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(54) **METHOD AND SYSTEM FOR CONTROLLING AN ELECTRIC MOTOR FOR MOVING A CLOSURE ELEMENT WITH ANTI-PINCH REVERSAL**

(57) The invention relates to a method for controlling an electric motor (M) for moving a closure element (C), comprising: detecting a position (d) of the closure element (C); controlling the motor (M) for providing opening and closing movements according to user's commands, taking into account the detected position (d); detecting a pinch event in the case of an obstruction during a closing movement; controlling the motor (M) for providing a reversal movement, if a pinch event has been detected; wherein the controlling of the motor (M) for providing the reversal movement comprises in a normal operation of the detection of the position (d) of the closure element (C), controlling the motor (M) for providing the reversal movement until the position (d) reaches a predefined reversal target position. According to the invention, in the case of a failure of the detection of the position (d) of the closure element (C), the motor (M) is controlled for providing the reversal movement for a reversal time interval, which is calculated based on a detected reversal start speed of the closure element (C) after the start of the reversal movement, wherein in the case of a failure of the detection of the reversal start speed, the reversal time interval is alternatively calculated based on a detected closing speed of the closing element during the closing movement for which the pinch event has been detected, and wherein in the case of a failure of the detection of the closing speed the reversal time interval is alternatively calculated based on a predefined reversal speed.

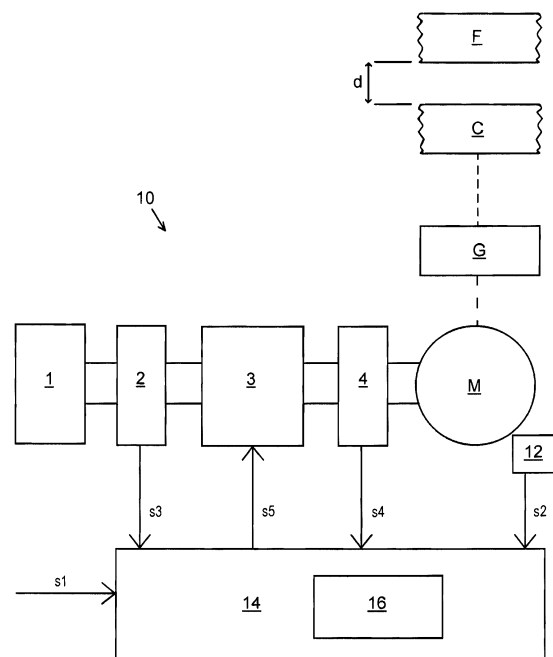


Fig. 1

Description

[0001] The present invention relates to a method and a system for controlling an electric motor for moving a closure element of a closing system.

[0002] Such methods and systems are known in the prior art, as for example for controlling an electric motor in a motor vehicle for sliding and/or tilting ("moving") a sunroof ("closure element") of the vehicle in a movement range between an opened position and a closed position. Such a known controlling method can comprise:

- detecting a position of the sunroof by means of a sensor signal representative of the position of the sunroof,
- controlling the motor for providing opening movements and closing movements of the sunroof according to user's commands, taking into account the detected position of the sunroof,
- detecting a pinch event in the case of an obstruction during a closing movement of the sunroof,
- controlling the motor for providing an anti-pinch reversal movement (towards the opened position) of the sunroof, if a pinch event has been detected.

[0003] In many countries exist legal regulations, according to which the sunroof position after an anti-pinch reversal movement must be at a specific distance from the front edge of the sunroof mechanics, for example a length distance for sliding movement, or a corresponding specific tilt angle distance for tilting movement.

[0004] In the case of a normal operation of the detection of the position of the sunroof, such a specific distance can be accomplished by controlling the motor for providing the reversal movement until the detected current position of the sunroof reaches a predefined "reversal target position", which can for example be stored in a memory (e.g. RAM) of the controlling system used.

[0005] In the case of a failure of the detection of the sunroof position, this reversal method does not work. However, during an error of the position detection, a specified reversal distance may be assured by using a "reversal time parameter" which is counted from the beginning of the reversal movement. At the point of error occurrence, the remaining travel distance is done in the remaining time. Such a reversal time parameter can be suitably dimensioned for the respective application and can be for example parametrized by application engineer as part of a parameter file used by the controlling system.

[0006] However, the reversal time parameter may not ensure sufficient distance between a sunroof panel and the front edge of the sunroof system. If the parameter is set to a very high value, the reversal distance may get too large and the mechanical system may get damaged. For most sunroof systems a so-called open block (a me-

chanical end travel) is not designed to withstand many full openings of the sunroof panel. Other sunroof systems do not foresee a mechanical stop in the opening travel direction. In this case the reversal movement based on the fixed reversal time parameter then damages the mechanics.

[0007] On the other hand, the reversal movement often is part of a safety mechanism with high priority, so that a fixedly predefined reversal time parameter cannot be shorter than a specific time interval.

[0008] Another problem of many prior art methods and systems is that they do not deal with short supply power losses, which may stop a reversal movement, for example until power is available again and a microcontroller has been reset.

[0009] It is an object of the present invention, to mitigate the above mentioned problems regarding an inaccuracy of the actually reached reversal end position in view of a required reversal target position.

[0010] According to the present invention, this object is solved by a method according to claim 1 and a system according to claim 6. The dependent claims are directed to advantageous embodiments of the invention.

[0011] Starting from a method according to the preamble of claim 1, the method according to the invention is characterized in that the controlling of the motor for providing the reversal movement further comprises:

- in the case of a failure of the detection of the current position of the closure element, controlling the motor for providing the reversal movement for a reversal time interval, which is calculated based on a detected reversal start speed ("open speed") of the closure element after the start of the reversal movement,

wherein in the case of a failure of the detection of the reversal start speed, the reversal time interval is alternatively calculated based on a detected closing speed of the closing element during the closing movement for which the pinch event has been detected,

wherein in the case of a failure of the detection of the closing speed the reversal time interval is alternatively calculated based on a predefined reversal speed (which can be generally expected for an opening movement as the reversal movement).

[0012] With the invention, it is advantageously possible to improve the accuracy of the reversal movement in terms of the end position reached by the closure element (e.g. a sunroof panel) at the end of the reversal movement. During a reversal movement with position detection error, in particular for closure systems (e.g. sunroof systems) without open block or with a mechanical weak open block, a damage can be advantageously avoided.

[0013] According to the invention, a preferred use of the inventive method or system is the control of an electric motor for moving a closure element of a closing system of a vehicle (e.g. car, lorry etc.), for example a sunroof panel or an other element of an openable roof system,

or a window, or a door providing access to a passenger compartment or a trunk etc. (e.g. driver's door, passenger's door, tailgate etc.).

[0014] The "detection of the position" of the closure element can be provided by using a sensor adapted to directly sense the position of the closure element. Alternatively, such sensor can be adapted to directly sense an operational position of the electric motor, for example a rotary position of the motor, which for example can be coupled via a mechanical gearing to the closure element, for converting rotary motor drive to a corresponding translational and/or tilting movement of the closure element.

[0015] The "sensor signal" representative of the current position of the closure element, as used in the invention, can be a counting signal as typically provided by commonly used position sensors. Strictly spoken, such sensor signal is often sensitive only to changes of the respective position and can for example "count" a number of incremental steps of positional changes ("counting signal"). A continuously updated counting result then indicates the position.

[0016] The "opening movements and closing movements" of the closure element according to user's commands shall mean displacements of the closure element in the opening direction or the closing direction, respectively. Such movements can be commanded e.g. to achieve a (fully) opened position or a (fully) closed position or an intermediate position of the closure element between the opened position and the closed position.

[0017] In an embodiment of the invention, an input of "user's commands" is possible by means of manually operable devices, e.g. as commonly used in form of switches, buttons, knobs etc. installed in a passenger compartment in a vehicle, or e.g. arranged on a mobile RF remote control device of a vehicle.

[0018] The opening movements and closing movements can be conducted with taking into account the detected current position of the closure element, so that the respective movement is stopped when the detected current position reaches a desired position ("target position").

[0019] The "detection of a pinch event" in the case of an obstruction during a closing movement of the closure element can for example foresee that a pinch event can be detected only in a predefined critical range of the movement range near the closed position, for example with a distance ("gap") between the closure element and a fixed element (e.g. front edge of a sunroof opening) of less than a predefined critical range parameter (e.g. 200 mm, or a corresponding tilt angle). Alternatively, the detection of a pinch event can be provided possible for the whole movement range.

[0020] The "anti-pinch reversal movement" in the case of an detected pinch event serves to open the closure element up to a predefined reversal target position.

[0021] The "reversal target position" can be predefined and/or used for example in a way, so that an absolute

value thereof (within the total movement range of the respective closure system) is dependent on the position at which the pinch event has occurred.

[0022] For example, if the pinch event has been detected for the closure element positioned within a critical range as mentioned above (near the fully closed position), the reversal target position can be for example defined as the position, which has a fixed distance (expressed as a length and/or a tilt angle, e.g. a length as 200 mm, or an angle as 20°, etc.) from the closed position (e.g. corresponding to the end of the critical range).

[0023] On the other hand, if the pinch event has been detected for the closure element positioned outside such a critical range, the reversal target position may be defined for example as a position, which has a fixed distance from the position at which the pinch event has been detected (but of course not going beyond the fully opened position of the respective closure system).

[0024] According to the invention, the controlling of the motor for providing the reversal movement in the case of a normal operation of the detection of the position of the closure element comprises a controlling the motor for providing the reversal movement until the current position of the closure element reaches a predefined reversal target position.

[0025] This can be realized for example by periodically or (more or less) continuously comparing a detected current position with the predefined reversal target position, and stopping the reverse movement when the reversal target position has been reached.

[0026] However, in the case of a failure of the detection of the current position of the closure element, the motor is controlled for providing the (remaining) reversal movement for a reversal time interval, which is calculated, if possible, based on a detected reversal start speed ("open speed") of the closure element.

[0027] The "reversal start speed" shall mean a speed of the closure element after the start of the reversal movement. This speed can be determined by dividing a reversal distance by a corresponding reversal time. Preferably, immediately after start of the reversal movement, a detection of such distance(s) or distance change(s), and such time(s) or time change(s), is conducted. If the position detection of the position of the closure element becomes erroneous during the reverse movement, the reversal start speed can be determined for example by dividing the total reversal distance (up to the occurrence of the failure) by the corresponding reversal time (up to the occurrence of the failure). Generally, the reversal start speed can be determined from detected reversal distance(s) (e.g. counted position steps) and reversal time(s) (e.g. counted time steps) right after the start of the reversal movement and/or from such distance(s) and time(s) detected during the subsequent reversal movement (until occurrence of the failure of position detection).

[0028] Then, the (remaining) reversal time interval can be calculated as the quotient between a (remaining) distance (up to the reversal target position) and the deter-

mined (calculated) reversal start speed.

[0029] However, in the case of a failure of the detection of the reversal start speed, the reversal time interval is alternatively calculated based on a detected closing speed of the closing element during the closing movement for which the pinch event has been detected.

[0030] The "closing speed" can be determined by dividing a closing distance by a corresponding closing time. Preferably, immediately after start of the closing movement, a detection of such distance(s) or distance change(s), and such time(s) or time change(s), is conducted. If then the pinch event is detected during the closing movement, the closing speed can be determined for example by dividing the total closing distance (up to the occurrence of the pinch event) by the corresponding closing time (up to the pinch event).

[0031] Then, the reversal time interval may be calculated as the quotient between a distance (up to the reversal target position) and the determined (calculated) closing speed.

[0032] However, preferably, the determined (calculated) closing speed is used for calculating an (estimated) "opening speed" or (estimated) "reversal speed". For example, such "opening speed" can be calculated as a function of the above mentioned closing speed. This can be realized for example by assuming the opening speed being proportional to the closing speed and thusly calculating the opening speed by multiplying the closing speed by a predefined (e. g. fixedly predefined) "speed factor".

[0033] Then, the reversal time interval can be calculated as the quotient between a distance (up to the reversal target position) and the determined (calculated) opening speed.

[0034] However, in the case of a failure of the detection of the closing speed (and thusly failure of determining an opening speed), the reversal time interval is alternatively calculated based on a predefined (expected) reversal speed.

[0035] In this case, a specified reversal distance can be assured by using a "reversal speed parameter", or equivalently by using a "reversal time parameter". A reversal time can be calculated as the quotient between the distance (up to the reversal target position) and the reversal speed. Then, a time counting from the beginning of the reversal movement can be conducted, and the necessary travel distance is done in the time until the end of the reversal time interval.

[0036] Such a reversal speed parameter or reversal time parameter can be suitably dimensioned for the respective application and can be for example parametrized by application engineer as part of a parameter file used by the controlling system.

[0037] In an embodiment, the controlling of the motor for providing the reversal movement further comprises: storing an information representative of the reversal target position in a RAM (Random-Access Memory) and/or storing an information representative of the calculated reversal time interval, in a (or the same) RAM, wherein

each RAM (or the RAM) is able to keep the information stored therein after a reset, but only for a short time interval.

[0038] Hereinafter, such a RAM is also called a "controlled RAM". Preferably, the short time interval is shorter than 10 s, in particular for example shorter than 5 s.

[0039] Advantageously, this embodiment enables to enhance the safety of the anti-pinch functionality in cases in which for example an operating power loss takes place during an anti-pinch reversal movement (resulting to a reset of the used control device comprising the controlled RAM).

[0040] In a further development of this embodiment, the method further comprises, in case of an initialization after an operating power loss ("power-on reset"), determining whether the controlled RAM has stored therein the (a "valid") information representative of the reversal target position and/or the (a "valid") information representative of the reversal time interval, and if so, starting an anti-pinch reversal movement of the closure element until the reversal target position is reached or until the reversal time interval has elapsed, respectively. To this end, the information retrieved after the reset from the controlled RAM can be advantageously used. According to a further aspect of the present invention, a controlling system for controlling an electric motor for moving a closure element of a closing system is provided, wherein the controlling system is adapted to conduct a controlling method as described therein.

[0041] According to a further aspect of the present invention, a controlling system for controlling an electric motor for moving a closure element of a closing system in a movement range between an opened position and a closed position is provided, wherein the controlling system comprises:

- a position sensor device adapted to detect a position of the closure element, providing a sensor signal representative of the position of the closure element,
- a control device adapted to control the motor for providing opening movements and closing movements of the closure element according to user's commands, taking into account the detected position of the closure element,
- a pinch event detecting device adapted to detect a pinch event in the case of an obstruction during a closing movement of the closure element,

wherein the control device is further adapted to control the motor for providing an anti-pinch reversal movement of the closure element, if a pinch event has been detected, and wherein the controlling of the motor for providing the reversal movement comprises:

- in the case of a normal operation of the detection of the position of the closure element, controlling the

motor for providing the reversal movement until the current position of the closure element reaches a predefined reversal target position,

characterized in that the controlling of the motor for providing the reversal movement further comprises:

- in the case of a failure of the detection of the current position of the closure element, controlling the motor for providing the reversal movement for a reversal time interval, which is calculated based on a detected reversal start speed of the closure element after the start of the reversal movement,

wherein in the case of a failure of the detection of the reversal start speed, the reversal time interval is alternatively calculated based on a detected closing speed of the closing element during the closing movement for which the pinch event has been detected, wherein in the case of a failure of the detection of the closing speed the reversal time interval is alternatively calculated based on a predefined expected reversal speed.

[0042] The embodiments and specific details described here for the method according to the invention can be provided, in an analogous manner, individually or in any combination, as embodiments or specific details of the device according to the invention, and vice versa.

[0043] In an embodiment of the controlling system according to the invention, the position sensor device is formed by a rotary sensor providing a sensor signal representative of a current rotary position of the motor.

[0044] In an embodiment, the control device is formed by a software-controlled computing device with interfaces for an input of the user's commands and the position sensor signal and for an output of a drive control signal for driving the motor.

[0045] In an embodiment, the pinch event detecting device is realized by means of a software-controlled computing device with an interface for an input of one or more signals representative of one or more operational parameters of the operation of the motor.

[0046] The invention will now be described by way of an exemplary embodiment with reference to the accompanying drawings, in which

Fig. 1 shows a schematic block diagram of a controlling system, and

Figs. 2 to 5 show a flowchart of a controlling method conducted by the controlling system of Fig. 1.

[0047] Fig. 1 shows a controlling system 10 for controlling an electric motor M for moving a closure element C of a closing system, for example a sunroof panel of an openable roof system of a vehicle.

[0048] The controlling system 10 controls the motor M for providing movements of the closure element C, for

example sliding movements, in a movement range between an opened position and a closed position.

[0049] Fig. 1 illustrates a current position of the moveable closure element C characterized by a "distance d" between the closure element C and a fixed element F. If the closure element C is a slideable sunroof panel, the distance d assumes a maximum value for the opened position and a minimum value ($d = 0$) for the closed position.

[0050] In the shown example, the closure element C is coupled to the motor M via a gearing mechanism G providing for a conversion of a rotational movement of the motor M into a translational movement (sliding) of the closure element C.

[0051] The controlling system 10 comprises a position sensor device 12 adapted to detect the position d of the closure element C, providing a sensor signal s2 representative of the current position d of the closure element C.

[0052] In the shown example, the position sensor device 12 is a Hall sensor device comprising at least one Hall sensor for detecting the current rotational position of the motor M and thusly the current position d of the closure element C.

[0053] The controlling system 10 further comprises a control device 14 adapted to control the motor M for providing opening movements (increasing "d") and closing movements (decreasing "d") of the closure element C according to user's commands, taking into account the detected current position d of the closure element C.

[0054] In the shown example, the control device 14 is implemented as a software-controlled computing device (e.g. microcontroller) for digitally processing of input signals as for example the Hall sensor signal s2 and a command signal s1 representing user's commands and generating output signals as for example a drive control signal s5 for driving the motor M.

[0055] In the shown example, the drive of the motor M is provided as a PWM (pulse width modulation) drive, using a PWM drive circuit arrangement comprising an electric power supply 1, a first measuring device 2, a PWM driver 3 and a second measuring device 4, as shown in Fig. 1.

[0056] In an application on-board of a vehicle (e.g. for controlling an openable roof system, a window, or a tailgate), the electric power supply 1 can be made up of an electric battery or an electrical on-board system ("board-net") comprising such battery. In the example, the power supply 1 provides a DC supply voltage to an input side of the PWM driver 3, wherein the first measuring device 2 provides a sensor signal s3 representative of at least one electric operational parameter, as e.g. the electric voltage and/or the electrical current supplied to the PWM driver 3. The PWM driver 3 generates one or more pulse width modulated motor voltages supplied to the motor M, based on the drive control signal s5 provided by the control device 14. The second measuring device 4 provides a sensor signal s4 representative of at least one electrical

operational parameter, as for example the motor voltage(s) and/or corresponding motor current(s).

[0057] The controlling system 10 further comprises a pinch event detecting device 16 adapted to detect a pinch event in the case of an obstruction during a closing movement of the closure element C, and the control device 14 is adapted to control the motor M for providing an anti-pinch reversal movement of the closure element C, if a pinch event has been detected.

[0058] In the shown example, the pinch event detecting device 16 is implemented by means of software as a functionality of the control device 14. As to the working principle of the pinch event detecting device 16, there exist many technical solutions in the prior art, which can be used also in the shown control device 14.

[0059] In particular, this working principle can for example rely on the fact that an obstruction during a closing movement of the closure element C causes a sudden slowdown of the closing movement speed and a sudden increase of a mechanical force counteracting the closing movement.

[0060] Such a slowdown may be detected for example by an evaluation of the time-dependent position (here: Hall) sensor signal s2, and such an increased counteracting force may be detected for example by means of an evaluation of the electrical operational parameter(s) provided by means of the sensor signal s3 and/or sensor signal s4 (e.g. sudden increase of motor current).

[0061] Upon a detection of a pinch event, the control device 14 changes the drive control signal s5 so that the rotational direction of the motor M is reversed for providing the reversal movement of the closure element C (in the opening direction).

[0062] The controlling of the motor M for providing the reversal movement in the case of a normal operation of the detection of the position d of the closure element C comprises controlling the motor M for providing the reversal movement until the detected current position d of the closure element C reaches a predefined "reversal target position".

[0063] To this end, the control device 14 continuously (periodically in small time intervals) checks whether the current position d has already reached the reversal target position or not, and causes a continued moving of the closure element C until the target has been reached.

[0064] In the case of a failure of the detection of the current position d of the closure element C, however, the control of the motor M provides the reversal movement for a "reversal time interval", which is calculated based on a detected reversal start speed of the closure element C after the start of the reversal movement.

[0065] In the shown example, to this end, the control device 14 continuously monitors the position d during the reversal movement and counts the time of reverse movement, as long as possible (error-free position sensor signal s2). When then the failure of the detection of the position d occurs, the control device 14 calculates the "reversal (start) speed" as the quotient between the distance

travelled so far and the time required for this travel of the reversal movement. Then, the control device 14 calculates a "distance till target", which remains to be travelled for reaching the reversal target position and consequently can calculate the reversal time interval as the quotient between the distance till target and the reversal speed.

[0066] However, in the case of a failure of the detection of the reversal start speed, the reversal time interval is alternatively calculated based on a detected closing speed of the closing element C during the closing movement for which the pinch event has been detected, wherein in the case of a failure of the detection of the closing speed the reversal time interval is alternatively calculated based on a predefined expected reversal speed.

[0067] In the shown example, upon each start of a closing movement, the control device 14 monitors the distance travelled so far and the time required for this travel of the closing movement. This enables the control device 14 to calculate the closing speed, if required. The closing speed can be calculated as the quotient between the distance travelled so far and time required for this in the closing movement. Although this calculated closing speed may be used as the above mentioned reversal speed for calculating a distance till target, in the shown example the reversal time interval is calculated based on the assumption of a reversal speed which is different from the closing speed and thusly is calculated from the closing speed. In the example, the reversal speed is calculated as the product of the closing speed and a "speed factor" reflecting a typical deviation between closing speed and opening speed of the respective closure system. Given such calculated reversal speed ("speed open"), the reversal time interval can be again calculated as the quotient between the distance till target and the reversal speed.

[0068] The Fig. 2 to 5 show a schematic flow chart of the controlling method conducted by the system 10 shown in Fig. 1. The method starts with a step "Start closing movement" shown in Fig. 2.

[0069] In view of the above explanations, the flow chart shown in the Figs. 2 to 5 is self-explanatory. Therefore, in the following only some details of the algorithm defined by this flow chart, which are not explicitly explained above, will be dealt with. Each of such details provided in the shown example can be advantageously provided also in general, i.e. as a particular embodiment of the present invention.

[0070] As for example shown in Fig. 2, a decision step "Start movement time passed?" is provided to determine, whether upon a start of the electric motor sufficient time has passed, so that a detectable operational movement of the motor can be expected or not. In practice, the start movement time can be predefined for example lying in a range of 1 ms to 100 ms.

[0071] As shown in Fig. 4, a decision step "Block event?" is provided to determine during the reversal movement for a reversal time interval, whether at any time (before the reversal time interval has passed) a

blocking of the motor occurs (e.g. recognized, if no position counting pulse is detected within a predefined time interval (e.g. 200 ms)). If so, the movement is stopped and the motor will be "relaxed", i.e. driven in the opposite direction (closing direction) for a short time (to relax the mechanics in the path from the motor to the closure element). If no such blocking has occurred and the reversal time interval has passed, the movement is also stopped (but without relaxation). In practice, a relaxation time interval can be predefined for example lying in a range of 100 ms to 500 ms.

[0072] As shown in Fig. 5, such a decision step "Block event?" can also be provided to determine whether a blocking of the motor occurs during the reversal movement until the detected current position of the closure element reaches the predefined reversal target position. If so, the movement is stopped and the motor will be relaxed.

[0073] In summary, with the invention and the described embodiment, the reversal movement of the closure element after a pinch event continues even if a counting mechanism (position detection by counting small increments of the respective movement) fails or a short power loss happens during the reversal movement. In case the counting mechanism fails, the closure element advantageously continues the reversal for a time interval which is calculated out of the speed of the started reversal movement or, if not available, out of the open speed. The open speed of the closure element is calculated out of the speed of the closing movement for which the pinch event has occurred. If the closing speed is not available, the open speed is a parameter retrieved from a memory (e.g. RAM) of the used control device (and specified during the parametrization process for the software controlling the control device). For dealing with short power losses, the reversal target position of the reversal movement is preferably stored into a controlled RAM. For handling the case in which the current position of the closure element is not available (for comparing it with the reversal target position of the reversal movement), also the calculated reversal time interval is preferably stored into the controlled RAM. Advantageously, on each system initialization after a power loss (power-on reset), if one of these stored variables is available, then a reversal movement starts and continues until the reversal target position is reached or until the reversal time interval (previously retrieved from the controlled RAM) has elapsed.

[0074] With the invention, it is advantageously possible to assure a required reversal distance in the real environmental situations, when a position detection (e.g. position counting) is no longer possible. It can also assure a suitable reversal continuation after a short power drop. In this way, the invention provides a safety mechanism with improved precision and reliability. Further, it can be advantageously assured that an open block or a similar device for mechanical restriction of the opening movement is never reached due to a reversal movement with

nonfunctional position detection (e.g. position counting mechanism).

5 Claims

1. A method for controlling an electric motor (M) for moving a closure element (C) of a closing system in a movement range between an opened position and a closed position, wherein the method comprises:

- detecting a position (d) of the closure element (C) by means of a sensor signal representative of the position (d) of the closure element (C),
- controlling the motor (M) for providing opening movements and closing movements of the closure element (C) according to user's commands, taking into account the detected position (d) of the closure element (C),
- detecting a pinch event in the case of an obstruction during a closing movement of the closure element (C),
- controlling the motor (M) for providing an anti-pinch reversal movement of the closure element (C), if a pinch event has been detected,

wherein the controlling of the motor (M) for providing the reversal movement comprises:

- in the case of a normal operation of the detection of the position (d) of the closure element (C), controlling the motor (M) for providing the reversal movement until the current position (d) of the closure element (C) reaches a predefined reversal target position,

characterized in that the controlling of the motor (M) for providing the reversal movement further comprises:

- in the case of a failure of the detection of the current position (d) of the closure element (C), controlling the motor (M) for providing the reversal movement for a reversal time interval, which is calculated based on a detected reversal start speed of the closure element (C) after the start of the reversal movement,

wherein in the case of a failure of the detection of the reversal start speed, the reversal time interval is alternatively calculated based on a detected closing speed of the closing element during the closing movement for which the pinch event has been detected,

wherein in the case of a failure of the detection of the closing speed the reversal time interval is alternatively calculated based on a predefined reversal speed.

2. The method according to claim 1, wherein the controlling of the motor (M) for providing the reversal movement further comprises:

- storing an information representative of the reversal target position in a controlled RAM. 5

3. The method according to claim 1 or 2, wherein the controlling of the motor (M) for providing the reversal movement further comprises: 10

- storing an information representative of the calculated reversal time interval, in a controlled RAM. 15

4. The method according to claim 2 or 3, wherein the method further comprises:

- in case of an initialization after an operating power loss, determining whether the controlled RAM has stored therein the information representative of the reversal target position and/or the information representative of the reversal time interval, and if so, starting an anti-pinch reversal movement of the closure element (C) until the reversal target position is reached or until the reversal time interval has elapsed, respectively. 20 25

5. A controlling system (10) for controlling an electric motor (M) for moving a closure element (C) of a closing system, adapted to conduct a method according to any of claims 1 to 4. 30

6. A controlling system (10) for controlling an electric motor (M) for moving a closure element (C) of a closing system in a movement range between an opened position and a closed position, wherein the controlling system (10) comprises: 35 40

- a position sensor device (12) adapted to detect a position (d) of the closure element (C), providing a sensor signal (s2) representative of the position (d) of the closure element (C),
- a control device (14) adapted to control the motor (M) for providing opening movements and closing movements of the closure element (C) according to user's commands (s1), taking into account the detected current position (d) of the closure element (C),
- a pinch event detecting device (16) adapted to detect a pinch event in the case of an obstruction during a closing movement of the closure element (C), 45 50 55

wherein the control device (14) is further adapted to control the motor (M) for providing an anti-pinch reversal movement of the closure element (C), if a

pinch event has been detected, and wherein the controlling of the motor (M) for providing the reversal movement comprises:

- in the case of a normal operation of the detection of the position (d) of the closure element (C), controlling the motor (M) for providing the reversal movement until the current position (d) of the closure element (C) reaches a predefined reversal target position,

characterized in that the controlling of the motor (M) for providing the reversal movement further comprises:

- in the case of a failure of the detection of the current position (d) of the closure element (C), controlling the motor (M) for providing the reversal movement for a reversal time interval, which is calculated based on a detected reversal start speed of the closure element (C) after the start of the reversal movement,

wherein in the case of a failure of the detection of the reversal start speed, the reversal time interval is alternatively calculated based on a detected closing speed of the closing element during the closing movement for which the pinch event has been detected,

wherein in the case of a failure of the detection of the closing speed the reversal time interval is alternatively calculated based on a predefined expected reversal speed.

7. The controlling system (10) according to claim 6, wherein the position sensor means (12) is formed by a rotary sensor providing a sensor signal (s2) representative of a current rotary position of the motor (M). 40

8. The controlling system (10) according to claim 6 or 7, wherein the control device (14) is formed by a software-controlled computing device with interfaces for an input of the user's commands (s1) and the sensor signal (s2) and for an output of a drive control signal (s5) for driving the motor (M). 45

9. The controlling system (10) according to any of claims 6 to 8, wherein the pinch event detecting device (16) is realized by means of a software-controlled computing device with an interface for an input of one or more signals (s3, s4, s2) representative of one or more operational parameters of the operation of the motor (M). 50 55

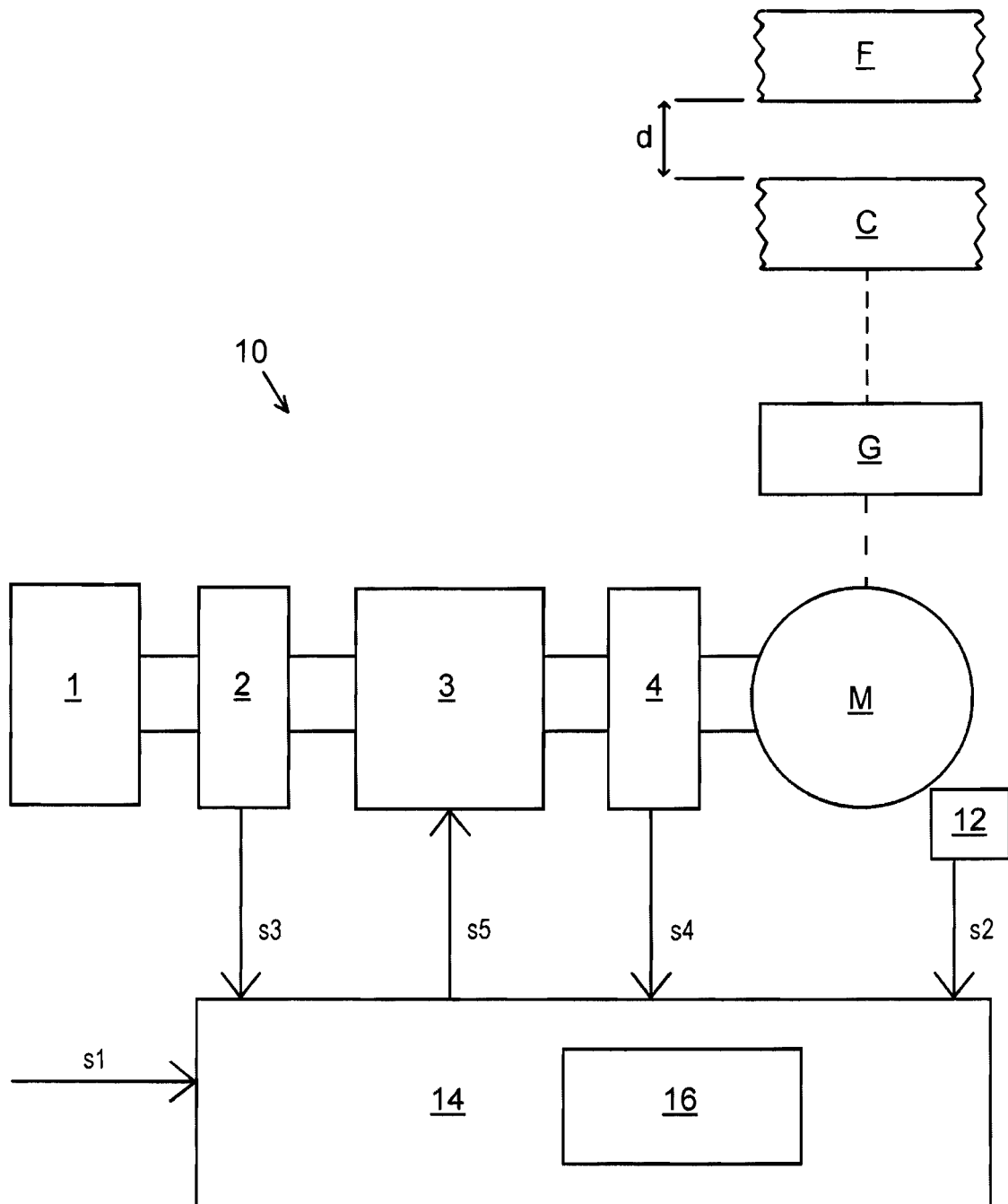


Fig. 1

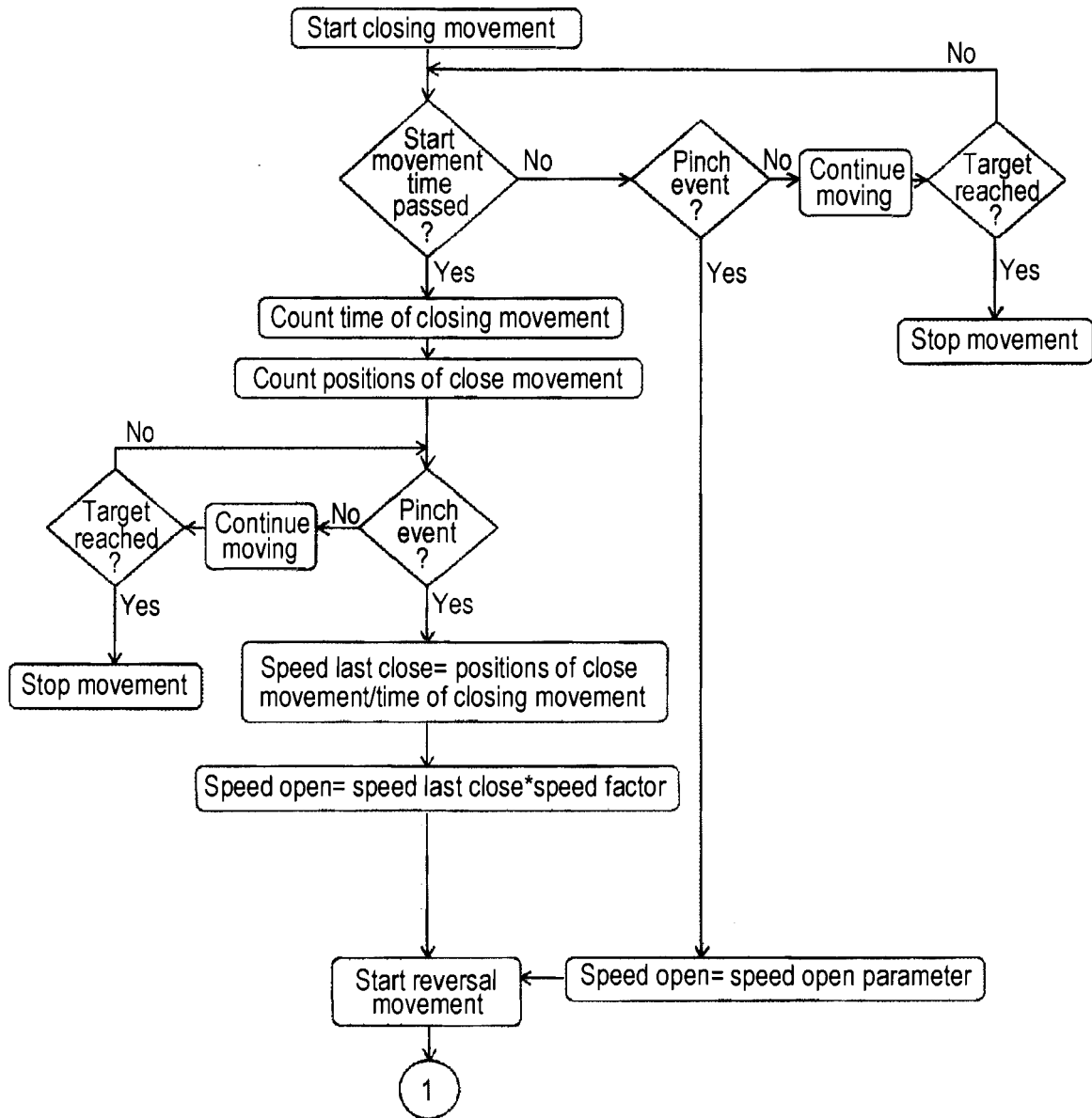
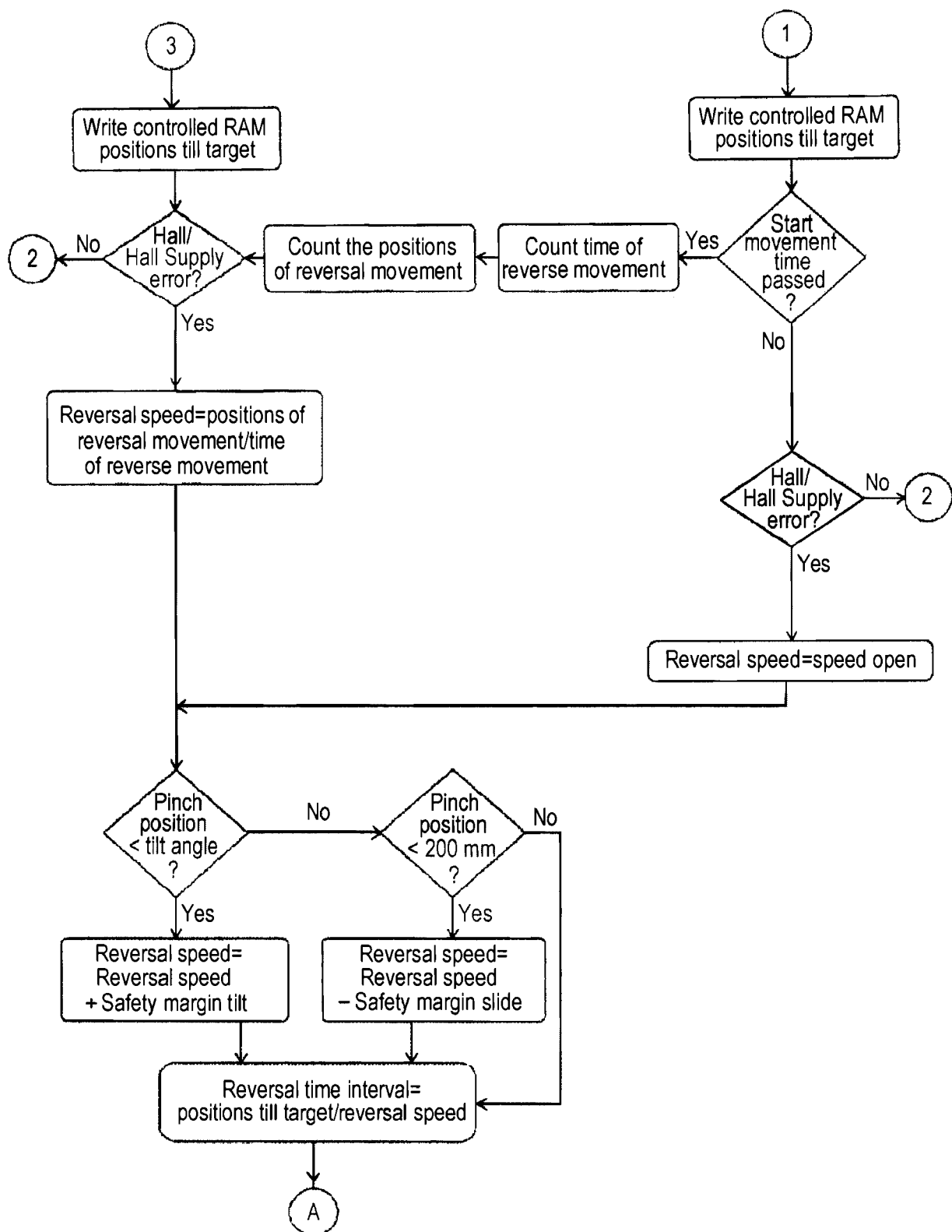
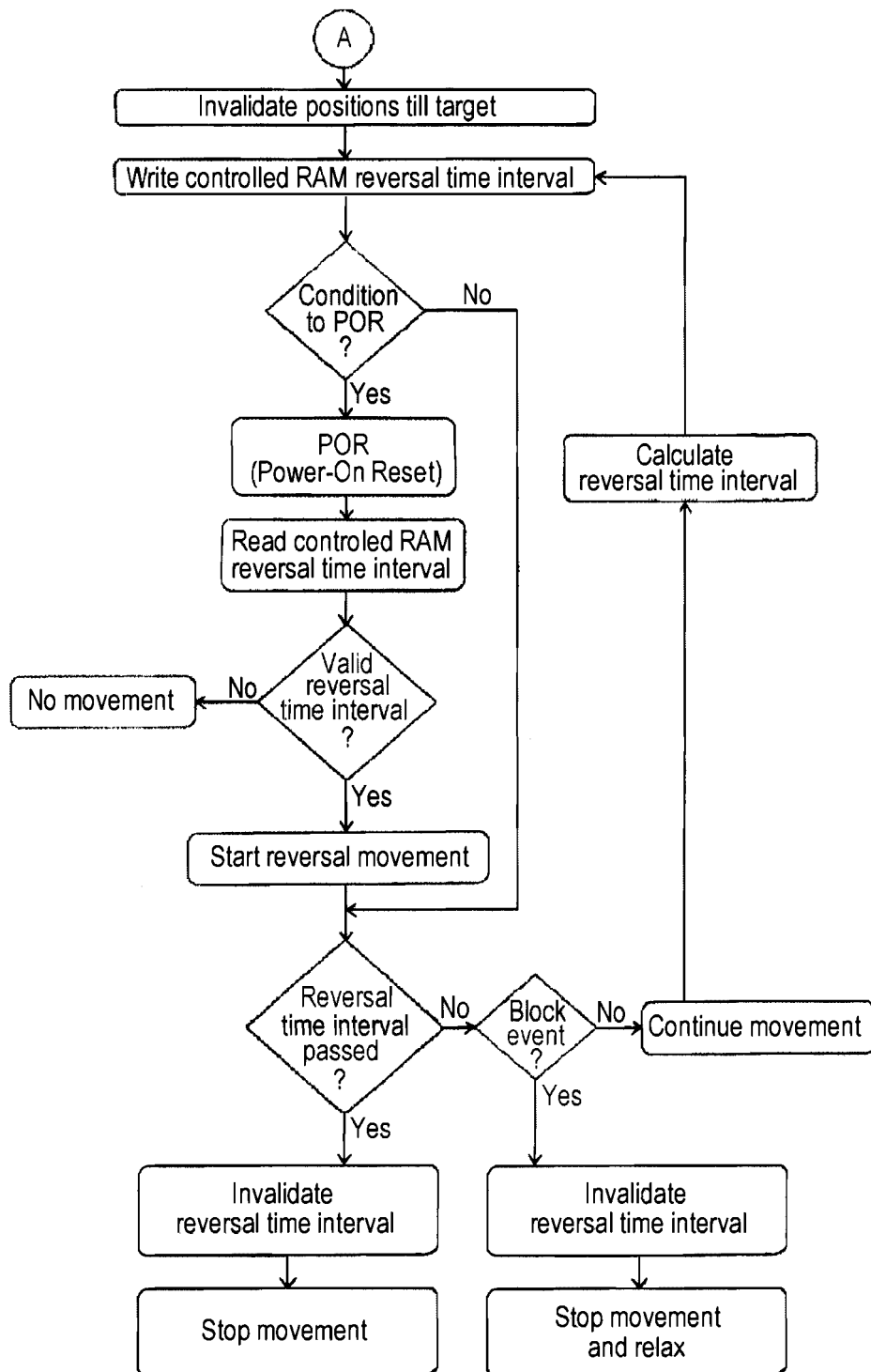


Fig. 2

**Fig. 3**

**Fig. 4**

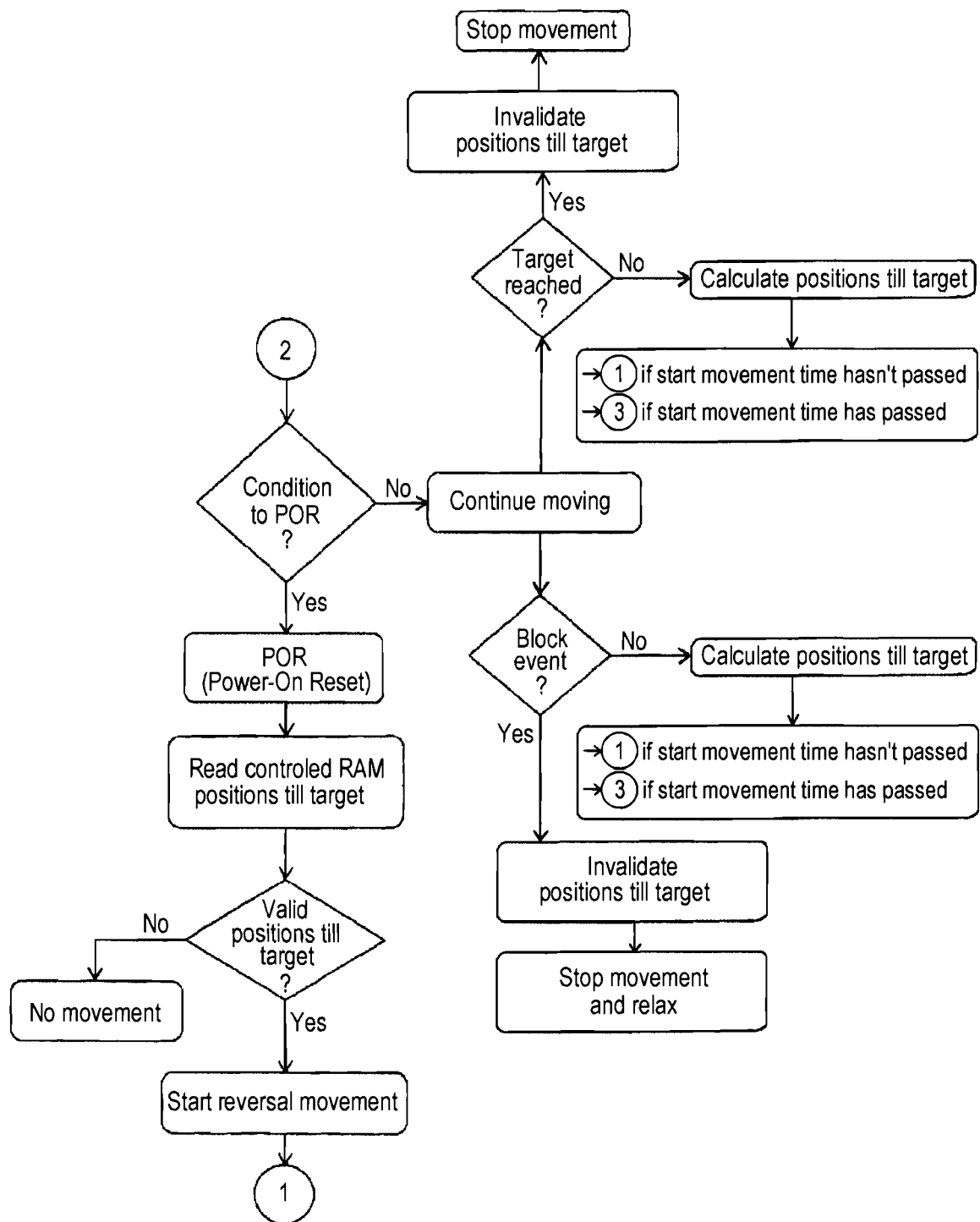


Fig. 5



EUROPEAN SEARCH REPORT

Application Number
EP 19 18 8059

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 6 972 536 B2 (ASMO CO LTD [JP]) 6 December 2005 (2005-12-06) * column 1, line 15 - column 2, line 43; figure 9 * * column 8, line 6 - column 14, line 49; figures 1-9 *	1-9	INV. E05F15/40
Y	DE 10 2018 104045 B3 (ASSA ABLOY SICHERHEITSTECHNIK GMBH [DE]) 29 May 2019 (2019-05-29) * paragraphs [0002] - [0044]; figure 1 *	1-9	
Y	EP 2 657 442 A1 (RIB LAB INC [JP]; HONDA MOTOR CO LTD [JP]) 30 October 2013 (2013-10-30) * paragraphs [0063] - [0073]; figures 1-15 *	1-9	
Y	US 8 341 885 B2 (DYNACO EUROP [BE]; BOSTYN FREDERIC [BE]) 1 January 2013 (2013-01-01) * the whole document *	1,5,6	TECHNICAL FIELDS SEARCHED (IPC) E05F
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 20 January 2020	Examiner Boufidou, Maria
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 19 18 8059

5 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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20-01-2020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6972536 B2	06-12-2005	DE 10260588 A1 US 2003122516 A1	17-07-2003 03-07-2003
DE 102018104045 B3	29-05-2019	NONE	
EP 2657442 A1	30-10-2013	CN 103124827 A EP 2657442 A1 JP 5398920 B2 JP W02012086555 A1 US 2013106435 A1 WO 2012086555 A1	29-05-2013 30-10-2013 29-01-2014 22-05-2014 02-05-2013 28-06-2012
US 8341885 B2	01-01-2013	BR PI1107019 A2 CA 2753254 A1 CN 102409920 A HK 1168883 A1 JP 6055965 B2 JP 2012067590 A RU 2011138933 A US 2012073200 A1	24-04-2013 23-03-2012 11-04-2012 09-12-2016 11-01-2017 05-04-2012 27-03-2013 29-03-2012