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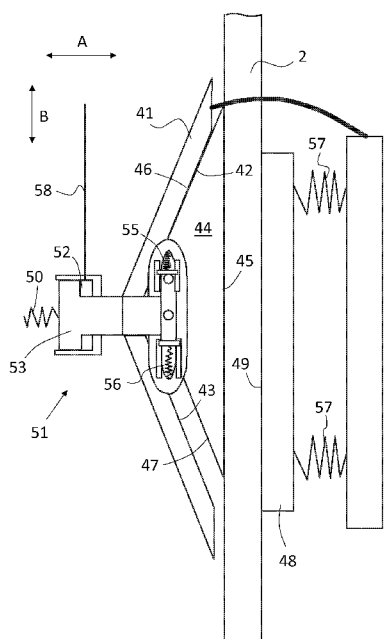


FIG. 3

(57) Abstract: The safety gear (40) for an elevator comprises a frame (41), a brake element (44) having a braking surface (45) facing a guide surface of a guide rail (2) and a wedge surface (46) facing a wedge surface (42) of the frame (41), the brake element (44) being moveable in a direction (A) perpendicular to guide surfaces of the guide rail (2) and in a direction (B) parallel to the longitudinal direction of the guide rail (2) to allow moving the brake element (44) between release and gripping positions, a counterpart (48) having a braking surface (49) facing another guide surface of the guide rail (2), a biasing spring (50) biasing the brake element (44) towards the guide rail (2), and safety gear release means (51) comprising a cylinder (52) and piston (53) and being connected to the brake element (44) such that a force to oppose the force of the biasing spring (50) is applied to the brake element (44) when hydraulic pressure is applied to said piston (53) for moving the brake element (44) to the release position and keeping the brake element (44) in the release position.

## **SAFETY GEAR AND SAFETY ARRANGEMENT FOR AN ELEVATOR AND ELEVATOR**

### Technical field of the invention

- 5 The present invention concerns a safety gear for an elevator comprising a guide rail, as defined in claim 1. The invention also concerns a safety arrangement for an elevator and an elevator.

### Background of the invention

10 Elevators have safety gears to stop elevator car movement in case of an emergency, such as in an overspeed situation of an elevator car. A conventional safety gear is activated by a mechanical overspeed governor, which has a governor rope coupled to the safety gear and running via a governor sheave. In an overspeed situation the safety gear is activated by stopping the governor sheave and governor rope, such that a wedge  
15 mechanism of the safety gear moves into a gripping position against a guide rail of the car.

Often an elevator car has two such safety gears disposed on the opposite sides of the car. They are interconnected by a common synchronization axis which ensures that both safety gears will be activated upon operation of the  
20 overspeed governor. The synchronization axis together with the safety gears need space above or below the car to ensure proper operation. On the other hand, space-efficiency is an increasingly important factor in modern elevators.

Because overspeed governor components are located separately from the safety gear in the elevator system, maintenance and inspection may be difficult  
25 and laborious, as the serviceman needs to go to different places in the elevator system to get the maintenance or inspection job done.

A traditional mechanical overspeed governor has only one tripping speed, which may be, for example, 25 percent over the rated speed of the elevator car. For safety reasons, it would be beneficial to be able to activate the safety  
30 gear at different speed levels, for example in different operational situations or at different elevator car locations within the elevator shaft.

Because of the afore mentioned reasons, safety gears with electrically controllable actuators have been introduced. An electrically controllable actuator may be controlled by an electronic overspeed governor, i.e. a programmable safety device, which contains overspeed monitoring function of an elevator car. Such an actuator may comprise an electromagnet, which when energized keeps the wedge of the safety gear separate from an elevator guide rail, i.e. in an inactive position. Safety gear is activated by de-energizing the electromagnet, such that the wedge inside the safety gear will move into a gripping position against the guide rail to arrest movement of the car. This operating principle causes continuous power losses in the electromagnet, which is against the general need to reduce energy consumption of elevators.

#### Summary of the invention

An object of the present invention is to provide an improved safety gear for an elevator that comprises a guide rail having a first guide surface and a second guide surface for guiding an elevator car or a counterweight of the elevator, the first and second guide surfaces of the guide rail facing opposite directions, the safety gear being configured to be mounted to an elevator car or a counterweight of the elevator and configured to cooperate with said guide rail of the elevator to stop said elevator car or counterweight when activated. Another object of the invention is to provide an improved safety arrangement for an elevator. A further object of the invention is to provide an improved elevator.

The safety gear according to the invention comprises

- a frame that is configured to be attached to said elevator car or counterweight, the frame having at least a first wedge surface, which is in a mounted position of the safety gear inclined relative to the longitudinal direction of the guide rail,
- a brake element having a braking surface that is configured to face said first guide surface of the guide rail and a first wedge surface facing and being parallel to the first wedge surface of the frame, the brake element being moveable relative to the frame in a first direction, which is in a mounted position of the safety gear perpendicular to said guide surfaces of the guide rail, and in a second direction, which is in a mounted position of the safety gear parallel to the longitudinal direction of the guide rail to allow moving of the brake element between a release

- position, in which the brake element allows moving of said elevator car or counterweight, and a gripping position, in which the brake element is wedged between the frame of the safety gear and the first guide surface of the guide rail to prevent moving of said elevator car or counterweight,
- 5 - a counterpart arranged at a distance from the brake element in the first direction and having a braking surface that is configured to face in a mounted position of the safety gear the second guide surface of the guide rail,
- 10 - at least one biasing spring configured to bias the brake element in the first direction towards the guide rail, and
- 15 - safety gear release means comprising at least one cylinder and a piston moveable within the cylinder, the safety gear release means being connected to the brake element such that the safety gear release means can apply to the brake element a force in the first direction to oppose the force of the biasing spring when hydraulic pressure is applied to said piston for moving the brake element away from the guide rail to the release position and for keeping the brake element in the release position.

20 The safety gear according to the invention can thus be released and kept in the released state by hydraulic pressure. This allows keeping the safety gear in the released state with no or minimal energy consumption. The safety gear is activated by releasing pressure from the cylinder of the safety gear release means. When the pressure is relieved from the cylinder, the biasing spring brings the brake element into contact with the guide rail. The safety gear

25 according to the invention helps avoiding the problems of both mechanical and electrical safety gears.

According to an embodiment of the invention, the frame further comprises a second wedge surface and the brake element comprises a second wedge surface facing and being parallel to the second wedge surface of the frame,

30 the first wedge surfaces of the frame and the brake element being configured to cooperate with each other to stop said elevator car or counterweight when said elevator car or counterweight moves in a first moving direction, and the second wedge surfaces of the frame and the brake element being configured to cooperate with each other to stop said elevator car or counterweight when

35 said elevator car or counterweight moves in a second moving direction. The

safety gear can thus be configured to operate in both moving directions of the elevator. However, the elevator could also be provided with separate safety gears for different moving directions.

5 According to an embodiment of the invention, at least one connection spring is arranged between the piston and the brake element such that when the brake element is in the gripping position and a sufficient hydraulic force is applied to the piston, the piston can move in the first direction away from the brake element. For releasing the safety gear from a wedged position, the elevator car or counterweight needs to be moved to allow moving of the brake  
10 element. For moving the car and the counterweight, brakes of the elevator needs to be released. The connection spring allows arranging the brakes of the elevator, such as the brakes of the elevator car, in the same hydraulic circuit with the safety gear release means.

15 According to an embodiment of the invention, the safety gear comprises at least one positioning spring for positioning the brake element in the second direction relative to the frame. The positioning spring can keep the brake element centered and move the brake element back to an initial position from a wedged position.

20 The safety arrangement according to the invention comprises a safety gear defined above. The safety arrangement further comprises

- pressurizing means configured to pressurize hydraulic fluid and being arranged in fluid communication with said at least one cylinder of the safety gear release means to allow supplying pressurized hydraulic fluid into said at least one cylinder,
- 25 - a fluid reservoir arranged in fluid communication with said at least one cylinder of the safety gear release means and with the pressurizing means for supplying hydraulic fluid to the pressurizing means and for receiving hydraulic fluid from said at least one cylinder of the safety gear release means, and
- 30 - at least one safety valve having a closed state and an open state, said at least one safety valve being arranged between said at least one cylinder of the safety gear release means and the fluid reservoir such that in the open state of the safety valve flow from said at least one cylinder into the fluid reservoir is allowed, and in the closed state of the

safety valve flow from said at least one cylinder through the safety valve into the fluid reservoir is prevented.

The safety gear can be triggered by means of the at least one safety valve and released by means of the pressurizing means.

5 According to an embodiment of the invention, the arrangement comprises at least two safety valves arranged in parallel such that flow from said at least one cylinder of the safety gear release means into the fluid reservoir is allowed when at least one of the safety valves is in the open state. Two safety valves provide redundancy and ensure that the safety gear is triggered in case at least  
10 one of the safety valves functions.

According to an embodiment of the invention, the safety arrangement comprises at least two safety gears arranged in fluid communication with said pressurizing means and said fluid reservoir. For instance, safety gears on two sides of an elevator can be arranged in the same hydraulic circuit to ensure  
15 simultaneous activation of the safety gears.

According to an embodiment of the invention, the safety gear is mounted to an elevator car and the safety arrangement comprises at least one brake device mounted to said elevator car, the brake device comprising

- 20 - at least one moveable brake element, said at least one brake element having a braking position, in which braking position the brake element is configured to be engaged with a guide rail of the elevator car for stopping the elevator car and/or for preventing moving of the elevator car and a release position, in which release position the brake element allows moving of the elevator car,
- 25 - at least one biasing spring that is configured to bias the brake element towards the braking position, and
- brake release means, the brake release means comprising at least one cylinder and a piston moveable within the cylinder, the brake release means being configured to move said at least one brake element to the  
30 release position when hydraulic pressure overcoming a biasing force caused by said at least one biasing spring is applied to the piston, wherein said pressurizing means are arranged in fluid communication with said at least one cylinder of the brake release means to allow supplying pressurized hydraulic fluid into said at least one cylinder of

the brake release means, said fluid reservoir is arranged in fluid communication with said at least one cylinder of the brake release means for receiving hydraulic fluid from said at least one cylinder of the brake release means, and said at least one safety valve is arranged between said at least one cylinder of the brake release means and the fluid reservoir such that in the open state of the safety valve flow from said at least one cylinder into the fluid reservoir is allowed, and in the closed state of the safety valve flow from said at least one cylinder through the safety valve into the fluid reservoir is prevented.

10 The brake of the elevator car can thus be arranged in the same hydraulic circuit with the safety gear, thus allowing the same hydraulic components to be used for controlling both the brakes and the safety gear.

According to an embodiment of the invention, the brake release means, safety gear release means and the biasing springs of the brake device and the safety gear are configured such that the hydraulic pressure needed for keeping the safety gear in the release position is lower than the hydraulic pressure needed for keeping the brake device in the release position. This ensures that the brake element of the safety gear normally moves before the brake element of the brake device when the brakes are released and after the brake element of the brake device when braking. The brake device can thus be used for controlled deceleration and controlled start of moving of the elevator car or counterweight.

20 According to an embodiment of the invention, the pressurizing means comprise a hydraulic cylinder and a piston that are configured to be moveable relative to each other to pressurize hydraulic fluid in the hydraulic cylinder. By means of the cylinder and piston, the pressure in the hydraulic circuit can be easily controlled for achieving precisely controlled deceleration. Also, compared to hydraulic pumps, the piston and cylinder help achieving a lower noise level.

25 According to an embodiment of the invention, the pressurizing means comprise a linear actuator for driving the piston or the hydraulic cylinder. A linear actuator allows precise control of the pressurizing means.

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According to an embodiment of the invention, the linear actuator is provided with a brake. By means of the brake, the pressure in the hydraulic system can be maintained with minimal energy consumption.

5 According to an embodiment of the invention, the arrangement is configured to monitor one or more predetermined trigger events, and in case a trigger event is detected, to cut power supply to said at least one safety valve to switch said at least one safety valve to the open state. The trigger events can be monitored, for instance, by means of mechanical switches and/or different sensors.

10 The elevator according to the invention comprises a safety arrangement defined above.

#### Brief description of the drawings

Embodiments of the invention are described below in more detail with reference to the accompanying drawings, in which

15 Fig. 1 shows schematically a safety gear according to an embodiment of the invention in a release position,

Fig. 2 shows the safety gear of figure 1 in a contact position,

Fig. 3 shows the safety gear of figure 1 in a gripping position,

20 Fig. 4 shows the safety gear of figure 1 in the gripping position with pressurized safety gear release means,

Fig. 5 shows schematically a safety arrangement according to an embodiment of the invention, and

Fig. 6 shows an elevator car with a safety arrangement according to an embodiment of the invention.

#### 25 Detailed description of embodiments of the invention

Figures 1 to 4 show schematically a safety gear 40 according to an embodiment of the invention. The safety gear 40 forms part of a safety arrangement of an elevator. Figure 5 shows schematically parts of a safety arrangement comprising the safety gear 40. Figure 6 shows schematically an

elevator car 3 that is provided with the safety gear 40 according to the invention. The safety gear 40 according to the invention is intended for use in an elevator that comprises at least one guide rail 2.

5 The elevator comprises an elevator car 3 that is arranged into an elevator shaft. The elevator car 3 can move in the elevator shaft in the vertical direction. The elevator further comprises a counterweight (not shown in the figures). The elevator car 3 is connected to the counterweight via a hoisting member. The hoisting member can be, for example, a steel wire, a belt, such as a toothed belt or a flat belt, a carbon fiber rope or a coated rope. The elevator can  
10 comprise several hoisting members. The elevator car 3 and the counterweight are connected to each other in such a way that they move to opposite directions in respect of each other. The elevator is further provided with a hoisting machinery. The hoisting machinery can comprise an electric motor. The motor drives a sheave, which can be connected to the motor either directly  
15 or via a gear. As the sheave rotates, the hoisting member moves and the elevator car 3 and the counterweight are moved. The motor can be arranged in a machine room located above the elevator shaft. Alternatively, the elevator can be a machine-room-less elevator and the motor can be arranged in the elevator shaft.

20 The elevator car 3 is guided in the elevator shaft by guide rails 2. A pair of guide rails 2 is arranged on opposite sides of the elevator shaft. The guide rail 2 can have, for instance, a T-shaped profile. The arms of the profile are attached to the walls of the elevator shaft, for instance via guide rail brackets. The stem, or nose, of the profile forms two guide surfaces for guiding the  
25 elevator car 3. The guide rail 2 has a first guide surface and a second guide surface. The guide surfaces face opposite directions. The elevator car 3 can be provided with rollers or other elements that roll or slide against the guide surfaces of the guide rail 2. The counterweight of the elevator can be guided by similar guide rails.

30 The safety gear 40 can be used as a safety device of the elevator car 3. The safety gear 40 can stop the elevator car 3 in case of emergency, for instance in an overspeed situation. The safety gear 40 could also be used as a safety device of the counterweight. The safety gear 40 is configured to be mounted to the elevator car 3 or the counterweight of the elevator and configured to  
35 cooperate with the guide rail 2 of the elevator to stop the elevator car 3 or

counterweight when activated. The elevator car 3 can be provided with two or more safety gears 40. For instance, the elevator car 3 can be provided with a safety gear 40 on two sides of the elevator car 3, each safety gear 40 being configured to cooperate with one of the guide rails 2. Also, the elevator car 3 could be provided with separate safety gears 40 for downward and upward movement of the elevator car 3. The safety gear 40 could also be mounted to the counterweight. Also the counterweight could be provided with two or more safety gears 40. In the following, the safety gear 40 is described by referring to a safety gear of an elevator car 3, but a safety gear 40 of a counterweight can have a similar construction and can function in a similar way.

The safety gear 40 comprises a frame 41 that is configured to be attached to the elevator car 3. The frame 41 has at least a first wedge surface 42, which is in a mounted position of the safety gear 40 inclined relative to the longitudinal direction of the guide rail 2. The safety gear 40 also comprises a brake element 44 having a braking surface 45 that is configured to face the first guide surface of the guide rail 2, and a first wedge surface 46 facing and being parallel to the first wedge surface 42 of the frame 41. The brake element 44 can exert a friction force on the first guide surface of the guide rail 2.

The brake element 44 is moveable relative to the frame 41 in a first direction A, which is in a mounted position of the safety gear 40 perpendicular to the guide surfaces of the guide rail 2. The first direction A is thus a horizontal direction. The brake element 44 is further moveable in a second direction B, which is in a mounted position of the safety gear 40 parallel to the longitudinal direction of the guide rail 2. The second direction B is thus the vertical direction.

The brake element 44 can move between a release position, in which the brake element 44 allows moving of the elevator car 3, and a gripping position, in which the brake element 44 is wedged between the frame 41 of the safety gear 40 and the first guide surface of the guide rail 2 to prevent moving of the elevator car 3. Figure 1 shows the brake element 44 in the release position and figure 3 shows the brake element 44 in the gripping position.

The safety gear 40 further comprises a counterpart 48 arranged at a distance from the brake element 44 in the first direction A. The counterpart 48 has a braking surface 49 that is configured to face in a mounted position of the safety gear 40 the second guide surface of the guide rail 2. In the embodiment of the

figures, the counterpart 48 is attached to the frame 48 by means of springs 57. The counterpart 48 could also be an integral part of the frame 41. Alternatively, the counterpart 48 could be similar to the brake element 44.

5 The safety gear 40 comprises a biasing spring 50 that is configured to bias the brake element 44 in the first direction A towards the guide rail 2. The biasing spring 50 can be a mechanical spring, such as a coil spring. Only one biasing spring 50 is shown in the figures, but the safety gear 40 could comprise two or more biasing springs 50.

10 The safety gear 40 further comprises safety gear release means 51 comprising a cylinder 52 and a piston 53 moveable within the cylinder 52. The figures show one cylinder 52 and one piston 53, but the safety gear release means 51 could comprise two or more cylinders and pistons. In particular, the safety gear 40 could comprise similar brake elements 44 on both sides of the guide rail 2, one of the brake elements 44 forming the counterpart 48 referred to above, in  
15 which case the safety gear release means 51 could comprise similar cylinders and pistons for both brake elements. The safety gear release means 51 are connected to the brake element 44 such that the safety gear release means 51 can apply to the brake element 44 a force in the first direction A to oppose the force of the biasing spring 50 when hydraulic pressure is applied to the  
20 piston 53 for moving the brake element 44 away from the guide rail 2 to the release position and for keeping the brake element 44 in the release position. Hydraulic fluid can be supplied into the cylinder 52 and released from the cylinder 52 via a fluid line 58.

25 In the embodiment of the figures, the frame 41 of the safety gear 40 further comprises a second wedge surface 43 and the brake element 44 comprises a second wedge surface 47 facing and being parallel to the second wedge surface 43 of the frame 41. The first wedge surfaces 42, 46 of the frame 41 and the brake element 44 are configured to cooperate with each other to stop the elevator car 3 when the elevator car 3 or counterweight moves downwards.  
30 The second wedge surfaces 43, 47 of the frame 41 and the brake element 44 are configured to cooperate with each other to stop the elevator car 3 when the elevator car 3 moves upwards. The safety gear 40 thus functions in both moving directions of the elevator. However, the elevator could be provided with separate safety gears for the two moving directions. It is thus not necessary to  
35 provide the frame 41 and the brake element 44 with two wedge surfaces.

The safety gear 40 comprises positioning springs 55, 56 for positioning the brake element 44 in the second direction B relative to the frame 41. The positioning springs 55, 56 keep the brake element 44 centered relative to the frame 41 when no force in the second direction B is exerted on the brake element 44. The positioning springs 55, 56 allow moving of the brake element 44 to the gripping position.

When the elevator moves, hydraulic pressure overcoming the biasing force of the biasing spring 50 is maintained in the cylinder 52 of the safety gear release means 51. The brake element 44 is thus kept in the release position shown in figure 1. When pressure is relieved from the cylinder 52, the biasing spring 50 can push the brake element 44 against the guide rail 2 to a contact position, as shown in figure 2. If the elevator car 3 is not moving when the brake element 44 contacts the guide rail 2, the brake element 44 remains in the contact position shown in figure 2. If the elevator car 3 keeps moving downwards, friction force moves the brake element 44 relative to the frame 41 of the safety gear 40. As a result, the brake element 44 gets wedged into the gripping position between the frame 41 and the guide rail 2, as shown in figure 3. Also the counterpart 48 is pulled against the guide rail 2 and the elevator car 3 stops.

For moving the brake element 44 back to the release position, pressurized hydraulic fluid is introduced into the cylinder 52 of the safety gear release means 51 to move the piston 53 against the biasing force of the biasing spring 50. To allow moving of the brake element 44 in the first direction A, the frame 41 of the safety gear 40 needs to be moved in the second direction B relative to the brake element 44. This can be done by moving the elevator car 3. Alternatively, if the position of the frame 41 of the safety gear 40 is adjustable, the frame 41 could be moved relative to the elevator car 3.

The safety arrangement according to the invention comprises a safety gear 40 described above. The safety gear 40 is operated by means of a hydraulic circuit. The hydraulic circuit comprises pressurizing means 11 that are configured to pressurize hydraulic fluid. The pressurizing means 11 are arranged in fluid communication with the cylinder 52 of the safety gear release means 51 to allow supplying pressurized hydraulic fluid into the cylinder 52 via the fluid line 58.

The hydraulic circuit further comprises a fluid reservoir 22 that is arranged in fluid communication with the cylinder 52 of the safety gear release means 51 and with the pressurizing means 11 for supplying hydraulic fluid to the pressurizing means 11 and for receiving hydraulic fluid from the cylinder 52 of the safety gear release means 51. The hydraulic circuit further comprises safety valves 16, 17. Each safety valve 16, 17 has a closed state and an open state and the safety valves 16, 17 are arranged between the cylinder 52 of the safety gear release means 51 and the fluid reservoir 22. If at least one of the safety valves 16, 17 is in the open state, flow from the cylinder 52 of the safety gear release means 51 into the fluid reservoir 22 is allowed. If all the safety valves 16, 17 are in the closed state, flow from the cylinder 52 of the safety gear release means 51 into the fluid reservoir 22 is prevented.

In the embodiment of the figures, the safety arrangement comprises two safety valves 16, 17 to provide redundancy. However, the arrangement could comprise a single safety valve 16, 17 or more than two safety valves 16, 17.

In the embodiment of figure 5, the safety valves 16, 17 are normally open valves. The safety valves 16, 17 are thus biased to the open position, for instance by means of a spring. Each of the valves 16, 17 is provided with an electrical actuator for switching the valve 16, 17 to the closed state. If the electrical actuator fails or there is a power failure, the valve 16, 17 is automatically switched to the open state. This releases pressure from the cylinder 52 of the safety gear release means 51 and switches the safety gear 40 to a gripping state. The safety arrangement thus functions in a safe manner in case of power failures and other fault situations.

Figure 5 shows only one safety gear 40. However, there can be two or more safety gears 40 in the same hydraulic circuit. Figure 6 shows an embodiment, where the elevator car 3 is provided with two safety gears 40. Each safety gear 40 cooperates with one of the guide rails 2 guiding the elevator car 3. Both safety gears 40 are arranged in the same hydraulic circuit.

In the embodiment of the figures, the pressurizing means 11 comprise a hydraulic cylinder 12 and a piston 13 configured to be driven in the cylinder 12 to pressurize the hydraulic fluid supplied to the cylinder 52 of the safety gear release means 51. The pressurizing means 11 comprise a linear actuator 14 for driving the piston 13. Instead of moving the piston 13, the linear actuator

## 13

14 could be configured to move the hydraulic cylinder 12. The piston 13 could thus be stationary. The linear actuator 14 can be an electrical linear motor.

The linear actuator 14 can be provided with a brake. The brake can be, for instance, electrically actuated. When the brake is in a locked state, moving of  
5 the linear actuator 14 is prevented. Consequently, also the mutual movement of the piston 13 and the hydraulic cylinder 12 of the pressurizing means 11 is prevented. Pressure in the hydraulic system of the safety arrangement can thus be maintained even if the linear actuator 14 is not energized. This allows  
10 maintaining the safety gear 40 in the release state with minimal energy consumption.

In the embodiment of figure 5, the safety gear 40 is mounted to an elevator car 3. The safety arrangement further comprises a brake device 4 mounted to the elevator car 3. In figure 5, one brake device 4 is shown, but the arrangement preferably comprises at least one brake device 4 on each side of the elevator  
15 car 3. The brake device 4 can function during the normal operation of the elevator for stopping the elevator or keeping the elevator car 3 in a correct position at a landing, but also as an emergency brake for stopping the elevator in an overspeed situation. The brake device 4 can thus be used as the primary means for stopping the elevator car 3 and the safety gear 40 functions as  
20 secondary means ensuring stopping of the elevator car 3.

The brake device 4 comprises a moveable brake element 5 having a braking position, in which braking position the brake element 5 is configured to be engaged with the guide rail 2 of the elevator car 3 for stopping the elevator car 3 and/or for preventing moving of the elevator car 3, and a release position, in  
25 which release position the brake element 5 allows moving of the elevator car 3. The brake device 4 comprises a biasing spring 6 that is configured to bias the brake element 5 towards the braking position, and brake release means 7. The brake release means 7 comprise a cylinder 8 and a piston 9 moveable within the cylinder 8. The brake release means 7 are configured to move the  
30 brake element 5 to the release position when hydraulic pressure overcoming a biasing force caused by the biasing spring 6 is applied to the piston 9. The brake device 4 thus functions in a similar manner as the safety gear 40.

In the embodiment of figure 5, the brake device 4 comprises two brake elements 5. The brake elements 5 are arranged on opposite sides of the guide

rail 2. However, the brake device 4 could also be implemented with a single brake element 5.

5 The biasing spring 6 of the brake device 4 can be a mechanical spring, such as a coil spring. In the embodiment of figure 5, the brake device 4 comprises two brake elements 5, and each brake element 5 is biased by means of a biasing spring 6 towards the braking position. The brake device 4 could comprise two or more biasing springs 6 for each brake element 5. The brake elements 5 and the biasing springs 6 can be arranged in a brake caliper.

10 The brake release means 7 can be integrated in the brake caliper. If the brake device 4 comprises two brake elements 5, the brake release means 7 can comprise two cylinders 8. However, the number of the brake elements 5 and the cylinders 8 does not need to be the same.

15 The pressurizing means 11 are arranged in fluid communication with the cylinder 8 of the brake release means 7 to allow supplying pressurized hydraulic fluid into the cylinder 8 of the brake release means 7. The fluid reservoir 22 is arranged in fluid communication with the cylinder 8 of the brake release means 7 for receiving hydraulic fluid from the cylinder 8 of the brake release means 7. The safety valves 16, 17 are arranged between the cylinder 8 of the brake release means 7 and the fluid reservoir 22 such when at least  
20 one of the safety valves 16, 17 is in the open state, flow from the cylinder 8 into the fluid reservoir 22 is allowed, and when all the safety valves 16,17 are in the closed state, flow from the cylinder 8 through the safety valves 16, 17 into the fluid reservoir 22 is prevented. The same safety valves 16, 17 thus control the operation of both the safety gear 40 and the brake device 4.

25 The brake release means 7, safety gear release means 51 and the biasing springs 6, 50 of the brake device 4 and the safety gear 40 are configured such that the hydraulic pressure needed for keeping the safety gear 40 in the release position is lower than the hydraulic pressure needed for keeping the brake device 4 in the release position. This can be achieved by suitable  
30 dimensioning of the pistons 53, 9 of the safety gear release means 51 and the brake release means 7 and by having suitable stiffness in the biasing springs 50, 6 of the safety gear release means 51 and the brake release means 7.

As the pressure in the hydraulic circuit decreases, the brake elements 5 of the brake device 4 move to the braking position before the brake element 44 of the safety gear 40 contacts the guide rail 2. This ensures that braking of the elevator car 3 takes place in a controlled manner. Similarly, when the brakes and the safety gear 40 are released, the brake element 44 of the safety gear 40 moves to the release position before the brake elements 5 of the brake device 4.

In the embodiment of the figures, a connection spring 54 is arranged between the piston 53 and the brake element 44 of the safety gear release means 51 such that when the brake element 44 is in the gripping position and a sufficient hydraulic force is applied to the piston 53, the piston 53 can move in the first direction A away from the brake element 44. When the brake element 44 of the safety gear 40 is in the gripping position of figure 3, the elevator car 3 needs to be moved upwards to allow moving of the brake element 44. If the brake devices 4 of the elevator car 3 are arranged in the same hydraulic circuit with the safety gear 40, as in the embodiment of figure 5, the cylinders 52 of the safety gear release means 51 are pressurized simultaneously with the cylinders 8 of the brake release means 7. The connection spring 54 allows the piston 53 of the safety gear release means 40 to move even when the brake element 44 is wedged between the frame 41 and the guide rail 2. This ensures that the pressure in the hydraulic circuit rises in a similar manner regardless of the position of the brake element 44.

The safety arrangement can be configured to monitor one or more predetermined trigger events, and in case a trigger event is detected, to cut power supply to the safety valve 16, 17 to switch the safety valves 16, 17 to the open state. The trigger events could comprise, for instance, overspeed of the elevator car 3 or a counterweight or opening of a landing door of the elevator 1. The safety arrangement can comprise different switches and/or sensors to detect the trigger events.

For switching the safety gear 40 and the brake device 4 to the release state, the safety valves 16, 17 are closed. A brake release command is sent to a drive unit of the linear actuator 14. The drive unit supplies electrical power to the linear actuator 14, which drives the pressurizing means 11. The pressurizing means 11 are driven until the mutual position of the piston 13 and the hydraulic cylinder 12 of the pressurizing means 11 corresponds to a

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predetermined target value. The brake of the linear actuator 14 is then switched to the braking state. The pressure in the system is thus maintained with minimal energy consumption.

5 For switching the brake device 4 to the braking state, a braking command is sent to the brake of the linear actuator 14 and to the drive unit. The brake of the linear actuator 14 is released. The motor of the linear actuator functions as a generator and resists the relative mutual movement of the piston 13 and the hydraulic cylinder 12 of the pressurizing means 11. By controlling the pressure release in the hydraulic circuit, the elevator car 3 can be braked in a controlled  
10 manner by the brake devices 4. When the brake device 4 is in the braking state, the safety valves 16, 17 are opened to equalize the pressure between the fluid reservoir 22, the pressurizing means 11, the brake device 4 and the safety gear 40. Also the brake element 44 of the safety gear 40 thus contacts the guide rail 2, but does not move to the gripping position.

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Claims:

1. A safety gear (40) for an elevator that comprises a guide rail (2) having a first guide surface and a second guide surface for guiding an elevator car (3) or a counterweight of the elevator, the first and second guide surfaces of the guide rail (2) facing opposite directions, the safety gear (40) being configured to be mounted to an elevator car (3) or a counterweight of the elevator and configured to cooperate with said guide rail (2) of the elevator to stop said elevator car (3) or counterweight when activated, the safety gear (40) comprising
- 5 - a frame (41) that is configured to be attached to said elevator car (3) or counterweight, the frame (41) having at least a first wedge surface (42), which is in a mounted position of the safety gear (40) inclined relative to the longitudinal direction of the guide rail (2),
  - 10 - a brake element (44) having a braking surface (45) that is configured to face said first guide surface of the guide rail (2), and a first wedge surface (46) facing and being parallel to the first wedge surface (42) of the frame (41), the brake element (44) being moveable relative to the frame (41) in a first direction (A), which is in a mounted position of the safety gear (40) perpendicular to said guide surfaces of the guide rail (2), and in a second direction (B), which is in a mounted position of the safety gear (40) parallel to the longitudinal direction of the guide rail (2) to allow moving of the brake element (44) between a release position, in which the brake element (44) allows moving of said elevator car (3) or counterweight, and a gripping position, in which the brake element (44) is wedged between the frame (41) of the safety gear (40) and the first guide surface of the guide rail (2) to prevent moving of said elevator car (3) or counterweight,
  - 15 - a counterpart (48) arranged at a distance from the brake element (44) in the first direction (A) and having a braking surface (49) that is configured to face in a mounted position of the safety gear (40) the second guide surface of the guide rail (2),
  - 20 - at least one biasing spring (50) configured to bias the brake element (44) in the first direction (A) towards the guide rail (2), and
  - 25 - safety gear release means (51) comprising at least one cylinder (52) and a piston (53) moveable within the cylinder (52), the safety gear release means (51) being connected to the brake element (44) such
  - 30
  - 35

- 5 that the safety gear release means (51) can apply to the brake element (44) a force in the first direction (A) to oppose the force of the biasing spring (50) when hydraulic pressure is applied to said piston (53) for moving the brake element (44) away from the guide rail (2) to the release position and for keeping the brake element (44) in the release position.
- 10 2. A safety gear (40) according to claim 1, wherein the frame (41) further comprises a second wedge surface (43) and the brake element (44) comprises a second wedge surface (47) facing and being parallel to the second wedge surface (43) of the frame (41), the first wedge surfaces (42, 46) of the frame (41) and the brake element (44) being configured to cooperate with each other to stop said elevator car (3) or counterweight when said elevator car (3) or counterweight moves in a first moving direction, and the second wedge surfaces (43, 47) of the frame (41) and the brake element (44) being configured to cooperate with each other to stop said elevator car (3) or counterweight when said elevator car (3) or counterweight moves in a second moving direction.
- 15 3. A safety gear (40) according to claim 1 or 2, wherein at least one connection spring (54) is arranged between the piston (53) and the brake element (44) such that when the brake element (44) is in the gripping position and a sufficient hydraulic force is applied to the piston (53), the piston (53) can move in the first direction (A) away from the brake element (44).
- 20 4. A safety gear (40) according to any of claims 1–3, wherein the safety gear (40) comprises at least one positioning spring (55, 56) for positioning the brake element (40) in the second direction (B) relative to the frame (41).
- 25 5. A safety arrangement for an elevator, the safety arrangement comprising a safety gear (40) according to any of the preceding claims and
- 30 - pressurizing means (11) configured to pressurize hydraulic fluid and being arranged in fluid communication with said at least one cylinder (52) of the safety gear release means (51) to allow supplying pressurized hydraulic fluid into said at least one cylinder (52),
- a fluid reservoir (22) arranged in fluid communication with said at least one cylinder (52) of the safety gear release means (51) and with the

- pressurizing means (11) for supplying hydraulic fluid to the pressurizing means (11) and for receiving hydraulic fluid from said at least one cylinder (52) of the safety gear release means (51), and
- 5 - at least one safety valve (16, 17) having a closed state and an open state, said at least one safety valve (16, 17) being arranged between said at least one cylinder (52) of the safety gear release means (51) and the fluid reservoir (22) such that in the open state of the safety valve (16, 17) flow from said at least one cylinder (52) into the fluid reservoir (22) is allowed, and in the closed state of the safety valve (16, 17) flow from said at least one cylinder (52) through the safety valve (16, 17) into the fluid reservoir (22) is prevented.
- 10
6. A safety arrangement according to claim 5, wherein the arrangement comprises at least two safety valves (16, 17) arranged in parallel such that flow from said at least one cylinder (52) of the safety gear release means (51) into the fluid reservoir (22) is allowed when at least one of the safety valves (16, 17) is in the open state.
- 15
7. A safety arrangement according to claim 5 or 6, wherein the safety arrangement comprises at least two safety gears (40) arranged in fluid communication with said pressurizing means (11) and said fluid reservoir (22).
- 20
8. A safety arrangement according to any of claims 5–7, wherein the safety gear (40) is mounted to an elevator car (3) and the safety arrangement comprises at least one brake device (4) mounted to said elevator car (3), the brake device (4) comprising
- 25 - at least one moveable brake element (5), said at least one brake element (5) having a braking position, in which braking position the brake element (5) is configured to be engaged with a guide rail (2) of the elevator car (3) for stopping the elevator car (3) and/or for preventing moving of the elevator car (3), and a release position, in which release position the brake element (5) allows moving of the elevator car (3),
- 30 - at least one biasing spring (6) that is configured to bias the brake element (5) towards the braking position, and
- brake release means (7), the brake release means (7) comprising at least one cylinder (8) and a piston (9) moveable within the cylinder
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(8), the brake release means (7) being configured to move said at least one brake element (5) to the release position when hydraulic pressure overcoming a biasing force caused by said at least one biasing spring (6) is applied to the piston (9),

5 wherein

- said pressurizing means (11) are arranged in fluid communication with said at least one cylinder (8) of the brake release means (7) to allow supplying pressurized hydraulic fluid into said at least one cylinder (8) of the brake release means (7),
- 10 - said fluid reservoir (22) is arranged in fluid communication with said at least one cylinder (8) of the brake release means (7) for receiving hydraulic fluid from said at least one cylinder (8) of the brake release means (7), and
- said at least one safety valve (16, 17) is arranged between said at  
15 least one cylinder (8) of the brake release means (7) and the fluid reservoir (22) such that in the open state of the safety valve (16, 17) flow from said at least one cylinder (8) into the fluid reservoir (22) is allowed, and in the closed state of the safety valve (16, 17) flow from said at least one cylinder (8) through the safety valve (16, 17) into  
20 the fluid reservoir (22) is prevented.

9. A safety arrangement according to claim 8, wherein the brake release means (7), safety gear release means (51) and the biasing springs (6, 50) of the brake device (4) and the safety gear (40) are configured such that the hydraulic pressure needed for keeping the safety gear (40) in the  
25 release position is lower than the hydraulic pressure needed for keeping the brake device (4) in the release position.
10. A safety arrangement according to any of claims 5–9, wherein the pressurizing means (11) comprise a hydraulic cylinder (12) and a piston (13) that are configured to be moveable relative to each other to  
30 pressurize hydraulic fluid in the hydraulic cylinder (12).
11. A safety arrangement according to claim 10, wherein the pressurizing means (11) comprise a linear actuator (14) for driving the piston (13) or the hydraulic cylinder (12).

12. A safety arrangement according to claim 11, wherein the linear actuator (14) is provided with a brake.
- 5 13. A safety arrangement according to any of claims 5–12, wherein the arrangement is configured to monitor one or more predetermined trigger events, and in case a trigger event is detected, to cut power supply to said at least one safety valve (16, 17) to switch said at least one safety valve (16, 17) to the open state.
14. An elevator comprising a safety arrangement according to any of claims 5–13.

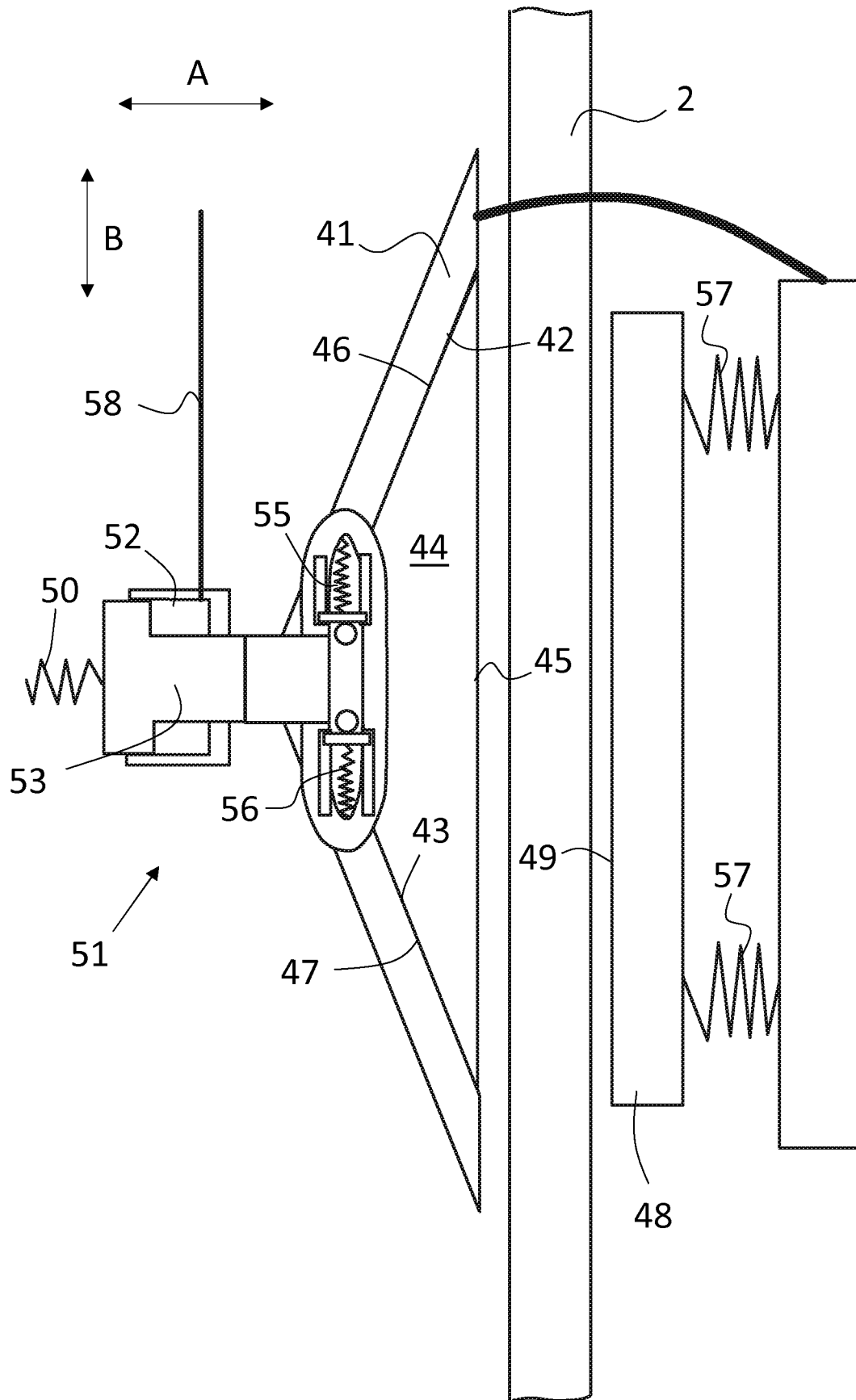


FIG. 1

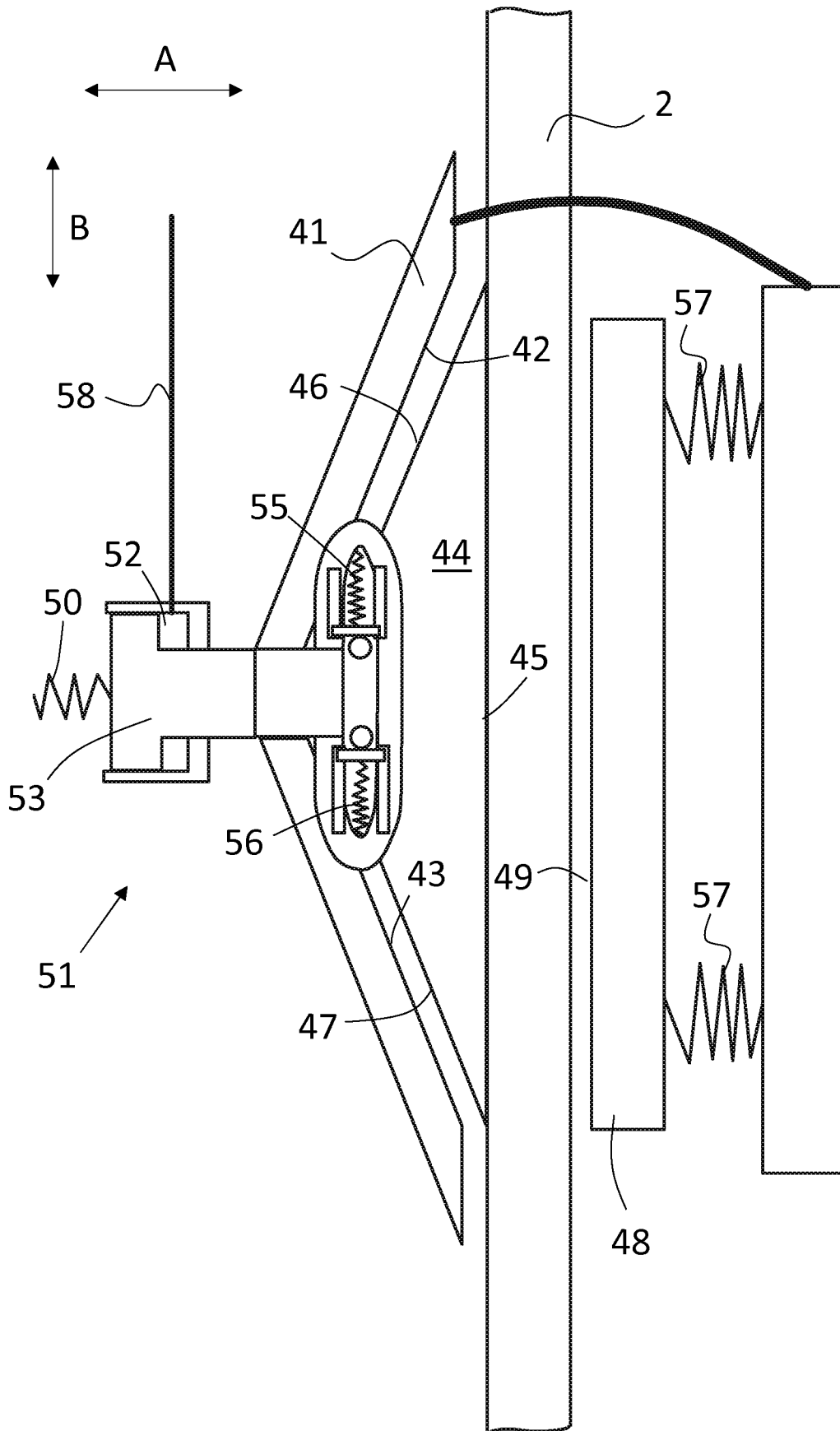


FIG. 2



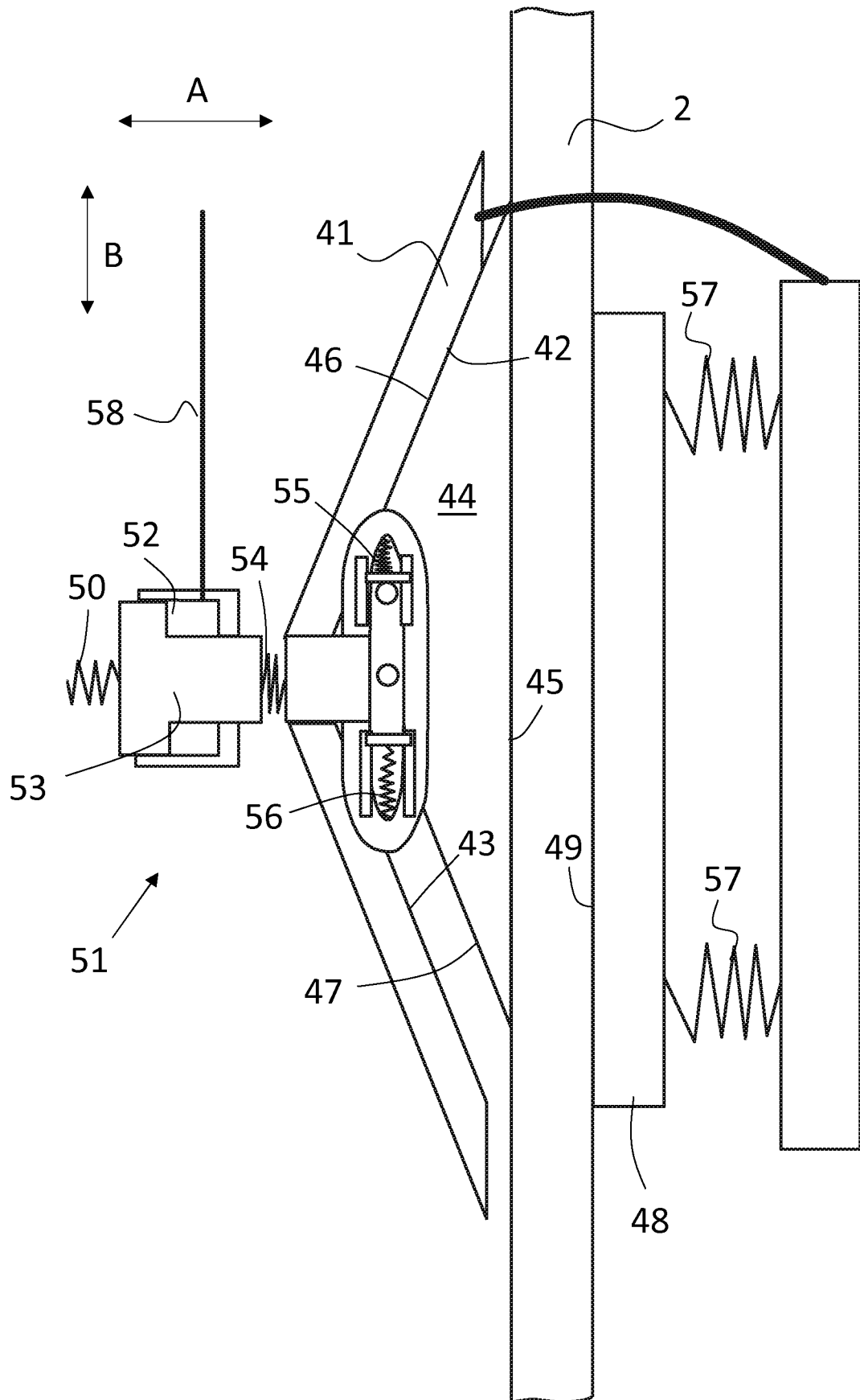


FIG. 4

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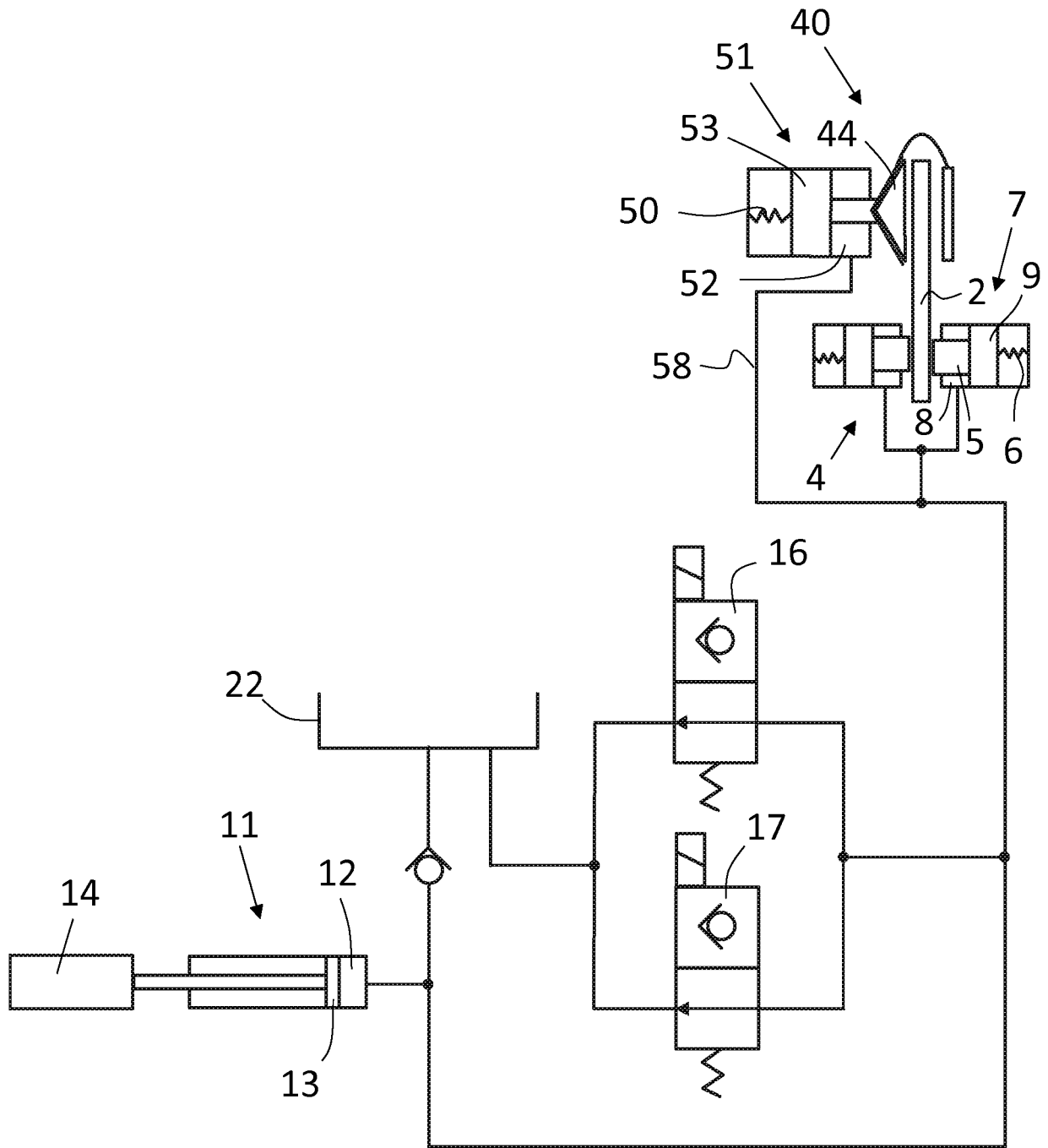


FIG. 5

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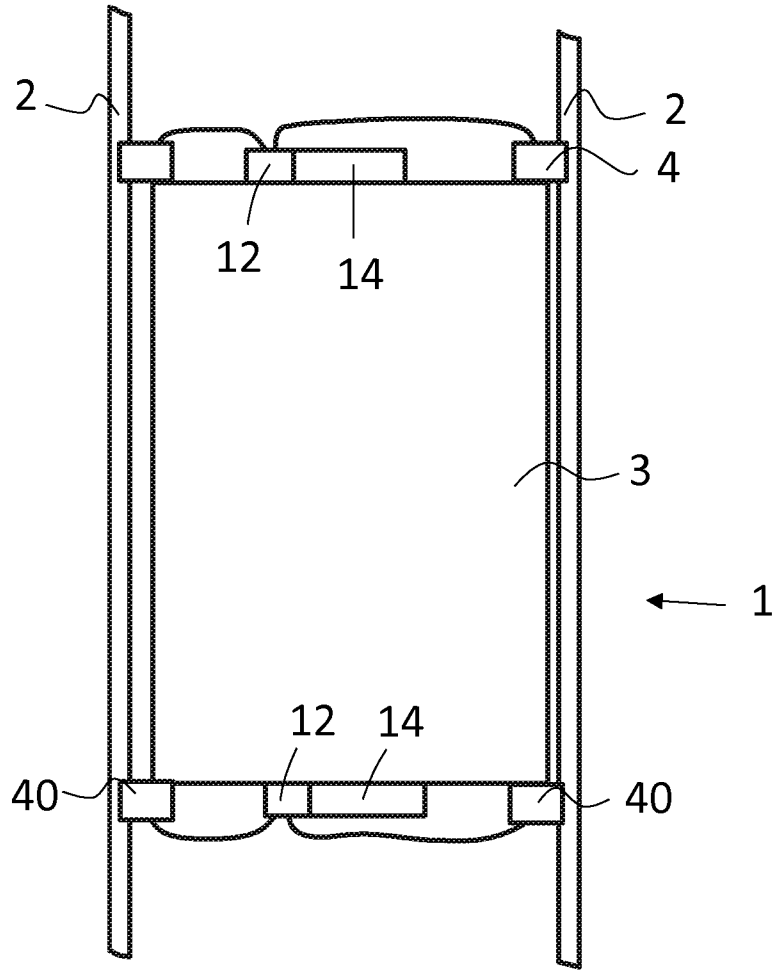


FIG. 6

# INTERNATIONAL SEARCH REPORT

International application No  
**PCT/FI2023/050339**

**A. CLASSIFICATION OF SUBJECT MATTER**  
**INV. B66B5/22**  
**ADD.**

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

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
**B66B**

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

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

**EPO-Internal, WPI Data**

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
<b>X</b>	<b>CN 112 110 312 A (SUZHOU BALANCE ELEVATOR TECH CO LTD) 22 December 2020 (2020-12-22)</b>	<b>1-4</b>
<b>A</b>	<b>paragraph [0056] - paragraph [0099]; figures 1-3, 15, 16</b>	<b>5-14</b>
-----		
<b>X</b>	<b>CN 112 744 663 A (ZHENGZHOU RAILWAY VOCATIONAL &amp; TECHNICAL COLLEGE) 4 May 2021 (2021-05-04)</b>	<b>1-14</b>
	<b>paragraph [0021] - paragraph [0029]; figures 1, 5-7</b>	
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<b>A</b>	<b>CN 105 366 481 A (LU TIANMIN) 2 March 2016 (2016-03-02)</b>	<b>1-14</b>
	<b>abstract; figure 2</b>	
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Further documents are listed in the continuation of Box C.

See patent family annex.

\* Special categories of cited documents :

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- "E" earlier application or patent but published on or after the international filing date
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- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

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

Date of mailing of the international search report

**29 November 2023**

**15/12/2023**

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

**PCT/FI2023/050339**

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
<b>CN 112110312</b>	<b>A</b>	<b>22-12-2020</b>	<b>NONE</b>	
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<b>CN 112744663</b>	<b>A</b>	<b>04-05-2021</b>	<b>NONE</b>	
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<b>CN 105366481</b>	<b>A</b>	<b>02-03-2016</b>	<b>NONE</b>	
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