(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 528 053 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
26.03.2025 Bulletin 2025/13

(21) Application number: **23198242.2**

(22) Date of filing: **19.09.2023**

(51) International Patent Classification (IPC):
E05B 47/00 *(2006.01)* *E05C 3/04* *(2006.01)*
G01P 15/00 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
E05B 47/00; E05B 2047/0067; E05B 2047/0068; E05C 3/043; G01P 15/00

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(71) Applicant: **VKR Holding A/S**
2970 Hørsholm (DK)

(72) Inventors:
- **Langbo, Lars**
  2970 Hørsholm (DK)
- **Nielsen, Kristian Ørnsvig**
  2970 Hørsholm (DK)
- **Bertman, Per Holm**
  2970 Hørsholm (DK)

(74) Representative: **Høiberg P/S**
Adelgade 12
1304 Copenhagen K (DK)

(54) DETECTION OF WINDOW STATE OF A ROOF WINDOW BASED ON GRAVITATIONAL ACCELERATION INFORMATION

(57) The disclosure relates to a building roof window comprising a window state detection system (2). The roof window comprises a movable frame (3) which is supported by a fixation frame (4) by means of a hinge arrangement (14) that allows the movable frame (3) to move relative to the fixation frame (4). The movable frame (3) comprises a handle arrangement (6) which is connected to at least one locking part (5a) of a locking system (5). The handle arrangement (6) is configured to be operated by human hand to be moved relative to the movable frame (3) and thereby displace the locking part (5a) between different states (S1-S3) comprising one or more locking states (S1, S2) and an unlocked state (S3). The locking system (5) in the one or more locking states (S1, S2) is configured to maintain the movable frame (3) in a predefined, locked position (CP, VP), wherein the locking system (5) in the unlocked state (S3) is configured to allow the movable frame to open towards a substantially fully open position. The window state detection system (2) comprises a data processing arrangement (11) and a multi axis accelerometer arrangement (10). The multi axis accelerometer arrangement (10) is arranged at the handle arrangement and comprises one or more multi axis accelerometers, wherein the multi axis accelerometer arrangement (10) is configured to provide gravitational acceleration information (SEO). The data processing arrangement is configured to provide data processing of the gravitational acceleration information (SEO) so as to determine if the roof window is in a predefined locked state (CS, VS) or in an open state (OS), and determine a window opening value representing an angular position of the movable frame (3) relative to the fixation frame (4). The determination of the window opening value is based on reference data comprising data which is based on an installation angle of the roof window.

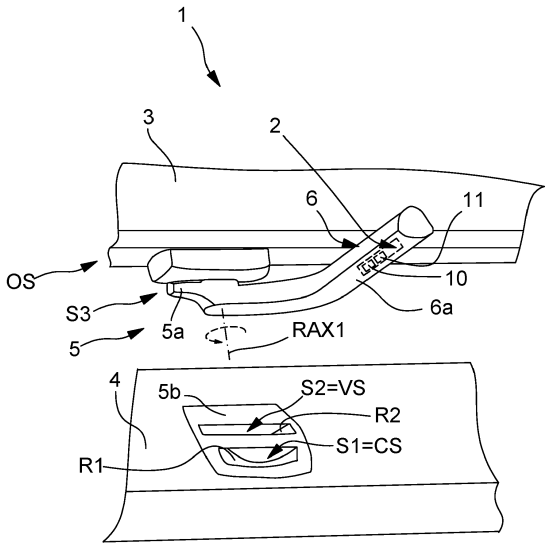


Fig. 1

EP 4 528 053 A1

Description

[0001] The present disclosure relates to a building roof window comprising a window state detection system, and a method of providing window state detection at a building roof window.

Background

[0002] It is advantageous to be able to obtain sensor information of if a roof window is e.g. open/in an open state or in a locked state. Such information may be used in home automation systems, used in building alarm systems, or in other ways used for informing users or systems that one or more windows are open or closed and/or the like. Solutions with sensors for determining a state of a building window are well known. For example, patent document EP 1 896 678 B1 discloses a solution comprising Hall sensor and magnet or an opto-electric device. Patent document US 9,896,876 discloses use of acceleration data. Patent document FR2906558 discloses a solution where an inclinometer is arranged at on a sash frame in order to determine angular position of a sash of a roof window. An actuator controls the sash.

[0003] The above solutions may suffer from drawbacks such as one or more of being cost expensive, lacking information in order to reliably determine window states, needing increased individual adaption and/or being a mechanically complex system.

[0004] The present disclosure provides a solution that may solve or reduce one or more of such drawbacks. For example, the present disclosure may provide a solution that may be easy to install and/or retrofit, may be cost efficient and/or which may make advantageous sensor information available. Additionally or alternatively, the present disclosure may provide a solution that may be easy to adapt to different roof windows.

Summary

[0005] The present disclosure relates to a building roof window comprising a window state detection system. The roof window comprises a movable frame which is supported by a fixation frame by means of a hinge arrangement that allows the movable frame to move relative to the fixation frame. The movable frame supports an insulating glass unit. The movable frame comprises a handle arrangement which is connected to at least one locking part of a locking system of the window, The handle arrangement is configured to be operated by human hand to be moved relative to the movable frame and thereby displace the locking part between different states comprising one or more locking states and an unlocked state. The locking system in the one or more locking states is configured to maintain the movable frame in a predefined, locked position. The locking system in the unlocked state is configured to allow the movable frame to open towards a substantially fully open position.

[0006] The window state detection system comprises a data processing arrangement and a multi axis accelerometer arrangement. The multi axis accelerometer arrangement is arranged at the handle arrangement and comprises one or more multi axis accelerometers. The multi axis accelerometer arrangement is configured to provide gravitational acceleration information. The data processing arrangement is configured to provide data processing of the provided gravitational acceleration information so as to determine

- if the roof window is in a predefined locked state or in an open state, and
- a window opening value representing an angular position of the movable frame relative to the fixation frame.

The determination of the window opening value is based on reference data. The reference data comprises data which is based on an installation angle of the roof window.

[0007] Building roof windows are mostly arranged in a roof structure having an inclining roof pitch. Modern building roof windows having movable frames are capable of being installed in different roof structures having different roof pitch without compromising water tightness of the roof window. This will however provide that the installation angle of the building roof window will vary individually dependent on the roof pitch.

[0008] The inventor has realized that gravitational acceleration output information from a multi axis accelerometer arranged at the handle arrangement may enable a determination of if the roof window is in a predefined locked state or in an open state, as well as determination of a window opening value representing an opening angle or the like of the movable frame relative to the fixation frame. And that is despite the fact that the handle may move relative to the movable frame. The inventor has found that in roof windows, when using an accelerometer for state detection and determination of window opening value, the installation angle of the roof window will influent on the gravitational acceleration output from the multi axis accelerometer. The final installation angle of the roof window is normally not known prior to roof window installation.

[0009] According to the present disclosure, the one or more multi axis accelerometers of the multi axis accelerometer arrangement is/are configured to move together with the handle arrangement relative to the movable frame, and also move together with the movable frame when the movable frame is moved relative to the fixation frame, e.g. between an open

position and a closed position. Due to this arrangement of the multi axis accelerometer arrangement, gravitational acceleration information output from the multi axis accelerometer arrangement will change dependent on the position of the handle arrangement relative to the movable frame, and also dependent on the position of the movable frame relative to the fixation frame.

[0010] The inventor has realized that providing reference data, e.g. in a data storage, that relates to/is based on an installation angle of the specific roof window may enable the state detection system to know a "reference position" for the accelerometer when the accelerometer is in a predefined position/orientation defined by a combination of the position/-state of the handle relative to the movable frame and the position/state of the movable frame relative to the fixation frame. This enables the processing arrangement to determine the state of the roof window (locked or unlocked) and a window opening value based on gravitational acceleration information.

[0011] In one or more embodiments of the present disclosure, the solution according to the present disclosure may be able to determine one or more of if the window is:

- in a closed and locked state,
- in an open and a locked state,
- in an open and unlocked state
- in a closed and unlocked state

[0012] Providing accelerometer based state detection and window opening values may also provide a cost efficient, more simple and/or a more power saving solution. It may additionally be space-saving. Normally, a movable frame of a roof window will not be opened or closed around a vertical axis. Hence, by the solution according to embodiments of the present disclosure, a yaw rate sensor may be omitted as the accelerometer arrangement is used for both determining window state and window opening value.

[0013] In some embodiments of the present disclosure, the reference data may be predefined reference data, such as data stored in a data storage.

[0014] In one or more embodiments of the present disclosure, the reference data may comprise threshold data.

[0015] In some embodiments of the present disclosure, the reference data may directly or indirectly indicate, such as be a measure for, the installation angle of the roof window.

[0016] In some embodiments of the present disclosure, the reference data comprises data which is based on an installation angle of the roof window in the sense that the reference data has been adapted, such as updated or set, based on the installation angle of the roof window.

[0017] A direct indication of the installation angle of the roof window may comprise an angular indication, such as e.g. "35°", "45°" or the like.

[0018] An indirect indication of the installation angle of the roof window may comprise a reference value such as a percentage value, a number value, such as a binary number value, a hexadecimal number, a decimal number, or the like representing the window opening value.

[0019] An indirect indication of the installation angle may in some embodiments of the present disclosure be provided by means of a data value, such as a number value, in substantially the same format as provided by the multi axis accelerometer arrangement. This may hence be used for correlating, such as directly correlating, with a one or more values obtained during standstill of the handle and the movable unit.

[0020] An indirect indication of the installation angle may alternatively comprise a zeroed or otherwise adapted reference data which has been set/updated after window installation. This reference data may define a predefined setting of the installed roof window, such as for example fully closed.

[0021] As the multi axis accelerometer is arranged at the handle arrangement, it will move together with the movable frame and provide sensor output based thereon.

Moreover, the multi axis accelerometer is configured to move together with the handle relative to the movable unit and provide sensor output based thereon.

[0022] In one or more embodiments of the present disclosure, the reference data may comprise a representation of, or may be based on, gravitational acceleration information retrieved after the roof window is installed at a roof structure. This may e.g. provide a user friendly and/or cost efficient solution. Additionally or alternatively, it may provide a power saving solution.

[0023] The reference data may provide a calibration that take into account the individual installation angle of the window.

[0024] The reference data may provide a calibration so as enable identification of the correct window opening value and/or if the window is in an open state or in one or more predefined locked states, such as a predefined (locked) ventilation state and an fully closed, locked state.

[0025] When the roof window has been installed at a roof structure, the readings/output from the accelerometer comprises data which is influenced by the installation angle of the roof window. This may e.g. be caused by that the multi axis accelerometer is fixed to the handle arrangement with a certain, fixed orientation relative to the handle.

[0026] For example, an indication of the installation angle of the roof window may comprise a number value such as e.g. a value read directly or indirectly from the multi axis accelerometer when the movable frame and/or handle is in a predefined position, such as a fully closed or fully open position. This may e.g. comprise an X-axis and a Z-axis reading from the multi axis accelerometer arrangement. It may e.g. be gravitational acceleration values obtained during standstill of the handle and the movable unit. This/these value may be used (directly or indirectly) by the processing arrangement as a reference value for determining or representing the physical angular orientation of the movable frame relative to the fixed frame, as it inherently takes the installation angle of the roof window into account. Additionally or alternatively, it may be used for determining the window state such as one or more of if the movable frame is in a closed state, ventilation state or an open state.

[0027] The building roof window may be configured for installation in a residential building or office building.

[0028] In one or more embodiments of the present disclosure, the reference data may comprise a look up table.

[0029] In one or more embodiments of the present disclosure, the reference data may be used for determining, such as calculating, the window opening value and/or the if the movable frame is in a closed state, ventilation state or an open state.

[0030] In some embodiments of the present disclosure, the reference data may comprise a look up table or other data that has been generated based on the installation angle of the roof window, e.g. obtained during an updating session. Hence, for example, a set of predefined thresholds related to different opening angles of the movable frame relative to the fixed frame may be stored as reference data in a data storage, and the provided gravitational acceleration information may hence be correlated with the lookup table information or other data in order to determine a window opening value and/or the window state.

[0031] In one or more embodiments of the present disclosure, the determined window opening value represents, indicates or is a window opening angle of the movable frame relative to the fixation frame. This may provide useful data to a user and/or system so that enhanced window monitoring may be obtained.

[0032] In embodiments of the present disclosure, the determined window opening value may be an angular value representing the angular position of the movable frame relative to the fixation frame, relative to a predefined position such as a fully open or fully closed position. For example, if the angular value is "35", it may define that the movable frame is 35° open.

[0033] In another embodiment of the present disclosure, the window opening value may be a number value, such as within a predefined interval, for example between 0% and 100%, where "0%" represents a fully open or fully closed movable frame, and "100%" indicates the other of a fully open or fully closed movable frame. Hence, for example, a window opening value of 25% may indicate that the movable frame is 25% open.

[0034] It is generally to be understood that the resolution of the window opening value may be more than merely "open" or "closed", but may not necessarily, in some embodiments of the present disclosure, be designed to indicate every small angular displacement between the movable frame and fixation frame.

[0035] For example, in embodiments of the present disclosure, the processing arrangement may be configured to select between different predefined window opening values based on the provided gravitational acceleration information. For example, the processing arrangement may provide the determination of the window opening value by means of calculation and/or a lookup table, and set the window opening value to a predefined value such as for example 10%, open, 20% open, 60% open or the like, based on the provided gravitational acceleration information and the reference data. Hence, different ranges may be provided, and dependent on within which range the provided gravitational acceleration information lies, different opening values may be provided. For example with a resolution, such as a predefined resolution, corresponding to e.g. 1°. 5°, 10° or 20° resolution. Hence, when the processing arrangement determines that the provided gravitational acceleration information is within a first range, the window opening value may be set to indicate e.g. 20° open, and when the processing arrangement determines that the provided gravitational acceleration information is within a neighbouring range, the window opening value may be set to indicate e.g. 30° open, and so on (i.e. a 10° resolution). The same may be provided by means of an opening percentage indication or the like.

[0036] In one or more embodiments of the present disclosure, the state detection system is configured so that the gravitational acceleration information used for determining if the roof window is in a predefined locked state or in an open state, and for determining the window opening value representing an angular position of the movable frame relative to the fixation frame, is gravitational acceleration information data obtained while the movable frame and the handle arrangement are non-moving.

[0037] This may provide a more reliable state detection and detection of window opening value, since the acceleration experienced by the multi axis accelerometer is substantially only the gravitational acceleration values when the movable unit and handle is non-moving relative to the fixation frame.

[0038] In one or more embodiments of the present disclosure, said processing so as to determine the window opening value is configured to comprise correlating, such as comparing, gravitational acceleration information obtained from the multi axis accelerometer arrangement with reference data, wherein the reference data comprises gravitational acceleration reference data, such as predefined gravitational acceleration reference data, stored in a data storage.

[0039] This may e.g. enable a less data processing demanding calculation which may e.g. be more simple, enable a

more cost efficient solution and/or be power saving.

[0040] The gravitational acceleration reference data may be based on output from the accelerometer obtained after window installation, e.g. during a reference data updating session. For example, the gravitational acceleration reference data may comprise one or more predefined values obtained from the multi axis accelerometer when the movable frame and/or handle is in a predefined position, such as a fully closed position, or the like, and this information may be stored directly or after a certain processing, as gravitational acceleration reference data in the data storage. Additionally or alternatively, a lookup table may be determined by the processing arrangement based on the obtained data from the multi axis accelerometer, which may be used as reference data when the processing arrangement subsequently determines the window opening value representing an opening value of the movable frame relative to the fixation frame.

[0041] In one or more embodiments of the present disclosure, the determination of the window opening value and the determination of if the roof window is in a predefined locked state or in an open state are configured to be determined on the basis of gravitational acceleration information which is maintained in the acceleration domain.

[0042] Hence, no integration or the like of the sensor data may be provided in order to determine opening angle or locked state. By using the gravitational acceleration information from the sensor without integration into speed or position, this may provide a less power consuming solution.

[0043] In one or more embodiments of the present disclosure, the data processing of the provided gravitational acceleration information so as to determine if the roof window is in a predefined locked state or in an open state, and the data processing of the provided gravitational acceleration information so as to determine the window opening value is configured to be based on gravitational acceleration information retrieved from the same multi axis accelerometer, such as a single multi axis accelerometer, arranged at the handle arrangement.

[0044] This may e.g. provide a more simple and/or cost efficient solution.

[0045] In other embodiments of the present disclosure, the data processing of the provided gravitational acceleration information so as to determine if the roof window is in a predefined locked state or in an open state may be configured to be based on gravitational acceleration information retrieved from a first multi axis accelerometer, and the data processing of the provided gravitational acceleration information so as to determine the window opening value may be configured to be based on gravitational acceleration information retrieved from a second multi axis accelerometer.

[0046] In one or more embodiments of the present disclosure, the roof window is configured to be arranged in a predefined, locked ventilation state, and in a predefined, closed, locked state, respectively,
wherein the data processing is configured so as to determine if the building window is arranged in the predefined ventilation state or in the predefined, closed, locked state.

[0047] This may provide relevant information, e.g. in relation to improve energy optimization, improve indoor climate, improving information enabling preventing damage due to rain entering indoor environment, and/or the like.

[0048] In some embodiments of the present disclosure, the movable frame may be configured to be in a predefined ajar position in the predefined, locked ventilation state.

[0049] In other embodiments of the present disclosure, the movable frame may be in a substantially closed and locked position in the ventilation state, preferably so that a substantially air-tight connection between the movable frame and the fixation frame is provided, like/as in the closed and locked state. Here, a valve arrangement may in further embodiments be configured to be operated by means of the handle arrangement that is also used for opening/closing the window. When the valve arrangement is an open position, the window may be in a predefined, locked, ventilation state, and when the valve arrangement is in the closed position, the window is in the predefined, closed, locked state.

[0050] It is understood that the movable frame in the open state may be arranged in a further, more open position than in the predefined ventilation state.

[0051] In some embodiments of the present disclosure, the locking part is configured to engage with an engagement arrangement, such as a striker part, e.g. a striker plate, of the locking system at the fixation frame so as to place the locking system in the first locking state (providing the closed state) and optionally also in a second locking state (providing the ventilation state).

[0052] In some embodiments of the present disclosure, the locking system comprising the engagement part at the fixation frame and the locking part at the movable frame is configured to provide, such as define, one or more of the predefined locked positions of the movable frame. In this/these predefined locked positions, the locking system may in further embodiment be configured to resists the movable frame to be moved to a more open position or a more closed position without manipulating the locking part by means of the handle arrangement so that the locking system is arranged in in an unlocked state.

[0053] This may result in merged data from the accelerometer related to the position of the handle arrangement relative to the movable frame, and data related to the position of the movable frame relative to the fixation frame. However, the inventor has found that this may provide relevant information from the accelerometer that may enable reliable determination of if the window is in one or more of the above mentioned states.

[0054] In one or more embodiments of the present disclosure, the gravitational acceleration information may comprise at least two of X-axis gravitational acceleration information, Y-axis gravitational acceleration information and Z-axis

gravitational acceleration information. In further embodiments, the value of said at least two of X-axis gravitational acceleration information, Y-axis gravitational acceleration information and Z-axis gravitational acceleration information is a result of a combination of the position of the handle arrangement relative to the movable frame and the position of the movable frame relative to the fixation frame.

[0055] The present inventor has found that such merged information may be usable for window state detection relating to both window opening angle and locking state.

[0056] For example, when the handle arrangement is moved relative to the movable frame, this results in a change in one or more of the X-axis information, Y-axis information and Z-axis information of the sensor output. Additionally, when the movable frame is moved relative to the fixation frame, this also results in a change in one or more of the X-axis information, Y-axis information and Z-axis information of the sensor output. Hence, for example the X-axis information, the Y-axis information and/or the Z-axis information may reflect a specific window state of the window relating to both the state of the locking system and the positional state of the movable frame. One or more of the X-axis information Y-axis information and/or the Z-axis information of the sensor output may hence be considered as comprising a merge of information relating to the position of the movable frame relative to the fixation frame and the position of the handle arrangement relative to the fixation frame.

[0057] When the window is opened, closed or the like, this changes the angular position of the movable frame and hence the angular position of the handle arrangement. Hence, the processing arrangement may detect the positional change of the movable frame through the position changes at the handle arrangement.

[0058] In one or more embodiments of the present disclosure, the roof window is a roof window that is installed in a roof structure of a building, wherein the roof structure has a roof pitch between 10° and 85°, for example between 18° and 80°, relative to horizontal in a closed (CS) window state.

[0059] In one or more embodiments of the present disclosure, the roof window is a roof window of the type that is configured to be installed in a roof structure having a roof pitch between 10° and 85°, for example between 18° and 80°, relative to horizontal in a closed window state.

[0060] In one or more embodiments of the present disclosure, the movable frame may be configured to pivot around at least one horizontal axis. This is when the roof window is installed in a roof structure. In one or more embodiments of the present disclosure, the movable frame may be centre hung or top hung by means of the hinge arrangement. In such window solutions, the inventor has found that a multi-axis accelerometer based sensor solution may be sufficient for both determining window opening value and window state.

[0061] In some embodiments of the present disclosure, the window state detection system may be integrated in the handle arrangement. This may e.g. be provided from the window manufacturer or by exchanging the handle arrangement at the building/window site. The present solution provides a solution that does not need mechanical integration with e.g. the locking system, a hinge arrangement and/or the like of the window. Hence, easy adaption of the window to comprise a window state detection system for detecting one or more window states is facilitated.

[0062] In some embodiments of the present disclosure, the window state detection system may be integrated in a retrofitting body that is retrofitted onto the handle arrangement. This may provide easy retrofitting of the window state detection system.

[0063] In some embodiments of the present disclosure, after installation, the movable frame may be configured so as to not be able rotate around a vertical axis.

[0064] In some embodiments of the present disclosure, after installation, the movable frame may be configured so as not to be side hung, and the movable frame may thus not be able to rotate around an axis that extends parallel to a longitudinal direction of a side profile of the movable frame.

[0065] In some embodiments of the present disclosure, after window installation, the movable frame may be configured so as to only rotate around one or more horizontal after the roof window is installed in a roof structure. At least during normal use of the installed roof window.

[0066] In one or more embodiments of the present disclosure, the movement of the handle arrangement relative to the movable frame may comprise a rotation of the handle arrangement around a rotation axis. In some further embodiments of the present disclosure, said rotation axis may be substantially parallel to a plane defined by a major surface of the insulating glass unit.

[0067] In some embodiments of the present disclosure, the movable frame may be configured to be in a closed and locked position in a predefined, locked ventilation state.

[0068] In other embodiments of the present disclosure, said movement of the handle arrangement relative to the movable frame may comprise a rotation of the handle arrangement around a rotation axis that is substantially perpendicular to a plane defined by a major surface of the insulating glass unit. In further embodiments hereof, the movable frame may be configured to be in a predefined ajar position in a predefined ventilation state such as a predefined, locked ventilation state.

[0069] In some embodiments of the present disclosure, the rotation axis of the handle may be substantially parallel to the at least one horizontal axis around which the movable frame may be configured to pivot.

[0070] The reference data may in embodiments of the present disclosure be calibrated or recalibrated automatically during a data updating session. This may be provided automatically by the system according to a program code, by means of user inter action or a combination thereof

[0071] In one or more embodiments of the present disclosure, a reference data updating system is configured to generate and/or update the reference data when predefined criteria is/are complied with. This generating and/or updating may be based on gravitational acceleration information received from the multi axis accelerometer, preferably after installation of the roof window.

[0072] This may e.g. help to provide a calibration or re-calibration of the state detection system, e.g. to account for the window installation angle.

[0073] Many roof windows may be installed so that a major plane of the insulating glass unit is arranged with an angle different from horizontal or vertical, such as between 10° and 85°, for example between 18° and 80° relative to horizontal in the closed window state. This may however vary dependent on the roof pitch which may vary. Hence, arranging the window installed in the roof structure in a predefined state such as the closed and locked state and e.g. also fulfilling predefined criteria to update the reference data with information retrieved directly or indirectly from the multi axis accelerometer may provide that the system knows what the accelerometer/sensor output should be in in the closed window state for that specific window. This may additionally or alternatively be applied for a predefined, ventilation state, e.g. a predefined locked ventilation state (if present/facilitated by the window) and/or the like.

[0074] In one or more embodiments of the present disclosure, said updating may be configured so that gravitational acceleration information provided by the multi axis accelerometer is used for generating or updating the gravitational acceleration reference data, such as while the handle and/or the movable frame is/are arranged into one or more predefined reference positions.

[0075] In one or more embodiments of the present disclosure, the handle arrangement may be connected to the at least one locking part of the locking system of the window. This may in some embodiments be provided by the handle arrangement being mechanically connected to the at least one locking part, so as to interact with and/or control the locking part. In other embodiments of the present disclosure, it may be provided by the handle arrangement being wirelessly (such as electrically or magnetically) connected to the at least one locking part, so as to interact with and/or control the locking part.

[0076] In some embodiments of the present disclosure, the window state detection system comprises a wireless data transmission arrangement configured to wirelessly transmit state information based on said provided state information output.

[0077] In some embodiments of the present disclosure, the window state detection system may comprise a battery, e.g. arranged at the handle arrangement together with the window state detection system, wherein the battery is configured to power the window state detection system.

[0078] In some embodiments of the present disclosure, the state detection system comprising the multi axis accelerometer arrangement, the processing arrangement, wired or wireless data transmission arrangement and/or the like may be arranged at the handle, e.g. at or in a common unit, such as at or in a retrofitting body or at or in a part the handle.

[0079] In one or more embodiments of the present disclosure, said determination of if the roof window is in a predefined locked state or in an open state, and/or said determination of the window opening value, may be configured so as to be provided when the movable unit and handle is in standstill and is thus not moving.

[0080] This may help to provide a more precise state determination and/or window opening value determination.

[0081] For example, a timer, counter or the like may in certain embodiments be used for directly or indirectly assuring that the window state and/or window opening value is determined, such as confirmed/approved, when a plurality of samples, such as a plurality of consecutive samples, of the received sensor information/output SEO lies within a defined range, such as a predefined range.

[0082] A plurality of samples from the accelerometer arrangement collected/received within a time period, such as a predefined time period, may e.g. and correlated in a suitable way to determine if the movable unit and handle are not moving/in standstill. Alternatively, samples from the sensor may be collected and stored with a defined,, such as a predefined time interval, and these may be correlated in order to determine if the movable unit and handle are moving or not moving/in standstill.

[0083] When the movable unit and handle are in standstill, the sensor output from the accelerometer arrangement will represent gravitational acceleration information that may be used for determining if the roof window is in a predefined locked state or in an open state, and/or determining the window opening value.

[0084] The present disclosure moreover relates, in a second aspect, to a method of providing window state detection at a building roof window installed at a roof structure of a building, preferably wherein the roof structure has a roof pitch angle larger than 10° relative to horizontal. The roof window comprises a movable frame which is supported by a fixation frame by means of a hinge arrangement that allows the movable frame to move relative to the fixation frame, wherein the movable frame supports an insulating glass unit. The movable frame comprises a handle arrangement which is mechanically connected to at least one locking part of a locking system of the window. The handle arrangement is configured to be

operated by human hand to be moved relative to the movable frame and thereby displace the locking part between different states comprising one or more locking states and an unlocked state. The locking system in the one or more locking states is configured to maintain the movable frame in a predefined, locked position, wherein the locking system in the unlocked state is configured to allow the movable frame to open towards a substantially fully open position. A window state detection system comprises a multi axis accelerometer arrangement arranged at the handle arrangement so that the multi axis accelerometer arrangement moves together with the handle arrangement relative to the movable frame. The multi axis accelerometer arrangement comprises one or more multi axis accelerometers. A data processing arrangement of the window state detection system processes gravitational acceleration information received from the multi axis accelerometer arrangement so as to determine if the roof window is in a predefined locked state or in an open state. Moreover, the data processing arrangement of the window state detection system processes gravitational acceleration information received from the multi axis accelerometer arrangement arranged, so as to determine a window opening value representing an opening value of the movable frame relative to the fixation frame. The determination of at least the window opening value is based on reference data stored in a data storage, wherein the reference data comprises data which is based on an installation angle of the roof window.

[0085] In one or more embodiments of the present disclosure, the building roof window may be a roof window according to any of the preceding embodiments and/or according to one or more of claims 1-14.

[0086] The present disclosure additionally relates, in a third aspect, to a system comprising a user device, such as a handheld user device, and a building roof window comprising a window state detection system according to any of the preceding embodiments and/or any of claims 1-14. State information comprising the detected/determined window state and the detected window opening value is transmitted wirelessly to a user device, such as a hand held user device, comprising a screen. Based on the transmitted state information, state information is presented by means of a user interface on the screen of the user device to a user. The presented state information is updated/changed when the window state and/or the window opening value changes.

[0087] In some embodiments of the third aspect, the presented state information 60 may indicate if the window is in an open state, a closed state or a ventilation state.

[0088] In some embodiments of the third aspect, the presented information may comprise a visual animation indicating if the window is open, such as fully or partly open, or closed.

[0089] In some embodiments of the third aspect, the presented information may indicate the window opening value, e.g. by writing, by a graph, such as a visual bar, or the like, on the screen of the user device.

[0090] In some embodiments of the third aspect, the presented information may indicate the window opening value by means of a visual animation on the user device screen.

[0091] In some embodiments of the third aspect, the transmittance of the state information may e.g. be configured to be provided directly from the transmitter and to the handheld user device or from the transmitter and by means of an intranet or the internet to the handheld user device.

Description of the drawings

[0092] The present disclosure will in the following be described in greater detail with reference to the accompanying drawings:

Fig. 1	: Illustrates a schematic view of a building window comprising a window state detection system, according to embodiments of the present disclosure,
Fig. 2	: Illustrates a schematic view of a roof window in a predefined closed, locked state, according to embodiments of the present disclosure,
Fig. 2a	: Illustrates a schematic view of the building window of fig. 2 in a predefined ventilation state, according to embodiments of the present disclosure,
Fig. 2b	: Illustrates a schematic view of the building window of fig. 2 in an open state, according to embodiments of the present disclosure,
Fig. 3	: Illustrates a schematic view of a building window in an open state where the movable frame of the window is in an open position, according to embodiments of the present disclosure,
Fig. 4	: Illustrates a schematic view of a window state detection system according to embodiments of the present disclosure,
Figs. 4a-4c:	Illustrate schematic views of a state detection system providing state detection and a window opening value according to various embodiments of the present disclosure,
Figs. 5-8	: Illustrate a schematic view of a window state detection system placed at/in a retrofitting body, according to embodiments of the present disclosure,
Figs. 9-10	: Illustrate schematic flow charts of operation of a window state detection system according to various embodiments of the present disclosure,

Fig. 11 : Illustrates a schematic view of a window state detection system according to further embodiments of the present disclosure,

Fig. 12 : Illustrates a schematic view of a roof window of the top hung type, according to embodiments of the present disclosure,

Fig. 13 : Illustrates a schematic view of a roof window installed in a building having a non-horizontal roof pitch, according to embodiments of the present disclosure,

Fig. 14 : Illustrates a schematic flowchart relating to update of reference data to take the roof pitch angle into account, according to embodiments of the present disclosure, and

Fig. 15 : Illustrates a schematic flowchart relating to collection of data from a multi axis accelerometer, according to embodiments of the present disclosure.

Detailed description

[0093] Fig. 1 illustrates schematically a part of a building window 1 according to embodiments of the present disclosure.

[0094] The building window comprises a movable frame 3, which is supported by a fixation frame 4 by means of a hinge arrangement 14 (not illustrated in fig. 1) that allows the movable frame 3 to move relative to the fixation frame 4. The fixation frame 4 is configured to be attached (directly or indirectly) to a structure of a building, often by means of one or more mechanical fasteners such as screws, clips and/or the like.

[0095] It is generally to be understood that the window may be a building roof window 1, such as a roof window configured to be installed in an inclining roof having a non-horizontal roof pitch, se e.g. figs. 2-3 and/or 12-13.

[0096] The hinge arrangement 14 type may vary dependent on the window 1 type. For example whether the window is top hung, centre hung, side hung or bottom hung and/or a "tilt and turn" solution. Generally, the opening and closing of the movable frame 3 may preferably provide an angular change between the fixation frame 4 and the movable frame 3.

[0097] The window 1 comprises a handle arrangement 6. The handle arrangement comprises a grip part 6a configured to be grabbed and operated by human hand so that the handle arrangement is moved relative to the movable frame 3. This provides that the locking part 5a of a locking system 5 of the building window 1 may be displaced between different states S1-S3 at the movable frame 3.

[0098] In fig. 1, the handle arrangement 6 is configured to be rotated around a rotation axis RAX1 that is substantially perpendicular to a plane PL defined by a major surface (see example of major surface 7a plane PL at figs. 2-2b) of the insulating glass unit 7.

[0099] However, other movement directions, rotation directions and/or the like of the handle arrangement relative to the movable frame 3 may be provided in other embodiments of the present disclosure.

[0100] In fig. 1, the handle arrangement 6 is mechanically connected to the locking part 5a, as the locking part 5a is integrated with the handle as a unitary part that is unitary with the grip part 6a. The locking part 5a may e.g. be or comprise one or more movable pawls configured to be operated by means of the handle arrangement. In other embodiments, the locking part may not be unitary with the handle, but may be directly or indirectly mechanically connected thereto.

[0101] The locking system 5 is configured to be arranged in different locking states S1-S3 by means of the handle by human hand operating the grip part 6a.

[0102] Fig. 1 illustrates the locking system 5 in an unlocked state S3. Here, the locking system allows the movable frame 3 to open towards a substantially fully open position, as it does not engage with the engagement part 5b, such as a striker part, such as a striker plate, of the locking system 5. The engagement part 5b is attached to, and/or integrated in, the fixation frame 4. The window is hence in an open state OS.

[0103] One or more mechanical stop arrangements (not illustrated) of the window 1, for example one or more mechanical stops provided by the hinge arrangement 14, a part of one or both frames 3, 4 or the like may define/determine when the movable frame is fully open and hence cannot be opened more/further. Additionally or alternatively,

[0104] A breaking/holding arrangement may be provided for holding the movable frame 3 in a predefined open position. In this case, this holding arrangement may be considered defining the fully open position. The holding arrangement may be spring actuated, gas spring actuated and/or the like.

[0105] It is understood that the fully open position may in some embodiments be considered the most open. predefined position in which movable unit can be placed in and maintained in without user interference. Some solutions may offer the possibility of forcing the movable unit further open from the fully open state, but when a user releases the movable frame, the movable frame may return to the fully open position, e.g. due to gravity. In some embodiments, the fully open position may be a predetermined position providing that the major surface of the glass unit still inclines a little so that water can run off the window and onto the roof structure. If the window opens too much, water may enter into the building which is unwanted.

[0106] In fig. 1, the engagement part 5b is configured to cooperate with the locking part 5a so as to lock the movable frame 3 in different, predefined locking positions.

[0107] When the handle 6 is rotated and the locking part 5a is arranged to extend into the recessed portion R1 of the

engagement part 5b, the window 1 is in a predefined, fully closed and locked state CS. Here, the locking system 5 is in a predefined first locking state S1 resulting in that gaskets and/or other parts or tightening means of the window 1 are activated, such as compressed, in order to reduce, such as minimize flow of air between the movable frame and the fixation frame.

[0108] When the handle 6 is rotated by hand and the locking part 5a is arranged to extend into the recessed portion R2 of the engagement part 5b, the window 1 is in a predefined, locked, ventilation state VS. Here the locking system 5 is in a predefined, second locking state S2 that keeps the movable frame 3 ajar so that ventilation air is allowed to enter between the movable frame 3 and the fixation frame 4.

[0109] When the locking system 5 is in the first or second locking states S1, S2, it is hence configured to maintain the movable frame 3 in a predefined, locked position so that the movable frame is in a locked position 3 relative to the fixation frame 4.

[0110] The building window comprises a window state detection system 2 comprising a multi axis accelerometer arrangement 10 arranged at the handle arrangement 6. The window state detection system 2 is configured to detect if the building window is arranged in at least one predefined locked state CS, VS or in an open state OS. The multi axis accelerometer 10 is configured to move together with the handle arrangement/handle 6 relative to the movable frame, and hence the accelerometer may detect the movement of the handle arrangement 6. The detected movement hence include movement of the handle arrangement 6 relative to the movable frame 3.

[0111] The window state detection system 2 moreover comprises a data processing arrangement 11 configured to process data based on the sensor output, for example including the first sensor output, from the multi axis accelerometer 10. This is provided in order to determine if the building window is arranged in one or more of the locked states such as the ventilation state and/or the closed state, and/or in the open state OS. The processing arrangement provides window state information output SIO based on said processing.

[0112] What is also to be recognized is that the multi axis accelerometer 10 will also register when the movable frame 3 is opened as the handle 6 and hence the accelerometer 10 of the system 2 moves together with the handle, and this enables that the system 2 can detect if the movable frame 3 is in an open state, such as the ventilation state or in the unlocked state. Hence by processing the sensor output from the accelerometer, information may be retrieved that reflects (directly or indirectly) both the position of the movable frame 3, e.g. relative to a predefined reference position such as the closed position, and also information of the handle movement/position (and hence the locking state) relative to the movable frame, thereby enabling that the system 2 can determine if the window 1 is in a predefined state such as a locked state and/or ventilation state.

[0113] For example, if the movable frame 3 is detected to be arranged in an angle that is larger than the angle where it is when the window is in the ventilation state, the output from the sensor with respect to the handle position relative to the movable frame may be of secondary importance, as the system know that when the movable frame is arranged at an opening position that is larger than when in the ventilation state, the window is per definition unlocked.

[0114] When the moveable frame 3 is in a closed position, a user may however have forgot to lock the window. Here, the information from the accelerometer arrangement 10 with respect to the position of the handle 6 relative to the movable frame 3 becomes relevant, as this information reflects if the window is actually in a locked state S1, S2.

[0115] When the moveable frame 3 is in a partly closed position substantially corresponding to the ventilation state, the window may however not have been locked by a user. In some situations it can be envisaged that the movable frame 3, due to wind or the like, may have been moved to a position that gives a user the impression that the window is locked. However, it may not be locked. Naturally, some users will be able to see that from the handle position, but not all users, and not all handle solutions may clearly, visually reflect if the window is locked or not, and it may depend on different circumstances. However, the window state detection system 2 according to the present disclosure may in some embodiments of the present disclosure be able to spot that the movable frame 3 is in a position corresponding to the ventilation state (by detecting the position of the movable frame in one away or the other based on the sensor data from the accelerometer), but the handle 6 is not moved relative to the movable frame 3 so that the locking system 5 is in the second locking state S2.

[0116] Since the accelerometer arrangement 10 of the window state detection system 2 is arranged at the handle 6, the inventor has found that it may also be possible to determine a window opening value representing an angular position of the movable frame 3 relative to the fixation frame 4.

[0117] This determination of the window opening value may be based on reference data, such as reference data stored in a data storage. The reference data may comprise data which is directly or indirectly based on an installation angle of the roof window.

[0118] Additionally, the determination of if the if the roof window is in a predefined locked state CS, VS or in an open state OS may be based on reference data that may directly or indirectly be based on an installation angle of the roof window.

[0119] Embodiments of determination of the window opening angle are described in more details later on.

[0120] The insulating glass unit 7 may comprise one or more insulting gaps between glass sheets/panes of the glass unit 7. The gap(s) may comprise a gas filled gap or may be evacuated. If the gap is evacuated, the insulating glass unit may be of the Vacuum Insulated Glass (VIG) unit type, e.g. comprising a plurality of spacers distributed in the evacuated gap to

maintain the gap due to the gap evacuation. The glass unit 7 may be laminated or unlaminated.

[0121] The multi axis accelerometer arrangement 10 may comprise one or more multi axis accelerometers. In some embodiments of the present disclosure, the data processing of the gravitational acceleration information so as to determine if the roof window is in a predefined locked state or in an open state, and the data processing of the provided gravitational acceleration information so as to determine the window opening value is configured to be based on gravitational acceleration information retrieved from the same multi axis accelerometer, may be retrieved from the same multi axis accelerometer of the multi axis accelerometer arrangement 10. In other embodiments of the present disclosure, the data processing of the gravitational acceleration information so as to determine if the roof window is in a predefined locked state or in an open state, and the data processing of the provided gravitational acceleration information so as to determine the window opening value may be configured to be based on gravitational acceleration information retrieved from different multi axis accelerometers of the arrangement 10.

[0122] Figs. 2 - 3 illustrates schematically a building roof window 1 according to various embodiments of the present disclosure. The roof window 1 in figs. 2-3 is of the type that is centre hung, and where the movable frame 3 is thus centre hung by means of a hinge arrangement (not illustrated) to rotate (by means of the hinge arrangement 14) and thus pivot around an axis RAX3 (not illustrated in fig. 2, see fig. 3) placed between the top and bottom of the movable frame 3 as indicated by the dashed arrows in fig. 2 and 3.

[0123] Figs. 2, 2a and 2b illustrate a cross sectional view of a roof window 1 with a centre hung movable frame 3 while fig. 3 illustrates a roof window with a centre hung movable frame 3 seen in perspective. The design of e.g. the handle arrangement varies a bit between figs. 2 and 3, but the general/overall functionality of the locking system as such, the handle arrangement, the window 1 and/or the like may in general be identical.

[0124] In figs 2-3, the glass unit 7 is of the laminated glass unit type. Here, a lamination glass is placed at the interior side facing the interior INT of the building a lamination interlayer adhere the lamination glass to another pane of the insulating glass unit and comprises the major surface of the glass unit facing the building interior.

[0125] The longitudinal direction of the rotation axis RAX3 of the movable frame 3 may extend between, such as extend through, side frame profiles of the movable frame 3. The axis RAX3 is normally placed to extend substantially horizontal when the window 1 is installed.

[0126] In figs. 2 and 3, at the upper part of the movable frame 3, the handle arrangement 6 is arranged with the grip part 6a configured to be grabbed and operated by human hand.

[0127] The grip part 6a may be a grip part that extends in a longitudinal direction that is substantially parallel with/to the pivot axis/rotation axis RAX3 of the movable frame 3 as also illustrated in fig. 3. Hence a user may grab and pull the handle 6 to open the window 1, and may push the handle to close the window 1.

[0128] In fig. 2, the window 1 is in a closed and locked state CS, and the window 1 is thus not in a ventilation position. In fig. 3, the window 1 is in an open state and the movable frame 3 is hence in an open position where it has been opened and rotated relative to the fixation frame 4 around the axis RAX3.

[0129] A common feature of the window of figs. 2-3 is that the handle arrangement 6 is attached to and/or comprises a hinged ventilation valve 8, such as a valve plate.

[0130] The handle arrangement 6 and valve plate 8 are configured to move and thus pivot relative to the movable frame 3.

[0131] The insulating glass unit may comprise one or more insulting gaps between glass sheets/panes of the glass unit 7. The gap(s) may comprise a gas filled gap or may be evacuated. If the gap is evacuated, the insulating glass unit may be of the Vacuum Insulated Glass (VIG) unit type, e.g. comprising a plurality of spacers distributed in the evacuated gap to maintain the gap due to the gap evacuation. The glass unit 7 may be laminated or unlaminated. A laminated glass unit is e.g. illustrated in fig. 2. Here, a lamination glass is placed at the interior side facing the interior INT of the building.

[0132] In fig. 2-2b and fig. 3, the movement/pivoting of the handle arrangement 6 relative to the movable frame 3 comprises a rotation around a handle rotation axis RAX2 that is substantially parallel to a plane PL1 defined by a major surface of the insulating glass unit 7.

[0133] This handle rotation axis RAX2 of the handle arrangement 6/handle may be substantially parallel with/to the pivot axis RAX3 of the movable frame 3. The window in figs 2-3 is of the centre hung type.

[0134] The handle 6 is directly or indirectly mechanically connected the locking part 5a of the locking system 5 of the window 1 by means of a linking part 9 that is placed between a lock housing 5c and the handle arrangement 6 and/or ventilation valve 8. Hence, when pivoting the handle 6 relative to the movable frame 3 by human hand (and/or by means of an electric actuator - not illustrated), the locking part 5a is displaced by the handle arrangement between different states comprising a locking S1 state (see figs. 2 and 2a) and an unlocked state S3 (see fig. 2b).

[0135] In fig. 2, the window is in the predefined closed, locked state CS. Here, the ventilation valve 8 is also in a closed state/position HCP to prevent ventilation air to pass between the movable frame 3 and the fixation frame 4, into the interior INT of the building.

[0136] In fig. 2a (illustrating a part of the window of fig. 2), the handle 6, and hence the hinged ventilation valve 8, is moved relative to the movable frame 3 around the handle rotation axis RAX2 to a predefined ventilation position HVP where the

valve 8 is in an open position//state, so that the window 1 is in a ventilation state VS. Here, ventilation air VA (dashed/dotted lines of fig. 2a) is allowed to pass into the building through an opening in the window 1. This handle 6 movement to the ventilation position HVP does not move the movable frame 3, and does not move the locking part 5a to an unlocked state, so the building window 1 is thus still in a predefined, closed and locked state CS. The Ventilation air VA may enter the window through a filter or the like (not illustrated) at the top of the window.

[0137] However, moving the handle 6 and ventilation valve 8 further from the ventilation position of fig. 2a, relative to the movable frame 3, as illustrated in fig. 4b, to a handle opening position HOP, provides that the handle arrangement interacts directly or indirectly with the locking system 5, so that the locking part 5a is moved to an unlocked state S3.

[0138] The linking part 9 controls the locking system of the lock housing 5c. The locking system 5 may be configured so as to maintain the ventilation valve 8 in a predefined angular position in the ventilation state relative to a closed position (see fig. 2) as illustrated in fig. 2a. One or more spring mechanisms, latch/notch solutions and or the like in the locking housing 5 may be configured to provide this. In some embodiments of the present disclosure, the locking system 5 may be of a type as described in patent document EP3848540 A1 and/or EP2281984 A1.

[0139] For example, a rotation of the handle 6 around the rotation axis RAX2 by an angle a1 e.g. between 10° and 45°, such as between 20° and 45°, for example around 30° relative to a closed position of the handle/valve 8 may place the handle and the valve 8 in a predefined ventilation position HVP relative to the movable frame 3. This predefined ventilation position HVP for the handle may be directly and/or indirectly represented/stored in a data storage of the window state detection system 2.

[0140] Upon further moving the handle arrangement and thus also the valve around the axis RAX3 to a further, larger angle a1 relative to the movable frame to the handle opening position HOP, this provides that the handle, by means of the linking park, disengages the locking system 5 so that the locking part moves to an disengaged state so that the locking system is in an unlocked state S3. This enables a human user to pull the handle 6 to open the window as illustrated in fig. 3.

[0141] For example, in embodiments, a rotation of the handle 6 around the rotation axis RAX2 of e.g. between 50° to 80°, such as between 55° and 65°, for example around 60° relative to a closed position of the handle/valve 8 may place the handle 6 and the valve 8 in an opening handle position HOP relative to the movable frame 3. This predefined handle opening position HVP for the handle 6 may be directly and/or indirectly represented/stored in a data storage of the window state detection system 2.

[0142] The angles a1 in the ventilation position HVP and the open position HOP may in preferred embodiments of the present disclosure be predetermined, e.g. by means of a spring arrangement and/or the like of the locking system 5. This may enable the window state detection system 2 to more easily deduce when the window is in the ventilation state VS, the open state OS (where the movable frame 3 is in an open position or can be arranged therein) or the closed state CS.

[0143] As can be seen from figs. 2-3, the window state detection system 2 moves together with the movable frame, and hence, an opening of the movable frame 3 would also provide a change of the sensor output from the multi axis accelerometer 10 of the system 2, that may be used directly or indirectly by the processing arrangement 11 for detecting if the movable frame is placed in an open position, and to determine a window opening value representing an angular position of the movable frame 3 relative to the fixation frame 4.

[0144] In the windows of figs. 1-3, the constitution of the locking system comprising the engagement part 5b at the fixation frame 4 and the locking part 5a at the movable frame 5 provides, such as defines, one or more of the predefined locked positions VC, CS of the movable frame 3. In this/these predefined locked positions, the locking system 6 resists the movable frame 3 to be moved to a more open position, or a more closed position without manipulating the locking part 5a by the handle 6 so that the locking system is in an unlocked state.

[0145] In fig. 1, fig. 2b and fig. 3, the window 1 may be considered in an open state. In figs. 1 and 3, the movable frame 3 is in an open position whereas in fig. 2b, the movable frame is in a closed position while the locking system is in an unlocked state. Hence, a pull in the handle or a push at the bottom part of the lower part movable frame 3 may open the movable frame to an open position.

[0146] Roof windows 1 often demands rather extensive water proofing to protect from water and/or snow entering the building through or at the roof window. Hence, e.g. a top cover (see fig. 2), and also side covers (dependent on the window type - not illustrated in fig. 2-3) may be provided. The top cover overlap the movable frame when the movable frame is in a closed position or slightly open. This provide water proofing at the top of the roof window. Side covers may be attached to the fixation frame and/or the movable frame, and may overlap the movable frame and/or the fixation frame when the movable frame is in a closed position. This also provides water proofing. Also, the movable frame 3 may overlap the bottom of the fixation frame to improve water proofing. In figs. 2-3, the roof window 1 is of the centre hung type, and the fixation frame hence surrounds the movable frame and/or may have a frame opening that is larger than the movable unit/frame 3 to enable that the movable unit 3 can rotate around rotation axis RAX3.

[0147] Fig. 4 illustrates schematically a window state detection system 2 according to embodiments of the present disclosure.

[0148] The window state detection system 2 comprises the multi axis accelerometer 10 arrangement. The multi axis accelerometer 10 comprises one or more multi axis accelerometers. The multi axis accelerometer(s) of the arrangement

10 may in some embodiments be of the MEMS (micro-electro-mechanical systems) type. In some embodiments of the present disclosure, the accelerometer 10 may comprise a piezo-based electric accelerometer such as a piezoelectric or piezo resistive or capacitive accelerometer. The accelerometer may be of the digital type. In some embodiments, the accelerometer is a 2-axis or a 3-axis accelerometer. One example of the accelerometer 10 may be an ADXL345 3-axis accelerometer, but it is understood that other types of accelerometers may be used for the system 2 in other embodiments of the present disclosure. Tests have shown that the ADXL345 accelerometer type may be relevant and fit for use as the accelerometer 10 of the window state detection system 2.

[0149] The accelerometer arrangement 10 provides sensor output SEO to the processing arrangement 11. The processing arrangement 11 comprises one or more processing units, such as one or more hardware processors, for example one or more microprocessors, configured to receive and process the sensor output SEO based on control code CTC stored in a data storage 11b. The data stored in the data storage 11b may additionally comprise reference data REF as described in more details later, but it is also understood that in other embodiments, the data CTC and REF may be stored in different data storages. A battery arrangement 12, such as a disposable or rechargeable battery provides electric power to the data window state detection system 2.

[0150] The processing arrangement 11 process data based on sensor output SEO from the multi axis accelerometer 10, and thereby determines if the building window 1 is in a predefined locked state CS, VS, such as the closed state CS or ventilation state VS, or in an open state OS, and the processing arrangement provides state information output SIO reflecting/comprising information of this window state. In at least the closed state, the movable frame 3 is in a closed and locked position, and in the open state, the movable frame 3 may be in an open position.

[0151] The state information output SIO is transmitted/forwarded to a wireless data transmission arrangement 11a of the system 2 configured to wirelessly transmit state information TSI based on said provided state information output SIO. Thereby, a receiver of the wireless signal TSI can get information of if the building window 1 is in a predefined locked state CS, VS, such as the closed state CS or ventilation state VS, or in an open state OS where the movable frame may be in an open position. The wireless communication may in embodiments of the present disclosure be based on Bluetooth, Zigbee, Wifi (wireeless Fidelity), cellular network technology such as 5G or 4G, or any other suitable wireless communication means. One example may be a low-rate wireless personal area network (LR-WPANs) such as according to the IEEE 802.15.4 standard. The wireless communication may e.g. be provided by means of radio waves and/or optical communication. An antenna arrangement, diode or the like of the system 2 may be used for the wireless transmission.

[0152] A receiving device 300, such as a mobile user device, for example a hand held mobile user device, such as a smartphone, receives the information of the signal TSI, for example directly or through a cloud based data communication system. For example, the signal TSI may be transmitted by means of a wireless protocol, such as over the internet, to an online server that distributes relevant information thereof to a software application at the user device 300.

[0153] A user interface 50 at the receiving device 300 hence presents window state information, for example by means of user notifications, at a screen, such as on a touch screen of the device 300. This is based on the received, wirelessly transmitted state information TSI. This may be provided by means of a software application installed by the user or another party at the device 300, for example by means of email, by means of a web browser at the mobile device, a specially adapted software application for presenting the window state information and/or the like. In some embodiments, the receiving device 300 may be considered a part of the window state detection system 2, in other embodiments it may not.

[0154] In other embodiments of the present disclosure (not illustrated) a device (different from the mobile user device) may be connected to mains and be supplied with power therefrom, and this device may receive the signals TSI, and comprise the processing arrangement 11. Such a device may hence send information wirelessly to the mobile user device directly or over the internet by means of one or more online servers.

[0155] In some embodiments of the present disclosure, the transmitted state information TSI may additionally or alternatively comprise information of the detected window opening value that represents an angular position of the movable frame of the window 1 relative to the fixation frame. This information may be used directly or indirectly at the device for informing a user of how much the movable frame 3 is open relative to the fixed frame 4. For example by defining how much the movable unit is open relative to the closed state CS and/or relative to a fully open state.

[0156] It is understood that in some embodiments of the present disclosure, the components 10, 11, 11a, 11b, 12 may be arranged at a common unit 13 such as at a common Printed Circuit board (PCB).

[0157] The battery arrangement 12 may e.g. be arranged at a printed circuit board comprising the multi axis accelerometer arrangement 10, the processing arrangement 11 the data storage 11b and/or the like. In other embodiments, the battery arrangement 12 may be arranged external to such a circuit board and provide power to the circuit board, e.g. by means of an electric wire connection.

[0158] Integrated solutions are available comprising wireless communication means, data processing unit, multi axis accelerometer and battery for powering these, that the inventor has found may be suitable for use for implementation of the system 2 according to embodiments of the present disclosure. In these solutions, the components 10, 11, 11a, 11b, 12 and/or the like are arranged at a common unit such as a common PCB. System on a chip (SoC) solutions may also be advantageous.

[0159] The reference data REF may be predefined reference data, such as threshold data.

[0160] The processing of the data by means of the processing arrangement 11 based on the sensor output SEO may in embodiments of the present disclosure comprise comprises correlating the reference data REF with the data based on sensor output from the multi axis accelerometer.

[0161] For example, the predefined reference data REF may comprise one or more parameter values, such as predefined parameter values, preferably one or more predefined thresholds, related to the position of the movable frame 3 relative to the fixation frame 4, and the said processing by means of the processing arrangement 11 may comprise correlating the one or more predefined parameter values of the reference data with the data based on the output from the accelerometer arrangement 10.

[0162] The processing may in embodiments of the present disclosure:

- be provided during movement and/or standstill of the handle 6 and/or movable frame 3,
- be provided with predefined time intervals (e.g. to save battery power),
- be provided by based on a wake-up routine that initiates the processing when predefined criteria are complied with

and/or the like.

[0163] In some embodiments of the present disclosure, the accelerometer arrangement 10 and/or processing arrangement 11 may comprise a sleep mode and a wake up mode. The wakeup mode may be activated based on a timer and/or another event, such as activated upon movement of the movable unit. This may start up accelerometer measurements and data processing of the sensor output. This may provide power saving and make the battery last longer.

[0164] The window state detection system 2 may in embodiments of the present disclosure be suitable for use at different window types (vertical building windows or roof windows, top hung or centre hung building windows and/or the like), window orientations and/or handle arrangements.

[0165] Building roof windows 1 are often arranged in a roof structure having an inclining roof pitch. Modern roof windows 1 having movable frames 3 may be capable of being installed in different roof structures having different roof pitch, without compromising water tightness of the roof window. This will however provide that the installation angle of the building roof window will vary individually dependent on the roof pitch.

[0166] The window state detection system 2 may thus, in some embodiments of the present disclosure comprise a reference data updating system (see also fig. 14) configured to update the reference data REF, such as threshold data of the reference data, when predefined criteria is/are complied with, prior to and/or after installation of the building window 1 and system 2. This may help to adapt the reference data to the individual installation conditions of the roof window 1, and thus help to provide reliable reference data that may be used for determining when the window is in a locked state CS, VS, such as a closed, locked state CS or ventilation state VS, or in an open state OS. It may additionally or alternatively be used in relation to determining the window opening value representing an angular position of the movable frame relative to the fixation frame.

[0167] For example a first reference parameter RE1 may comprises reference data information reflecting when the handle arrangement 6 is considered to be in a "closed" state so that the locking part 5a is in the or a locking position where it may engage with an engagement part 5b of the locking system at the fixation frame, and thereby keep the window in a closed and locked state. This handle position relative to the movable frame may in some embodiments be similar to both the closed position and the ajar position. In other embodiments it may be different, dependent on the locking system design and/or handle design.

[0168] A second reference parameter RE2 may comprise reference data information that is based on sensor output from the accelerometer when the movable frame is determined to be in a closed position.

[0169] Reference RE1 and RE2 may be provided by putting the window in a closed and locked state, and then fulfil the criteria that may update the reference data so that the processing arrangement know that the sensor output in this window state means "closed and locked".

[0170] A third reference parameter RE3 may comprise reference data information of when the window is in a ventilation state. Again this may be set by putting the window in a ventilation state and then fulfil the criteria that may update the reference data based on the sensor output in the ventilation state. In the embodiment of fig. 1 it may be relevant to store reference data when the movable frame is placed ajar and the locking part 5a is in the recess R2, as the movable frame 3 also changes angular position between the closed position and the ventilation position. In the embodiments of figs. 2-2a, the movable frame 3 does not change angular position between the closed state CS and ventilation state. However, it may still be relevant to store reference data related to the different multi axis output of the accelerometer, e.g. to improve window state detection and/or as references for determining further positions.

[0171] A fourth reference parameter RE4 may comprise reference data information of when the window is in an open state. For example, the sensor output may be recorded when the locking part 5a does not engage with the engagement part at one or more predefined positions of the movable frame 30. Additionally or alternatively, the fourth reference parameter may reflect when the movable frame is open. For example, the sensor output may reflect when the movable

frame moves, and by storing e.g. a threshold for such as reference data, the processing arrangement may be able to detect when the movable frame moves from a closed position.

[0172] One, more or all the above parameters may be recorded/updated after window installation so that the reference data is adapted to the orientation of the installed window.

[0173] It is however understood that one or more of the reference data parameters RE1-RE4 additionally or alternatively may be calculated/determined by the processing arrangement based on another reference data parameter. For example, in the solution as illustrated in figs. 2-3, when the first reference parameter RE1 is set/updated/adjusted, the processing arrangement 11 may be able to automatically detect that when the sensor output from the accelerometer reflects an e.g. 30° change relative to the reference data RE1 (as in fig. 2a), the window is in the predefined, locked ventilation state, and when the sensor output from the accelerometer reflects an e.g. 60° change relative to the reference data RE1 (as in fig. 2b), the window is in the open state OS.

[0174] In some embodiments of the present disclosure, the reference data may be reference data that is adapted with an "offset" that is determined by the roof pitch angle. In some embodiments, the reference data, such as RE1-R4 may be preset before or after system 2 installation and/or window 1 installation. A reference offset value (e.g. an offset value for one or more accelerometer axes, e.g. X-axis and Y-axis) that reflects/is determined based on the installation angle of the roof window may be provided and the reference data RE1-RE4 may be based on this offset value. In some embodiments, the reference offset value may e.g. be subtracted from the reference data RE1-RE4 or in other ways taken into account in order to adapt the reference data RE1-RE4 to the specific window installation conditions so that the reference data comprises data which is based on an installation angle of the roof window, such as based directly or indirectly on the roof pitch angle.

[0175] The system 2 may in embodiments of the present disclosure be able to deduct that when the window is in the three states as illustrated in figs. 2-2b, the window may be closed and locked, locked and in ventilation state, or in an open state. There may here be no, or a relatively limited, risk of water entering the window, even if the movable frame 3 is maintained in the open state OS as illustrated in fig 2b. However, if the sensor arrangement 10 provides information indicating for example that the accelerometer moves further from the open state as illustrated in fig. 2b, the movable frame 3 may be in an open position (see fig. 3) and hence water may enter through the window. The state information SIO may hence also reflect information relating to whether the movable frame 3 is not in a closed position, or is in a closed position.

[0176] In some embodiments of the present disclosure, the state information output SIO may comprise information of a window opening value representing an angular position of the movable frame relative to the fixation frame. This information may reflect the magnitude of the opening of the movable frame 3, e.g. between 0% open and 100% open, an angular position of the movable frame relative to the fixation frame and/or the like.

[0177] It is generally understood that the user interface 50 in embodiments of the present disclosure may provide user notifications based on the received information of the to a user by means of one or more of:

- written words,
- one or more visual animations,
- one or more icons,
- one or more colour changes and/or light intensity changes,

at the screen of the device. This may depend on the information to be presented, type of user interface 50, and the presentation possibilities available thereby.

[0178] It is generally understood that in embodiments of the present disclosure, the handle arrangement 6 is connected to the at least one locking part 5a of the locking system 5 of the window, by the handle arrangement 6 being mechanically and/or electrically connected to the at least one locking part 5a. a mechanical connection may e.g. be provided by the locking part being integrated in the handle (as e.g. illustrated in fig. 1), or may comprise an interconnecting linking part and/or locking housing or the like (as e.g. illustrated in figs. 2-3). An electric connection may comprise a wired or wireless communication system for controlling the locking part.

[0179] Figs 4a-4c illustrates schematically various embodiments of usage of the information retrieved by means of the multi-axis accelerometer arrangement.

[0180] In fig. 4a, the movable frame 3 is partly open relative to the fixation frame 4. This provides that the state detection system 2 will register that the roof window 1 is in an open state and also determines the window opening value representing an angular position of the movable frame 3 relative to the fixation frame 4. In this case the movable frame is 10% open. Accordingly, state information TSI is transmitted comprising this information. Based on the transmitted state information TSI, information is provided by means of a user interface on a screen 50 of a user device 300 to a user. The state information 60 indicates that the window (window WD1) is in an open state OS. The state information 70 may comprise a visual animation indicating that the window is open or partly open. The information 80 indicates the window opening value WOV, e.g. by writing, a graph, such as a bar, or the like. In this example, the movable frame is detected to be 10% open relative to "fully closed" and "fully open" state. Hence, the user may be presented with information 80 indicating the opening value of " window 1" (WD1) to be 10%.

[0181] In fig. 4b, the movable frame 3 is fully open relative to the fixation frame 4. This provides that the state detection system 2 will register that the roof window 1 is in an open state OS and the window opening value representing an angular position of the movable frame 3 relative to the fixation frame 4 will be 100%. Accordingly, state information TSI is transmitted comprising window status OS status and window opening angle information. Based on the transmitted state information TSI, information is provided to a user by means of a user interface on a screen 50 of a user device 300. The presented state information 60 indicates that the window (window WD1) is in an open state OS. The presented state information 70 may comprise a visual animation indicating that the window is open or fully open. The presented information 80 indicates the window opening value WOV, e.g. by writing, a graph, such as a bar, or the like. In this example, the movable frame is detected to be 100% open relative to "fully closed" and "fully open" state. Hence, the user may be presented with information 80 indicating opening value of "window 1" (WD1) of 100% open.

[0182] In fig. 4c, the movable frame 3 is in a closed state CS. This provides that the state detection system 2 will register that the roof window 1 is in a closed state and the window opening value representing an angular position of the movable frame 3 relative to the fixation frame 4 will be 0%. Accordingly, state information TSI is transmitted comprising window status CS status and possibly also window opening angle information. Based on the transmitted state information TSI, information is provided to a user by means of a user interface on a screen 50 of a user device 300. The presented state information 60 indicates that the window (window WD1) is in a closed state CS. The presented state information 70 may comprise a visual animation indicating that the window is closed. The presented information 80 indicates the window opening value WoV, e.g. by writing, a graph, such as a bar, or the like. In this example, the movable frame is detected to be in a fully closed state. Hence, the user may be presented with information 80 indicating opening value of "window 1" (WD1) of 0%, indicating "Closed" or the like.

[0183] In some embodiments of the present disclosure, the window state detection system 2 may be integrated in the handle 6, e.g. in an interior closed or partly closed cavity or recess of the handle arrangement 6, e.g. from factory, already when installing the window.

[0184] In some embodiments of the present disclosure, as illustrated according to different embodiments of the present disclosure in figs. 5-8, the window state detection system 2 may be integrated in a retrofitting body 20 that is retrofitted onto/at the handle arrangement 6.

[0185] In fig. 5, a retrofitting body 20 comprises the window state detection system 2 placed in a housing 21 of the retrofitting body 2. The body 20 is placed inside a predefined cavity of an elongated grip 6a of the handle arrangement 6, for example of the type as illustrated in one or more of figs. 1-3). The window state detection system 2 may be moulded into, attached to or in other ways be integrated with the retrofitting body 20. A battery 12 exchange may be enabled by/at the retrofitting body, and/or it may be configured to facilitate wired or wireless recharge of the battery 12 (see previous description). In some embodiments, the battery 12 may be placed external to the retrofitting body and be connected to the control arrangement 11 and/or the like of the system 12 by means of one or more power supply wires. The battery 12 may be arranged at the handle arrangement 6 too in preferred embodiments of the present disclosure, both in embodiments where the battery is arranged external to the retrofitting body 20 or arranged at or in the body 20.

[0186] The outer surface 20a of the retrofitting body 20 provides a connection interface for the body 20 so that it can be arranged inside and be supported by the interior walls of the grip 6a.

[0187] In fig. 6, the retrofitting body 20 comprising the system 2 comprises a connection interface part 20a that is a curved surface (in this case a concave surface) that is preshaped to the surface shape and size of the handle arrangement that is to be connected/attached to, in order to improve the aesthetical impression and/or user experience when retrofitting the retrofitting body 20 onto the handle 6.

[0188] Fig. 7 illustrates a retrofitting body 20 according to further embodiments of the present disclosure. Here, the retrofitting body comprises a user interface 90 for providing user notifications. The interface 90 comprises electronic communication hardware such as one or more light emitting means such as light emitting diode(s) (LED's) configured to transmit visible light reflecting if the window is in one or more of a locked state, e.g. in one of the states CS, VS, or in an open state. The state information output SIO from the processing arrangement 11 may hence provide an output to the user interface 90 providing e.g. the light emitting means to light up, change colour, blink and/or the like dependent on the detected window state. Hence, a user can visually see the status of the window 1 by means of the user interface 90. This may e.g. be especially advantageous for windows that are not immediately accessible for a user to check by hand. Generally, the information from the user interface 90 may provide an improved user experience, as the user may e.g. see the detected window state from further distance. The user interface 90 may also in other embodiments (not illustrated) e.g. be integrated in or with the handle arrangement 6.

[0189] Mechanical fastening means may in embodiments of the present disclosure be used for attaching/fixating the retrofitting body 20 to the handle arrangement 6. These fastening means may e.g. comprise mechanical fastening means such as a clips system, a trail configured to receive one or more protruding parts of one of the body 20 and the handle arrangement 6a, one or more screws and or the like. Additionally or alternatively, the fastening means may comprise chemical fastening means such as an adhesive, for example glue or adhesive tape and/or the like.

[0190] Fig. 8 illustrates a retrofitting body 20 according to further embodiments of the present disclosure. Here, the

handle arrangement 6 comprises a gripping profile 6a as substantially illustrated in fig. 3. The gripping profile 6a in this embodiment is integrated with the ventilation valve 8. In other embodiments, the ventilation valve may be separate to the griping profile. The gripping profile comprises an interior space defined by interior surfaces enclosed by one or more curves or corners that are less than 180 degrees so as to provide a recessed portion where a person can place her/his fingers to grab and pull the handle. The retrofitting body 20 is placed in this interior space and may be substantially fully or partly hidden in the handle arrangement 6.

[0191] Fig. 9 illustrates a flow chart according to embodiments of the present disclosure. In the first, optional test TE91, The system 2 may be configured to determine if a movement is detected by the accelerometer arrangement 10. Some accelerometer solutions and/or processing arrangement 11 solutions may be implemented with a power saving hibernate/sleep mode where power is saved, and in a wake up mode, such as within predefined time spans, the systems determines if a movement is detected. If on movement is detected, the system goes back to sleep mode.

[0192] If a movement is detected, the system 2 tests (Test TE92) if the sensor output corresponds to what is expected according to the reference data RE1, e.g. by correlating data based on the sensor output with the reference data RE1. If the correlation shows that the sensor output corresponds to what is expected according to the reference data RE1 (e.g. by being within one or more thresholds), the processing arrangement determines that the window is in the closed state (WD=CS) - See step ST91. Thus the movable frame 3 is detected to be in a closed position and the locking system 5 is in a locked state. Hence the processing arrangement may store and/or communicate this as state information output SIO (Step S94).

[0193] If the processing arrangement determines that the sensor output does not correspond to what is expected according to the reference data RE1, the system 2 tests (Test TE93) if the sensor output corresponds to what is expected according to the reference data RE2, e.g. by correlating data based on the sensor output with the reference data RE2. If the Sensor output corresponds to what is expected according to the reference data RE2, the processing arrangement determines that the window is in the ventilation state (WD=VS) - see step ST92. Hence, the processing arrangement may store and/or communicate this as state information output SIO (Step ST94).

[0194] If the processing arrangement determines that the sensor output does not correspond to what is expected according to the reference data RE2, the system 2 tests (Test TE94) if the sensor output corresponds to what is expected according to the reference data RE3, e.g. by correlating data based on the sensor output with the reference data RE3. If the sensor output corresponds to what is expected according to the reference data RE4, the processing arrangement determines that the window is in the open state (WD=OS) - see step ST93, i.e. the window is in the ventilation state and stores and/or communicates this as state information output SIO (Step ST94).

[0195] It is generally to be understood that the tests TE92-TE94 may comprise one or more correlations of different data and/or calculation results. For example, in the event that the system 2 is to be used at a roof window as illustrated in figs. 2-3 comprising the locking system solution where the movable frame 3 is maintained in the same locked position for both the closed state CS and ventilation state VS, the tests TE92 and TE93 may be performed by testing the sensor output against stored reference data REF. The reference data may here correspond to the sensor output (or calculated derivatives thereof) that has been previously obtained or calculated in a calibration routine where the window has been put in e.g. the closed state, the ventilation state and/or the like after window installation in a building roof.

[0196] Fig. 10 illustrates a flow chart according to further of the present disclosure. This may e.g. be relevant in relation to a window state detection at a window as illustrated in fig. 1.

[0197] In the first, optional test TE101, The system 2 may be configured to determine if a movement is detected by the accelerometer as also described above with respect to fig. 9.

[0198] In the second test TE102, The processing arrangement processes data received from the accelerometer 10 in order to determine the angular position of the movable frame relative to a reference position. In test TE102, the processing arrangement 11 may correlate information of the sensor output from the accelerometer with reference data to determine if the movable frame is placed in the closed position CP. If the movable frame is detected to be in the closed position, this may still not necessarily mean that the locking system is in a locked state. Hence, the processing arrangement may in in test TE103 (LSY=LS?) further correlate information from the accelerometer 10 representing the positional state of the handle arrangement with further reference data. If the system detects that the handle arrangement 6 is placed in a position where the locking system can be determined to be in a locked state, the processing arrangement may conclude that the window is in a closed state and hence update a state parameter reflecting this, see step ST101 (WD=CS refer to Window = closed state), and stores and/or communicates this as state information output SIO (Step ST104).

[0199] In some embodiments (not illustrated in fig. 10), one reference data value may represent the combination of a movable frame in a closed position and the handle arrangement 6 being placed in a position where the locking system can be determined to be in a locked state. Thus, test TE102 and TE103 may e.g. be combined into one test.

[0200] At test TE102, if the test here was negative, (or if the above mentioned combined test is negative) the processing arrangement of the system 2 hence may conclude that the movable frame is not in a closed state/position, the processing arrangement may in test TE104 correlate information of the sensor output from the accelerometer with reference data to determine if the movable frame is placed in a ventilation position. In this scenario, it is hence expected that the movable

frame 3 is in different positions when the window 1 is in a closed state and a ventilation state respectively, e.g. defined by the locking system (see fig. 1). The output from the accelerometer will be different in each of these scenarios. If the movable frame is detected to be in the ventilation position, this may still not mean that the locking system is in a locked state. Hence, the processing arrangement of the system 2 in test TE105 correlates information from the accelerometer 20 representing the positional state of the handle arrangement with further reference data. If the system detects that the handle arrangement is placed in a position relative to the movable frame where the locking system can be determined/concluded to be in a locked state (LSY=LS?), the processing arrangement may conclude that the window is in a ventilation state VS and hence updates a state parameter reflecting this, see step ST102, and stores and/or communicates this as state information output SIO (Step ST104).

[0201] Again, in embodiments of the present disclosure (not illustrated in fig. 10), one reference data value may represent the combination of a movable frame in a ventilation position and the handle arrangement 6 being placed in a position where the locking system can be determined to be in a locked state. Thus, test TE104 and TE105 may be combined into one test.

[0202] If the locking system 5 is not determined to be in a locked state in tests TE105 or TE103, the processing arrangement may conclude that the window is in an open state and hence updates a state parameter reflecting this (see steps ST103 or ST105), and store and/or communicates this as state information output SIO (Step ST104).

[0203] In some further embodiments of the present disclosure (not illustrated), the processing arrangement may, in case both tests TE104, TE102 are negative (or the combined test(s) mentioned above), correlate information of the sensor output from the accelerometer with reference data to determine if the movable frame is placed at an angular position that is larger than a certain amount, for example larger than the angular position when the movable frame is in the ventilation state. This may provide further relevant information, e.g. in relation to estimating the risk of rainwater or snow entering the inside of the building, in order to estimate a degree of ventilation and/or the like. In this scenario, the window should however still be determined by the processing arrangement of the system 2 to be in an open state OS.

[0204] As mentioned above, the reference data may in some embodiments of the present disclosure allow for one combined test of the state of the window, as the reference data may represent merged gravitational acceleration information from the multi axis accelerometer arrangement. The gravitational acceleration information from the multi axis accelerometer arrangement 10 may in for example the closed and locked state have a first value (e.g. for each relevant axis provided by the multi axis accelerometer), and in the predefined ventilation state have another value (for each relevant axis provided by the multi axis accelerometer). This value represent a merge of the handle position relative to the movable frame and the position of the frame relative to the fixation frame. This value may vary dependent on the installation angle of the window, but after window installation, the window installation angle is fixed. Hence, by using this gravitational acceleration information directly or indirectly for the reference data, the processing arrangement may determine that if the received data from the accelerometer arrangement matches the first value (for example is within a range, such as a predefined range, based on the first value), the window is in a closed and locked state. If it on the other hand matches the other value (for example is within a range, such as a predefined range, based on the other value), it may be in the predefined ventilation state.

[0205] It is understood that further, stored reference data that is based on or represent the gravitational acceleration information obtained from the multi axis accelerometer arrangement may allow the processing arrangement to determine if the window is in an open state and/or to estimate the window opening value.

[0206] Fig. 11 illustrates reference data REF according to embodiments of the present disclosure. As can be seen, the reference data comprises a number of parameters/parameter representations RE1-REn. Each parameter representation has values assigned to it related to X, Y and Z parameters that represents X, Y and Z values of the accelerometer. Hence, the accelerometer may provide sensor output SEO comprising acceleration information related to a plurality of axes X, Y, Z as it is a multi-axis accelerometer.

[0207] For example, reference parameter RE1 comprises:

- Reference data information X1 relating to the X-axis of the accelerometer,
- Reference data information Y1 relating to the Y-axis of the accelerometer, and Reference data information Z1 relating to the Z-axis of the accelerometer.

Not all the X-Y-Z axes may provide relevant data, however dependent on the window setup, type and/or the like.

[0208] As can be seen in the tests further below (Tables 1-3 and associated text under section "Test examples"), it has been tested and confirmed that data form the accelerometer reliably provided sensor information relating to different axes when installed at a handle arrangement.

[0209] Hence, taking for example Table 1 below, it reflected that in the test setup, the Z-axis information from the accelerometer would be about 9.34 to 9.53 and the X-axis information would be about -3.30 to -3.41 when the window 1 is in the closed and locked state.

[0210] Hence, knowing this, e.g. during an initial calibration process for example by means of a reference data updating

system/arrangement of the window state detection system 2 as described in more details below, the reference RE1 may be set so that X1 and Z1 reflects these values, respectively.

[0211] Thresholds may be implemented in embodiments of the present disclosure, for example a predetermined value, percentage and/or range defined based on sensor data or the reference data RE1-REn.

[0212] As an example, X1 may be defined as a range based on the numbers acquired during the test below (See table 1) - or may be a value with one or more applied thresholds, and Z1 may in a similar way be defined as a threshold range or value.

[0213] The processing arrangement 11 may thus correlate X-axis and Z-axis information/ output SEO from the accelerometer with the X1 and Z1 data to determine if the window is in the closed state CS.

[0214] As one example, a threshold range for the Z-axis (when the window is in a closed state) may e.g. be set to be a certain percentage above and below one or more measured extremity values. For example in Table 1 below, the largest variation in the Z-axis test results was test 2 (9.34 - 9.53). A 5% threshold range for the Z-axis in the closed state may e.g. be defined as 9.34-5% to 9.53+5% = 8.9-10. Hence, should the received sensor data reflect a Z-axis value within this range (and should the X-axis value also fit with a threshold range for this), the window may be determined to be in a closed state.

[0215] A timer, counter or the like may in certain embodiments be used for assuring that the window state is first confirmed/approved when several substantially consecutive samples of the received sensor information/output SEO lies within the defined range for a predefined time period.

[0216] Additionally or alternatively, a timer or the like may determine when to determine or update the window state. IT may be preferred that the determination of the window state is provided when the movable unit and handle is in standstill and no movement (or acceleration) occurs.

[0217] In some embodiments, when the processing arrangement 11 correlates X- and Z- axis information of the sensor output SEO with the reference data RE1 and finds that it complies with rules related to reference data RE1, for example that in a predefined time period (e.g. 0.5 seconds, 1 second, 2 seconds or the like) the sensor information/output is within a range/value defined based on the X1 and Z1 data of the reference data RE1, the processing arrangement 11 may conclude that the window is in the closed and locked state.

[0218] The other reference data/parameters RE2 and RE3 may relate to e.g. the open state OS and/or ventilation state VS in the same way, and hence, correlating X and Z axis sensor information/output SEO with rules based on these (X2, Z2, X3, Z3) may enable the processing arrangement 11 to determine if the window is in the open state OS or in the locked ventilation state VS.

[0219] The processing by the processing arrangement 11 so as to determine the window opening value may be configured to comprise correlating, such as comparing, gravitational acceleration information SEO obtained from the multi axis accelerometer 10 with reference data, In some embodiments, the reference data may comprise gravitational acceleration reference data such as predefined gravitational acceleration reference data REF, RE1-REn, stored in a data storage 11b. This data may have been adapted according to the window installation angle, e.g. during an updating of the reference data.

[0220] In preferred embodiments of the present disclosure, the acceleration data SEO received/retrieved from the accelerometer may be used for processing, such as for correlation, with reference data REF in the process of determining one or more window states CS, VS, OS and the window opening value WOV. Accordingly, the determination of the window opening value and the determination of if the roof window is in a predefined locked state or in an open state may be configured to be determined on the basis of the gravitational acceleration information (SEO) which is maintained in the acceleration domain, and hence remained e.g. un-integrated.

[0221] The accelerometer 10 at rest at the handle arrangement 6, 6a will measure/detect the acceleration of gravity/-gravitational acceleration (the acceleration due to Earth's gravity (straight upwards) is around $g \approx 9.81\ m/s^2$). This information may in some embodiments of the present disclosure be used by the processing by arrangement 11 without further integration. The same is the case for determining the window opening state.

[0222] The acceleration data when the window is in closed state and/or in ventilation state (and the window is installed in a roof structure) may hence be obtained and used as a reference/calibration data for determining the reference data REF, RE1-RE3, and this reference data may thus be used for correlation, such as comparing with acceleration data SEO from the accelerometer 10 when the window is at rest in an open state OS, ventilation state VS or closed, locked state CS.

[0223] In some embodiments of the present disclosure, the processing arrangement 11 may be configured to determine, such as calculate, a representation of a window opening value, such as an opening angle, of the moveable frame. By detecting the gravitational acceleration, and knowing the window installation angle, it may be possible to calculate or estimate the angle of the movable frame relative to the fixation frame. This may in some embodiments be used for calculating and/or estimating how much the window is opened (i.e. how much movable frame is open relative to fixation frame) and thereby provide a window opening value representing an angular position of the movable frame 3 relative to the fixation frame 4. See e.g. also figs. 14 and 15 and description thereto. This may in some embodiments of the present disclosure be provided, as e.g. previously disclosed in relation to e.g. figs 4a-4c, in order to e.g. inform a user by means of a user interface 50 (e.g. through a software application receiving the information of the wirelessly transmitted state

information TSI (see fig. 4-4c)) of if, and possibly also how much, the movable frame 3 is opened.

[0224] In some embodiments of the present disclosure, a user may place the movable frame 3 in a fully open position, and then fulfil predefined criteria as e.g. previously described to update reference data. Hence the system may comprise reference data reflecting when the respective window is fully open, and hence know, or be able to determine, the opening range between closed position and fully open position.

[0225] The window opening value data can also be provided for building heating or ventilation control, HVAC systems or to control other motorised windows in the building.

[0226] Preferably the window data can be used in a leave building scenario, where a "locked building" test may be performed to confirm all access units (doors and windows) are locked.

[0227] One or more of the reference data REF, RE1-REn may be stored/updated in the data storage 11a by means of a reference data updating system/arrangement (not illustrated) after installation of the window 1 and/or the window state detection system 2 in accordance with embodiments of the present disclosure. This is provided in order to assure that the reference data is adapted according to the installation angle of the window. A user may for example, in embodiments of the present disclosure, by means of an instruction manual and/or a software application, be prompted/instructed to place the movable frame 3 in the closed position and "close the handle" so that the window is in the closed and locked state CS. Then the user may provide/fulfil the predefined criteria and sensor data of the multi axis accelerometer may hereby be collected, possibly processed, and then the one or more reference data RE-RE3, REF1 may be updated and stored based thereon. Additionally or alternatively, a user may by means of an instruction manual and/or a software application be prompted to place the window in the ventilation state VS. Then the user may provide/comply with the predefined criteria and sensor data of the multi axis accelerometer may hereby be collected, possibly processed, and then one or more reference data RE-RE3, REF1 may be updated based thereon.

[0228] Thereby the reference data may comprise suitable information that may be used for correlation purpose together with sensor data from the accelerometer in order to determine if the roof window is placed in the closed, locked state CS, the locked ventilation state VS or an open state OS. This reference data will reflect the installation angle of the roof window.

[0229] The predefined criteria may in embodiments of the present disclosure comprise one or more of

- registration of a button being activated/pressed by a user at the handle arrangement and/or in a software application of a handheld mobile user device such as a smartphone, for example a button presented on a touch screen, or the like,
- one or more timer runouts,
- perform one or more movements of the window to the extreme positions such as from closed and locked to unlocked and fully open,
- providing a specific gesture movements with the handle arrangement (e.g. with a predefined speed and/or in one or more predefined directions

and/or the like.

[0230] Hereby the window state detection system 2 comprising the data processing arrangement 11 can "learn" the window installation angle. And learn the handle arrangement's 6 different states S1-S3.

[0231] Fig. 12 illustrates schematically a further example of a building roof window type 1 according to further embodiments of the present disclosure. In fig. 12, the building window 1 is a top hung roof window (arranged with an angle relative to horizontal HZ), and hence, the hinge arrangement 14 is arranged at the top part of the window 1. In fig. 12, the window 1 is in an open state.

[0232] Fig. 13 illustrates schematically a roof window of the centre hung type which is installed in a building roof structure 120 of a building 110, according to embodiments of the present disclosure. The roof window 1 is according to embodiments of the present disclosure of the type that is configured to be installed in the roof structure 120 so that a major plane of the insulating glass unit (when the window/movable unit is closed), is arranged with an angle different from horizontal and vertical, such as with an angle larger than 10° such as larger than 18° relative to horizontal, for example between 10° and 85°, such as between 18° and 80°, relative to horizontal, in a closed window state. This angle may be defined by the roof pitch angle PA. The roof pitch angle PA may be larger than 10° such as larger than 18° relative to horizontal. For example, the roof pitch angle PA may be between 10° and 85°, for example between 18° and 80°.

[0233] Fig. 14 illustrates schematically a simplified flowchart relating to setting/updating the reference data so that the system is able to correctly determine the angular position of the movable frame 3 relative to the fixation frame and/or to determine the window state CS, VS, OS (as e.g. previously described)

[0234] Since building roof windows 1 are often arranged in a roof structure having an inclining/ non-horizontal roof pitch, this will provide that the installation angle will result in an influence on the gravitational acceleration output SEO from the multi axis accelerometer arrangement 10. For example, a roof window 1 installed in a roof structure having a roof pitch of 20° will, when the movable frame 3 is in a locked and closed position CS may provide a first X-axis value and a first Z-axis value of the sensor output SEO from the multi axis accelerometer arrangement which is a result of gravitational acceleration. The same roof window 1 installed in a roof structure having a roof pitch of 35° will, when the movable

frame 3 is in a locked and closed position CS, provide a second X-axis value and a second Z-axis value of the sensor output SEO from the multi axis accelerometer arrangement which is a result of the gravitational acceleration.

[0235] In fig. 14 the system tests in test TE141 if predetermined criteria for updating the reference data of the system 2 are complied with. This/these criteria may comprise one or more of a timer, a user executing a predetermined action such as pushing a reset/update button, providing an action by means of a software implemented user interface of a hand held unit, manipulating with a power supply to the system 2 and/or the like.

[0236] When the criteria is complied with, the system may know that the system is in a predetermined position.

[0237] Hence, in step S141, the gravitational acceleration data SEO from the multi axis accelerometer is collected (COLL ACC DAT), and in step S142 an update of the reference data REF is provided based thereon. The updating of the reference data my be provided in different ways. For example, a reference offset value as e.g. previously described may be updated or generated, and correlation of the gravitational acceleration values from the accelerometer arrangement may be adapted according to this reference offset value, and/or predefined stored reference data relating to e.g. one or more states of the window may be adapted based on this reference offset value.

[0238] This help to adapt the reference data to the individual installation conditions of the roof window 1, and thus help to provide reliable reference data that may be used for determining when the window is in a locked state CS, VS, such as a closed, locked state CS or ventilation state VS, or in an open state OS. It may additionally or alternatively be used in relation to determining the window opening value representing an angular position of the movable frame relative to the fixation frame.

[0239] The update of the reference data REF may for example be provided when the movable frame 3 is in a closed position CS (see fig. 2 for example) and/or when the locking system is in the locking state S1 (see also Table 1 further below). When the movable frame 3 is in a closed position and the locking system is in the locking state, this may be a relevant, well known, predetermined state/position/ condition to use for calibrating and/or set the reference data.

[0240] Other and/or alternative predefined positions of the movable unit and/or handle (relative to the movable frame) may additionally or alternative, in some embodiments, be subject for updating the reference data. For example, a reference data update may be provided in one or more of the closed state CS, the predefined ventilation state VS (if present/facilitated), open state and/or fully open state. In other embodiments, just one predefined state of the roof window may be used for updating all relevant reference values, as these may in some embodiments be calculated or estimated based on the sensor output in the predefined state.

[0241] The updated reference data may e.g. be subtracted from the data output of the accelerometer arrangement 10 or in other ways used as correction data for the data output of the multi axis accelerometer, in order to determine the window state and/or angular position of the movable frame 3.

[0242] The updating of the reference data provides that the reference data is adjusted according to the installation angle of the window in the roof structure.

[0243] It is understood that in some embodiments of the present disclosure, the state detection system 2 may be configured so that the provided gravitational acceleration information SEO that is used for determining if the roof window is in a predefined locked state CS, VS or in an open state OS, and is used for determining the window opening value representing an angular position of the movable frame 3 relative to the fixation frame 4, may be data obtained while the movable frame 3 and the handle arrangement 6 are non-moving. The same may apply for the data used for updating the reference data.

[0244] Fig. 15 illustrates schematically a flow chart according to embodiments of the present disclosure relating to data collection and data validation. Here the system 2, such as the processing arrangement 11, is configured to provide a plurality of consecutive data collections of the gravitational acceleration data from the multi axis accelerometer arrangement 10 and processing these data collections, such as comparing/correlating this/these data collections, from the accelerometer arrangement 11. This is provided in order to to determine if the movable frame 3 and handle 6 are still standing / non-moving and that the accelerometer output is therefore result of gravitational acceleration alone.

[0245] Initially, the system tests in test TE151 if a change in the sensor output from the multi axis accelerometer arrangement 10 is provided. This may e.g. be provided by means of a dedicated signal, such as a wakeup signal, from the multi axis accelerometer or another movement detection arrangement (2). If a movement is registered, it is likely that the sensor output has changed. Additionally or alternatively, the system 2 may be configured to periodically compare saved data from a previous output from the accelerometer 10 with new sensor data in order to register if a change may have occurred. If a movement is registered, it is plausible that the sensor output has changed.

[0246] If a change has occurred in the sensor data, the test TE151 is positive. Hence, in step S151 the system 2, such as the processing arrangement starts to collect consecutive sensor data readings form the multi axis accelerometer arrangement 10. This consecutive data collection may or may not be provided at a predefined time interval. For example, in some embodiments, sensor data may be read every 1/10 of a second, every half second, every second or the like and may e.g. be stored in a data storage and/or processed in other ways. Based on these consecutive readings, the system in test TE152 tests if it based on predetermined criteria can be deducted from the collected data whether consecutive, substantially identical measurements have been provided/occured. As one example, if the system 2 determines that the

last 10 readings representing data collection over e.g. 5 seconds are substantially identical, such as fall within a deviation threshold, it may be safe to assume that the handle and movable unit are in stand still / non-moving.
Thus, in step S152:

- it is determined (DET WS) if the roof window is in a predefined locked state CS, VS or in an open state OS, and
- a window opening value WOV representing an angular position of the movable frame 3 relative to the fixation frame 4 is determined (DET WOV).

These determinations may be based on the data used in test TE152 for validating that consecutive, substantially identical readings have occurred and/or may be based on further data collection from the accelerometer arrangement 10. In step S153, the state information output SIO is updated and/or provided to comprise the detected window state CS, VS, OS and the window opening value WOV. This may e.g. result in a transmission of the data so that a user can see the window state and window opening value (see e.g. figs 4a-4c), and/or so that a system can use this information in an automation solution.

[0247] In some embodiments of the present disclosure, a timer may be set so that sudden, minor movements, such as vibrations or the like are not considered relevant. Additionally or alternatively, the timer may help to assure that updating of window state and window opening value is not provided while the handle and/or movable frame 3 are moved. This may however in some embodiments also be obtained by timing or time stamping the consecutive data collection and/or the like. A timer may also be omitted, e.g. if another timer or the like controls the time between data collection and/or time stamp the data collection, as the number of data collections inherently will then indicate a time.

Test examples

[0248] The present disclosure is further described by the following test examples, which are not to be construed as limiting the scope of protection. The features disclosed in the foregoing description and in the following examples may, both separately or in any combination thereof, be material for realising one or more embodiments of the present disclosure.

[0249] A test setup with a multi axis accelerometer was attached to the handle arrangement of a roof window of a type as illustrated in figs. 2-3. The accelerometer used in the test was an ADXL345 digital 3-axis accelerometer from the supplier/manufacturer Analog Devices. Here, the accelerometer was attached to the grip part 6a (by means of a rubber band) and was connected with wires to a micro controller (processing arrangement).Tests have been provided by means of the test setup in order to determine if reliable and usable gravitational acceleration data was retrieved from the accelerometer when installed at the window 1.

Test of closed state

[0250] A first test was provided at the test setup in order to determine if the data which the accelerometer sensor provided was substantially the same every time the widow was closed. This was confirmed. The window was opened four times and closed again, and each time the sensor output in the closed window position/state CS was substantially the same for the Z-axis and X-axis, respectively as illustrated in table 1 below.

Table 1 - Test of closed state sensor output

Test number	Test value on z-axis	Test value on x-axis
1	9.45 - 9.53	-3.37 - -3.41
2	9.34 - 9.53	-3.37 - -3.41
3	9.38 - 9.53	-3.30 - -3.37
4	9.41 - 9.53	-3.30 - -3.33

Test of ventilation state

[0251] The test of the data from the accelerometer 10 in the ventilation state VS was moreover performed in the test setup the same way as the above-mentioned test. The ventilation valve 8 was arranged in an open position (see fig. 2a) and then in a closed position in order to detect if the data for/from the ventilation state was the same from the accelerometer 10. This was confirmed by the inventor, see Table 2 below.

Table 2 - Test of ventilation state sensor output

Test number	Test value on z-axis	Test value on x-axis
1	10.08 -10.16	0.00 - -0.08
2	10.08 -10.16	0.00 - -0.04
3	10.08 - 10.16	0.08 - 0.00
4	10.08 - 10.16	0.00 - -0.04

Test of a fixed open position

[0252] The procedure of testing the sensor output for a fixed open position OS was the same as the two above-mentioned tests. Here, the window is opened in a fixed position four times, to detect if the values from the z and x-axis was the same.

Table 3 - Test of open state sensor output

Test number	Test value on z-axis	Test value on x-axis
1	8.90 - 8.98	5.06 - 5.10
2	8.87 - 8.94	5.18 - 5.22
3	8.87 - 8.94	5.18 - 5.22
4	8.87 - 8.94	5.10 - 5.22

[0253] The above tests validate that the multi axis accelerometer was able to detect the three window positions/states, i.e. the closed and locked state, the locked ventilation state and the open state, as the values from all three tests are almost the same for the respective test. The small deviations which was seen may be caused by the load from wires on the accelerometer as the accelerometer was not used in a wireless setup in the test and/or that the accelerometer was attached with a rubber band to the handle. However, it was concluded that the results on the z- and x-axis are within tolerances in order to accept the results.

[0254] In general, it is to be understood that the present disclosure is not limited to the particular examples described above but may be adapted in a multitude of varieties within the scope of the present disclosure as specified in e.g. the claims. Accordingly, for example, one or more of the described and/or illustrated embodiments above may be combined to provide further embodiments of the present disclosure.

Claims

1. A building roof window (1) comprising a window state detection system (2), wherein the roof window (1) comprises a movable frame (3) which is supported by a fixation frame (4) by means of a hinge arrangement (14) that allows the movable frame (3) to move relative to the fixation frame (4), wherein the movable frame supports an insulating glass unit (7),

wherein the movable frame (3) comprises a handle arrangement (6) which is connected to at least one locking part (5a) of a locking system (5) of the window, wherein the handle arrangement (6) is configured to be operated by human hand to be moved relative to the movable frame (3) and thereby displace the locking part (5a) between different states (S1-S3) comprising one or more locking states (S1, S2) and an unlocked state (S3),
wherein the locking system (5) in the one or more locking states (S1, S2) is configured to maintain the movable frame (3) in a predefined, locked position (CP, VP), wherein the locking system (5) in the unlocked state (S3) is configured to allow the movable frame to open towards a substantially fully open position,
wherein the window state detection system (2) comprises a data processing arrangement (11) and a multi axis accelerometer arrangement (10), wherein the multi axis accelerometer arrangement (10) is arranged at the handle arrangement and comprises one or more multi axis accelerometers, wherein the multi axis accelerometer arrangement (10) is configured to provide gravitational acceleration information (SEO),
wherein the data processing arrangement is configured to provide data processing of the provided gravitational acceleration information (SEO) so as to determine

- if the roof window is in a predefined locked state (CS, VS) or in an open state (OS), and
- a window opening value (WOV) representing an angular position of the movable frame (3) relative to the fixation frame (4),

wherein the determination of the window opening value is based on reference data (REF, RE1-RE4), wherein the reference data comprises data which is based on an installation angle of the roof window.

2. A building roof window (1) according to claim 1, wherein the reference data (REF, RE1-RE4) comprises a representation of, or is based on, gravitational acceleration information (SEO) retrieved after the roof window is installed at a roof structure.

3. A building roof window (1) according to any of the preceding claims, wherein said processing so as to determine the window opening value (WOV) is configured to comprise correlating, such as comparing, gravitational acceleration information (SEO) obtained from the multi axis accelerometer arrangement (10) with the reference data (REF, RE1-RE4), and wherein the reference data comprises gravitational acceleration reference data, such as predefined gravitational acceleration reference data, stored in a data storage (11b).

4. A building roof window (1) according to any of the preceding claims, wherein the determination of the window opening value (WOV) and the determination of if the roof window is in a predefined locked state (CS, VS) or in an open state (OS) are configured to be determined on the basis of the gravitational acceleration information (SEO) which is maintained in the acceleration domain.

5. A building roof window (1) according to any of the preceding claims, wherein the data processing of the provided gravitational acceleration information (SEO) so as to determine if the roof window is in a predefined locked state (CS, VS) or in an open state (OS), and the data processing of the provided gravitational acceleration information (SEO) so as to determine the window opening value (WOV) is configured to be based on gravitational acceleration information (SEO) retrieved from the same multi axis accelerometer, such as a single multi axis accelerometer, arranged at the handle arrangement.

6. A building roof window (1) according to any of the preceding claims, wherein the roof window (1) is configured to be arranged in a predefined, locked ventilation state (VS), and in a predefined, closed, locked state (CS), respectively, wherein the data processing is configured to determine if the building window is arranged in the predefined, locked ventilation state (VS) or in the predefined, closed, locked state (CS).

7. A building roof window (1) according to any of the preceding claims, wherein the gravitational acceleration information (SEO) comprises at least two of X-axis gravitational acceleration information, Y-axis gravitational acceleration information and Z-axis gravitational acceleration information, and
wherein the value said at least two of X-axis gravitational acceleration information, Y-axis gravitational acceleration information and Z-axis gravitational acceleration information is a result of a combination of the position of the handle arrangement (6) relative to the movable frame (3) and the position of the movable frame (3) relative to the fixation frame (4).

8. A building roof window (1) according to any of the preceding claims, wherein the roof window is a roof window that is installed in a roof structure (120) of a building (110), wherein the roof structure (120) has a roof pitch (PA) between 10° and 85°, for example between 18° and 80°, relative to horizontal in a closed (CS) window state.

9. A building roof window (1) according to any of the preceding claims, wherein the roof window is a roof window of the type that is configured to be installed in a roof structure having a roof pitch (PA) between 10° and 85°, for example between 18° and 80°, relative to horizontal in a closed (CS) window state.

10. A building roof window (1) according to any of the preceding claims, wherein the movable frame (3) is configured to pivot around at least one horizontal axis (RAX3), such as wherein the movable (3) frame is centre hung or top hung by means of the hinge arrangement (14).

11. A building roof window (1) according to any of the preceding claims, wherein the movement of the handle arrangement (6) relative to the movable frame (3) comprises a rotation of the handle arrangement (6) around a rotation axis (RAX2),

wherein said rotation axis (RAX2) is substantially parallel to a plane (PL) defined by a major surface (7a) of the

insulating glass unit (7),
preferably wherein the movable frame (3) is configured to be in a closed and locked position in a predefined, locked ventilation state (VS).

12. A building roof window (1) according to claim 10 and 11, wherein the rotation axis (RAX2) is substantially parallel to the at least one horizontal axis (RAX3).

13. A building roof window (1) according to any of the preceding claims, wherein a reference data updating system is configured to generate and/or update the reference data (REF, RE1-REn) when predefined criteria is/are complied with, based on gravitational acceleration information (SEO) received from the multi axis accelerometer, preferably after installation of the roof window (1).

14. A building roof window (1) according to any of the preceding claims, wherein the handle arrangement (6) is connected to the at least one locking part (5a) of the locking system (5) of the window, preferably by the handle arrangement (6) being mechanically or wirelessly connected to the at least one locking part (5a) so as to interact with and/or control the locking part.

15. A method of providing window state detection at a building roof window (1) installed at a roof structure (120) of a building (110), wherein the roof structure (120) has a roof pitch angle (PA) larger than 10° relative to horizontal,

wherein the roof window (1) comprises a movable frame (3) which is supported by a fixation frame (4) by means of a hinge arrangement (14) that allows the movable frame (3) to move relative to the fixation frame (4), wherein the movable frame supports an insulating glass unit (7),
wherein the movable frame (3) comprises a handle arrangement (6) which is mechanically connected to at least one locking part (5a) of a locking system (5) of the window, wherein the handle arrangement (6) is configured to be operated by human hand to be moved relative to the movable frame (3) and thereby displace the locking part (5a) between different states (S1-S3) comprising one or more locking states (S1, S2) and an unlocked state (S3),
wherein the locking system (5) in the one or more locking states (S1, S2) is configured to maintain the movable frame (3) in a predefined, locked position (CP, VP), wherein the locking system (5) in the unlocked state (S3) is configured to allow the movable frame to open towards a substantially fully open position,
wherein a window state detection system (2) comprises a multi axis accelerometer arrangement (10) arranged at the handle arrangement (6) so that the multi axis accelerometer (10) moves together with the handle arrangement (6) relative to the movable frame (3),
wherein a data processing arrangement (11) of the window state detection system (2) processes gravitational acceleration information (SEO) received from the multi axis accelerometer arrangement, so as to determine if the roof window is in a predefined locked state (CS, VS) or in an open state (OS),
wherein a data processing arrangement (11) of the window state detection system (2) processes gravitational acceleration information (SEO) received from the multi axis accelerometer arrangement (10), so as to determine a window opening value (WOV) representing an opening value of the movable frame (3) relative to the fixation frame (4),
wherein the determination of at least the window opening value (WOV) is based on reference data stored in a data storage, wherein the reference data comprises data which is based on an installation angle of the roof window, preferably wherein the building roof window is a building roof window according to any of claims 1-14.

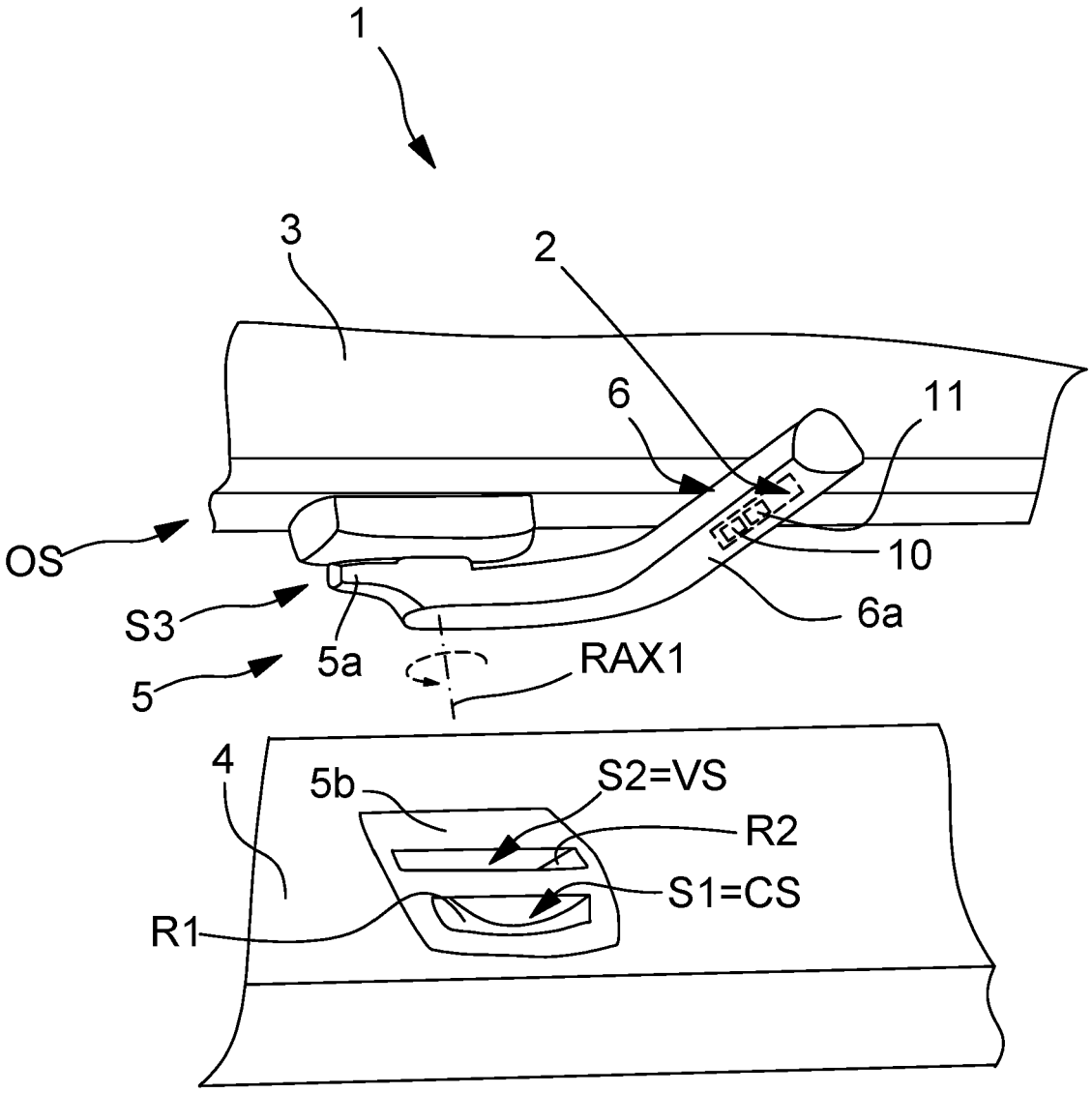
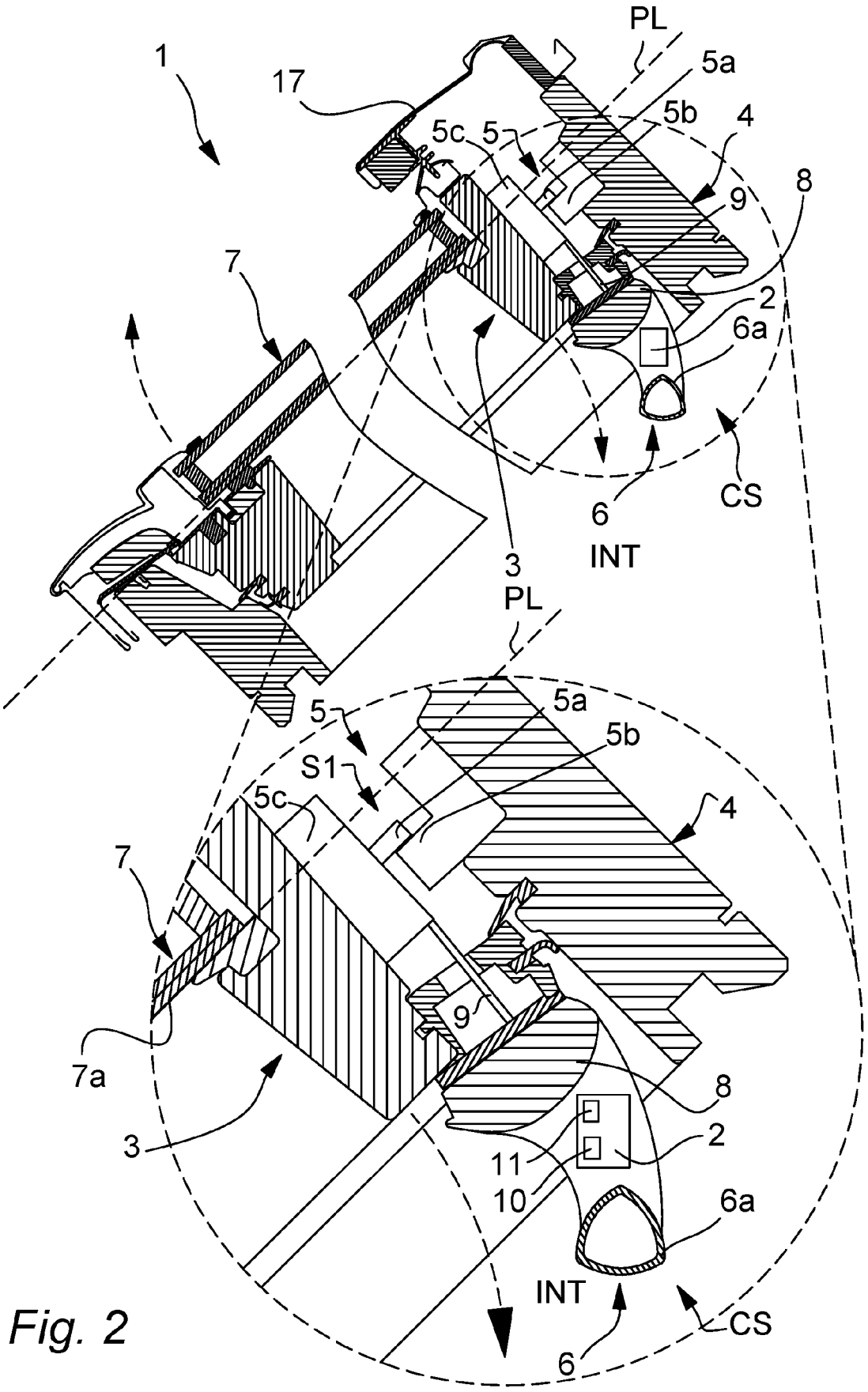


Fig. 1


PL
1
17
5a
5b
4
5c
5
9
8
7
2
6a
CS
6
INT
3
PL
5
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7
9
7a
8
3
2
11
10
6a
INT
CS
6

Fig. 2

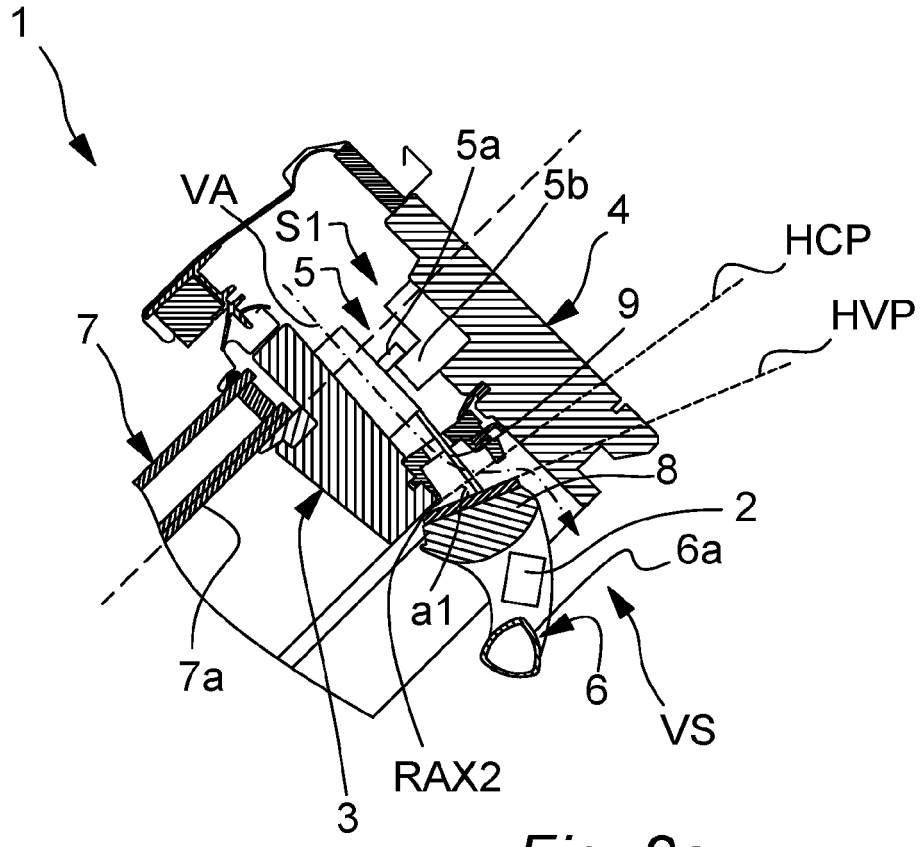
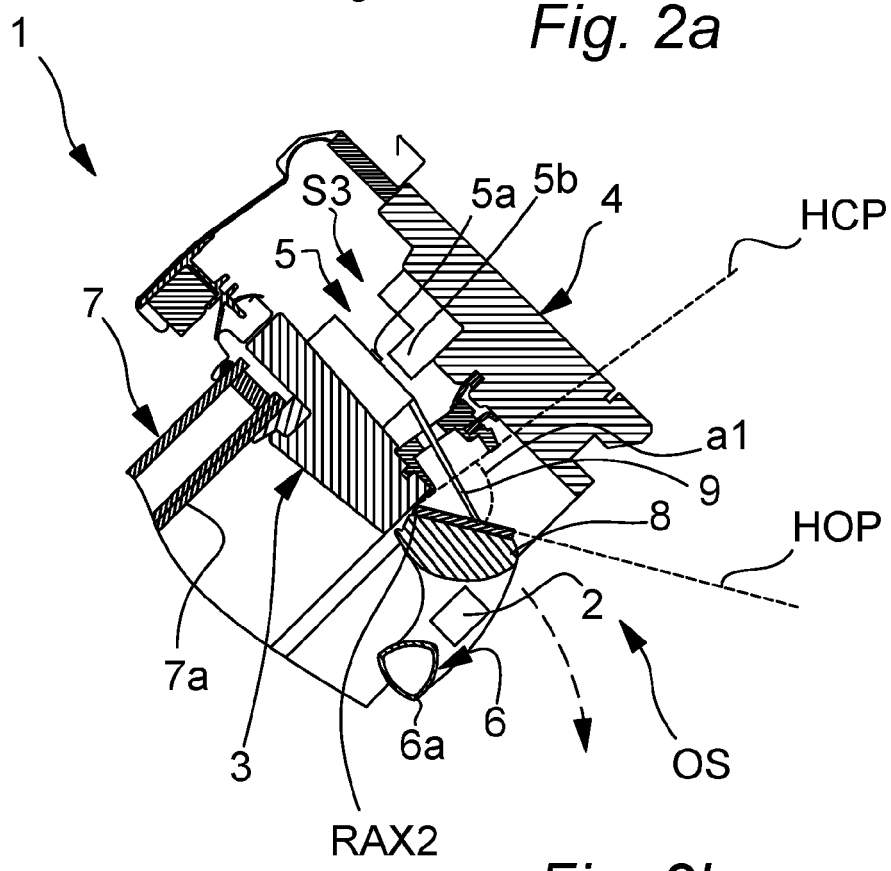

1
VA
S1
5
5a
5b
4
HCP
HVP
9
7
8
2
6a
a1
7a
6
VS
RAX2
3

Fig. 2a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S3
5
5a
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a1
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8
HOP
2
7a
6
6a
3
OS
RAX2

Fig. 2b

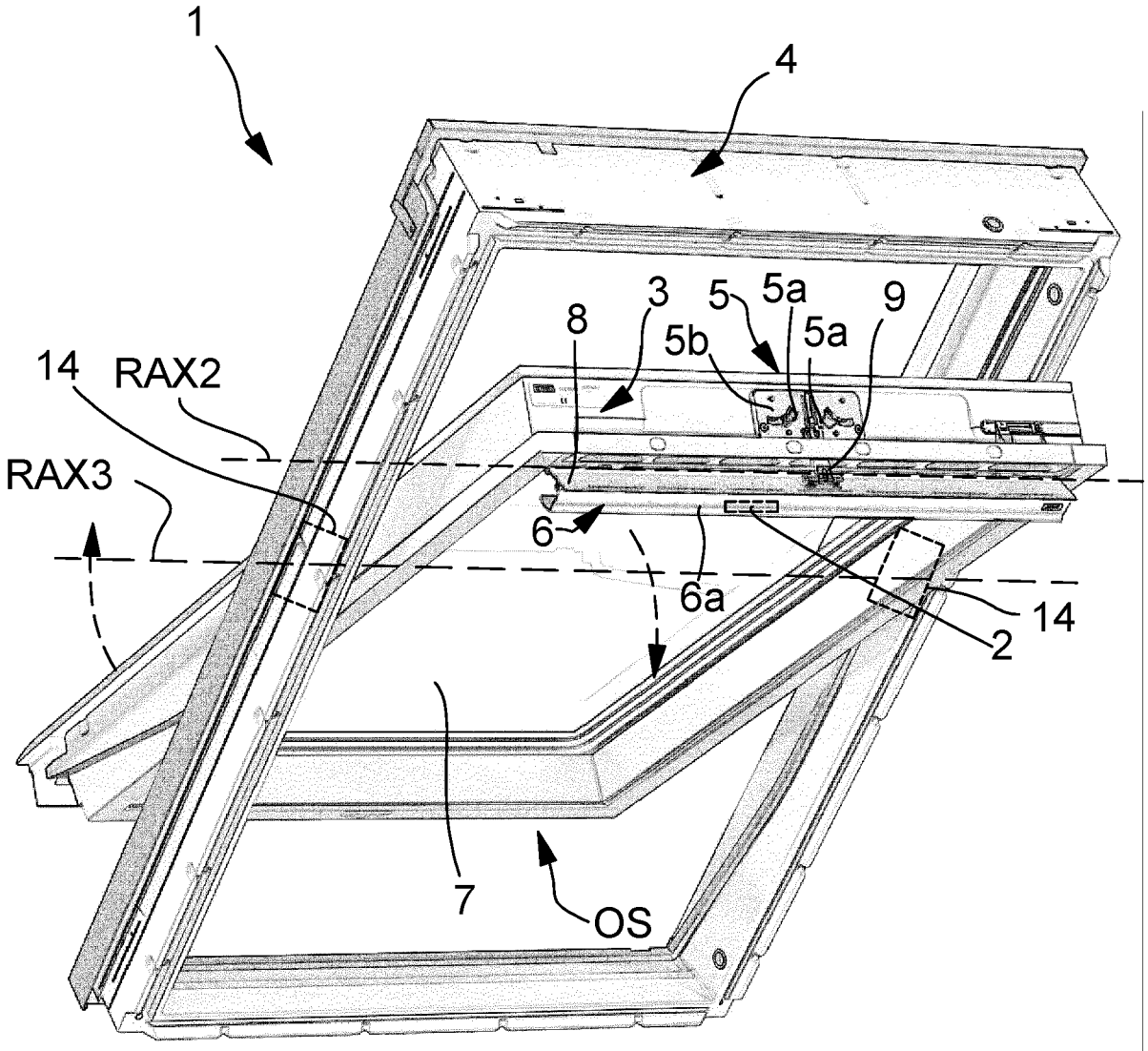


Fig. 3

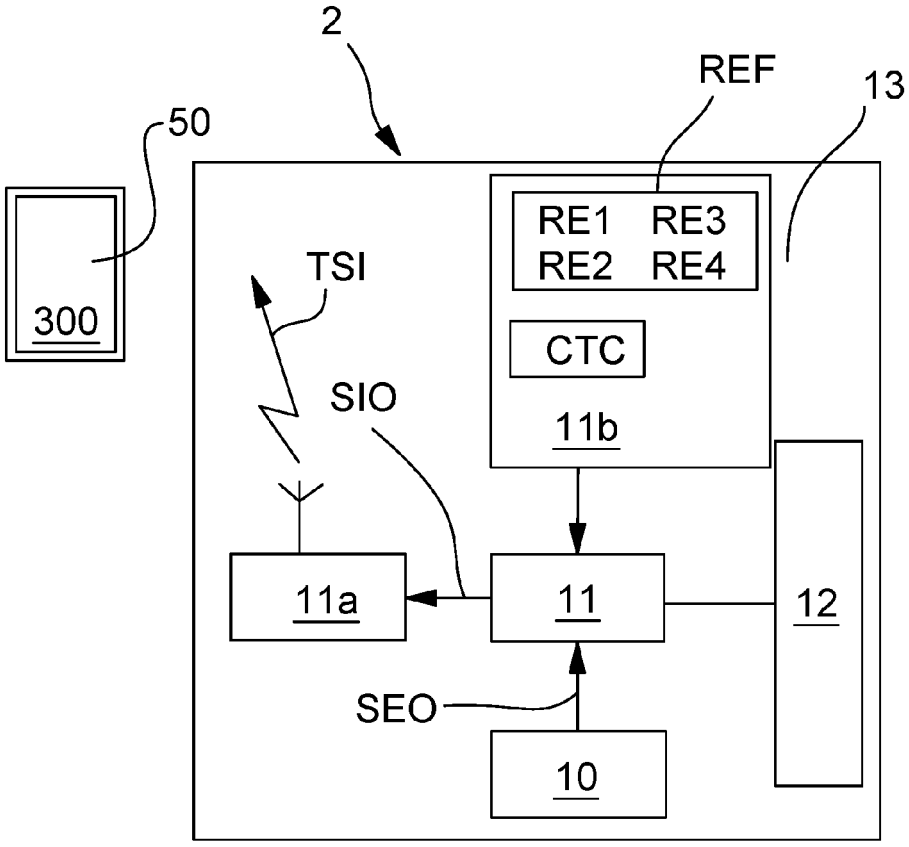
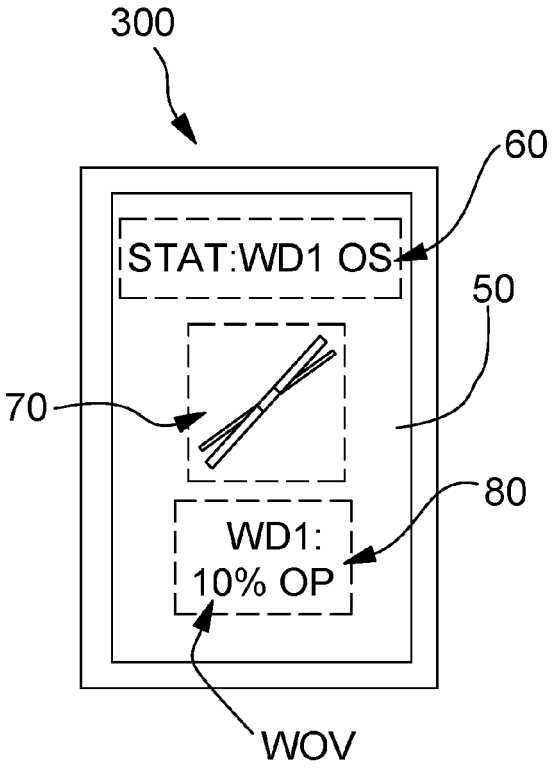

2
REF
13
50
RE1 RE3
RE2 RE4
TSI
CTC
SIO
11b
300
11a
11
12
SEO
10

Fig. 4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60
STAT:WD1 OS
50
70
80
WD1:
10% OP
WOV

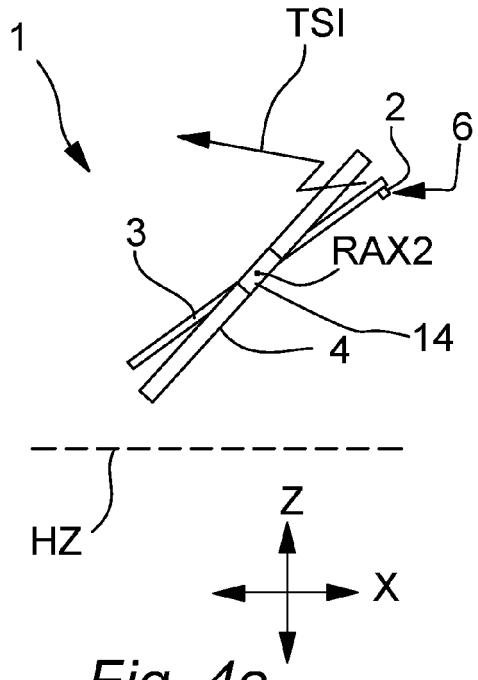
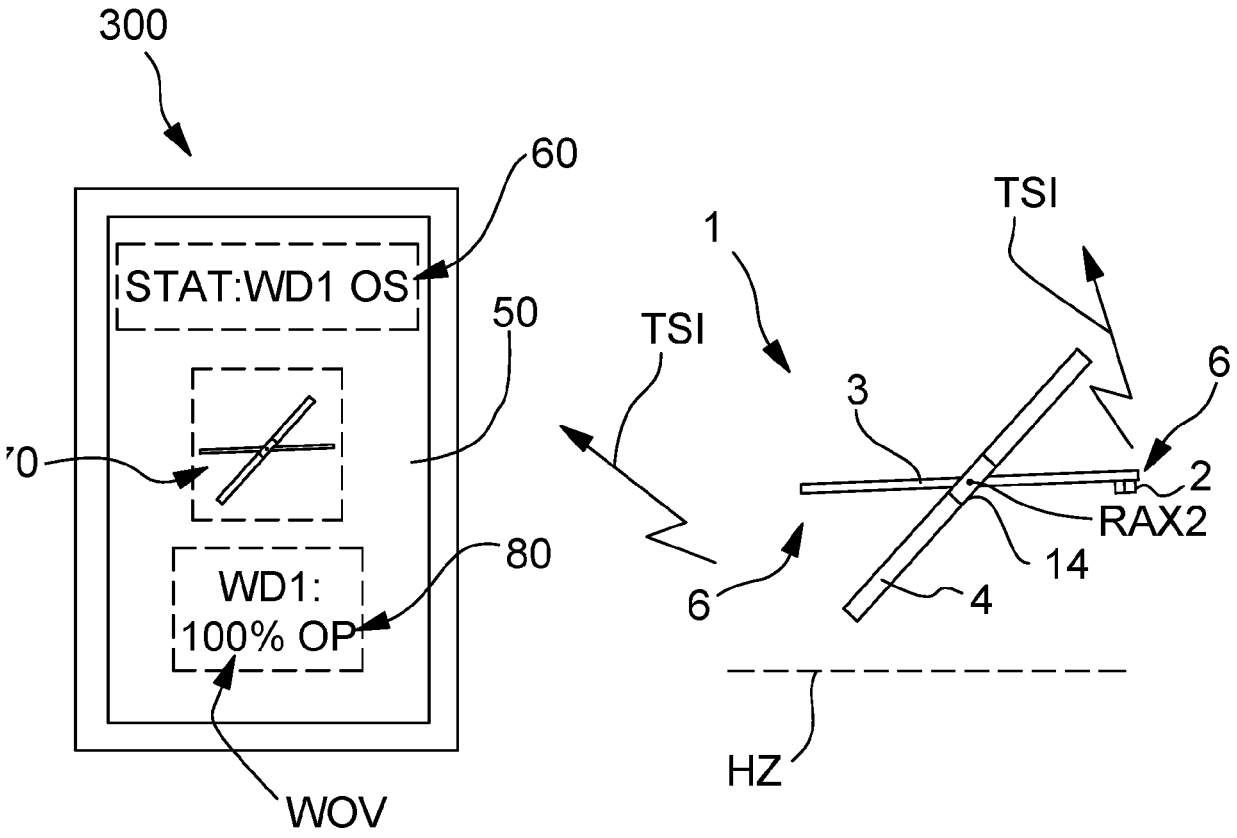

1
TSI
2
6
3
RAX2
14
4
HZ
Z
X

Fig. 4a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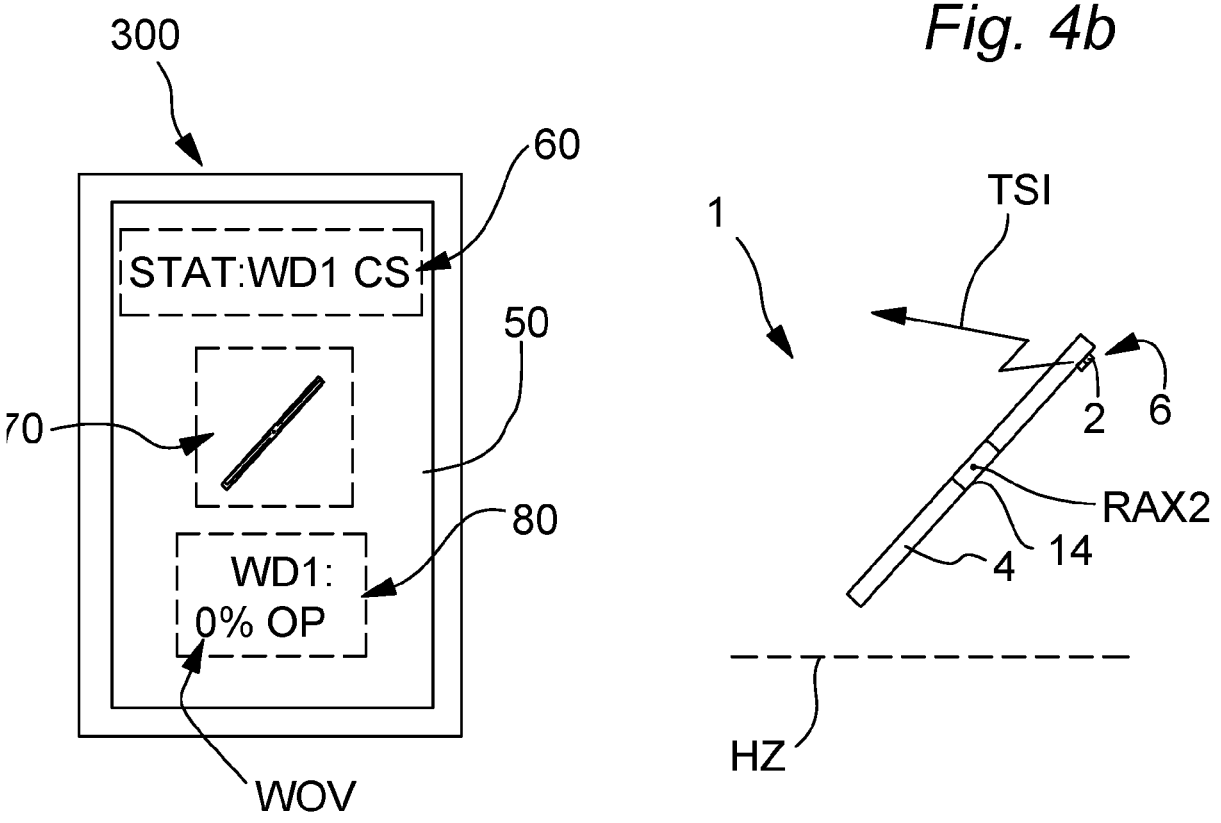
60
STAT:WD1 OS
50
70
80
WD1:
100% OP
WOV
TSI
1
TSI
6
3
2
RAX2
14
4
HZ

Fig. 4b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60
STAT:WD1 CS
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70
80
WD1:
0% OP
WOV
TSI
1
2
6
RAX2
14
4
HZ

Fig. 4c

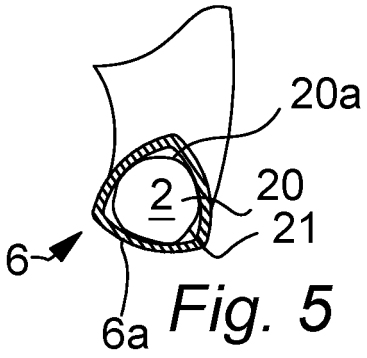


Fig. 5

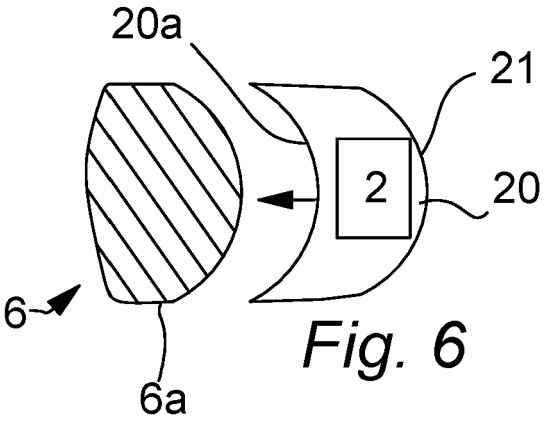


Fig. 6

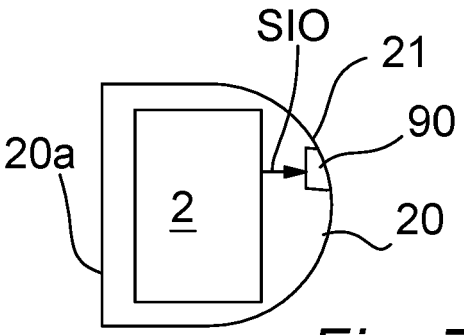


Fig. 7

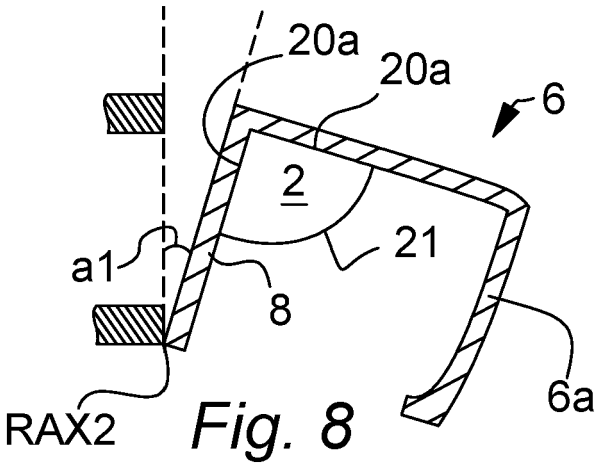


Fig. 8

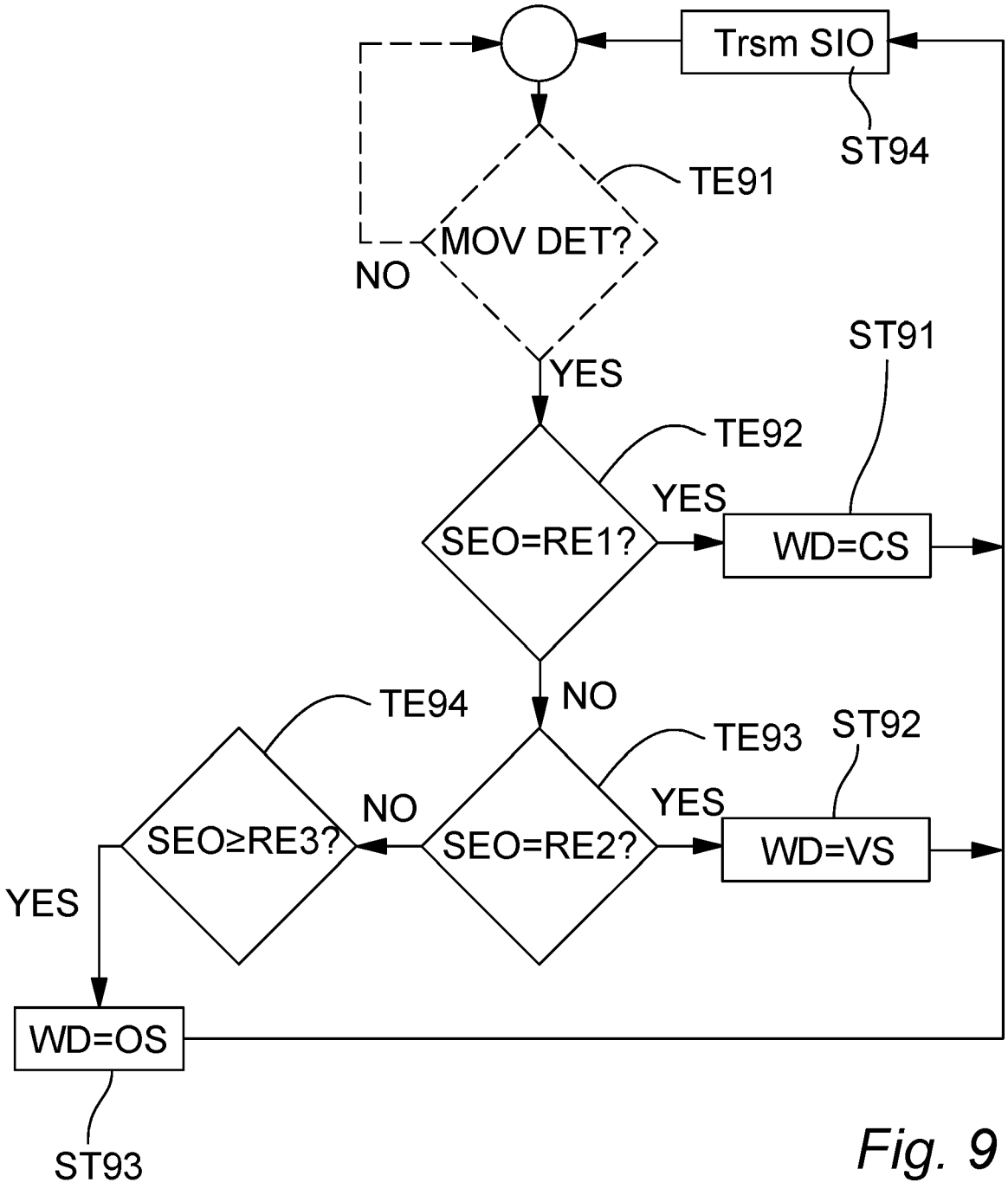
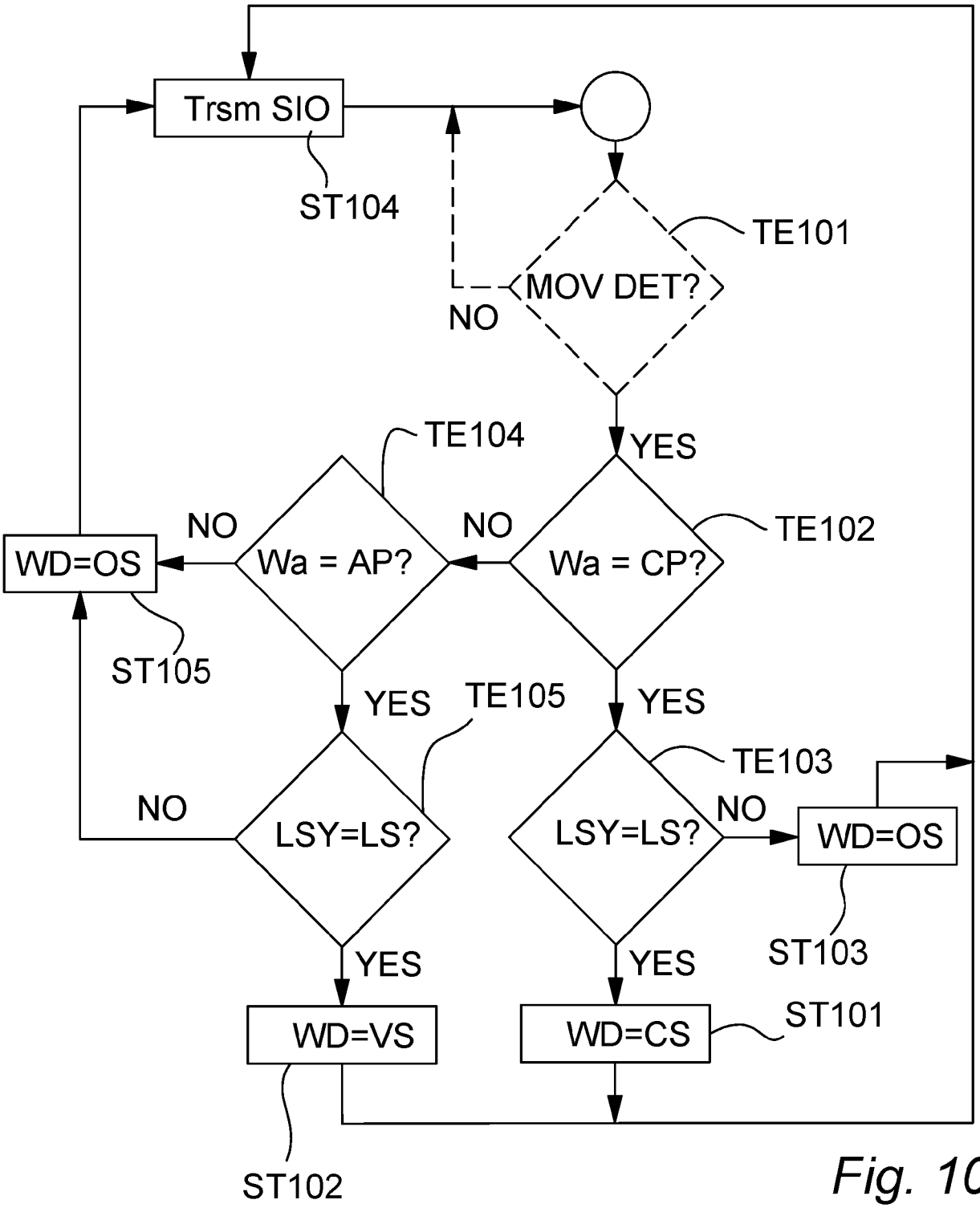

Trsm SIO
ST94
TE91
MOV DET?
NO
YES
ST91
TE92
SEO=RE1?
YES
WD=CS
NO
TE94
TE93
ST92
SEO≥RE3?
NO
SEO=RE2?
YES
WD=VS
YES
WD=OS
ST93

Fig. 9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TE101
MOV DET?
NO
YES
TE104
NO
Wa = AP?
NO
Wa = CP?
TE102
WD=OS
ST105
YES
TE105
YES
TE103
NO
LSY=LS?
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LSY=LS?
WD=OS
ST103
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YES
WD=VS
WD=CS
ST101
ST102

Fig. 10

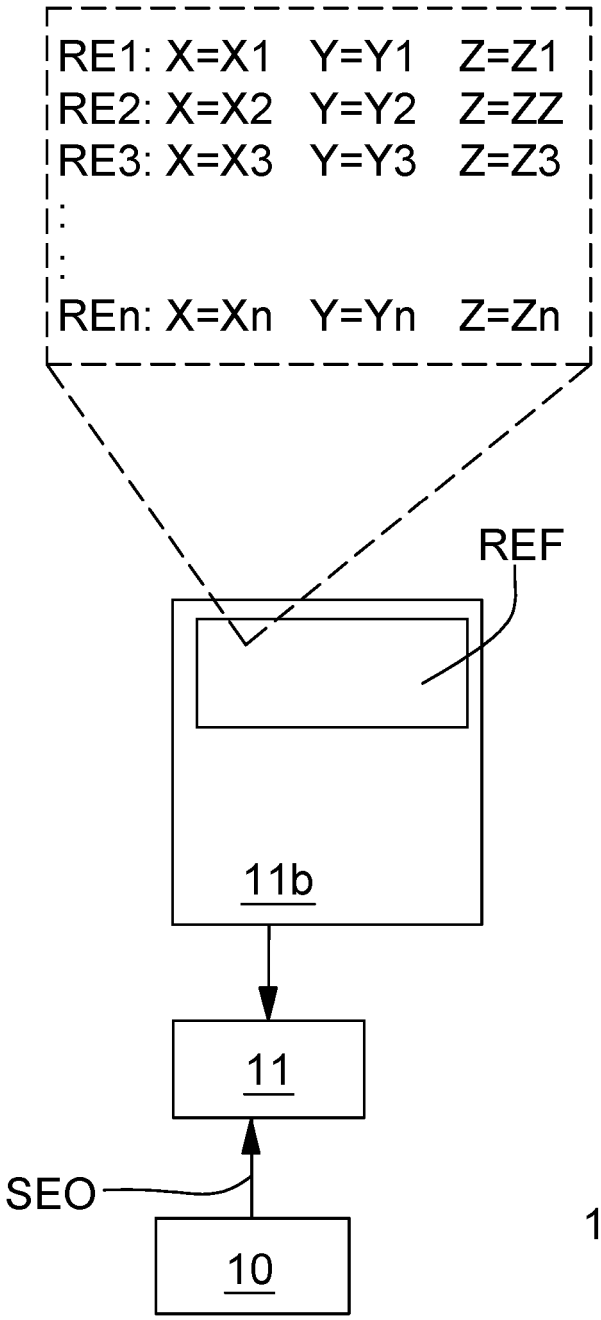


Fig. 11

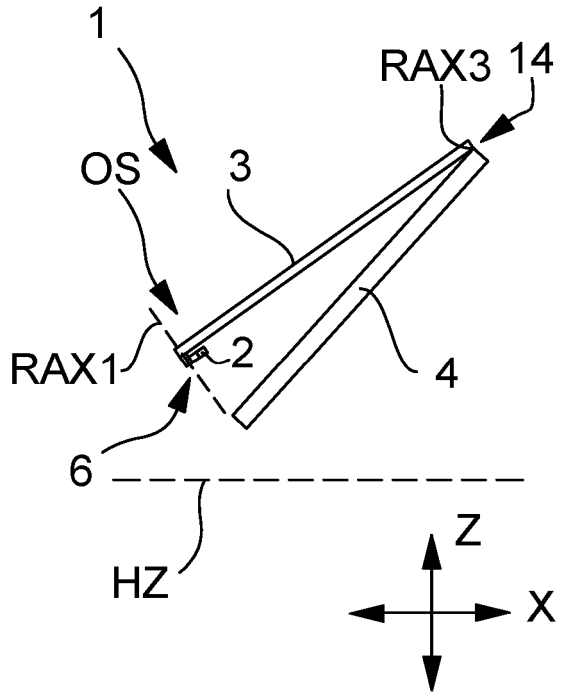


Fig. 12

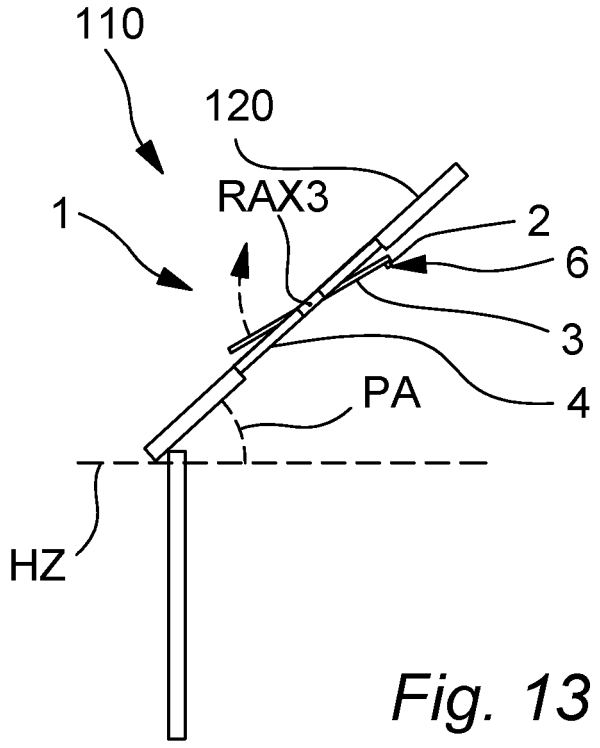
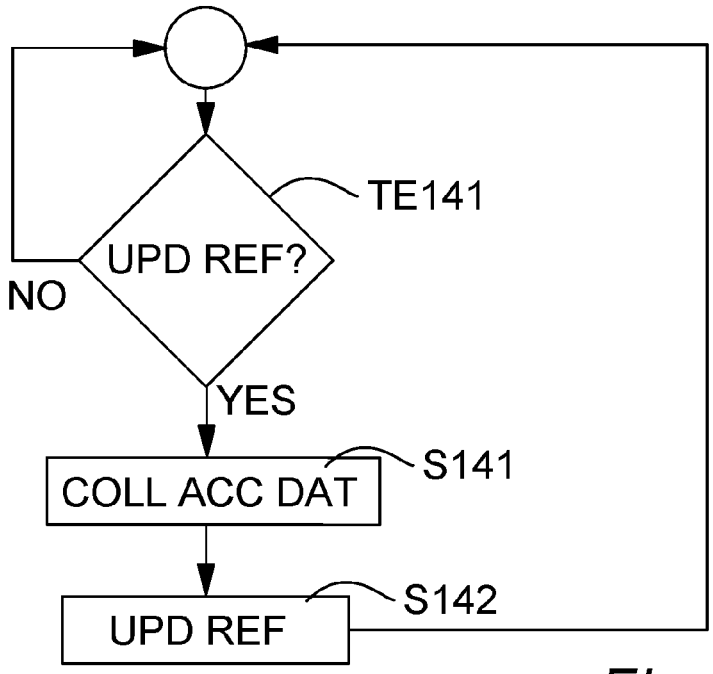


Fig. 13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UPD REF?
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S141
COLL ACC DAT
S142
UPD REF

Fig. 14

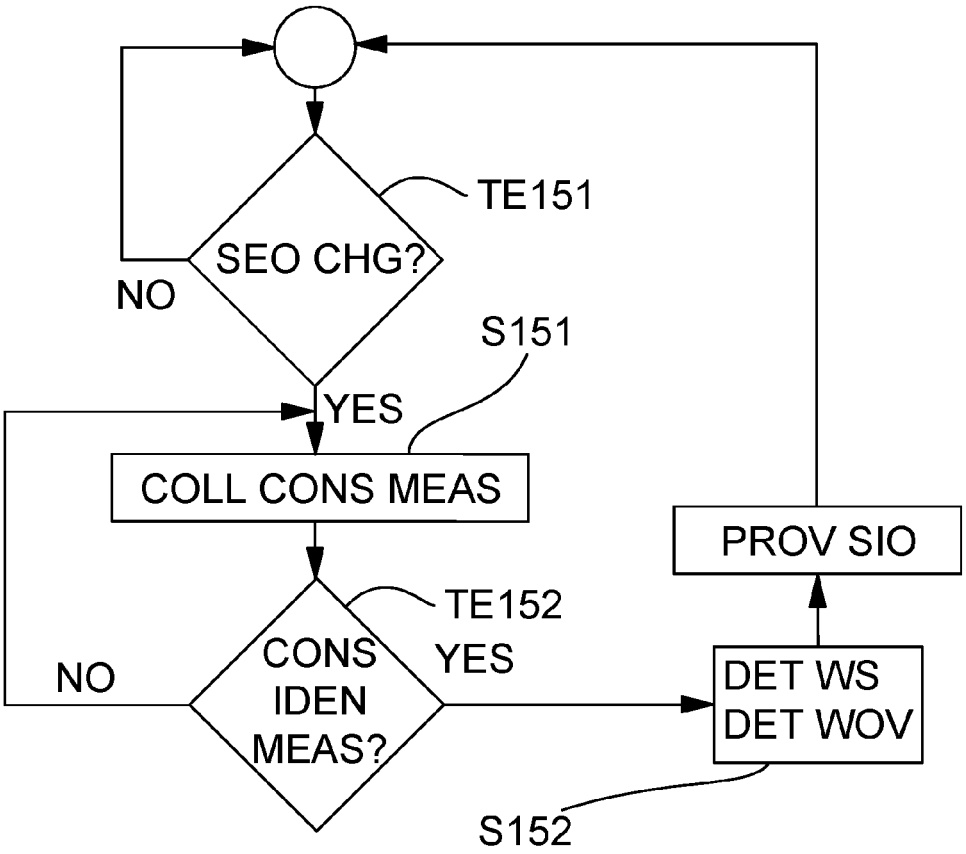
TE151
SEO CHG?
NO
S151
YES
COLL CONS MEAS
PROV SIO
TE152
CONS IDEN MEAS?
NO
YES
DET WS
DET WOV
S152

Fig. 15

Europäisches Patentamt
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EUROPEAN SEARCH REPORT

Application Number
EP 23 19 8242

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)
G01P
E05B
E05C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	26 January 2024	Cruyplant, Lieve

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26-01-2024

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