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(54) **AUTOMATED WINDOW FOR INSTALLATION IN AN INCLINED ROOF**

(57) A roof window (1) adapted for being installed in an inclined roof, the window (1) comprising a window frame (2) in which an upper window sash (3) and a lower window sash (4) are installed. The roof window (1) further comprises two collapsible side railings (6), each side railing (6) being connected to a window frame side member (2c, 2d) and a lower window sash side member (4c, 4d) . The side railings (6) are collapsed when the lower window sash (4) is in a closed position and extended when the lower window sash (4) is in an open position. The roof window (1) further comprises at least one electrically driven lower actuator (10), comprising an electric drive motor (11), arranged to pivot the lower window sash (4) between the open and closed positions. The lower actuator (10) further comprises a first actuator part (10a) and a second actuator part (10b), at least one of the actuator parts (10a, 10b) extending in parallel with the window frame side member (2c, 2d) when the lower window sash (4) is in the open position, and the first and second actuator parts (10a, 10b) extending in parallel with the window frame side member (2c, 2d) when the lower window sash (4) is in the closed position.

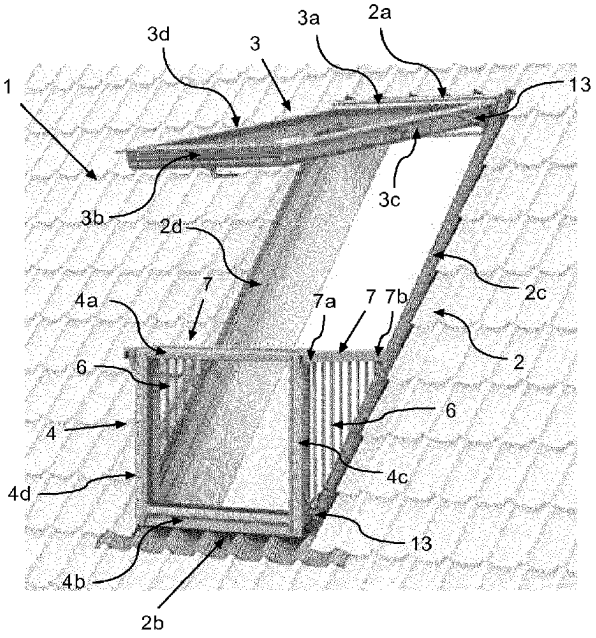


Fig. 1

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## Description

### TECHNICAL FIELD

**[0001]** The disclosure relates to a window adapted for being installed in an inclined roof. The window comprises a window frame in which a top-hinged upper window sash and a bottom-hinged lower window sash are installed. The window further comprises collapsible side railings connected to the window frame and the lower window sash. The side railings are collapsed when the lower window sash is in the closed position and extended when the lower window sash is in the open position.

### BACKGROUND

**[0002]** Over the years, few houses were built with roof windows since the volume directly underneath the roof, the attic, usually was to be used for storage or not at all. Today, however, due to e.g. a severe lack of housing, attic spaces are often rebuilt into functional homes or offices. When rebuilding, roof windows of different variants are usually installed. It may also be desirable to provide the new home or office with a balcony. Adding a traditional balcony to an existing building is an expensive and labor intense process, as it requires significant modification of the roof, e.g. affecting the roof trusses.

**[0003]** Balcony roof windows, having a window frame, an upper window sash, and a lower window sash may be a cost effective and labor efficient substitute for a traditional balcony. When installing the frame of a roof window at a sufficiently low height above the floor, the space closest to the roof foot can be used as a balcony when the window sashes are opened outwards. When open, the lower window sash functions as a balcony breast wall, while protective side railings, extending between frame and lower window sash, function as balcony side walls.

**[0004]** EP0518988 discloses such a balcony roof window wherein the side railing is designed such that the window, in a relatively simple manner, can be adapted for being installed in inclined roof surfaces of varying inclinations.

**[0005]** There is a constant need for improving the design of balcony roof window arrangements in order to achieve a balcony roof window which is environmentally friendly in both design and function, and which is easy to operate for everyone, including disabled persons.

### SUMMARY

**[0006]** It is an object to mitigate the above problems, and to provide a window with two easily and efficiently operated window sashes.

**[0007]** The foregoing and other objects are achieved by the features of the independent claim. Further implementation forms are apparent from the dependent claims, the description, and the figures.

**[0008]** According to a first aspect, a roof window is adapted for being installed in an inclined roof, the window comprising a window frame in which a top-hinged upper window sash and a bottom-hinged lower window sash are installed, the window frame comprising a top member, a bottom member, and at least two side members, each window sash comprising a top member, a bottom member, and two side members, the upper window sash being hinged adjacent to the window frame top member by means of at least one hinge mechanism, the lower window sash being hinged adjacent to the window frame bottom member by means of at least one hinge mechanism, each window sash being adapted for pivoting between at least one open position and a closed position, the roof window further comprising two collapsible side railings, each side railing being connected to a window frame side member and a lower window sash side member, the side railings being collapsed when the lower window sash is in the closed position and extended when the lower window sash is in the open position(s), at least one electrically driven lower actuator, comprising an electric drive motor, arranged to pivot the lower window sash between the open and closed positions, the lower actuator comprising a first actuator part and a second actuator part, at least one of the first and second actuator parts extending in parallel with the window frame side member when the lower window sash is in the open position, and the first and second actuator parts extending in parallel with the window frame side member when the lower window sash is in the closed position.

**[0009]** Providing one, or both, sash(es) of a roof window with electrically driven actuators facilitates automatic opening and closing of the window. This is not only a comfortable solution for everyday use, but especially advantageous for persons having difficulties manoeuvring a window manually. It is also an advantage seen from an environmental perspective, since the window can be set to open or close automatically, e.g. preventing the window being left open unintentionally. A further advantage from a safety perspective is automatic closing due to weather conditions such as wind or rain. Since at least one actuator part extends in parallel with window frame side member, this part does not protrude into the interior of the building. Such a solution is not visible from the interior, at least when the window is closed, providing a more aesthetic window.

**[0010]** In one possible implementation form of the first aspect, the roof window further comprises at least one electrically driven upper actuator, comprising an electric drive motor, arranged to pivot the upper window sash between the open and closed positions, allowing both window sashes to be operated automatically.

**[0011]** In one further possible implementation form of the first aspect, each side railing comprises a hand rail extending in parallel with the lower window sash side member when the lower window sash is in the closed position, and extending perpendicular to the lower window sash side member when the lower window sash is in the open position, a first hand rail end being connected

to the lower window sash side member and an opposite second hand rail end being connected to the window frame side member, one of the hand rail ends being slidingly and pivotally connected, and one of the hand rail ends being pivotally connected to the side members, allowing a simple solution for moving the lower window sash, and the side railing, along the window frame.

**[0012]** In one further possible implementation form of the first aspect, the first hand rail end is slidingly and pivotally connected to the lower window sash side member, and the second hand rail end is pivotally connected to the window frame side member, allowing another simple solution for moving the lower window sash, and the side railing, along the window frame.

**[0013]** In one further possible implementation form of the first aspect, the side rail is arranged, at least partially, along an outer side of the window frame side member, providing a window in which the side rail is invisible from the inside.

**[0014]** In one further possible implementation form of the first aspect, the hand rail is arranged such that it is offset past a front face of the window frame, when the lower window sash is in the closed position, allowing the roof window be provided with standard window frame elements since the provision of a hand rail does not affect the external dimensions of the window.

**[0015]** In one further possible implementation form of the first aspect, the lower window sash side member comprises at least one flashing, a part of the flashing covering a gap between the lower window sash side member and an adjacent window frame side member, providing a waterproof seal of the gap towards the interior.

**[0016]** In one further possible implementation form of the first aspect, the hand rail is arranged such that it is offset past a front face of the window frame, when the lower window sash is in the closed position, allowing the provision of a hand rail without affecting the standard width of the window.

**[0017]** In one further possible implementation form of the first aspect, the lower window sash side member comprises at least one flashing, a part of the flashing covering a gap between the lower window sash side member and an adjacent window frame side member such that a water-tight window is provided.

**[0018]** In one further possible implementation form of the first aspect, the hand rail is arranged at least partially in the gap between the lower window sash side member and an adjacent window frame side member, allowing a hand rail which is less visible from the exterior of a building to be provided.

**[0019]** In one further possible implementation form of the first aspect, at least one of the first and second actuator parts is arranged inside the window frame side member, improving the aesthetics of the window and protecting the electric components.

**[0020]** In one further possible implementation form of the first aspect, at least one of the first and second actuator parts extends in parallel with the window frame side member such that the actuator part(s) do(es) not protrude past the external dimensions of the side member in a direction perpendicular to a face of the window frame, when the lower window sash is in the open position. When the actuator does not protrude past the extension of the window frame, there are no parts protruding into the interior of the room when the window sash is in being opened or in the open position.

**[0021]** In one further possible implementation form of the first aspect, the first and second actuator parts extend in parallel with the window frame side member such that the actuator parts do not protrude past the external dimensions of the side member, in a direction perpendicular to a face of the window frame, when the lower window sash is in the closed position. Such a solution is invisible from the interior of the room when the window is closed, providing a more aesthetic window.

**[0022]** In one further possible implementation form of the first aspect, at least one of the hinge mechanisms is integral with the electrically driven upper actuator and/or the electrically driven lower actuator, allowing a hinge mechanism which is invisible as well as reinforced by the actuator.

**[0023]** In one further possible implementation form of the first aspect, the first actuator part is stationary and the second actuator part is moveable. This way, the more stable housing of the actuator may be fixedly and securely attached to the window frame, providing a stable solution.

**[0024]** In one further possible implementation form of the first aspect, the second actuator part is connected to either the lower window sash, which increases the simplicity of the solution, or to the second hand rail end, allowing the actuator to both operate a hand rail lock and pivot the sash, sequentially.

**[0025]** In one further possible implementation form of the first aspect, the lower actuator comprising a spindle actuator. A spindle actuator is a well-tried and reliable solution.

**[0026]** In one further possible implementation form of the first aspect, a linkage mechanism is arranged between the lower window sash and the second actuator part. The use of an intermediate linkage mechanism allows the actuator to connect to any suitable part of the lower window sash, increasing the flexibility of the solution.

**[0027]** In one further possible implementation form of the first aspect, the lower actuator comprises a chain actuator, the first actuator part being an actuator housing. A chain actuator is a highly cost-effective solution which has a strong holding/locking force when the sash is closed.

The above will be apparent from the drawings and the embodiments described below.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0028]** In the following detailed portion of the present

disclosure, the aspects, embodiments, and implementations will be explained in more detail with reference to the example embodiments shown in the drawings, in which:

Fig. 1 shows a schematic perspective view of an embodiment of a roof window according to the present invention, wherein the roof window is in a fully open position.

Fig. 2 shows a schematic side view of the roof window according to Fig. 1, wherein the roof window is in a closed position.

Fig. 3 shows a schematic side view of the roof window according to Figs. 1 and 2, wherein the roof window is in a partially open position.

Fig. 4 shows a schematic side view of the roof window according to Figs. 1 to 3, wherein the roof window is in fully open position.

Fig. 5 shows a further embodiment of a roof window according to the present invention.

Fig. 6 shows a further embodiment of a roof window according to the present invention.

Fig. 7 shows a further embodiment of a roof window according to the present invention.

Fig. 8 shows a further embodiment of a roof window according to the present invention.

Fig. 9 shows a further embodiment of a roof window according to the present invention.

Fig. 10 shows a cross-sectional view of a further embodiment of a roof window according to the present invention.

Fig. 11 shows a cross-sectional view of a further embodiment of a roof window according to the present invention.

## DETAILED DESCRIPTION

**[0029]** Fig. 1 shows a schematic perspective view of a first embodiment of a roof window, wherein the roof window is in a fully open position. Fig. 2 shows the same roof window from the side and in a closed position.

**[0030]** The roof window 1 is a so-called balcony window which is to be installed in an inclined roof. The roof window 1 comprises a window frame 2, which is to be installed in the roof such that the plane of the window frame 2 substantially aligns with the plane of the roof. A top-hinged upper window sash 3 and a bottom-hinged lower window sash 4 are installed in the window frame 2. The window frame 2 comprises a top member 2a, a bottom member 2b, and at least two side members 2c, 2d, each side member extending between the top member and the bottom member. Each window sash 3, 4 comprises a top member 3a, 4a, a bottom member 3b, 4b, and two side members 3c, 3d, 4c, 4d.

**[0031]** Each window frame side member 2c, 2d may comprise an upper side member part 2ca, 2da and a lower side member part 2cb, 2db, the upper side member part 2ca, 2da extending in parallel with the upper window sash 3 and the lower side member part 2cb, 2db extending in parallel with the lower window sash 4, when the upper and lower window sashes 3, 4 are in the closed position. The window frame, in this embodiment, is essentially divided into an upper U-shaped part and a lower U-shaped part.

**[0032]** The top member 3a of the upper window sash 3 is hinged, by means of at least one hinge mechanism 13, adjacent to the top member 2a of the window frame 2a, and the bottom member 4b of the lower window sash 4 is hinged, by means of at least one similar hinge mechanism 13, adjacent to the bottom member 2b of the window frame 2. The window sash top members 3a, 4a, the window frame top member 2a, the window sash bottom members 3b, 4b, and the window frame bottom member 2b, in other words, extend in parallel with each other.

**[0033]** The upper window sash 3 is connected to the window frame 2 such that it can be pivoted between at least one open position, shown in Figs. 1 and 3-9, and a closed position, shown in Fig. 2. The lower window sash 4 is, correspondingly, connected to the window frame 2 such that it can be pivoted between at least one open position, shown in Figs. 1 and 3-9, and a closed position, shown in Fig. 2.

**[0034]** The lower window sash 4 may, simultaneously with the pivoting movement, be moved obliquely downwards from the bottom member 2b of the window frame 2. I.e., the lower window sash 4 is hinged adjacent to the bottom member 2b of the window frame 2 in such a way that the bottom member 4b of the lower window sash 4 is displaced downwards from the bottom member of the window frame 2b and substantially parallel to the plane of the window frame 2, when being opened, while correspondingly being displaced upwards towards the bottom member of the window frame 2b and substantially parallel to the plane of the window frame 2, when being closed. This movement may be achieved by hinging the bottom member 4b of the lower window sash 4, at both sides, to the lower end of a supporting lever which extends in parallel with the window frame side member 2c, 2d. The upper end of the supporting lever is connected to the window frame side members 2c, 2d by means of a pair of pivotal parallelogram joints.

**[0035]** Other pivotal joints may be used as well. Furthermore, the lower window sash 4 may be provided with springs which are compressed by the pivotal joints when the window sash 4 is in the closed position, in order to reduce the force needed to pivot the lower window sash

4 open.

**[0036]** In the closed position, shown in Fig. 2, the upper window sash 3 and the lower window sash 4 are substantially aligned with each other and with the plane of the window frame 2 such that they cover the opening of the window frame 2.

**[0037]** However, there may be some overlap between the upper window sash 3 and the lower window sash 4 in order to keep the window water-tight. In one embodiment, the bottom member 3b of the upper window sash 3 overlaps the top member 4a of the lower window sash 4 when the window sashes 3, 4 are both in the closed position.

**[0038]** Further, the upper window sash 3 may be configured to enter into locking engagement with the window frame 2 when the upper window sash 3 is in the closed position.

**[0039]** In the open position, the upper window sash 3 and the lower window sash 4 may be arranged at acute angles $\alpha$, $\beta$ to the plane of the window frame 2, see for example Fig. 4. The acute angles $\alpha$, $\beta$ are adjustable during installment of the window, such that they can be adjusted to match horizontal and vertical sash positions in relation to the roof slope. The upper window sash 3 may be arranged at a variety of angles $\alpha$, from substantially just over 0°, 0° corresponding to a closed window sash, to an angle where the window sash 3 extends horizontally when installed in a roof, i.e. a balcony position as well as a range of ventilation positions. The lower window sash 4, preferably, only has one open position at an angle $\beta$ where the window sash 4 extends substantially vertically when installed in a roof, i.e. a balcony position. This is due to the fact that the lower window sash 4 functions as a balcony breast wall, wherefore the extension of the lower window sash 4 cannot deviate too much from the vertical plane. The open upper window sash 3 forms a roof which partly covers the balcony formed by the lower window sash 4 being opened outwards.

**[0040]** The roof window 1 is further provided with two collapsible side railings 6. Each side railing 6 is connected to a window frame side member 2c, 2d and a lower window sash 4 side member 4c, 4d, such that it, in the open position, extends between the window frame 2 and the lower window sash 4 and functions as balcony side walls. The side railings 6 are collapsible such that they fold into, or onto, the window frame 2 when the lower window sash 4 is in the closed position, and extend when the lower window sash 4 is in the open position. Each side railing 6 comprises a plurality of rods 12 and a hand rail 7.

**[0041]** In one embodiment, the side railing 6 comprises a hand rail 7 with a first hand rail end 7a which is pivotally connected to an upper section of a lower window sash side member 4c, 4d. The opposite, second hand rail end 7b is pivotally and slidably connected to the window frame side member 2c, 2d.

**[0042]** When the lower window sash 4 is moved from the open position to the closed position, the hand rail 7 is collapsed such that the first hand rail end 7a pivots on the lower window sash side member 4c, 4d, while the second hand rail end 7b pivots on, and slides along, the window frame side member 2c, 2d in a direction from the lower window sash 3, see Figs. 3 and 4.

**[0043]** In a further embodiment, the first hand rail end 7a is pivotally and slidably connected to the window sash side member 4c, 4d, while the second hand rail end 7b is pivotably connected to the window frame side member 2c, 2d. This is illustrated, schematically, in Fig. 5. When the lower window sash 4 is moved from the open position to the closed position, the hand rail 7 is collapsed such that the first hand rail end 7a both pivots on, and slides along, the lower window sash side member 4c, 4d in a direction towards the lower window sash bottom member 4b, while the second hand rail end 7b pivots on the window frame side member 2c, 2d.

**[0044]** The hand rail 7 extends substantially perpendicular to the plane of the lower window sash 4, i.e. perpendicular to the lower window sash side member 4c, 4d, when the lower window sash 4 is in the open position, i.e. horizontally when installed in a roof, as shown in Figs. 4-9. The hand rail 7 extends in parallel with the lower window sash side member 4c, 4d when the lower window sash 4 is in the closed position.

**[0045]** As mentioned above, as the lower window sash 4 moves from the open position to the closed position, in one embodiment, the second hand rail end 7b slides along the window frame side member 2c, 2d in a direction from the lower window sash 3, see Figs. 3 and 4, such that it eventually extends along and aligns with the window frame side member 2c, 2d, see Fig. 2. In a further embodiment, the first hand rail end 7a slides along the lower window sash side member 4c, 4d in a direction towards the lower window sash bottom member 4b, see Fig. 5.

**[0046]** The hand rail 7 is also connected to vertical rail bars 12 which, when moving the lower window sash 4 to its closed position, are folded from their vertical position into, or onto, the window frame 2 together with the hand rail 7, such that they also extend along and align with the window frame side member 2c, 2d. One end of the vertical rail bar is pivotally connected to the hand rail 7 and the other end is adapted for sliding freely along the window frame side member 2c, 2d.

**[0047]** The lower window sash side member 4c, 4d may comprise at least one flashing 5, a part of the flashing 5 covering the gap between the lower window sash side member 4c, 4d and the adjacent window frame side member 2c, 2d. In one embodiment, the flashing 5 extends, at least partially, between the hand rail 7 and the lower window sash side member 4c, 4d. In a further embodiment, the flashing is arranged to at least partially cover the hand rail 7.

**[0048]** In one embodiment, shown in Fig. 10, the side rail 6, including the hand rail 7, is arranged along an outer side of the window frame side member 2c, 2d such that the side rail 6 extends, substantially, in parallel with the window frame side member 2c, 2d when the lower win-

dow sash is in the closed position. In a further embodiment, shown in Fig. 11, the side rail 6, is arranged at least partially in the gap between the lower window sash side member 4c, 4d and the adjacent window frame side member 2c, 2d, i.e. along an inner side of the window frame side member 2c, 2d such that the side rail 6 extends, substantially, in parallel with the window frame side member 2c, 2d when the lower window sash is in the closed position.

**[0049]** The outer side of the window frame side member 2c, 2d is the side which is the farthest away from the opposite window frame side member 2d, 2c, i.e., the side which is directed towards the roof into which the roof window 1 is mounted. Correspondingly, the inner side if the window frame side member 2c, 2d is the side which faces the inner side of the opposite window frame side member 2d, 2c, and which is directed towards the window sash 3, 4.

**[0050]** Similarly, the front face F of the window frame 2 is the face which is directed towards the exterior of a building, when the roof window 1 is mounted in the roof of the building, i.e. the front face F comprises the front sides of the window frame top, bottom, and side members 2a, 2b, 2c, 2d. The rear face R of the window frame is the face which is which is directed towards the interior of the building, when the roof window 1 is mounted in the roof of the building, i.e. the rear face R comprises the rear sides of the window frame top, bottom, and side members 2a, 2b, 2c, 2d.

**[0051]** In one embodiment, shown in Fig. 10, the hand rail 7 of the side railing 6 is arranged such that it is offset to protrude past the front face of the window frame 2, towards the exterior of a building when mounted in the roof of the building, when the lower window sash 4 is in the closed position. In a further embodiment, the hand rail 7 is arranged such that it does not protrude past the front face of the window frame 2, when the lower window sash 4 is in the closed position.

**[0052]** The roof window 1 further comprises at least one electrically driven lower actuator 10, which comprises an electric drive motor 11, and which is adapted for pivoting the lower window sash 4 between open and closed positions. In one embodiment, the roof window 1 also comprises at least one electrically driven upper actuator 9, comprising an electric drive motor 11, and which is adapted for pivoting the upper window sash 3 between open and closed positions. In a further embodiment, the window is provided with one upper actuator 9 and one lower actuator 10 per side. Both the upper actuator 9 and the lower actuator 10 are associated with the window frame 2, preferably a side member 2c, 2d.

**[0053]** At least one of the above-mentioned hinge mechanisms 13 may be integral with the electrically driven upper actuator 9 and/or the electrically driven lower actuator 10. The hinge mechanism 13 may be located within the structural housing of the upper or lower actuator 9, 10.

**[0054]** The lower actuator 10 may be arranged at least partially within the window frame side member 2c, 2d, or along an outer side of the window frame side member 2c, 2d. When the lower actuator 10 is arranged such that it extends along the outer side of the window frame side member 2c, 2d, the hand rail 7 and/or the flashing 5 may be arranged above the lower actuator 10, such that the flashing extends between the hand rail 7 and the lower actuator 10.

**[0055]** In one embodiment, the lower actuator 10 is arranged next to the sash side member 4c, 4d in a side-by-side relationship so the sash side member 4c, 4d and the lower actuator 10 are substantially in the same plane.

**[0056]** In a further embodiment, the lower actuator 10 is arranged at least partially between the window frame side member 2c, 2d and a part of the flashing 5.

**[0057]** The electrically driven lower actuator 10 comprises a first actuator part 10a and a second actuator part 10b. Correspondingly, the electrically driven upper actuator 9 comprises a first actuator part 9a and a second actuator part 9b. At least one of the actuator parts 9a, 9b, 10a, 10b extends in parallel with the window frame side member 2c, 2d when the upper 3 and/or lower 4 window sash is in the open position. Furthermore, both the first actuator part 9a, 10a and the second actuator part 9b, 10b extend in parallel with the window frame side member 2c, 2d when the lower window sash 4 is in the closed position, i.e. do not protrude from the plane of the window frame 2. In one embodiment, at least one of the first actuator parts 9a, 10a and the second actuator parts 9b, 10b is arranged inside the window frame side member 2c, 2d. By "inside the window frame" is understood that the actuators may be hidden by profiles, covers, or flashings.

**[0058]** The second actuator part 9b, 10b cooperates with the first actuator part 9a, 10a. Preferably, the first actuator part 9a, 10a is arranged to be substantially stationary such that it is not moved along the window frame side members 2c, 2d, while the second actuator part 9b, 10b is moveable either along the window frame side members 2c, 2d or in other directions to and from the plane of the window frame 2.

**[0059]** The second actuator part 10b of the electrically driven lower actuator 10 is connected to either the lower window sash 4 or to the second hand rail end 7b. The connection may be made through a bracket, a chain, a link, and/or a hinge.

**[0060]** In one embodiment, at least one of the first and second actuator parts 10a, 10b extends in parallel with the window frame side member 2c, 2d such that the actuator part 10a, 10b doesn't protrude past the external dimensions of the side member 2c, 2d in a direction d perpendicular to a face of the window frame 2, when the lower window sash 4 is in the open position, see Fig. 10. The external dimensions of the window frame side member 2c, 2d are the outer dimensions which delimit the above-mentioned front face, rear face, inner side, and outer side or the window frame side member 2c, 2d.

**[0061]** In a further embodiment, both the first and sec-

ond actuator parts 10a, 10b extend in parallel with the window frame side member 2c, 2d such that the first and the second actuator part 10a, 10b do not protrude past the external dimensions of the side member 2c, 2d, in a direction d perpendicular to the face of the window frame 2, when the lower window sash 4 is in the closed position.

**[0062]** The lower window sash 4 may be maintained in its open position either by means of the self-locking effect of the lower actuator 10, or by means of a lock. The lock may be arranged in connection with a sliding hand rail end, e.g. a hand rail end 7b which is slidably connected to the window frame side member 2c, 2d, or a hand rail end 7a which is slidably connected to the window sash side member 4c, 4d. The lock is configured to lock the side railing 6/hand rail 7 in position when the lower window sash 4 is in the open position and the side rail 6 is extended, as shown in Figs. 4 to 9. The lock may be active or passive, and configured to be released by a controller. A passive lock can be engaged and/or released by the second actuator part 9b, 10b, e.g. by guiding a pin in a groove with a locking path toward the end. An active lock can be engaged and/or released by a discrete electric means such as a magnet, a solenoid, or a small motor. Such electric means are preferably arranged on the window frame side member 2c, 2d. The lock may further be configured for manual override such that a person can, at least, release the lock without the use of electricity, e.g. by means of a lever or a pin.

**[0063]** The upper actuator 9 and the lower actuator 10 may each comprise an electric drive motor 11, operated by an electronic control unit. The electric drive motor has a feedback signal which establishes the position of the actuator. The actuators 9, 10 are operated independently of each other, allowing not only both window sashes 3, 4 to be opened or closed substantially simultaneously, but also the upper window sash to be opened on its own, or correspondingly, the lower window sash to be closed on its own.

**[0064]** As mentioned above, the upper window sash 3 may overlap the lower window sash 4 when in the closed position. Therefore, the actuators 9, 10 have to operate such that the upper window sash 3 starts opening slightly before the lower window sash 4, and such that the lower window sash 4 arrives at the closed position slightly before the upper window sash 3. The electronic control unit is configured to initiate the pivoting movement of the upper window sash 3 from the closed position to the open position prior to initiating the pivoting movement of the lower window sash 4 from the closed position to said open position.

**[0065]** Correspondingly, the electronic control unit is configured to initiate the pivoting movement of the lower window sash 4 from the open position to the closed position in relation to initiating the pivoting movement of the upper window sash 3 from the open position to the closed position in such a way that the lower window sash 4 arrives at its closed position before the upper window sash 3 arrives at its closed position.

**[0066]** In one embodiment, the electronic control unit is configured to initiate the pivoting movement of the lower window sash 4 from the open position to the closed position prior to initiating the pivoting movement of the upper window sash 3 from the open position to the closed position, and the lower window sash 4 and the upper window sash 3 are moved at substantially equal speed.

**[0067]** In a further embodiment, the electronic control unit is configured to simultaneously initiate the pivoting movement of the lower window sash 4 from the open position to the closed position and the pivoting movement of the upper window sash 3 from the open position to the closed position, while moving the lower window sash 4 to the closed position at a higher speed than the upper window sash 3.

**[0068]** In one embodiment, the actuators 9, 10 are configured to automatically disengage the upper window sash 3 and/or the lower window sash 4 when the window sash 3, 4 is moved manually, e.g. by means of manually releasable couplings. In other embodiments, the actuators 9, 10 are not self-locking and can therefore be moved whenever the window sash 3, 4 is moved by manual force.

**[0069]** In some embodiments, see Figs. 6 and 8, the lower actuator 10 of the lower window sash 4 is a linear actuator, preferably a spindle actuator. A spindle actuator operated sash may have a dead extreme position, since the spindle force is low when the sash is in the closed position. Hence, a ramp guide may be employed to aid the sash movement at an almost closed position, i.e. to push the spindle away from the dead extreme position. Such a ramp guide may be operated by the same spindle actuator.

**[0070]** The first actuator part 10a and the second actuator part 10b, shown in Fig. 6, both extend along the window frame side member 2c, 2d, in the longitudinal direction of the frame side member 2c, 2d, and are both substantially parallel with the inner and outer sides of the window frame side members 2c, 2d, regardless of the position of the lower window sash 4.

**[0071]** The first actuator part 10a is secured to a side member 2c, 2d of the window frame 2, while the second actuator part 10b is slidingly connected to the first actuator part 10a. Further, one end of the second actuator part 10b is pivotally connected to the second hand rail end 7b.

**[0072]** In the open position, the major part of the second actuator part 10b is arranged within the first actuator part 10a. When moving the lower window sash 4 from the open position to the closed position, the second actuator part 10b is pushed outwards from within the first actuator part 10a, in a direction towards the top member 2a of the window frame 2. Subsequently, the second hand rail end 7b is moved in the same direction. The movement of the hand rail 7 causes the lower window sash 3 to pivot inwards towards the plane of the window frame 2, and the side railing 6 is folded into the window frame 2 such that it, eventually, is aligned with the plane

of the window frame 2, as shown in Fig. 2.

**[0073]** In the closed position, the major part of the second actuator part 10b extends from the first actuator part 10a. When moving the lower window sash 4 from the closed position to the open position, the second actuator part 10b is pulled inwards towards the interior of the first actuator part 10a, in a direction towards the bottom member 2b of the window frame 2. Subsequently, the second hand rail end 7b is moved in the same direction. The movement of the hand rail 7 causes the lower window sash 3 to pivot outwards from the plane of the window frame 2, and the side railing 6 is extended such that the hand rail 7 eventually extends perpendicular to the lower window sash 4, i.e. horizontally when installed in a roof.

**[0074]** In a further embodiment, shown in Fig. 7, the lower actuator 10 of the lower window sash 4 is a chain actuator, also referred to as a push-pull chain actuator.

**[0075]** The first actuator part 10a extends along the window frame side member 2c, 2d, and is aligned with the plane of the window frame 2 regardless of the position of the lower window sash 4.

**[0076]** The first actuator part 10a, a housing, is fixed to a side member 2c, 2d of the window frame 2 and extends along the window frame side member 2c, 2d, in the longitudinal direction of the frame side member 2c, 2d. One end of the second actuator part 10b, i.e. the chain, is connected to the interior of the first actuator part/housing 10a. The other end of the second actuator part/chain 10b is connected to the lower window sash 4.

**[0077]** In the open position, the main part of the second actuator part/chain 10b is pushed out of the first actuator part/housing 10a. When moving the lower window sash 4 from the open position to the closed position, the second actuator part/chain 10b is pulled into the interior of the first actuator part/housing 10a, in a direction towards the side member 2c, 2d of the window frame 2. The movement of the second actuator part/chain 10b causes the lower window sash 3 to pivot inwards towards the plane of the window frame 2, Subsequently, the second hand rail end 7b is moved in the same direction. The entire side railing 6 is turned/folded into the window frame 2 such that it is eventually aligned with the plane of the window frame 2, as shown in Fig. 2.

**[0078]** In the closed position, the main part of the second actuator part, i.e. the chain 10b, is pulled into the first actuator part/housing 10a. The chain 10b is stored in a magazine inside the housing 10a and extends in parallel with the housing, possibly folded in multiple layers. When moving the lower window sash 4 from the closed position to the open position, the second actuator part/chain 10b is pushed outwards from the interior of the first actuator part/housing 10a, in a direction substantially perpendicular to plane of the window frame 2. The movement of the lower window sash 4 causes the hand rail end 7b to move in a direction towards the bottom member 2b of the window frame 2, and the side railing 6 is extended such that the hand rail 7 eventually extends perpendicular to the lower window sash 4, i.e. horizontally when installed in a roof.

**[0079]** In an additional embodiment, shown in Fig. 8, the lower actuator 10 of the lower window sash 4 is a linear actuator, preferably a spindle actuator. The first actuator part 10a and the second actuator part 10b both extend along the window frame side member 2c, 2d, and are both aligned with the plane of the window frame 2 regardless of the position of the lower window sash 4.

**[0080]** The first actuator part 10a is fixed to a side member 2c, 2d of the window frame 2, while the second actuator part 10b is slidingly connected to the first actuator part 10a. One end of the second actuator part is connected to the lower window sash 4 by means of a linkage mechanism 8 arranged between the lower window sash 4 and an end of the second actuator part 10b. The linkage mechanism 8 may provide both a pivot and a translatory displacement, such that when the lower window sash 4 is pivoted from the closed position to the open vertical position, its bottom may be displaced simultaneously. In other words, the pivot axis is translatorily displaced during the opening movement. This is, i.a., due to the water drain design of roof windows and a desire for better use of space. Such linkage mechanisms 8 may, e.g., be provided in the form of a scissor linkage, a parallelogram linkage mechanism, or a pivot hinge. Furthermore, the linkage mechanism may be provided with an arm slide whereby the pivot axis is displaced by the arm. The movable actuator part 10b may act directly on the linkage mechanism 8 to open and close the lower window sash 4. The movable actuator part 10b may alternatively act on the lower sash 4. The linkage mechanism 8 disclosed in this embodiment is compatible with all other embodiments. Optionally, an actuator and/or spring acts on the linkage mechanism 8.

**[0081]** In the open position, the major part of the second actuator part 10b is pushed out of the first actuator part 10a towards an end stop defined during window installation. When moving the lower window sash 4 from the open position to the closed position, the second actuator part 10b is pulled towards the interior of the first actuator part 10a, in a direction towards the top member 2a of the window frame 2. The movement of the linkage mechanism 8 causes the lower window sash 3 to pivot inwards towards the plane of the window frame 2, Subsequently, the second hand rail end 7b is moved in the same direction. The entire side railing 6 is turned/folded into the window frame 2 such that it is substantially aligned with the plane of the window frame 2, as shown in Fig. 2.

**[0082]** In the closed position, the main part of the second actuator part 10b is pulled into the first actuator part 10a towards the end stop. When moving the lower window sash 4 from the closed position to the open position, the second actuator part 10b is pushed outwards from the interior of the first actuator part 10a, in a direction towards the bottom member 2b of the window frame 2. The movement of the lower window sash 4 causes the hand rail end 7b to move in the same direction, and the

side railing 6 is extended such that the hand rail 7 eventually extends perpendicular to the lower window sash 4, i.e. horizontally when installed in a roof.

**[0083]** In yet another embodiment, shown in Fig. 9, the lower actuator 10 of the lower window sash 4 is combination of a pull actuator and a push actuator. The first actuator part 10a of said lower actuator 10 is a pull actuator comprising a wire and a windup mechanism. The second actuator part 10b of said lower actuator 10 is a push actuator comprising a resilient mechanism such as e.g. a gas spring.

**[0084]** The first actuator part/wire and windup 10a is connected to both a window frame side member 2c, 2d and to a second hand rail end 7b. One end of the second actuator part/resilient mechanism 10b is pivotally connected to a window frame side member 2c, 2d and the other end of the second actuator part/resilient mechanism 10b is pivotally connected to the lower window sash 4.

**[0085]** The windup is fixedly connected to the window frame side member 2c, 2d, such that it does not move other than rotate around its centre in order to wind up/out the wire. One end of the wire is attached to the windup mechanism, while the other end is attached to the second hand rail end 7b.

**[0086]** The first actuator part/wire and windup 10a of is adapted for only moving the lower window sash 4 from the open position to the closed position. The second actuator part/resilient mechanism 10b is, on the other hand, adapted for only moving the lower window sash 4 from the closed position to the open position. The push actuator 10b and the pull actuator 10a can also be arranged in other ways. For example the push actuator may be provided by the same spring which aids opening the lower sash. Such spring may be connected to the bottom hinge or to the rail. For example the pull actuator needs not be connected to the rail 7, but it may be connected to the lower sash.

**[0087]** In the open position, the wire of the first actuator part 10a is wound out and the second actuator part/resilient means 10b is arranged at an angle to the plane of the window frame 2 so as to push the lower window sash 4 outwards and hold it in open position. When moving the lower window sash 4 from the open position to the closed position, the wire of the first actuator part 10a is wound up onto the windup mechanism of the first actuator part 10a. As the wire is wound up, it pulls the second hand rail end 7b in a direction towards the top member 2a of the window frame 2. The movement of the hand rail 7 causes the lower window sash 3 to pivot inwards towards the plane of the window frame 2, and the side railing 6 is turned/folded into the window frame 2 such that it is substantially aligned with the plane of the window frame 2, as shown in Fig. 2. The pulling force provided by the first actuator part/wire and windup 10a is larger than the pushing force provided by the second actuator part/resilient mechanism 10b, and therefore the second actuator part/resilient mechanism 10b is pressed together and moved to a position where it stores energy and optionally aligns with the plane of the window frame 2.

**[0088]** The first actuator part 10a may be similar to that which is shown in EP2957700. Such an actuator may be operated by means of the previously mentioned electronic control unit, and it is also possible to extend and withdraw manually (e.g. it is not self-locking) due to the wind up drum which is spring loaded and rotated by a one-way clutch motor. The first actuator part 10 may also be a motorised drum that withdraws and winds up the wire.

**[0089]** In the closed position, the wire of the first actuator part 10a is wound up and resting on the windup without applying substantial force to the lower window sash 3. The second actuator part/resilient means 10b is pressed together. When activating the second actuator part/resilient means 10b such that it expands and hence pivots, the lower window sash 4 is moved from the closed position to the open position. The second actuator part/resilient means 10b is preferably activated by means of an electrically releasable lock or by withdrawal of the wire, and moved from its closed position to a position which is at an angle to the plane of the window frame 2. As the second actuator part/resilient means 10b is activated, its push force is applied onto the lower window sash 4 such that the lower window sash 4 is pivoted outwards and thereafter held in open position. As the lower window sash 4 moves, the hand rail end 7b moves in a direction towards the bottom member 2b of the window frame 2. As the hand rail end 7b moves, the wire of the first actuator part 10a is wound out from the windup mechanism of the first actuator part 10a. At the same time, the side railing 6 is extended such that the hand rail 7 eventually extends perpendicular to the lower window sash 4, i.e. horizontally when installed in a roof.

**[0090]** The second actuator part/resilient means 10b acts automatically and moves the lower window sash 4 towards the open position. The second actuator part/resilient means 10b can be closed manually by means of human force or electrically by means of force from the first actuator part 10a, e.g. wire windup.

**[0091]** The various aspects and implementations have been described in conjunction with various embodiments herein. However, other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed subject-matter, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measured cannot be used to advantage.

**[0092]** The reference signs used in the claims shall not be construed as limiting the scope.

## Claims

1. A roof window (1) adapted for being installed in an inclined roof, said window (1) comprising
a window frame (2) in which a top-hinged upper window sash (3) and a bottom-hinged lower window sash (4) are installed, said window frame (2) comprising a top member (2a), a bottom member (2b), and at least two side members (2c, 2d), each window sash (3, 4) comprising a top member (3a, 4a), a bottom member (3b, 4b), and two side members (3c, 3d; 4c, 4d),
said upper window sash (3) being hinged adjacent to said window frame top member (2a) by means of at least one hinge mechanism (13), said lower window sash (4) being hinged adjacent to said window frame bottom member (2b) by means of at least one hinge mechanism (13), each window sash (3, 4) being adapted for pivoting between at least one open position and a closed position,
said roof window (1) further comprising two collapsible side railings (6), each side railing (6) being connected to a window frame side member (2c, 2d) and a lower window sash side member (4c, 4d), said side railings (6) being collapsed when said lower window sash (4) is in said closed position and extended when said lower window sash (4) is in said open position(s), at least one electrically driven lower actuator (10), comprising an electric drive motor (11), arranged to pivot said lower window sash (4) between said open and closed positions,
said lower actuator (10) comprising a first actuator part (10a) and a second actuator part (10b), at least one of said first and second actuator parts (10a, 10b) extending in parallel with said window frame side member (2c, 2d) when said lower window sash (4) is in said open position, and
said first and second actuator parts (10a, 10b) extending in parallel with said window frame side member (2c, 2d) when said lower window sash (4) is in said closed position.

2. The roof window (1) according to claim 1, further comprising at least one electrically driven upper actuator (9), comprising an electric drive motor (11), arranged to pivot said upper window sash (3) between said open and closed positions.

3. The roof window (1) according to claim 1 or 2, wherein each side railing (6) comprises a hand rail (7) extending in parallel with said lower window sash side member (4c, 4d) when said lower window sash (4) is in said closed position, and extending perpendicular to said lower window sash side member (4c, 4d) when said lower window sash (4) is in said open position,
a first hand rail end (7a) being connected to said lower window sash side member (4c, 4d) and an opposite second hand rail end (7b) being connected to said window frame side member (2c, 2d), one of said hand rail ends (7a, 7b) being slidingly and pivotally connected, and one of said hand rail ends (7b, 7a) being pivotally connected to said side members (2c, 2d, 4c, 4d).

4. The roof window (1) according to claim 3, wherein said first hand rail end (7a) is slidingly and pivotally connected to said lower window sash side member (4c, 4d), and said second hand rail end (7b) is pivotally connected to said window frame side member (2c, 2d).

5. The roof window (1) according to any one of the previous claims, wherein said side rail (6) is arranged, at least partially, along an outer side of said window frame side member (2c, 2d).

6. The roof window (1) according to claim 5, wherein said hand rail (7) is arranged such that it is offset past a front face of said window frame (2), when said lower window sash (4) is in said closed position.

7. The roof window (1) according to any one of the previous claim, wherein said lower window sash side member (4c, 4d) comprises at least one flashing (5), a part of said flashing (5) covering a gap between said lower window sash side member (4c, 4d) and an adjacent window frame side member (2c, 2d).

8. The roof window (1) according to claim 7, wherein said hand rail (7) is arranged at least partially in said gap between said lower window sash side member (4c, 4d) and an adjacent window frame side member (2c, 2d).

9. The roof window (1) according to claim 7 or 8, wherein said flashing (5) at least partially covers said hand rail (7).

10. The roof window (1) according to claim 7 or 8, wherein said flashing (5) extends at least partially between said hand rail (7) and said window frame (2).

11. The roof window (1) according to any one of the previous claims, wherein at least one of said first and second actuator parts (10a, 10b) is arranged inside said window frame side member (2c, 2d).

12. The roof window (1) according to any one of the previous claims, wherein at least one of said first and second actuator parts (10a, 10b) extends in parallel with said window frame side member (2c, 2d) such that said actuator part(s) (10a, 10b) do(es) not protrude past the external dimensions of said side member (2c, 2d) in a direction (d) perpendicular to a face of said window frame (2), when said lower window

sash (4) is in said open position.

**13.** The roof window (1) according to any one of the previous claims, wherein said first and second actuator parts (10a, 10b) extend in parallel with said window frame side member (2c, 2d) such that said actuator parts (10a, 10b) do not protrude past the external dimensions of said side member (2c, 2d), in a direction (d) perpendicular to a face of said window frame (2), when said lower window sash (4) is in said closed position.

**14.** The roof window (1) according to any one of the previous claims, wherein at least one of said hinge mechanisms (13) is integral with said electrically driven upper actuator (9) and/or said electrically driven lower actuator (10).

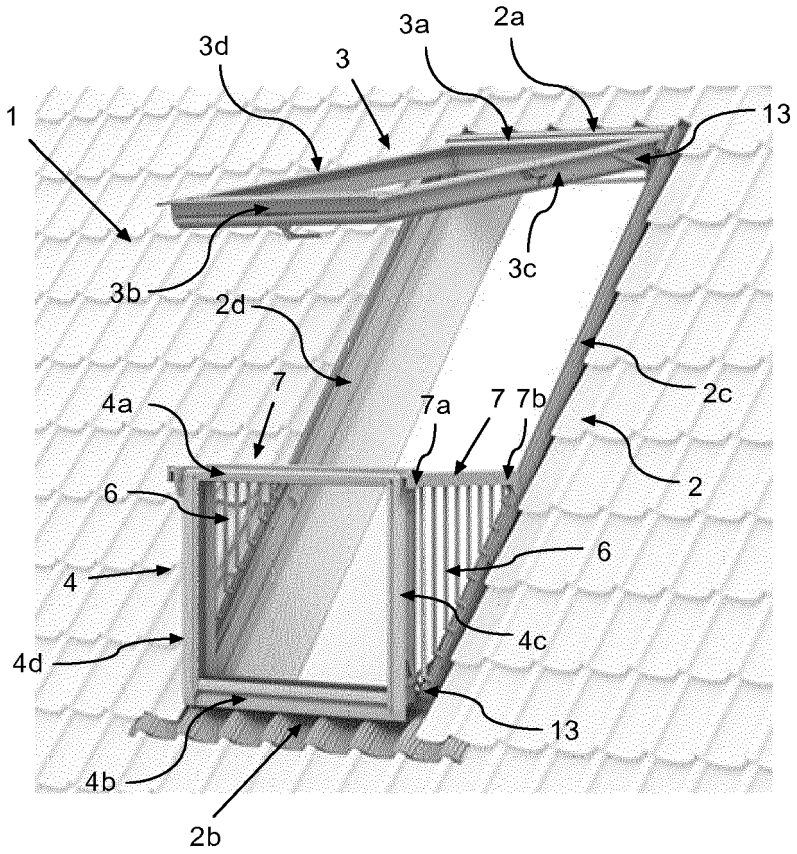
**15.** The roof window (1) according to any one of the previous claims, wherein said first actuator part (10a) is stationary and said second actuator part (10b) is moveable.

**16.** The roof window (1) according to any one of the previous claims, wherein said second actuator part (10b) is connected to either said lower window sash (4) or to said second hand rail end (7b).

**17.** The roof window (1) according to any one of the previous claims, wherein said lower actuator (10) comprises a spindle actuator.

**18.** The roof window (1) according to any one of the previous claims, wherein a linkage mechanism (8) is arranged between said lower window sash (4) and said second actuator part (10b).

**19.** The roof window (1) according to any one of claims 1 to 16, wherein said lower actuator (10) comprises a chain actuator, the first actuator part (10a) being an actuator housing.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3d
3
3a
2a
13
3b
3c
2d
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4
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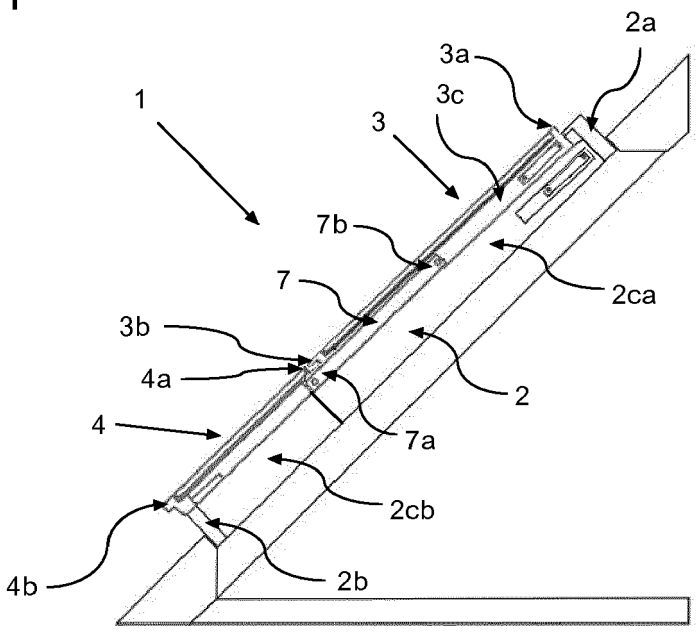
13
4b
2b

Fig. 1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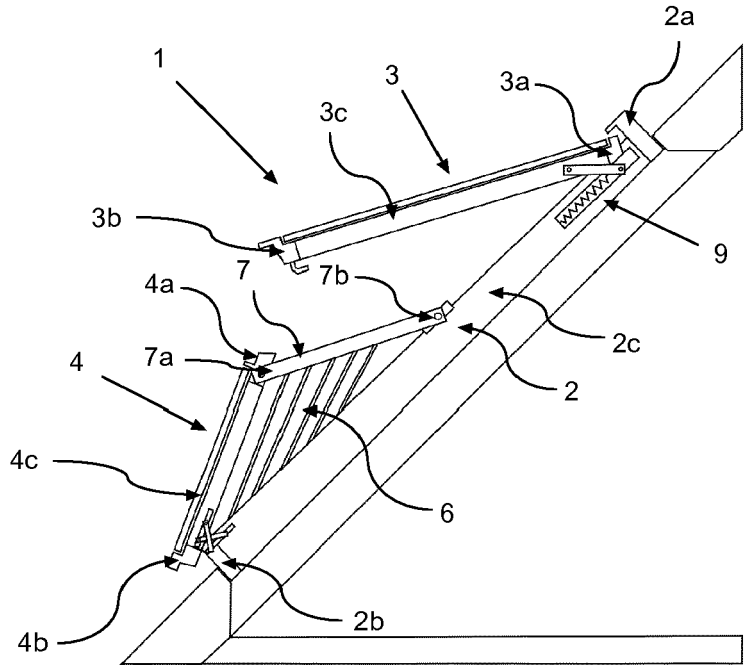
4b
2b

Fig. 2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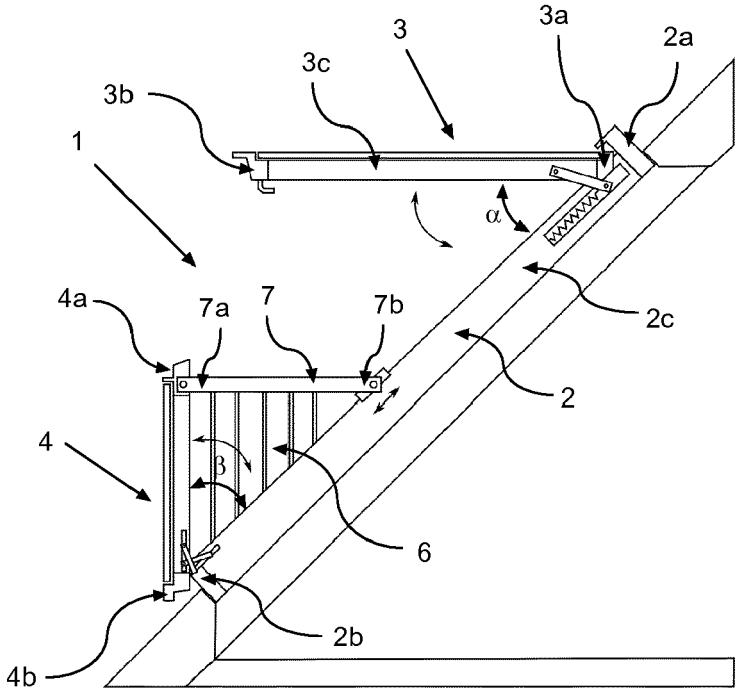
4b

Fig. 3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3a
2a
3c
3b
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α
4a
7a
7
7b
2c
2
4
β
6
2b
4b

Fig. 4

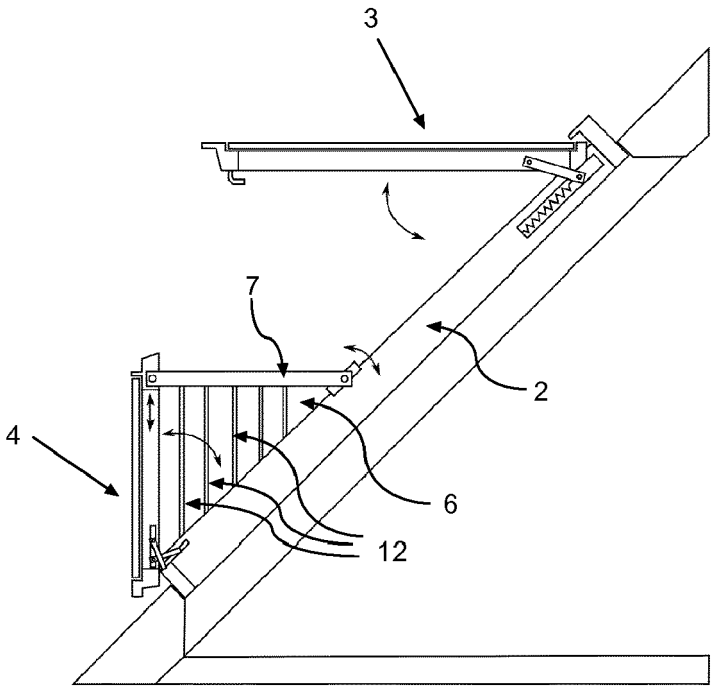


Fig. 5

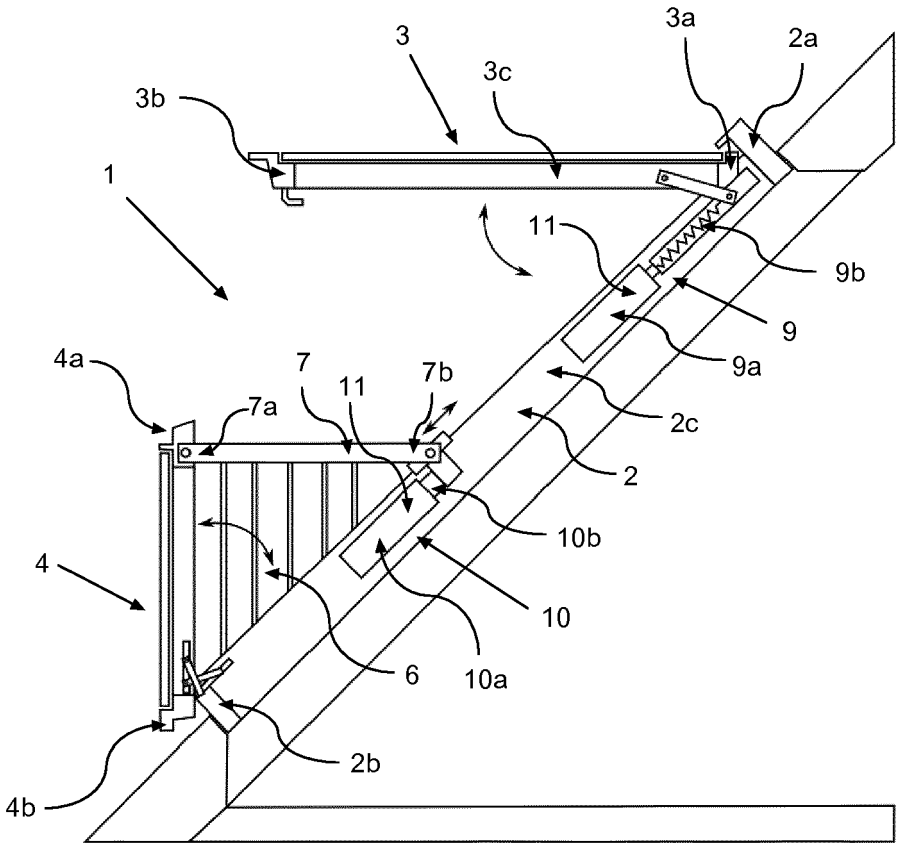


Fig. 6

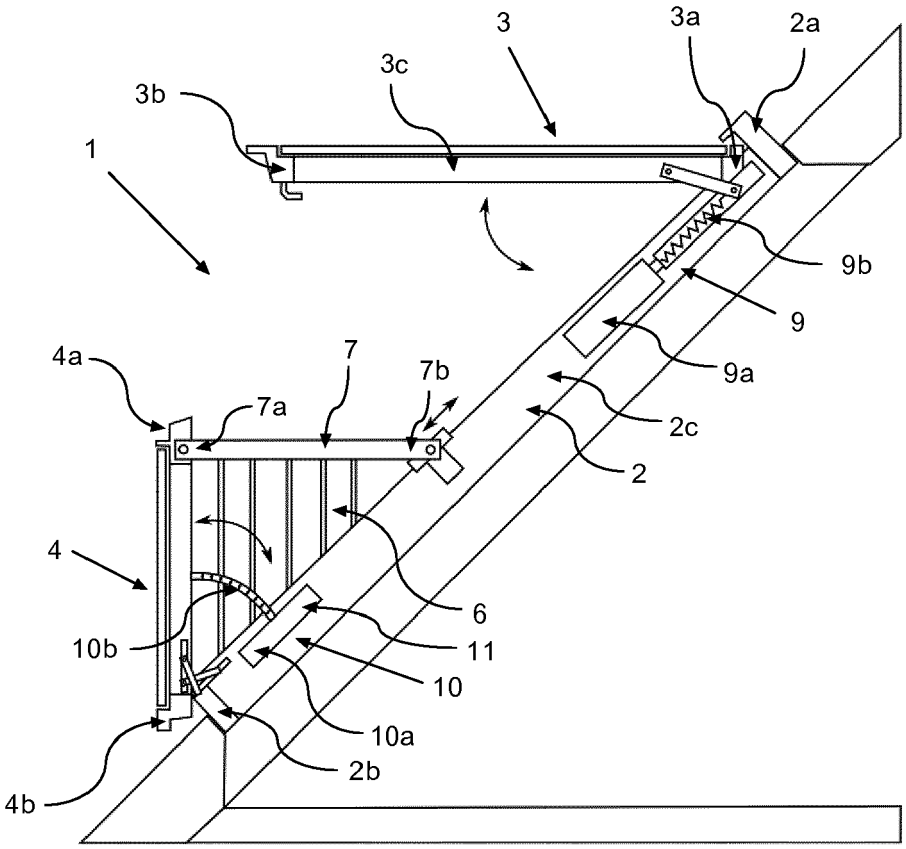


Fig. 7

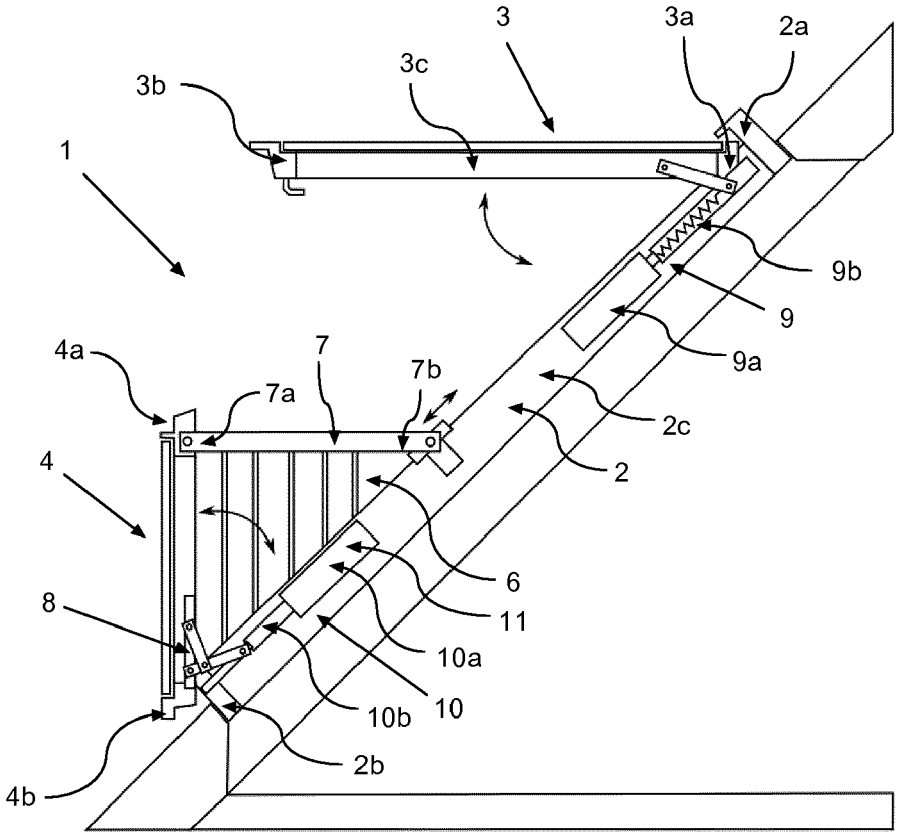


Fig. 8

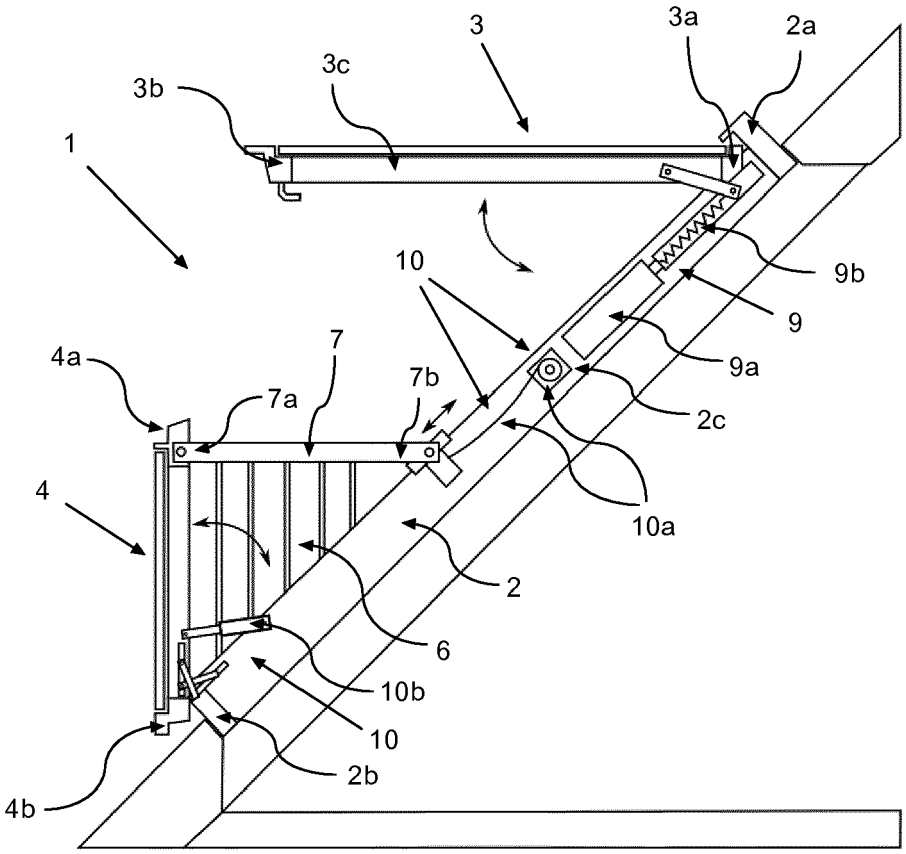


Fig. 9

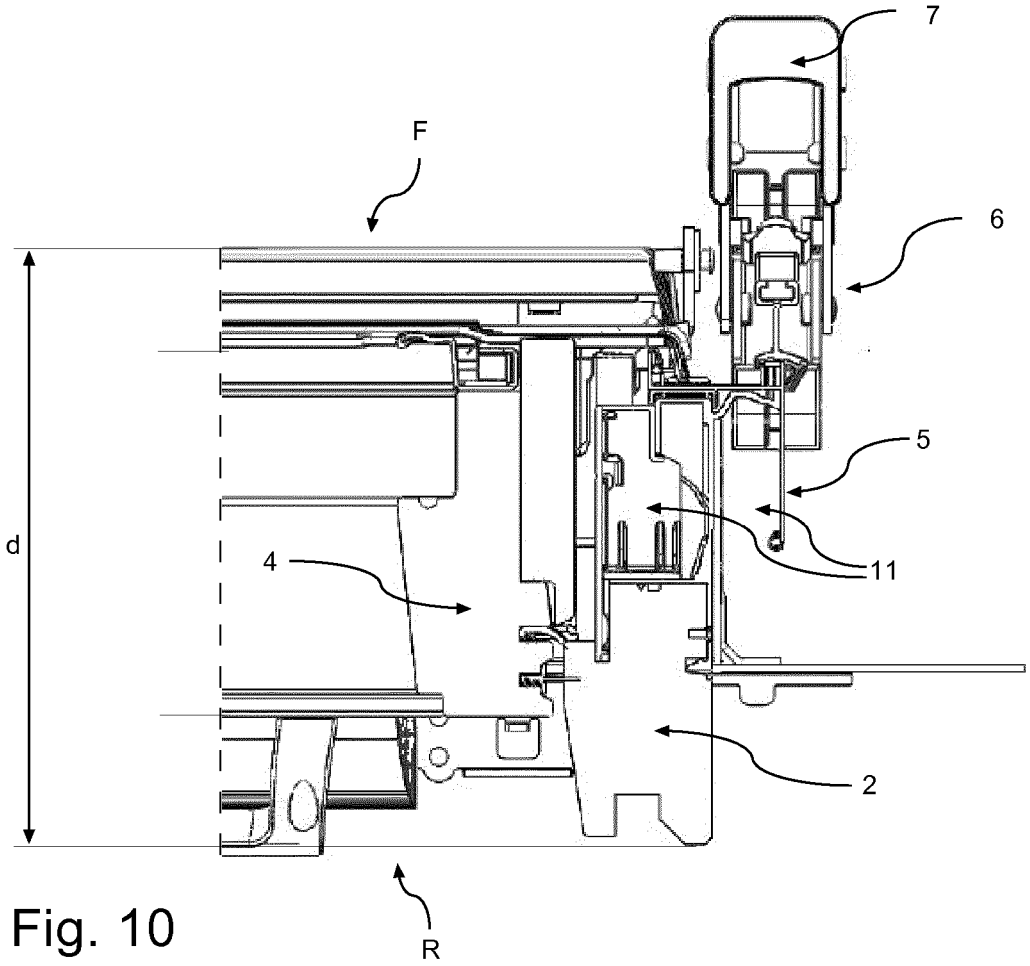


Fig. 10

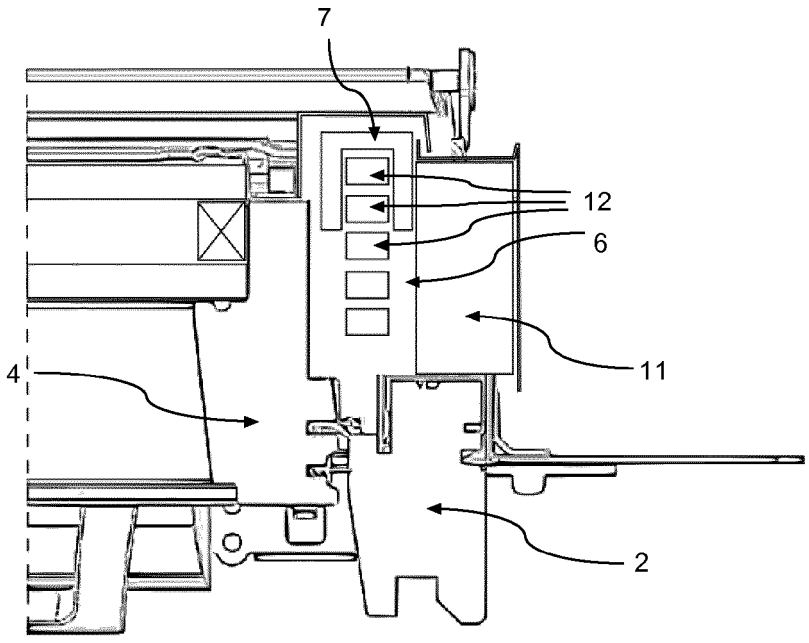


Fig. 11

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# EUROPEAN SEARCH REPORT

Application Number
EP 18 15 0103

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
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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 | Leroux, Corentine |

CATEGORY OF CITED DOCUMENTS

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## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 18 15 0103

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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12-06-2018

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