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(54) **ROOF WINDOW**

(57) A roof window (10) comprises a window frame (20), a sash (30) and a glazing (8) mounted in the sash frame (32). The sash frame (32) has an outer distance between two sash side members (33) being smaller than the inner distance between the two frame side members (22) allowing the sash (30) to pivot into an open position through the opening in the frame (20) about a second axis (4). A suspension arms is arranged on each side of the sash frame and the suspension arm (40) is rotationally connected at a first suspension end (42) to the window frame and the second suspension end (44) of each of the suspension arms (40) is connected to the sash (30). The roof window (10) further comprises an actuator (50) having an activation element (60) with a first end (62) connected to the suspension arm (40) at a first connecting point (46) allowing the sash (30) about a first axis (2).

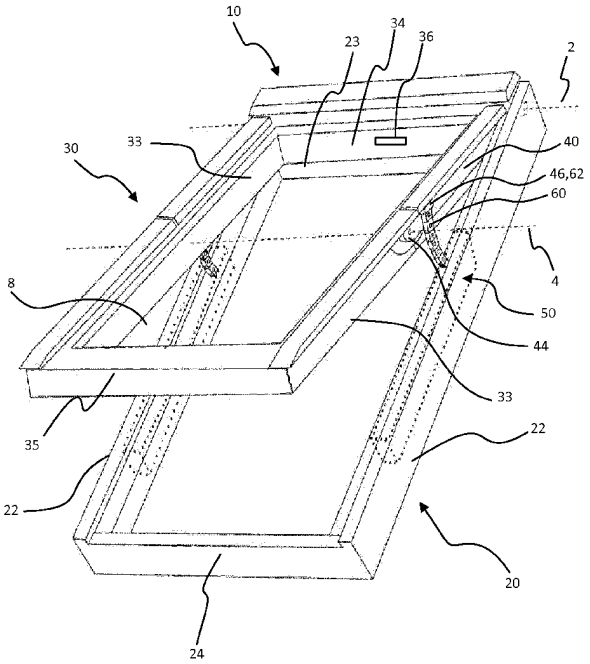

FIG. 1A

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Description

Summary

[0001] The invention relates to a roof window comprising a window frame configured to be fixed to the roof of a building, wherein the frame comprises two frame side members connected to a top frame member and a bottom frame member.

Background

[0002] Roof windows are inherently difficult to mount due to the installation location being on top of the roof surface of a building.

[0003] It is commonly known within the technical field to use an electrical actuator to provide a remote control of the positions (i.e. open or closed) of the roof windows. E.g. from WO 02/31304 A1 it is therefore known to provide a roof window with a chain actuator between the window frame and the sash frame at the middle of the bottom frame member.

[0004] A disadvantage of the above is that, if an actuator is to be arranged between the window frame and the sash, the actuator will have to be installed after the roof window has been mounted to the roof surface, and the post-installation will have to be done by an electrician or similar specialist to ensure correct installation. Furthermore, arranging an actuator in the middle of the bottom frame member limits the view out of the window, which is not desirable for aesthetical reasons.

[0005] It is therefore a general object of the present invention to provide a roof window having a sash which can be installed from the interior side of the window after the window frame has been mounted to the roof surface.

[0006] It is a further object of the present invention to provide a roof window which can be installed in a cost-efficient manner without the use of a crane or another lifting equipment to hoist the roof window into place during installation on the inclined roof surface of a building.

[0007] A further object of the present invention is to provide a roof window which is configured to be installed without further adaptation of the window frame or the sash, nor requires any special tool during connection of the sash relative to the window frame.

[0008] A further object of the present invention is to provide a cost-efficient technique enabling an electrical operation of the roof window.

[0009] The above objects along with numerous other objects will be evident from the below detailed description andare, according to a first aspect of the present invention, obtained by a roof window comprising:

- a window frame configured to be fixed to the roof of a building, wherein the frame comprises two frame side members connected to a top frame member and a bottom frame member;
- a sash comprising a sash frame with two sash side members connected to a top sash member and a bottom sash member, and a glazing mounted in the sash frame, wherein said sash is able to pivot into an open position through the opening in the frame about a second axis,
- a suspension arm being arranged on each side of the sash frame and being rotationally connected at a first suspension end to the window frame to define a horizontal first axis of rotation of the sash positioned at or near the top of the window frame allowing the sash to rotate about said first axis of rotation between an open and a closed position by the action of an actuator, wherein said sash is pivotally connected to a second suspension end of each of the suspension arms allowing the sash to pivot about the second axis;
- the pivotal connection between said second suspension end of the suspension arms and the sash frame being formed by a releasable pivot hinge including a first hinge member and a second hinge member; wherein the roof window further comprises
- an actuator comprising an activation element arranged in said frame side member, and wherein said activation element has a first end connected to the suspension arm at a first connecting point,
- wherein operations of said actuators bring about said rotation of said sash about said first axis.

[0010] Arranging the actuator including an activation element in the frame side member provides the advantage that the installation of the roof window can be achieved in a two-step installation mode, where the window frame is mounted on the inclined roof surface in the first installation step. This has the advantage that the sash, which is normally quite heavy, need not be hoisted into position before the sash is ready to be connected to the suspension arm via the releasable connection - in the second installation step.

[0011] Furthermore, by arranging the actuator in the frame side member of the window, a further advantage is that the view through the roof window is not hindered or reduced as the thickness and dimension of the frame side member and sash side members remain unchanged.

[0012] In this context, the term "actuator" is a linear actuator comprising a chain and transmission capable of providing thrust to the sash during the lifting operation of the sash. The actuator is also known as a rigid chain actuator, a linear chain actuator, a push-pull chain actuator, an electric chain actuator or a column-forming chain actuator.

[0013] In this context the term "releasable connection" should be understood as any kind of coupling, link, etc., which is capable of providing a connection between the suspension arms and the sash frame for allowing the sash frame to be released, detached or disconnected from the suspension arms without the use of tools.

[0014] In an embodiment according to a first aspect of

the present invention, the activation element is constituted by a push-pull chain having a first chain end connected to the suspension arm at a first connecting point. Through the use of an activation element constituted by a push-pull chain, it is possible to provide thrust to the sash frame during the lifting operations of the sash.

[0015] In an embodiment according to a first aspect of the present invention, said releasable pivot hinge has a first hinge member connected to the sash frame and a second member hinge connected to the first end of each of the suspension arms. By using a releasable pivot hinge having two mutually engaging hinge members connected to the suspension arms and connected to the sash frame, respectively, it is possible to achieve a simple an efficient releasing mechanism.

[0016] Using a releasable pivot hinge between the sash and the suspension arms has the advantage that the sash can be rotated, at least to a degree; that the outside surface of the sash frame with the glazing can be reached from the inside, hereby enabling that the outside surface may be cleaned from the inside which is particularly advantageous in relation with roof windows.

[0017] In an embodiment according to a first aspect of the present invention, said first hinge member is formed as an integrated part of the suspension arms. By using a releasable pivot hinge formed as an integrated part of the suspension arm, it is possible to simplify the suspension means for the sash.

[0018] Arranging the releasable pivot hinge around the middle of the sash side member is advantageous in that the sash is hereby balanced and can be maintained in any given position by use of no or very little rotational resistance.

[0019] It should further be noted that the term "middle region" in this context should be interpreted as the middle half; preferably the middle third of the longitudinal length of the sash side member.

[0020] In an embodiment according to a first aspect of the present invention, an actuator is arranged in each of the frame side members and each actuator includes an electrical motor being connected to a power source for supplying power to the electrical motor and being connected to a controller. Arrangement of the actuators in both frame side members of the window frame is advantageous in that the load is distributed uniformly, and in that the two actuators can be configured to be smaller that one large actuator - thereby enabling simpler fitting and a more compact design.

[0021] In an embodiment according to a first aspect of the present invention, the actuator, the electrical motor, the controller and the push-pull chains are arranged in a hollow profile portion of said frame side member. Arranging the actuators in the frame side member has the advantage that the view out of the window is not hindered, and the installation time is also reduced compared to an actuator and a controller being arranged on the exterior of the window frame.

[0022] In an embodiment according to a first aspect of the present invention, the actuator comprises an actuator housing with an opening for allowing the push-pull chain to extend through the opening, and the first chain end of the push-pull chain is anchored adjacent to the pivot hinge, and the second chain end is engaged by a sprocket inside the actuator housing.

[0023] In an embodiment according to a first aspect of the present invention, the actuator is self-locking by means of a transmission or a brake arranged inside the actuator housing, hereby preventing the sash from being moved if the actuator is not operated or moved during a power failure.

[0024] In an embodiment according to a first aspect of the present invention, each actuator is synchronized by a controller and is arranged opposite one another in the two side members.

[0025] Operation of the actuator in a synchronized manner has the advantage that it provides a more uniform load on the roof window assembly.

[0026] In an embodiment according to a first aspect of the present invention, the releasable pivot hinge enables the sash to pivot at least 70 degrees in relation to the frame.

[0027] The releasable pivot hinge allows the sash to pivot in relation to the suspension arm and the window frame, respectively. Therefore, the outside surface of the sash can be reached from the inside, and cleaning of the outside surface from the inside is thereby possible. Thus, the present pivot levels present an advantageous relationship between cost and effect.

[0028] In an embodiment according to a first aspect of the present invention, a lifting mechanism includes a damper being interconnected between the frame side member and the suspension arms to compensate for the weight of the sash.

[0029] Providing the roof window with lifting mechanism with a damper - such as a coil spring, a pneumatic spring, an elastic member - has the advantage that the actuator can be down-sized as the lifting mechanism can compensate for some of the lifting capacity hereby reducing the overall cost af the roof window.

[0030] In an embodiment according to a first aspect of the present invention, the first connecting point is offset relative to the second axis in a direction towards the first axis; hereby it is possible to adjust the curvature of the push-pull chain.

[0031] In an embodiment according to a first aspect of the present invention, the sash can be operated manually to pivot about the second axis, whereby an operator can manually pivot the sash enabling that the outside surface of the glazing can be reached and cleaned from the interior side of the roof window.

[0032] By the invention is also provided a method of assembling a roof window, the method comprising the following steps:

- fixating the window frame to the roof of a building, wherein the frame comprises two frame side mem-

bers connected to a top frame member and a bottom frame member;

- providing a sash comprising a sash frame with two sash side members connected to a top sash member and a bottom sash member, and a glazing mounted in the sash frame, wherein said sash is able to pivot inwards between about the second axis;
- providing two suspension arms, each having a first and a second suspension end;
- providing a releasable pivot hinge including a first hinge member connected to the sash and a second hinge member connected to the suspension arm;
- connecting the first suspension of the suspension arms to each side of the sash frame of the window frame to define a horizontal first axis of rotation of the sash positioned at or near the top of the window frame;
- providing an actuator comprising an activation element arranged in said frame side member;
- connecting the first end of said activation element to the suspension arm at a first connecting point;
- arranging the sash relative to the window frame enabling the first hinge member to engage the second hinge member and allowing the sash to pivot about a second axis.

[0033] Generally, locking and release of the pivot hinge may be done by for example an angle-dependent connection, so the pivot hinge engages within one angle range and is released within another angle range. Generally, locking and release of the pivot hinge may for example be provided by means of a releasable snap tab to hold the connectors in place.

Detailed description

[0034] The invention will now be explained in more detail below by means of examples of presently preferred embodiments with reference to the schematic drawing.

Figure 1A shows a schematic view of the roof window.

Figure 1B shows a perspective view of the roof window.

Figure 2 shows a side view of the roof window according to the present invention, where the sash has been rotated into a horizontal position relative to the window frame.

Figure 3 shows a side view of the roof window according to an alternative embodiment of the present invention, where the sash has been rotated into a horizontal position relative to the window frame.

Figure 4 shows a side view of the roof window according to the present invention, where the sash has been rotated into a horizontal position relative to the window frame.

Figure 5 shows a side view of the roof window according to the present invention, where the sash has been pivoted relative to the window frame.

Figure 6 shows a cross-sectional view of the roof window according to the present invention, where the sash is in a closed position.

Figure 7 shows a perspective view of the lifting mechanism.

Figure 8 shows a perspective view of the first hinge member.

Figure 9 shows a perspective view of the second hinge member.

Figure 10 shows a perspective view of an embodiment of the actuator.

[0035] Fig. 1A and fig. 1B both show a perspective view of the roof window 10 configured to be fixed to the roof of a building. The roof window 10 is depicted in an inclined position as if it is mounted on a fictive sloping roof of a building. The roof window 10 of the present invention is neither used for or is intended to be mounted on a vertical surface of a building, which would be the case for facade windows.

[0036] The roof window 10 has a window frame 20 comprising two frame side members 22 positioned in parallel with one another. The two side members 22 are interconnected to a top member 23 and a bottom member 24 forming a rectangular frame that defines an opening. In all of the embodiments shown in the drawings, the window is rectangular and the window frame comprises four frame members.

[0037] The sash frame 32 comprises two sash side members 33 connected to a top sash member 34 and a bottom sash member 35. The sash frame 32 has a rectangular shape complementing the window frame 20

[0038] In the fig. 1A and fig. 1B, the window frame 20 of the roof window 10 has a rectangular frame with an opening allowing the sash frame 32 to be received within the opening defined by the frame 20; however, it is within the scope of the invention to provide a frame having another polygonal geometry such as a square. The sash frame 32 is to be arranged in-between the two side members 22 of the frame 20.

[0039] The frame members 21, 22, 23, 24 can, for example, be a wooden member, metal profiles, member made from a polymeric material or a combination thereof.

[0040] The sash 30 comprises a sash frame 32 and a glazing 8 mounted in the sash frame 32, where the sash 30 is releasebly connected to one end of each of the suspension arms 40. The sash 30 is pivotable relative to

the suspension arms 40 allowing the sash frame 32 to be pivotable about a horizontal second axis 4 which constitutes the sash centre axis.

[0041] The sash frame 32 has an outer distance between two sash side members 33 which is smaller than the inner distance between the two frame side members 22 allowing the sash 30 to pivot into an open position through the opening in the window frame 20 about the second axis 4.

[0042] Fig. 1A and fig. 1B show that the two suspension arms 40 are connected to the window frame 20 about a first horizontal axis positioned at or near the top of the window frame 20 allowing the suspension arms 40 to pivot relative to the frame 20. The suspension arm 40 has a first suspension end shown in detail in Fig. 10.

[0043] In figs 1A-1B, a suspension arm 40 is arranged on each side of the sash frame 32 and is rotationally connected at a first suspension end 42 to the window frame 20 allowing the sash 30 to rotate about said first axis 2 of rotation between an open and a closed position by the action of an actuator 50.

[0044] The sash 30 is pivotally connected to a second suspension end 44 of each of the suspension arms 40 allowing the sash 30 to pivot about a second axis 4. The pivotal connection between said second suspension end 44 of the suspension arms 40 and the sash frame 32 is formed by a releasable pivot hinge 90 including a first hinge member 110 and a second hinge member 120. The releasable pivot hinge 90 is shown in detail in fig. 8 and fig. 9.

[0045] The roof window 10 assembly may further be provided with a locking mechanism 36 arranged at the sash top member 34 of the sash frame 30 and connected to the suspension arms 40. The locking mechanism 36 provides the possibility of fixating the window sash 30 relative to the suspension arms 40. By releasing the locking mechanism, it is possible to manually rotate the sash 30, hereby allowing the sash to be reversed e.g. for cleaning of the outer side of the window glazing 8 from the interior side of the roof window.

[0046] An additional suspension member may be used for interconnecting the suspension arms 40 and the additional member, hereby forming a suspension frame for the sash frame 30. The lock mechanism 36 could also be placed inside one or both of the suspension arms 40.

[0047] The actuator 50 comprises an activation element 60 arranged in the frame side member 22 and the activation element is formed as a push-pull chain having a first end 62 connected to the suspension arm 40 at a first connecting point 46. One actuator 60 is arranged in each frame side members 22 and each actuator 60 includes an electrical motor 52 being connected to a power source for supplying power to the electrical motor 52. Each actuator 60 can have its own controller 59 or be coupled to a central controller located in the top member 22.

[0048] In the embodiments shown in fig. 1A through fig. 7, the actuator 50, the electrical motor 52, the actuator housing 54, the controller 59 (not shown) and the push-pull chain 60 are arranged in a hollow profile portion of said frame side member 22.

[0049] A roof window 10 has a releasable pivot hinge enabling the sash 30 to pivot at least 70 degree in relation to the frame 20. During operation of the actuators 50, the sash 30 is caused to rotate about the first axis 2, and hereby the roof window 10 will be moved into an open position.

[0050] In fig. 1B, fig. 4, fig 5, the roof window 10 is shown with a lifting mechanism 70 including a damper, which is interconnected between the frame side member 22 and the suspension arms 40 to compensate for some of the weight of the sash 30. The lifting mechanism is shown in more detail in fig. 10.

[0051] Figs 2-4 show the roof window 10 having an actuator 50 arranged in each of the side members 22 of the window frame 20. Each actuator 50 has a push-pull chain being connected to the suspension arms 40 at a first connecting point 46 offset relative to the first axis 2 towards the second axis 4. The sash 30 is pivotally connected to the suspension arms 40 allowing the sash 30 to pivot about a second axis 4. When the actuator 50 is operated, the push-pull chain 60 will apply a thrust substrantially perpendicular to the frame towards the suspension arms 40 hereby lifting the sash in relation to the window frame 20 with the result that the roof window will be opened.

[0052] Figure 3 shows a side view of the roof window 10 according to an alternative embodiment of the present invention, where the sash 30 has been rotated into a horizontal position relative to the window frame 20. The actuator has a push-pull chain arranged with the back-end of the push-pull facing away for the first axis 2. Tension means 59,69 are arranged on the back-end of the push-pull chain 60, hereby applying a pressure on the push-pull chain to prevent the push-pull chain from collapsing.

[0053] The pivot hinge 90 forms a releasable connecting between the sash 30 and the window frame 20 and the pivot hinge 90 has a first hinge member connected to the sash frame 30 and a second member hinge connected to the second end of each of the suspension arms 40.

[0054] In the embodiment shown in figs 2-4, each actuator includes an electrical motor connected to a power source for supplying power to the electrical motor and being connected to a controller. The actuators are controlled to operate synchronously - i.e. both actuators move the same distance at the same time. However, in another embodiment the synchronous control operation could be omitted if the actuators would be operated synchronously at all times or if the roof window was designed to tolerate at least a small asynchronous operation of the actuators.

[0055] Fig. 5 shows the roof window 10 according to an alternative embodiment of the present invention, where the sash 30 is pivoted relative to the window frame

20, and the actuator 50 is arranged in the side members 22, where the first chain end 62 is connected to the suspension arms 40 at a first connecting point 54, where the first connecting point 54 is offset relative to the second axis 4. The first chain end 62 of the push-pull chain is anchored adjacent to the pivot hinge 90.

[0056] Fig. 6 shows a cross-sectional view along the second axis of the roof windows, where the roof window 10 is in a closed position. The sash frame 32 comprises a sash side member 33 and a glazing 8 mounted in the sash frame 32, where the sash 30 is releasebly connected to a first end of each of the suspension arms 40. The glazing 8 could be e.g. a double glazing. The actuator 50 is arranged in the frame side members 22 of the window frame 20, and the chain-end connector 63 of the push-pull chains 52 has one end connected to the supporting arm 40 at a first connecting point and the first connecting point 54 is offset relative to the sash centre axis.

[0057] In the embodiment shown in fig.6, the first chain end 62 of the push-pull chain 52 is connected the suspension arm 40 through the use of a connecting bracket 66 and a screw penetrating the aperture located in the chain-end connector 63. The push-pull chain 60 will extend and retract perpendicularly to the longitudinal direction of the frame side member 22, preferably substantially perpendicularly thereof.

[0058] By using a connecting bracket 66, it is possible compensate for the distance between the chain-end connector 63 and the surface of the suspension arm 40 at the first connecting point 46.

[0059] The actuator 50 is arranged in the frame 22 side-by-side relative to the sash frame 33.

[0060] In the embodiment shown in fig. 6, the roof window 10 has some additional panels covering the sash frame 32 in order to provide a weather-tight transition between the roof window 10 and the surrounding roofing. These panels include a number of sealing members 212,214 and cladding members 200, 202, 204. The first sealing element 210 is fixated to the suppension arms 40 and the second sealing element 212 is fixated on the sash side members 33. The first sealing element 210 provides sealing between the frame side members 22 and the frame side members 22 and the second sealing element 212 provides additional sealing.

[0061] Fig. 7 show a presently preferred embodiment of the lifting mechanism 70 for the roof windows in a position which corresponds to an open position of the roof window about the first axis (2). The lifting mechanism 70 is connected to the frame side member 22 and the suspension arm 40 to compensate for some of the weight of the sash 30. By incorporating a lifting mechanism in-between the frame 20 and the suspension arms 40, it is possible to counterbalance the weight of the sash 30 hereby reducing the force needed during operational movement of the sash 30.

[0062] The lifting mechanism 70 comprises a lifting lever 74 interconnected to a damper 72 and the lifting mechanism 70 is arranged to lift the sash 30 in relation to the window frame 20. The lifting lever 74 is, at a first end, connected to a lifting bracket 76 and is configured to be fastened to the frame side member 22 of the window frame 20 or to the top frame member 23 of the window frame 20. At the opposite end of the first-end connecting point 77, the damper 72 is pivotally connected to the suspension arm 40 at a second-end connecting point 78.

[0063] The suspension arm 40 is rotatably connected to the lifting bracket 76 allowing the sash to rotate about a first axis 2 of rotation between an open and a closed position.

[0064] Fig. 8 and fig. 9 illustrate a presently preferred embodiment of the releasable pivot hinge 90 including a first hinge member 100 configured to be connected to the first end of each of the suspension arms 40 and the second member hinge 110 configured to be connected to the sash frame 32. In fig. 8 the first hinge member 100 is formed as an integrated part of the second suspension end 44 of the suspension arm 40.

[0065] The pivot hinge 90 includes two hinge members 100,110. The first hinge member 100 includes a base plate 102 configured to be fastened to suspension arm 40. The base plate 102 supports a guide portion 103 forming a convex guide surface and, in combination with a leaf spring 108, it defines a circular passageway 104. The leaf spring 108 is supported by two pins 109 (the pins are part of rivets connecting the portions of the first hinge member 100) arranged between the base plate 102 and a first plate 105. The circular guide passageway 104 receives a curved slide member 115 of the second hinge member 110 to provide pivot rotation.

[0066] The second hinge member 110 includes a base plate 112 configured to be fastened to the sash 30 of the roof window, preferably to the sash side member 33. A cam 113 is connected to the base plate 112, and a hinge pin 114 is projecting from the cam. The hinge pin 114 supports the curved slide member 115. The curved slide member 115 is provided with a bore in which the hinge pin 114 is received. The curved slide member 115 can be formed in one single part or formed by a plurality of stacked metal elements. The guide pin 116 and a drive pin 117 are fixated to the base plate 112. The drive pin 117 is placed so as to engage with and drive the curved slide member 115 into the passageway during the movement of the curved slide member 115 in a direction into the passageway.

[0067] The pivot hinge 90 has a first rotation (pivot rotation) where the curved slide member 115 slides in the circular guide passageway 104.This pivot rotation has a defined friction due to the spring 108 so the window stays is the set position. The pivot hinge further provides a second rotation which is needed when the exterior glazing is to be cleaned or when the sash is to be installed. This rotation is about the axis of the hinge pin 114 with the aid of the cam 113. The plate 105 has an opening 106 for allowing a guide pin 116 to exit from the circular passageway 104, and thereby the guide pin 116 controls when the rotating movement about hinge pin 114 is possible.

[0068] The pivot hinge 90 has a two-stage pivoting mode; a first pivoting mode occurring when the sash 30 is pivoted from a closed position relative to the window frame 20 to a first pivot position (see fig. 5). The second pivoting mode is where the second hinge member 110 is the rotation about the hinge pin 114. During the first pivoting mode, the curved slide member 115 of the second hinge member 110 is moving in the circular guide passageway 104 of the first hinge member 100.

[0069] During the second pivoting mode, the sash is pivoting about the hinge pin 114, which is possible as the curved slide member 115 is moved away from the circular guide passageway 104. Due to the second pivoting mode, it is possible for the sash 30 to be revolved hereby enabling the sash 30 to be rotated more than 90 degrees.

[0070] The pivot hinge 90 provides the advantageous effect that it is possible to clean the exterior glazing from the interior side of the roof windows, but a further advantageous effect is that the pivot hinge 90 is releasable, which allows an operator to disconnect the sash 30 from the window frame 20 during installation of the roof window.

[0071] The releasable pivot hinge 90 comprises two hinge members 100,110 which can be disconnected by pushing the keeper pin 111 and extracting the curved slide member 115 from the circular guide passageway 104. The two hinge members 100,110 are disengaged during installation of the window sash. As an alternative to disconnection of the hinge members 100,110, the hinge itself may be releasable from the sash or the suspension arms. For example by sliding the base plate 102 or 112 into a holding clamp etc.

[0072] It should be understood that pivot hinge is located in the central one-third portion of the sides - to define the second axis 4. The second axis 4 is the pivot axis for the sash 30 and is located in parallel with the top sash member 34 and bottom sash member 35.

[0073] Fig. 10 shows a perspective view of the actuator 50 according to a presently preferred embodiment of the actuator. In the shown embodiment, the actuator 50 comprises an electrical motor 52 and a transmission 56 including a gear 57 and a sprocket located below the gear 58 arranged to drive a push-pull chain. The actuator further comprises an actuator housing 54 with an opening for allowing the push-pull chain 60 to extend through the opening. The push-pull chain 26 is preferably of a semi-rigid type and bendable in one direction.

[0074] A the first end, the chain 62 is configured to be connected to the suspension arm 40 via first chain-end connector 63 (e.g. mounting bracket), and the second chain end 64 is engaged by a sprocket inside the actuator housing 54. However, it is obvious to the skilled person that a motorized chain actuator 13 can be designed in numerous other ways.

[0075] In the shown embodiment, the actuator 50 is self-locking by means of a transmission 56 arranged inside the actuator housing 54 enabling the actuator 50 to hold the window in the open positions and preferably also the closed position. This self-locking effect can for example be provided by a worm gear in the chain actuator. However, in another embodiment, the chain actuator could be non-self-locking and provide the holding position by a releasable brake, lock or similar.

[0076] The actuator has a manual override whereby a manual input can rotate the gear to withdraw and retract the chain without use of electricity.

[0077] The controller 59 is configured to control the actuator and thus the position of the sash 30. Further, the controller 59 is configured to electronically lock and unlock the sash 30.

[0078] The controller 59 is, in an embodiment, provided with a user interface 120 or connected to a device with a user interface such as a remote control unit which could e.g. be a smartphone with an app installed thereon for controlling the operation of the roof window 10 via the controller 59.

[0079] The controller 59 may also be connected to other sensors, such as a rain, storm or squeeze protection sensor and the controller 59 may be configured to automatically reduce the opening or even to close and lock the roof window 10 when rain or storm is detected and the controller 59 may be configured to stop movement of the sash 3, or even to partially withdraw the last movement of the sash 3 when a squeeze event is detected, i.e. detects that an object obstructs the closing of the sash and the object, such as the body part of an operator, is being squeezed.

[0080] According to a second aspect of the present invention, a method of assembling a roof window 10 is provided, the method comprising the following steps:

- providing a window frame 20 configured to be fixed to the roof of a building, wherein the frame comprises two frame side members 22 connected to a top frame member 23 and a bottom frame member 24;
- providing a sash 30 comprising a sash frame 32 with two sash side members 33 connected to a top sash member 34 and a bottom sash member 35, and a glazing 8 mounted in the sash frame 32, wherein the sash 30 pivots inwards between the first axis 2 and the second axis 4;
- providing a suspension arm 40 being arranged on each side of the sash frame 32 and being rotationally connected at a first suspension end 42 to the window frame to define a horizontal first axis 2 of rotation of the sash 30 positioned at or near the top of the window frame 20;
- providing an actuator 50 comprising an activation element 60 arranged in said frame side member;
- connecting the sash 30 to a second suspension end 44 of each of the suspension arms 40 allowing the sash 30 to pivot about a second axis 4, wherein said pivotal connection is formed by a releasable pivot hinge 90 including a first hinge member 110 and a second hinge member 120;
- connecting the first end 62 of said activation element

to the suspension arm 40 at a first connecting point 46.

[0081] According to a third aspect of the present invention, a method of operating a roof window 10 comprising a window frame 20, a sash 30, two suspension arms 40 and an actuator 50 is provided, said method further comprising the following steps:

- operating the actuator 50 in a first operational mode allowing the electrical motor 52 to release the tension in the push-pull chain prior to a second operational mode;
- wherein the second operational mode includes a manual operation allowing the sash 30 to rotate about the second axis 4 from a first position to an open position.

[0082] Although the invention has been described above with reference to a number of specific and advantageous embodiments, it is understood that the present invention is by no means limited to the above disclosure of the above described advantageous embodiments, as the features of the above embodiments may be combined to provide additional embodiments. The additional embodiments are all construed to be part of the present invention. Furthermore, the present invention is to be understood compassed by any equivalent or similar structure as described above and also to be encompassed by the scope limited by the below claims defining the protective scope of the present patent application.

Reference numbers

[0083] In the following is given a list of reference numbers that are used in the detailed description of the invention.

first axis 2
second axis 4
roof window 10
window frame 20
frame side members 22
top frame member 23
bottom frame member 24
sash 30
sash frame 32
sash side members 33
top sash member 34
bottom sash member 35
locking mechanism 36
suspension arms 40
first suspension end 42
second suspension end 44
first connecting point 46
actuator 50
electrical motor 52
actuator housing 54
tension means 55
transmission 56
sprocket 57
gear 58
push-pull chain 60
first chain end 62
chain-end connector 63
second chain end 64
connecting bracket 66
screw 68
tension means 69
lifting mechanism 70
damper 72
lifting lever 74
lifting bracket 76
first-end connecting point 77
second-end connecting point 78
pivot hinge 90
first hinge member 100
base plate 102
guide portions 103
circular passageway 104
first plate 105
leaf spring 108
second hinge member 110
base plate 112
cam 113
hinge pin 114
curved slide member 115
guide pin 116
drive pin 117
user interface 120
cladding members 200, 202, 204
sealing element 210, 212

Claims

1. A roof window (10) comprising:

- a window frame (20) configured to be fixed to the roof of a building, wherein the frame comprises two frame side members (22) connected to a top frame member (23) and a bottom frame member (24);
- a sash (30) comprising a sash frame (32) with two sash side members (33) connected to a top sash member (34) and a bottom sash member (35), and a glazing (8) mounted in the sash frame (32), wherein said sash frame (32) has an outer distance between two sash side members (33) being substantially smaller than the inner distance between the two frame side members (22) allowing the sash (30) to pivot into an open position through the opening in the frame (20) about a second axis (4);
- a suspension arm (40) being arranged on each side of the sash frame (32) and being rotationally

connected at a first suspension end (42) to the window frame to define a horizontal first axis (2) of rotation of the sash (30) positioned at or near the top of the window frame (20) allowing the sash (30) to rotate about said first axis (2) of rotation between an open and a closed position by the action of an actuator (50), wherein said sash (30) is pivotally connected to a second suspension end (44) of each of the suspension arms (40) allowing the sash (30) to pivot about the second axis (4);

- the pivotal connection between said second suspension end (44) of the suspension arms (40) and the sash frame (32) being formed by a releasable pivot hinge (90) including a first hinge member (110) and a second hinge member (120);
- an actuator (50) comprising an activation element (60) arranged in said frame side member, and wherein said activation element has a first end (62) connected to the suspension arm (40) at a first connecting point (46),
- wherein operation of said actuators brings about said rotation of said sash (30) about said first axis (2).

2. A roof window according to claim 1, wherein the activation element is constituted by a push-pull chain (60) having a first chain end (62) connected to the suspension arm (40) at a first connecting point (46).

3. A roof window according to claim 1 or 2, wherein said releasable pivot hinge (90) has a first hinge member (110) connected to the sash frame (32), and a second member hinge is connected (120) to the first end of each of the suspension arms (40).

4. A roof window according to claim 3, wherein said first hinge member (110) is formed as an integrated part of the suspension arms (40).

5. A roof window according to any of the preceeding claims, wherein an actuator is arranged in each of the frame side member (22), and wherein each actuator includes an electrical motor (52) being connected to a power source for supplying power to the electrical motor (52) and being connected to a controller (59).

6. A roof window according to any of the preceeding claims 2-5, wherein the actuator, the electrical motor (52), the controller (59) and the push-pull chain are arranged in a hollow profile portion of said frame side member (22).

7. A roof window according to any of the preceeding claims, wherein the actuator (50) comprises an actuator housing (54) with an opening for allowing the push-pull chain (60) to extend through the opening, and wherein the first chain end (62) of the push-pull chain is anchored adjacent to the pivot hinge (90), and the second chain end (64) is engaged by a sprocket inside the actuator housing (54).

8. A roof window according to any of the preceeding claims, wherein the actuator (50) is self-locking by means of a transmission (56) or a brake (58) arranged inside the actuator housing (54).

9. A roof window according to any of the preceeding claims, wherein each actuator (50) is synchronized by a controller and is arranged opposite one another in the two side members (22).

10. A roof window according to any of the preceeding claims, wherein the releasable pivot hinge enables the sash (30) to pivot at least 70 degrees in relation to the frame (20).

11. A roof window according to any of the preceeding claims, wherein the roof window further comprises a screen (80) arranged between the sash frame (32) and the frame (20), wherein the screening means are arranged to extend from the top member, preferably 20 % in the direction towards the bottom member (24).

12. A roof window according to any of the preceeding claims, wherein a lifting mechanism (70) includes a damper (72) being interconnected between the frame side member (22) and the suspension arms (40) to compensate for the weight of the sash (30).

13. A roof window according to any of the preceeding claims, wherein the first connecting point (46) is offset relative to the second axis (4) towards the first axis (2).

14. A roof window according to any of the preceeding claims, wherein the sash (30) can be operated manually to pivot about the second axis (4).

15. Method of assembling a roof window (10), the method comprising the following steps:

- fixating the window frame (20) to the roof of a building, wherein the frame comprises two frame side members (22) connected to a top frame member (23) and a bottom frame member (24);
- providing a sash (30) comprising a sash frame (32) with two sash side members (33) connected to a top sash member (34) and a bottom sash member (35), and a glazing (8) mounted in the sash frame (32), wherein said sash is able to pivot inwards between the first axis (2) and the

second axis (4);
- providing two suspension arms (40) having a first suspension end (42) and a second suspension end (44);
- providing a releasable pivot hinge (90) including a first hinge member (110) being connected to the sash (30) and a second hinge member (120) being connected to each suspension arm (40) ;
- providing an actuator (50) comprising an activation element (60) arranged in said frame side member;
- connecting the first end (62) of said activation element to the suspension arm (40) at a first connecting point (46);
- connecting a first suspension end (42) to the window frame (20) to define a horizontal first axis (2) of rotation of the sash (30) positioned at or near the top of the window frame (20);
- arranging the sash relative to the window frame enabling the first hinge member to engange second hinge member and allowing the sash to pivot about a second axis;
- forming a releasable connection between the first hinge member (110) and the second hinge member (120).

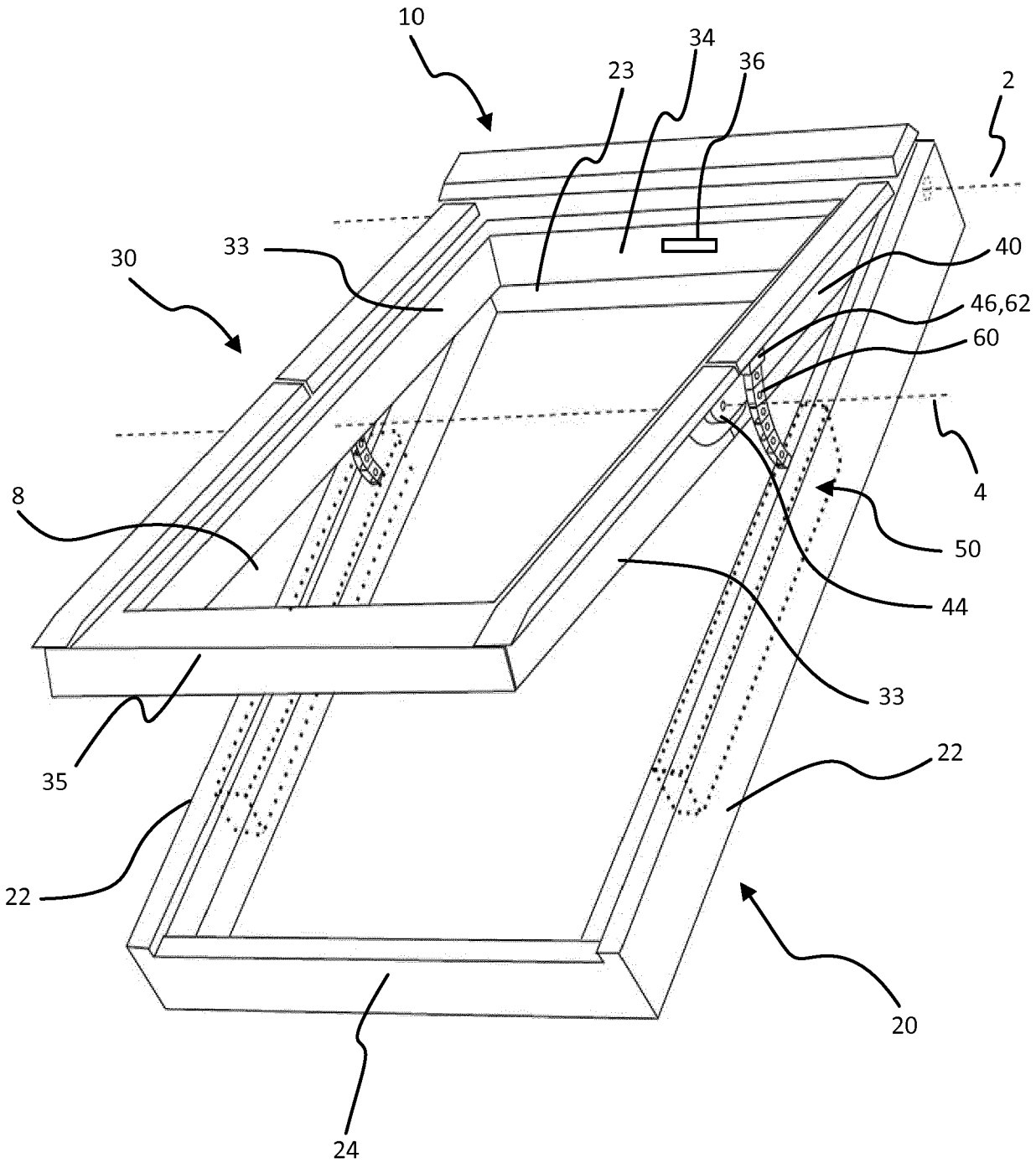

FIG. 1A

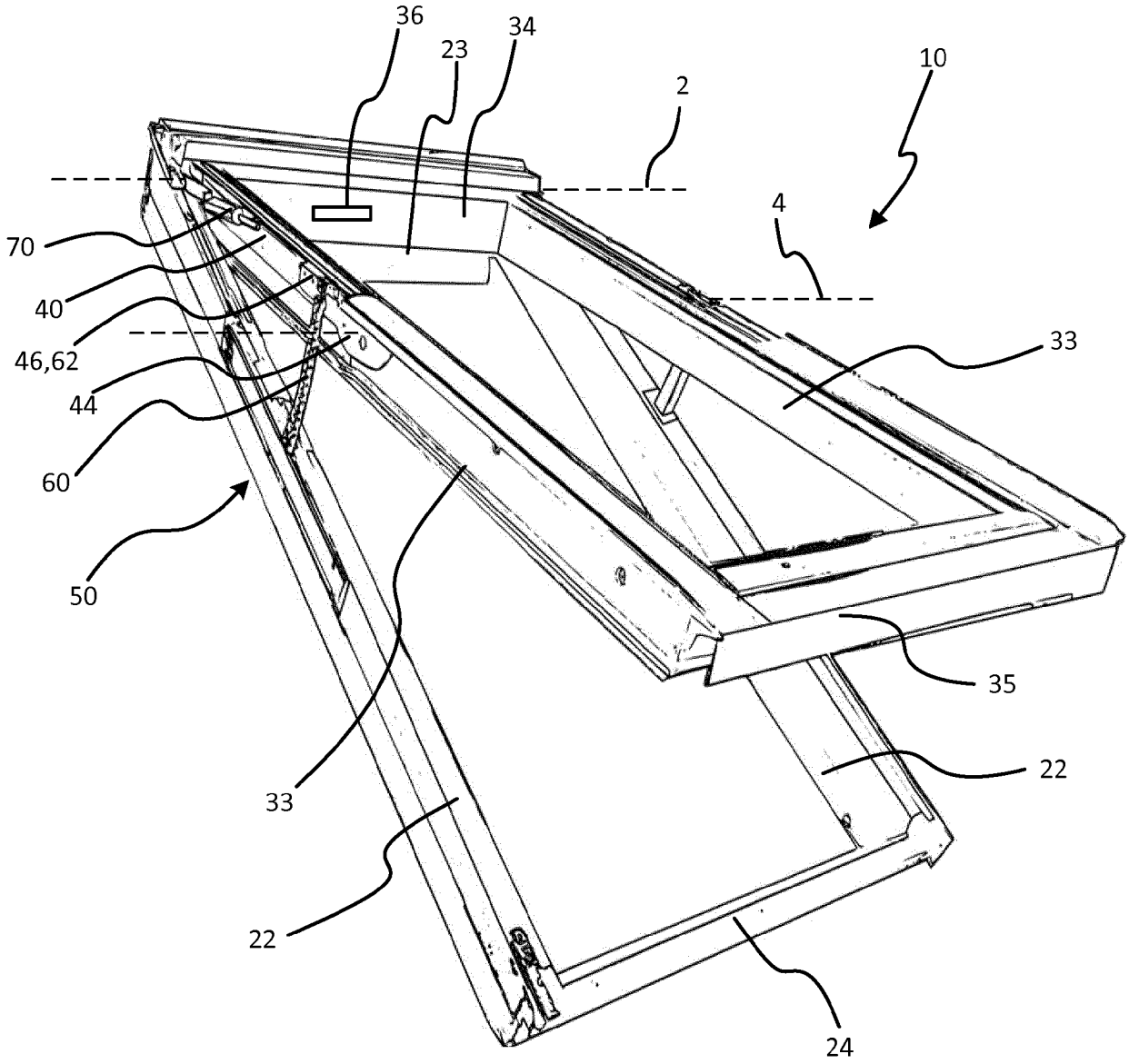

FIG. 1B

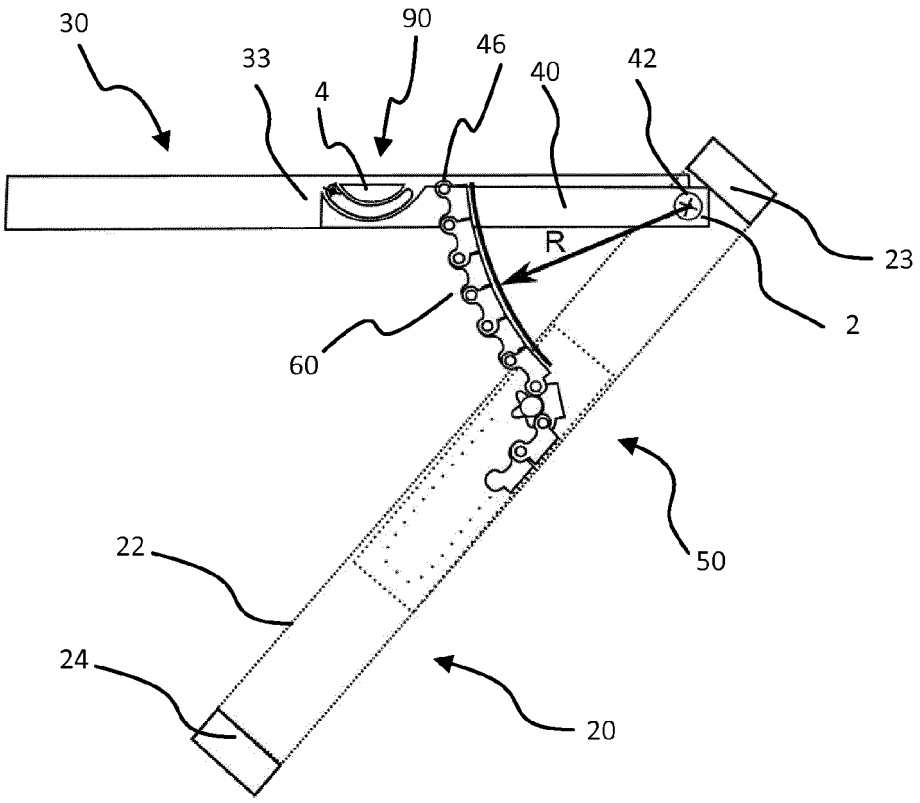
30
33
4
90
46
40
42
23
R
2
60
50
22
24
20

FIG. 2

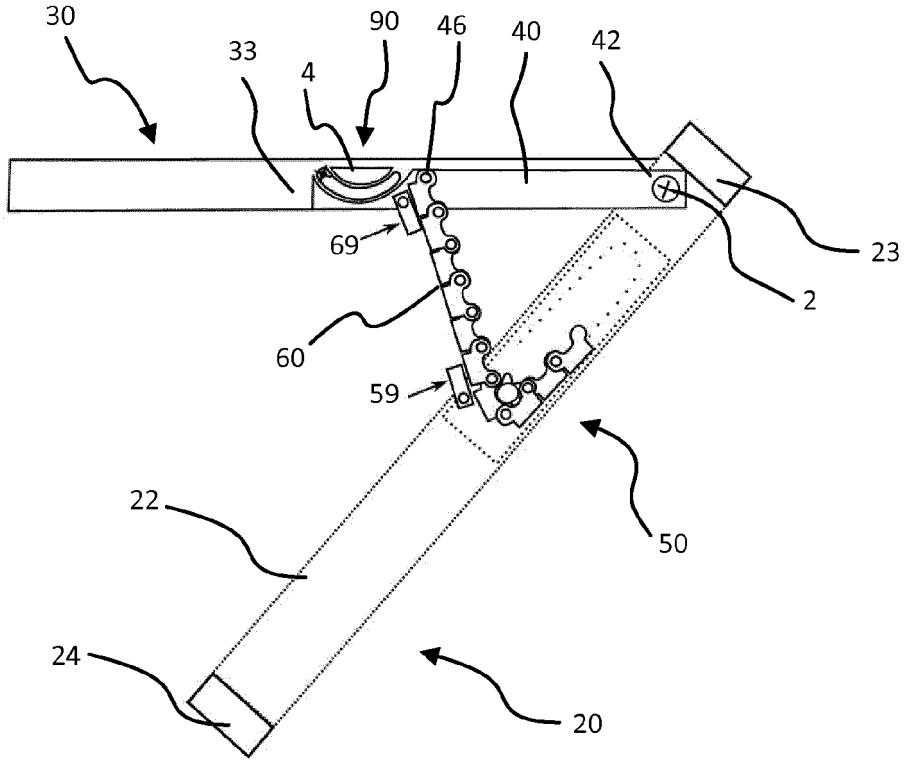
30
33
4
90
46
40
42
23
69
2
60
59
50
22
24
20

FIG. 3

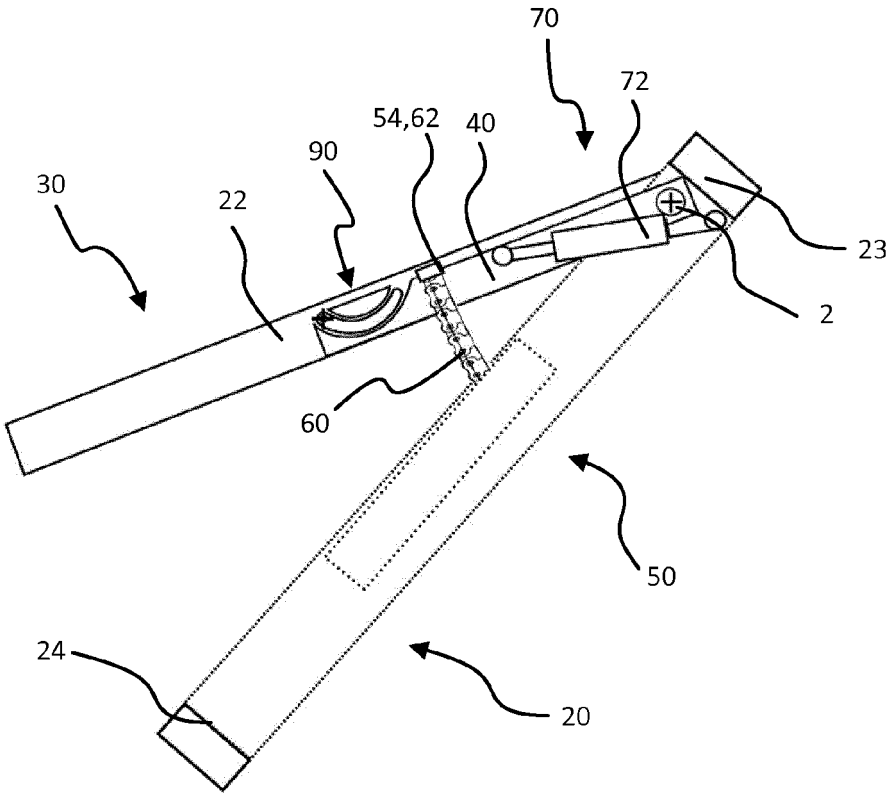
70
72
54,62
40
90
30
22
23
2
60
50
24
20

FIG. 4

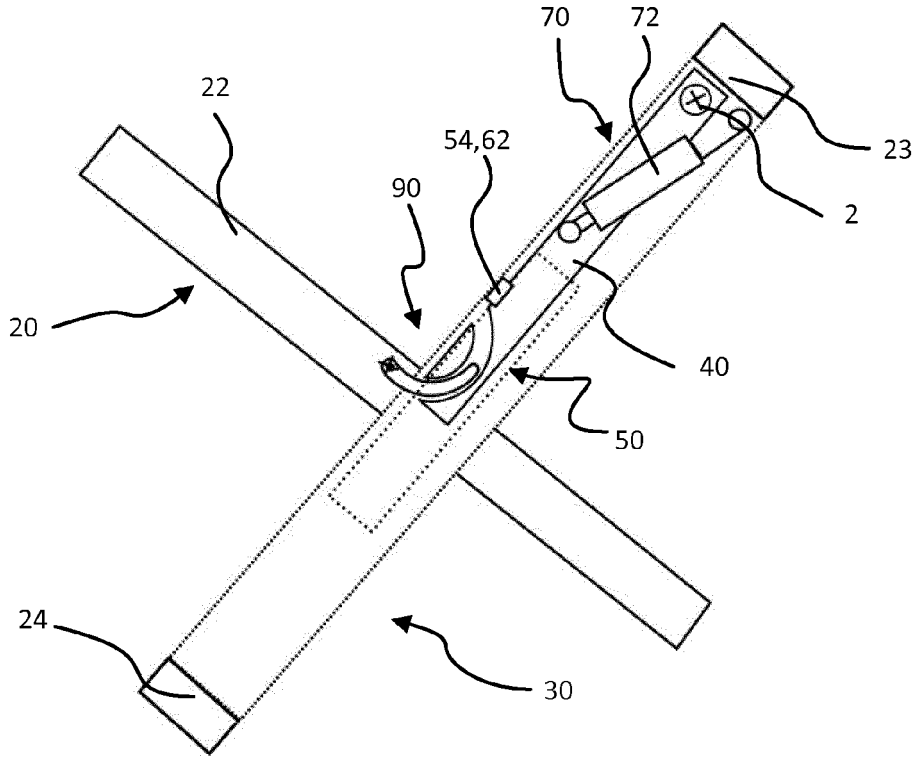
70
72
22
23
54,62
90
2
20
40
50
24
30

FIG. 5

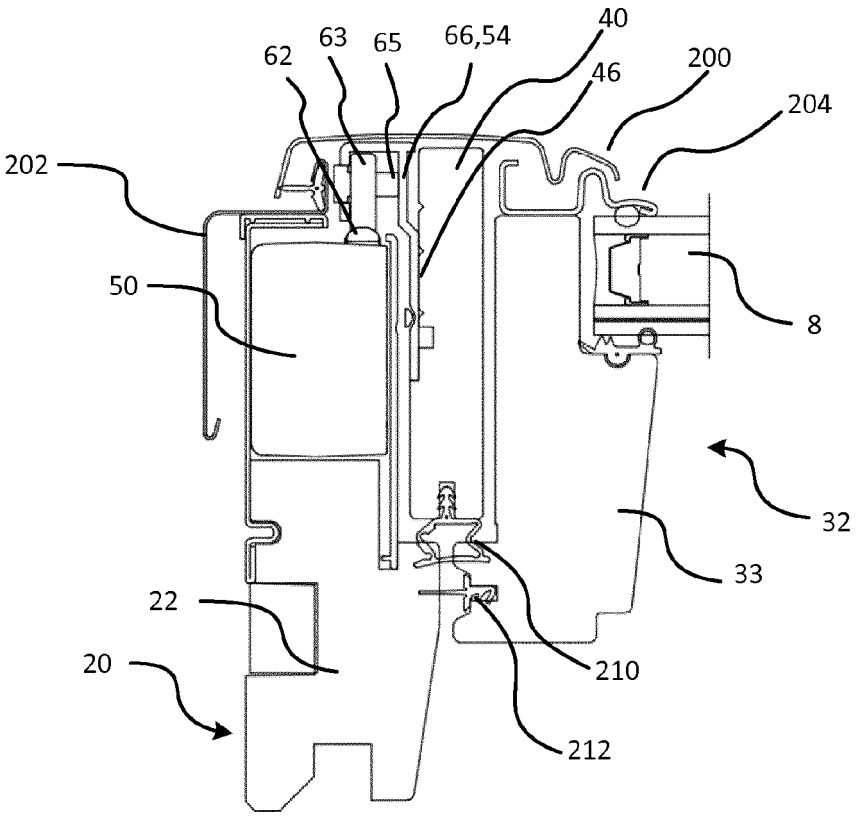
62
63
65
66,54
40
46
200
204
202
50
8
32
33
22
20
210
212

FIG. 6

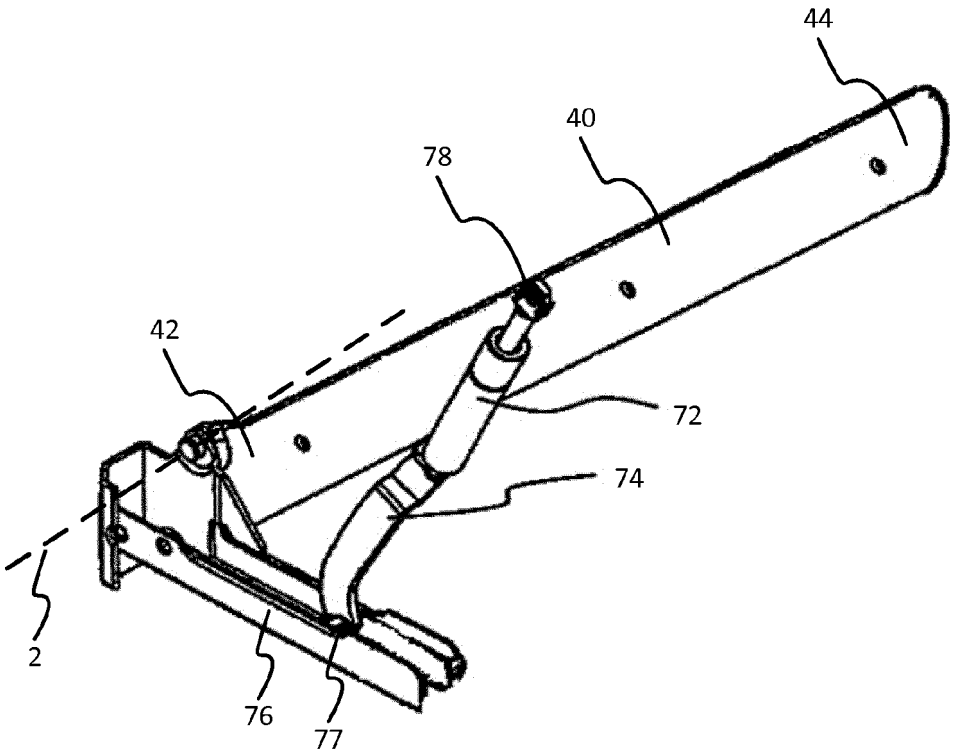
44
40
78
42
72
74
2
76
77

FIG. 7

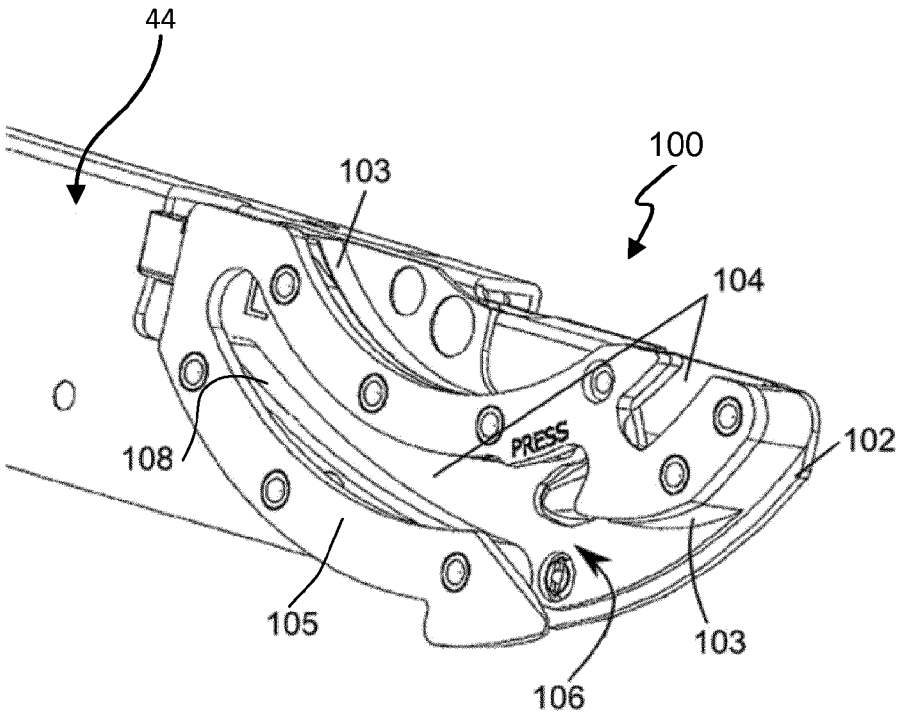
44
100
103
104
108
PRESS
102
105
103
106

FIG. 8

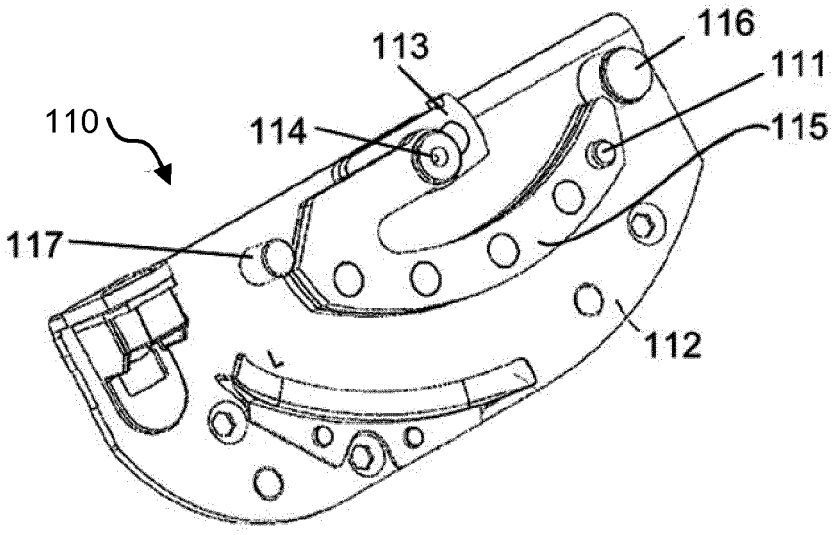
116
113
111
110
114
115
117
112

FIG. 9

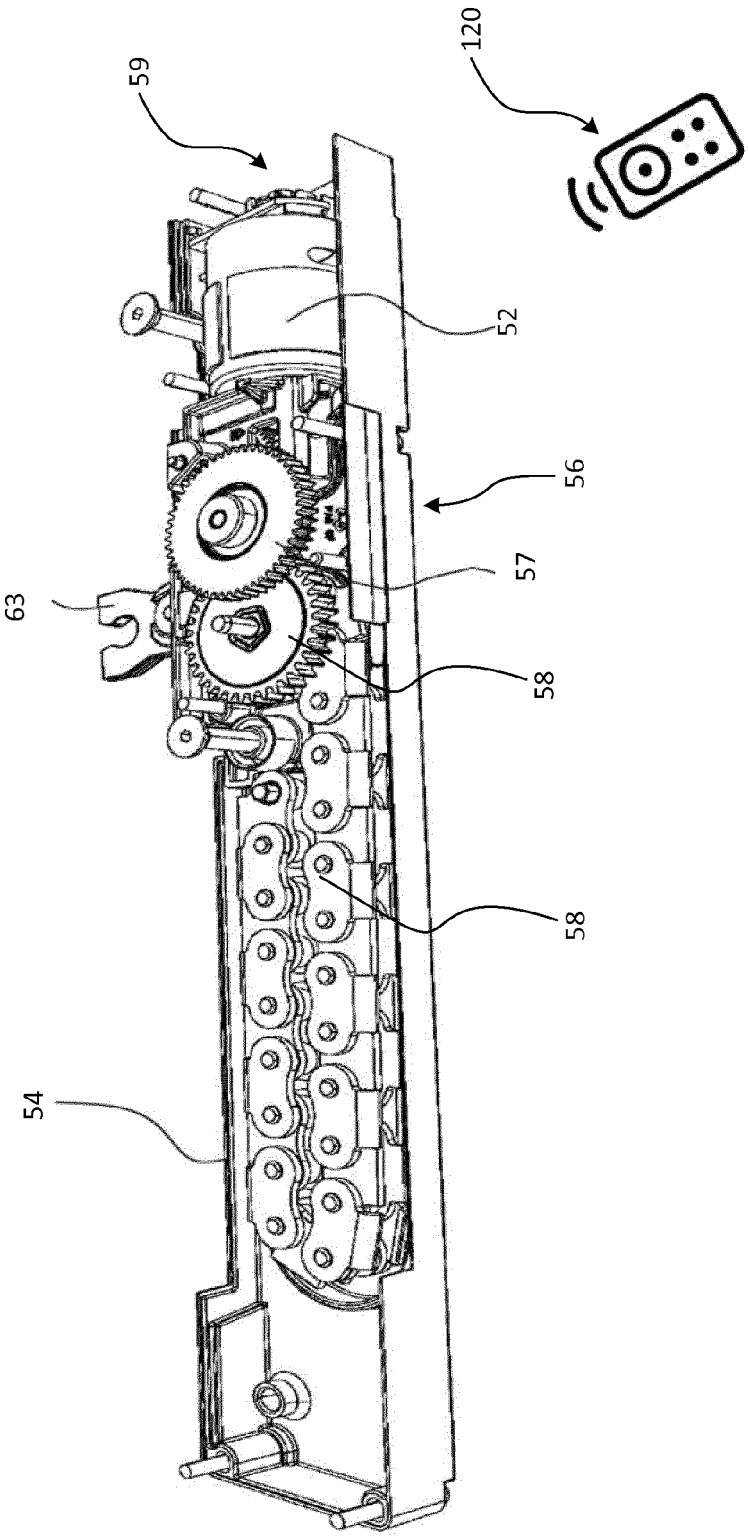

FIG. 10

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EUROPEAN SEARCH REPORT

Application Number
EP 17 21 0612

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	EP 2 924 209 A1 (VKR HOLDING AS [DK]) 30 September 2015 (2015-09-30) * paragraph [0032] - paragraph [0033] * * paragraph [0035] * * paragraph [0038] - paragraph [0039] * * figures 1-7 * -----	1-10, 12-15 11	INV. E05D15/04 E05F15/619
X	EP 2 143 864 A1 (ROTO FRANK AG [DE]) 13 January 2010 (2010-01-13) * paragraph [0019] * * paragraph [0022] * * paragraph [0033] - paragraph [0037] * * figures 4-7 * -----	1,3-6, 8-10,14, 15	
Y	EP 3 235 991 A1 (VKR HOLDING AS [DK]) 25 October 2017 (2017-10-25) * column 4, line 26 - line 27 * * figure 2 * -----	11	

TECHNICAL FIELDS SEARCHED (IPC)

E05D
E05F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	12 June 2018	Prieto, Daniel

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12-06-2018

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2924209 A1	30-09-2015	EP 2924209 A1	30-09-2015
		EP 3239439 A1	01-11-2017
EP 2143864 A1	13-01-2010	AT 503905 T	15-04-2011
		DK 2143864 T3	25-07-2011
		EP 2143864 A1	13-01-2010
EP 3235991 A1	25-10-2017	EP 3235991 A1	25-10-2017
		EP 3235992 A1	25-10-2017
		EP 3235993 A1	25-10-2017

EPO FORM P0459

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Patent documents cited in the description

- WO 0231304 A1 **[0003]**