

**Title: SENSOR DEVICE HAVING ROTATIONAL
 DIRECTION DETECTION**

Description

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The invention relates to a sensor device, in particular for rotary knobs of electronic, respectively electro-mechanic knob cylinders.

10 It is known to utilize electronic systems, respectively elements of rotary knobs of knob cylinders during their operation to activate an actuator, which is accommodated in an associated profile cylinder of a leaf lock, respectively to rotationally-operatively connect a lock bit of the profile cylinder to the rotary
15 knob. Once the operation ends, the actuator is switched off. Typically the operation is realized contact-less, for example by means of a code card by way of example in the shape of a transponder card, which is placed on a reader of the rotary knob or is held close to the reader and includes authorization
20 data. The reader will read said data and check whether or not there is an authorization allowing to open the respective leaf. If the check is successful, the actuator is activated, respectively energized and the leaf can be unlocked and opened by means of the rotary knob.

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It is now problematic to be able to recognize when the door is unlocked or (again) locked, in order to be able to cancel again the activation of the rotary knob, respectively the operation of the actuator.

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Rotary knobs offer only very little space, so an incremental encoder cannot be installed in a space-saving manner. In addition, the slotted discs have the disadvantage of becoming soiled, whereby the operating safety can be compromised. Last
10 but not least a relative complicated data analysis is required in order to detect the rotational direction of the slotted disc.

The object of the invention is to at least reduce the shortfalls of the state-of-the-art.

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This problem is solved by the subject matter of the claims 1 and 6. Advantageous further developments of the invention are set forth in the dependent claims.

20 An inventive sensor device is adapted to be partially inserted into a rotary knob of a knob cylinder. The device includes at least one pair of sensors and a counter-element. Said counter-element and the at least one pair of sensors are disposed to be movable with regard to each other along an essentially circular
25 displacement path, for example via a transmission. In other words, the counter-element or the respective pair of sensors

may be stationarily disposed, while correspondingly the respective pair of sensors respectively the counter-element is moved along the circular displacement path, namely along a respective circle perimeter. The counter-element and the
5 sensors are located opposite each other in such a way that the detection areas of the sensors respectively include a partial area of the displacement path and partially overlap each other in the area of the displacement path. In other words, each sensor detects a pre-determined area of the displacement path,
10 the two areas thus share one partial area. The displacement path is partially located outside the detection areas of the at least one pair of sensors. In other words, the detection areas of both sensors do not detect the whole displacement path. This is why the counter-element “moves” consecutively through the
15 detection areas of the at least one pair of sensors. By way of example, at first the counter-element reaches the partial detection area of only one sensor, thereupon it reaches the overlapping area of both sensors, then the partial detection area now of the other sensor, and thereupon it reaches an area
20 which none of the sensors detects. This procedure allows to detect in which direction the movement happens. In addition, backward and forward movements can be detected, and this can be done with simple means requiring little space. By establishing several sensor detection areas, the counter-
25 element does not have to include filigree structures for the sensor functioning, like those in a slotted disc.

Preferably, the sensors are configured by means of GMR sensors. In other words, the counter-element is magnetic, respectively electrically magnetized for example. In a simple manner, this circumstance allows for being able to utilize the electric resistance of the sensors as a measured value. In addition, the relative movement of the counter-element with regard to the sensors effects relatively important changes of the electrical resistance of the sensors, which allows for a simple evaluation circuit.

Furthermore, the inventive sensor device preferably presents such an evaluation circuit. Based on sensor signals, which are output by the at least one pair of sensors, the evaluation circuit is adapted to detect when the counter-element moves past each sensor. It is thereby detectable in which partial detection area the counter-element is located, or if it is located outside the detection areas.

The evaluation circuit detects the passing movement preferably in that it XOR concatenates the sensor signals to each other. In other words, the evaluation circuit always detects when another counter-element "enters" or leaves a partial detection area. This is a particularly simple and inexpensive solution.

The passing movement is preferably detected in that the evaluation circuit delays a signal, which is formed by means of the XOR concatenated sensor signals, by a pre-determined value as a delay signal, and XOR concatenates the formed
5 signal to the delay signal. An entire output signal can thereby be generated, which just includes level change pulses instead of longer phases with a changed level. This circumstance is advantageous in that a potential downstream control of the knob cylinder is activated for a considerably shorter period of
10 time, namely just during the short pulses, which has an energy-saving effect.

An inventive rotary knob is disposed to be freely rotatable with regard to a locking bit of a profile cylinder. In addition the knob
15 can be operated in order to energize an actuator, which thereupon rotationally-operatively connects the rotary knob to the locking bit, such that, during rotation, the rotary knob will move along the locking bit. The rotary knob has a reader, which is adapted to read data of an access data carrier, such as a
20 code card. Finally, the rotary knob includes a portion of the above-described sensor devices. In other words, with the exception of the sensor device, the rotary knob remains almost untouched. The actuator may be for example a motor or a linear solenoid, which is coupled to a coupling mechanism, which,
25 when the actuator is being energized, is operated in such a way that the above-mentioned rotational connection is established.

Preferably in an active mode, the reader is connected, such as to be able to read the data of an access data carrier. However, in an inactive condition, the reader will be switched off such as to be (no longer) able to read the data of an access data carrier of a person, such as for example a code card, which includes biometric data, respectively the memorized access code (mental characteristics) as the access data. Thus, in the inactive mode the reader does not use any or merely any energy. According to the invention, the sensor device comprises the above-mentioned evaluation circuit. Said circuit is adapted to trigger the connection of the read device, once the evaluation circuit has detected the counter-element moving past one of the sensors. In other words, the sensor device is able to fulfil two tasks, on the one hand, detecting the direction of movement and, on the other hand, just detecting the rotational movement in general, and all this without any expensive logic system.

For this purpose, the evaluation circuit preferably comprises an XOR element (exclusive OR), to which the sensor signals are input, and the output signal thereof is input to the reader or to a control system, which activates the reader. In other words, conventional inexpensive standardized components can be utilized, which is cost-effective.

Furthermore, the evaluation circuit preferably includes a time delay element, to which the output signal of the above mentioned one XOR element is input. In addition, the circuit includes another XOR element, to which the output signal of the one XOR element and one output signal, formed by the delay
5 element, is input. The output signal of said other XOR element in turn is input to the reader, respectively to the control system thereof.

10 The above mentioned counter-element or the at least one pair of sensors is preferably disposed to be stationary, thus it is preferably not moved in relation to the entire rotary knob. In the simplest case, the counter-element, respectively said pair of sensors is disposed at the profile cylinder or is integral with said
15 cylinder. Correspondingly, when rotating the rotary knob, said pair of sensors, respectively the counter-element is disposed to move along the displacement path by the rotary knob. Preferably said pair of sensors, respectively the counter-element is therefore disposed at the rotary knob or integral with
20 the rotary knob. In other words, the sensor can be incorporated in a simple and space-saving manner.

Further features and advantages of the invention will become apparent from the following description of preferred embodiments, in which:

5 Figure 1 shows two views of a knob cylinder according to an embodiment of the invention,

Figure 2 shows curves of sensor signals,

10 Figure 3 shows an extension of the knob cylinder of Figure 1,
and

Figure 4 shows an extension of Figure 3.

15 Figure 1 shows two views of a knob cylinder 100 as a component of a lockable leaf lock, and namely only the components, which are relevant for the invention.

According to Figure 1a, the knob cylinder 100 comprises a
20 profile cylinder 110 with a freely rotatable locking bit 111 and a forend hole 112. A rotary knob 120 is affixed to one end of the profile cylinder 110. Said knob is provided with a reader 121, which, for a contact-less contacting, is coupled to a non-illustrated access data carrier with an antenna 122.
25 Furthermore, a preferably visual indication device 124 is configured by way of example in the shape of a luminous ring.

Finally, an independent energy supply in the shape of a battery 123 or of an accumulator is accommodated in the rotary knob 120.

- 5 As illustrated in Figure 1b, the rotary knob 120, at its side oriented towards the profile cylinder 110, includes four sensors 125, preferably in the shape of GMR sensors. The sensors 125 are disposed such that the detection areas 126 of the individual sensors 125, represented by the hatched areas, partially
10 overlap each time for each pair, represented by the cross-hatched areas.

Corresponding thereto, the profile cylinder 110, at its side oriented towards the rotary knob 120, presents elements, in this
15 case in the shape of two magnets 113, which can be detected by the sensors 125.

If the rotary knob 120 is turned, the sensors 125 follow a respective, advantageously the same circular trajectory, the
20 centre thereof being the rotary axis of the rotary knob. This circumstance results in the detection areas 126 of the individual sensors 125 alternately moving past one of the magnets 113. One of the respective sensors 125 is thereby able to detect when the respective magnet 113 enters or leaves the
25 associated detection area 126. Based thereupon, each sensor 125 outputs a corresponding signal.

The signals of, preferably, all sensors 125, however at least of one pair of sensors 125, namely of two sensors of detection areas 126 partially overlapping each other, are transmitted to a data processing logical system, for example a processor.

Preferably the sensor signals will be, respectively are digitized.

By way of example for the upper pair of sensors 125, a sensor signal S1 is associated to the left sensor 125, whereas a sensor signal S2 is associated to the right sensor 125.

Figure 2 indicates different curves for the sensors signals S1, S2.

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If the magnet 113 is located outside the detection areas 126 of both sensors 125, the two signals S1, S1, as shown in Figure 2a, have a low level. If the magnet 113 enters the detection area 126, by way of example of the sensor 125, shown on the upper left side in Figure 1b, the associated signal (in this case S1) changes to a high level. The other signal remains at a low level. If the rotary knob 120 continues to be turned, the magnet 113 enters the overlapping area of both detection areas 126, and the second signal as well (in this case S2) changes to the high level. Upon further rotating the rotary knob 120, at one point the magnet 113 leaves the overlapping area and remains

in the detection area 126 of the other one of the two sensors, namely of the sensor 125 on the right upper side in Figure 1b. Once the magnet leaves this detection area 126 as well, both signals S1, S2 change again to the low level. Figure 2a
5 illustrates three consecutively realized rotations of the rotary knob 120. In this case, the duration of the high and low level phases depends on the rotating speed of the rotary knob 120.

If the rotary knob 120 is rotated in the opposite direction, the
10 course of the signals will be like illustrated in Figure 2b. This circumstance is apparent in that now the signal S2 reaches and leaves the high level earlier than the signal S1.

Figure 2c shows the case in which the rotary knob 120 is not
15 continuously turned in one direction. Instead, shortly after leaving the detection area 126 of the sensor 125 associated to the signal S1, the rotary knob 120 is turned back such as to re-enter the detection area 126 of said sensor 125 without having reached already the detection area 126 of the sensor 125
20 associated to the signal S2. The resulting signal courses clearly reflect this operation.

According to Figure 2d, the rotary knob 120 is turned back
before even leaving the detection area 126 of the other sensor
25 125, because two high level phases of the signal S2 overlap with one and the same high level phase of the sensor signal S1.

And the resulting signal courses clearly reflect again this operation.

5 The inventive arrangement is thus not only able to detect the direction of rotation but also a change in the direction of rotation, without requiring any expensive logic processing system.

10 If the rotary knob 120 is activated, namely rotationally-operatively connected to the locking bit 111, the unequivocal signal curves allow for easy determination whether or not the rotary knob 120 has been rotated in the direction of unlocking or locking of the non-illustrated leaf lock, and thus if the connected leaf should be unlocked or locked. Furthermore, the number of
15 rotations of the rotary knob can be taken as a basis. It may be provided that, if the verification of the access data is successful, a user needs to turn the rotary knob twice in the unlocking direction prior to the rotary knob releasing the rotational operative connection.

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Figure 3 shows an extension of the knob cylinder 100.

According to Figure 3a, the sensor signals S1, S2 are input to an XOR element or to an XOR gate 101. The output signal A
25 thereof is input to a control system 102. If the signal A has reached the high level and the rotary knob 120 is not activated,

the control system 102 has the function for example to activate the reader 121, namely to connect it or to switch it on, either immediately or after the output signal A exceeds a pre-determined number of high level phases. In other words, a
5 person, who would like to open a door for example, is able to activate the reader 121 by simply turning the rotary knob 120. Preferably when activating the reader 121, the indication device 124 is activated such as to radiate yellow light, in order to indicate its readiness to read.

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Figure 3b shows the curves of the output signal A with respect to the curves of the sensor signals S1, S2 illustrated in Figure 2.

The control system 102 is able to recognize with this
15 arrangement when the magnet 113 "enters" or leaves a respective (partial) detection area 126.

Figure 4 shows an extension to the arrangement shown in Figure 3a. In this case, a delay element 103, configured by means of a dead-time element, and a second XOR element 101
20 are connected in series between the XOR element 101 and the control system 102. In addition to the output signal A of the first XOR element 101 a signal V, which corresponds to the output signal A, is input to the second XOR element 101, with the
25 difference that the curve thereof is offset by a pre-determined

period of time Δt by means of the delay element 103. The following is valid for the point in time t : $V(t) = A(t - \Delta t)$.

The output signal S of the second XOR element 101 resulting
5 thereof is now input as the signal S into the control system 102.
The delayed signal V together with the second XOR element
101 serves the purpose of modifying a signal A , having
relatively long high level phases, into a signal S having
relatively short high level phases. In other words, signals having
10 very short high-level pulses can be input into the control
system 102.

The duration of time Δt is determined in that the downstream
control system 102 is able to continue to reliably detect each
15 pulse even at minimum pulse width.

Figure 4b shows the curve of the signals S_1 , S_2 , A , V , and S for
the curves of the signals S_1 , S_2 according to Figure 2a. In this
case again, the time delay Δt between the signals A , V is clearly
20 recognizable.

The invention is not limited to the above-described
embodiments.

25 It may be intended for example to illustrate the condition of the
sensor signals S_1 , S_2 . For this purpose, the indication device

124 is provided by way of example with a multi-coloured lighting device, for example in the shape of a RGB LED. The LED does not radiate if both signals S1, S2 are on a low level. If S1 changes its condition to a high level, the LED radiates red light.
5 If the other signal S2 changes to a high level as well, the LED will radiate blue light. Now, if the signal S1 loses its high level (again), the LED radiates green light.

As an alternative or in addition to such a visual indication device, an audible indication may be provided, which may emit
10 a special audible signal for each condition of the sensor signals S1, S2.

The rotary cylinder 100, respectively the rotary knob 120
15 thereof includes preferably three operative conditions:

- Sleep mode: only the sensors 125 are active
- authorization or read mode: the reader 121 is connected;
20 the sensors 125 are possibly inactive
- active mode: the rotary knob 120 is activated; the reader 121 is
25 possibly switched off again.

In the sleep mode, only one sensor 125 may be activated, in order to activate the reader 121.

5 In the active mode as well the sensors 125 may be activated, in order to be able for example, during continuous activation of the rotary knob 120, to perform evaluations on the door-opening frequency and the like.

10 If the rotary knob 120 is activated, it is preferably intended the sensors 125 remain activated. It is thereby possible to correspondingly prolong the time of activation of the rotary knob 120 by means of turning the rotary knob 120. Furthermore, it may be intended to effect an unlocking of the leaf, after detecting that the rotary knob 120 has performed a pre-determined number of rotations (for example: two).

Furthermore, it may be intended to switch off the rotary knob 120 and preferably also the sensors 125 for a pre-determined period of time.

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The amount of pairs of sensors 125 is not limited. It is possible for example to dispose three sensors 125, the detection areas 126 thereof partially overlapping each other pair by pair. Altogether the three detection areas 126 may be able to detect
25 the entire displacement path, but just not the overlapping detection areas 126 located next to each other pair by pair.

The amount of magnets 113 is not limited either.

5 The respective magnet 113 may be configured as a permanent magnet or else as a solenoid.

10 The sensors 125 may be based on visual, haptic, sound or on any other kind. The magnet 113 is realized by means of a counter-element belonging to the sensor 125 for actuating the sensor.

The sensors 125 and the magnets 113 may be exchanged for each other.

15 In addition or as an alternative, the sensors 125 may serve to wake up, respectively to activate the reader 121. In other words, the user needs to first rotate the rotary knob 120 before an access data carrier can be read at all.

20 It is likewise possible to realize specific modes of operation, such as emergency opening in that the rotary knob 120 needs to be rotated in a specific manner, which operation will easily be recognized by the inventive sensor device.

As a result, the invention offers a very simply configured and space-saving solution for detecting a rotary movement of preferably the rotary knob 120 of a knob cylinder 100.

List of reference numerals

	110	knob cylinder
	111	XOR element
5	112	control system
	113	delay element
	110	profile cylinder
	111	locking bit
	112	forend hole
10	113	magnetic part
	120	rotary knob
	121	reader
	122	antenna
	123	energy supply
15	124	indication device
	125	sensor
	126	detection area
	A	output signal
20	S	control signal
	S1, S2	sensor signal
	V	delay signal
	Δt	time delay

Patent claims

1. A sensor device,
 - adapted to be partially inserted into a rotary knob
5 (120) of a knob cylinder (100),
 - including
 - at least one pair of sensors (125), and
 - a counter-element (113),
 - wherein the counter-element (113) and the at least
10 one pair of sensors (125)
 - are disposed to be movable in relation to each other along an essentially circular displacement path, and
 - are located opposite each other in such a way
15 that detection areas (126) of the sensors (125)
 - respectively comprise a partial area of the displacement path, and
 - partially overlap each other in the area of the displacement path,
 - wherein the displacement path is partially located
20 outside the detection areas (126) of the at least one pair of sensors (125).
2. The device according to claim 1, wherein
 - 25 • the sensors (125) are configured by means of GMR sensors (125), and

- the counter-element (113) is magnetized.
3. The device according to claim 1 or 2, furthermore including an evaluation circuit (101; 101, 103, 101) which is adapted, based on sensor signals (S1, S2) which are output by at least one pair of sensors (125), to detect the passing counter-element (113) at each sensor (S1, S2).
 4. The device according to claim 3, wherein the evaluation circuit (101; 101, 103, 101) detects the passing movement in that it XOR concatenates the sensor signals (S1, S2).
 5. The device according to claim 4, wherein the evaluation circuit (101, 103, 101) detects the passing movement in that it
 - delays a signal (A) formed by means of the XOR concatenation of the sensor signals (S1, S2) by a pre-determined value (Δt) as a delay signal (V), and
 - XOR concatenates the formed signal (A) to the delay signal (V).
 6. A rotary knob (120),
 - disposed to be freely rotatable with regard to a locking bit (111) of a profile cylinder (110),

- able to be activated in such a way that the rotary knob (120) energizes an actuator for the duration of the activation in that the rotary knob (120) is rotationally-operatively connected to the locking bit (111), and
- including
 - a reader (121), adapted to read data of an access data carrier, and
 - a sensor device according to one of the preceding claims.

7. The rotary knob (120) according to claim 6, wherein
- the reader (121)
 - is connected in an active mode, such as to be able to read the data of an access data carrier, and
 - is switched off in an inactive mode, such as not to be able to read the data of an access data carrier,
 - the sensor device is configured according to one of the claims 3 to 5, and
 - the evaluation circuit (101; 101, 103, 101) is adapted to trigger connecting the reader (121), if the evaluation circuit (101; 101, 103, 101) has detected a passing counter element (113) at one of the sensors (125).

8. The rotary knob (120) according to claim 7, wherein the evaluation circuit (101) comprises an XOR element (101), to which the sensor signals (S1, S2) are input, and the output signal (A) thereof is input to the reader (121) or to a control system (102) activating the reader (121).
9. The rotary knob (120) according to claim 8, wherein the evaluation circuit (101, 103, 101) furthermore
- includes a time delay element (103) to which the output signal (A) of the one XOR element (101) is input, and
 - includes another XOR element (101),
 - to which the output signal (A) of the one XOR element (101) and an output signal (V) formed by the delay element (103) are input, and
 - the output signal (S) thereof is input to the reader (121), respectively to the control system (102).
10. The rotary knob (120) according to one of the claims 6 to 9, wherein
- the counter-element (113) or the at least one pair of sensors (125) is disposed to be stationary, and
 - when rotating the rotary knob (120), the at least one pair of sensors (125), respectively the counter-

element (113) is disposed to be moved along the displacement path by the rotary knob (120).