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

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(54) **SMART LOCK HAVING AN ELECTROMECHANICAL KEY**

(57)   The invention concerns a locking mechanism
(10) configured to equip an opening unit and to switch
from a locked state to an unlocked state, comprising a
processor (15) configured to read an identification code
(12) of an identification key (11) and configured to cause
the locking mechanism to switch from the locked state
to the unlocked state if the identification code (12) of the
at least one identification key (11) is an authorized code
(13) of the locking mechanism, a key hole shaped to ac-
cept insertion of a physical identification key (11), a me-
chanical actuation lever (14) configured to be moved to
switch between a closed configuration of the opening unit
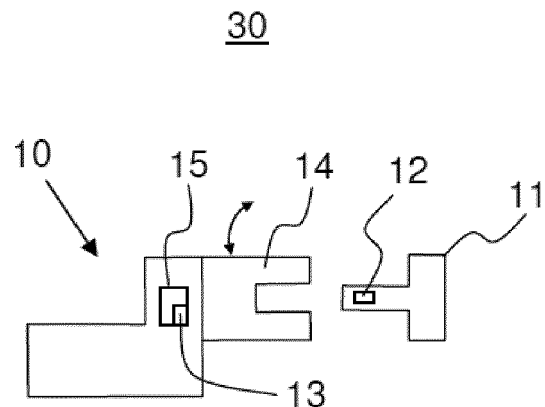and an open configuration of the opening unit.

FIG.1

Description

FIELD

[0001]   The invention relates to the field of secure key control and concerns a locking mechanism configured to equip an opening unit, and to switch between a locked state and an unlocked state. The invention also concerns a method for switching a locking mechanism configured to equip an opening unit from a locked state to an unlocked state.

BACKGROUND

[0002]   Electromechanical lock and key with identification code are widespread. They enable authorized key holders to have access to locked rooms if the identification code of the key corresponds to a predetermined code in relation with the electromechanical lock. The key may be an ordinary looking key to insert into the lock or an access badge to pass in front of the lock.

[0003]   The electromechanical lock comprises a processor configured to compare the identification code of the key with the predetermined code. If the identification code corresponds to the predetermined code, the electromechanical lock switches from its locked state to its unlocked state.

[0004]   Commonly locks are formed with a body that can be easily unscrewed by a locksmith to facilitate rekeying. The body has the function to lock and unlock the lock. A lock body may be found under the form of a European cylinder (defined by the DIN18251). A European cylinder is a type of lock cylinder. There exist other profiles of lock bodies like the oval cylinder that is used in the Nordic countries. A body may not be in the form of a cylinder. A lock body may be inserted into a lock or a mortise lock or a slot-in lock. This function offers the advantage of allowing its change without altering the boltwork hardware. Removing the body typically requires only loosening a set screw, then sliding the body from the boltwork.

[0005]   If the identification key is an ordinary looking key, when the electromechanical lock is in its locked state, it is generally necessary to insert the key into a key hole, apply a force on the key and at the same time turn the key into the hole of the lock to unlock the electromechanical lock and switch from the closed configuration of the opening unit to its open configuration. This solution requires the user to use the key as a mechanical actuation lever to open the opening unit. It implies that each authorized person should have its own key to open a door. And a person without a key cannot open the opening unit.

[0006]   There are electromechanical locks that are controlled by a smart phone that sends an authorized code to the lock to unlock the door. But electronic locks than can be operated only with a smart phone present a number of drawbacks both in terms of limitations of the population of users (some population groups, for example elderly or young children, do not necessary have a smart phone or if so, are not skilled users of it) and of convenience of use (when in a hurry, it is easier to turn a key than to enter one's smart phone code, find and use the correct application). Conversely, the use of physical keys has its own limitations, since it does not allow distributing access rights electronically through virtual keys.

[0007]   Indeed, the existing electromechanical locks do not allow flexibility in the use of the lock and there is a need for an electromechanical lock that seamlessly integrates a combined use of physical and virtual keys.

[0008]   There is consequently a need for a locking mechanism configured to be both operated with at least a remote control and/or a physical key and comprising a mechanical actuation lever configured to switch between a closed configuration of the opening unit and an open configuration of the opening unit.

SUMMARY OF THE INVENTION

[0009]   The proposed solution to overcome this drawback is a locking mechanism with a mechanical actuation lever, and cooperating with an identification key, wherein the key may be any kind of key, thus unlocking the lock if the identification code of the key is an authorized code of the locking mechanism. The mechanical actuation lever of the lock has to be moved, either with the key inserted into the lock or not, to switch from a closed configuration to an open configuration of the opening unit.

[0010]   To this end, the subject of the invention is a locking mechanism configured to equip an opening unit and to switch from a locked state to an unlocked state, comprising a processor configured to read an identification code of an identification key and configured to cause the locking mechanism to switch from the locked state to the unlocked state if the identification code of the at least one identification key is an authorized code of the locking mechanism, a key hole shaped to accept insertion of a physical identification key, a mechanical actuation lever configured to be moved to switch between a closed configuration of the opening unit and an open configuration of the opening unit.

[0011]   The locking mechanism may comprise an interface configured to receive the identification code from an identification key that is one of a physical identification key or a virtual identification key.

[0012]   The interface may be a contact interface, an RF interface, an optical interface and/or an acoustic interface.

[0013]   According to an embodiment of the invention, the at least one identification key may be one of an electronic key or a remote control.

[0014]   According to an embodiment of the invention, the at least one identification key is a smart phone configured to receive the identification code from an external connection or to generate the identification code.

[0015]   According to another embodiment of the inven-

tion, the processor is configured to determine if the identification code is an authorized code of the locking mechanism.

[0016] Advantageously, the processor comprises an algorithm of asymmetrical cryptography configured to verify that the identification code is an authorized code of the locking mechanism.

[0017] The invention also relates to a method for switching a locking mechanism, configured to equip an opening unit, from a locked state to an unlocked state, with an identification key, and comprising a mechanical actuation lever configured to be moved to switch between a closed configuration of the opening unit and an open configuration of the opening unit, the method comprising the steps of causing the identification key to cooperate with the locking mechanism, switching the lock mechanism between the locked state to the unlocked state if an identification code of the identification key is an authorized code of the locking mechanism, moving the mechanical actuation lever.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The accompanying drawings illustrate various non-limiting, example, innovative aspects in accordance with the present descriptions :

- Figure 1 schematically represents a first embodiment of a locking mechanism according to the invention;
- Figure 2 schematically represents a second embodiment of a locking mechanism according to the invention;
- Figure 3 represents a block diagram of the steps of a method for switching a locking mechanism from a locked state to an unlocked state according to the invention.

[0019] For the sake of clarity, the same elements have the same references in the various figures.

DETAILED DESCRIPTION

[0020] Although many of the features of this invention are described in relation to a door, it is understood that they are generally applicable to any opening unit, such as a window. Moreover, these features are also applicable to many other devices, for example a padlock, having a locked state and an unlocked state.

[0021] In order to illustrate the invention, the explanations are related to a door. Note that these explanations may be applied similarly to any opening unit. A door is an opening unit enabling the access to a room (or from a room to the outside) through an aperture. The door is connected to a door frame that frames the aperture and is fixed to the walls around the aperture. In an unlocked state of the door, the door is mobile in relation to the door frame, typically mobile in rotation around doors hinges

(or in translation in the case the door and the door frame are configured to let the door slide through a part of the door frame and into the wall). The door may be in an open configuration or a closed configuration. In the closed configuration, the door covers the aperture (i.e. no one can go through the aperture). Typically the door is equipped with a lock mechanism. The lock mechanism has a latch that is either inserted into a slot of the door frame (the door is closed) or retracted inside the door (the door is no longer attached to the door frame and may be open). In the closed configuration, the latch is inserted into the slot of the door frame. In existing lock mechanisms, a lock clutch is connected to the latch. The lock clutch is usually engaged with both the indoor and outdoor door knobs. This enables a user to activate the lock clutch to make the latch move by moving one of the door knobs. Therefore a user has to move a door knob of the door to switch from the closed configuration of the door to the open configuration of the door. Indeed, the lock clutch being engaged with the knob, the movement of the knob leads to the movement of the latch. Moving the door knob makes the latch retract into the door. The user can pull or push the door to open it.

[0022] In the closed configuration of the door, the lock mechanism can be either in a locked state or an unlocked state. The unlocked state corresponds to the case discussed above. The door may be open by a user when activating a door knob and pushing or pulling the door. More precisely, the lock mechanism has a deadbolt entirely positioned inside the locking mechanism in the unlocked state. In the locked state, this deadbolt projects beyond the lock mechanism and is inserted into a slot of the door frame, thus locking the door to the frame. The movement of the deadbolt can be mechanically obtained, for example by a rotation of a key inserted into the locking mechanism. The rotation of the key clockwise, respectively anticlockwise, causes the deadbolt to translate either outside the lock mechanism to be inserted into the slot of the door frame, or inside the lock mechanism. To switch from the locked state of the door to the unlocked state of the door, a user has to rotate the key with the corresponding rotation of the key inside the lock mechanism. As an alternative to a rotation of the key, the lock mechanism may be unlocked by an authorized identification key. When it is identified in the vicinity of the lock mechanism, the authorized identification key may activate a motor in the lock mechanism that causes the deadbolt to translate. Then, to open the door, the user turns a door knob or pushes a door handle of the door, as explained before.

[0023] This previous case corresponds to a single-point lock mechanism (i.e. with a single deadbolt). The invention similarly applies to a multi-point lock mechanism. A multi-point lock, also known as a safety lock, provides extra security as it distributes the locking points (i.e. a plurality of deadbolts) over the entire door. The most common multi-point lock is the three-point lock composed of a main deadbolt in the center and two other

bolts at the top and at the bottom actuated by a rod. Some multi-point locks may have up to ten locking points.

[0024]   Figure 1 schematically represents a first embodiment of a locking mechanism 10 according to the invention. The locking mechanism 10 is configured to equip an opening unit and to switch from a locked state to an unlocked state. The locking mechanism 10 comprises a processor 15 configured to read an identification code 12 of an identification key 11 received at the locking mechanism 10 and configured to cause the locking mechanism to switch from the locked state to the unlocked state if the identification code 12 of the at least one identification key 11 is an authorized code 13 of the locking mechanism 10. The locking mechanism 10 comprises a key hole shaped to accept insertion of a physical identification key 11. This key hole may take a number of shapes depending on the shape of the physical identification key, for example, it could include, but is not limited to, the following shapes: cylindrical, parallelepipedic and more generally any shape wherein the section is quadrilateral, a circle, or an oval and/or a combination of these shapes (for instance a proximal part of the key hole with a circular section and an other part with a cubic section). In other words the key hole may take various shapes. The locking mechanism 10 also comprises a mechanical actuation lever 14 configured to be moved to switch between a closed configuration of the opening unit and an open configuration of the opening unit. The lock mechanism according to the invention enables a natural gesture of opening an opening unit by moving a mechanical actuation lever, for example rotating a door knob.

[0025]   An authorized person with an authorized key wishing to open the door inserts the key 11 into the key hole. Since the key is an authorized key with an authorized code of the locking mechanism 10, the processor causes the locking mechanism 10 to switch from its locked state to its unlocked state. The deadbolt of the locking mechanism is now inserted inside the lock mechanism 10. The authorized person further moves the mechanical actuation lever 14, for example by a rotation, thus causing the latch of the door to retract. The authorized person can then push or pull the door to open it. This process corresponds to a natural gesture of a human being willing to open a door.

[0026]   The lock mechanism 10 according to the invention comprises a processor 15 configured to read the identification code 12 of the at least one identification key 11 and determine if the identification code 12 is an authorized code 13 of the locking mechanism 10. The processor 15 of the lock mechanism 10 comprises an algorithm that is able to generate a plurality of codes. When moving an identification key 11 close to the locking mechanism 10, (i.e. until about 10 meters of the lock mechanism, for example thanks to the BLE technology (acronym of Bluetooth™ Low Energy technology), one of the codes generated by the algorithm of the processor 15 is transmitted from the processor 15 to the identification key 11. In return, the processor 15 should receive from the identification key 11 an authorized code, that is to say an identification code 12 corresponding to the code transmitted by the processor 15. There is a communication between the lock mechanism 10 and the identification key 11. And if the processor 15 receives from the identification key 11, as a response to its code, an authorized code, the identification key 11 is considered as an authorized key for switching the lock mechanism 10 between the locked and unlocked state. The processor 15 may deliver a command if the identification code 12 of the at least one identification key 11 is an authorized code 13 of the lock mechanism 10. This command may be an activation of a motor of the lock mechanism 10 to translate the deadbolt to unlock the door.

[0027]   The identity of the identification key may by instance be verified by asymmetrical cryptography. The algorithm standard used for the asymmetrical cryptography is state of the art. This cryptographic system uses pairs of keys: public keys which may be disseminated widely, and private keys which are known only to the owner. This system may accomplish two functions: authentication, which is when the public key is used to verify that a holder of the paired private key sent the message, and encryption, whereby only the holder of the paired private key can decrypt the message encrypted with the public key. Therefore, each identification key will receive a public key from the lock mechanism and the lock mechanism will keep a public key of each identification. They are then able to communicate in a secure way, being sure that the message is encrypted and authenticated, meaning from an authorized identification key.

[0028]   According to the invention, the authorized user having an identification key under the form of an ordinary key, as represented in Figure 1, may insert the identification key 11 into the key hole. This results in unlocking the lock mechanism 10. To open the door, the user can either let the key inserted into the key hole and moving the mechanical actuation lever 14. Or he can take it back before moving the mechanical actuation lever 14.

[0029]   In Figure 1, the key hole in positioned in the mechanical actuation lever 14. After the user has inserted his identification key into the key hole, he may also either turn the key to make the mechanical actuation lever 14 turn, or turn the mechanical actuation lever 14, the identification key being either in the key hole or not.

[0030]   The invention also applies to a key hole not positioned in the mechanical actuation lever 14, for example next to the lever 14. In this configuration, after having inserted the key into the key hole, the user may chose if he lets the key in the key hole or not, and then he has to turn the mechanical actuation lever 14 to retract the latch of the door to open it. The locking mechanism according to the invention offers a wide variety of ways to open the door.

[0031]   Furthermore, the key hole may have a particular shape to limit the access of the key hole to keys only having the particular complementary shape. But thanks to the high level of security due to the identification code

of the key cooperating with the processor, the key hole may in some embodiments have a very simple shape, for example be cuboid in shape as depicted in Figure 1.

[0032] The locking mechanism may comprises an interface configured to receive the identification code from an identification key that is one of a physical identification key 11 or a virtual identification key, as explained below. Therefore, the interface may be one of a contact interface, an RF interface such as BT™, NFC™, Wi-Fi™, an optical interface or an acoustic interface.

[0033] Figure 2 schematically represents a second embodiment of a locking mechanism 20 according to the invention. The locking mechanism 20 represented in Figure 2 is identical to the locking mechanism 10 represented in Figure 1. In Figure 2, the locking mechanism 20 is configured to cooperate with an identification key, that may be either an electronic key as explained before with the locking mechanism 10, or a remote control 21 such as an access badge, a smart phone, a tablet, etc. The remote control 21 may be a smart phone configured to receive the identification code 22 from an external connection or to generate the identification code. This configuration allows a lot of flexibility in managing the access to the house while maintaining a high level of security.

[0034] Figure 2 is represents an embodiment of a locking system 40, incorporating the invention, wherein the identification key is a remote control and the processor 15 of the lock mechanism 20 is configured to receive from the remote control 21 the authorized code and deliver a command to unlock the lock mechanism 20. The remote control may be a smart phone or a tablet. The communication between the processor 15 and the remote control may operate for example through Wi-Fi™, NFC™ or Bluetooth™. The main advantage of this embodiment is the flexibility of the control. Indeed it is possible to deliver the command to unlock the lock mechanism 20 thanks to the remote control. It is also possible to transfer the switching control to any other remote controls in case of need. For example, a person waiting for a postal package in his absence may send to the postman an authorized code valid for a predetermined time period. The postman may use his own smart phone with the downloaded authorized code to unlock the lock mechanism 20, so as to come in and deliver the postal package. And even if the postman does not lock the lock mechanism 20 after leaving the house, the processor 15 may be configured to send to the motor of the lock mechanism 20 the command to lock the lock mechanism 20, as explained before, thus ensuring a high level of security, even if a person with a special authorization had a temporary control of the lock mechanism 20. This system may also be useful to make sure the door is locked when you are on your way and do not remember if you looked the door.

[0035] Figure 3 represents a block diagram of the steps of a method for switching a locking mechanism from a locked state to an unlocked state according to the invention. The method according to the invention comprises the step 101 of causing the identification key 11, 21 to cooperate with the locking mechanism 10, 20. The cooperation of a physical identification key with the locking mechanism comprises an insertion of the physical key into the key hole of the locking mechanism and an exchange of identification codes between the identification key and the processor of the locking mechanism. If the identification key is a remote control, the cooperation only comprises an exchange of identification codes between the identification key and the processor of the locking mechanism. The method further comprises the step 102 of switching the lock mechanism 10, 20 between the locked state to the unlocked state if an identification code 12, 22 of the identification key 11, 21 is an authorized code of the locking mechanism 10, 20. And the method comprises the step 103 of moving the mechanical actuation lever 14, 24 to open the door.

[0036] The method further comprises the step 104 of reading the identification code 12, 22 of the at least one identification key 11, 21 by the processor 15, 25, and the step 105 of determining if the identification code 12, 22 is an authorized code of the locking mechanism 10, 20.

[0037] The processor 15, 25 of the lock mechanism according to the invention may be configured to check if the step 101 of cooperating the identification key with the locking mechanism occurs in an authorized time slot. This is of particular interest to determine when an authorized person may have access to the house.

[0038] An authorized person is for example all day at his/her office and only expects his child to come home for lunch between 12 a.m and 1 p.m. The authorized time slot is set between 12 a.m and 1 p.m. When a key is inserted into the key hole, the processor 15 checks if the cooperating of the key with the locking mechanism occurs within an authorized time slot, i.e. between 12 a.m and 1 p.m. If it is 12.30 a.m, it is in the authorized time slot when a child is expected to come back home. The lock mechanism 10 will further determine if the identification code sent by the identification key is an authorized one.

[0039] If it is 11.30 a.m. or 2 p.m., the insertion of the key into the key hole did not occur within the authorized time slot. At that time, no one is expected to come back home. The process of the lock mechanism may send an alarm in case a temptative to open the door appears during this time slot.

[0040] Thanks to the invention, access to house may be granted only to authorized persons, possibly within authorized time slots. The lock mechanism according to the invention enables the user to perform a single and natural gesture while offering the possibility to have various identification key types. The lock mechanism according to the invention brings more flexibility in its use compared to existing locks since it is adapted to various ways to proceed when opening a door, while maintaining a high level of security.

[0041] The examples disclosed in this specification are therefore only illustrative of some embodiments of the invention and may be combined. They do not in any man-

ner limit the scope of said invention which is defined by the appended claims.

Claims

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1. A locking mechanism (10, 20) configured to equip an opening unit and to switch from a locked state to an unlocked state, comprising:

    - a processor (15, 25) configured to read an iden-*10* tification code (12, 22) of an identification key (11, 21) and configured to cause the locking mechanism to switch from the locked state to the unlocked state if the identification code (12, *15* 22) of the at least one identification key (11, 21) is an authorized code (13, 23) of the locking mechanism,
    - a key hole shaped to accept insertion of a physical identification key (11), *20*
    - a mechanical actuation lever (14, 24) configured to be moved to switch between a closed configuration of the opening unit and an open configuration of the opening unit.

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2. The locking mechanism (10, 20) of claim 1, comprising an interface configured to receive the identification code from an identification key (11, 12) that is one of a physical identification key (11) or a virtual identification key. *30*

3. The locking mechanism (10, 20) of claim 2, wherein the interface is a contact interface, an RF interface, an optical interface and/or an acoustic interface.

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4. The locking mechanism (10, 20) of one of claims 2 to 3, wherein the at least one identification key (11, 21) is one of an electronic key (11) or a remote control (21).

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5. The locking mechanism (20) of claim 4, wherein the at least one identification key (21) is a smart phone configured to receive the identification code (22) from an external connection or to generate the identification code. *45*

6. The locking mechanism (10, 20) of one of claims 1 to 5, wherein the processor (15, 25) is configured to determine if the identification code (12, 22) is an authorized code (13, 23) of the locking mechanism. *50*

7. The locking mechanism (10, 20) of claim 6, wherein the processor (15, 25) comprises an algorithm of asymmetrical cryptography configured to verify that the identification code (12, 22) is an authorized code *55* (13, 23) of the locking mechanism.

8. A method for switching a locking mechanism (10,

20), configured to equip an opening unit, from a locked state to an unlocked state, with an identification key (11, 21), and comprising a mechanical actuation lever (14, 24) configured to be moved to switch between a closed configuration of the opening unit and an open configuration of the opening unit, the method comprising:

    - Causing the identification key (11, 21) to cooperate with the locking mechanism (10, 20),
    - Switching (102) the lock mechanism (10, 20) between the locked state to the unlocked state if an identification code (12, 22) of the identification key (11, 21) is an authorized code of the locking mechanism (10, 20),
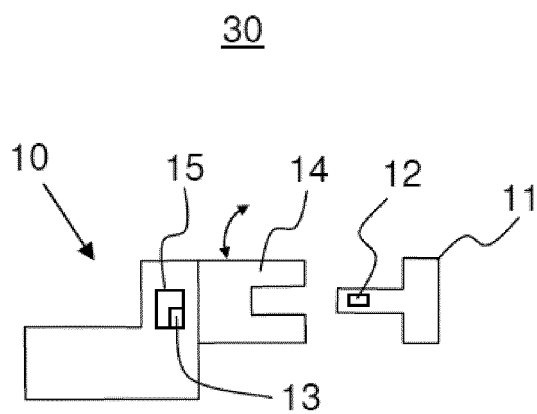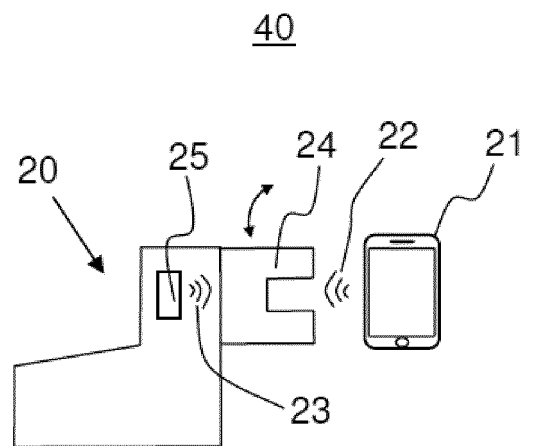   - Moving (103) the mechanical actuation lever (14, 24).

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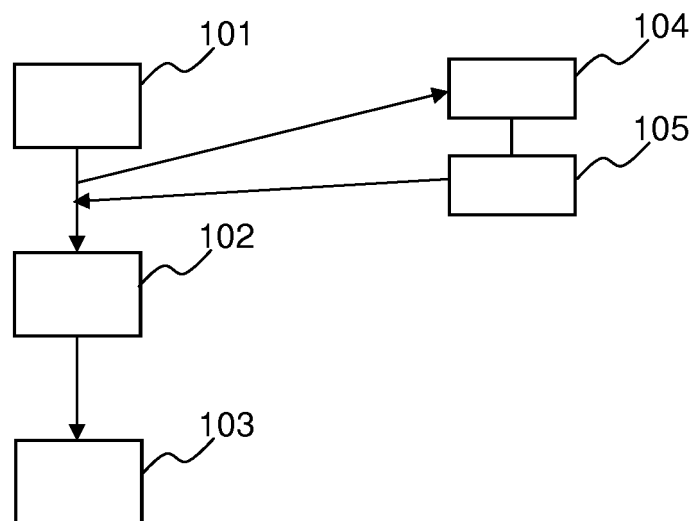10 15 14 12 11

13

FIG.1

40

20 25 24 22 21

23

FIG.2

101 104

105

102

103

FIG.3

EUROPEAN SEARCH REPORT

Application Number

EP 17 30 6962

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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G07C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	28 May 2018	Verhoof, Paul

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT
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