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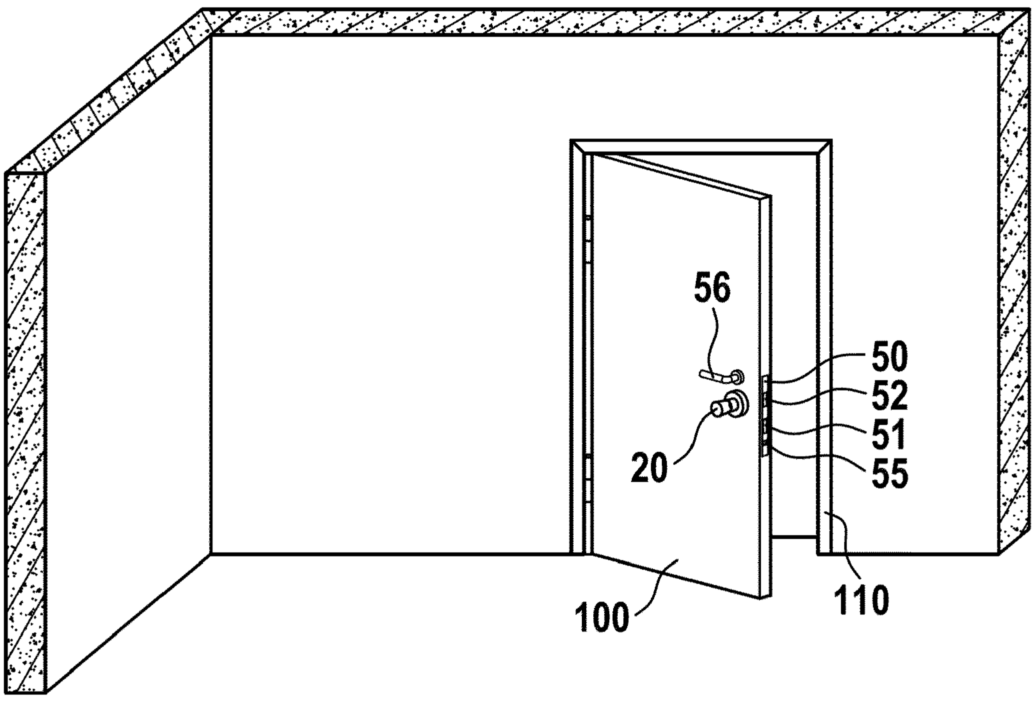
# (54) DOOR LATCH ACTUATION MEANS

(57) The position of a door leaf 100 relative to its door frame 110 can be determined by obtaining magnetic field information in the door leaf's coordinate system and comparing these magnetic field information with corresponding predetermined magnetic field information.

Fig. 1

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## Description

### Field of the invention

**[0001]** The invention relates to an electro-mechanical door lock and to a method for determining whether a door leaf in open or closed.

### Description of the related art

**[0002]** In particular in Europe mortise locks according to DIN-18251 are widely used. Examples of this kind of mortise locks are disclosed e.g. in EP 1842989 B1, US95636510, EP 280755 B1, EP575660 to name only a few.

**[0003]** This type of mortise locks is usually inserted from the narrow side into a corresponding recess of a door leaf. The mortise locks have a latch and a dead bolt, which often can be actuated independently. There exist other essentially similar mortise locks, e.g. the Scandinavian standard mortise lock, British standard mortise lock, etc.

**[0004]** The latch can be retracted by rotation of a so called "nut", the latter essentially being a follower having a through hole for receiving an output shaft being connected to a set of door handles or at least to a single door handle. Actuation of the door handle rotates the nut and thereby actuates the mechanism for retracting the latch. There exist as well mortise locks for emergency doors, where rotation of the follower as well retracts the dead bolt.

**[0005]** In most cases, however, the dead bolt can be advanced and retracted at least by operation of a cylinder lock. A typical example of a cylinder lock is the Europrofile lock. These cylinder locks usually have a cam, which interacts with a corresponding interface of the mortise lock. Rotation of the cam advances and/or retracts the dead bolt and after retraction of the dead bolt most mortise locks as well enable to retract the latch by further rotating the cam in the same direction. Modern locks are often fitted with electronic cylinders. These electronic cylinders typically have an electromagnetic clutch for coupling a handle with the latch if the lock is unlocked, to thereby enable actuation of the latch by rotation of the handle and for decoupling the handle from the latch by opening the clutch if the door is locked. Alternatively or in addition the handle and/or the latch may be coupled to a housing to thereby prevent the handle from being rotated and/or the latch from being retracted if the lock is in its locked state. The clutch is operated by a controller in response to an authorization check, which can be based in RFID technique, biometric characteristics, a remote controls signal or the like. Corresponding electronic locks and the corresponding clutches are known from a number of publications, e.g. DE 10 235 201,DE 19603320, EP 976896 B1, DE 10 2013 100 484, DE 9004675U1. These electronic locks often include communication means for communicating their actual locking state (i.e. locked or unlocked) to burglar alarm systems.

**[0006]** Only to avoid misunderstandings, a door is an opening in a wall, a fence or any other barrier. The opening can be used to pass through the barrier if the door is open. If the door is closed, the opening is blocked, one may not pass the barrier. The door is opened or closed by moving a door leaf into an open or into a closed position, respectively. Thus, when the door leaf is in its closed position the door is considered to be closed and vice versa. Doors often have door frames with door jambs being attached to the barrier and supporting the door leaf(s) by hinges.

### Summary of the invention

**[0007]** The invention is based on the observation that the in most cases the locking state of a door lock can be derived from the rotational position of the handle, i.e. by simply counting the number of revolutions in each direction (taking into account the respective actual clutch state). However, in practice, it may happen that the dead bolt is extended and the door lock (more precise its controller) considers the door to be in a "locked" state, but the dead bolt does not engage into the corresponding striking plate being installed in the doorjamb. This would be recognized as "door locked", although the door could be entered through without authentication for any person or matter.

**[0008]** The problem to be solved by the invention is to enhance reliability of status recognition of doors without the necessity of additional wiring or installation of additional contacts. This would enable to document the status of a door, e.g. as proof for an insurance company, e.g. by simply installing a cylinder lock according to any standard to a corresponding mortise lock. For example, each status change could be protocolled and stored to a memory, for being retrieved if required.

**[0009]** Solutions of the problem are described in the independent claims. The dependent claims relate to further improvements of the invention.

**[0010]** In particular, the problem is solved by a method for determining the position of a door leaf relative to a door frame, e.g. by a door lock, like a cylinder lock. The door frame defines a first coordinate system. As always the door leaf is movably supported relative to the door frame and thus movable in the first coordinate system. In most cases the door leaf is pivotable to thereby open or close the door, but there exist sliding doors, as well.

**[0011]** According to the invention the spatial orientation of a magnetic field vector and/or the length of the magnetic field vector and/or at least one of the magnetic field vector's component is measured by a magnetic field sensor, e.g. by a magnetometer, being attached to the door leaf. Thus, the corresponding information about the magnetic field is obtained in the door leaf's coordinate system. If the door leaf is closed, the magnetic field at the sensor's position changes during the movement of the door leaf. When the door leaf reaches its closed end position the magnetic field has a particular direction and strength, both being essentially constant and thus indicative for the door leaf's closed position. Thus, by comparing the magnetic information being obtained by said magnetic field sensor with the predetermined information, one can determine if the door is open or closed. The method thus has at least two steps: First, at least the spatial orientation of a magnetic field vector in the door leaf's coordinate system and/or the length of the magnetic field vector and/or the length of a component of the magnetic field vector is obtained using at least a magnetic field sensor being attached to the door leaf. In a second, subsequent step, the spatial orientation and/or the length of the magnetic field vector (or of the respective component) is compared with at least a first or a second predetermined orientation and/or first or second predetermined length, respectively, to thereby determine if the door is open or closed. The door is determined to be closed, if a first closed condition is met, wherein the first closed condition is met if the magnetic field vector points in a first predetermined direction and/or has a first predetermined length and/or at least one of its components has first predetermined length. The door is determined to be open, if a first open condition is met, wherein the first open condition is met, if the magnetic field vector points in a second predetermined direction and/or has a second predetermined length and/or at least one of its components has second predetermined length.

**[0012]** Only to avoid confusion, it is noted, that the first or a second predetermined orientation and/or first or second predetermined length(s) (of the component(s)) are preferably corresponding ranges and thus intervals.

**[0013]** Thus, the invention is based on the observation that the external magnetic field (i.e. if no other magnetic fields are present, the earth magnetic field) can be used to distinguish an open door from a closed door. Accordingly, there is no need for additional contacts or cables. Retrofitting existing doors with a corresponding lock is thus simple.

**[0014]** If the neither the first closed condition is met nor the first open condition the method may comprise determining the door to be in an undefined position. This may account for magnetic noise.

**[0015]** Preferably, said obtaining comprises supporting the magnetic field sensor by a rotatable portion of a door lock being attachable (as normal) to the door leaf, wherein the rotatable portion is rotatable relative to the door leaf. The rotatable portion can be e.g. a door knob for example of an electromagnetic cylinder lock or a handle bar.

**[0016]** For example, determining the angular position of the rotatable portion relative to the door leaf's coordinate system provides a measurement of the angle between the magnetic field sensor's coordinate system and the reference direction in the door leaf's coordinate system. The angular position of the rotatable portion may be determined based on the data provided by an acceleration sensor and/or a position sensor. For example, if no external forces are applied to the door leaf, the acceleration sensor measures the acceleration by gravity, only. This state can easily be detected as the gravity vector is known and constant. Thus, if the acceleration sensor provides a signal being (at least essentially constant) and being representative for gravity ($g \approx 9{,}81 ms^{-2}$) the door leaf and the handle can be considered not to be moving relative to the door frame's reference system. This enables to determine the angular position of the rotatable portion relative to the door leaf and thus as well to determine the angular position of the magnetic field sensor relative to the door leaf.

**[0017]** The measurement of the spatial orientation of the magnetic field at the position of the magnetic field sensor by the magnetic field sensor is preferably obtained in the magnetic field sensor's coordinate system. Rotating the measured spatial orientation against said angle enables to obtain the spatial orientation of the magnetic field at the position of the magnetic field sensor in the door leaf's coordinate system. Alternatively (or as well in addition), the reference direction as defined in the door leaf's coordinate system may be rotated by said angle to obtain the reference direction in the magnetic field sensor's coordinate system. Both rotations enable to determine the spatial orientation of the magnetic field relative to said reference orientation, wherein both the spatial orientation and the reference orientation are in the rotatable portion's (e.g. the handle's) coordinate system or both the door leaf's coordinate system. In any case they can be compared to test the first closed and/or the first open condition. The method may thus comprise comparing the spatial orientation of the magnetic field relative to said reference orientation with the predetermined orientation wherein both the spatial orientation of the magnetic field relative to said reference orientation and the predetermined orientation are either in the rotatable portion's coordinate system or both the door leaf's coordinate system.

**[0018]** Preferably, the method comprises a calibration sequence comprising at least closing the door and initializing a calibration mode of the door lock. These two steps may be performed in any sequence. Subsequently, the calibration sequence may comprise obtaining at least the spatial orientation of a magnetic field vector relative to a reference direction being defined in the door leaf's coordinate system after the door was closed and/or the length of the corresponding vector (or at least one of its components). Generally, it is sufficient to determine the length of a component of the magnetic field vector, but precision can be enhanced when accounting for all three components. The such obtained magnetic field vector information may be assigned to a (first) predetermined orientation, the (first) predetermined magnetic field and/or the (first) predetermined length of a component of the magnetic field vector, respectively. For simplicity, we refer to this information as well as 'predetermined magnetic field information'. The predetermined magnetic field information was thus obtained while the door was closed. Subsequently, the calibration sequence may end. Additionally the, calibration sequence may comprise positioning the door leaf in at least one open position and to determine magnetic information at the same position in the door leaf's coordinate system. The thereby obtained magnetic information may be assigned to a second predetermined orientation, the second predetermined magnetic field and/or the second predetermined length of a component of the magnetic field vector, respectively.

**[0019]** The calibration sequence may be repeated regularly to thereby recalibrate and account for changes in the magnetic field, e.g. due to electric devices being installed in the vicinity of the door.

**[0020]** The calibration sequence is preferably terminated without assigning at least one of the measured values if the absolute value of the mean of the acceleration and/or the maximum of the absolute value of the acceleration in the time interval starting after closing of the door and ending with the end of the measurement of the obtaining step of the calibration sequence exceeds a respective acceleration threshold. Thereby, it can be avoided to store a (first or second) predetermined magnetic field information erroneously. In other words, the assigning step may be skipped, if the absolute value of the mean of the acceleration and/or the maximum of the absolute value of the acceleration in the time interval starting after closing (or opening, respectively) of the door and ending with the end of the measurement of the obtaining step of the calibration sequence as explained above exceeds the respective acceleration threshold. In addition or alternatively, the assigning step may be skipped, if the obtained magnetic field information is not at least essentially constant. If the magnetic field information is not essentially constant, this may have at least two reasons:

(i) the door leaf is moved during the calibration sequence, and/or
(ii) the external magnetic field changes during the calibration sequence, e.g. due to electrical machines operating in the vicinity of the door. In this case one likely observes an oscillating magnetic field.

**[0021]** In particular in the second case one often can resolve the problem by installing a permanent magnet in the vicinity of the door frame, e.g. by attaching it to a striking plate or in the vicinity of the striking plate. It is noted that reliability of the position detection is enhanced if the permanent magnet is installed independently from the existing magnetic field. The magnet's field superposes with the 'natural'(including the field by electrical installations) external magnetic field and the relative changes in the external magnetic field in the vicinity of the door handle/door knob are reduced. This holds in particular if the magnetic field of the permanent magnet is guided by the door leaf or parts attached to the door leaf to the magnetic field sensor as will be explained below.

**[0022]** In an example of the invention, the method comprises measuring the magnetic field strength at a position being defined in the door leaf's coordinate system, and subsequently comparing the measured field strength with a first and/or a second reference field strength. Thereby, one may determine if a second open or a second closed condition is met and determine the door to be closed, if the first and the second closed conditions are met, and open, if the first and the second opens conditions are not met. If only a single of the two conditions is met the door's status may be determined to be undefined.

**[0023]** For example, the method may further comprise determining, while the door is being closed the acceleration of the door leaf as a function of time and storing at least one value being indicative for the acceleration while closing the door, i.e. the acceleration of the door leaf during the process of closing the door is determined. Similarly, the acceleration of the door leaf while being opened may be determined (in addition or alternatively) and at least one value being indicative for the acceleration when opening the door may be stored. Subsequently, the acceleration of the door as a function of time may be measured and compared to the measured acceleration(s) of the door with the at least one stored value, to thereby determine if a third open or a third closed condition is met, and determining the door to be closed, if the first and/or the second and/or the third closed conditions are met and open, if the first and/or the second and/or the third open conditions are met. In this example the reliability in determining the door's position is enhanced. In particular, if a door is opened, it often swings open without being abruptly stopped, thus acceleration of the door leaf when slowing down is quite low and continuous. When closing a door, in contrast, the door leaf usually abuts the door frame being causing a corresponding peak in the acceleration (as a function of time). Most door frames have an elastic gasket absorbing the shock when closing the door. The gasket affects the peak enabling to distinguish when the door leaf abuts against the gasket from the situation when an extended dead bolt of a door lock abuts a door frame, or if the latch does not retract.

**[0024]** The precision of estimating the door status can be further augmented, by monitoring the position of a dead bolt and/or a latch of a door lock being mounted to said door leaf.

**[0025]** The problem underlying the invention can as well be solved by an electro mechanic door lock for being mounted to a door leaf. The door lock can be e.g. a cylinder lock. The door lock preferably comprises at least a rotatable handle, at least one clutch for rotatably coupling and decoupling the handle with a transmission and/or a lock housing, a controller e.g. for controlling the clutch and a magnetic field sensor. The handle can be e.g. a door knob or a door lever. The clutch enables to selectively couple and decouple the handle with a transmission. The transmission can be e.g. the cam of cylinder lock or as well an output shaft for being coupled to a follower for retracting a latch of a mortise lock. More generally the transmission is a coupling means for coupling the lock with means (e.g. of the mortise lock) for operating a latch and/or a dead bolt. The at least one clutch enables to selectively couple the handle to the transmission and/or the housing. The clutch is preferably an electromechanical clutch being controlled by controller. The controller verifies if a user is authorized to lock or unlock the lock by some user interface. The user interface may be an RFID-reader, a sensor for biometric recognition (e.g. a fingerprint sensor or the like), a keypad or any other means enabling user authentication. If a user is authorized, the clutch is operated accordingly i.e. opened or closed. The magnetic field sensor is preferably a 3D-magnetic field sensor (i.e. a 3-axis magnetometer). The magnetic field sensor has a measuring area. This measuring area is preferably at least approximately centered ($\pm$3cm, preferably $\pm$2cm, even more preferred $\pm$1cm or even less) with the rotational axis of the handle. Thereby, a rotation of the handle does not displace the magnetic field sensor in the respective field. Thus, a measurement of the magnetic field strength is not affected by rotation of the handle, provided the angular position of the handle has no (or only negligible) effect on the magnetic field. But even if the handle has a non-vanishing magnetic field, this field can be determined by simply rotating the handle in a constant external magnetic field and obtaining the magnetic field information for at least two angular positions. Subsequently the contribution of the handle's magnetic field (and thus the contribution of the handle's angular position) to the measured magnetic field information can be calculated, i.e. is known and can be subtracted from the measured magnetic field information to thereby obtain a corrected measured magnetic field information.

**[0026]** The invention may thus as well (i.e. in addition or alternatively) include rotating a handle of a lock, while measuring the direction and/or the length of the magnetic field vector in the vicinity of the handle, e.g. by a magnetic field sensor being attached to the handle, and determining the change of the magnetic field vector as function of the angular position of the handle. In a preferred embodiment the magnetic field $\vec{B}(\vec{r}, \phi)$ (wherein $\vec{r}$ represents a position and $\phi$ and angular orientation of the handle) is measured for at least two orientations of $\phi_1$, $\phi_2$, wherein preferably $\phi_1 = \phi_2 + \pi$. If the latter condition is met, the corrected magnetic field $\vec{B}_{ext}(\vec{r})$. in other words the external magnetic field, can be obtained as the mean of the two measurements, i.e.

$$\vec{B}(\vec{r}) = \frac{1}{2} \cdot (\vec{B}(\vec{r}, \phi_1) + \vec{B}(\vec{r}, \phi_2)).$$

Other relations between $\phi_1$ and $\phi_2$ may as well be used. In practice, the rotation by $\pi$ cannot be performed exactly, but it can be performed within an accuracy of a few degrees (e.g. $\pm 10° \approx \pm 0{,}028 rad$).

**[0027]** The method can be implemented using an electromechanical cylinder lock. The cylinder lock has a lock housing, e.g. according to DIN 18252 (the so called EURO-cylinder) to fit in mortise locks according to DIN 18252-1 to -3. The cylinder lock comprises at least a handle, a clutch, a cam, and a controller. The clutch is controlled by the controller and if closed, it provides a torque proof connection between the handle and the cam. If the clutch is open, the torque proof connection is disengaged, i.e. there is no torque transmission between form the handle to the cam via the clutch and preferably as well not from the cam to the handle. "No torque" includes 0 Nm, but small torques may still be transmitted, provided the transmitted torque is to low to lock or unlock a door (e.g. by operating a mortise lock as defined in DIN 18252-1 to -3).

**[0028]** Preferably, the cylinder lock comprises at least one magnetometer enabling to determine the orientation and/or strength of a magnetic field at the position of the magnetometer. For example, the magnetometer may be inside the handle. Preferably the magnetometer is a three axis magnetometer enabling to measure the components of the magnetic field. The magnetometer is coupled via a data link with the controller, enabling the controller to store and process the measurement data obtained by the magnetometer. As the wording implies, the measurement data of the magnetometer provides information like magnetic field strength and/or direction of the magnetic field or at least one component of the magnetic field vector to the controller and is in this sense related to the magnetic field at the magnetometer's position. The data link may be a digital bus system (like e.g. $I^2C$ or any other appropriate communication bus) or simply an analog voltage representing the measured magnetic field strength (either the total field strength and/or the component(s) of the magnetic field vector). The data link simply provides a communication of measurement data to the controller.

**[0029]** In particular, if the magnetometer is rotatable relative to the lock housing, the cylinder lock preferably comprises a position sensor for determining the angular position of the magnetometer relative the cylinder housing. The position sensor is coupled via a position data link to the controller, thereby enabling the controller to obtain angular position information from the position sensor. Again the position data link may be e.g. a digital bus or any other appropriate means to signal the angular position of the magnetometer to the controller. The position sensor is not necessarily directly attached to the magnetometer (but it may be). It may be mounted to a structure being torque proof coupled to the magnetometer (or the magnetometer itself). For example, if the magnetometer is positioned inside a handle and rotates with that handle (e.g. if it is attached to the handle), the position sensor may determine the rotational position of the handle and the position may be used as rotational position of the magnetometer. The position sensor may measure the angular position directly, i.e. relative to the cylinder housing or indirectly, e.g. relative to another reference that is typically in a static relation with the cylinder housing. For example, the position sensor may determine the angular position relative to the gravity vector. In this example, the position sensor can be an accelerometer.

**[0030]** Mostly, the lock housing is configured to be attached via a mounting screw, often as well referred to as "cylinder screw" or "forend screw", to a mortise lock. For example, the cylinder housing may have threaded hole, typically extending orthogonally to the cylinder lock's longitudinal axis for receiving the mounting screw. In a preferred example, a paramagnetic material magnetically bridges the distance between the screw hole and the cylinder lock's magnetometer. In this sense the paramagnetic material magnetically connects the hole and the magnetometer. This enables to conduct a magnetic flow from the threaded hole to the magnetometer or at least to the vicinity of the magnetometer. Thus, if a magnetic flow is coupled via the threaded hole to the cylinder lock, it can be detected with a high reliability by the magnetometer, i.e. the magnetometer provides a sharp signal. In this example, the mounting screw may as usual extend from the mortise lock's forend through a portion of the mortise lock's housing into the threaded hole. If the mounting screw is of a paramagnetic material a magnetic flow can be coupled via the mounting screw into the cylinder housing. Thus, if one positions a small permanent magnet opposite of the mounting screw's head to the door frame (supposing the door leaf to be closed), the magnetic flow of the permanent magnet is conducted at least in part via the magnetic mounting screw and the magnetic bridge to the magnetometer. If the door is only slightly opened, the magnetic coupling between the permanent magnet and the mounting screw is reduced significantly, as the air gap increases between the mounting screw and the permanent magnet as soon as the door leaf pivots form its closed positon to an only slightly open position (as the magnetic susceptibility of air is essentially zero). This reduction in the magnetic coupling can be measured by the processor using the magnetometer as a reduction in the magnetic field strength. If the door is subsequently closed, the measured magnetic field strength enhances significantly.

**[0031]** In another example, a permanent magnet is movably supported by the door frame and rotated if the door is closed. Thus, by closing the door, the direction of the magnetic field being provided by the permanent magnet changes and can be detected. For example, at least one permanent magnet may be movably, e.g. rotatably supported by the door frame, e.g. by a striking plate. The movable magnet may be comprised by a movable portion. The movable portion is movably supported relative to the door frame, e.g. relative to the striking plate and/or a door jamb. The movably supported magnet may have at least first and a second position. The movement of the magnet thus changes the magnetic field in the vicinity of the magnet, which can be detected, e.g. using the magnetometer of the cylinder door lock as explained above, thereby discrimination an open door from a closed one.

**[0032]** In a preferred embodiment, the magnetic field is rotated, this enabled particularly safe discrimination of the door status (open, closed or potentially in transition). To this end, the magnet is preferably rotatably supported and rotatable between said first and second positions. But rotation of the magnet is not the only way to rotate the magnetic field. A translation of the magnet may as well translate in a rotation of the magnetic field using (para-) magnetic legs.

**[0033]** In a particular preferred example, the movable portion blocks a recess of a door frame or door jamb being configured for receiving a latch or a dead bolt, if the magnet and thus the movable portion are in their first position(s). If the latch or the dead bolt, respectively, engages into the recess, it pushes the movable portion and thus the magnet into its second position, thereby altering the magnetic field in the vicinity of the door lock. This altering can be detected by the controller using the magnetic field information obtained from the magnetometer. Summarizing, in an aspect of the invention, the invention may be implemented by a striking plate with a bearing rotatably supporting the movable portion, wherein the bearing enables the movable portion to move (e.g. to rotate) between at least two positions, a first position, in which the movable portion would - if not movably supported - block a recess of the striking plate. In the second position the recess is not blocked. Blocking the recess does not necessarily mean that the movable portion engages into the recess, but at least a dead bolt and/or a latch cannot be (fully) extended through the recess without pivoting the magnet (e.g. via the movement of the lever) into its second position. In other words, in the second position the recess is clear of the movable portion. Thus movable magnet enables not only to distinguish an open door from a closed door (latch engaged into the corresponding recess), but as well an unlocked door (dead bolt not engaged into its recess) from a locked door (dead bolt engaged).

**[0034]** In a preferred example, the movable portion has a center of gravity. In the first position of the movable portion, its center or gravity is below the position of its center of gravity in the second position. Thus, by moving the movable portion from its first into its second position it gains potential energy. When opening the door, the movable portion automatically reverts into its first position, thereby restoring the magnetic field indicating "door open".

## Description of Drawings

**[0035]** In the following the invention will be described by way of example, without limitation of the general inventive concept, on examples of embodiment with reference to the drawings.

Figure 1 shows an example door.

Figure 2 shows a first example cylinder lock.

Figure 3 shows a second example cylinder lock.

Figure 4 shows a third example cylinder lock.

Figure 5 shows a fourth example cylinder lock.

Figure 6 shows a preferred embodiment of a striking plate.

Figure 7 shows another preferred embodiment of a striking plate.

**[0036]** Figure 1 shows a door with a cylinder lock according to a preferred embodiment. The door has a door leaf 100 being pivotably supported relative to a door frame 110. The door comprises a mortise 50 lock being inserted into the narrow facing front end of the door leaf 100. The mortise lock has a dead bolt 51 and a latch 52 for being retraced by operation of a door handle 56. For extending and retracting the dead bolt (and the latch) the mortise lock provides a transmission being driven by a cam 11 of cylinder lock, e.g. by the cam 11 of the cylinder lock 1 as depicted in Figure 2. Often the transmission as well enables to retract the latch 52. Strictly speaking the cam 11 is part of a transmission providing a torque proof connection (if the clutch is closed) between the handle 20 and the dead bolt and/or a latch. The cam has the function of a mechanical connector of a releasable coupling.

**[0037]** The example cylinder lock in figure 2 has a cylinder housing 10 adapted to be mounted to a mortise lock. A threaded hole 16 enables to secure the cylinder lock 1 relative to the mortise lock using a mounting screw, which may be inserted from the narrow side facing the corresponding striking plate.

**[0038]** The cylinder housing 10 provides an axial bearing for a cylinder core comprising the cam 11. The cylinder lock 1 further comprises a (cylinder) handle 20 being rotatably supported by the cylinder housing 10. The handle 20 and the cam 11 have a common rotational axis 2 (as well referred to as cylinder axis) can be coupled and decoupled to each other by closing or opening a clutch 12, respectively. For simplicity, the clutch 12 is depicted only symbolically, but a large number of different clutch systems for connecting a handle to a cam have been reported to so far (see e.g. DE10235201B4, DE 102004056988 B4, EP 1953314 B1, DE 10 2013 104 366, to name only a few). The clutch 12 is not necessarily positioned in the cylinder core but can as well be integrated in a handle, e.g, as suggested in EP978611B1. Operation of the clutch 12 is controlled by a controller 13 in response to signals received from an authentication device 14. In this example the authentication device is symbolized as an antenna as used e.g. for RFID authentication. But other means may be used as well, like e.g. a fingerprint sensor, a keypad for entering a personal code or the like or some sort of remote control receiver.

**[0039]** If a user's authentication is verified, the controller 13 closes the clutch and thereby enables the user, by rotating the handle 20 to rotate the cam 11 as indicated by arrow 13 (or in the other direction). Rotation of the cam enables to operate the mortise lock (50), e.g. to advance or retract a dead bolt 51 and/or to retract a latch 52 (cf. Fig. 1).

**[0040]** Preferably, the cylinder lock further comprises a magnetometer 30. The magnetometer may be connected to the controller 13 via a data link thereby enabling the controller 13 to measure using the magnetometer the magnetic field $\vec{B}(\vec{r})$ or at least the magnitude of the magnetic field, e.g. $\left|\left|\vec{B}(\vec{r})\right|\right| = \sqrt{\vec{B}(\vec{r})^2}$ and/or the magnitude of at least a component $B_i(\vec{r})$ of the magnetic field $\vec{B}(\vec{r})$ and or the direction $\vec{d}$ of the magnetic field $\vec{B}(\vec{r})$, what is summarized under the term magnetic field information. Based on the magnetometer data, i.e. magnetic field information, the processor may determine whether the door is closed or open (as depicted in Fig. 1). Potentially, the processor may as well determine the door to be in an undefined state as explained above in more detail.

**[0041]** Optionally, the cylinder lock may comprise an angular position sensor 35 enabling to determine the angular position of the cylinder handle 20 relative to the cylinder housing 10 and/or the door leaf 100. In this example, the angular position sensor 35 can be an accelerometer as indicated by $\overset{\leftrightarrow}{a}$. The accelerometer enables to determine the orientation of the gravity vector and thus of the angular position of the cylinder handle 20.

**[0042]** Fig. 3 shows another preferred example of the cylinder lock 1. This example is almost identical to the example of Fig. 2 and the description of Fig. 1 can be read on Fig. 2 as well. Like the cylinder housing 10 of the cylinder 1 in Fig. 2, the cylinder housing in Fig. 3 is preferably a non magnetic (e.g. diamagnetic) material, e.g. of brass. Different from the cylinder housing 10 in Fig. 2, the cylinder housing 10 in Fig. 3 magnetically connects the threaded hole 16 with the cylinder housing's front end side 17 by inserts of magnetic material 19. The magnetic material is preferably paramagnetic, i.e. have a (volume) magnetic susceptibility $\chi_v$ greater than 0, i.e. $\chi_v > 0$. In practice the magnetic susceptibility $\chi_v$ of the magnetic material should be greater than those of air (and of the material the housing body is manufactured of. The magnetic material (hereinafter "insert", for short) can be e.g. a (para)magnetic steel rod. If steel rods are use, the body in addition reinforced rendering successful mechanical attacks against the cylinder lock less probable.

**[0043]** The inserts 19.1-19.3 are inserted and preferably secured in recesses 18 of the cylinder housing 10. In the example of Fig. 3, there are three recesses 18.1 to 18.3. A first recess 18.1 extends essentially parallel to the axis 2 from the front side 17 at least almost to the hole 16. There may remain a small amount of nonmagnetic material remaining between the dead end of the recess and the hole 16. Alternatively the recess 18.1 extends into the hole 16. At least almost perpendicular (±15 or better) to the first recess 18.1 is a second recess 18.2 extending from the bottom side 15 towards the axis 2. The closed end of the second recess 18.2 is connected to a third recess 18.3 extending again at least essentially parallel (±15° or better) to the axis 2 from the front side 17 to the end section of the second recess 18.2. In each recess is an insert 19.1-19.3. The inserts preferably contact is other mechanically. There may be gaps in between of the inserts 19.1 to 19.3, but these should be kept small to provide an essentially closed magnetic path. If a magnetic flux is coupled via a screw extending into (or through) the hole 16, at least a portion of the magnetic flux couples into the inserts and is literally conducted towards the handle 20. The magnetic field thus exits via the handle 20 facing side of the insert 19.3 and can be detected by the magnetometer 30 inside the handle. To improve said detection, the handle 20 may comprise a magnetic structure 29 being positioned between the magnetometer 30 and the front surface of the recess 19.1. The magnetic structure 29 so to speak picks up the magnetic field (lines) exiting the insert 19.3 and guides them to the magnetometer for detection. Other paths for guiding a magnetic flux from the hole 16 to the magnetometer may be realized as well.

**[0044]** Another example is depicted in Fig. 4. Again the description of Fig. 2 can be read on Fig. 4 as well. The example of Fig. 4 differs from the example in Fig. 3 (and Fig. 2) only in that the magnetic connection between the hole 16 and the magnetometer 30 is provided by a single insert 19 of an magnetic material, being positioned in a single recess 18 extending obliquely relative to the axis 2. The advantage of this example is that only a single recess 18 is and only a single insert 19 are required. The disadvantage comes in manufacturing, requiring to drill (or mill or otherwise provide) a recess in an oblique angle via the front side opening of the cylinder housing 10.

**[0045]** Another preferred example is depicted in Fig. 5 and again the description of Fig. 2 can be read on Fig. 5, as well: It differs from the examples of Fig. 3 and 4 in that it has two recesses 18.1 and 18.2, each housing an insert 19.1, 19.2, respectively for magnetically, connecting the whole 16 with the magnetometer. Compared to the example of Fig. 3, the magnetometer 30 has been moved into a shaft section of the handle. But of course the examples of Fig. 2 and 3 are not limited to the respective position of the magnetometer 30.

**[0046]** Fig. 6 shows an example of a striking plate 120. The striking plate 120 may be mounted as indicated to a door jamb of a door frame 110 and have at least one, preferably two recesses 121, 122 for receiving a dead bolt 51 and a latch 52. By attaching a permanent magnet 130 to the striking plate 120 or in the vicinity of the striking plate the change of the magnetic field at the position $\vec{r}$ of the magnetometer 30 in the examples of Fig. 2 to 5 can be detected more reliably and used by the processor to determine if the door leaf is open or closed with an enhanced accuracy. The magnet 130 is not necessary, but significantly reduces the computational effort for reliably determining if a door is opened or closed and thereby enhances the battery lifetime of the battery powering the cylinder lock. In addition the decision can be made quicker without using a more powerful, i.e. more expensive controller. For determining whether the door is open or closed the processor may use at least one of, the measured magnetic field strength $||\vec{B}(\vec{r})||$, the strength of at least one of the components of the magnetic field $\vec{B}_i$, wherein $i = x, y$ *or* $z$ and/r the direction $\vec{d}$ of the magnetic field $\vec{B}(\vec{r})$, which can be expresses a $\vec{d} = \vec{B}(\vec{r})/||\vec{B}(\vec{r})||$.

**[0047]** Fig. 7 shows a further example of a striking plate 120. Like the striking plate 120 in Fig. 6 it may be mounted as indicated to a door jamb of a door frame 110 and have at least one, preferably two recesses 121, 122 for receiving a dead bolt 52 and a latch 51. Attached to the striking plate 120 are two movable magnets 130.1 and 130.2 as example for movable portions of the striking plate. In practice, a single movable portion 130.1, 130.2 may be sufficient, but for illustrative purposes both are depicted. As apparent, the movable portions 130.1, 130.2 would block the recesses 121, 122, respectively, but they are movably supported enabling a latch and a dead bolt to simply pivot movable portions 130.1, 130.2 upwards. Thereby, the magnetic field in the vicinity of the corresponding cylinder lock is altered (i.e. the direction $\vec{d}$ of the magnetic field $\vec{B}(\vec{r})$ changes) and this alteration can be detected by a magnetometer of a cylinder lock, e.g. as depicted in FIGs. 2 to 5. In a preferred embodiment, both movable portions 130.1 and 130.2 are installed, but the respective magnets have a different strength. This enables to distinguish if the first movable portion 130.1, if the second movable portion or of both movable portions 130.1, 130.2 are pivoted upwards. In Fig. 7, the upper portions of the movable portions 130.1, 130.2 are indicated by a dashed line, to indicate that they are behind the striking plate 120. Accordingly, the shaft supporting the movable portions 130.1, 130.2 is as well indicated as dashed line.

**[0048]** In this application $\vec{B}(\vec{r})$ indicates the magnetic field in the door leaf's reference system at a position $\vec{r}$, i.e. a potential rotation of the magnetometer has been compensated. The non compensated magnetic field is referred to as $\vec{B}(\vec{r}, \phi)$, wherein $\phi$ indicates an angle of rotation of the magnetometer (and/or the handle 20). This angle $\phi$ can be determined by said angular position sensor 35. More generally $\phi$ is a vector as well, but in the depicted examples it is sufficient to compensate for a rotation of the magnetometer 30 around the axis 2 and can thus be represented as scalar.

**[0049]** If a striking plate with a magnet 130 (and/or with a rotatable portion 130.1., 130.2 comprising a magnet) is used, the magnetic field of the magnet is in most cases much stronger than the external magnetic field, e.g. the earth magnetic field or even fluctuating magnetic fields being produced by electrical apparatus in the vicinity of the door. Any change of these fields thus has a reduced if not negligible effect in distinguishing the door to open or closed based on the measurement data provided by the magnetometer. This effect is further enhanced if there is a magnetic path effectively connecting the magnet 130 with the magnetometer, e.g. via a magnetic mounting screw and at least one magnetic insert 19 (including 19.1 to 19.3).

**List of reference numerals**

**[0050]**

| | |
|---|---|
| 1 | cylinder lock |
| 2 | cylinder axis, rotational axis of cam 11 and cylinder handle 20 |
| 3 | rotation |
| 10 | cylinder housing (e.g. Euro cylinder housing) |
| 11 | cam |
| 12 | clutch |
| 13 | controller |
| 14 | authentication means, e.g. antenna, coil, fingerprint sensor, key-pad,... |
| 15 | bottom side |
| 16 | threaded hole |
| 17 | front end side of the cylinder housing 10 |
| 18.1 | first recess |
| 18.2 | second recess |
| 18.3 | third recess |
| 19 | magnetic material (e.g. paramagnetic or ferromagnetic) / insert |
| 19.1 | first insert |
| 19.2 | second insert |
| 19.3 | third insert |
| 20 | cylinder handle, briefly handle |
| 30 | magnetometer (e.g. 3-axis magnetometer) |
| 35 | angular position sensor |
| 50 | mortise lock |
| 51 | dead bolt |
| 52 | latch |
| 55 | mounting screw, cylinder screw, front end screw |
| 56 | door handle |
| 100 | door leaf |
| 110 | doorframe |
| 120 | striking plate |
| 121 | recess for dead bolt 51 |
| 122 | recess for latch 52 |
| 130 | magnet |
| 130.1 | first magnet / first movable portion |
| 130.2 | second magnet / second movable portion |

**Claims**

1. Method for determining the position of a door leaf (100) relative to a door frame (110), **characterized in that** the method comprises at least the steps of:

   - obtaining at least the spatial orientation of a magnetic field vector relative to a reference direction being defined in the door leaf's (110) coordinate system and/or the length of the magnetic field vector, and or at least one component of the magnetic field vector and or its length being attached to the door leaf (100) using at least a magnetic field sensor (35);
   - comparing the spatial orientation and/or the length of the magnetic field vector or of at least one of its components with at least a first or a second predetermined orientation and/or first or second predetermined length, respectively, to thereby determine if the door is open or closed, wherein the door is determined to be

     ◦ closed, if a first closed condition is met, wherein the first closed condition is met if the magnetic field vector points in a first predetermined direction and/or has a first predetermined length and/or at least one of its components has a first predetermined value,
     ◦ open, if a first open condition is met, wherein the first open condition is met if met if the magnetic field vector points in a second predetermined direction and/or has a second predetermined length and/or at least one of its components has a second predetermined value.

2. The method of claim 1, **characterized in that** it comprises determining the door leaf (100) to be in an undefined position if neither the closed nor the open condition is met.

3. The method of claim 1, **characterized in, that** it said obtaining comprises:

   - supporting the magnetic field sensor (35) by a rotatable portion of a door lock (1) being attached to the door leaf (100), wherein the rotatable portion is rotatable relative to the door leaf (100),
   - measuring the angle between the magnetic field sensor's coordinate system and the reference direction in the door leaf's coordinate system,
   - measuring the spatial orientation of the magnetic field at the position of the magnetic field sensor by the magnetic field sensor in the magnetic field sensor's coordinate system,
   - rotating the measured spatial orientation against said angle to thereby obtain the spatial orientation of the magnetic field at the position of the magnetic field sensor in the door leaf's coordinate system and/or rotating the reference direction as defined in the door leaf's coordinate

system by said angle to obtain the reference direction in the magnetic field sensor's coordinate system,
- determining the spatial orientation of the magnetic field relative to said reference orientation wherein both the spatial orientation and the reference orientation are either in the rotatable portion's coordinate system or both the door leaf's coordinate system,

and **in that** comparing step comprises:

- comparing the spatial orientation of the magnetic field relative to said reference orientation with the predetermined orientation wherein both the spatial orientation of the magnetic field relative to said reference orientation and the predetermined orientation are either in the rotatable portion's coordinate system or both the door leaf's coordinate system.

**4.** The method of one of claims 1 to 3, **characterized in, that** it further comprises a calibration sequence, said calibration sequence comprising:

- closing or opening the door,
- initializing a calibration mode of the door lock,
- obtaining at least the spatial orientation of a magnetic field relative to a reference direction being defined in the door leaf's coordinate system after the door was closed,
- assigning the predetermined orientation a vector being derived from said spatial orientation being obtained in said calibration mode while the door remained closed,

**5.** The method of claim 4, **characterized in that** it further comprises:

- measuring at least the absolute value of the acceleration of the door leaf (100) and
- skipping thee the assigning step, if the absolute value of the mean of the acceleration and/or the maximum of the absolute value of the acceleration in the time interval starting after closing of the door and ending with the end of the measurement of the obtaining step as defined in claim 4 exceed a threshold.

**6.** The method of one of the preceding claim, **characterized in that** it further comprises:

- Measuring the magnetic field strength at a position being defined in the door leaf's coordinate system,
- comparing the measured field strength with a first or a second reference field strength, to thereby determine if a second open or a second closed condition is met and determining the door to be

◦ closed, if the first and the second closed conditions are met, and
◦ open, if the first and the second opens conditions are met.

**7.** The method of one of the preceding steps, **characterized in that** it further comprises:

- Determining, while the door is being closed the acceleration of the door as a function of time and storing at least one value being indicative for the acceleration, and
- Subsequently, measuring the acceleration of the door as a function of time,
- Comparing the measured acceleration of the door with the at least one stored value, to thereby determine if a third open or a third closed condition is met, and determining the door to be

◦ closed, if the first and/or the second and/or the third closed conditions are met,
◦ open, if the first and/or the second and/or the third open conditions are met.

**8.** The method of one of the preceding steps, **characterized in that** it further comprises: monitoring the position of a dead bolt (51) and/or a latch (52) of a door lock being mounted to said door leaf (110) and performing the obtaining and comparing steps as defined in claim after the dead bolt (51) was advanced and/or after the latch (52) was blocked.

**9.** Door lock (1) for being mounted to a door leaf (100) comprising at least,

- a housing (1) rotatably supporting a transmission means (11)
- a rotatable handle (20) being supported by the housing (1),
- a clutch (12) for torque-proof coupling and decoupling the handle (20) with the transmission (11) and/or a lock housing (10),
- a controller (13),

**characterized in that** it further comprises a magnetometer (35) being connected via a data link with the controller, for providing measurement data relating to the magnetic field at the magnetometer's position to the controller (13).

**10.** Door lock (1) of claim 9, **characterized in that** the door lock further comprises an angular position sensor being torque proof connected to the magnetometer and being connected via a data link to the controller (13).

**11.** A striking plate (120) or a door jamb, comprising a plate having at least one recess (121, 122) being configured for receiving a dead bolt (51) and/or a latch (52) of a mortise lock (50), **characterized in that** at least one movable portion (130. 1, 130.2) comprising at least one magnet is movably supported by the striking plate (120) or the door jamb, respectively, enabling the movable portion (130.1, 130.2) and thus the magnet to be moved at least from a first positon to a second position, wherein in the first position, the movable portion (130.1, 130.2) blocks the recess (121, 122) and wherein in the second position, the recess (121, 122) is clear.

**12.** The striking plate of claim 11, **characterized in that**, the movable portion (130.1, 130.2) has a center of gravity being moved upwards, when moving the movable (130.1, 130.2) portion from its first position into it second position.

**Amended claims in accordance with Rule 137(2) EPC.**

**1.** Method for determining the position of a door leaf (100) relative to a door frame (110), wherein the method comprises at least the steps of:

- obtaining at least the spatial orientation of a magnetic field vector relative to a reference direction being defined in the door leaf's (110) coordinate system and/or the length of the magnetic field vector, and or at least one component of the magnetic field vector and or its length being attached to the door leaf (100) using at least a magnetic field sensor (35);
- comparing the spatial orientation and/or the length of the magnetic field vector or of at least one of its components with at least a first or a second predetermined orientation and/or first or second predetermined length, respectively, to thereby determine if the door is open or closed, wherein the door is determined to be

◦ closed, if a first closed condition is met, wherein the first closed condition is met if the magnetic field vector points in a first predetermined direction and/or has a first predetermined length and/or at least one of its components has a first predetermined value,
◦ open, if a first open condition is met, wherein the first open condition is met if met if the magnetic field vector points in a second predetermined direction and/or has a second predetermined length and/or at least one of its components has a second predetermined value.

- executing a calibration sequence, the calibration sequence comprising:

◦ closing the door,
◦ initializing a calibration mode of the door lock,
◦ obtaining at least the spatial orientation of a magnetic field relative to a reference direction being defined in the door leaf's coordinate system after the door was closed,
◦ assigning the predetermined orientation a vector being derived from said spatial orientation being obtained in said calibration mode while the door remained closed,

**characterized in that** the calibration sequence further comprises

- measuring at least the absolute value of the acceleration of the door leaf (100) and
- skipping thee the assigning step, if the absolute value of the mean of the acceleration and/or the maximum of the absolute value of the acceleration in the time interval starting after closing of the door and ending with the end of the measurement of the obtaining step as defined in claim 4 exceed a threshold.

**2.** The method of claim 1,
**characterized in that** it comprises determining the door leaf (100) to be in an undefined position if neither the closed nor the open condition is met.

**3.** The method of claim 1,
**characterized in, that** it said obtaining comprises:

- supporting the magnetic field sensor (35) by a rotatable portion of a door lock (1) being attached to the door leaf (100), wherein the rotatable portion is rotatable relative to the door leaf (100),
- measuring the angle between the magnetic field sensor's coordinate system and the reference direction in the door leaf's coordinate system,
- measuring the spatial orientation of the magnetic field at the position of the magnetic field sensor by the magnetic field sensor in the magnetic field sensor's coordinate system,
- rotating the measured spatial orientation against said angle to thereby obtain the spatial orientation of the magnetic field at the position of the magnetic field sensor in the door leaf's coordinate system and/or rotating the reference direction as defined in the door leaf's coordinate

system by said angle to obtain the reference direction in the magnetic field sensor's coordinate system,
- determining the spatial orientation of the magnetic field relative to said reference orientation wherein both the spatial orientation and the reference orientation are either in the rotatable portion's coordinate system or both the door leaf's coordinate system,

and **in that** comparing step comprises:

- comparing the spatial orientation of the magnetic field relative to said reference orientation with the predetermined orientation wherein both the spatial orientation of the magnetic field relative to said reference orientation and the predetermined orientation are either in the rotatable portion's coordinate system or both the door leaf's coordinate system.

**4.** The method of one of the preceding claims, **characterized in that** it further comprises:

- Measuring the magnetic field strength at a position being defined in the door leaf's coordinate system,
- comparing the measured field strength with a first or a second reference field strength, to thereby determine if a second open or a second closed condition is met and determining the door to be

◦ closed, if the first and the second closed conditions are met, and
◦ open, if the first and the second opens conditions are met.

**5.** The method of one of the preceding claims, **characterized in that** it further comprises:

- Determining, while the door is being closed the acceleration of the door as a function of time and storing at least one value being indicative for the acceleration, and
- Subsequently, measuring the acceleration of the door as a function of time,
- Comparing the measured acceleration of the door with the at least one stored value, to thereby determine if a third open or a third closed condition is met, and determining the door to be

◦ closed, if the first and/or the second and/or the third closed conditions are met,
◦ open, if the first and/or the second and/or the third open conditions are met.

**6.** The method of one of the preceding claims, **characterized in that** it further comprises: monitoring the position of a dead bolt (51) and/or a latch (52) of a door lock being mounted to said door leaf (110) and performing the obtaining and comparing steps as defined in claim 1 after the dead bolt (51) was advanced and/or after the latch (52) was blocked.

**7.** Door lock (1) for being mounted to a door leaf (100) comprising at least,

- a housing (1) rotatably supporting a transmission means (11)
- a rotatable handle (20) being supported by the housing (1),
- a clutch (12) for torque-proof coupling and decoupling the handle (20) with the transmission (11) and/or a lock housing (10),
- a controller (13),
- a magnetometer (35) being connected via a data link with the controller, for providing measurement data relating to the magnetic field at the magnetometer's position to the controller (13),

**characterized in that** the door lock is configured to execute the method of one of the preceding claims..

**8.** Door lock (1) of claim 7, **characterized in that** the door lock further comprises an angular position sensor being torque proof connected to the magnetometer and being connected via a data link to the controller (13).

Fig. 1

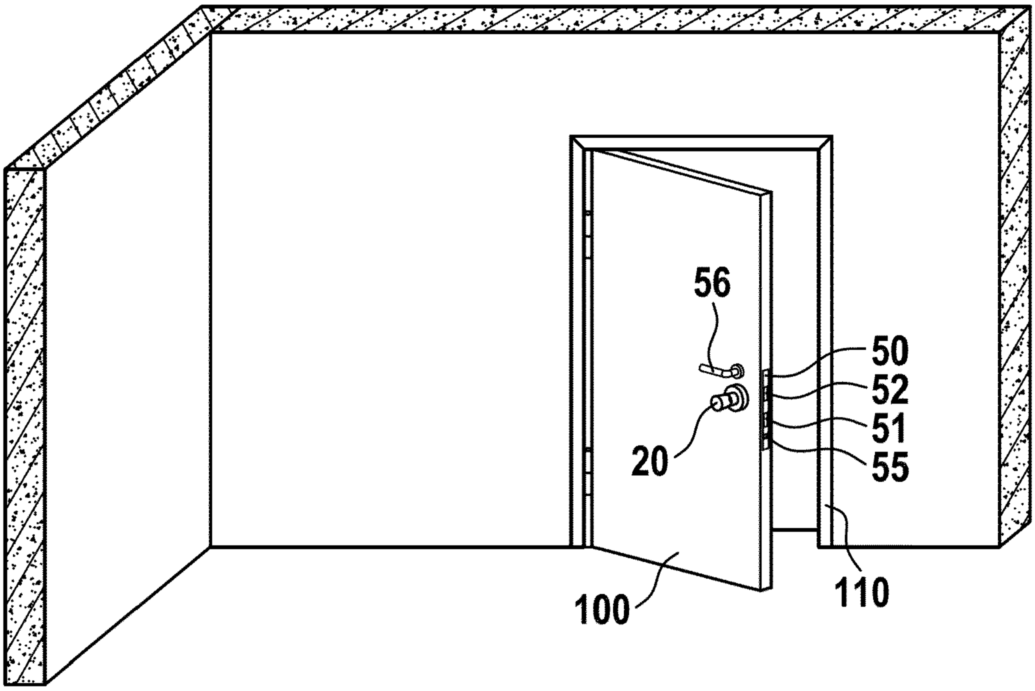



Fig. 2

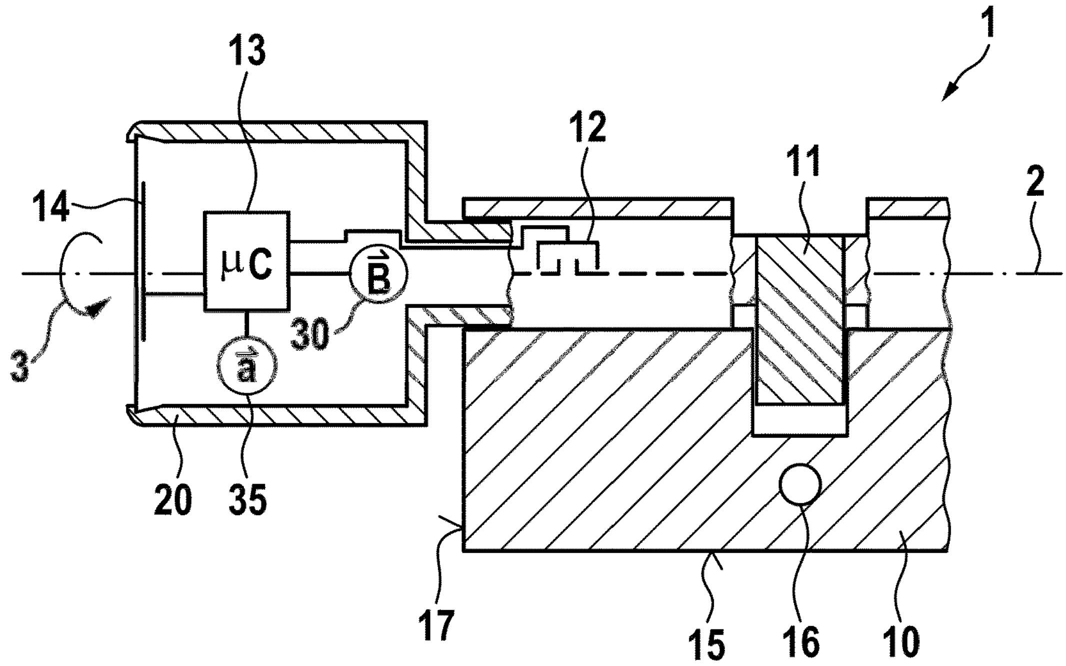
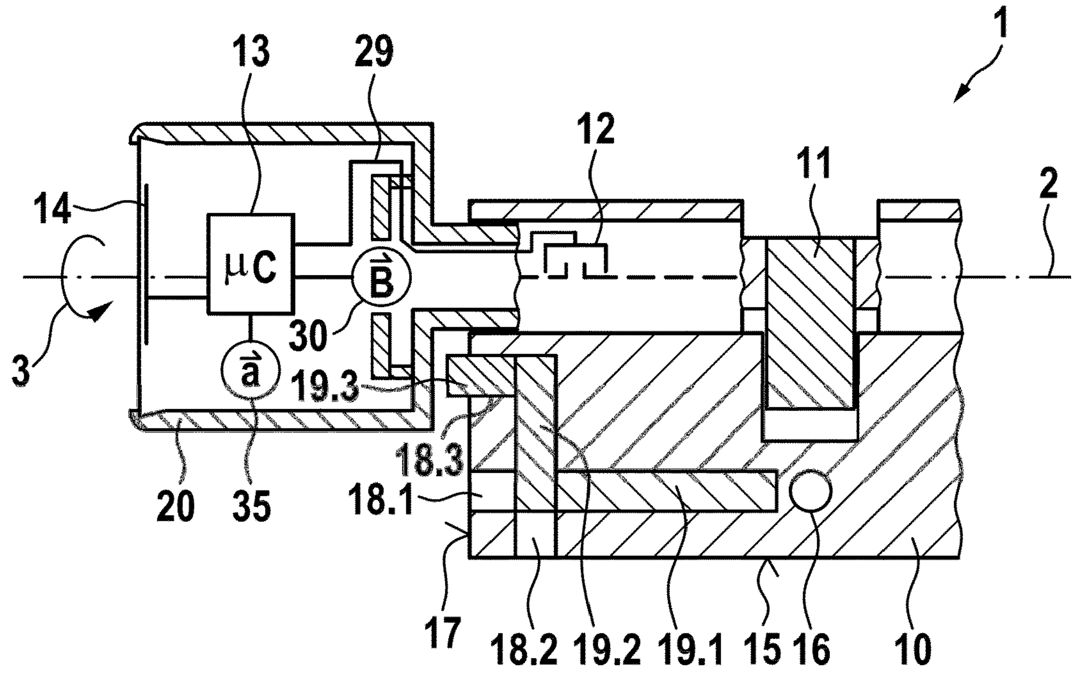


Fig. 3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13
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11
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μC
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30
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a
19.3
18.3
18.1
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18.2
19.2
19.1
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10

Fig. 4

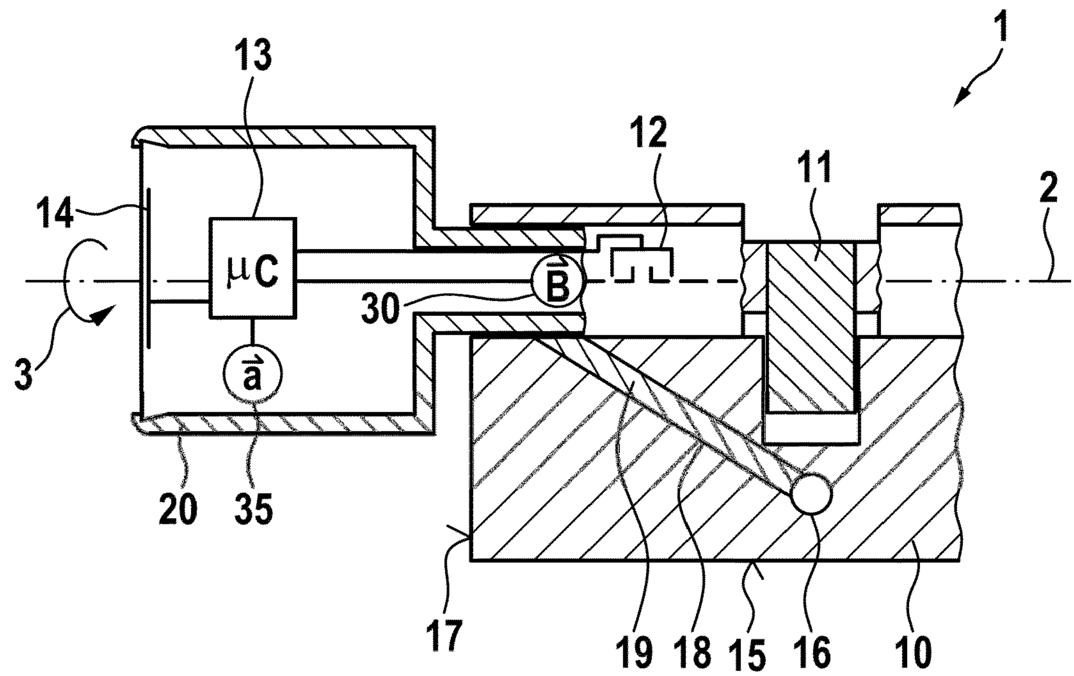
1
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Fig. 5

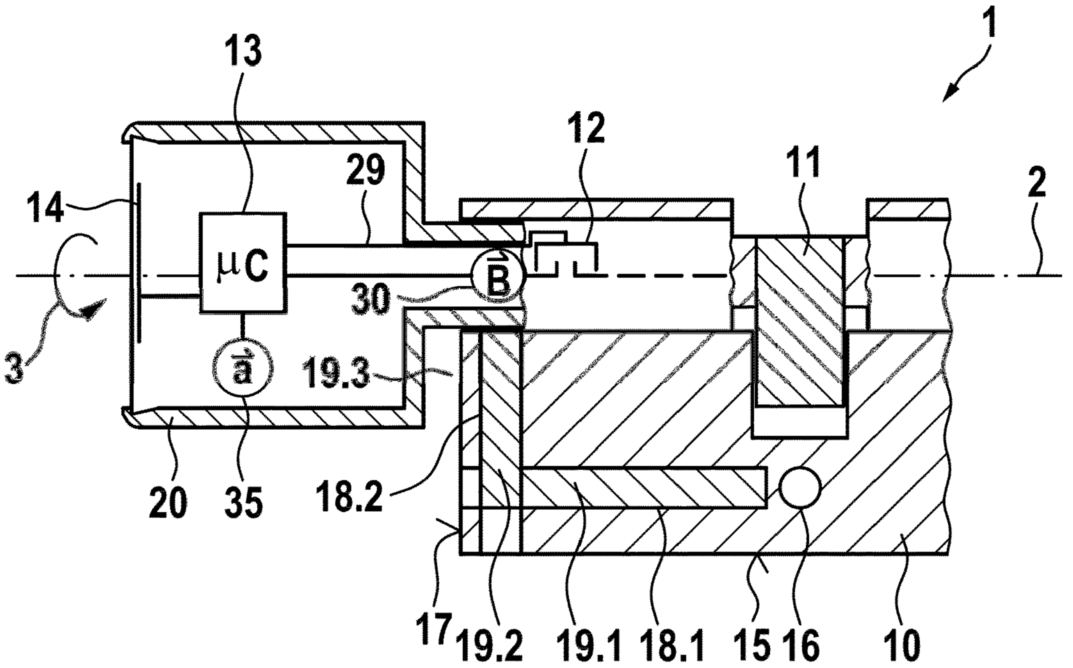



Fig. 6

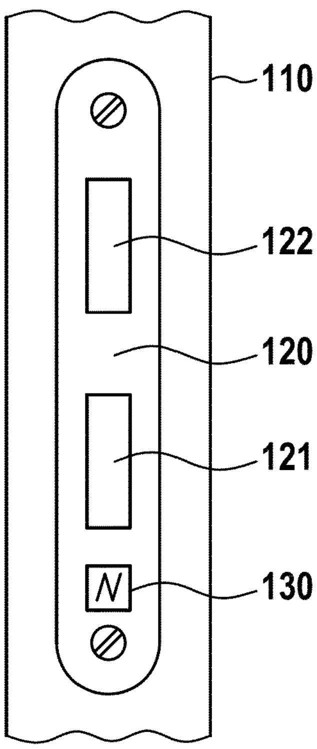
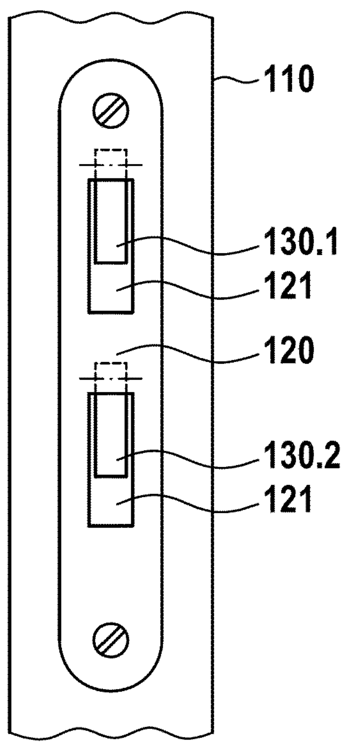



Fig. 7



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# EUROPEAN SEARCH REPORT

Application Number
EP 17 20 8059

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
| X<br>A | WO 2014/154738 A1 (MICROHARD SRL [IT]) 2 October 2014 (2014-10-02)<br>* the whole document * | 1,3,4, 6-10<br>5 | INV.<br>E05B45/08<br>E05B47/06<br>E05B47/00 |
| X | WO 2011/141056 A1 (EIDEBENZ TINO [DE]) 17 November 2011 (2011-11-17)<br>* the whole document * | 1,3,6-10 | |
| X | US 2016/187368 A1 (MODI YASH [US] ET AL) 30 June 2016 (2016-06-30)<br>* paragraph [0020] - paragraph [0021]; figures 1-7 *<br>* paragraph [0030] - paragraph [0032] *<br>* paragraph [0034] - paragraph [0036] * | 1,2,4, 6-8 | |
| X | US 2015/330140 A1 (KINCAID RYAN C [US] ET AL) 19 November 2015 (2015-11-19)<br>* the whole document * | 1,4,6,8 | |
| X | US 2017/193724 A1 (JOHNSON JASON [US] ET AL) 6 July 2017 (2017-07-06)<br>* paragraph [0547] - paragraph [0569]; figures 39-42 * | 1,4,6-8 | TECHNICAL FIELDS SEARCHED (IPC)<br>E05B |
| X | US 2016/290005 A1 (GOLDENSON ANDREW W [US]) 6 October 2016 (2016-10-06)<br>* paragraphs [0006], [0007], [0022]; figures 1-5 * | 1,4,6, 11,12 | |
| A,D | DE 10 2004 056988 B4 (SIMONSVOSS TECHNOLOGIES AG [DE]) 6 December 2012 (2012-12-06) | 9 | |

The present search report has been drawn up for all claims

2

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| The Hague | 24 April 2018 | Viethen, Lorenz |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

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Application Number

EP 17 20 8059

## CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

- [ ] Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

- [ ] No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

## LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

- [ ] All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

- [X] As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

- [ ] Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

- [ ] None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

- [ ] The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

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# LACK OF UNITY OF INVENTION SHEET B

Application Number
EP 17 20 8059

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-12

   Method to monitor

1.1. claims: 1-10

   Method to determine door position by magnetic field and door lock for using the method

1.2. claims: 11, 12

   Method for determining bolt position and striker for using the method

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Please note that all inventions mentioned under item 1, although not necessarily linked by a common inventive concept, could be searched without effort justifying an additional fee.

## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 17 20 8059

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

24-04-2018

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| WO 2014154738 A1 | 02-10-2014 | EP 2978913 A1 | 03-02-2016 |
| | | KR 20150133834 A | 30-11-2015 |
| | | US 2016054148 A1 | 25-02-2016 |
| | | WO 2014154738 A1 | 02-10-2014 |
| WO 2011141056 A1 | 17-11-2011 | EP 2569496 A1 | 20-03-2013 |
| | | WO 2011141056 A1 | 17-11-2011 |
| US 2016187368 A1 | 30-06-2016 | US 2016187368 A1 | 30-06-2016 |
| | | WO 2016109446 A1 | 07-07-2016 |
| US 2015330140 A1 | 19-11-2015 | CA 2949071 A1 | 19-11-2015 |
| | | US 2015330140 A1 | 19-11-2015 |
| | | US 2018038159 A1 | 08-02-2018 |
| | | WO 2015175697 A1 | 19-11-2015 |
| US 2017193724 A1 | 06-07-2017 | NONE | |
| US 2016290005 A1 | 06-10-2016 | US 2016290005 A1 | 06-10-2016 |
| | | US 2017226774 A1 | 10-08-2017 |
| DE 102004056988 B4 | 06-12-2012 | NONE | |

EPO FORM P0459

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

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description

- EP 1842989 B1 **[0002]**
- US 95636510 B **[0002]**
- EP 280755 B1 **[0002]**
- EP 575660 A **[0002]**
- DE 10235201 **[0005]**
- DE 19603320 **[0005]**
- EP 976896 B1 **[0005]**
- DE 102013100484 **[0005]**
- DE 9004675 U1 **[0005]**
- DE 10235201 B4 **[0038]**
- DE 102004056988 B4 **[0038]**
- EP 1953314 B1 **[0038]**
- DE 102013104366 **[0038]**
- EP 978611 B1 **[0038]**