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(54) ARM ACTUATOR FOR PIVOTING A BUILDING ELEMENT

(57) An arm actuator (1) comprising a suspension arm (4) configured to move a building element (2) and a push-pull chain (5) configured to be operably connected to said suspension arm (4). The push-pull chain (5) can bend freely in a first direction (D1) when subjected to a first force (F1), and bend only to a limited extent in a second direction (D2) when subjected to a second force (F2), said second direction (D2) being opposite to said first direction (D1). A chain support arm (6) is provided, which pivots at least partially simultaneously with said suspension arm (4). The chain support arm (6) is configured to engage and prevent said push-pull chain (5) from bending, in said second direction (D2), past a first bending radius (RI).

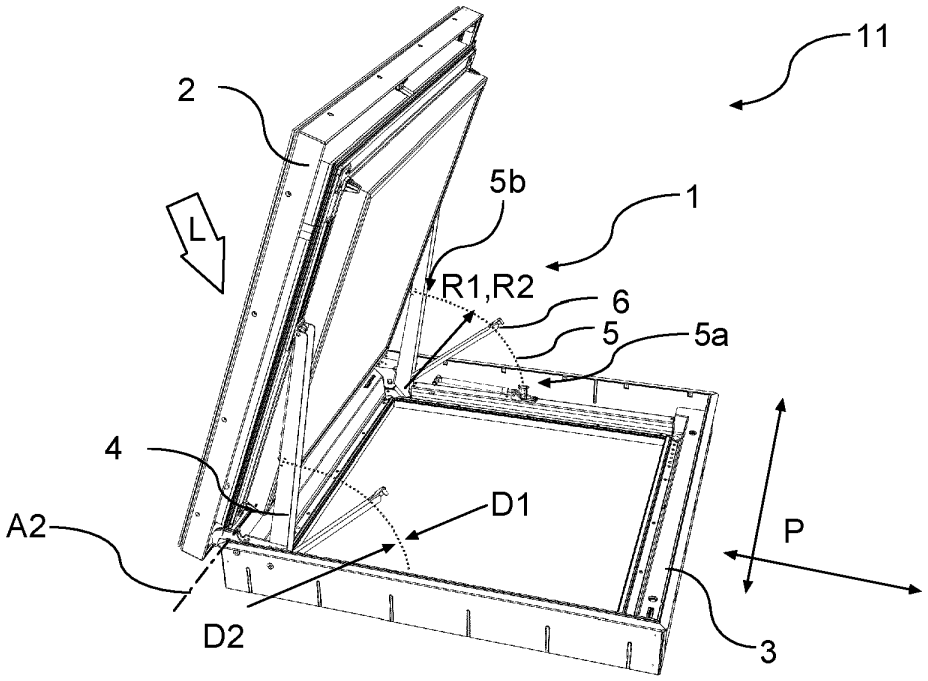

Fig. 1

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Description

TECHNICAL FIELD

[0001] The disclosure relates to an arm actuator for pivoting a building element relative a frame, as well as a building component such as a roof window comprising an arm actuator.

BACKGROUND

[0002] Building elements such as windows, hatches, and doors may be operated fully, or partially, automatically by means of electric actuators. It may be particularly beneficial for roof windows that are both difficult to install and to operate manually due to their placement. The use of electrically operated actuators also allows automatic indoor temperature regulation or automatic closing due to changing weather conditions.

[0003] Some prior art actuators are provided with a so-called push-pull chain extending between a stationary frame and the moveable building element. A push-pull chain is stiff enough to support the building element when extended, yet foldable such that it fits within a compact actuator housing when retracted. Usually, the push-pull chain becomes stiff and stabile by bending the chain beyond a straight line. A further advantage is that this also allows the chain to follow a movement radius of the building element.

[0004] The push-pull chain folds, i.e. collapses and optionally spirals, when subjected to a force in a first direction perpendicular to the longitudinal extension of the push-pull chain, while the chain reaches and maintains a straight configuration, or a slightly arched configuration, when subjected to force extending in an opposite second direction. When the push-pull chain is in the straight or slightly arched configuration, the push-pull chain is stable enough to carry the weight of a building element such as a window sash and, subsequently, it can be used to push the building element open or hold it in an open position.

[0005] One disadvantage of a push-pull chain actuator is that the push-pull chain can be accidentally folded due to undesired force being applied onto the chain in the first direction. DE 298 16 102 U1 provides a solution to this problem where the push-pull chain is stabilized against undesired force by offsetting the point at which load is applied onto the push-pull chain, such that a counteracting force is generated which helps to maintain the push-pull chain in the straight or slightly arched configuration.

[0006] However, this solution does not prevent accidental collapse completely. For example, a gust of wind may lift the sash shown in DE 298 16 102 U1 upwards. The offset point of load would in this case induce a collapsing movement since the offset point of load will be pivoted around an end of the push-pull chain, partially in the first direction, and effectively force the push-pull chain to straighten or bend in the first direction. As the additional load provided by the gust of wind disappears, the load applied by, e.g., the weight of the sash onto the unstable or possibly even bent and semi-collapsed push-pull chain will cause the sash to pivot uncontrollably downwards into the frame.

[0007] Hence, there is a need for an improved arm actuator for pivoting a building element relative to a frame.

SUMMARY

[0008] It is an object to provide an arm actuator with improved stability.

[0009] 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.

[0010] According to a first aspect, there is provided an arm actuator configured to pivot a building element relative to a frame accommodating the building element, the arm actuator comprising a suspension arm configured to pivot around a first pivot axis and to, when pivoting, move the building element relative to the frame, a push-pull chain having a longitudinal extent along a centerline, a first end of the push-pull chain being configured to be operably connected to the frame, and a second end of the push-pull chain being operably connected to the suspension arm, the push-pull chain being configured to bend freely in a first direction when a first force is applied onto the push-pull chain in the first direction, and to bend only to a limited extent in a second direction, when a second force is applied onto the chain in the second direction, such that the chain forms an arc having a first bending radius, the second direction being opposite to the first direction, a chain support arm configured to pivot at least partially simultaneously with the suspension arm, the chain support arm being configured to engage and prevent the push-pull chain from bending past the first bending radius in the second direction, when subjected to the second force.

[0011] This actuator solution is stabilized by a stabilizing force provided by the chain support arm, which prevents accidental breakage of the push-pull chain of the actuator. This is achieved without affecting the form factor, or the action, of the actuator negatively since the chain support arm is, to some extent, embedded within the remainder of the actuator.

[0012] In a possible implementation form of the first aspect, the chain support arm is configured to prevent the push-pull chain from bending past the first bending radius, in the first direction, when subjected to the first force. This prevents the push-pull chain of the actuator from accidentally collapsing, e.g., if a gust of wind lifts the building element such that the push-pull chain is stretched.

[0013] In a possible implementation form of the first aspect, the chain support arm is configured to engage the push-pull chain when the push-pull chain forms the arc with the first bending radius or, optionally, forms the

arc with the second bending radius, the second bending radius being larger than the first bending radius, and to not engage the push-pull chain when the push-pull chain is bent at a radius other than the first bending radius and, optionally, the second bending radius. This ensures the building element stays in an open position relative to the frame regardless of wind or other external factors.

[0014] In a further possible implementation form of the first aspect, the chain support arm is configured to provide stabilizing forces onto the push-pull chain, the stabilizing force preventing the push-pull chain from bending in the first direction and the stabilizing force preventing the push-pull chain from bending in the second direction.

[0015] In a further possible implementation form of the first aspect, the first pivot axis extends through a first end of the suspension arm, and a second end of the suspension arm is configured to slidingly engage a member of the building element, such that the second end slides longitudinally along the member as the suspension arm pivots around the first pivot axis. This allows a smooth connection between building element and actuator.

[0016] In a further possible implementation form of the first aspect, an angular displacement range of the chain support arm is smaller than an angular displacement range of the suspension arm. This limits the provision of stabilizing forces to an opening range where it is needed, while preventing the stabilizing forces from affecting the actuation movement negatively.

[0017] In a further possible implementation form of the first aspect, the chain support arm and the suspension arm move with identical angular velocity, allowing the chain support arm to pivot without added friction.

[0018] In a further possible implementation form of the first aspect, in a first pivot end position, the suspension arm extends within, or parallel with, a plane comprising the frame, and, in a second pivot end position, the suspension arm extends at an opening angle to the plane, and the chain support arm extends at an angle to the plane, the angle being $\alpha<\beta<0°$, the angle preferably being half of the opening angle. This ensures the form factor and the action of the actuator is not affected negatively.

[0019] In a further possible implementation form of the first aspect, the chain support arm comprises a recess allowing a limited amount of movement of the push-pull chain in the first direction and in the second direction before the chain support arm engages the push-pull chain. This allows the bending radius of the push-pull chain to change as the building element moves.

[0020] In a further possible implementation form of the first aspect, the first end of the chain support arm engages the suspension arm, and the second end of the chain support arm is configured to engage the push-pull chain by means of the recess, removing the need for additional and separate features.

[0021] In a further possible implementation form of the first aspect, the chain support arm engages the suspension arm by means of bolts, allowing a simple and reliable mechanical way of connecting the chain support arm and the suspension arm.

[0022] In a further possible implementation form of the first aspect, the suspension arm engages the chain support arm by means of a flange configured to engage a corresponding surface of the suspension arm when the suspension arm reaches an intermediate angle, the intermediate angle optionally being half of the opening angle. This allows the suspension arm to move, to a degree, independently of the chain support arm such that the suspension arm is activated only when needed.

[0023] In a further possible implementation form of the first aspect, the suspension arm engages the chain support arm by means of wires, a first wire extending between the suspension arm and the chain support arm, a second wire extending between the chain support arm and a member of the frame. This allows an alternative way of connecting the chain support arm and the suspension arm.

[0024] In a further possible implementation form of the first aspect, the suspension arm engages the chain support arm by means of a torsion spring extending between the chain support arm and an actuator housing attached to the frame. This allows an alternative way of connecting the chain support arm and the suspension arm.

[0025] In a further possible implementation form of the first aspect, the chain support arm engages the push-pull chain when the chain support arm extends at the angle and when the push-pull chain is bent at the first bending radius or, optionally, at the second bending radius. This restricts engagement to situations where a substantially temporary increase in load arises.

[0026] In a further possible implementation form of the first aspect, the engagement is achieved by a protrusion configured to extend into a gap separating two parallel links of the push-pull chain, facilitating reliable and simple engagement.

[0027] In a further possible implementation form of the first aspect, the push-pull chain has a chain back where links of the chain engage to, when the push-pull chain bends in the second direction, form a rigid chain having the first bending radius, the push-pull chain being arranged such that the chain back faces the first pivot axis.

[0028] In a further possible implementation form of the first aspect, the arm actuator further comprises a spring configured to assist the movement of the suspension arm and/or the chain support arm.

[0029] In a further possible implementation form of the first aspect, the chain support arm comprises two mutually slidable parts configured to extend or retract sequentially, along a longitudinal axis of the chain support arm, as the chain support arm pivots. This allows the chain support arm to extend to the length that is most suitable at any given angle.

[0030] According to a second aspect, there is provided a building component comprising a moveable panel and a stationary frame accommodating the panel, the building component optionally being a roof window, the panel being configured to pivot around a second pivot axis ex-

tending in parallel with a member of the frame, at least one arm actuator, according to the above, extending between the panel and the frame.

[0031] This allows the building component, when in an open position, to be stabilized by the stabilizing force provided by the actuator, while also preventing accidental breakage of the actuator in response to a sudden and significant increase in force on the building component, and hence the actuator, for example, due to wind or snow.

[0032] In a possible implementation form of the second aspect, the building component comprises a window, hatch, or door arranged in a wall or a roof of a building, as the actuator is suitable for any type of openable and closeable building component.

[0033] In a further possible implementation form of the second aspect, the second pivot axis extends in parallel with the first pivot axis of the arm actuator. This allows the arm actuator to be arranged at a suitable location less dependent of the location of the building component pivot axis.

[0034] In a further possible implementation form of the second aspect, the arm actuator is adapted for pivoting the movable panel relative to the stationary frame against a load mainly caused by the weight of the movable panel. This facilitates use with many types of panels, including heavy double-glazed or steel panels.

[0035] In a further possible implementation form of the second aspect, the building component comprises a top-hung roof window and the arm actuator is arranged adjacent a frame bottom member of the roof window, facilitating a particular type of embodiment.

[0036] In a further possible implementation form of the second aspect, the building component comprises a center-pivoted roof window and two arm actuators, each arm actuator being arranged adjacent one side member of the frame of the roof window or hatch, facilitating a particular type of embodiment.

[0037] This and other aspects will be apparent from the embodiments described below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038] 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 a building element in accordance with an example of the embodiments of the invention;

Fig. 2 shows a schematic perspective view of an arm actuator in accordance with an example of the embodiments of the invention;

Fig. 3 shows a schematic perspective view of an arm actuator in accordance with an example of the embodiments of the invention, wherein the chain support arm of the arm actuator has not been deployed, i.e. is in a first end position;

Fig. 4 shows the arm actuator of Fig. 3, wherein the chain support arm has been deployed, i.e. is in a second end position;

Fig. 5 shows a partially transparent perspective view of an arm actuator in accordance with an example of the embodiments of the invention;

Fig. 6 shows a detail view of an arm actuator in accordance with an example of the embodiments of the invention;

Fig. 7 shows a detail view of an arm actuator in accordance with an example of the embodiments of the invention;

Fig. 8 shows a detail view of an arm actuator in accordance with an example of the embodiments of the invention;

Fig. 9 shows a side view of a push-pull chain in accordance with an example of the embodiments of the invention.

DETAILED DESCRIPTION

[0039] Fig. 1 shows an example of a building component 11 according to the present invention, i.e. a roof window. However, the building component 11 may be any type of openable component, such as a vertical window or door arranged in a wall, or hatch arranged in a wall or the roof of a building. The building component 11 may be used for allowing light into the building, for ventilation, as an entry/exit point under normal conditions, or as an exit point in an emergency such as fire.

[0040] The building component 11 comprises a moveable panel 2, or sash as shown in Fig. 1, and a stationary frame 3 adapted for receiving the sash 2. The moveable member 2, or sash, is configured to pivot around a pivot axis A2 so as to open the moveable member 2 towards an outer side of the building component 11, i.e. towards the exterior of the building in which the building component is arranged. The sash 2 comprises two sash side members connected to a top sash member and a bottom sash member. Correspondingly, the frame 3 comprises two frame side members connected to a top frame member and a bottom frame member. The pivot axis A2 extends in parallel with one of the frame members.

[0041] The moveable panel 2 is suspended from the frame 3 by means of at least one arm actuator 1. Each arm actuator 1 extends at least partially between the panel 2 and the frame 3, optionally between a sash side member and an adjacent frame side member.

[0042] The building component 11 may be a top-hung

roof window and the arm actuator 1 may be arranged adjacent a frame bottom member of the roof window. The building component 11 may also be a center-pivoted roof window or hatch having two arm actuators 1, each arm actuator 1 being arranged adjacent one side member of the frame 3 of the roof window or hatch.

[0043] At least one arm actuator 1 is provided to pivot the moveable panel 2 between a closed position, which seals a building, and several open positions in relation to the frame 3, which allow access to the building. One open position is shown in Fig. 1. The arm actuator 1 may be adapted for securing the moveable panel 2 in the closed position.

[0044] The arm actuator 1 pivots the moveable panel 2 around a first pivot axis A1. The moveable panel A2 pivots around the previously mentioned second pivot axis A2, which may extend in parallel with the first pivot axis A1. The first pivot axis A1 and the second pivot axis A2 may also be coaxial.

[0045] The arm actuator 1 may be adapted for pivoting the movable panel 2 relative to the stationary frame 3 against a load L mainly caused by the weight of the movable panel 2. In part, the load L may also be attributed to external conditions such as, e.g., snow accumulating on the movable panel, or wind.

[0046] As shown in more detail in Fig. 9, the arm actuator 1 comprises a push-pull chain 5. The push-pull chain 5 may be received in an actuator housing connected to the frame 3. As the moveable panel 2 is closed, i.e. received in full within the frame 3, the push-pull chain 5 is completely, or almost completely, withdrawn within the actuator housing, e.g. by an electrical motor (not shown). The push-pull chain 5 is maintained in the withdrawn position by means of the motor or any other suitable locking means, such that the moveable panel 2is maintained in the closed position until the arm actuator 1 is activated in order to move the moveable panel 2 to an open position.

[0047] The push-pull chain 5 comprises a plurality of coupled links 9 as shown in Fig. 9. The push-pull chain 5 bends freely in a first direction D1, past a configuration in which the push-pull chain forms a straight line. This allows at least the main part of the push-pull chain 5 to be collapsed and wound together, for example along a spiral path. The first direction D1, in other words, is the direction in which the push-pull chain 5 folds to follow a path within the actuator housing when the push-pull chain 5 is completely or partially retracted. The push-pull chain 5 is, for example, completely retracted into the actuator housing when the building component is closed. The push-pull chain 5 can bend only to a limited extent past the straight-line configuration in a second, opposite direction D2. This allows the push-pull chain 5 to form a stable arc that can carry load, as illustrated in Fig. 1. The straight-line configuration is illustrated in Fig. 9, wherein the centerline C of the push-pull chain 5 extends straight. The second direction D2 is opposite to the first direction D1. The push-pull chain 5 may have a chain back B where the links 9 of the chain engage to, when the push-pull chain 5 bends in the second direction D2, form a rigid chain having a first bending radius R1, the push-pull chain 5 being arranged such that the chain back faces the first pivot axis A1.

[0048] The push-pull chain 5 may instead be arranged such that the chain back faces away from the first pivot axis A1, in which case the push-pull chain 5 is guided differently within the actuator housing.

[0049] The arm actuator 1, illustrated in more detail in Figs. 2 to 8, is as mentioned configured to pivot a building element 2 relative to a frame 3 accommodating the building element 2. The arm actuator 1 comprises the above-mentioned push-pull chain 5, a suspension arm 4 configured to pivot around the first pivot axis A1 and to, when pivoting, move the building element 2 relative to the frame 3, and a chain support arm 6 configured to pivot at least partially simultaneously with the suspension arm 4.

[0050] The push-pull chain 5 has a longitudinal extent along centerline C. A first end 5a of the push-pull chain 5 is configured to be operably connected to the frame 3, e.g. via the actuator housing, and a second end 5b of the push-pull chain 5 is operably connected to the suspension arm 4.

[0051] The push-pull chain 5 is configured to bend freely, in the previously mentioned first direction D1, when a first force F1 is applied onto the push-pull chain 5. The push-pull chain 5 is also configured to bend only to a limited extent in the second direction D2, when a second force F2 is applied onto the chain. The second force F2 is directed oppositely to the first force F1.

[0052] The first pivot axis A1 may extend through a first end 4a of the suspension arm 4, and a second end 4b of the suspension arm 4 may be configured to slidingly engage a member of the building element 2, such that the second end 4b slides longitudinally along the member as the suspension arm 4 pivots around the first pivot axis A1 (not shown).

[0053] The chain support arm 6 pivots at least partially simultaneously with the suspension arm 4, for example, the suspension arm 4 is rotated, and the moveable member 2 opened, to a certain degree before the chain support arm 6 starts rotating. This is best illustrated in Figs. 3 and 4. The chain support arm 6 may be configured to pivot around the first pivot axis A1 (not shown) or around a further pivot axis A3 extending in parallel with the first pivot axis A1, as illustrated in Fig. 2.

[0054] The chain support arm 6 is configured to engage and prevent the push-pull chain 5 from bending, in the second direction D2, past the first bending radius R1. The first bending radius R1 is the radius at which the arched push-pull chain 5 can extend without risk of breaking under load.

[0055] The chain support arm 6 may also be configured to prevent the push-pull chain 5 from bending, in the first direction D1, past a second bending radius R2. The second bending radius R2 is the radius at which the arched push-pull chain 5 can extend without the risk of uninten-

tionally collapsing.

[0056] In other words, the chain support arm 6 may be configured to engage the push-pull chain 5 when the push-pull chain 5 is bent by the first bending radius R1 or, optionally, the second bending radius R2. This ensures the moveable member 2 stays in an open position relative to the frame 3 regardless of wind or other external factors. Correspondingly, the chain support arm 6 is configured to release, i.e. to not engage, the push-pull chain 5 when the push-pull chain 5 is bent at a radius smaller than the first bending radius R1 and, optionally, larger than the second bending radius R2. This allows the moveable member 2 to be fully closed relative to the frame 3.

[0057] The chain support arm 6 may be configured to provide stabilizing forces F3, F4 onto the push-pull chain 5, as illustrated in Fig. 9. The stabilizing force F3 prevents the push-pull chain 5 from bending in the first direction D1 and the stabilizing force F4 prevents the push-pull chain 5 from bending in the second direction D2.

[0058] The angular displacement range of the chain support arm 6, i.e. the radial distance that the free end of the chain support arm 6 can move, may be smaller than the angular displacement range of the suspension arm 4, as illustrated in Fig. 4. Nevertheless, the chain support arm 6 and the suspension arm 4 may move with identical angular velocity when both arms 4, 6 move.

[0059] The suspension arm 4 and the chain support arm 6 may be arranged such that, in a first pivot end position, preferably a position wherein the building component 11 comprising the arm actuator 1 is considered closed, the suspension arm 4 extends within, or parallel with, a plane P comprising the frame 3. The chain support arm 6 would also extend within, or parallel with, plane P, assuming the position shown in Figs. 2 and 3.

[0060] In a second pivot end position, preferably a position wherein the building component 11 comprising the arm actuator 1 is considered fully open, the suspension arm 4 extends at an opening angle α to the plane P, while the chain support arm 6 extends at an angle β to the plane P, see Fig. 4. The angle β is $\alpha<\beta<0°$, the angle β is preferably around half of the opening angle α. As an example, angle α may be 70° while angle β is 35°. As a further example, angle α may be 90° while angle β is 45°

[0061] The chain support arm 6 may engage the push-pull chain 5 when the chain support arm 6 extends at the angle β and when the push-pull chain 5 is bent at the first bending radius R1 or, optionally, at second bending radius R2.

[0062] The engagement may be achieved by a protrusion 8, illustrated in Figs. 5 and 5. The protrusion 8 is configured to extend into a gap separating two parallel links of the push-pull chain 5.

[0063] The chain support arm 6 may comprise a recess 6c allowing a limited amount of movement of the push-pull chain 5 in the first direction D1 and in the second direction D2 before the chain support arm 6 engages the push-pull chain 5. The chain support arm 6 may be arranged such that the first end 6a of the chain support arm 6 engages the suspension arm 4, and the second end 6b of the chain support arm 6 engages the push-pull chain 5 by means of the recess 6c. The protrusion 8 may be part of the edge outlining the recess 6c.

[0064] The chain support arm 6 may engage the suspension arm 4 by means of bolts 7 (not shown). The suspension arm 4 may also engage the chain support arm 6 by means of wires, a first wire extending between the suspension arm 4 and the chain support arm 6, a second wire extending between the chain support arm 6 and a member of the frame 3 (not shown) . The suspension arm 4 may engage the chain support arm 6 by means of a torsion spring extending between the chain support arm 6 and an actuator housing attached to the frame 3 (not shown) . The suspension arm 4 may engage the chain support arm 6 by means of a flange 6d, as illustrated in Figs. 4 to 8. The flange 6d is configured to engage a corresponding surface 4c of the suspension arm 4 when the suspension arm 4 reaches an intermediate angle $\alpha 2$, the intermediate angle $\alpha 2$ optionally being around half of the opening angle α. The first end 4a of the suspension arm 4 may be open such that the chain support arm 6 can extend through the open first end 4a, while the chain support arm 6 has a portion that is wider than the suspension arm 4, the wider portion being configured to engage the suspension arm 4 at an angle whereby the chain support arm 6 follows the movement of the suspension arm 4 (Not shown).

[0065] The chain support arm 6 may comprise two mutually slidable parts configured to extend or retract sequentially, along a longitudinal axis A4 of the chain support arm 6, as the chain support arm 6 pivots (not shown).

[0066] The arm actuator 1 may further comprise a spring 10, such as a gas spring, configured to assist the movement of the suspension arm 4 and/or the chain support arm 6.

[0067] The chain support arm 6 may be a rigid monolithic arm, i.e. not comprising two or more interacting links. The chain support arm 6 may be made from bent sheet metal, and may be provided with an aperture along its center which allows the torsion spring and/or the spring 10 to pass therethrough. 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 measures cannot be used to advantage.

[0068] The reference signs used in the claims shall not be construed as limiting the scope. Unless otherwise indicated, the drawings are intended to be read (e.g., cross-

hatching, arrangement of parts, proportion, degree, etc.) together with the specification, and are to be considered a portion of the entire written description of this disclosure. As used in the description, the terms "horizontal", "vertical", "left", "right", "up" and "down", as well as adjectival and adverbial derivatives thereof (e.g., "horizontally", "rightwardly", "upwardly", etc.), simply refer to the orientation of the illustrated structure as the particular drawing figure faces the reader. Similarly, the terms "inwardly" and "outwardly" generally refer to the orientation of a surface relative to its axis of elongation, or axis of rotation, as appropriate.

Claims

1. An arm actuator (1) configured to pivot a building element (2) relative to a frame (3) accommodating said building element (2), said arm actuator (1) comprising:

    - a suspension arm (4) configured to pivot around a first pivot axis (A1) and to, when pivoting, move said building element (2) relative to said frame (3);
    - a push-pull chain (5) having a longitudinal extent along a centerline (C), a first end (5a) of said push-pull chain (5) being configured to be operably connected to said frame (3), and a second end (5b) of said push-pull chain (5) being operably connected to said suspension arm (4),

        said push-pull chain (5) being configured to bend freely in a first direction (D1) when a first force (F1) is applied onto said push-pull chain (5) in said first direction (D1), and
        to bend only to a limited extent in a second direction (D2), when a second force (F2) is applied onto said chain in said second direction (D2), such that said chain forms an arc having a first bending radius (R1), said second direction (D2) being opposite to said first direction (D1),

    - a chain support arm (6) configured to pivot at least partially simultaneously with said suspension arm (4),

    said chain support arm (6) being configured to engage and prevent said push-pull chain (5) from bending past said first bending radius (R1) in said second direction (D2) when subjected to said second force (F2).

2. The arm actuator (1) according to claim 1, wherein said chain support arm (6) is configured to prevent said push-pull chain (5) from bending past said first bending radius (R1) in said first direction (D1) when subjected to said first force (F1) .

3. The arm actuator (1) according to claim 1 or 2, wherein said chain support arm (6) is configured to engage said push-pull chain (5) when said push-pull chain (5) forms said arc with said first bending radius (R1) or, optionally, forms said arc with a second bending radius (R2), said second bending radius (R2) being larger than said first bending radius (R1), and to not engage said push-pull chain (5) when said push-pull chain (5) is bent at a radius other than said first bending radius (R1) and, optionally, said second bending radius (R2).

4. The arm actuator (1) according to any one of the previous claims, wherein said chain support arm (6) is configured to provide stabilizing forces (F3, F4) onto said push-pull chain (5), said stabilizing force (F3) preventing said push-pull chain (5) from bending in said first direction (D1) and said stabilizing force (F4) preventing said push-pull chain (5) from bending in said second direction (D2).

5. The arm actuator (1) according to any one of the previous claims, wherein an angular displacement range of said chain support arm (6) is smaller than an angular displacement range of said suspension arm (4).

6. The arm actuator (1) according to claim 5, wherein

    in a first pivot end position, said suspension arm (4) extends within, or parallel with, a plane (P) comprising said frame (3), and wherein,
    in a second pivot end position, said suspension arm (4) extends at an opening angle (α) to said plane (P), and said chain support arm (6) extends at an angle (β) to said plane (P), said angle (β) being $\alpha<\beta<0°$, said angle (β) preferably being half of said opening angle (α).

7. The arm actuator (1) according to claim 6, wherein said suspension arm (4) engages said chain support arm (6) by means of a flange (6d) configured to engage a corresponding surface (4c) of said suspension arm (4) when said suspension arm (4) reaches an intermediate angle ($\alpha 2$), said intermediate angle ($\alpha 2$) optionally being half of said opening angle (α).

8. The arm actuator (1) according to claim 6, wherein said chain support arm (6) engages said suspension arm (4) by means of bolts (7).

9. The arm actuator (1) according to any one of claims 6 to 8, wherein said chain support arm (6) engages said push-pull chain (5) when said chain support arm (6) extends at said angle (β) and when said push-pull chain (5) is bent at said first bending radius (R1)

or, optionally, at said second bending radius (R2).

10. The arm actuator (1) according to any one of the previous claims, wherein said chain support arm (6) comprises a recess (6c) allowing a limited amount of movement of said push-pull chain (5) in said first direction (D1) and in said second direction (D2) before said chain support arm (6) engages said push-pull chain (5).

11. The arm actuator (1) according to any one of the previous claims, wherein said engagement is achieved by a protrusion (8) configured to extend into a gap separating two parallel links of said push-pull chain (5).

12. The arm actuator (1) according to any one of the previous claims, wherein said push-pull chain (5) has a chain back (B) where links (9) of said chain engage to, when said push-pull chain (5) bends in said second direction (D2), form a rigid chain having said first bending radius (R1), said push-pull chain (5) being arranged such that said chain back faces said first pivot axis (A1).

13. The arm actuator (1) according to any one of the previous claims, further comprising a spring (10) configured to assist movement of said suspension arm (4) and/or said chain support arm (6).

14. The arm actuator (1) according to any one of the previous claims, wherein said chain support arm (6) comprises two mutually slidable parts configured to extend or retract sequentially, along a longitudinal axis (A4) of the chain support arm (6), as said chain support arm (6) pivots.

15. A building component (11) comprising a moveable panel (2) and a stationary frame (3) accommodating said panel, said building component optionally being a roof window,
said panel (2) being configured to pivot around a second pivot axis (A2) extending in parallel with a member of said frame (3), at least one arm actuator (1) according to any one of claims 1 to 14 extending between said panel (2) and said frame (3) .

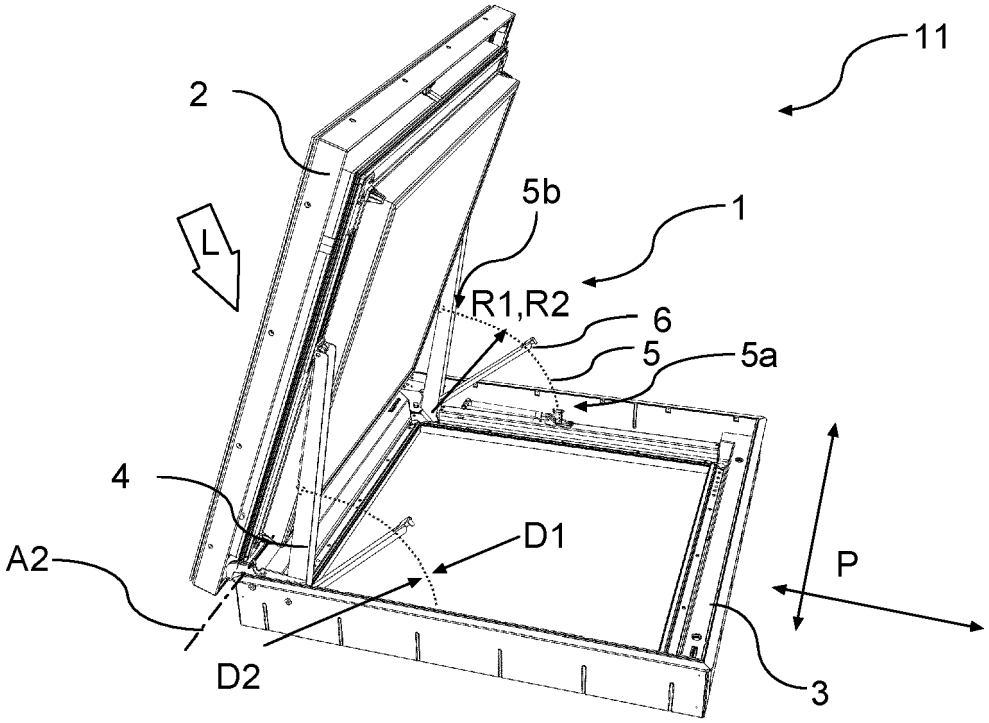

Fig. 1

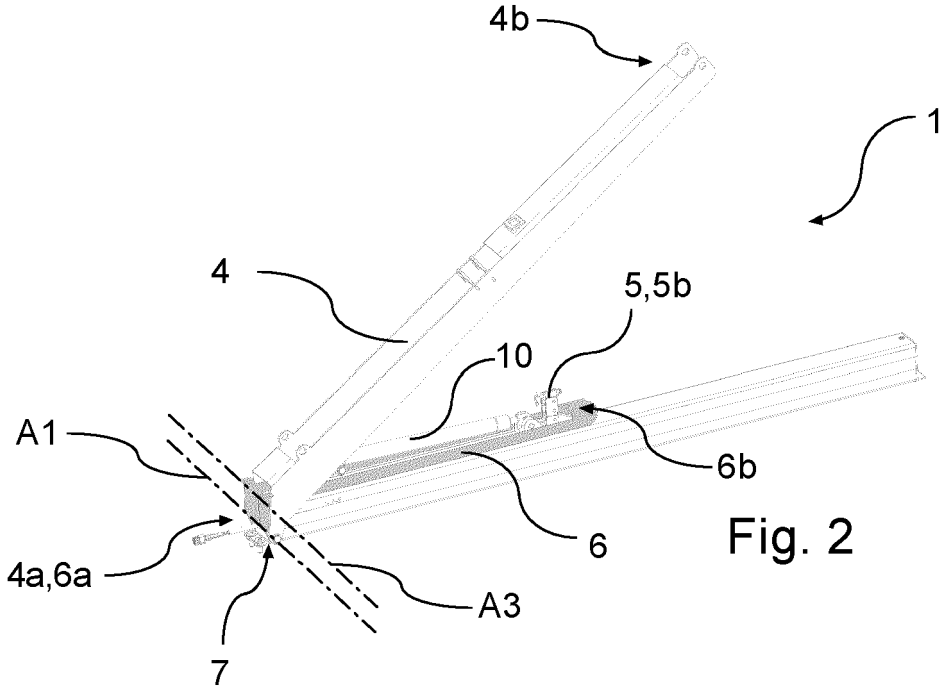

Fig. 2

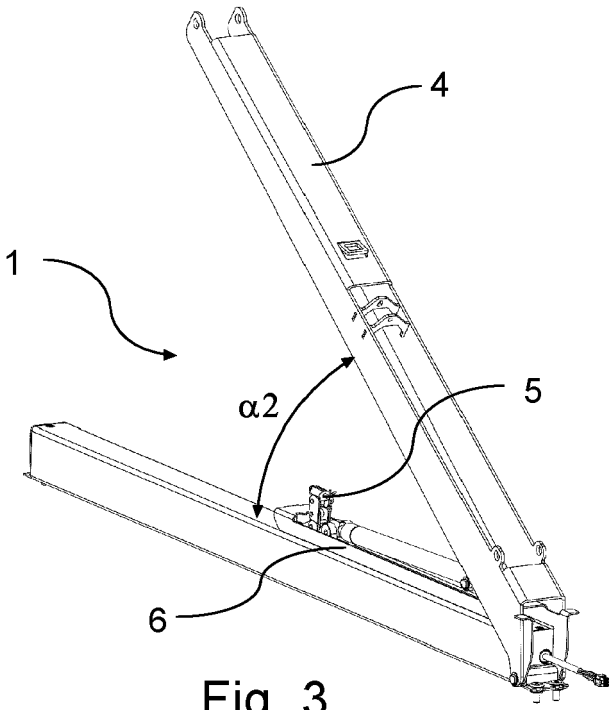

Fig. 3

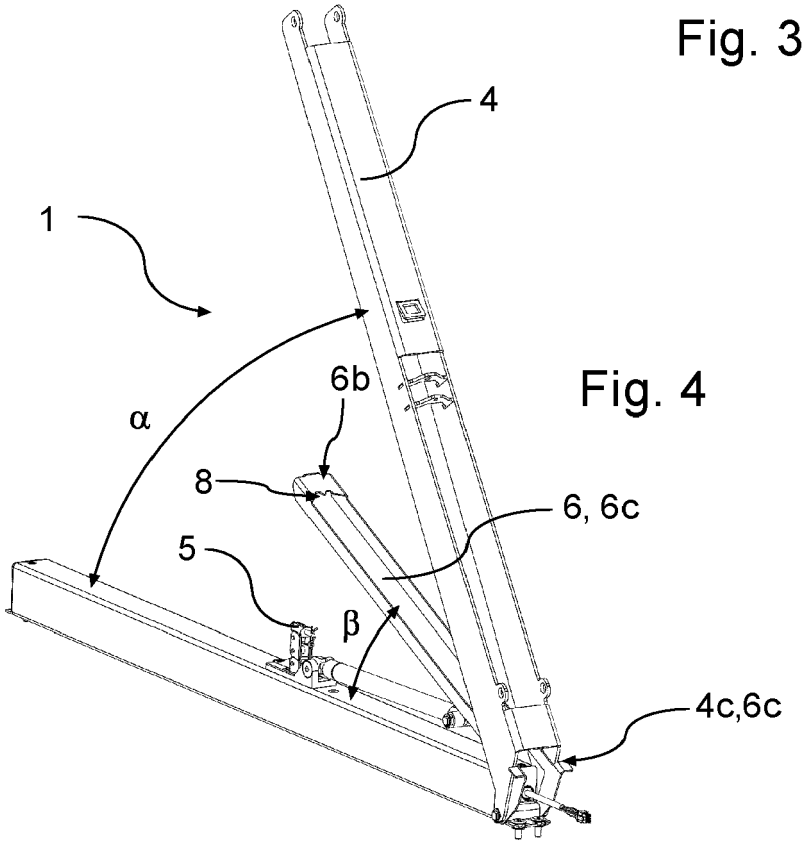

Fig. 4

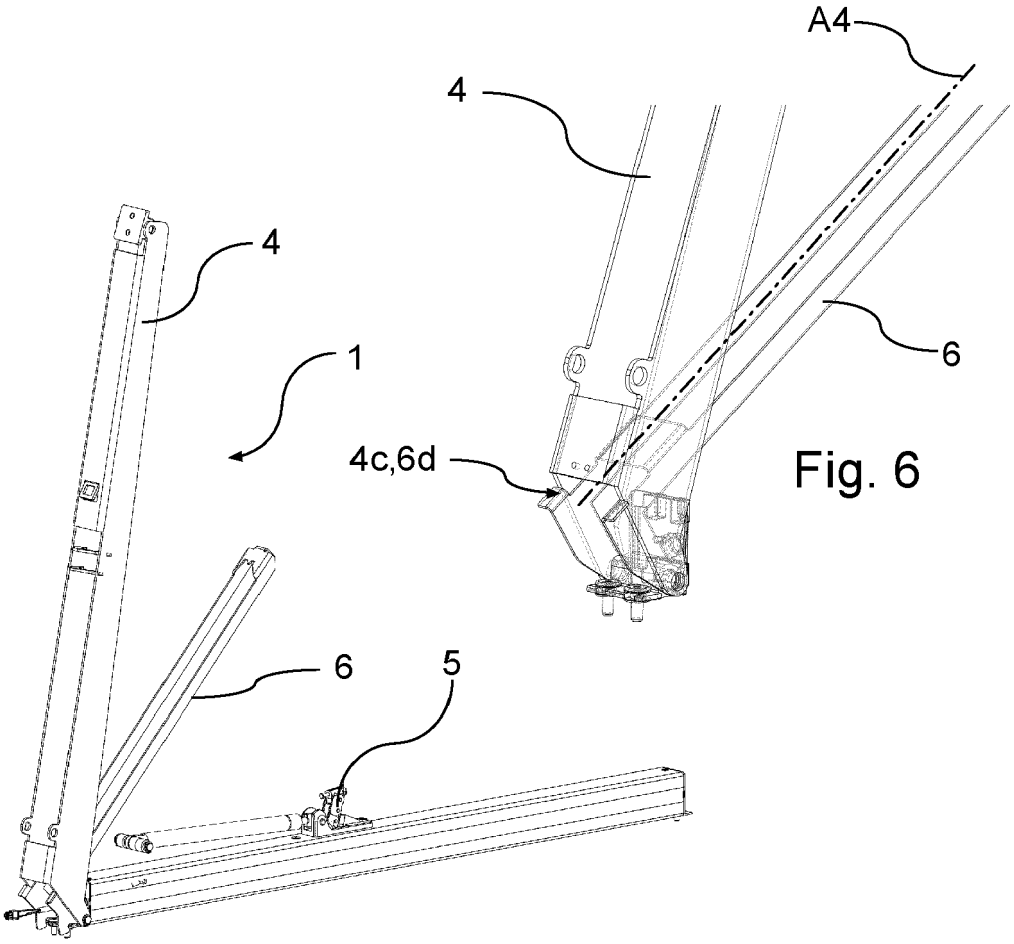

Fig. 6

Fig. 5

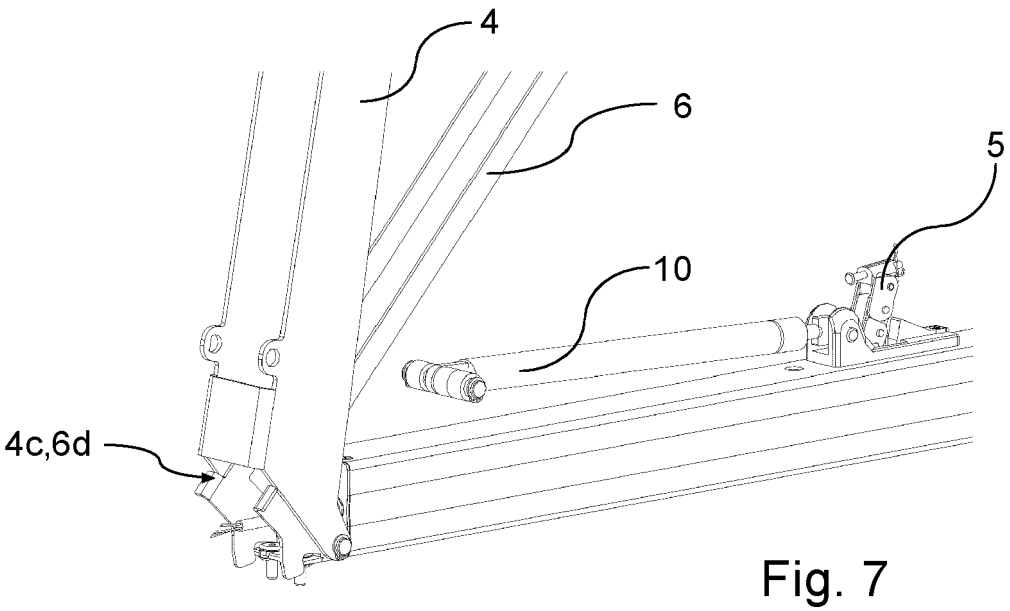

Fig. 7

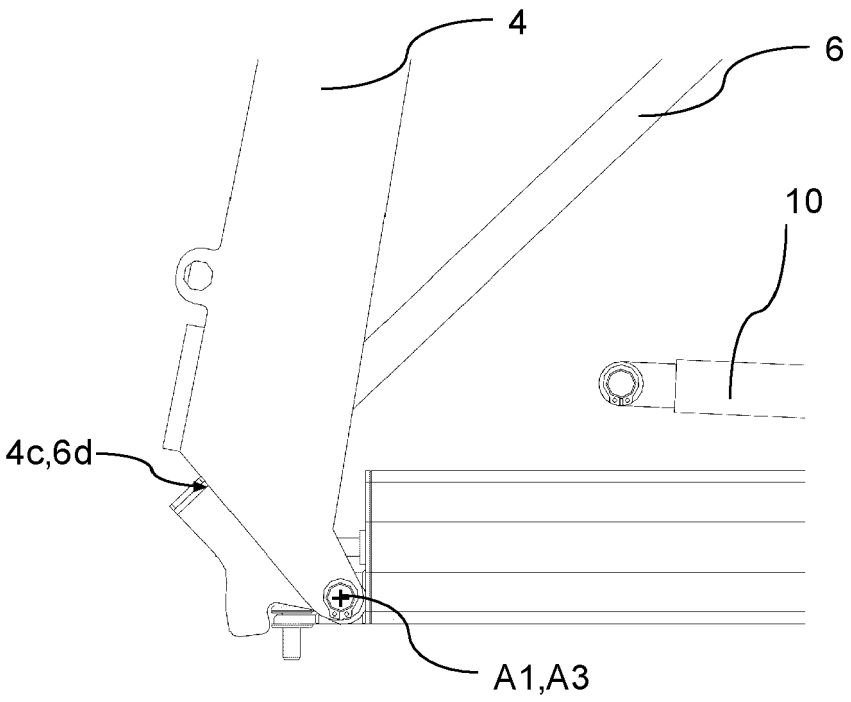

Fig. 8

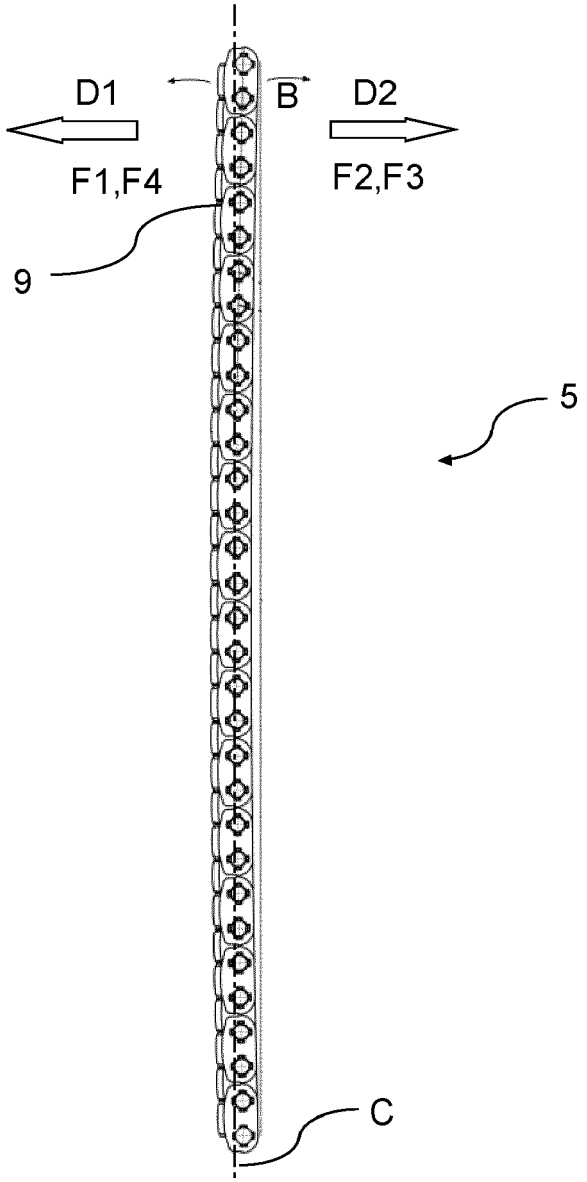

Fig. 9

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EUROPEAN SEARCH REPORT

Application Number
EP 24 18 7432

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2024/125163 A1 (FEJER O [DK]) 18 April 2024 (2024-04-18)	1-12,15	INV. E05F11/06
Y	* figures *	13	E05F15/619
A	* paragraph [0013] *	14	
	* paragraphs [0016], [0017] *		
	* paragraphs [0032] - [0038] *		

Y	EP 3 505 712 A1 (VKR HOLDING AS [DK]) 3 July 2019 (2019-07-03)	13	
A	* paragraph [0012] *	1,15	
	* paragraphs [0028], [0029] *		
	* paragraph [0062] *		
	* figures *		

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TECHNICAL FIELDS SEARCHED (IPC)

E05F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	24 July 2024	Mund, André

CATEGORY OF CITED DOCUMENTS

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24-07-2024

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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