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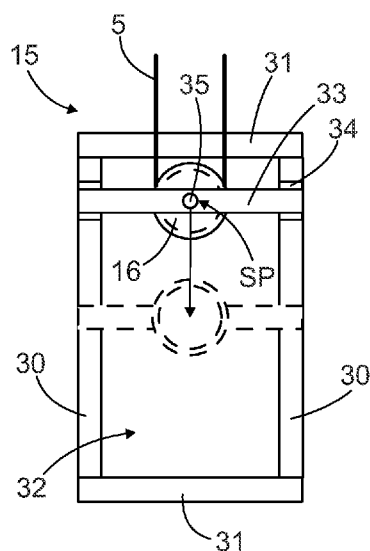


FIG. 4

(57) Abstract: A counterweight frame, a traction elevator and a method for supporting a counterweight assembly of a traction elevator. The counterweight frame (15) comprises a load supporting space (32) for receiving a counterweight provided with at least one filler element (23). The frame is supported by means of guide elements (26) to vertical guide rails (25) of an elevator shaft (2). The frame is supported vertically by means of a suspension rope (5) whereby the frame is provided with a counterweight pulley (16) or rope terminal serving as a counterweight support element (SE). The mentioned support element is arranged vertically movably relative to the frame. Thereby a suspension point (SP) of the counterweight frame is dynamically movable in vertical direction during the operation.

Counterweight frame, elevator and method

Background of the invention

The invention relates to a counterweight frame of an elevator. The frame is intended to support a counterweight in a controlled manner in an elevator shaft. The frame is provided with a counterweight support element in order support the frame vertically.

The invention further relates to a traction elevator and method for supporting a counterweight assembly of a traction elevator.

The field of the invention is defined more specifically in the preambles of the independent claims.

A counterweight in an elevator is used for balancing weight of an elevator car and part of load that the car is designed to withstand. This way, one aim of the counterweight is to reduce required drive power of a motor. Most elevators work like a pulley mechanism. When the elevator car moves upward, the counterweight moves downward, and vice versa. In a traction elevator the counterweight is also required to generate needed frictional forces between a suspension rope and a traction sheave driven by the motor. The suspension rope connects the car and the counterweight hanging in an elevator shaft. The counterweight may comprise several filler pieces which may be supported by means of a counterweight frame. The counterweight frame is provided with a pulley and the suspension rope passes around the pulley. Different frame structures and pulley mechanisms have been developed. However, the known solutions have shown to contain some disadvantages.

Brief description of the invention

An object of the invention is to provide a novel and improved counterweight frame, a traction elevator and a method for supporting a counterweight assembly of a traction elevator.

The apparatus according to the invention is characterized by the characterizing features of the first independent apparatus claim.

5 The arrangement according to the invention is characterized by the characterizing features of the second independent apparatus claim.

The method according to the invention is characterized by the characterizing features of the independent method claim.

10 An idea of the disclosed solution is that a counterweight frame of an elevator is provided with at least one counterweight support element configured to receive a suspension rope. The counterweight support element is arranged vertically movably relative to the counterweight
15 frame whereby suspension point of the counterweight frame is dynamically movable in vertical direction during the operation. In other words, vertical position of the support element relative to centre of mass of the counterweight changes during the operation or the elevator in response to
20 the movement of the counterweight frame.

An advantage of the disclosed dynamically movable suspension point is that height of the counterweight frame may be increased since the increase in vertical dimension can be compensated by allowing the suspension point to move
25 towards the bottom part of the counterweight frame. Thus, the disclosed solution allows increasing effective vertical dimensions of a counterweight assembly. Due to the dynamically movable counterweight pulley or corresponding support structure more options are available for designing space
30 efficient low pit and low headroom elevator configurations.

According to an embodiment, the counterweight frame is suspended by means of one or more counterweight pulleys. One or more suspension ropes are arranged to pass via the counterweight pulleys. The pulley is serving as a counter-
35 weight support element and is vertically movable.

According to an embodiment, the counterweight frame is suspended by means of a rope terminal. The rope terminal is a counterweight support element for mounting free ends of one or more suspension ropes. The rope terminal is vertically movable. The rope terminals are implemented when suspension ratio or roping ratio of an elevator system is 1:1.

When the mentioned counterweight support element is a counterweight pulley, a centre of rotation i.e. rotation axis of the counterweight pulley defines a suspension point of a counterweight assembly. Vertical movement of the counterweight pulley is configured to change vertical position of the suspension point relative to the frame, and especially relative to a critical lowermost part of the frame.

When the counterweight support element is a rope terminal its fixing point defines the suspension point.

According to an embodiment, the dynamic movement of the counterweight support element, such as a pulley or rope terminal, means that the support element moves in response to the vertical movement of the counterweight frame. In other words, the movement of the pulley or the rope terminal relative to the frame occurs automatically during operating cycle of the elevator. Thus, the disclosed dynamic solution does not require operator control and external forces.

According to an embodiment, the counterweight frame comprises at least two vertical support beams located at a horizontal distance from each other and at least two horizontal support beams located at a vertical distance from each other, whereby the vertical and horizontal beams limit the mentioned load supporting space.

According to an embodiment, a bottom part of the counterweight frame comprises a buffer arrangement provided with two or more buffer pieces or spacers connected in a removable manner one after each other in their longitudinal direction. The buffer pieces may be removed in order to compensate stretching of the suspension ropes.

According to an embodiment, the counterweight support element is mounted to a horizontal support beam supported vertically movably to vertical support structures of the counterweight frame. In other words, the support element and the support beam can move together in vertical direction. The support beam provides proper support for the support element and guarantees controlled movements. The support element may be a pulley or rope terminal whereby the beam may be called also as a pulley beam or terminal beam.

10 According to an embodiment, a rotation axle of the counterweight pulley is mounted to the pulley beam.

According to an embodiment, the support beam is provided with bearing elements at its opposite ends for bearing mounting the support beam to vertical support beams of the frame. There may be slide bearings or roller bearings between the support beam and the vertical support beams.

15 According to an embodiment, the pulley is located between the pulley beam and the filler pieces loaded to the load supporting space. In other words, the pulley is facing towards the filler pieces and moves on one side of the counterweight.

According to an embodiment, a suspension point defined by a rotation axis of the counterweight pulley, or by a fixing arrangement of a rope terminal, is located always below a horizontal uppermost part of the counterweight frame. In other words, the pulley or the rope terminal does not protrude vertically above the uppermost part of the frame structure. The pulley and the rope terminal both move along one side surface of the counterweight.

25 According to an embodiment, the counterweight frame further comprises a moving apparatus for selectively moving the counterweight support element towards a bottom part of the counterweight frame. In other words, the moving apparatus may keep the suspension point at a designed position when in not in operational state and may move the suspension

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point towards the bottom part whereas vertical dimensions of the frame below the suspension point decrease.

According to an embodiment, the above mentioned moving apparatus is configured to be activated in response to vertical movement of the counterweight frame.

According to an embodiment, the mentioned moving apparatus is configured to be activated automatically when the counterweight frame reaches a predetermined vertical limit position when moving towards a pit of an elevator shaft. The mentioned limit position may be provided with one or more sensing means, or alternatively, it may be provided with one or more mechanical elements or mechanisms for providing the moving actuator with the required triggering signal or movement.

According to an embodiment, the moving apparatus comprises at least one spring element for generating a spring force and directed to move the counterweight pulley or the rope terminal towards the bottom part of the counterweight frame. The spring force moves the pulley or the rope terminal downwards when movement speed of the counterweight frame in downward direction is decelerated. The counterweight frame may comprise a braking mechanism, such as one or more braking shoes, for limiting speed of the frame when approaching the pit. This embodiment may be called a spring design or spring configuration. The one or more springs may be helical springs, for example. The braking shoes may comprises braking actuators for selectively pressing braking elements, such as brake pads, against guide rails.

According to an embodiment, the moving apparatus comprises at least one elongated first transmission element connected between the pulley arrangement and the frame. The first transmission element is actuated by means of at least one first force element which can be selectively connected to be driven by means of a rotating axle of the counterweight pulley in order to move the pulley vertically. The

mentioned elongated first transmission element may be a bendable element, such as a chain, belt or wire rope. The first force element may be a sprocket, pulley or drum depending on which type of first transmission element is implemented. The first force element may be connected to the rotating mechanism of the counterweight pulley by means of at least one second transmission element. The second transmission element may be a gearing, chain, belt or any other suitable transmission element capable to power the first force element. Further, the arrangement may comprise a third transmission element configured to turn the second transmission on and off in response to the vertical movement of the counterweight frame. This embodiment may be called a spool design or chain design.

According to an embodiment, the above disclosed spool or chain design may also be implemented when the counterweight support element is a rope terminal.

According to an embodiment, the moving apparatus is in accordance with the previous embodiment and further comprises at least one spooling device. Then the first force element is configured to spool the first transmission element around a pulley of the spooling device. In one additional embodiment the spooling device may be spring operated whereby there is no need to drive it by means of the rotation movement of the counterweight pulley. This embodiment may be called the spool design.

According to an embodiment, basic structure of the moving apparatus is in accordance with the previous embodiment above and called the spool design or chain design. And in addition to that, a first end of the at least one elongated first transmission element is mounted to a top part of the frame and a second end is mounted to a bottom part of the frame, whereby the first transmission element is between the top and bottom of the frame. The mentioned first force element is configured to move along the first transmission element when being actuated. Then the vertical

movement of the first force element is arranged to move the counterweight pulley vertically. The elongated first transmission element may be a chain or belt, for example. Alternatively, it may be a toothed bar and the first force element may then be a toothed wheel.

According to an embodiment, the above disclosed spool design may also be implemented when the counterweight support element is a rope terminal.

According to an embodiment, the moving apparatus comprises at least one actuator for generating the internal vertical motion in the counterweight assembly. It is then possible to execute the relative vertical movement between the frame and the counterweight support element by means of the actuator. The actuator may be an electric rotation motor or linear motor, for example. The counterweight assembly may be provided with an electric power storage, such as an accumulator for powering the electrical actuator, or alternatively, it may be provided with a generator for converting mechanical movement into electrical energy. One further possibility is to provide wired counterweight assembly with an electric cable arranged in connection with a compensation chain or cables.

According to an embodiment, the moving apparatus of the counterweight assembly comprises a screw jack type actuator for providing the counterweight support element, i.e. the pulley or the rope terminal, with the internal vertical movement. The solution may then comprise a ball-race screw bar, rotation motor and transmission elements. The motor may be electrically powered or it may be driven by means of pressure fluid.

According to an embodiment, the moving apparatus may be considered to be an apparatus arranged to lift the counterweight upwards relative to the counterweight pulley or the rope terminal.

According to an embodiment, the moving apparatus of the counterweight assembly comprises an electric actuator

such as an electric motor or solenoid for providing the counterweight support element, i.e. the pulley or the rope terminal, with the internal vertical movement. The electric actuator may react quickly when a so called counterweight
5 jump occurs. Thus, the solenoid or other electric actuator may also be utilized for preventing the jump situations.

According to an embodiment, the disclosed moving apparatus or system may also be implemented to dampen forces directed to the counterweight assembly. Then the movement
10 mechanism or apparatus of the counterweight support element may be controlled in order to provide desired dampening. Due to the damping feature, driving comfort of the elevator car be improved.

According to an embodiment, the disclosed moving
15 apparatus or system may also be implemented to detect elongation of the suspension rope. The detection may be based on monitoring the positions of the counterweight support element.

According to an embodiment, the disclosed moving
20 apparatus or system may also be implemented to compensate elongation of the suspension rope by moving the counterweight suspension element in response to the detected elongation. There may be a compensating system that monitors the detection and then controls the moving apparatus in
25 response to the sensing data.

According to an embodiment, the disclosed moving apparatus or system may also be implemented to provide data on operation and operational condition of the elevator and the counterweight assembly. Thus, the counterweight assembly
30 may be instrumented or provided with one or more sensors or measuring devices for providing a monitoring system with valuable data. The monitoring system may analyze the data and may generate monitoring and control signals including data on operation of the counterweight and the entire ele-
35 vator. The monitoring system may monitor vertical movement

of the counterweight pulley or the rope terminal in different operational situations and may indicate when abnormal situation occurs.

According to an embodiment, the disclosed monitoring system is arranged to monitor relative movements of the counterweight pulley or its supporting mechanism, such as a pulley beam, may generate sensing data which may be transmitted to an external 24/7 control system or control room.

According to an embodiment, the load supporting space of the counterweight frame is provided with several filler elements. Density of material of the filler elements or pieces is below 11 g/cm^3 . In other words, lead fillers are not implemented. Density of lead is 11.3 gram per cubic centimeter. The disclosed solution i.e. the counterweight frame with greater vertical dimensions makes this possible.

According to an embodiment, the load supporting space of the counterweight frame is provided with several filler pieces, density of which is below 8 g/cm^3 .

According to an embodiment, the filler pieces are made of iron density of which is 7.87 g/cm^3 .

An advantage of the embodiments above is that filler material with lower price can be utilized whereby great cost savings can be achieved. For example, lead fillers cost 3 - 4 €/kg whereas steel fillers cost 0.6 - 1 €/kg, and concrete fillers cost even less.

Let it be mentioned that the counterweight may comprise one or more containers as an alternative to the above mentioned filler pieces or plates. The containers may be filled with materials having the density below the mentioned 11 g/cm^3 . The container may be filled with the mentioned steel material, for example. The disclosed vertical movement system of the counterweight pulley can be implemented also in this case too.

Further, it may be possible to use a counterweight which is one block or unit, or which comprises only few

bigger filler elements. Also in this case the above mentioned material issues and densities are implemented.

According to an embodiment, weight by volume of the counterweight may be lower since volume of the load supporting space of the frame may be greater than before. This way the greater volume allows use of lower priced filler materials. Filler pieces or plates made of material having lower specific weight are also easier and safer to handle when being loaded on the frame.

The mentioned greater volume of the counter weight is possible since the counterweight can be dimensioned to extend greater distance in lower direction since the increased height of the counterweight is compensated by means of the movable pulley or rope terminal.

The counterweight frame can be made higher in order to fill it with enough of counterweight pieces or modules to provide sufficient ballast effect and balance to the elevator. Due to the dynamically movable support point of the frame, the counterweight arrangement does not require more space at the upper and lower parts of the elevator shaft.

According to an embodiment, the counterweight comprises several filler pieces one above each other, whereby the counterweight comprises several top filler pieces, several middle filler pieces and several bottom filler pieces. Further, at least the several top filler pieces are each provided with grooves on their first lateral side facing towards the pulley or the rope terminal. Thereby the grooves of the top filler pieces form a vertical space on a first lateral side of the counterweight. In other words, geometric shape of the filler pieces at least on top portion of the counter weight is designed so that there is a vertical space for the pulley or rope terminal.

The mentioned lateral groove may also be formed to a counterweight which is one single piece or comprises only few filler elements.

According to an embodiment, the pulley is facing towards the counterweight.

According to an embodiment, vertical moving range of the counterweight support element is at least 1/3 of the
5 total vertical height of the counterweight frame.

According to an embodiment, vertical moving range of the counterweight support element is up to 2/3 of the total vertical height of the counterweight frame.

According to an embodiment the moving range of the
10 counterweight support element corresponds to total vertical height of the counterweight.

According to an embodiment the moving range of the counterweight support element may be relative small when the arrangement is to be used as a part of a dampening
15 system, for example.

According to an embodiment, the pulley is arranged to move on one side of the counter weight space.

According to an embodiment, the disclosed solution relates to a traction elevator. The elevator comprises a
20 car assembly provided with an elevator car and a counterweight assembly provided with a counterweight frame, counterweight and at least counterweight pulley or rope terminal serving as a counterweight support element. The counterweight assembly is configured to be moved between an uppermost position and a lowermost position in an elevator shaft. The elevator further comprises a first guide assembly provided with first vertical guide rails mountable to the elevator shaft and first guide shoes mountable to the car. There is also a second guide assembly provided with second
25 vertical guide rails and second guide shoes for the counterweight frame. The mentioned guide shoes are supportable against the vertical guide rails. A hoisting machinery is configured to generate required hoisting movements. The hoisting machinery comprises an electric motor and a traction sheave driven by means of the motor. One or more suspension ropes connect the car assembly and the counterweight
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assembly. The suspension ropes are arranged to pass over the traction sheave. Operation of the elevator and related actuators are arranged to be controlled by means of a control system comprising one or more control units. Further, the counterweight assembly is in accordance with the embodiments and features disclosed in this document. Thus, the counterweight pulley or the rope terminal serving as a support element of the counterweight frame is configured to move towards a bottom end of the counterweight frame when the counterweight assembly approaches its lowermost position in the elevator shaft. In other words, suspension point defined by the vertical position of the counterweight support element is configured to be changed when the counterweight assembly reaches a pit at a bottom of the elevator shaft. When the counterweight support element moves towards the bottom of the counterweight frame, suspension height i.e. distance between the suspension point and the bottom part of the counterweight assembly decreases. Due to the movable pulley or rope terminal, vertical dimensions of the counterweight frame may be increased, i.e. volume of a counterweight supporting surface can be increased, and still vertical size of the pit and overhead room need not to be increased. Thus, the disclosed solution improves possibilities to design space effective elevators.

According to an embodiment, the disclosed solution may be implemented for elevators, which are without any machine rooms (i.e. machine room less traction elevators) and also to conventional elevators provided with machine rooms (machine room traction elevators).

According to an embodiment, the disclosed solution may be implemented for elevators wherein roping ratio or suspension ratio is 1:1, 1:2, 1:4. The roping ratio indicates the ratio of car movement and traction sheave periphery movement. Then 1:1 roping ratio means that car moves at the same pace than the traction sheave periphery car. 1:2

means that the car moves one unit while periphery moves two units.

According to an embodiment, the suspension rope may be a wire rope or a belt. Material of the suspension rope
5 may be metallic, such as steel, or it may be made of composite material comprising plastic material and fibers.

According to an embodiment, the solution relates to a method for supporting a counterweight assembly of a traction elevator. The method comprises providing a counterweight assembly with a counterweight frame, one or more
10 filler pieces or elements and at least one counterweight support element. The method further comprises supporting the counterweight frame laterally to guide rails on inner sides of an elevator shaft. The counterweight frame is supported vertically by means of at least suspension rope passing
15 around the counterweight pulley serving as the support element and being supported to the frame. Alternatively, a rope terminal is serving as the support element. In the disclosed method the counterweight support element moves vertically relative to the counterweight frame during
20 transport movement of the elevator. In other words, the counterweight support element is not fixedly connected to frame but instead it moves vertically during the operation. This kind of special dynamic pulley movement control or pulley shift principle provides several advantages not only
25 for the construction of the traction elevator but also for the control and monitoring as it is disclosed in this document.

The above disclosed embodiments may be combined in
30 order to form suitable solutions having those of the above features that are needed.

Brief description of the figures

Some embodiments are described in more detail in the accompanying drawings, in which

35 Figure 1 is a schematic and highly simplified side view of a traction elevator,

Figure 2 is a schematic view of a prior art counterweight frame provided with a fixed pulley,

Figure 3 is schematic top view of an elevator car assembly and a counterweight assembly and their guide systems,

Figure 4 is a schematic side view of counterweight frame provided with vertically movable pulley,

Figure 5 is a schematic side view of the counterweight frame after being loaded with several filler pieces,

Figure 6 is a schematic top view of a counterweight pulley facing towards a free space formed on a lateral side surface of a filler piece,

Figure 7 is a schematic top view of a basic filler piece without any pulley receiving lateral space,

Figure 8 is a schematic view showing vertical movement of a pulley relative to a counterweight frame when the frame reaches its lowermost position,

Figure 9 is a schematic view showing vertical movement of a pulley relative to a counterweight frame when the frame reaches its uppermost position,

Figures 10 - 12 are schematic and simplified views of different moving apparatuses or actuators configured to move counterweight pulleys,

Figure 13 is a schematic view of a pulley arrangement comprising a moving apparatus, a sensor and a dampening apparatus,

Figure 14 and 15 are schematic views showing differences between a new counterweight assembly and a prior art assembly in an uppermost and lowermost positions,

Figure 16 is a schematic side view of a counterweight assembly provided with a spring type moving device or arrangement for providing a pulley vertical movement,

Figure 17 is a schematic side view of a counterweight assembly provided with a spooling type moving device for providing a pulley vertical movement,

Figure 18 is a schematic side view of a counterweight assembly provided with a chain or belt type moving device for providing a pulley desired vertical movement,

Figures 19 - 21 are schematic side views of counterweight assemblies provided with rope terminals serving as counterweight support elements and comprising similar type of moving devices as it is disclosed in Figures 16 - 18; and

Figure 22 is a schematic side view of a screw jack or ball-race type moving actuator for providing a support beam with vertical movement.

For the sake of clarity, the figures show some embodiments of the disclosed solution in a simplified manner. In the figures, like reference numerals identify like elements.

Detailed description of some embodiments

Figure 1 discloses a traction elevator 1 mounted to an elevator shaft 2 of a building. The elevator 1 comprises an elevator car 3 for receiving load to be transported. The car 3 and a counterweight assembly 4 are suspended from a suspension rope 5 passing via a hoisting machinery 6. The hoisting machinery 6 comprises a traction sheave 7 driven by means of an electric motor M. Between the suspension rope 5 and the traction sheave 7 occurs friction which is utilized for transmitting lifting power to the elevator system. The hoisting machinery 6 may comprise one or more additional pulleys 8 for guiding and controlling the suspension rope 5. Further, different rope schemas and ratios may also be implemented. The hoisting machinery 6 may be located at an upper machine room 9, or alternatively the system may be a so called machine room less elevator. The car 3 can be driven to desired levels 10 or floors under control of one or more control units CU. Further, at a bottom part of the car 3 may be a buffer arrangement 11 comprising several removable buffer pieces or spacers. The bottom of the car

3 and a bottom of the counterweight assembly 4 may be connected by means of a compensator element 12, such as a chain, wire or belt. The compensator element 12 may pass via a compensator pulley 13 located at pit 14 of the elevator shaft 2. The counterweight assembly 4 may be as disclosed in this document.

Figure 2 discloses a prior art counterweight frame 15 provided with a counterweight pulley 16. As can be noted the pulley 16 is fixedly mounted to an upper part of the frame 15 and protrudes upwardly. This type of structure limits effective vertical dimensions of the counterweight and thus limits its volume.

Figure 3 shows that the car assembly 17 comprises an elevator car 3 and a support element 18. The car assembly 17 is supported to the elevator shaft 2 by means of a first guide assembly 19 comprising first vertical guide rails 20 mounted to inner surfaces of the elevator shaft 2 and first guide shoes 21 mounted to the support element 18. There may also be breaking shoes 22 or devices as well as security arrangements at the guide assembly 19.

A counterweight assembly 4 comprises a counterweight frame 15 and filler pieces 23. The frame 15 is supported to the elevator shaft 2 by means of a second guide assembly 24 comprising second vertical guide rails 25 and second guide shoes 26. Also the counterweight assembly 4 may be provided with breaking shoes 27 for decelerating movement of the counterweight assembly 4.

Figure 3 further shows that the guide assemblies 19 and 24 may be supported to the elevator shaft 2 by means of beam structures 28. The elevator shaft 2 and the car 3 are provided with a door system 29 of course. In Figure 3 suspension rope and pulleys are not shown for clarity reasons.

Figure 4 discloses a counterweight frame 15 suspended by means of a suspension rope 5 and a counterweight pulley 16. The frame 15 is a rectangular structure and may

comprise two vertical support beams 30 and two horizontal beams 31 thereby limiting a load supporting space 32. The counterweight pulley 16 may be supported to a pulley beam 33 which is supported vertically movably to the frame 15.

5 There may be slide bearing elements 34 for providing smooth movement for the arrangement. A rotation axle 35 of the counterweight pulley 16 may be supported to the pulley beam 33. The rotation axle 35 defines a support point SP of the counterweight assembly 4. As it is shown, the pulley beam 10 33, the pulley 16 and the support point SP can move vertically from an initial basic location towards the beam 31 at the bottom of the frame 15.

In Figure 5 the load supporting space 32 of the counterweight frame 15 shown in Figure 4 is loaded with 15 several filler pieces 23. Top most filler pieces may comprise a vertical space 36 or groove for receiving the pulley 16 and for allowing its movement. Other shape designs are also possible for providing the space for the pulley 16.

Figure 6 discloses a filler piece 23 provided with 20 a vertical space or groove 36 on its lateral sided surface. The groove 36 allows movement of a pulley 16. A rotation axle 35 of the pulley 16 may be supported to a pulley beam of any other suitable movable support structure 37 or configuration.

25 The filler piece 23 shown in Figure may be used at an upper portion of the counterweight. In Figure 7 is shown a filler piece 23 without the groove and intended to be used at the bottom part of the counterweight.

Figure 8 shows how a counterweight pulley 16 moves 30 towards a bottom part of the counterweight frame 15 when the counterweight assembly moves towards a pit during a normal operation.

Figure 9 shows how a counterweight pulley 16 can move towards a bottom part of the counterweight frame 15 35 when the counterweight assembly moves towards a machine room 9 during a normal operation.

Figure 10 discloses a moving apparatus 38 connected by means of transmission element 39 to a lower horizontal beam 31 of the frame 15. In Figure 11 the moving apparatus 38 is connected to the upper and lower beams 31 by means of the transmission element 39. In Figure 12 the transmission element 39 connects the moving apparatus 38 only to the upper beam 31. The moving apparatus 38 may be powered by movement of the pulley 16 or it may comprise an actuator or motor. The transmission element 39 may be a bendable element, such as a belt or wire. The moving apparatus 38 may be spring actuated, driven by the rotation movement of the pulley 16, driven by vertical movement of the counterweight assembly or it may comprise an electric or pressure medium operated actuator for generating the required forces.

Figure 13 discloses that an elevator shaft 2 may be provided with a triggering element or device 40 for initiating vertical movement of a pulley 16. The device 40 may be a mechanical element or electrical device. The device 40 may control operation of a moving apparatus 38. There may also be a separate dampening device 41 for dampening vertical movements of the pulley 16, or alternatively the dampening may be based on controlling the moving apparatus 38 in a suitable manner. Further, a counterweight assembly 4 may be provided with one or more sensors S for monitoring vertical movement of the pulley 16 or components relating to its movement. The sensing data may be transmitted to a control unit CU wherein it may be analyzed. The control unit CU may comprise a monitoring program and it may also be configured to control actuators of the elevator. The sensor S and the control unit CU may also communicate with a control room CR, cloud service CS and electrical terminal devices, such as smart phones SMP.

Figure 14 demonstrates that in the counterweight assembly 4 of the present solution the pulley 16 does not protrude above the frame 15 whereas in a prior art solution 42 there is a protruding pulley and less effective space is

possible for filler pieces. In Figure 15 is it demonstrated that in the present solution the counterweight may have greater vertical dimensions since the load i.e. the filler pieces is in a way lifted upwards when the counterweight 4 approaches the pit 14. The disclosed Figures 14 and 15 visualize the differences in the effective volume, for example.

Figure 16 discloses a counterweight assembly 4 wherein a counterweight frame 15 comprises one or more spring elements 43 serving as a moving apparatus 38 for moving the counterweight pulley 16 vertically. The spring element 43 is able to generate spring force directed to move the counterweight pulley 16 towards the bottom part of the counterweight frame 15, whereby the spring force is configured to move the counterweight pulley 16 downwards when movement speed of the counterweight frame in downward direction is decelerated. The deceleration may be made by means of braking shoes, for example. The spring elements 43 may be helical springs, for example, and they can be mounted between a support element 37 of the pulley 16 and a lower horizontal beam of the frame 15. The support element 37 may be a pulley beam supported movably to vertical beams of the frame. Number of the spring elements may be one, two or more. In Figure 16 the spring element 43 is arranged to pull the support element downwards. In an alternative solution there may be spring elements arranged to push the support element downwards.

Figure 17 discloses a counterweight assembly 4 provided with a spooling arrangement for providing a counterweight pulley 16 with a desired vertical movement. Then a counterweight frame 15 comprises a vertically movable support element 37 or pulley beam for supporting the pulley 16. A moving apparatus 38 for moving the counterweight pulley 16 vertically comprises one or more elongated bendable first transmission elements 39 connected between the movable pulley support structure 37 and a lower horizontal beam

31 the frame 15 or any other suitable point in the frame 15. The moving apparatus 38 further comprises one or more spooling devices 44 comprising a spooling pulley actuated by means of a force element. The force element is configured to spool the first transmission element 39 around the spooling pulley for providing the counterweight pulley 16 with the vertical movement relative to the frame 15. The force element may be integrated in the spooling device and may be a spring element, for example.

10 Figure 18 discloses another embodiment of the above discussed moving apparatus 38 for moving the counterweight pulley 16 vertically. The moving apparatus 38 comprises at least one elongated first transmission element 39 connected between the movable pulley support structure 37 and the frame 15. The first transmission element 39 is actuated by means of a first force element 45 which is connected by means of transmission system to a rotating mechanism of the counterweight pulley 16 for selectively driving the first force element 45 for moving the pulley support structure 37 vertically. The mentioned elongated first transmission element 39 may be a bendable element, such as a chain, belt or wire rope. The force element 45 may be a sprocket, pulley or drum depending on which type of first transmission element is implemented. The transmission system may be a gearing, chain, belt or any other suitable transmission element capable to power the force element 45. As can be noted, the transmission element 39 may be connected to horizontal upper and lower beams 31 of the frame 15 and may pass via the force element 45. This solution is the so called belt or chain design.

30 In Figures 16 - 18 the pulley 16 serves as a counterweight support element SE, whereas in Figures 19 - 21 a rope terminal 46 serves as the counterweight support element SE. In Figures 19 - 21 the counterweight assembly 4 is suspended by means 1:1 ratio. The rope terminal 46 connects suspension ropes 5 to a vertically movable suspension bar

37. Movement of the suspension bar 37 can be influenced by means of the corresponding arrangements disclosed already above in this document.

Figure 22 discloses a screw jack type moving device
5 38 which comprises a leadscrew or a ball-race screw 47, motor 48 and transmission 49. The motor 48 may be an electric motor or hydraulic motor, for example. The transmission 49 may comprise a rotating screw or bearing ball assembly, for example. The motor 48 may be controlled by means of a
10 control unit for moving a support bar 37 together with a pulley of rope terminal vertically. Operation and produced movements of the screw jack 50 may be accurate and fast.

The drawings and the related description are only intended to illustrate the idea of the invention. In its
15 details, the invention may vary within the scope of the claims.

Claims

1. A counterweight frame (15) of an elevator (1),
which frame (15) is a vertical rectangular structure com-
prising:

a load supporting space (32) configured to receive
a counterweight provided with at least one filler element
(23);

guide elements (26) supportable to vertical guide
rails (25) of an elevator shaft (2); and

at least one counterweight suspension element (SE,
16, 46) configured to receive at least one suspension rope
(5);

characterized in that
the counterweight suspension element (SE, 16, 46)
is arranged vertically movably relative to the counterweight
frame (15) whereby suspension point (SP) of the counter-
weight frame (15) is dynamically movable in vertical direc-
tion during the operation.

20

2. The counterweight frame as claimed in claim 1,
characterized in that

the counterweight suspension element (SE) is
mounted to a horizontal suspension beam (33, 37) supported
vertically movably to vertical support structures (30) of
the counterweight frame (15).

25

3. The counterweight frame as claimed in claim 1 or
2, characterized in that

a suspension point (SP) defined by the counterweight
suspension element (SE) is located always below an uppermost
part of the counterweight frame (15).

30

4. The counterweight frame as claimed in any one of
the preceding claims 1 - 3, characterized in that

35

the counterweight frame (15) further comprises a moving apparatus (38) for selectively moving the counterweight suspension element (SE) towards a bottom part of the counterweight frame (15).

5

5. The counterweight frame as claimed in any one of the preceding claims 1 - 4, characterized in that

the counterweight frame (15) comprises a moving apparatus (38) for moving the counterweight suspension element (SE) vertically; and

the moving apparatus (38) comprises at least one spring element (43) for generating spring force directed to move the counterweight suspension element (SE) towards the bottom part of the counterweight frame (15), whereby the spring force is configured to move the counterweight suspension element (SE) downwards when movement speed of the counterweight frame (15) in downward direction is decelerated.

20 6. The counterweight frame as claimed in any one of the preceding claims 1 - 4, characterized in that

the counterweight frame (15) comprises a moving apparatus (38) for moving the counterweight suspension element (SE) vertically;

25 the counterweight suspension element (SE) is mounted to a support structure (33, 37) connected vertically movably relative to the counterweight frame (15);

the moving apparatus comprises at least one elongated first transmission element (39) connected between the movable support structure (33, 37) and the frame (15);

30 the first transmission element (39) is actuated by means of at least one first force element (45) which is connected by means of at least one second transmission element to a rotating mechanism of the counterweight support element (SE) for selectively driving the first force element (45) for moving the support structure (33, 37) vertically.

35

7. The counterweight frame as claimed in any one of the preceding claims 1 - 4, characterized in that

the counterweight frame (15) comprises a moving apparatus (38) for moving the counterweight support element (SE) vertically;

the counterweight support element (SE) is mounted to a support structure (33, 37) connected vertically movably relative to the counterweight frame (15);

the moving apparatus (38) comprises at least one elongated bendable first transmission element (39) connected between the movable support structure (33, 37) and the frame (15);

the moving apparatus (38) further comprises at least one spooling device (44) comprising a spooling pulley actuated by means of a first force element;

and wherein the first force element is configured to spool the first transmission element (39) around the spooling pulley for providing the counterweight support element (SE) with the relative vertical movement.

20

8. The counterweight frame as claimed in any one of the preceding claims 1 - 7, characterized in that

the mentioned counterweight support element (SE) is a counterweight pulley (16).

25

9. The counterweight frame as claimed in any one of the preceding claims 1 - 7, characterized in that

the mentioned counterweight support element (SE) is a rope terminal (46) providing a fixing point for the at least one suspension rope (5).

30

10. The counterweight frame as claimed in any one of the preceding claims 1 - 9, characterized in that

the counterweight comprises a groove (36) at least on its vertical upper part and wherein the groove (36) is facing towards the counterweight support element (SE),

35

whereby the groove (36) forms a vertical space on a first lateral side of the counterweight.

11. A traction elevator (1) comprising:

5 a car assembly (17) provided with an elevator car (3);

 a counterweight assembly (4) provided with a counterweight frame (15), counterweight and at least counterweight support element (SE), and wherein the counterweight
10 assembly (4) is configured to be moved between an uppermost position and a lowermost position in an elevator shaft (2);

 a first guide assembly (19) provided with first vertical guide rails (20) mountable to the elevator shaft (2) and first guide shoes (21) mountable to the car assembly
15 (17), and correspondingly a second guide assembly (24) provided with second vertical guide rails (25) and second guide shoes (26) for the counterweight frame (15) and wherein the mentioned guide shoes (21, 26) are supportable against the guide rails (20, 25);

20 a hoisting machinery (6) comprising an electric motor (M) and a traction sheave (7) driven by means of the electric motor (M);

 at least one suspension rope (5) connecting the car assembly (17) and the counterweight assembly (4) and arranged to pass over the traction sheave (7); and
25

 a control system comprising at least one control unit (CU) configured to control operation of the elevator (1) and its actuators;

 characterized in that

30 the counterweight assembly (4) is in accordance with any one of the preceding claims 1 - 10; and

 the counterweight support element (SE) is configured to move towards a bottom end of the counterweight frame (15) when the counterweight assembly (4) approaches its
35 lowermost position in the elevator shaft (2).

12. The elevator as claimed in claim 11, characterized in that

the counterweight support element (SE) is movable dynamically in upward and downward directions in relation
5 to the counterweight frame (15) during the operating cycle of the elevator (1);

the relative movement of the counterweight support element (SE) is monitored by means of at least one sensing device (S) configured to produce sensing data; and

10 the gathered sensing data is transmitted at least to the control system of the elevator (1).

13. A method for supporting a counterweight assembly (4) of a traction elevator (1)

15 wherein the method comprises:

providing a counterweight assembly (4) with a counterweight frame (15), at least one filler element (23) and at least one counterweight support element (SE);

20 supporting the counterweight frame (15) laterally to guide rails (25) on inner sides of an elevator shaft (2); and

supporting the counterweight frame (15) vertically by means of at least suspension rope (5) coupled to the counterweight support element (SE) supported to the frame
25 (15);

characterized by

moving the counterweight support element (SE) vertically relative to the counterweight frame (15) during transport movement of the elevator (1).

30

14. The method as claimed in claim 13, characterized by

moving the counterweight support element (SE) towards a bottom end of the counterweight frame (15) when the

counterweight assembly (4) approaches its lowermost position in the elevator shaft (2) whereby a suspension point (SP) is moved towards the mentioned bottom end; and

5 moving the counterweight support element (SE) towards a top end of the counterweight frame (15) when the counterweight assembly (4) approaches its uppermost position in the elevator shaft (2) whereby the suspension point (SP) is moved towards the mentioned top end.

10 15. The method as claimed in claim 13 or 14, characterized by

dampening forces directed to the counterweight assembly (4) by controlling the vertical movement of the counterweight support element (SE) in relation to the counterweight frame (15).

15

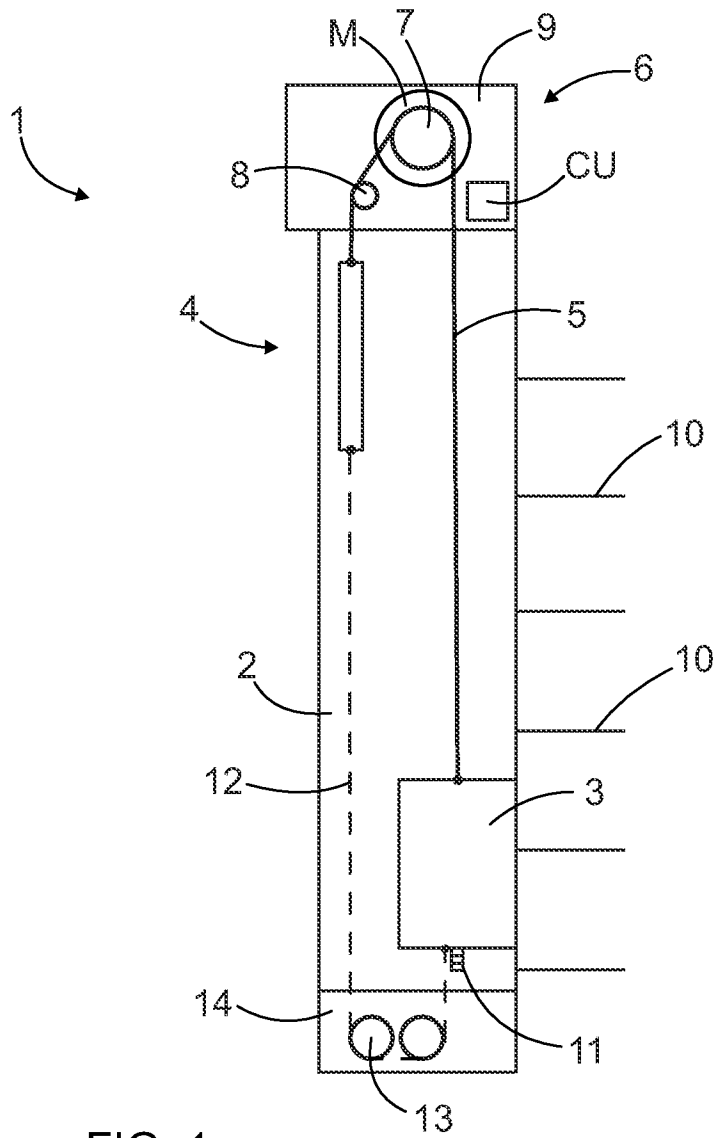
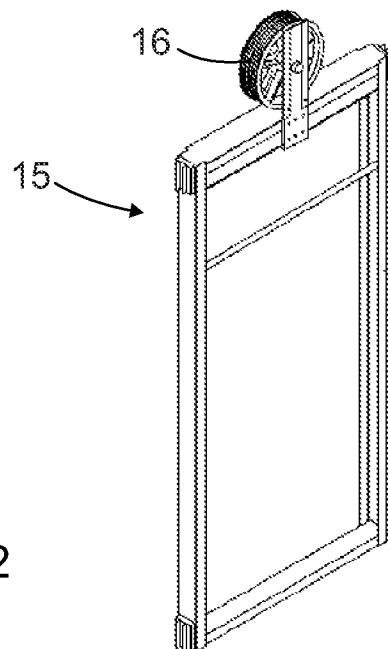
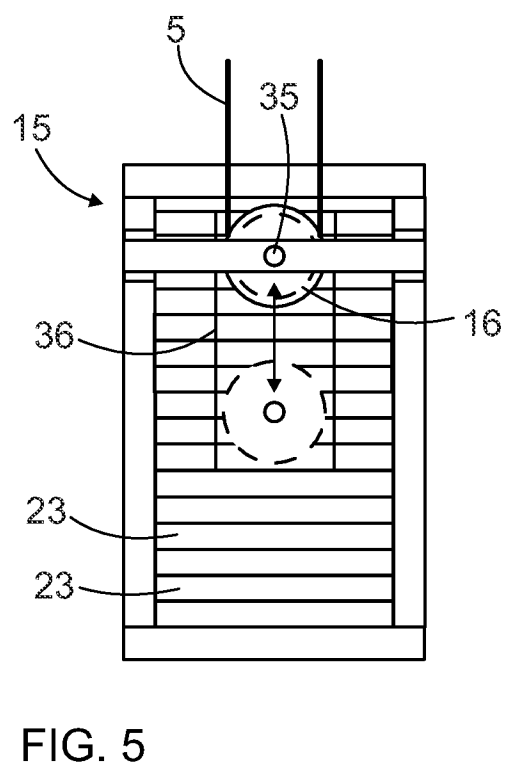
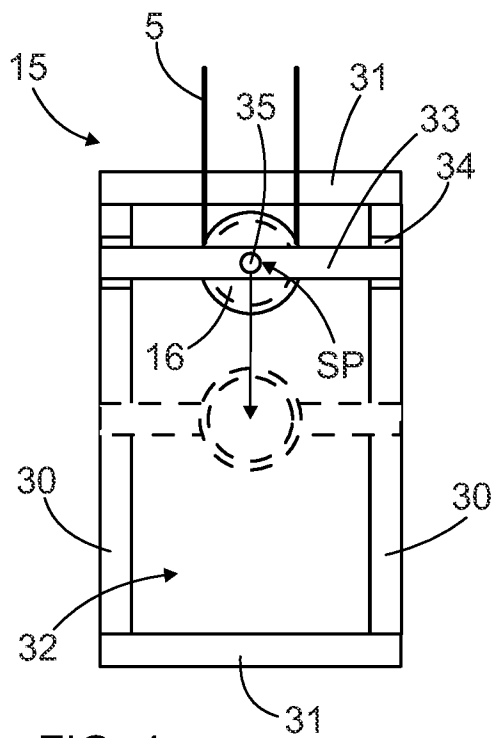
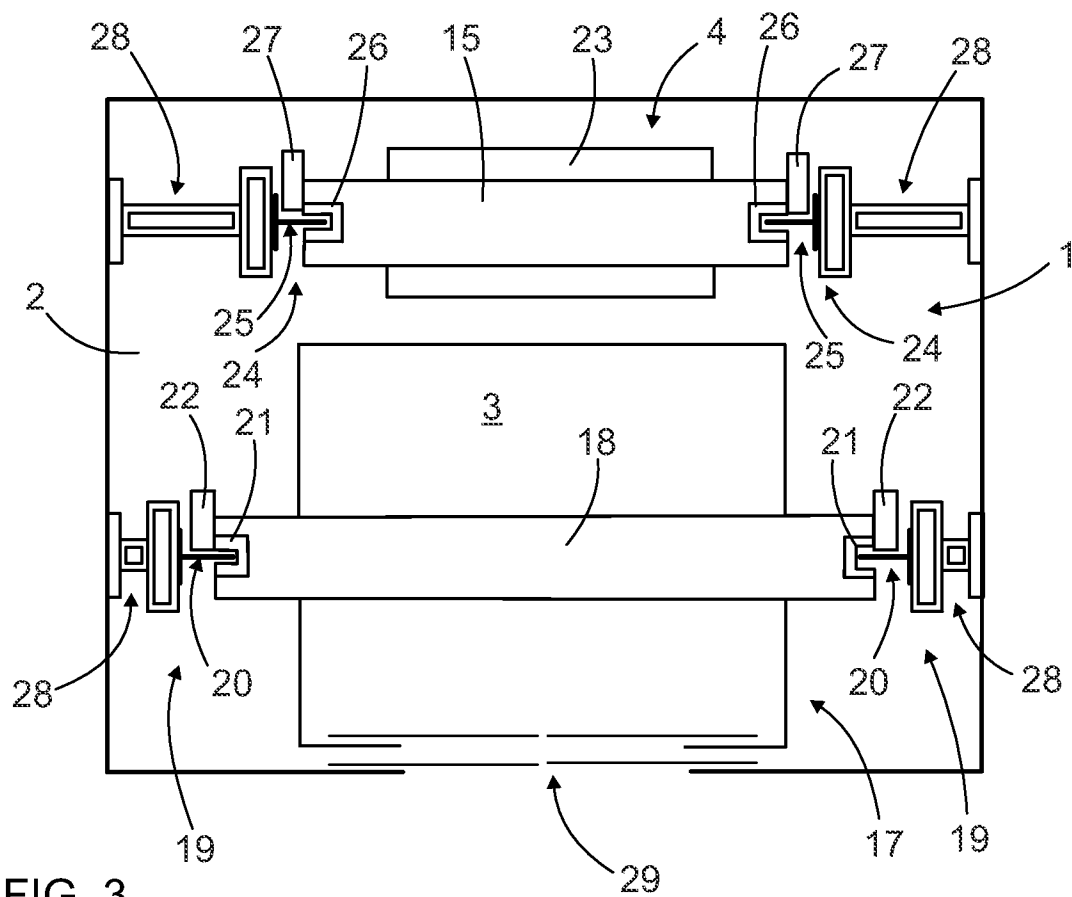


FIG. 1



Prior art

FIG. 2



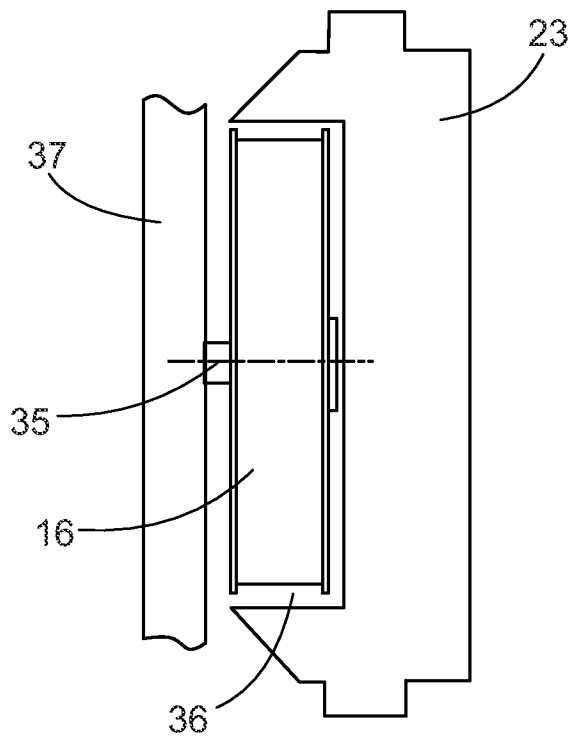


FIG. 6

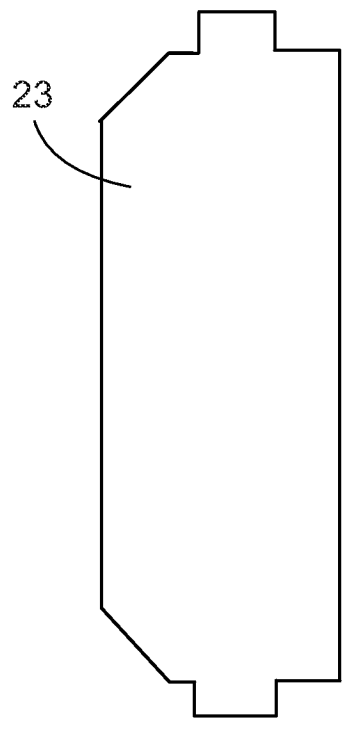


FIG. 7

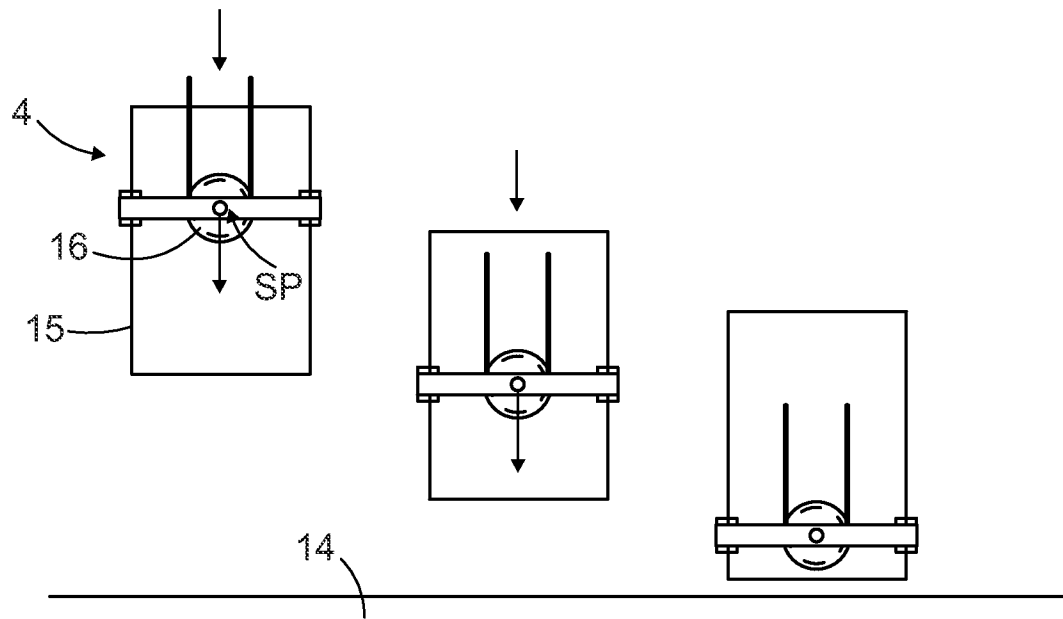
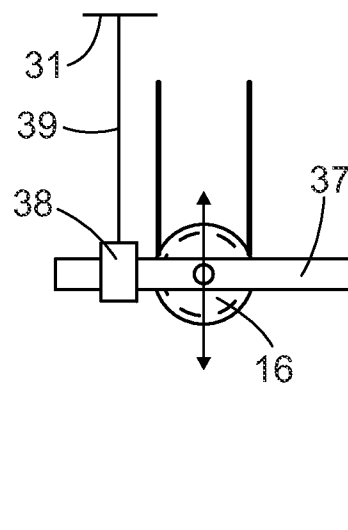
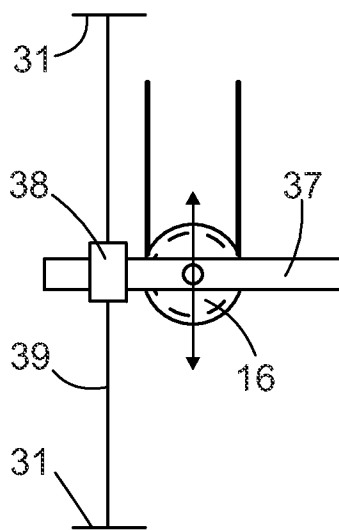
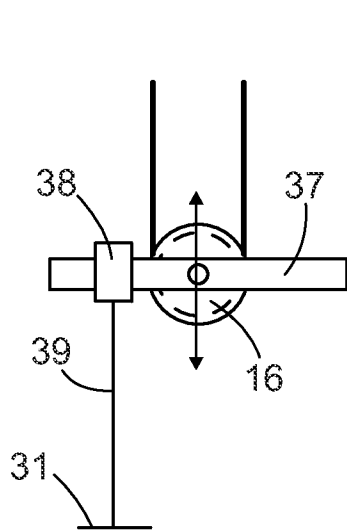
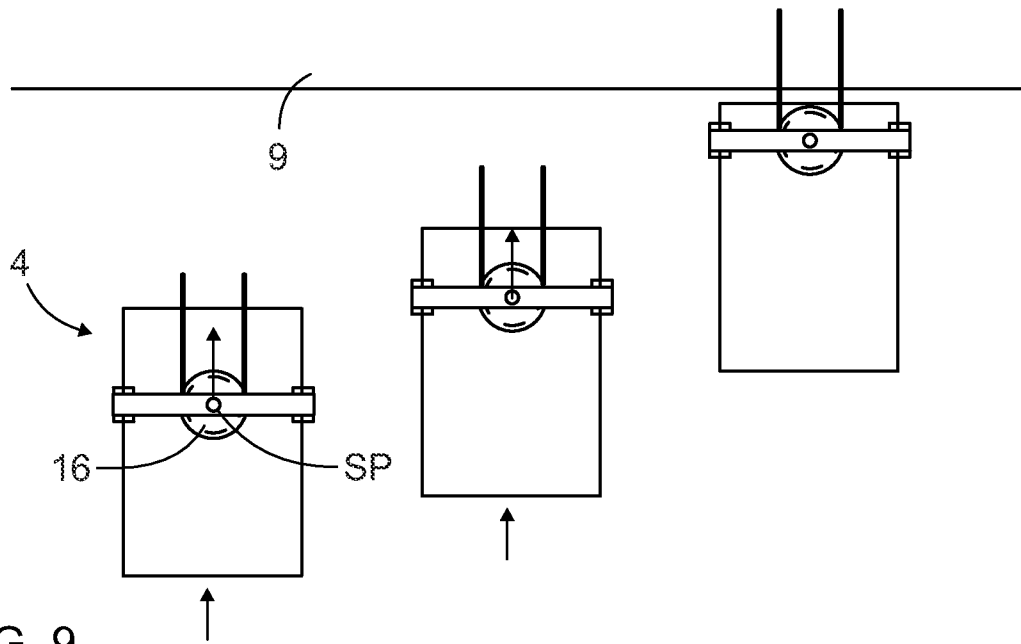


FIG. 8

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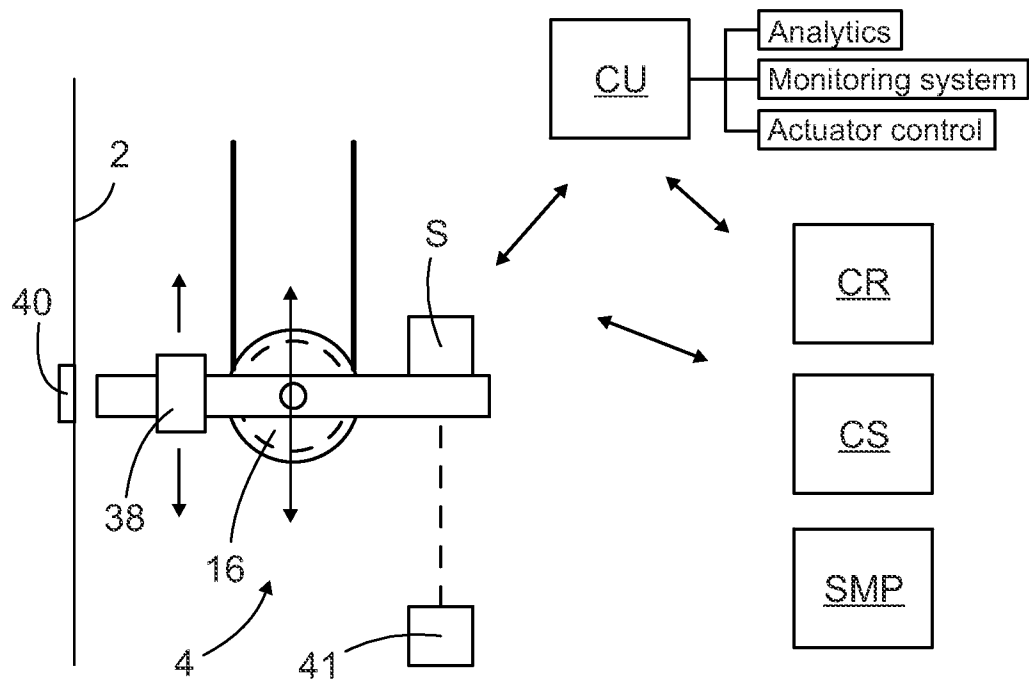


FIG. 13

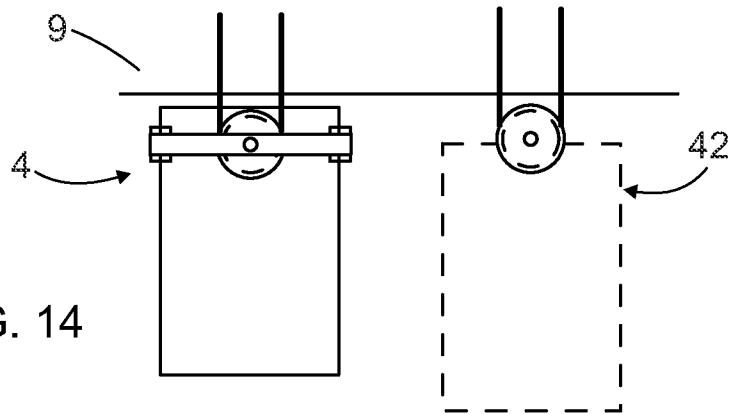


FIG. 14

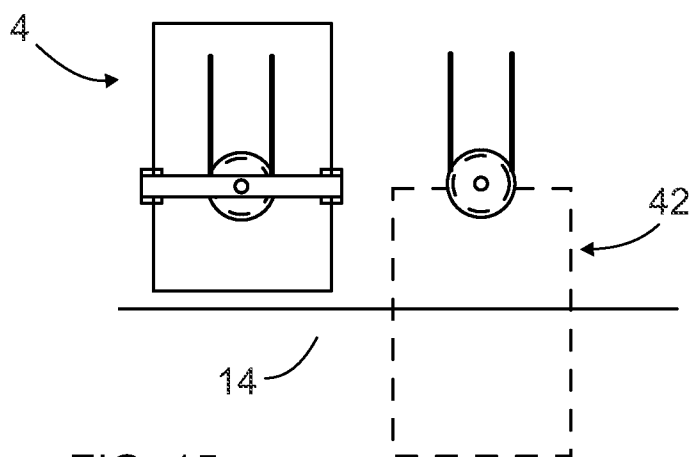


FIG. 15

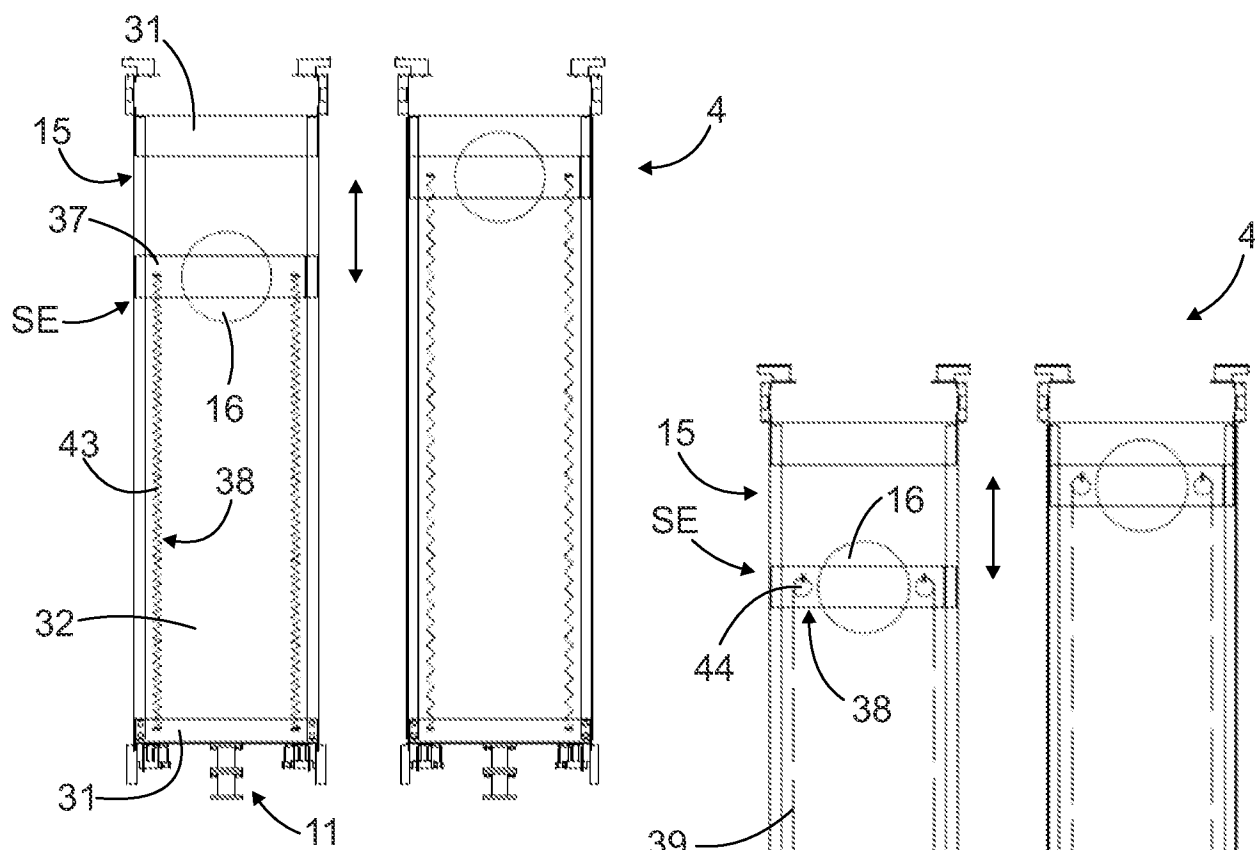


FIG. 16

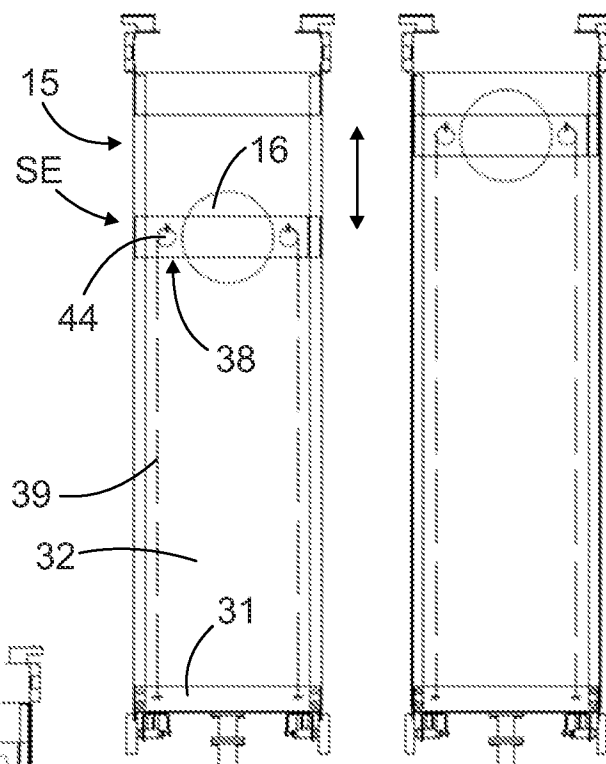


FIG. 17

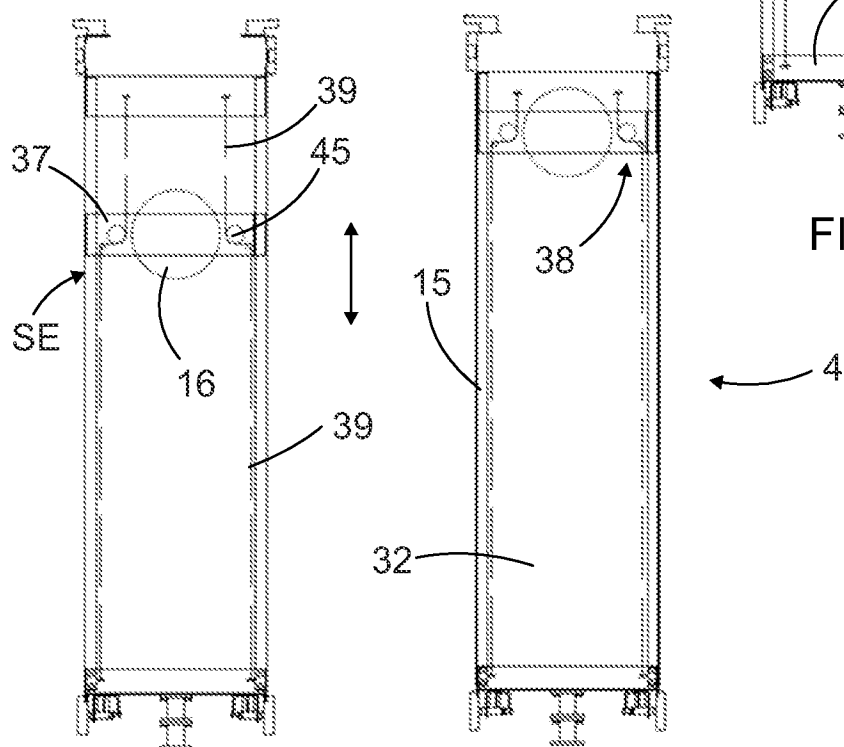
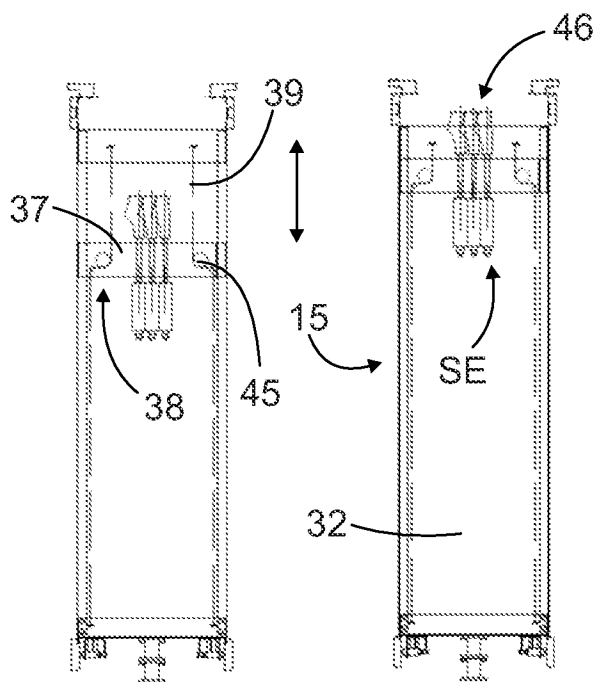
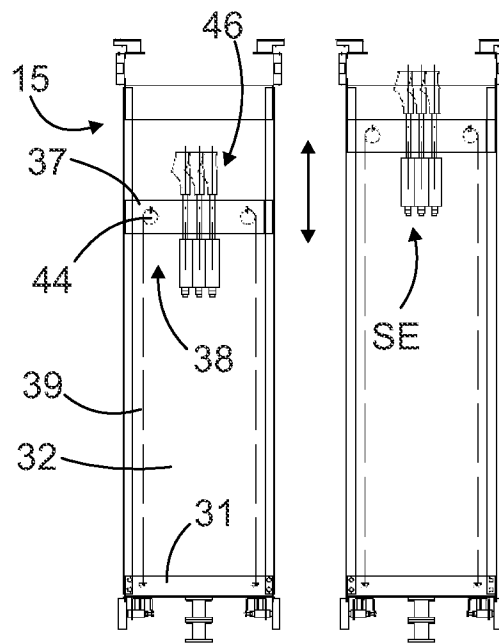
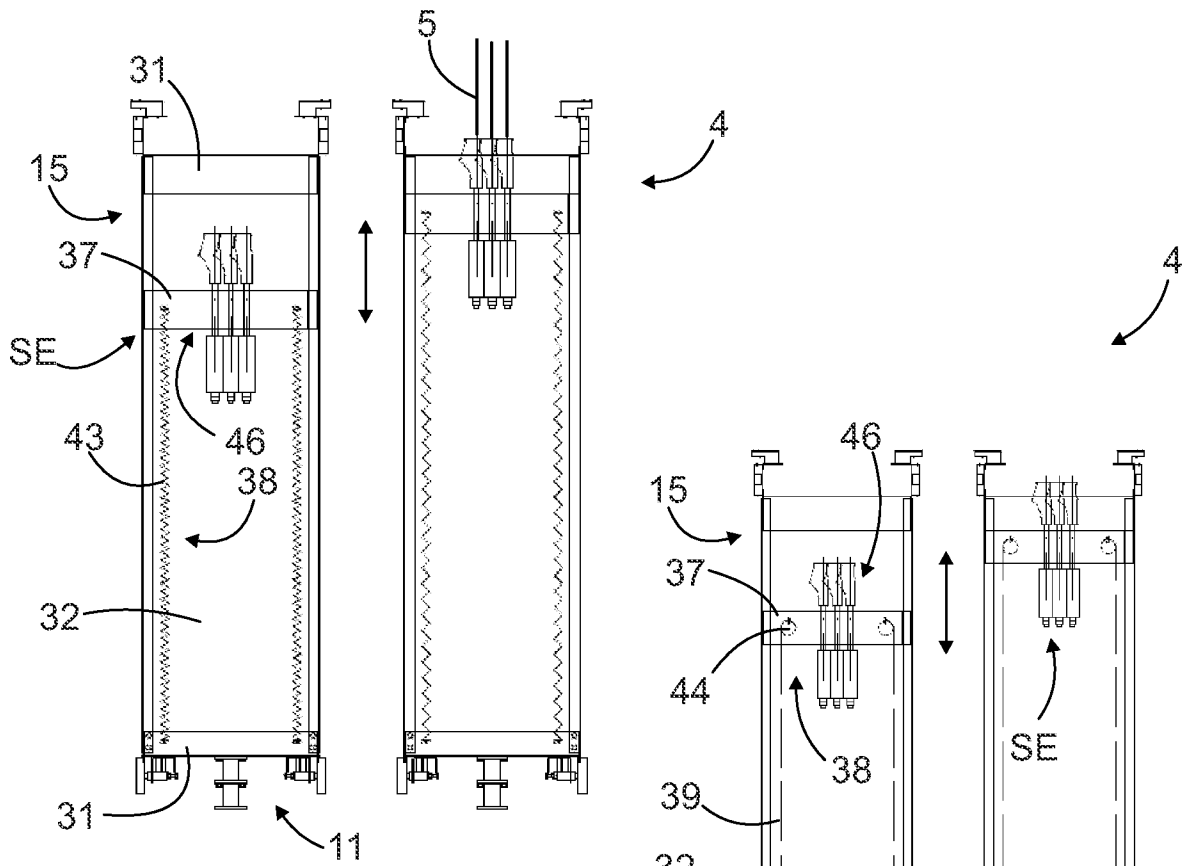


FIG. 18



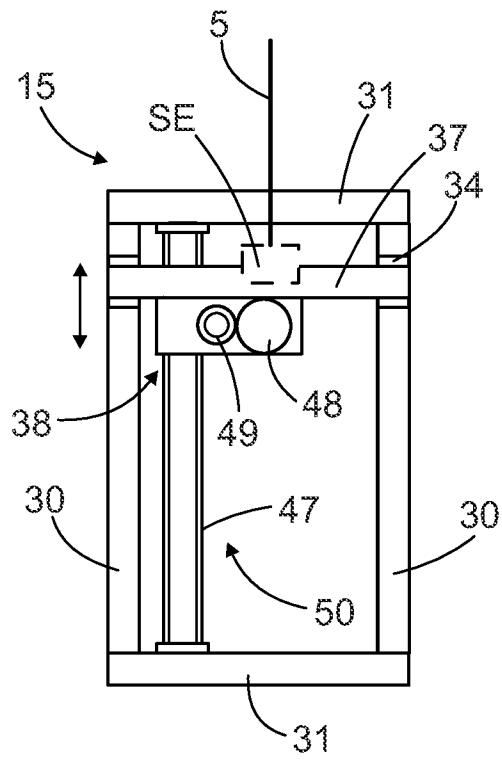


FIG. 22

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2021/050139

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

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)

IPC: B66B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
FI, SE, NO, DK

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

EPODOC, EPO-Internal full-text databases, Full-text translation databases from Asian languages, WPIAP

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 1071309 A (GOGGIN BYRON R [US]) 26 August 1913 (26.08.1913) Whole document, especially figure 1	1-3, 8, 9, 10

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

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"D" document cited by the applicant in the international application	"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
"E" earlier application or patent but published on or after the international filing date	"&" document member of the same patent family
"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	

Date of the actual completion of the international search 20 May 2021 (20.05.2021)	Date of mailing of the international search report 26 May 2021 (26.05.2021)
Name and mailing address of the ISA/FI Finnish Patent and Registration Office FI-00091 PRH, FINLAND Facsimile No. +358 29 509 5328	Authorized officer Annele Siltanen Telephone No. +358 29 509 5000

INTERNATIONAL SEARCH REPORT
Information on Patent Family Members

International application No.
PCT/FI2021/050139

US 1071309 A 26/08/1913 None

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2021/050139

CLASSIFICATION OF SUBJECT MATTER

IPC
B66B 17/12 (2006.01)