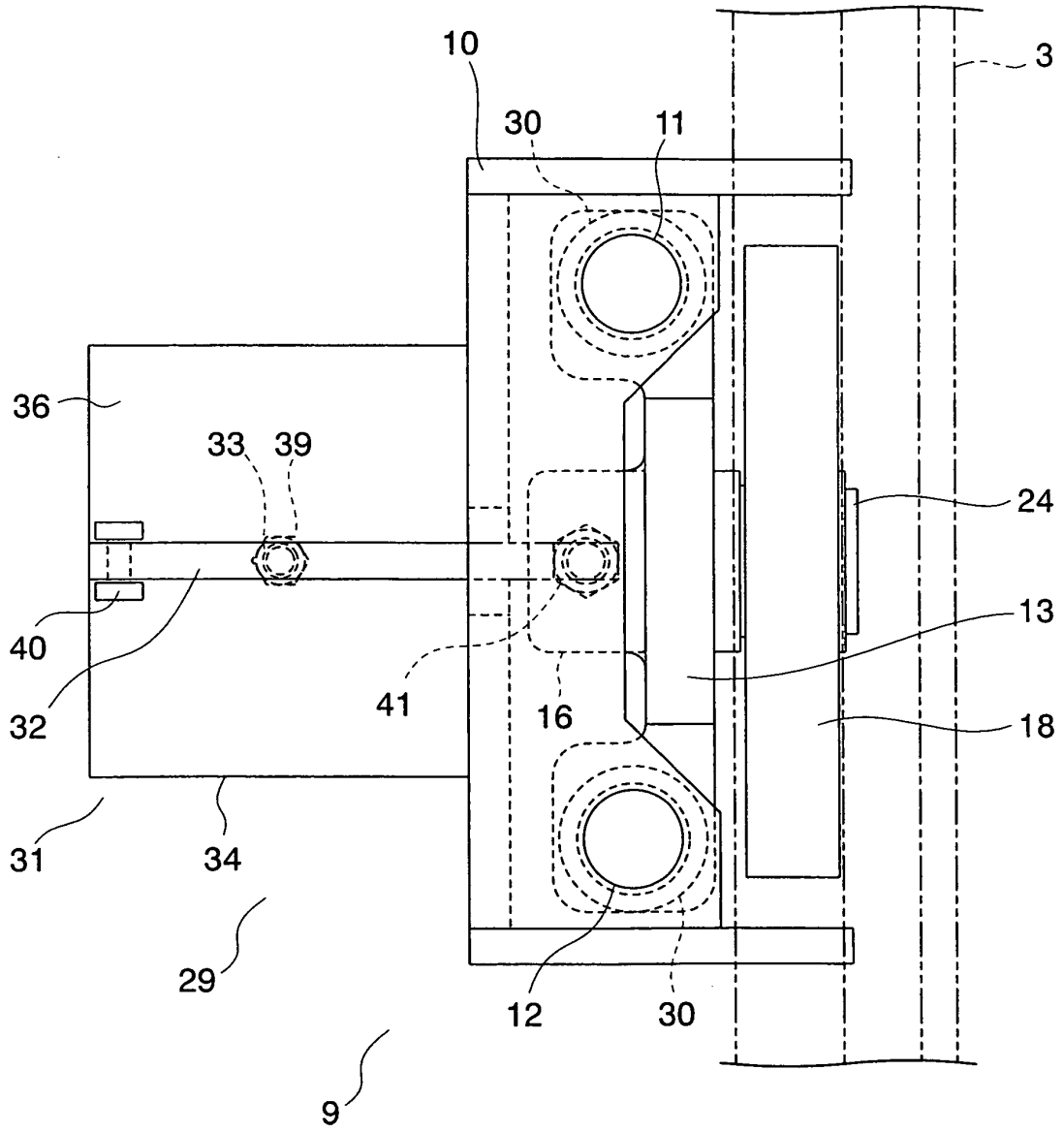


FIG. 5

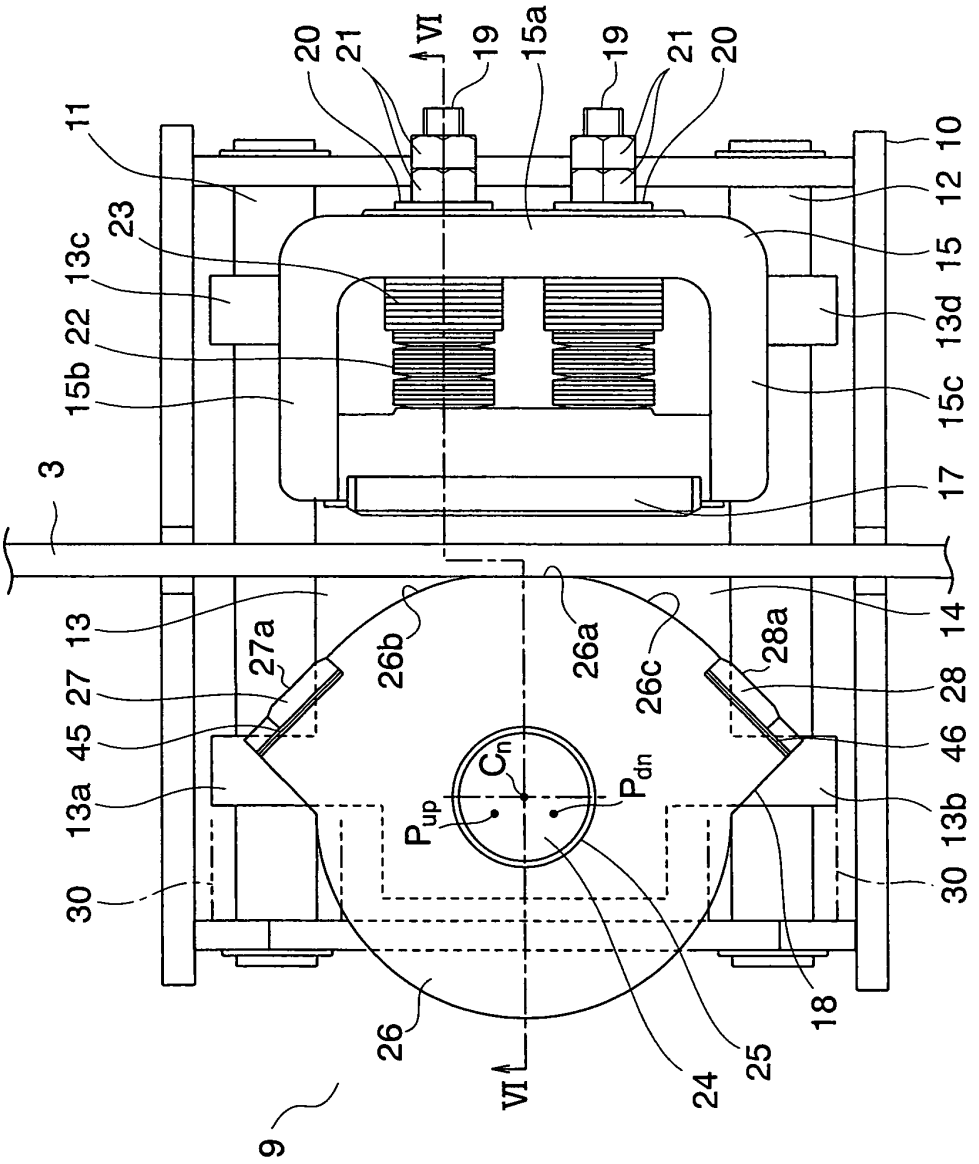

20
21
VI
19
15a
19
21
20
11
10
12
23
15
13c
13d
22
15b
15c
3
17
13
14
27a
26b
26a
26c
28a
27
28
45
46
C_n
P_{dn}
P_{up}
13a
13b
30
30
18
26
VI
24
25
9

FIG. 6

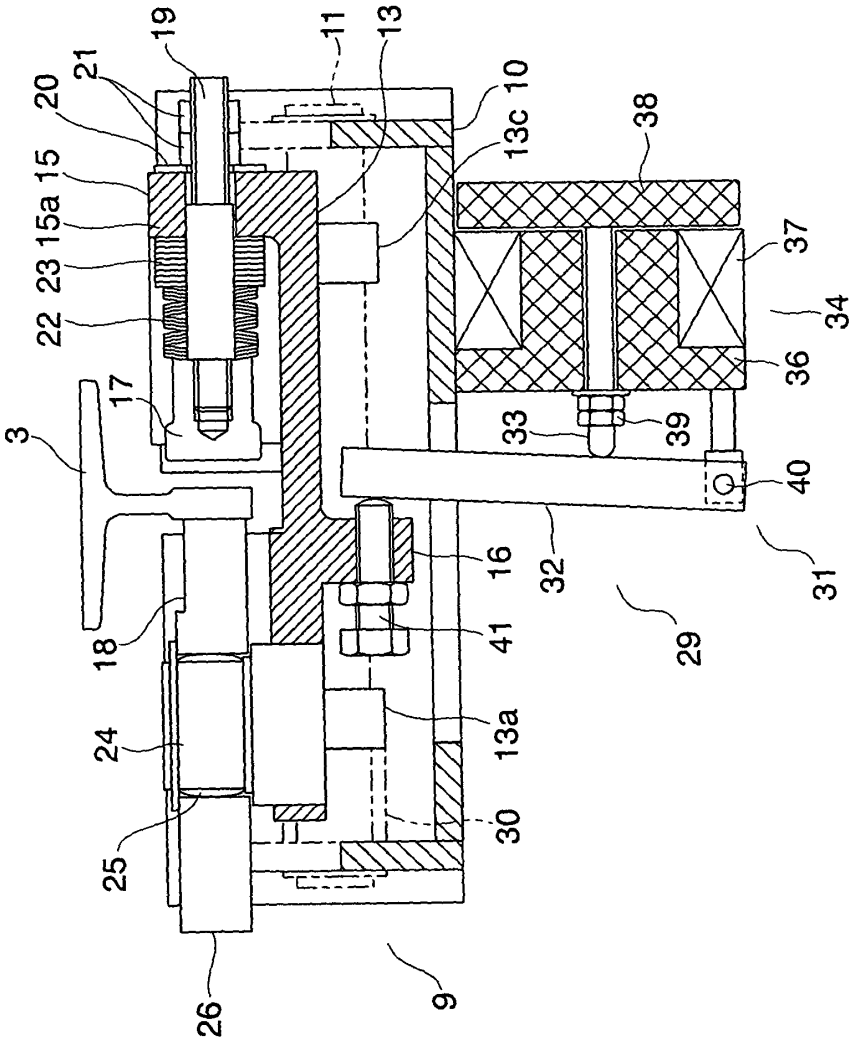

19
11
13
21
20
10
13c
38
15
15a
37
23
34
22
36
17
33
39
3
40
16
32
31
18
41
29
24
13a
30
25
26
9

FIG. 7

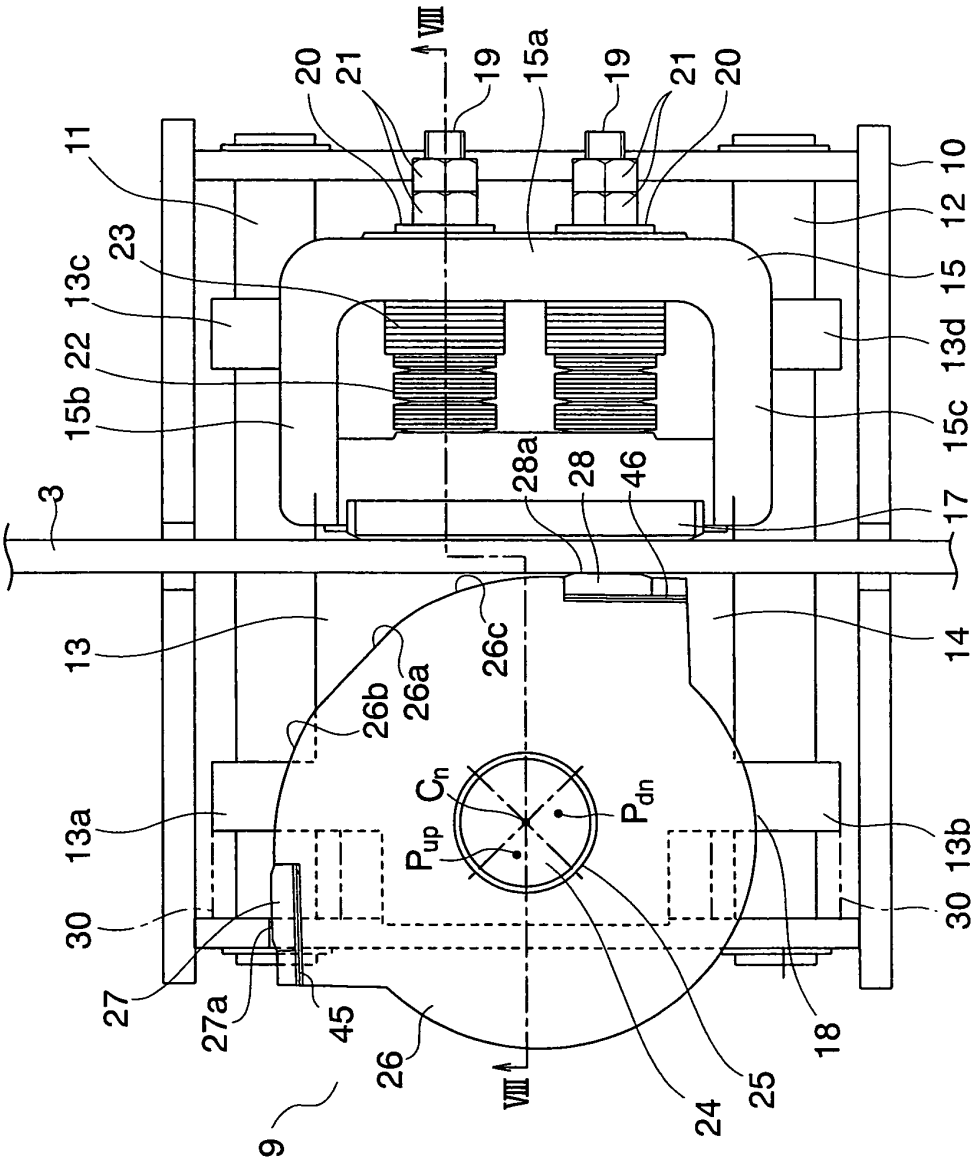

VIII
20
21
19
15a
19
21
20
11
10
12
23
13c
15
13d
22
15b
15c
28a
28
46
3
17
13
14
26c
26b
26a
C_n
P_{up}
P_{dn}
13a
13b
30
30
27
27a
45
26
18
VIII
25
24
9

FIG. 8

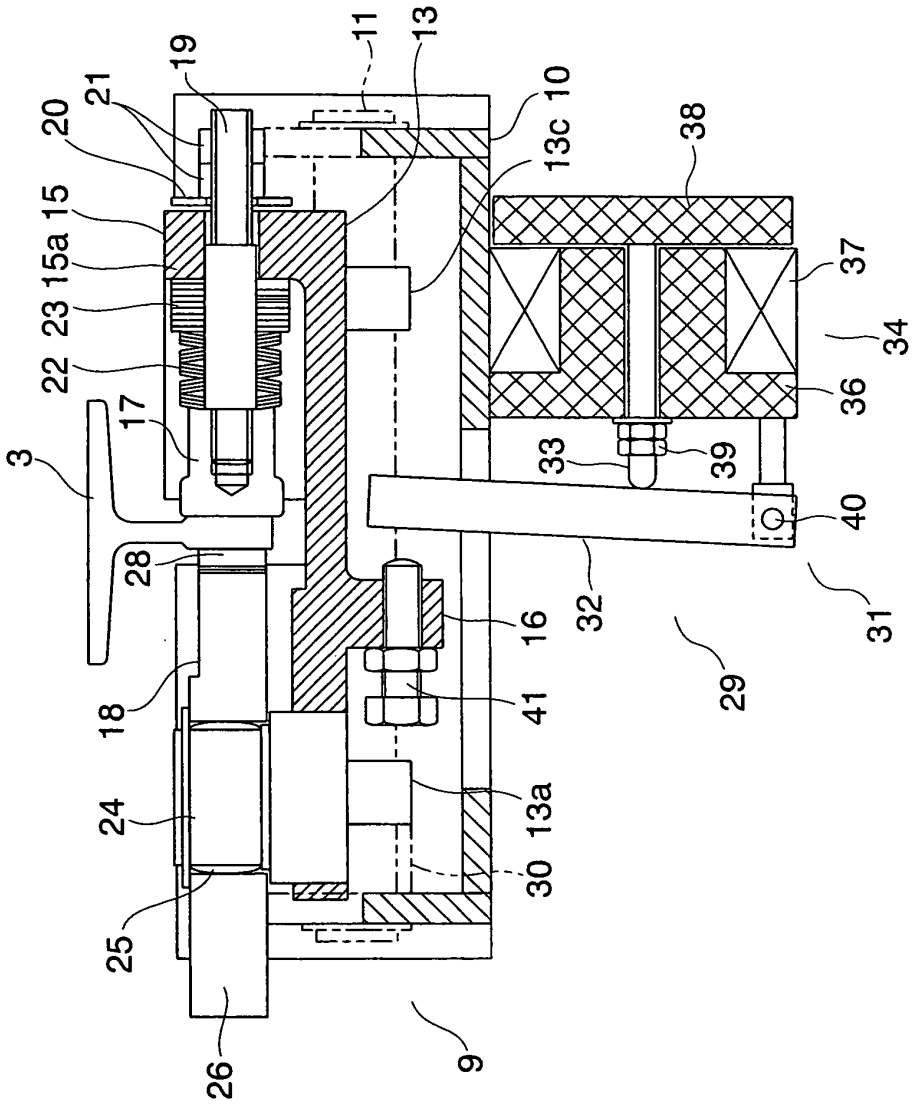

19
11
13
21
10
20
13c
38
15
15a
37
23
34
22
36
17
33
39
3
40
28
32
31
16
29
18
41
24
13a
30
25
26
9

FIG. 9

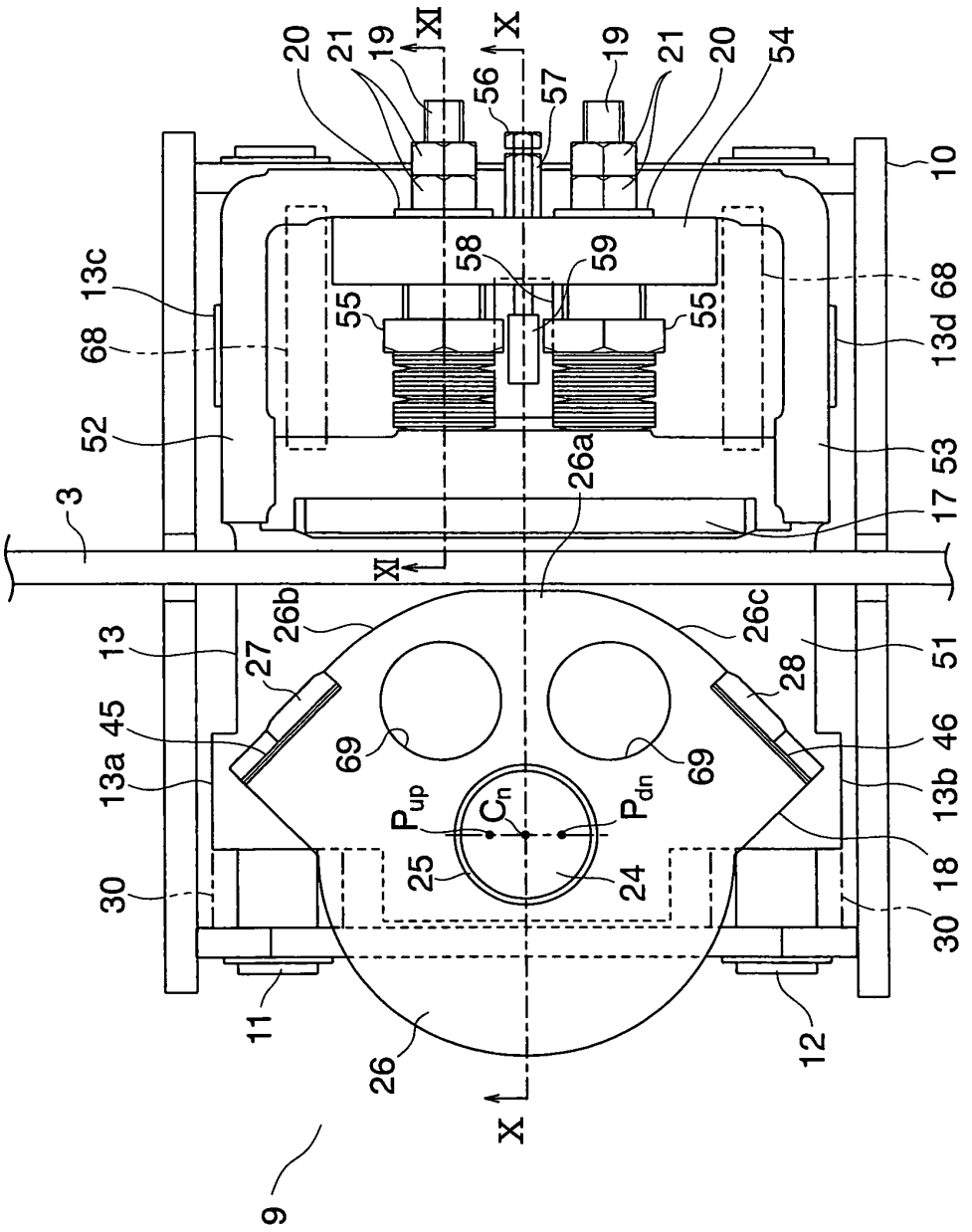

20
21
19
XI
X
56
57
19
21
20
54
10
13c
68
58
59
55
55
68
13d
52
53
26a
3
17
XI
26b
26c
13
27
51
28
45
46
69
69
13a
13b
P_{up}
C_n
P_{dn}
18
25
24
30
30
11
12
26
X
9

FIG. 10

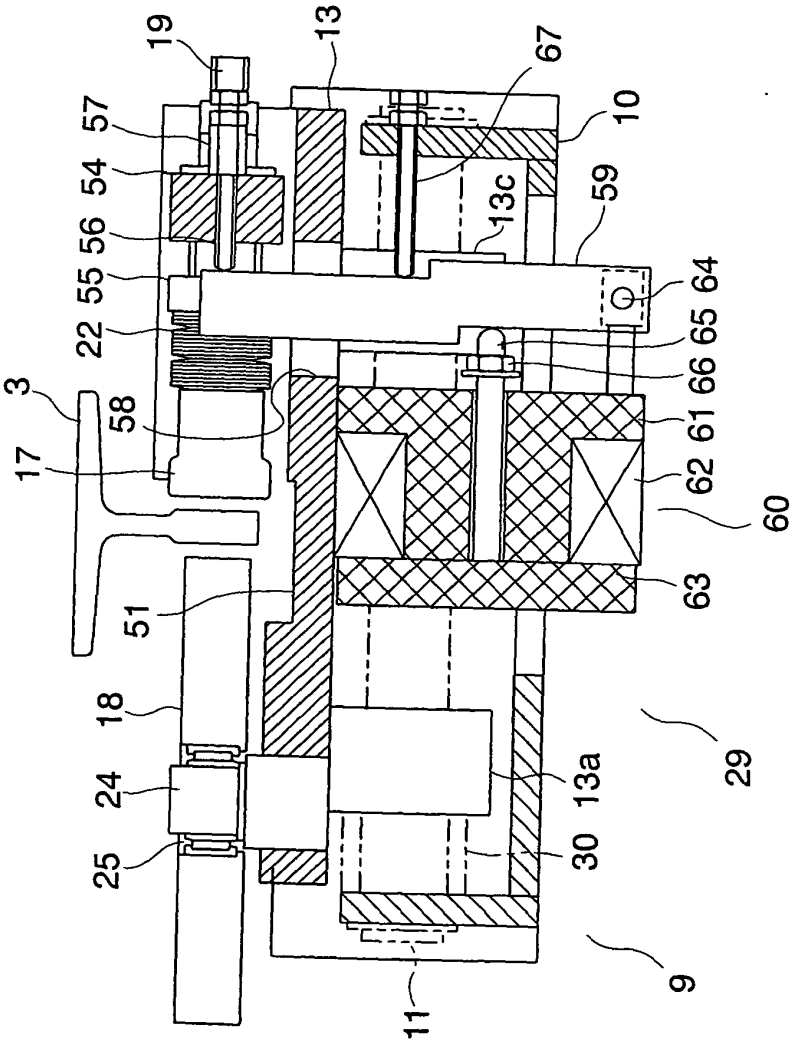

19
13
67
57
10
54
13c
59
56
64
55
65
22
66
3
58
61
17
62
60
63
51
18
29
24
13a
25
30
9
11

FIG. 11

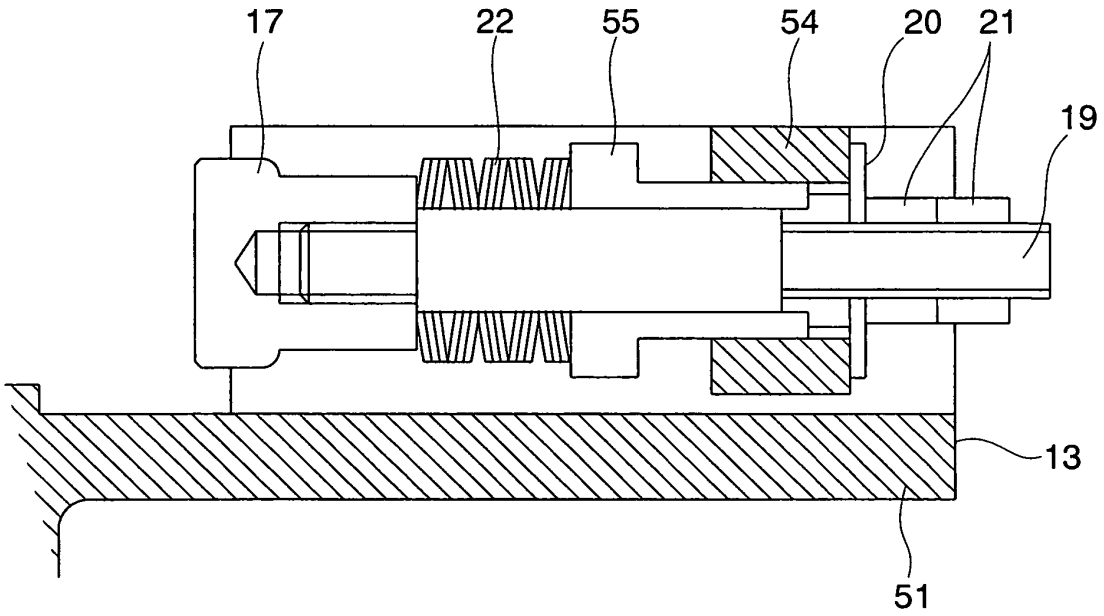


FIG. 12

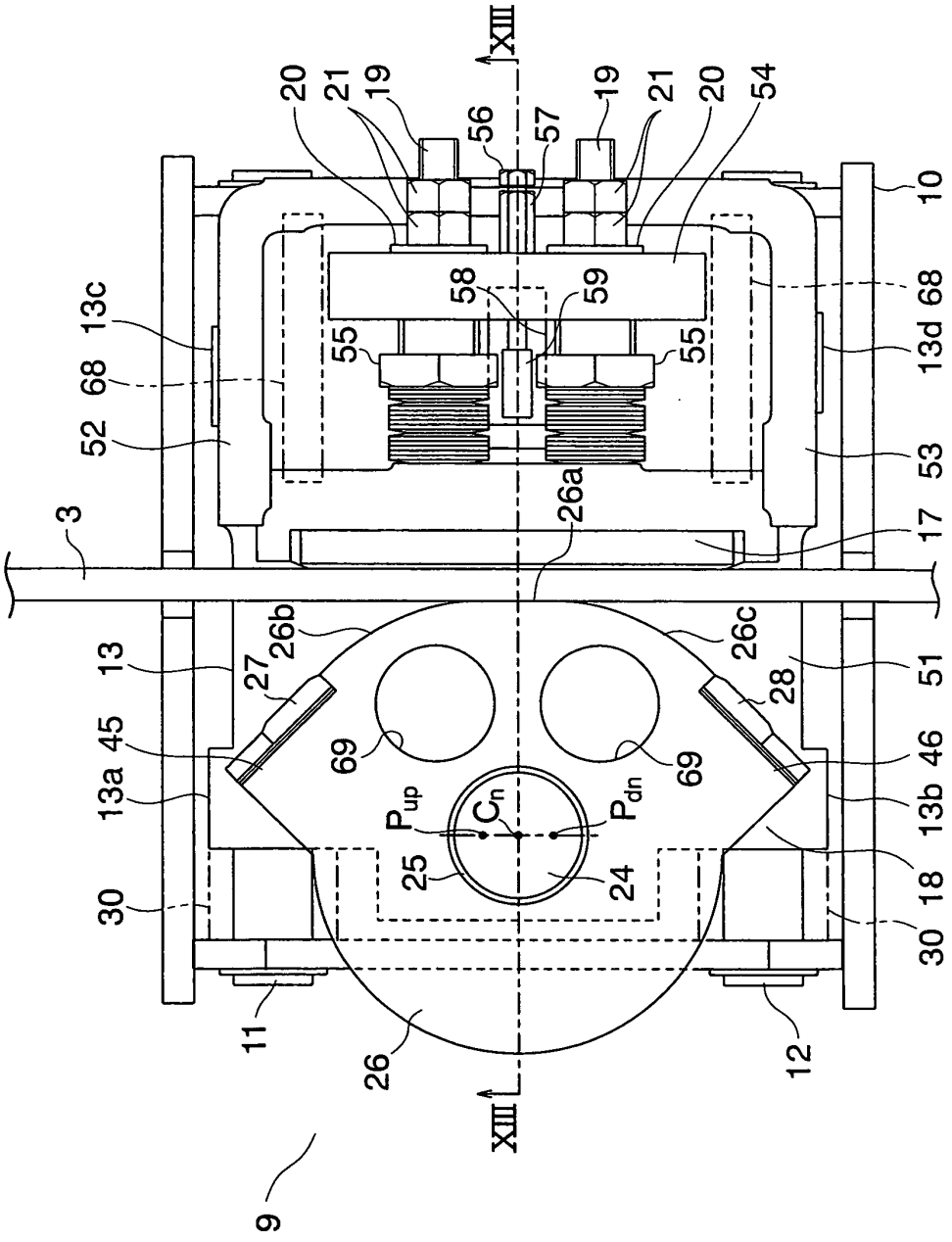

XIII
XIII
20
21
19
56
57
19
21
20
54
10
58
59
68
13c
55
55
13d
68
52
53
3
26a
17
26b
26c
13
27
28
51
45
69
69
46
13a
P_{up}
C_n
P_{dn}
13b
25
24
18
30
30
11
26
12
9

FIG. 13

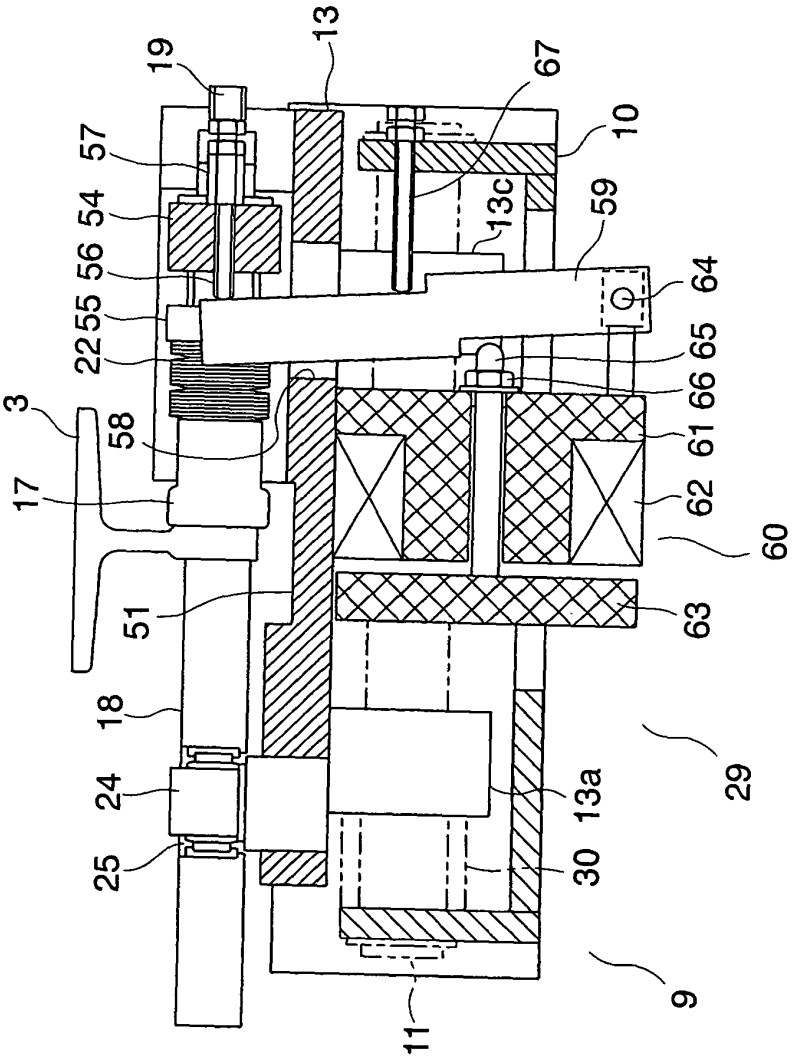

19
13
67
10
57
54
56
55
22
13c
59
64
65
66
61
62
60
63
3
58
17
51
18
24
25
13a
30
29
9
11

FIG. 14

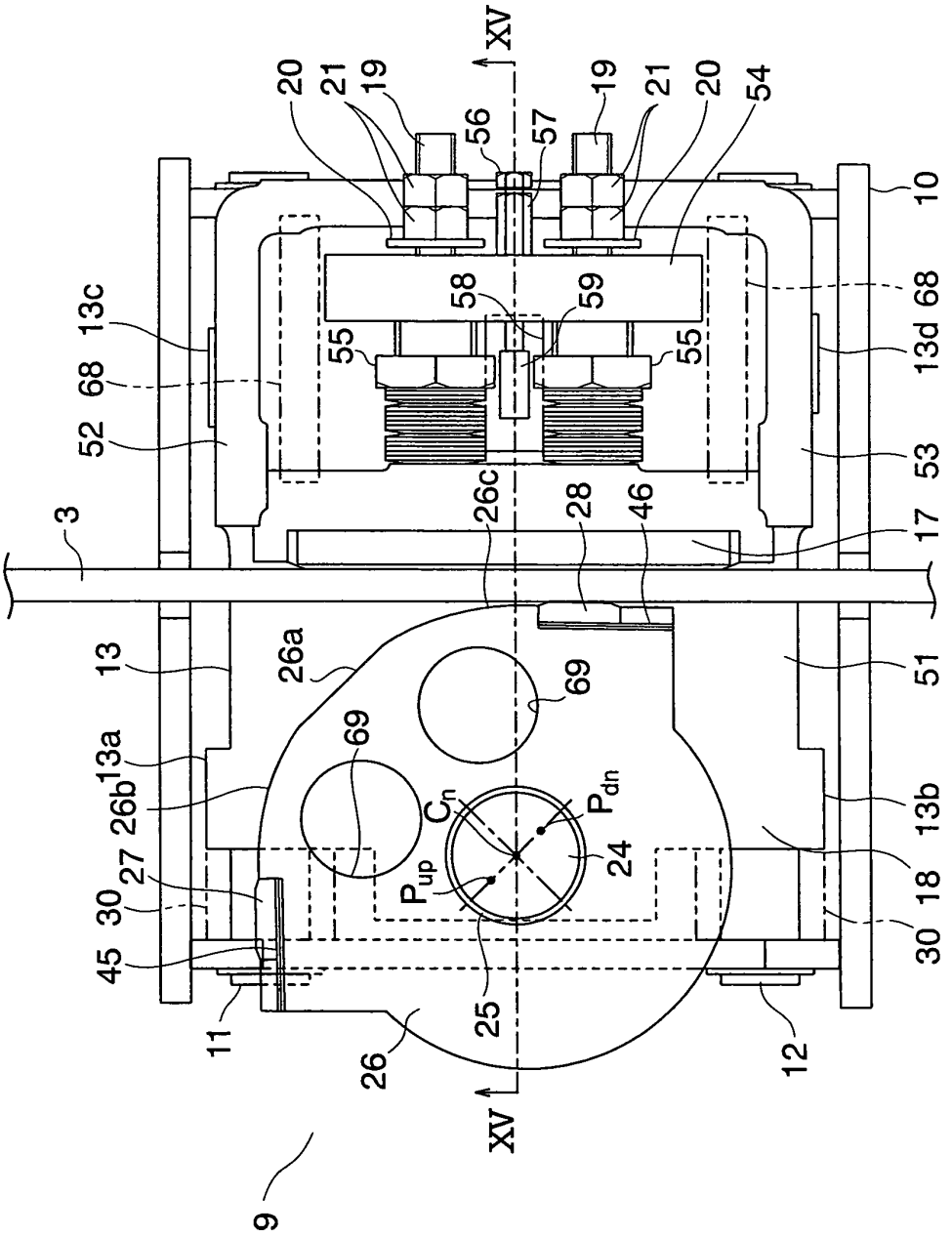
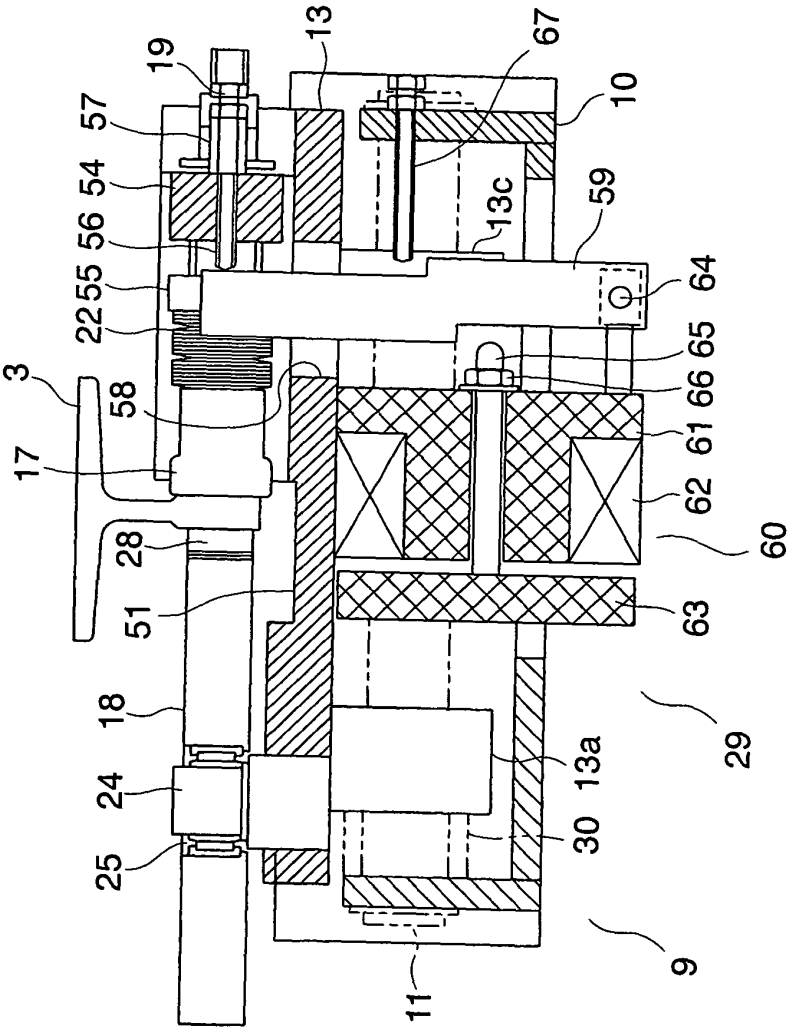

XV
XV
20
21
19
56
57
19
21
20
54
10
13c
68
58
59
68
13d
55
55
52
53
3
26c
28
46
17
13
26a
69
51
69
13a
26b
C_n
P_{dn}
13b
27
P_{up}
24
18
30
45
30
11
25
12
26
9

FIG. 15


19
13
67
57
10
54
13c
59
56
64
55
22
65
3
58
66
61
17
62
28
60
51
63
18
29
13a
24
30
25
9
11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/052701

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)
B66B5/00-B66B5/28

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 1996-2007
Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007

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.
A	JP 2006-347771 A (Inventio AG.), 28 December, 2006 (28.12.06), & US 2007/0007083 A1 & EP 1733992 A1	1-12
A	US 6176350 B1 (AUTZUGSTECHNOLOGIE SCHLOSSER GMBH), 23 January, 2001 (23.01.01), & EP 0899231 A1	1-12
A	WO 2004/083091 A1 (Mitsubishi Electric Corp.), 30 September, 2004 (30.09.04), & EP 1604935 A1 & WO 2004/083090 A1	12

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 October, 2007 (25.10.07)	06 November, 2007 (06.11.07)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (April 2007)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 2004083091 A **[0004]**
- EP 1460020 A **[0004]**