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(54) **ELECTRIC DRIVE SYSTEM FOR MOVING A WINDOW-RELATED ELEMENT WITH MECHANICAL LOCK**

(57) A locking system (8) for preventing an output shaft (5) of a main electric motor (4) from rotating. The locking system (8) comprises a mechanical locking arrangement (9) and an auxiliary electric motor (10). The mechanical locking arrangement (9) is resiliently biased in a first direction to prevent rotation of the output shaft (5), and the auxiliary electric motor (10) is configured to displace the resiliently biased mechanical locking arrangement (9) against the bias, in a second opposite direction, to allow rotation of the output shaft (5).

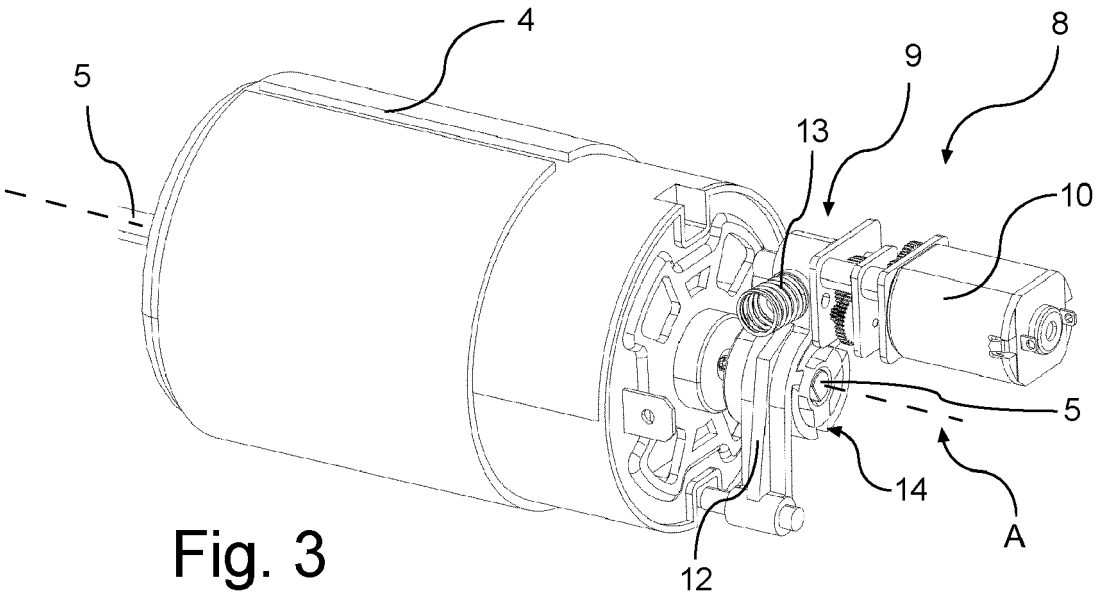

Fig. 3

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Description

TECHNICAL FIELD

[0001] The disclosure relates to an electric drive system for moving a window-related element such as e.g. a roof window sash, an awning, a blind, or a shutter between open and closed positions.

BACKGROUND

[0002] There are known electric drive systems for either lowering or raising a window-related element between open and closed positions, under control of a handheld remote or other control device. These systems include an electric drive motor that is operably coupled, through a mechanism that typically comprises a reduction gear, to the window-related element. When the electric drive motor is energized in response to a user command signal, the drive mechanism moves the sash, awning, blind, or shutter in a raising or in a lowering direction. When the electric drive motor is deenergized by the user, the window-related element should maintain its actual position. This is achieved by friction of the electric drive motor in the drive mechanism, sometimes supplemented by dedicated braking arrangements such as gas springs arranged between sash and frame of the window.

[0003] The window-related elements are affected by, e.g., gravity and the unwound hanging load. Thus, means need to be provided to ensure that the window-related element remains in position also when the electric drive motor is deenergized. Friction in the mechanism that connects the electric motor to the window-related element can in some circumstances provide sufficient protection against inadvertent movement of the window-related element. However, the load that acts on the window element is often unpredictable due to wind, snow load, and e.g. the (at the time of production of the window unknown) installation angle of the roof window.

[0004] Various known arrangements for providing additional braking capacity have disadvantages such as e.g. noise generation during movement of the window-related element by action of the electric drive motor.

[0005] Consequently, there is a need for improved means for securing that window-related elements remain in position when the electric drive motor of the electric drive system is deenergized.

SUMMARY

[0006] It is an object to provide an electric drive system for driving a window-related element that overcomes, or at least reduces, one of the problems mentioned above.

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

[0008] According to a first aspect, there is provided a locking system for preventing an output shaft of a main electric motor from rotating, the locking system comprising a mechanical locking arrangement and an auxiliary electric motor, the mechanical locking arrangement being resiliently biased in a first direction to prevent rotation of the output shaft, the auxiliary electric motor being configured to displace the resiliently biased mechanical locking arrangement against the bias, in a second opposite direction, to allow rotation of the output shaft.

[0009] A locking system which prevents rotation of a motor output shaft by being resiliently biased, but which can be released by means of an auxiliary electric motor, provides a reliable mechanical lock which only requires electrical energy when the main electric motor is in an operating state and the output shaft rotates, while securing the output shaft to prevent it from rotating, when the electric motor is a non-operating state. Thus, the system is inherently safe since it will mechanically lock when the electric power is removed.

[0010] In a possible implementation form of the first aspect, the locking system is configured to allow the output shaft to rotate when the main electric motor is energized, and to prevent the output shaft from rotating when the main electric motor is not energized.

[0011] In a further possible implementation form of the first aspect, the auxiliary motor is energized prior to, or simultaneously as, the main electric motor is deenergized, such that the locking mechanism is released at the latest simultaneously with the start of output shaft rotation.

[0012] In a further possible implementation form of the first aspect, the bias is sufficient to move the mechanical locking arrangement to a locked position when the auxiliary electric motor is not energized, allowing the locking system to be self-locking.

[0013] In a further possible implementation form of the first aspect, the mechanical locking arrangement provides a mechanical interlock preventing rotation of the output shaft.

[0014] In a further possible implementation form of the first aspect, the mechanical locking arrangement comprises a displaceable member such as e.g. a hinged lever.

[0015] In a further possible implementation form of the first aspect a free end of the displaceable member preferably being resiliently biased towards a towards the output shaft.

[0016] In a further possible implementation form of the first aspect, the mechanical locking arrangement comprises at least one recess such as an axial groove in the output shaft or in a locking rotor mounted on the output shaft, and the displaceable member comprises a tooth shaped protrusion that is sized to fit into the at least one recess.

[0017] In a further possible implementation form of the first aspect, the mechanical locking arrangement comprises a tooth shaped protrusion on the output shaft, or on a locking rotor mounted on the output shaft, and which

is sized to fit into the at least one recess, such as e.g. an axial groove, arranged in the displaceable member.

[0018] In a further possible implementation form of the first aspect, the tooth shaped protrusion engages the recess in order to interlock mechanically.

[0019] In a further possible implementation form of the first aspect, the free end of the displaceable member is resiliently biased towards the output shaft by a resilient element such as a spring, and wherein the free end of the displaceable member is moved away from the output shaft against the bias of the spring by, preferably by a rotatable cam or eccentric shaft operably coupled to an auxiliary electric motor.

[0020] According to a second aspect, there is provided an electric drive system for driving a window-related element such as e.g. a sash, blind, shutter or awning, the electric drive system comprising a main electric motor having an output shaft, the output shaft being configured to rotate about a rotation axis of the output shaft, an actuator configured to apply an external load onto the output shaft, the external load being mainly caused by the weight of the window related element, and the locking system according to the above, the mechanical locking arrangement of the locking system being configured to prevent the output shaft from rotating by engaging the output shaft, the auxiliary electric motor of the locking system being configured to release the mechanical locking arrangement from the engagement with the output shaft, allowing the output shaft to rotate.

[0021] Such an electric drive system provides a mechanical lock which only requires electrical energy when the main electric motor is in an operating state, i.e. when the window-related element is moving between positions, while preventing the output shaft of the main electric motor from rotating when in a non-operating state, i.e. when the window-related element is stationary, e.g. in an open position.

[0022] In a possible implementation form of the second aspect, the main electric motor is operably coupled to the window-related element by a drive mechanism, the drive mechanism preferably including a reduction gear.

[0023] In a further possible implementation form of the second aspect, the mechanical locking arrangement comprises a cam configured to rotate about a first axis parallel with the rotation axis, a lever comprising a first lever end, a second lever end, and a protrusion, the lever being pivotable at the first lever end about a second axis parallel with the rotation axis and distinct from the first axis, the protrusion extending in a direction towards the rotation axis and the first axis, a resilient element applying a biasing force onto the second lever end, such that the second lever end is biased towards a periphery of the cam, a locking rotor fixedly connected to the output shaft, the locking rotor sharing the rotation axis with the output shaft, the locking rotor comprising at least one peripheral recess configured to receive the protrusion, wherein, when the cam is in a first rotary position, the protrusion engages the recess, preventing the locking rotor and the output shaft from rotating about the rotation axis, and, when the cam is in a second rotary position, the protrusion is released from the recess and the locking rotor and the output shaft are allowed to rotate about the rotation axis in response to the external load, providing an increased capacity to hold the window-related element in position when the main electric motor is deenergized.

[0024] In a further possible implementation form of the second aspect, the resilient element is compressed as the cam rotates from the first rotary position to the second rotary position, and is decompressed as the cam rotates from the second rotary position to the first rotary position.

[0025] In a further possible implementation form of the second aspect, the protrusion and the peripheral recess(es) have a longitudinal extension extending parallel to, and in a plane including, the rotation axis.

[0026] In a further possible implementation form of the second aspect, the actuator is a linear actuator, preferably a chain actuator.

[0027] In a further possible implementation form of the second aspect, the mechanical locking arrangement further comprises a support frame, the lever being at least partially enclosed by the support frame, the locking rotor, and the cam.

[0028] In a further possible implementation form of the second aspect, the resilient element extends between the second lever end and the support frame.

[0029] In a further possible implementation form of the second aspect, the resilient element is a spring.

[0030] According to a third aspect, there is provided a roof window comprising a sash and a frame adapted for receiving the sash, the sash being configured to pivot around a pivot axis so as to open the sash towards an outer side of the window, the roof window further comprising an electric drive system according to the above, the actuator of the electric drive system being adapted for pivoting the sash in relation to the frame against a load of the sash, the sash being maintained in an open position by means of the electric drive system.

[0031] In a possible implementation form of the third aspect, the sash is maintained in the open position by means of the electric drive system when the electric drive system is not energized, preferably by the electric drive system itself only.

[0032] These and other aspects will be apparent from and the embodiment(s) described below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] 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 is a diagrammatic representation of a roof window comprising an electric drive system according to an embodiment of the present invention,

Fig. 2 is an elevated view of an electric drive system according to an embodiment of the present invention,

Fig. 3 is a partial, elevated view of the electric drive system shown in Fig. 2,

Fig. 4 is an elevated partially exploded view of the electric drive system of Fig. 3,

Fig. 5 is a partial end view of an electric drive system with a locking system according to an embodiment of the present invention, and

Fig. 6 is a partial end view of the locking system shown in Fig. 5.

DETAILED DESCRIPTION

[0034] Fig. 1 is a diagrammatic illustration of an electric drive system 1 for moving an element 2 related to a window between open and closed positions. In the present embodiment, the window is a roof window 17 that is installed at an inclination corresponding to the inclination of the roof and the window-related element 2 is a top hung sash. The roof window 17 comprises a sash 2 and a frame 3 adapted for receiving the sash 2, and the sash 2 is configured to pivot around a pivot axis so as to open the sash 2 towards an outer side of the window.

[0035] In Fig. 1, the sash 2 is shown in an open position by unbroken lines and in a closed position by broken lines. The curved double arrow line illustrates movement of the sash 2. It is understood that the element 2 that relates to a window does not need to be a sash, but could instead be e.g. a blind, shutter, or an awning.

[0036] The roof window 17 further comprises an electric drive system 1. The electric drive system 1 comprises a main electric motor 4 that is operably coupled to the window-related element 2 by a drive mechanism 6. The main electric motor 4 can e.g. be any suitable AC or DC drive motor with an output shaft 5, such as a tubular linear motor, and is preferably a main electric motor that itself provides some level of braking when it is not energized. The output shaft 5 is coupled to the drive mechanism 6. The drive mechanism 6 comprises, in one embodiment, a reduction gear.

[0037] The electric drive motor 4 comprises a housing from which the drive output shaft 5 protrudes. The output shaft 5 rotates when the main electric motor 4 is energized and the direction of rotation can be chosen by an operator. The electric drive motor 4 is provided with electrical contacts for connection to electric power.

[0038] The electric drive system 1, in particular the actuator 7 (described in more detail further below), pivots the window-related element/sash 2 in relation to the frame 3 and against a load of the sash 2, the load being mainly caused by the weight of the window-related element but also possibly cause by additional forces due to e.g. wind or build-up of snow.

[0039] The window-related element/sash 2 is also maintained in an open position by means of the electric drive system 1. In one embodiment, the main electric motor 4 of the electric drive system 1 is not energized and the sash 2 is maintained in the open position by means of the electric drive system 1 only. Preferably, the roof window 17 does not comprise any further support elements, such as gas springs, for maintaining the open sash 2 in position relative the frame 3 against the load of the sash 2.

[0040] Figs. 2 to 5 show the electric drive system 1 in greater detail.

[0041] The electric drive system 1 comprises the above-mentioned main electric motor 4 with output shaft 5. The output shaft 5 is configured to rotate about the rotation axis A of the output shaft 5, as indicated in Figs. 3 and 4.

[0042] The electric drive system 1 further comprises an actuator 7 configured to apply an external load onto the output shaft 5, the external load being mainly caused by the weight of the window-related element 2, and a locking system 8.

[0043] The locking system 8 provides a mechanical interlock preventing the output shaft 5 of the main electric motor 4 from rotating, at least temporarily, and comprises mechanical locking arrangement 9 and an auxiliary electric motor 10.

[0044] The mechanical locking arrangement 9 is resiliently biased in a first direction to prevent rotation of the output shaft 5, preferably in a direction towards the output shaft 5 as shown in Figs. 5 and 6. Preferably, rotation is prevented by the mechanical locking arrangement 9 engaging the output shaft 5 directly.

[0045] The auxiliary electric motor 10 is configured to displace the resiliently biased mechanical locking arrangement 9 against the bias, in a second opposite direction, preferably in a direction away from the output shaft 5, to allow rotation of the output shaft 5. The rotation is allowed as the auxiliary electric motor 10 acts to release the mechanical locking arrangement 9 from the engagement with the output shaft 5.

[0046] In one embodiment, the locking system 8 allows the output shaft 5 to rotate when the main electric motor 4 is energized, and prevents the output shaft 5 from rotating when the main electric motor 4 is not energized. The main electric motor 4 is preferably energized when moving the window-related element/sash 2 between positions, and deenergized when the window-related element/sash 2 is stationary in an open position. The auxiliary motor 10 may be energized prior to, or simultaneously as, the main electric motor 4 is deenergized. The bias of the mechanical locking arrangement 9 may be sufficient to move the mechanical locking arrangement 9 to a locked position when the auxiliary electric motor 10 is not energized.

[0047] In one embodiment, the actuator 7 is connected to a first end of the output shaft 5, and the locking system

8 is connected to a second end of the output shaft 5. The actuator 7 may be a linear actuator, preferably a chain actuator.

[0048] In one embodiment, the mechanical locking arrangement 9 comprises a cam 11 configured to rotate about a first axis B parallel with the rotation axis A, which cam 11 is operably coupled to and rotated by the auxiliary electric motor 10. The rotational movement of the cam 11 is illustrated by the curved line with double sided arrows in Fig. 6. In a further embodiment, the mechanical locking arrangement 9 comprises an eccentric shaft which is operably coupled to the auxiliary electric motor.

[0049] The mechanical locking arrangement 9 further comprises a displaceable member such as a hinged lever 12 comprising a first lever end 12a, a second lever end 12b, and, in one embodiment, a protrusion 12c. The lever 12 is pivotable at the first lever end 12a about a second axis C parallel with the rotation axis A and distinct from the first axis B. The protrusion 12a extends in a direction towards the rotation axis A and the first axis B. The protrusion may be tooth shaped.

[0050] A resilient element 13, e.g. a spring, applies a biasing force onto the free second lever end 12b, such that the second lever end 12b is biased towards a periphery of the cam 11. In one embodiment, the resilient element 13 extends between the second lever end 12b and a support frame 16.

[0051] In one embodiment, a locking rotor 14 is fixedly connected to the output shaft 5, such that the locking rotor 14 shares rotation axis A with the output shaft 5. The locking rotor 14 may comprise at least one peripheral recess 15, preferably three equidistantly spaced peripheral recesses 15, configured to receive the protrusion 12c. The above-mentioned protrusion 12c is sized to fit into the recess 15 and engages the recess 15 in order to interlock mechanically.

[0052] In one embodiment, the three equidistantly spaced peripheral recesses 15 are arranged directly in the output shaft 5.

[0053] In a further embodiment, the protrusion 12c is arranged on the output shaft 5 or on the locking rotor 14, and the recess is arranged on the lever 12.

[0054] The rotational movement of the locking rotor 14 is driven by the rotation of the output shaft 5. The locking rotor 14 is directly coupled to the output shaft 5 to rotate in unison therewith. The output shaft 5 may, e.g., be provided with an integral key and the locking rotor 14 provided with a central bore with a keyway opening to the central bore. The output shaft 5 is (fittingly) inserted into the central bore with the integral key received in the keyway. Thus, it is ensured that the locking rotor 14 rotates in unison with the output shaft 5.

[0055] When the cam 11 is in a first rotary position, shown in Figs. 5 and 6, the protrusion 12c engages one recess 15, and hence prevents the locking rotor 14 and the output shaft 5 from rotating about the rotation axis A. When the cam 11 is moved to a second rotary position, the free second lever end 12b is moved in a direction away from the output shaft 5 and, subsequently, the protrusion 12c is released from the recess 15 and the locking rotor 14 and the output shaft 5 are allowed to rotate about the rotation axis A in response to external load. As the cam 11 moves from the second rotary position to the first rotary position, the lever protrusion 12c may end up in a position which is misaligned with any of the peripheral recesses 15. In such a case, the output shaft 5 and locking rotor 14 are allowed to rotate until the lever protrusion 12c aligns with the next coming peripheral recess 15. Hence, the bias provided by the resilient element 13 is sufficient to allow the lever protrusion 12c to engage a peripheral recess 15 when the auxiliary electric motor 10 is not energized.

[0056] The resilient element 13 is compressed as the cam 11 rotates from the first rotary position to the second rotary position, and is decompressed as the cam 11 rotates from the second rotary position to the first rotary position.

[0057] The protrusion 12c and the peripheral recesses 15 all have longitudinal extensions extending parallel to, and in a plane including, the rotation axis A. The recesses essentially form longitudinally extending axial grooves in the surface of the locking rotor 14 and, correspondingly, the protrusion 12c essentially forms a longitudinally extending ridge.

[0058] In one embodiment, the mechanical locking arrangement 9 further comprises a support frame 16, and the lever 12 is at least partially enclosed by the support frame 16, the locking rotor 14, and the cam 11. The support frame may comprise of one integral part or several individual parts as shown in Figs. 5 and 6.

[0059] 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.

[0060] The reference signs used in the claims shall not be construed as limiting the scope.

Claims

1. A locking system (8) for preventing an output shaft (5) of a main electric motor (4) from rotating,
   said locking system (8) comprising a mechanical locking arrangement (9) and an auxiliary electric motor (10),
   said mechanical locking arrangement (9) being resiliently biased in a first direction to prevent rotation of said output shaft (5),
   said auxiliary electric motor (10) being configured to displace said resiliently biased mechanical locking arrangement (9) against said bias, in a second op-

posite direction, to allow rotation of said output shaft (5).

2. The locking system (8) according to claim 1, configured to allow said output shaft (5) to rotate when said main electric motor (4) is energized, and to prevent said output shaft (5) from rotating when said main electric motor (4) is not energized.

3. The locking system (8) according to claim 1 or 2, wherein said auxiliary motor is energized prior to, or simultaneously as, said main electric motor (4) is deenergized.

4. The locking system (8) according to any one of the previous claims, wherein said bias is sufficient to move said mechanical locking arrangement (9) to a locked position when said auxiliary electric motor (10) is not energized.

5. An electric drive system (1) for driving a window-related element (2) such as e.g. a sash, blind, shutter or awning, said electric drive system (1) comprising:

a main electric motor (4) having an output shaft (5), said output shaft (5) being configured to rotate about a rotation axis (A) of said output shaft (5),
an actuator (7) configured to apply an external load onto said output shaft (5), said external load being mainly caused by the weight of said window-related element (2), and
the locking system (8) according to any one of the previous claims,
the mechanical locking arrangement (9) of said locking system (8) being configured to prevent said output shaft (5) from rotating by engaging said output shaft (5),
the auxiliary electric motor (10) of said locking system (8) being configured to release said mechanical locking arrangement (9) from said engagement with said output shaft (5), allowing said output shaft (5) to rotate.

6. The electric drive system (1) according to claim 5, wherein said main electric motor (4) is operably coupled to said window-related element (2) by a drive mechanism (6), said drive mechanism (6) preferably including a reduction gear.

7. The electric drive system (1) according to claim 5 or 6, wherein said mechanical locking arrangement (9) comprises

- a cam (11) configured to rotate about a first axis (B) parallel with said rotation axis (A),
- a lever (12) comprising a first lever end (12a), a second lever end (12b), and a protrusion (12c), said lever (12) being pivotable at said first lever end (12a) about a second axis (C) parallel with said rotation axis (A) and distinct from said first axis (B), said protrusion (12a) extending in a direction towards said rotation axis (A) and said first axis (B),
- a resilient element (13) applying a biasing force onto said second lever end (12b), such that said second lever end (12b) is biased towards a periphery of said cam (11),
- a locking rotor (14) fixedly connected to said output shaft (5), said locking rotor (14) sharing said rotation axis (A) with said output shaft (5),

said locking rotor (14) comprising at least one peripheral recess (15) configured to receive said protrusion (12c),
wherein, when said cam (11) is in a first rotary position, said protrusion (12c) engages said recess (15), preventing said locking rotor (14) and said output shaft (5) from rotating about said rotation axis (A), and,
when said cam (11) is in a second rotary position, said protrusion (12c) is released from said recess (15) and said locking rotor (14) and said output shaft (5) are allowed to rotate about said rotation axis (A) in response to said external load.

8. The electric drive system (1) according to claim 7, wherein said resilient element (13) is compressed as said cam (11) rotates from said first rotary position to said second rotary position, and is decompressed as said cam (11) rotates from said second rotary position to said first rotary position.

9. The electric drive system (1) according to claim 7 or 8, wherein said protrusion (12c) and said peripheral recess(es) (15) have a longitudinal extension extending parallel to, and in a plane including, said rotation axis (A).

10. The electric drive system (1) according to any one of claims 5 to 9, wherein said actuator (7) is a linear actuator, preferably a chain actuator.

11. The electric drive system (1) according to any one of claims 7 to 10, wherein said mechanical locking arrangement (9) further comprises a support frame (16), said lever (12) being at least partially enclosed by said support frame (16), said locking rotor (14), and said cam (11).

12. The electric drive system (1) according to any one of claims 7 to 11, wherein said resilient element (13) extends between said second lever end (12b) and said support frame (16) .

13. The electric drive system (1) according to any one

of claims 7 to 12, wherein said resilient element (13) is a spring.

14. A roof window (17) comprising a sash (2) and a frame (3) adapted for receiving said sash (2), said sash (2) being configured to pivot around a pivot axis so as to open said sash (2) towards an outer side of said window, said roof window further comprising an electric drive system (1) according to any one of claims 5 to 13,
the actuator (7) of said electric drive system (1) being adapted for pivoting said sash (2) in relation to said frame (3) against a load of said sash (2),
said sash (2) being maintained in an open position by means of said electric drive system (1).

15. The roof window (17) according to claim 14, wherein said sash (2) is maintained in said open position by means of said electric drive system (1) when said electric drive system (1) is not energized, preferably by the electric drive system itself only.

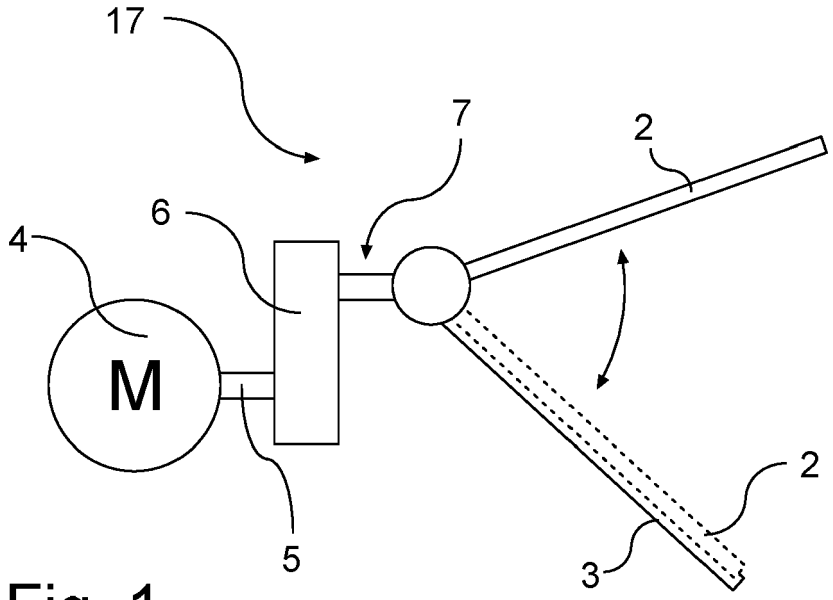

Fig. 1

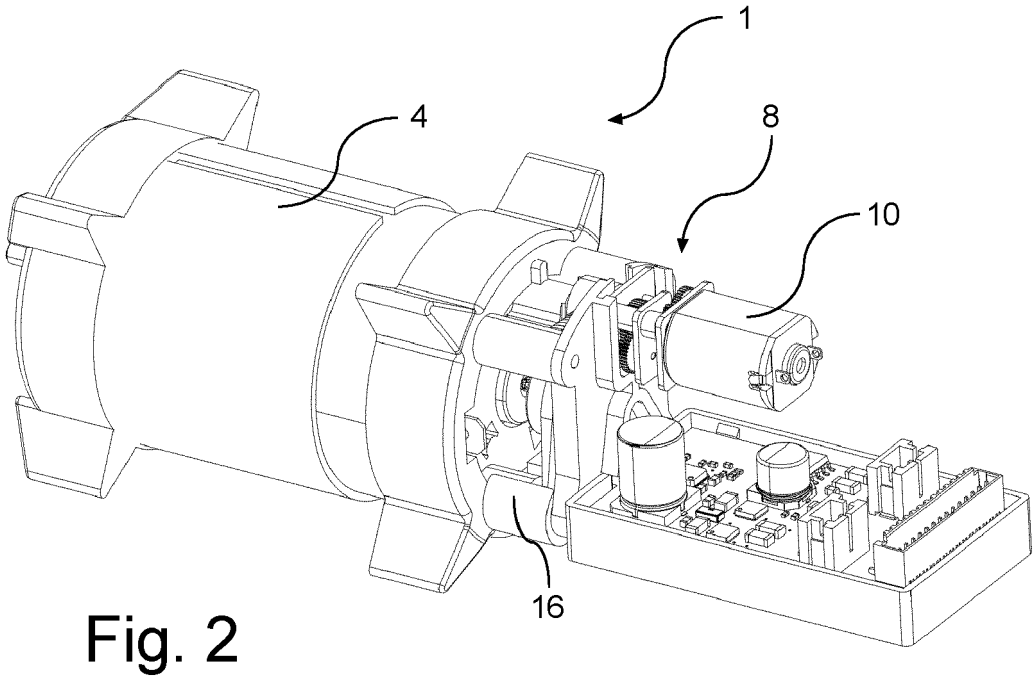

Fig. 2

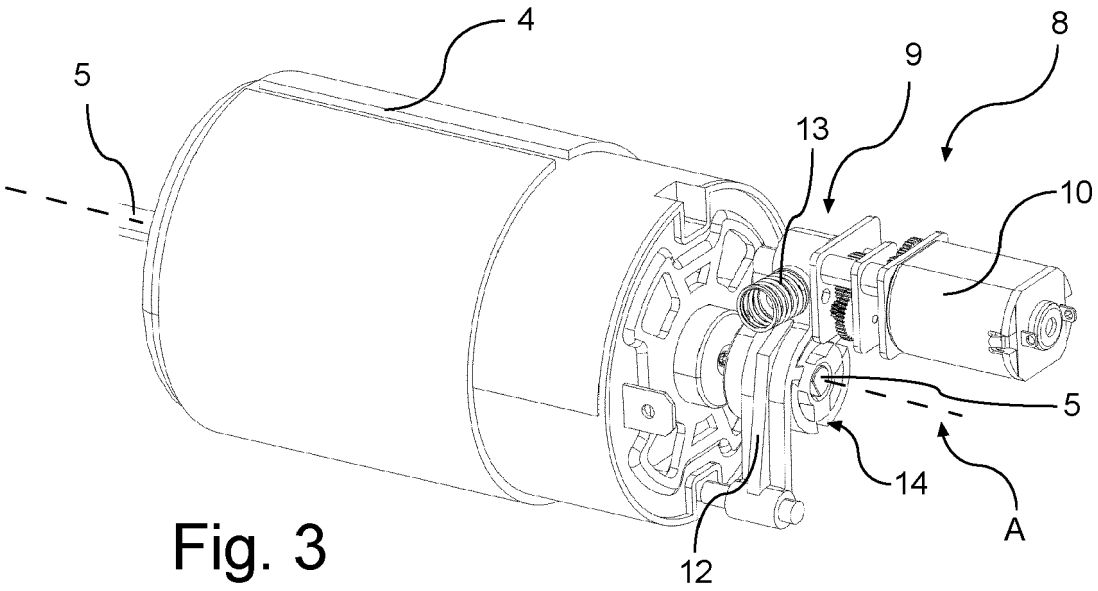

Fig. 3

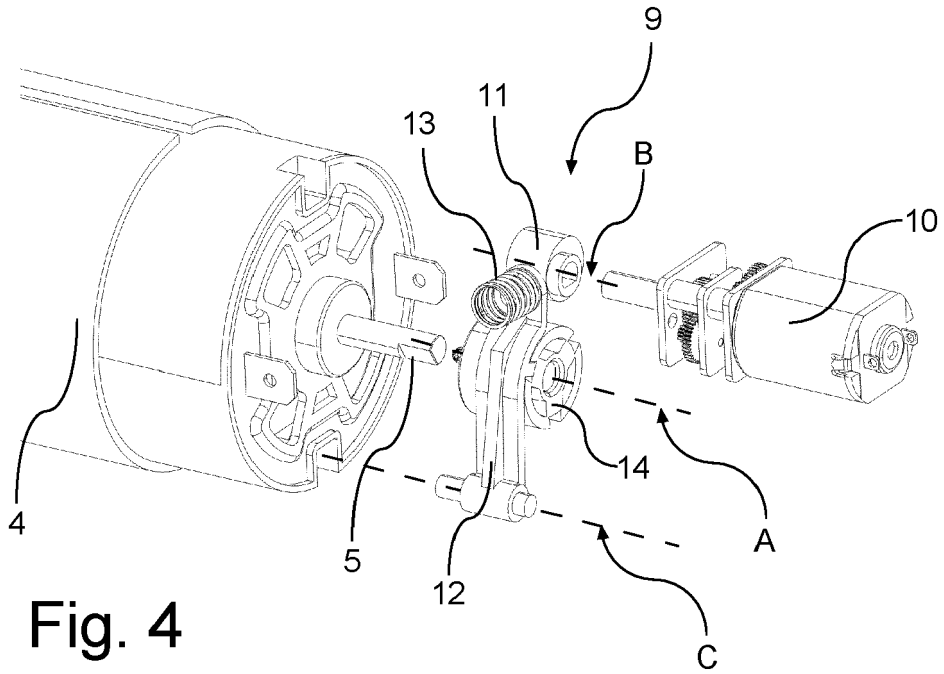

Fig. 4

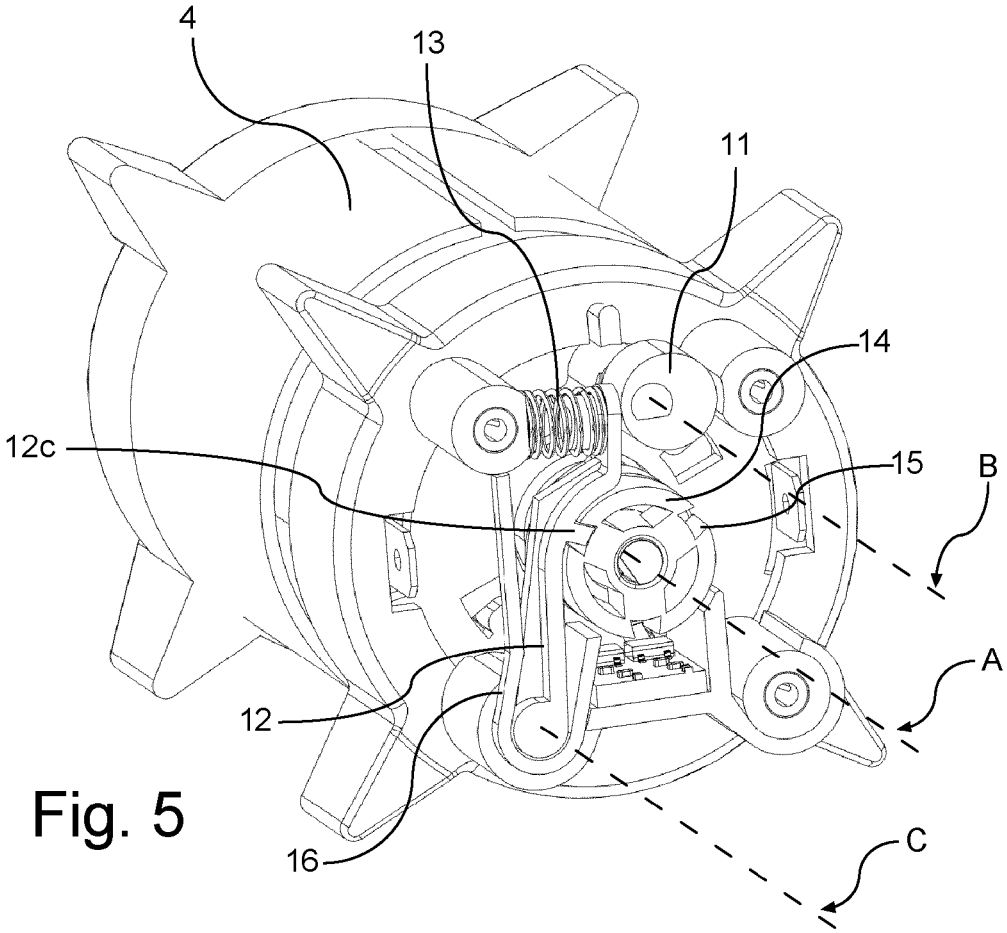

Fig. 5

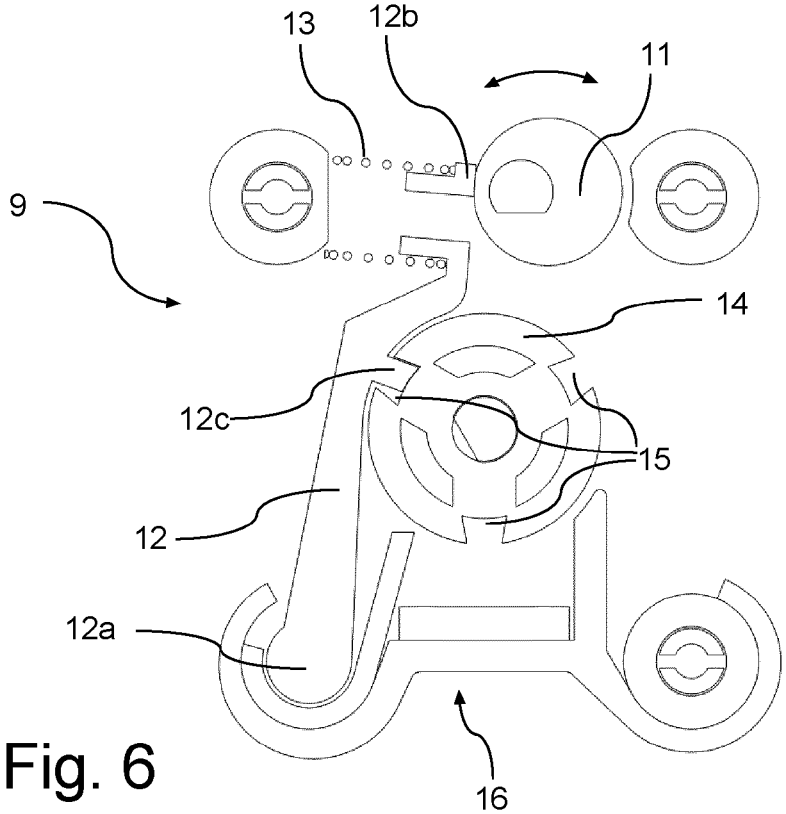

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 20 15 4815

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	EP 0 366 575 A1 (JEANDEAUD JEAN CLAUDE) 2 May 1990 (1990-05-02) * column 1, line 1 - line 7 * * column 5, line 22 - line 43; figures 1,8-11 *	1,5,6 2-4,7-15	INV. E05F15/614 E05F15/619
Y	US 5 826 377 A (SIMSON ANTON K [US] ET AL) 27 October 1998 (1998-10-27) * column 1, line 4 - line 7 * * column 3, line 54 - line 61; figures 1,3 *	2-4	
Y	US 2009/019773 A1 (GRUHN KLAUS [DE] ET AL) 22 January 2009 (2009-01-22) * paragraphs [0036], [0037]; figures 5-7 *	7-15	

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	6 July 2020	Rémondot, Xavier

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 20 15 4815

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