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(54) **WINDOW ACTUATOR WITH OBSTACLE DETECTION**

(57) An electrically operated actuator (10) for operating a window (1), the window comprising a frame (2) and a sash (3) being pivotally suspended from the frame (2) by a horizontal pivot axis. The actuator (10) is adapted to perform a first closing operation (101) while monitoring an indicator of a closing force applied onto the sash (3) by the actuator (10). The actuator is adapted to initiate a first reversing operation (102) upon the indicator of closing force exceeding a threshold during the first closing operation (101), and the actuator (10) is configured to initiate a subsequent, second closing operation (104) after the first reversing operation (102). The threshold is selected from a plurality of predetermined thresholds.

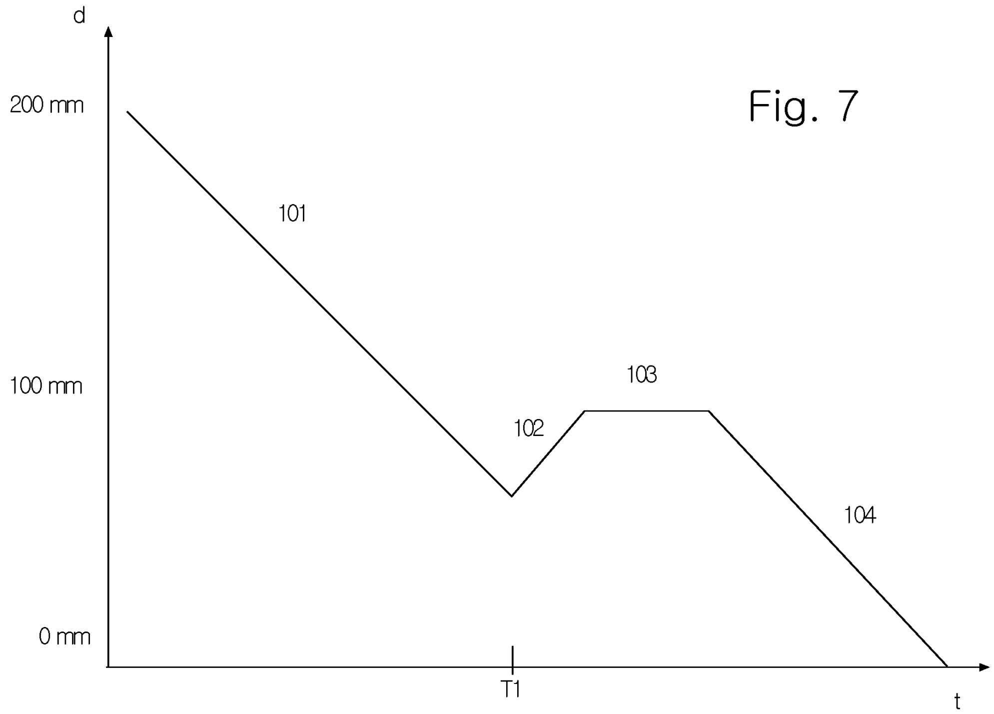

Fig. 7

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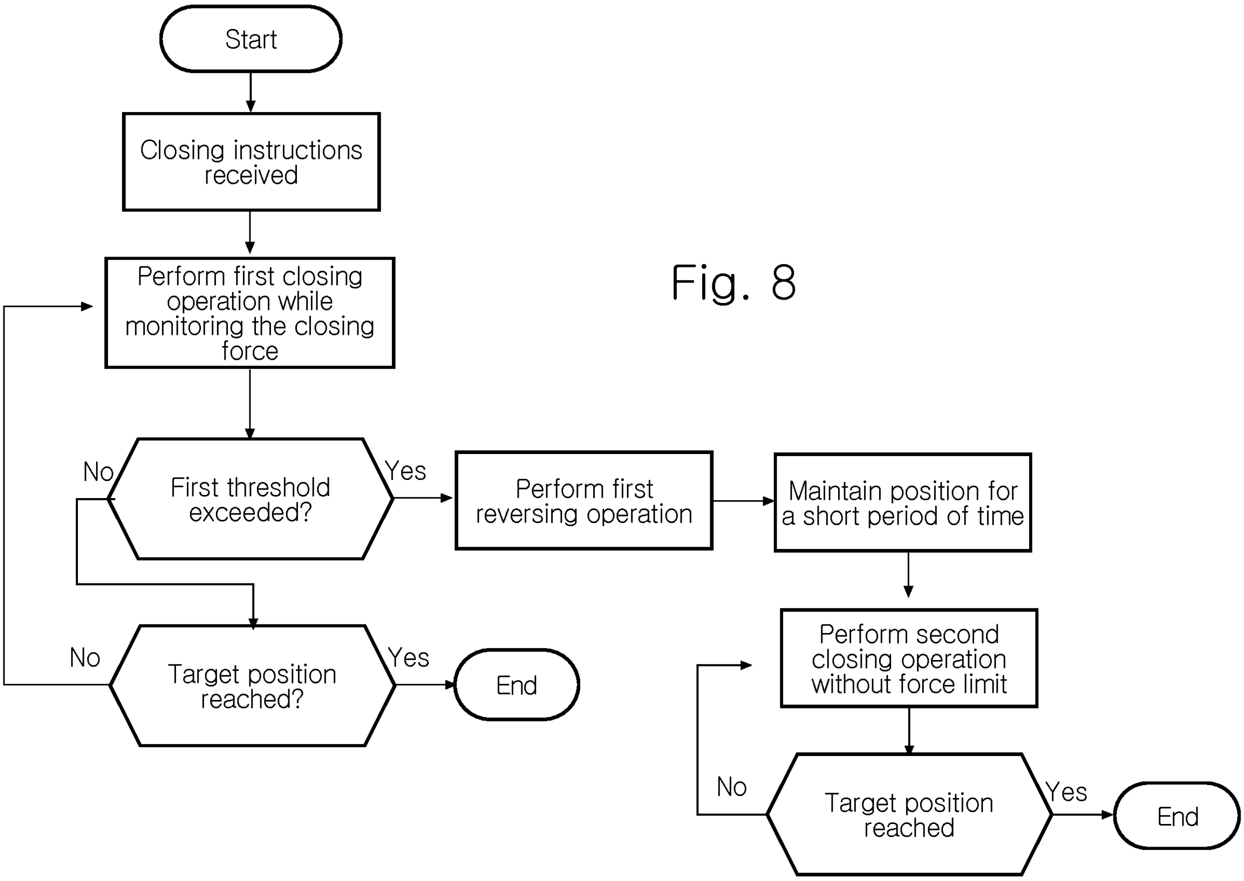
Start
Closing instructions received
Perform first closing operation while monitoring the closing force
First threshold exceeded?
No
Yes
Perform first reversing operation
Maintain position for a short period of time
Perform second closing operation without force limit
Target position reached?
No
Yes
End
Target position reached
No
Yes
End

Fig. 8

Description

TECHNICAL FIELD

[0001] This disclosure relates to a window having an electrically pivotable sash and the electrically operated actuator used for operating such a sash. Particularly, the disclosure relates to anti-pinch sensing and control of the movement of the sash.

BACKGROUND

[0002] EP 2754820 discloses a pivotable window with an actuator on each side. Each actuator has a safety strip on the actuator housing to detect an object entrapped between the actuator housing and the window frame.

[0003] EP 1441100 discloses a pivotable window without pinch detection. Instead, the closing movement is performed stepwise to increase the attention of the person nearby and to limit the risk of pinching.

[0004] However, due to various reasons which are explained below, it has shown to be difficult to provide a reliable pinch detection, which also is cost effective. Further, it is an object to provide an actuator, which is easy to retrofit to a window that is already installed in a building.

[0005] Different window sizes may use the same actuator drive, yet require different closing forces. The final closing movement of a window sash creates a spike in the closing force needed to compress the gasket between the frame and sash.

[0006] Wind or draft can also change the closing force needed. Some pivotable windows such as roof windows may be installed in differently sloped roofs and consequently the force requirements may differ. Further, snow may change the weight of the window sash temporarily and hence the closing force needed. Likewise, the window may be retrofitted with a blind or a shutter which also changes the weight of the sash. As a window ages, the resistance (friction) and closing forces also change.

SUMMARY

[0007] It is an object of the invention to solve or at least reduce the problems indicated above, and to provide a solution which compensates for sample tolerances, installation differences, and wear and tear of a roof window.

[0008] This object is achieved according to a first aspect by an electrically operated actuator for operating a window, the window comprising a frame and a sash being pivotally suspended from the frame by a horizontal pivot axis, the actuator being adapted to perform a first closing operation while monitoring an indicator of a closing force applied onto the sash by the actuator, the actuator being adapted to initiate a first reversing operation upon the indicator of closing force exceeding a threshold during the first closing operation, and the actuator being configured to initiate a subsequent, second closing operation after the first reversing operation, the threshold being selected from a plurality of predetermined thresholds.

[0009] By closing the window with the force limited to a relatively low first threshold a pinching event or entrapment event can be detected without large force being applied to the trapped or pinched object. The reversing action allows the trapped or pinched object to be removed, before the second closing action takes place. The second closing action can be carried out with a higher threshold allowing a larger force to be applied to the window. This larger force may be necessary due to excessive friction or wind conditions. Thus, proper closing of the window is ensured whilst the risk of injury to e.g. fingers or other body parts of a person is reduced since the person will have a chance to remove their hand, fingers or other body part during the reversing operation. Thus, there is provided an enhanced entrapment detection, which does not terminate the closing operation due to false pinching signals caused, e.g., by strong winds. Further, it is ensured that the window closes while still allowing trapped objects to escape. Also, the force threshold is adapted to current conditions, e.g. allowing a higher threshold when the closing action is executed at a higher speed.

[0010] In a first possible implementation form of the first aspect, the actuator is configured to monitor the indicator of closing force during the second closing operation, adapted to initiate a second reversing operation upon the indicator of closing force exceeding a threshold during the second closing operation, and further configured to initiate a subsequent, third closing operation after the second reversing operation, the threshold being selected from a plurality of predetermined thresholds.

[0011] In a second possible implementation form of the first aspect, the actuator is driven by an electric drive motor and the threshold is selected in response to the speed of the electric drive motor and/or a position of the sash.

[0012] In a third possible implementation form of the first aspect, each speed of the electric drive motor belongs to one of a plurality of predetermined speed ranges.

[0013] In a fourth possible implementation form of the first aspect, the plurality of sash speed ranges comprises of at least a low-speed range and a high-speed range.

[0014] In a fifth possible implementation form of the first aspect, the speed of the electric drive motor is selected in response to the position of the sash, each sash position belonging to one of a plurality of predetermined position zones.

[0015] In a sixth possible implementation form of the first aspect, the plurality of predetermined position zones comprises of at least an open position zone, a near closed position zone, and a visually closed position zone.

[0016] In a seventh possible implementation form of the first aspect, a compressible seal or gasket is arranged between the frame and the sash, the seal or gasket bridging at least a part of the visually closed position zone.

[0017] In an eight possible implementation form of the first aspect, the monitoring of the indicator of closing force is disengaged when the sash reaches the visually closed position zone.

[0018] In a ninth possible implementation form of the first aspect, a very highest threshold is selected when the electric drive motor speed is in the high-speed range and/or the sash is in the open position zone.

[0019] In a tenth possible implementation form of the first aspect, a lowermost threshold is selected when the electric drive motor speed is in the low-speed range and/or the sash is in the near closed position zone.

[0020] In an eleventh possible implementation form of the first aspect, the indicator of closing force comprises a calculation of a rate of change in electric current consumed by the electric drive motor.

[0021] In a twelfth possible implementation form of the first aspect, the electric current is filtered by means of a signal processing unit prior to calculating the rate of change.

[0022] In a thirteenth possible implementation form of the first aspect, a filter parameter of the signal processing unit is selected from a plurality of predetermined filter parameters.

[0023] The foregoing and other objects are achieved by the features of the independent claim. Further implementation forms are apparent from the dependent claims, the detailed description, and the figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] In the following detailed portion of the present disclosure, the invention will be explained in more detail with reference to the example embodiments shown in the drawings, in which:

Fig. 1 illustrates an example embodiment of a pivoting roof window with a chain actuator,

Fig. 2 illustrates an example of a pivoting roof window with an exterior sun screening installed,

Fig. 3 is a diagrammatic illustration of a window actuator with a control unit,

Fig. 4 is an elevated view of the window actuator of Fig. 3,

Fig. 5 is an elevated cutaway view of a portion of the window actuator of Fig. 3,

Fig. 6 shows an example of measured motor current, a low-pass filtered motor current, a filtered current derivative, and a filtered current derivative threshold of the motor of the window actuator,

Fig. 7 is a graph illustrating a closing procedure for a window with a window actuator,

Fig. 8 is a flowchart illustrating the closing procedure of Fig. 7,

Fig. 9 is a graph illustrating another closing procedure for a window with a window actuator,

Fig. 10 is a flowchart illustrating the closing procedure of Fig. 9,

Fig 11. illustrates the open position zone, the near closed position zone, the visually closed position zone, and the fully closed position of a pivoting roof window, and

Fig. 12a, 12b, and 12c illustrate an example embodiment of a section of a pivoting roof window in a near closed position, a visually closed position, and a fully closed position, respectively.

DETAILED DESCRIPTION

[0025] Fig. 1 illustrates a roof window 1 with top hung rectangular sash 3 with a window pane 4 therein and a matching rectangular frame 2, i.e. the sash 3 is pivotally connected to the frame 2 along its top member by a hinge for pivotal movement of the sash 3 between a closed position D and any number of open positions. Fig. 2 illustrates a roof window 1 with a pivot hung sash 3 and a matching rectangular frame 2. The roof window 1 of Fig. 2 is provided with an exterior sun screening 6.

[0026] The roof window of Fig. 1 and Fig. 2 is provided with a compressible gasket (shown in Fig. 12) between the rectangular sash 3 and the rectangular frame 2. The compressible gasket is tightly compressed or deformed between the rectangular sash 2 and the rectangular gasket 3 when the roof window 1 is fully closed. The roof window is further provided with an actuator for moving the window i.e. moving the sash 3 between an open position and a fully closed position D (see Fig. 11 and Fig. 12c). The actuator can be any suitable type of actuator, e.g. a push-pull (thrust) chain actuator such as that shown in Fig. 1. The actuator itself can be installed in or on the frame 2, or in or on the sash 3. The actuator need not be installed at the bottom member of a window as shown in Fig. 1, but could be installed at the opposite side, i.e. the top member of the window.

[0027] The sash 3 is pivotally suspended from the frame 2 by a horizontal pivot axis and, when pivoted, positioned in one of an open position zone A, a near closed position zone B, and a visually closed position zone C, see Fig. 11 and Fig. 12a-c. The compressible seal or gasket 5, provided between frame and sash, bridges at least a part of the visually closed position zone C. When the sash 3 is locked, it is in the fully closed position D. In the visually closed position C, the gasket and lock are about to engage with a corresponding window component.

[0028] In one embodiment, the distance d between the frame 2 and a section of the sash 3 is at least 25 mm when the sash is in the open position zone A. The distance d is shown schematically in Fig. 12a. The visually closed zone C extends from the frame 2 and at least up to an outer limit of the seal or gasket 5, in one embodiment past the outer limit of the seal or gasket 5, such that the seal or gasket 5 bridges at least a part of the visually closed zone C. In the visually closed zone, the window appears to be closed and it is nearly impossible to become trapped between the sash 3 and the frame 2. In the nearly closed position zone, the seal or gasket 5 is always uncompressed.

[0029] For illustration purposes, a roof window has been shown in Figs. 1 and 2, but it is understood that the actuator can be used also for other types of windows, particularly for any other type of top hung or pivot hung window. The actuator is particularly suitable for retrofitting onto an existing window, e.g. a manually operated window, since it does not require additional components such as special locks or external sensors.

[0030] Figs. 3 to 5 shows an embodiment of an actuator 10 in the form of a push-pull chain actuator with a push-pull chain 11. However, it is understood that the actuator can be of another type, in particular any type of linear actuator such as e.g. a spindle actuator. The actuator 10 comprises a housing 15 that holds an electric drive motor 12, a chain magazine, a push-pull chain 11, and a position sensor 14. The electric drive motor 12 may be linear or a rotating electric motor connected to means that convert the rotational movement of the electric drive motor 12 to linear movement. The position sensor can, e.g., be a rotary pulse generator on the electric motor 12.

[0031] The actuator 10 is provided with an electronic control unit 50. The electronic control unit 50 can be external to the actuator 10 or it can be located in the housing 15. In one example, the electronic control unit 50 is embedded in a secure separate processor to provide fail-safe operation. The electronic control unit 50 is connected to a source of electric power and configured to control the operation of the actuator 10, i.e. to control the operation of the electric drive motor 12. Typically, there will be a single electric drive motor 12. However, in an embodiment there can be two drive motors 12 in tandem, as shown in Fig. 5.

[0032] The closing force applied onto the sash by the actuator 10 is preferably the same regardless of the speed of the electric drive motor 12. In one embodiment, the force is measured by monitoring an indicator of a closing force. Such an indicator may, e.g., be the electric current directly consumed by the electric drive motor 12. However, in an embodiment, the actual current is measured and the derivative of the current calculated. The derivative of current is, by other words, the rate of change over time of the consumed current. By calculating the derivate, atypical deviations such can be disregarded, and the indication of a pinching event enhanced.

[0033] When monitoring the derivative, the magnitude of the rate of change in current is monitored instead of the actual motor current. If something or someone is trapped between frame and sash, the motor current will increase rapidly and significantly. The derivative indicates how fast the motor current increases, and if the derivative is high enough, a threshold will be reached and entrapment detected. See, e.g., the slope of the derivative curve D_F in Fig. 6 between times t_1 and t_2, as well as derivative threshold D_{Th}.

[0034] In one embodiment, the monitoring of the indicator of closing force comprises calculating the derivative, i.e. rate of change, of filtered electric current I_F consumed by the electric drive motor 12 over a change in time, $(I_2-I_1)/(t2-t1)$, and comparing the calculation to a predetermined threshold value D_{Th}.

[0035] In a further embodiment, the monitoring of the indicator of closing force instead comprises calculating the derivative/ rate of change of filtered electric current consumed by the electric drive motor 12 over a constant time window, while adjusting the threshold value D_{Th} e.g. in relation to the speed of the electric drive motor 12. A lower speed requires a lower threshold due to a slower rate of change, and vice versa.

[0036] The measured electric current I_M is, in one embodiment, filtered by means of a signal processing unit. The filtering is executed prior to calculating the derivative/rate of change, in which calculation the filtered current I_F is used. The filter parameter of the signal processing unit may be selected from a plurality of predetermined filter parameters; each filter parameter being related to, e.g., the speed of the electric motor 12 and/or the position of the sash 3.

[0037] By filtering the current and monitoring the derivative/rate of change, false entrapment detection is avoided to a large extent since a slow increase in rate of change, i.e. force, e.g. due to wind, is disregarded.

[0038] Fig. 6 shows a graph that illustrates the measured electric current I_M in A to the electric drive motor 12 over time as well as the measured low-pass filtered current I_F in A to the electric drive motor 12 over time. The increase of the current I_M, I_F towards the end of the time span and thus of the force applied by the actuator 10 to the sash can be an indication of a pinching event. Figure 6 further illustrates the derivative D_F, i.e. rate of change, of the filtered current I_F as well as a threshold D_{Th} for said derivative D_F. A significant increase in current and derivative is shown between times t_1 and t_2, which leads to the derivative threshold D_{Th} being exceeded at t_2. The electronic control unit 50 receives instructions, e.g. from a remote-control unit (not shown), a sensor system such as a fire alarm (not shown), a timer, or a rain sensor, or from a control panel (not shown), to close an open window 1 completely or to move the window 1 to a desired intermediate position. The instructions can also come from a control system that controls the climate of a building by adjusting the opening of windows in such building.

[0039] If the window is open, as shown in Figs. 1 and 2, the electronic control unit 50 may receive an instruction to close the window 1. The electronic control unit 50 is configured to initiate a first closing operation upon receipt of such an instruction. Each closing operation is executed at, at least one of, a plurality of electric drive motor speeds.

[0040] An example of a closing procedure is illustrated in Fig. 7. At the start of the closing procedure the electronic control unit 50 has received an instruction to close the window. Thereupon, the electronic control unit 50 initiates a first closing operation 101. During the first closing operation 101 the electronic control unit 50 monitors the indicator of closing force applied to the sash by the actuator 10, e.g. by monitoring the derivative/rate of change of the current delivered to the electric drive motor 12. The electronic control unit 50 is configured to monitor that the force applied to the window does not exceed a first threshold. The first threshold preferably relates to a force which is low enough to avoid injury if a body part, such as the hand or fingers or person is trapped in the window opening, i.e. the opening between the sash 3 and the frame 2.

[0041] The electronic control unit 50 is configured to continue the first closing operation 101 until the window 1 is fully closed if the instructions received by the electronic control unit 50 are to close the window 1 completely. If the instructions are to close the window to a desired position n, for example a ventilating position in which the window is slightly open, the procedure lasts until the desired position is reached. In the example in Fig. 7 the instruction received by the electronic control unit 50 is to close the window 1 completely.

[0042] At time T1, the derivative/rate of change of the current delivered to the electric drive motor 12 exceeds the first threshold (indicated as D_{Th} in Fig. 6) and the electronic control unit 50 is configured to terminate the first closing action 101 and to initiate a first reversing action 102. The first reversing action 102 is preferably a relatively small movement, i.e. relatively small compared to a full movement of the window 1 between its fully open position and fully closed position. The first reversing action should 102 be large enough for a person to move a trapped body part away from the window 1.

[0043] The electronic control unit 50 is configured to hold the window still for a first short period of time 103 after the first reversing action has been completed, in order to give a person, that has a body part trapped, time to move this body part away from the window 1. The short period of time 103 is a brief time. The short period of time could be a momentary pause allowing a trapped body part to be removed.

[0044] The electronic control unit 50 is configured to initiate a second closing operation 104 at the end of the first short period of time 103. The electronic control unit 50 is in an embodiment configured to monitor the indicator of closing force applied by the actuator 10 to the window 1, i.e. derivative/rate of change of the current delivered to the electric drive motor 12, during the second closing operation 104, and to terminate the second closing operation 104 if the derivative/rate of change exceeds a second threshold. The second threshold can be identical to the first threshold, but also be higher or lower than the first threshold. In an embodiment, the electronic control unit 50 is configured to allow the actuator to apply its maximum force during the second closing operation 104. Either, or both, of the first threshold and the second threshold may be set to indicate a force which is lower than the maximum force of the actuator. The maximum force may, e.g., be set to 400 N.

[0045] Each threshold is selected from, or automatically matched to one of, a plurality of predetermined thresholds. In one embodiment, the threshold is selected/matched in response to the speed of the electric drive motor 12 and/or the position of the sash 3. Each specific speed of the electric drive motor 12 belongs to one of a plurality of predetermined speed ranges. In one embodiment, the speed ranges comprise a low-speed range and a high-speed range. The speed ranges may comprise additional ranges such as a normal-speed range for speeds between the low-speed range and the high-speed range, the normal-speed range being the speed at which the electric drive motor 12 operates during the main part of the closing operation. The electric drive motor 12 speed may be selected in response to the position of the sash 3. The electric drive motor 12 may be operated at a normal closing speed, in the normal-speed range, when the sash 3 is positioned in the open position zone A. Further, the electric drive motor 12 may be operated at a decreased speed, in the low-speed range, when the sash 3 is positioned in the near closed position zone B, and the electric drive motor 12 may be operated at an increased speed, in the high-speed range, when the reversing operation is executed. The very highest threshold possible may be selected when the electric drive motor speed is in the high-speed range and/or the sash is in the open position zone A. Correspondingly, the lowermost threshold may be selected when the electric drive motor speed is in the low-speed range and/or the sash 3 is in the near closed position zone B. The electric drive motor speed may be decreased in order to reduce the noise made by the window 1 when beginning to lock the sash to the frame in the visually closed zone C.

[0046] Fig. 8 is a flowchart illustrating the operation of the actuator 10. After start, the electronic control unit 50 receives instructions to move the window 1 to a target position, e.g. the fully closed position of the window 1. Thereupon, the electronic control unit 50 initiates the first closing operation 101 while monitoring the closing force applied to the window 1. The electronic control unit 50 determines whether a first threshold is exceeded during the first closing operation 101. If the first threshold is not exceeded the electronic control unit 50 verifies whether the target position has been reached during the first closing operation 101. If the target position has not been reached the electronic control unit 50 continues with the first closing operation 101. When the electronic control unit 50 detects that the target position has been reached, the electronic control unit terminates the first closing procedure 101. If the target position was the fully closed position, the first closing procedure 101 ends with the window 1 in its fully closed position.

[0047] If the electronic control unit 50 detects that the closing force exceeds the first threshold during the first closing operation 101, the electronic control unit 50 initiates a first reversing operation 102 and thereafter maintains the position of the window 1 for a first short period of time 103, e.g. less than a couple of seconds.

[0048] At the end of the first short period of time 103, the electronic control unit 50 initiates the second closing operation 104. The electronic control unit 50 may contin-

ue to monitor the indicator of closing force, or it may disengage, i.e. not monitor, the closing force during the second closing operation 104 and allowing the actuator 10 to apply its maximum closing force during the second closing operation 104. The electronic control unit 50 is configured to verify whether the target position has been reached during the second closing operation 104. If the target position has not been reached the second closing operation continues. When the target position has been reached, the process ends and electronic control unit 50 is ready to receive new instructions. In one embodiment, monitoring of the indicator of closing force is disengaged when the sash reaches the visually closed zone C.
Even if monitoring is disengaged, there is a restriction on the allowed maximum force in order to limit the force exerted on the electric drive motor 12, i.e. overload protection. The maximum current limit may be set at 100 % when the sash is in the open position zone A, and reduced to 35 % when the sash reaches the visually closed position zone C. This will reduce the mechanical stress on the motor. E.g., the maximum closing force may be at least 36 kg and at the most 45 kg.

[0049] In an embodiment, that can be combined with any of the other embodiments, the electronic control unit 50 is configured to allow the actuator 10 to apply its maximum force during the very last part of the closing movement towards the fully closed position of the window 1. The very last part of the closing movement, the visually closed position zone, is preferably selected so small that it is difficult, if not impossible, for a person to get his fingers or other body part trapped between the frame 2 and the sash 3, and thus on one hand the risk of a pinching event is small and on the other hand a large force is typically needed for compressing the compressible gasket 5 in this part of the movement. The portion of the closing movement in which the compressible gasket needs to be compressed typically requires a much larger force to be carried out.

[0050] In an embodiment, illustrated with reference to Figs. 9 and 10, the electronic control unit 50 is configured to perform at least two reversing actions, when a respective first and second threshold is exceeded, before at least a third closing operation is carried out with a higher third threshold or without any limit on the force applied to the window. Each threshold is selected from a plurality of predetermined thresholds. Any number of reversing actions and subsequent closing actions is possible, and not limited to two or three. Each such closing action may comprise either monitoring against a specific threshold, or closing without monitoring. Also, any closing operation, deemed to be the last and final closing operation, may be closed without any limit on the force applied to the window.

[0051] This closing process is identical to the process described with reference to Figs. 7 and 8 up to the end of the short period of time 103. During the second closing operation 104 the electronic control unit 50 is configured to verify that the closing force does not exceed a second threshold. The second threshold can be identical to the first threshold or can be lower than the first threshold or can be higher than the first threshold. In an example, the first threshold can be set at 5 kg (12 %), with the second threshold being set at 10 kg (25 %). A further example is a first threshold set at 15 kg (37 %) The electronic control unit 50 is configured to terminate the second closing operation 104 and to initiate a second reversing operation 105 upon detecting that the second threshold has been exceeded. The second reversing operation 105 is preferably a small operation with a small stroke, similar to the first reversing operation 102 and small relative to the maximum movement of the window 1 between its fully closed and fully open position.

[0052] The electronic control unit 50 is configured to hold the window 1 still for a second short period of time 106 after the second reversing action 105 has been completed, in order to give the person that has a body part trapped one more opportunity to move this body part away from the window 1. The electronic control unit 50 is configured to initiate a third closing operation 107 at the end of the second short period of time 106. The electronic control unit 50 is in an embodiment configured to monitor the force applied by the actuator to the window during the third closing operation 107 and to terminate the third closing operation 107 if the force exceeds a third threshold. Either, or all, of the first, second, and third thresholds may be set to indicate a force which is lower than the maximum force of the actuator. The third threshold is preferably higher than the first and second threshold, e.g. 400 N. In an embodiment, the electronic control unit 50 is configured to allow the actuator 10 to apply its maximum force during the third closing operation 107.

[0053] The process of closing the window in accordance with the embodiment of Figs. 9 and 10, is identical to the process described in the flowchart in Fig. 8 up to, and including, maintaining the position of the window for the first short period of time 103. At the end of the first short period of time 103 the electronic control unit 50 is configured to initiate the second closing operation 104 while monitoring the closing force and to verify that the second threshold is exceeded or not.

[0054] If the second threshold is not exceeded, the electronic control unit 50 verifies whether the target position has been reached. If the target position has not been reached, the second closing operation 104 continues until the target position has been reached and then the process ends. If the second threshold is exceeded during the second closing operation 104 the electronic control unit 50 performs the second reversing operation 105 and thereupon maintains the position of the window for a second short period of time 106.

[0055] At the end of the second short period of time 106 the electronic control unit 50 initiates the third closing operation, preferably without applying a force limit. The electronic control unit 50 verifies whether the target position has been reached during the third closing operation 107 and ends the third closing operation 107 with the window one in its target position when the electronic control unit 50 has detected that the window in the target position and then the electronic control unit 50is ready to receive new instructions.

[0056] The invention has 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 invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measured cannot be used to advantage.

[0057] The reference signs used in the claims shall not be construed as limiting the scope.

Claims

1. An electrically operated actuator (10) for operating a window (1), said window comprising a frame (2) and a sash (3) being pivotally suspended from said frame (2) by a horizontal pivot axis,
said actuator (10) being adapted to perform a first closing operation (101) while monitoring an indicator of a closing force applied onto said sash (3) by said actuator (10),
said actuator being adapted to initiate a first reversing operation (102) upon said indicator of closing force exceeding a threshold during said first closing operation (101), and said actuator (10) being configured to initiate a subsequent, second closing operation (104) after said first reversing operation (102), said threshold being selected from a plurality of predetermined thresholds.

2. An actuator (10) according to claim 1, configured to monitor said indicator of closing force during said second closing operation (104), adapted to initiate a second reversing operation (105) upon said indicator of closing force exceeding a threshold during said second closing operation (104), and further configured to initiate a subsequent, third closing operation (107) after said second reversing operation (105), said threshold being selected from a plurality of predetermined thresholds.

3. An actuator (10) according to any one of the previous claims, wherein said actuator (10) is driven by an electric drive motor (12) and said threshold is selected in response to the speed of said electric drive motor (12) and/or a position of said sash (3).

4. An actuator (10) according to claim 3, wherein each speed of said electric drive motor (12) belongs to one of a plurality of predetermined speed ranges.

5. An actuator (10) according to claim 4, wherein said plurality of sash speed ranges comprises of at least a low-speed range and a high-speed range.

6. An actuator (10) according to any one of claims 3 to 5, wherein the speed of said electric drive motor is selected in response to the position of said sash (3), each sash position belonging to one of a plurality of predetermined position zones.

7. An actuator (10) according to claim 6, wherein said plurality of predetermined position zones comprises of at least an open position zone (A), a near closed position zone (B), and a visually closed position zone (C).

8. An actuator (10) according to claim 7, wherein a compressible seal or gasket (5) is arranged between said frame (2) and said sash (3), said seal or gasket (5) bridging at least a part of said visually closed position zone (C).

9. An actuator (10) according to claim 7 or 8, wherein the monitoring of said indicator of closing force is disengaged when said sash (3) reaches said visually closed position zone (C).

10. An actuator (10) according to any one of claims 5 to 9, wherein a very highest threshold is selected when said electric drive motor speed is in the high-speed range and/or said sash is in the open position zone (A).

11. An actuator (10) according to any one of claims 5 to 10, wherein a lowermost threshold is selected when said electric drive motor speed is in the low-speed range and/or said sash is in the near closed position zone.

12. An actuator (10) according to any one of claims 3 to claim 11, wherein said indicator of closing force comprises a calculation of a rate of change in electric current consumed by said electric drive motor (12).

13. An actuator (10) according to claim 12, wherein said electric current is filtered by means of a signal processing unit prior to calculating said rate of change.

14. An actuator (10) according to claim 13, wherein a filter parameter of said signal processing unit is selected from a plurality of predetermined filter parameters.

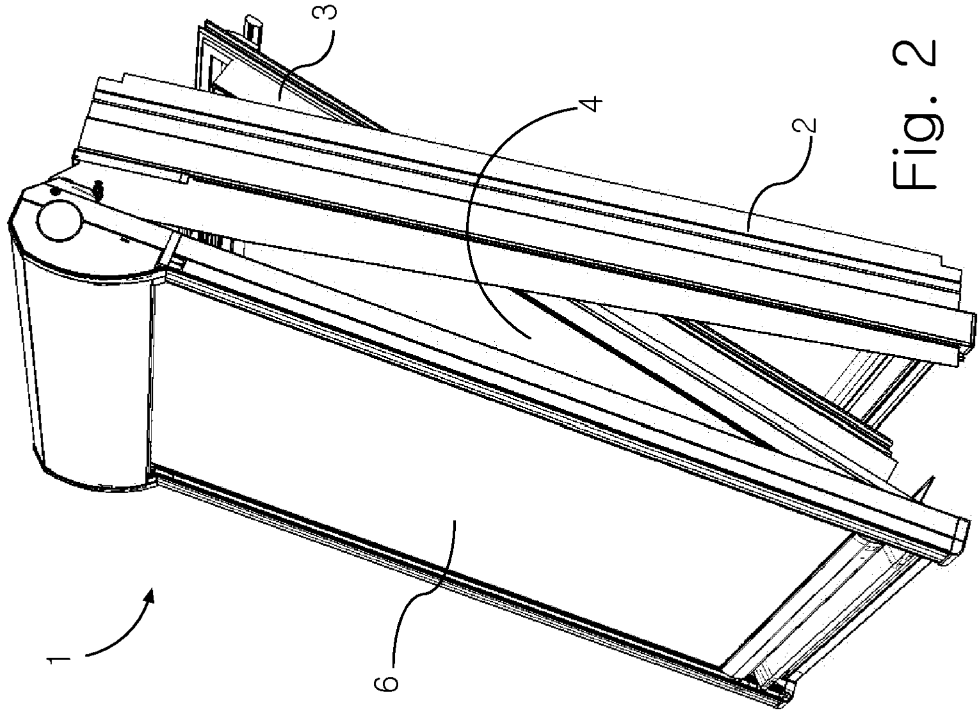

Fig. 2

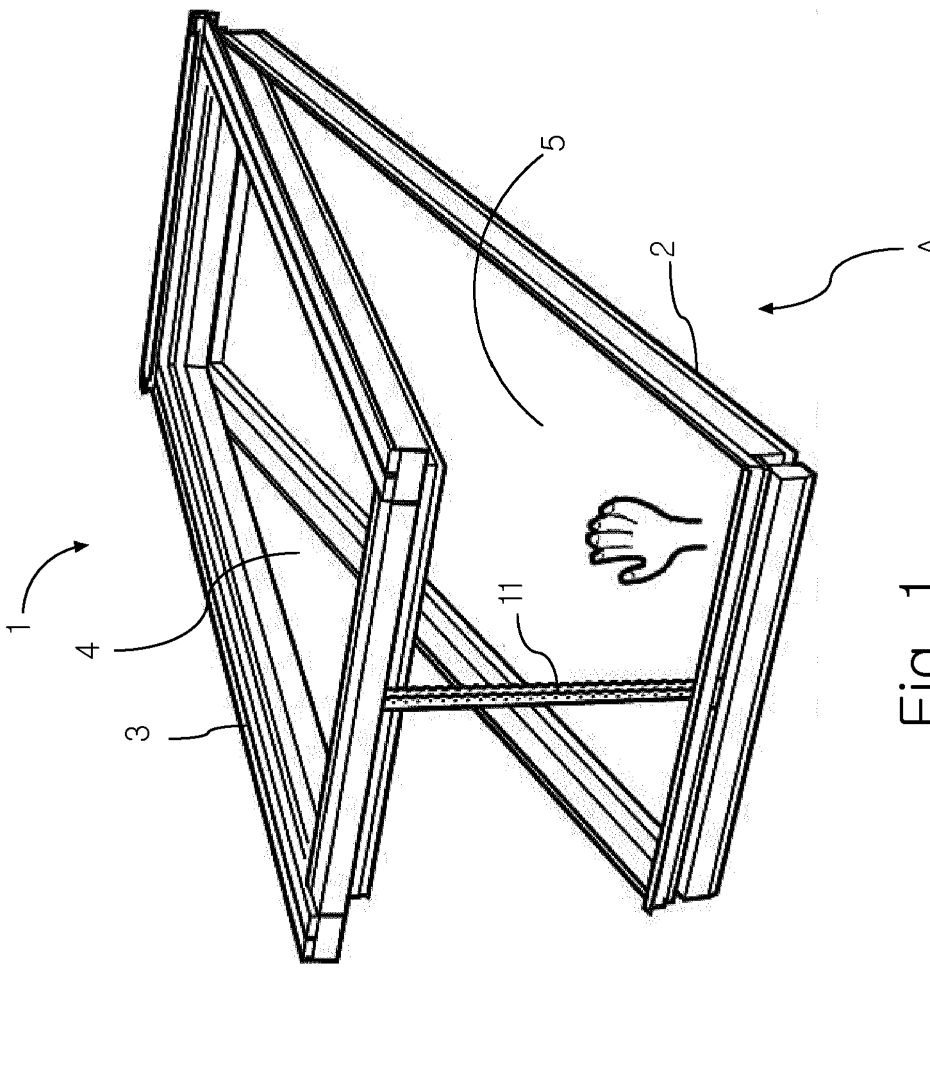

Fig. 1

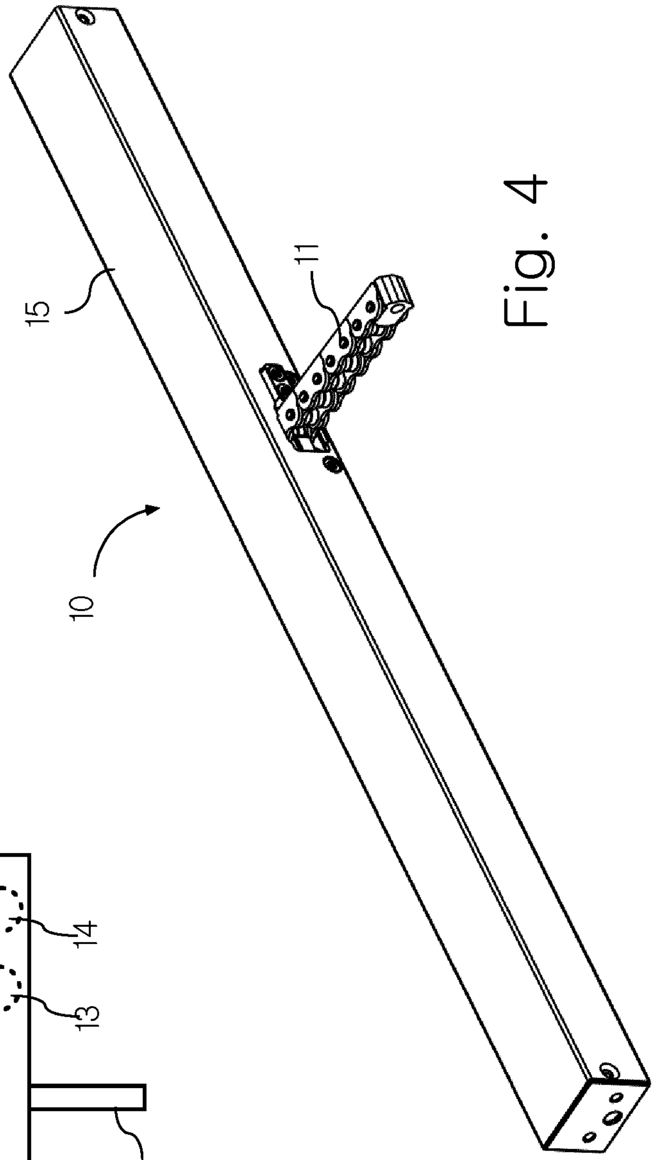

Fig. 4

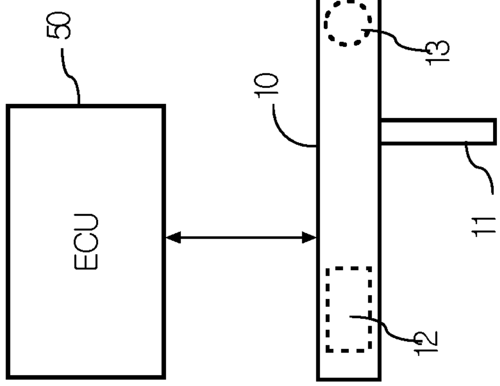

Fig. 3

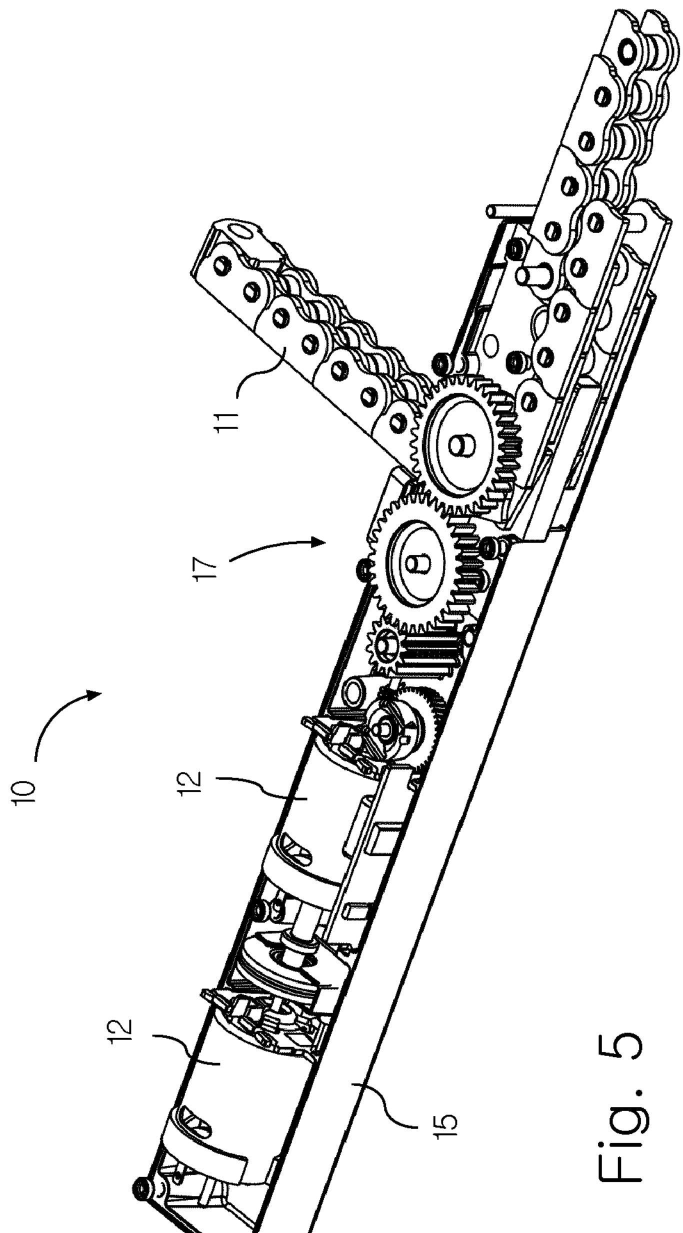

Fig. 5

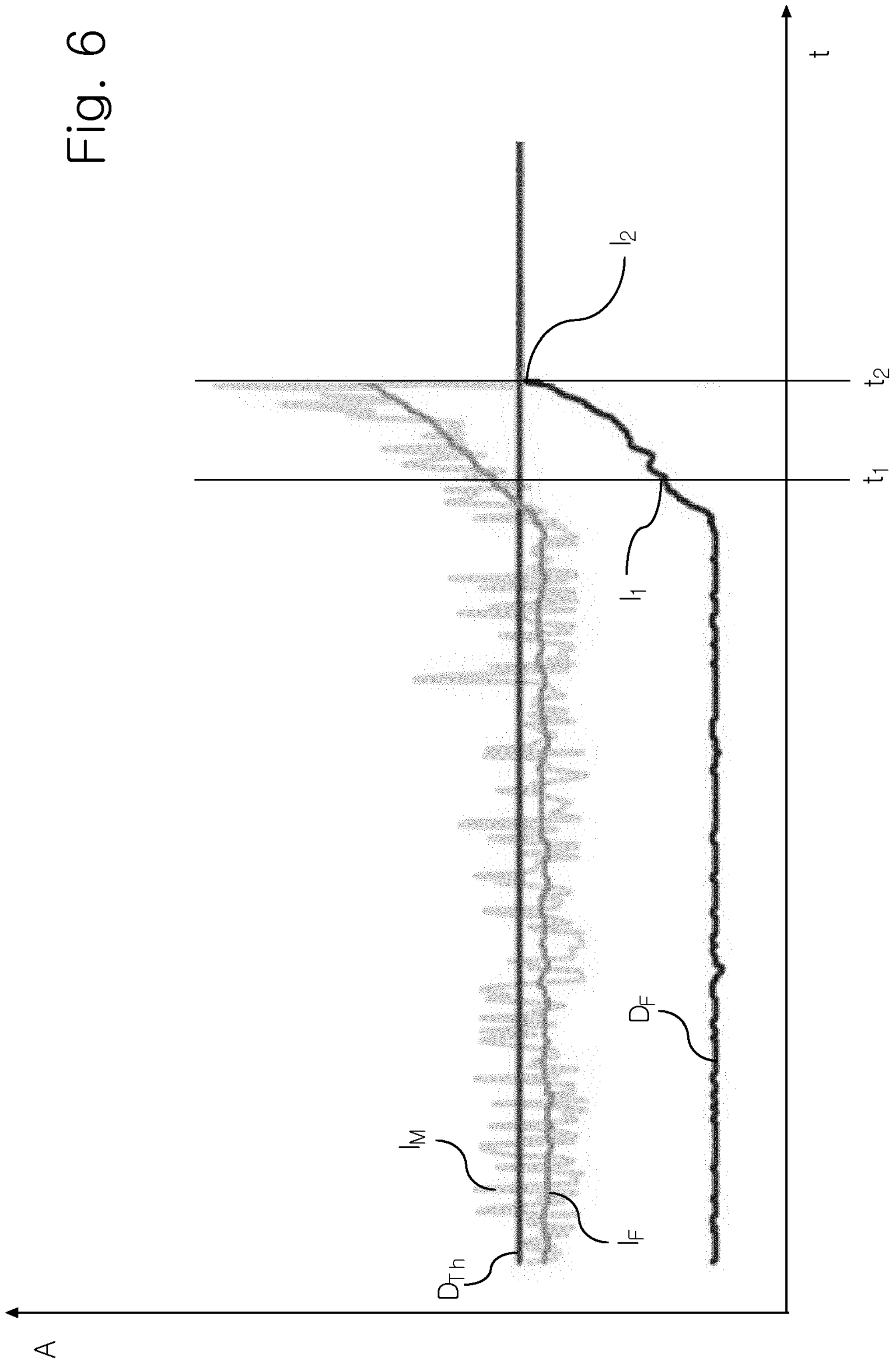

Fig. 6

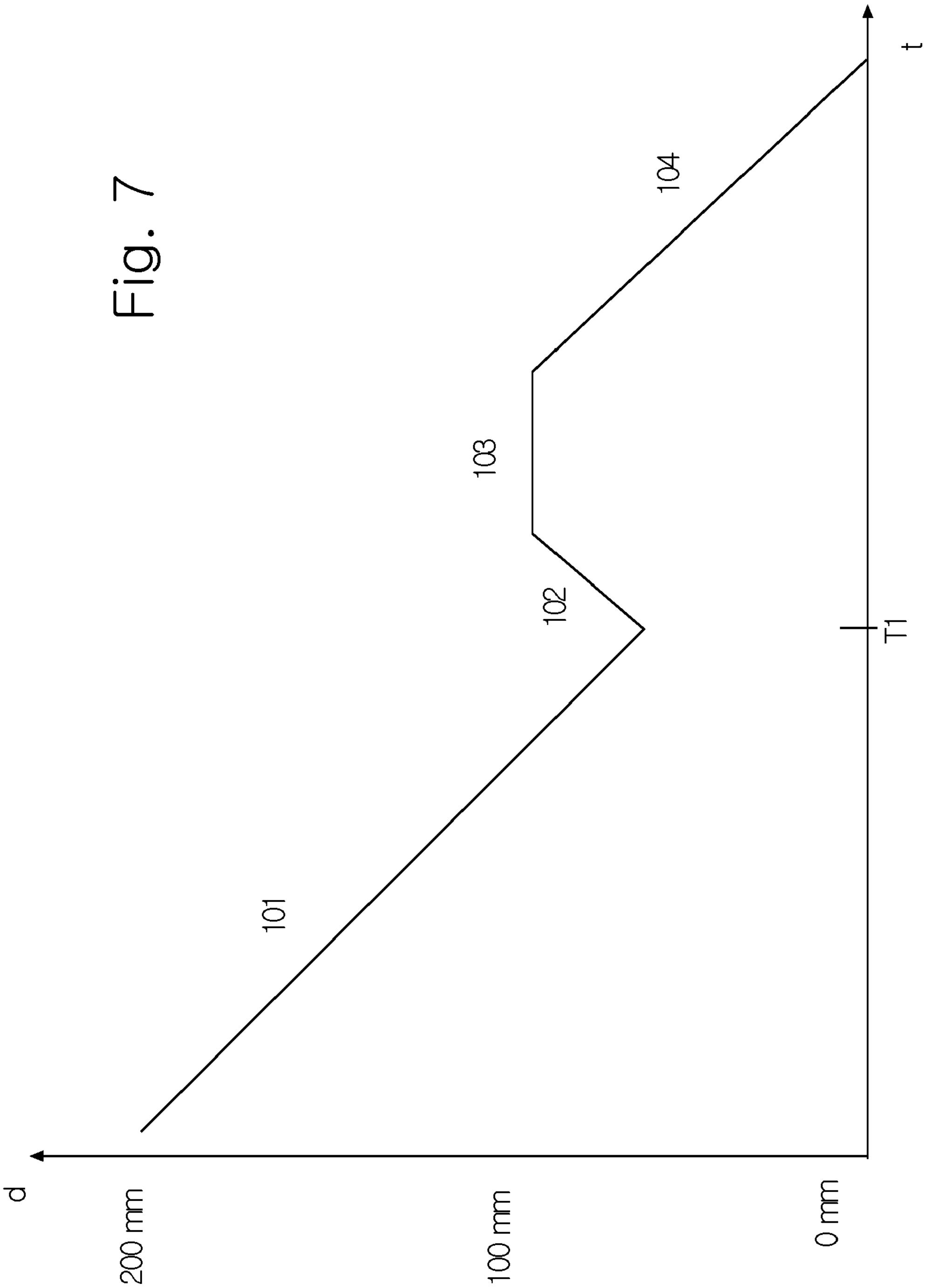

Fig. 7

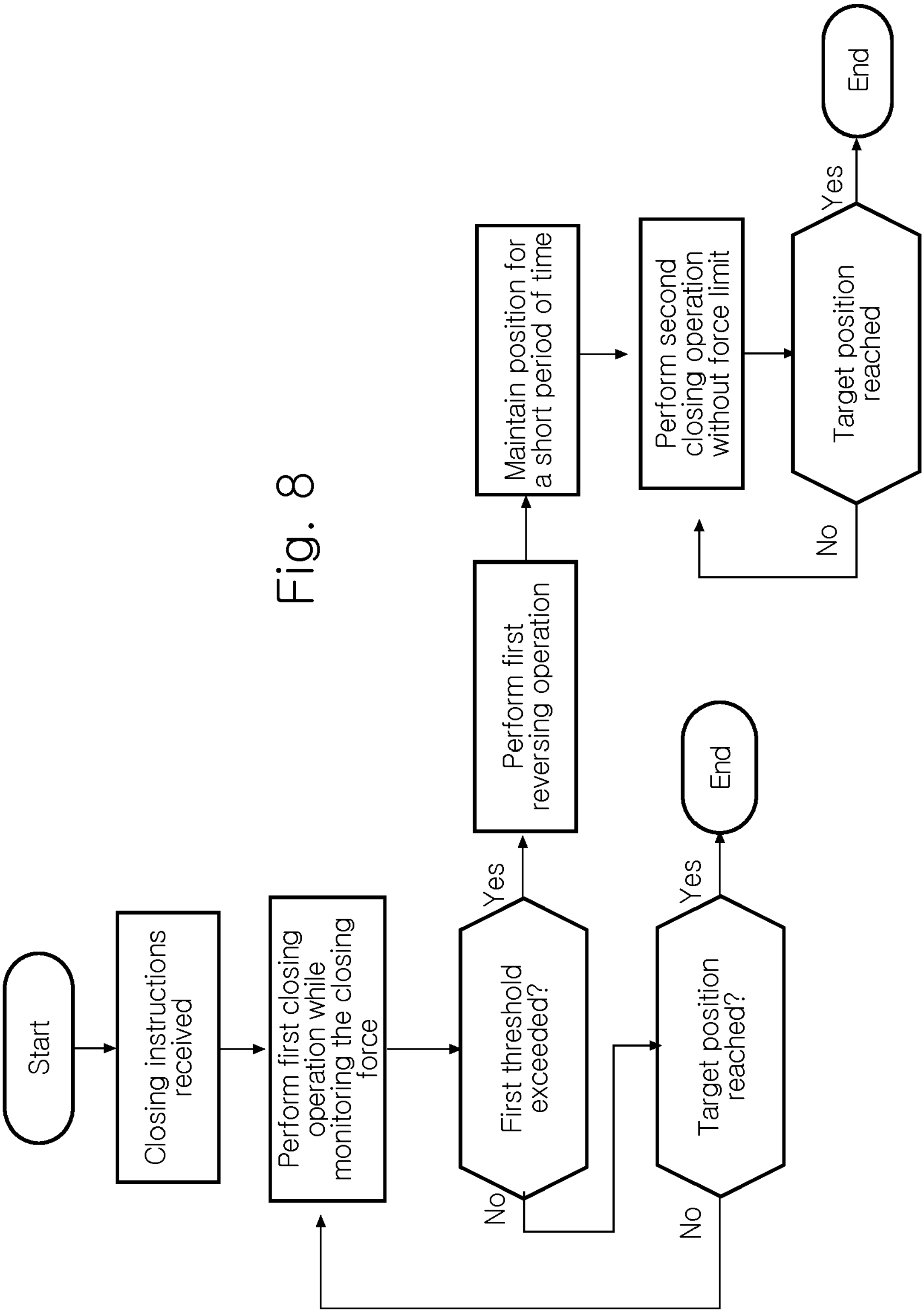
Start
Closing instructions received
Perform first closing operation while monitoring the closing force
First threshold exceeded?
Yes
No
Target position reached?
Yes
No
End
Perform first reversing operation
Maintain position for a short period of time
Perform second closing operation without force limit
Target position reached
Yes
No
End

Fig. 8

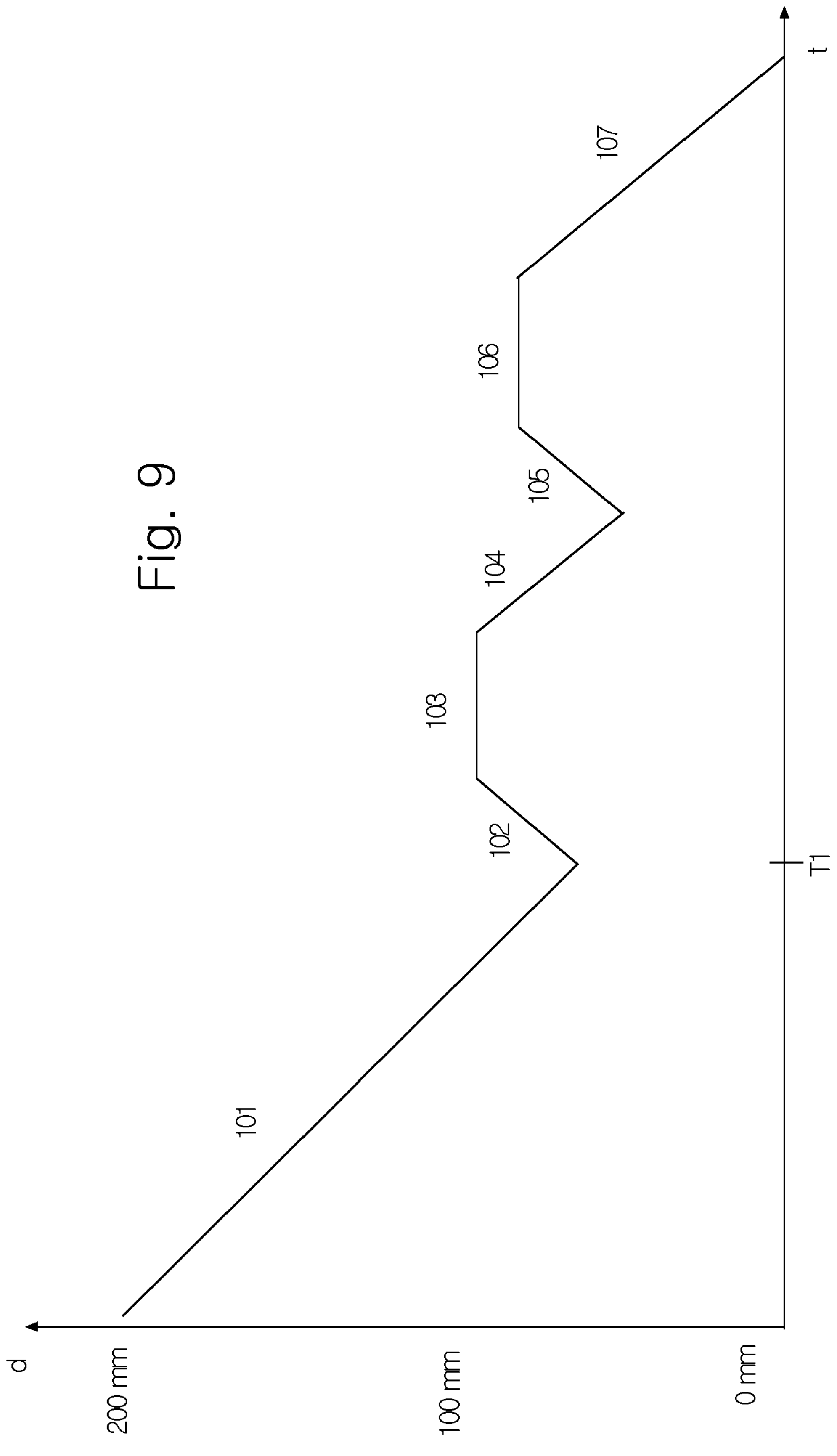

Fig. 9

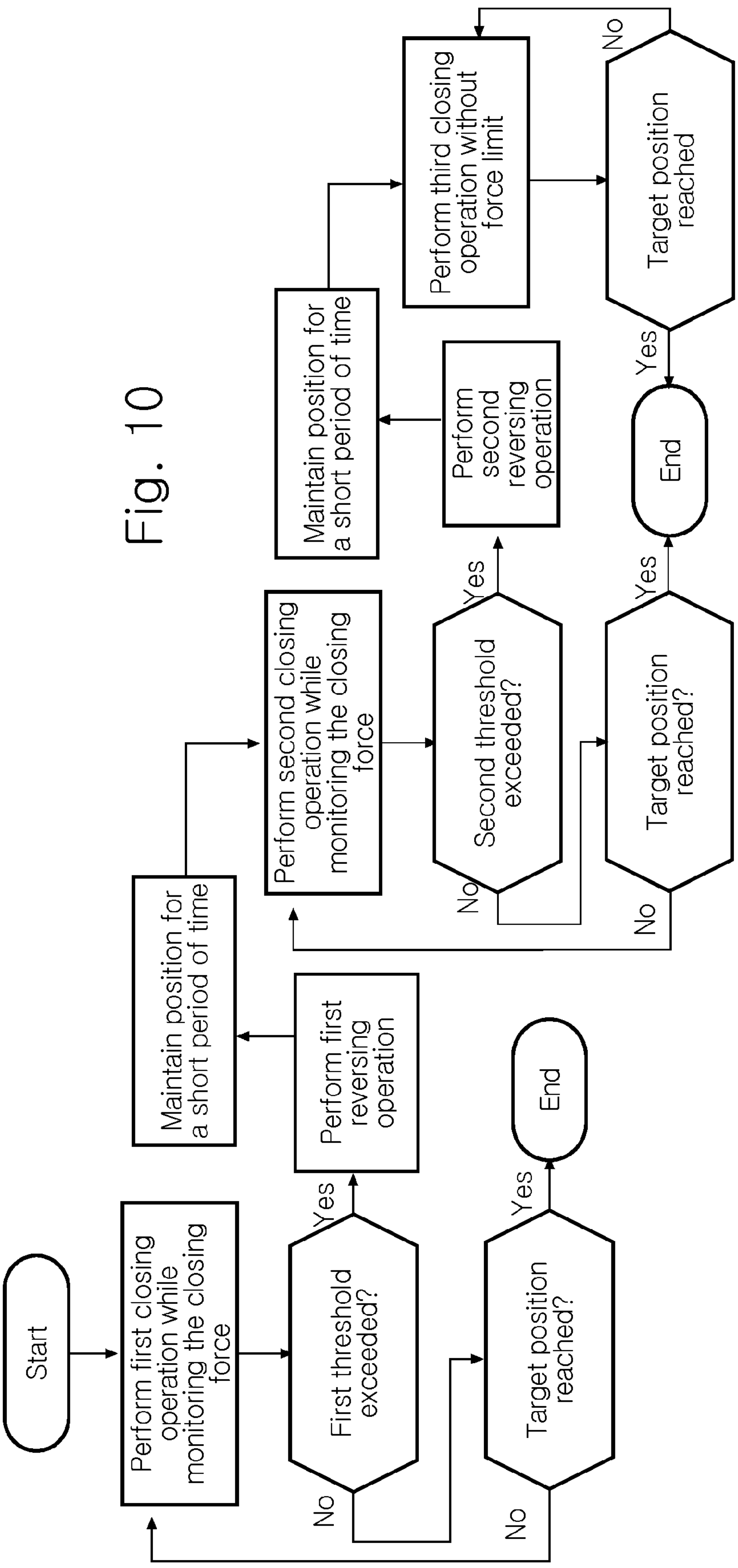
Start
Perform first closing operation while monitoring the closing force
First threshold exceeded?
No
Yes
Target position reached?
No
Yes
End
Perform first reversing operation
Maintain position for a short period of time
Perform second closing operation while monitoring the closing force
Second threshold exceeded?
No
Yes
Target position reached?
No
Yes
End
Perform second reversing operation
Maintain position for a short period of time
Perform third closing operation without force limit
Target position reached
No
Yes
End

Fig. 10

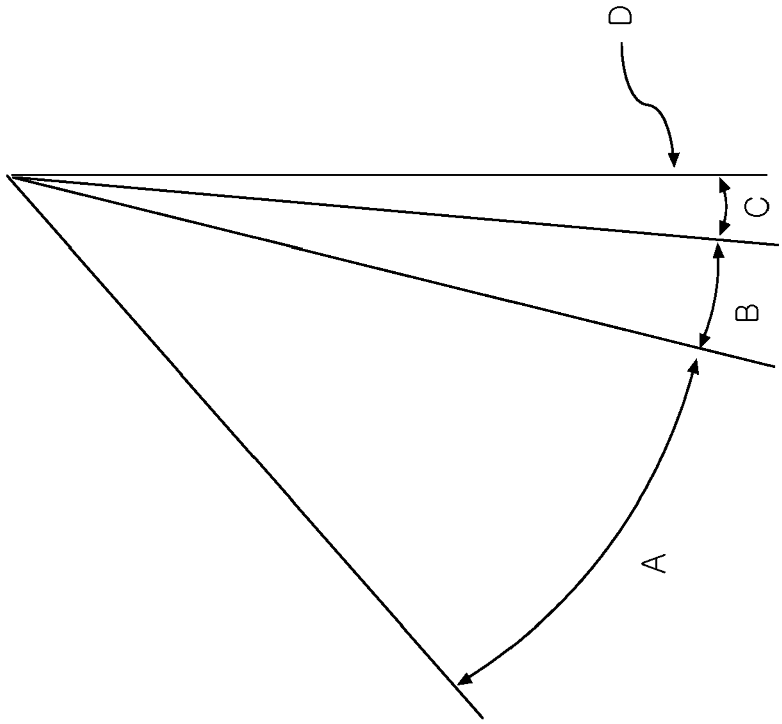

Fig. 11

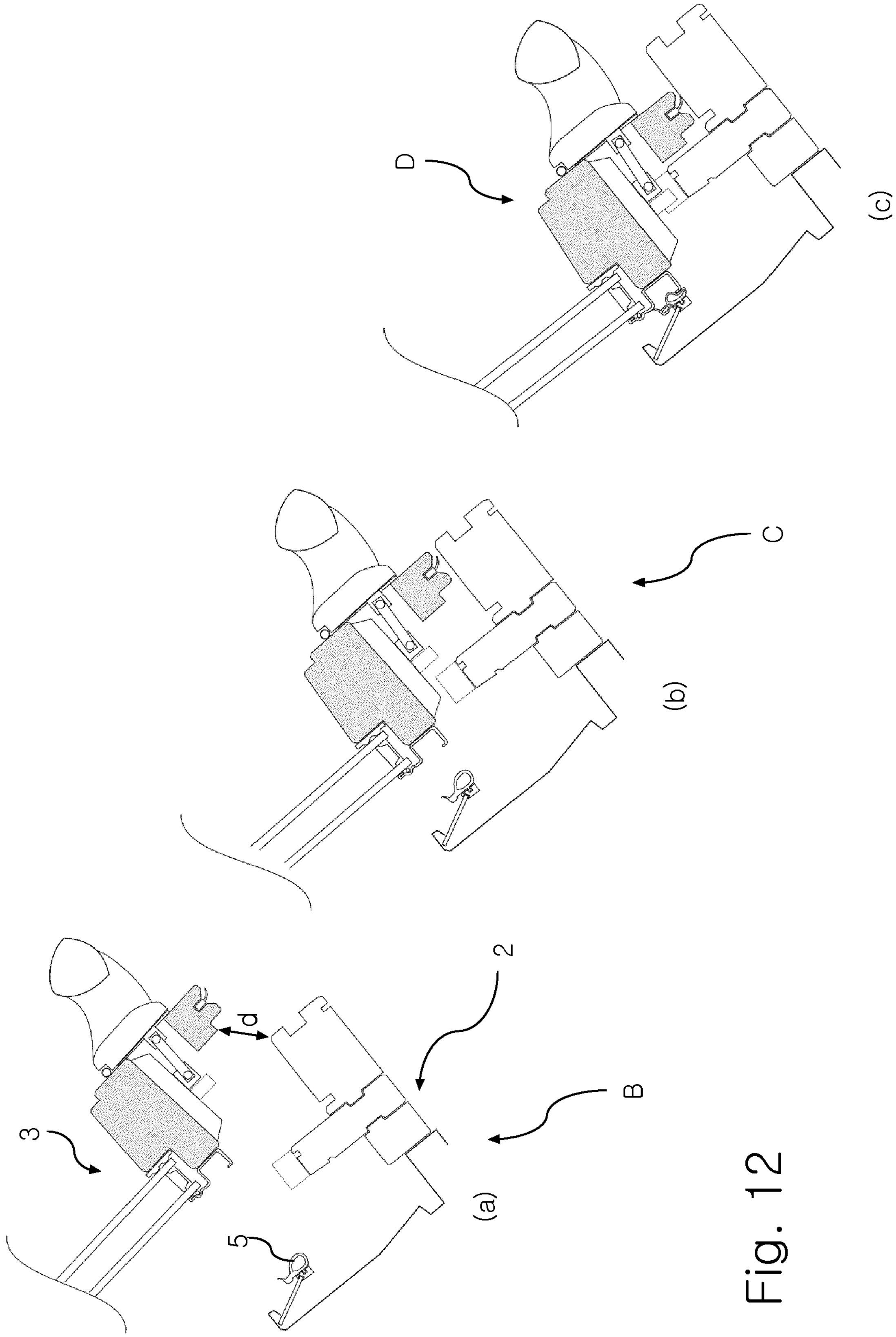

Fig. 12

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EUROPEAN SEARCH REPORT

Application Number
EP 17 16 6774

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	GB 2 026 723 A (TEKRON PATENTS LTD) 6 February 1980 (1980-02-06) * page 2, line 59 - line 71 * * page 3, line 32 - line 60 * * page 4, line 78 - page 5, line 45; figure 2 * * page 9, line 41 - line 56 * * page 11, line 129 - page 2, line 4 * -----	1-8,10, 11 9,12-14	INV. E05F15/41 E05F15/611 ADD. E05D7/08 E05D7/082 E05D7/081 E05F15/619
Y	WO 2015/068111 A1 (ADITYA AUTO PRODUCTS & ENGG I PVT LTD [IN]) 14 May 2015 (2015-05-14) * paragraph [0019] - paragraph [0020]; figure 2 * -----	9,12-14	
A	US 5 449 987 A (MCMILLAN SCOTT D [US]) 12 September 1995 (1995-09-12) * column 4, line 23 - column 5, line 7; figure 1 * * column 11, line 31 - column 12, line 23; figure 8 * -----	1-6	

TECHNICAL FIELDS SEARCHED (IPC)
E05D E05F

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
The Hague	11 August 2017	Rémondot, Xavier

CATEGORY OF CITED DOCUMENTS

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L : document cited for other reasons

& : member of the same patent family, corresponding document

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11-08-2017

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WO 2015068111 A1	14-05-2015	NONE	
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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- EP 2754820 A **[0002]**
- EP 1441100 A **[0003]**