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(71) Applicant: **MICROSOFT CORPORATION** [US/US]; One Microsoft Way, Redmond, Washington 98052-6399 (US).

(72) Inventors: **RIHN, Bernard K.**; c/o Microsoft Corporation, LCA - International Patents, One Microsoft Way, Redmond, Washington 98052-6399 (US). **DIETZ, Paul Henry**; c/o Microsoft Corporation, LCA - International Patents, One Microsoft Way, Redmond, Washington 98052-6399 (US). **BATHICHE, Steven Nabil**; c/o Microsoft Corporation, LCA - International Patents, One Microsoft Way, Redmond, Washington 98052-6399 (US). **GAULT, Joseph B.**; c/o Microsoft Corporation, LCA - International Patents, One Microsoft Way, Redmond, Washington 98052-6399 (US).

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(54) Title: SWITCHABLE MAGNETIC LOCK

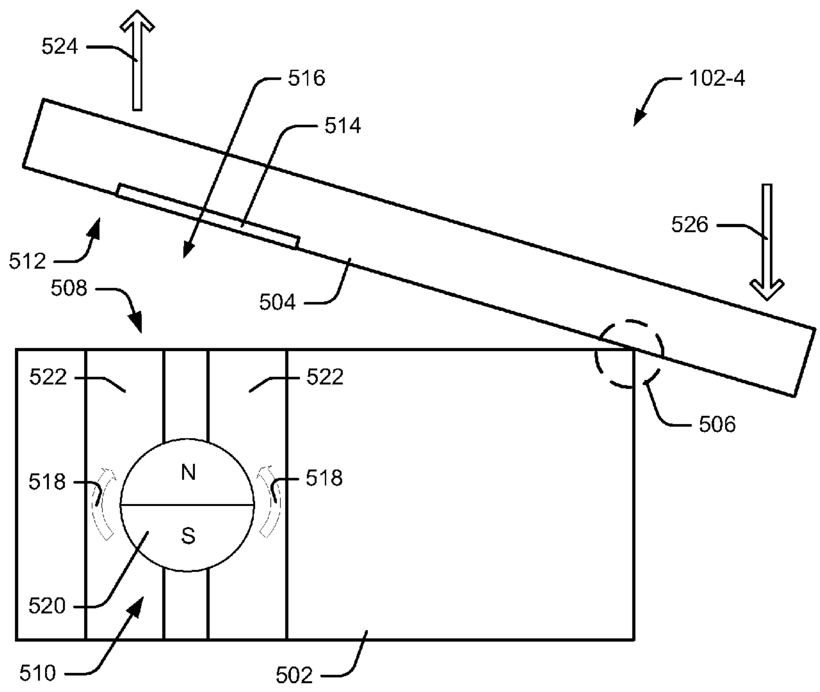

Fig. 5

[Continued on next page]

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(57) Abstract: This document describes techniques using, and apparatuses including, switchable magnetic locks. These techniques and apparatuses can enable low or no power consumption and a seamless design for locking and unlocking of devices one to the other, such as computing devices and peripherals.

SWITCHABLE MAGNETIC LOCK

BACKGROUND

[0001] Many computing devices have movable and removable parts and peripherals. A smart phone may include a stylus, a laptop a hinged display, a tablet computer a battery charger, or a portable audio player a docking station, to name just a few. Current techniques often fix these parts and peripherals to their computing devices using mechanic connectors, such as latches, sliding tabs, and so forth. These mechanical connectors, however, often fail to provide a satisfactory design because they have objects that jut out or holes that pierce the computer body, part, or peripheral. Examples include exposed latches, latch holes, tabs hooks, and tab reception detents, to name just a few.

[0002] Some techniques have attempted to address this failure in design through electromagnets or permanent magnets. Electromagnets, however, are unsatisfactory due to their power requirements and low magnetic force. Current techniques that use permanent magnets do not suitably fix the computing device to the part or peripheral or, if they do, require excessive force to separate the computing device from the part or peripheral.

SUMMARY

[0003] This document describes techniques enabling use of switchable magnetic locks and apparatuses including switchable magnetic locks. The techniques and apparatuses can enable computing devices to lock and unlock peripherals and other devices using little or no power and with a seamless design.

[0004] This summary is provided to introduce simplified concepts for switchable magnetic locks, which is further described below in the Detailed Description. This summary is not intended to identify essential features of the claimed subject matter, nor is it intended for use in determining the scope of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] Embodiments of techniques and apparatuses for switchable magnetic locks are described with reference to the following drawings. The same numbers are used throughout the drawings to reference like features and components:

Fig. 1 illustrates an example environment in which a switchable magnetic lock can be implemented.

Fig. 2 illustrates an example smart phone having a switchable magnetic lock and a retention structure for a stylus.

Fig. 3 is a detailed illustration of the switchable magnetic lock of the smart phone of Fig. 2.

Fig. 4 illustrates simplified, cross-section views of the switchable magnetic lock in the smart phone of Fig. 2.

Fig. 5 illustrates the all-in-one computer of Fig. 1 where the switchable magnetic lock is in a null state.

Fig. 6 illustrates the all-in-one computer of Figs. 1 and 5 where the switchable magnetic lock is in an unlock state.

Fig. 7 illustrates example methods enabling use of a switchable magnetic lock.

Fig. 8 illustrates an example device in which techniques enabling use of switchable magnetic locks can be implemented.

DETAILED DESCRIPTION

Overview

[0006] This document describes techniques using, and apparatuses including, switchable magnetic locks. These techniques and apparatuses can enable locking and unlocking of parts and peripherals with low or no power consumption and a seamless design.

[0007] Consider, for example, a current laptop computing device having an integrated body and display. The body and the display are connected with a hinge allowing the display to rotate to and from the body. On closing the display to the body, the display is locked to the body with latches. To open the laptop, this locking system typically requires the user to find one or two latch-release slides and then manually operate the slides while pulling the display from the body. Thus, this design may require a user to operate manual controls and includes two latches that jut out from the display, two latch-holes that pierce the body, and latch-release slides that also jut out from either the display or body.

[0008] The described techniques and apparatuses, however, enable a switchable magnetic lock to be used. Assume that instead of the above latch locking system, a laptop includes a switchable magnetic lock. In this case, on closing the display to the body, a controller in the laptop senses the proximity of the display to the body, activates an actuator effective to cease a null state of a permanent magnet and instead direct the permanent magnet's magnetic field to a magnetically permeable material in the display. By so doing, the display is drawn to the body and locked to the body. The controller then ceases to use power, as the magnetic circuit does not require power to be maintained.

[0009] On opening the laptop, the controller may sense a touch of the user on a portion of the display at which a person is likely to touch when attempting to open the laptop.

The controller then activates the actuator effective to null the magnetic field instead of direct it to the display's magnetically permeable material, thereby unlocking the display from the body. The display then easily moves away from the body. The magnetically permeable material can be seamlessly integrated into the display, as can the permanent magnet and actuator into the body. Therefore, instead of two latches and a latch release jutting out and two holes piercing the display or body, there are no jut-outs and no holes. Also, the techniques enable a user to easily open the laptop without operating a manual selector, such as the manual latch-release noted above.

[0010] This is but one example of how techniques and/or apparatuses enabling use of switchable magnetic locks can be performed. Techniques and/or apparatuses are referred to herein separately or in conjunction as the "techniques" as permitted by the context. This document now turns to an example environment in which the techniques can be embodied after which two example apparatus having a switchable magnetic lock, various example methods, and an example device are described.

Example Environment

[0011] Fig. 1 is an illustration of an example environment 100 in which techniques using, and an apparatus including, a switchable magnetic lock may be embodied. Environment 100 includes a computing device 102 having a switchable magnetic lock 104, sensors 106, and a controller 108.

[0012] Switchable magnetic lock 104 includes a permanent magnet 110 (or magnets), magnetic-field directors 112, and an actuator 114. Permanent magnet 110 is configured such that its magnetic field is capable of being directed. In some embodiments, permanent magnet 110 includes a diametrically magnetized magnet having a magnetic field polarized perpendicular to a long axis of the magnet such that rotating the magnet or field directors surrounding the magnet is effective to direct the magnetic field perpendicular to the long axis. These and other magnets and structures are set forth in greater detail below.

[0013] Magnetic-field directors 112 of switchable magnetic lock 104 are configured to direct the magnetic field of permanent magnet 110 to a null state and to a directed state. In the directed state, a magnetic circuit can be completed with a magnetically permeable material of another device (e.g., of a peripheral). These other devices may include various movable and/or removable parts and peripherals, such as cord connectors (e.g., power cords without mechanical retention), styluses, displays, mice, gaming controllers, docking stations, and so forth. When the directed state is completed, the other device is locked to computing device 102. Each of magnetic-field directors 112 may include an isolated magnetic circuit configured to selectably direct the magnetic field as noted. Alternatively or in addition to use of magnetic-field directors 112, switchable magnetic lock 104 may include a magnetic shield material to null or assist in nulling the magnetic field, such as Mu-metal, though this is not required.

[0014] Actuator 114 of switchable magnetic lock 104 is configured to move permanent magnet 110 and/or magnetic-field directors 112. Actuator 114 can be powered or unpowered. Thus, actuator 114 may include a simple mechanical device that can be manually operated by a user effective to direct the magnetic field so that switchable magnetic lock 104 locks or unlocks. Alternatively, actuator 114 can be powered and controlled, either manually or by controller 108. In the powered and controlled embodiment, actuator 114 moves permanent magnet 110 and/or field directors 112 effective to direct the magnetic field to a null state or a directed state. Actuator 114 may include various different types of electro-mechanical devices, such as a solenoid or geared vibrator motor.

[0015] Note that actuator 114 may be operated without using power in the manual case effective to change the state of switchable magnetic lock 104. Even in the powered case, however, power is not needed to maintain the state of switchable magnetic lock 104, rather, power is used to switch between the states. Switching between states can be done at low power and generally quickly, such that little power is used.

[0016] Sensors 106 are capable of sensing a user's interaction with computing device 102 and/or an associated device or peripheral, such as moving a peripheral in proximity with computing device 102, touching computing device 102, and so forth. Sensors 106 may sense actively, passively, and/or responsive to an explicit or implicit selection. In some cases, sensors 106 include a capacitive sensor capable of sensing contact of a user touching computing device 102 or another device having a magnetically permeable material. Alternatively or additionally, sensors 106 may include a magnetic load sensor capable of sensing proximity of a device, such as device having a digitizer or an LC circuit (*e.g.,* an inductor-capacitor circuit capable of sensing a particular signal). In addition to being capable of sensing a user's interaction, sensors 106 may sense a current state of switchable magnetic lock 104, such as with hall-effect sensors.

[0017] Controller 108 is capable of controlling actuator 114 effective to lock and unlock switchable magnetic lock 104. For example, in a case where permanent magnet 110 is a diametrically magnetized magnet having a long axis, controller 108 powers actuator 114 to rotate the diametrically magnetized magnet about the long axis from a lock position to an unlock position. Controller 108 acts responsive to input, such as from a sensor indicating a user's implicit or explicit selection to lock or unlock switchable magnetic lock 104. Controller 108 may also receive information indicating a current state of the magnetic field of switchable magnetic lock 104, such as from the above- noted hall-effect sensors.

[0018] Controller 108 can be embodied as part of, or separate from, switchable magnetic lock 104. Controller 108 may also be implemented as computer-executable instructions stored on computer-readable storage media 116 (media 116) and executable by one or more processors 118, though this is not required. Alternatively or additionally, controller 108 can be embodied as hardware, firmware, and/or computer-executable instructions as noted above, in whole or in part.

[0019] As shown in Fig. 1, computing device 102 can each be one or a combination of various devices, here illustrated with six examples: a laptop computer 102-1, a tablet computer 102-2, a smart phone 102-3, an all-in-one computer 102-4, and a gaming system 102-5, though other computing devices and systems, such as desktop computers, televisions, netbooks, media players, and cellular phones, may also be used.

Example Computing Devices having a Switchable Magnetic Lock

[0020] Fig. 2 illustrates an example smart phone having a switchable magnetic lock and a retention structure for a stylus. Consider again smart phone 102-3 of Fig. 1, here with a stylus 202 shown attached and unattached. Smart phone 102-3 is illustrated with a retention structure 204, a low-power permanent magnet 206 seamlessly integrated into retention structure 204, and a capacitive sensor 208 integrated seamlessly into an outer surface of smart phone 102-3. Smart phone 102-3 also includes a magnetic load sensor and hall-effect sensors, which are internal to smart phone 102-3 and are not illustrated.

[0021] Low-power permanent magnet 206 is shown within retention structure 204, though proximity rather than inclusion is sufficient. Low-power permanent magnet 206 provides another magnetic field in addition to that of the switchable magnetic lock. This other magnetic field has a power substantially less than the power of the magnetic field of the diametrically magnetized magnet. It does not lock stylus 202 to smart phone 102-3 sufficient to prevent accidental removal, but instead retains stylus 202 so that stylus 202 does not fall off when the switchable magnetic lock nulls its more-powerful magnetic field. Other low-force or temporary retention manners may also or instead be used in conjunction with the switchable magnetic lock, though they are not required. Note that nulling the magnetic field includes substantially weakening the magnetic field or fully nulling the magnetic field. Thus, some small amount of magnetic field may remain when in the null state, such as an amount sufficient to provide the low-force retention manner set forth above.

[0022] As illustrated in detail in Fig. 3, smart phone 102-3 also includes a switchable magnetic lock 302, shown in the foreground for visual clarity. Switchable magnetic lock 302 is illustrated with a portion 304 of stylus 202 of Fig. 2, this portion 304 having a magnetically permeable material capable of completing a magnetic circuit. Switchable magnetic lock 302 includes a diametrically magnetized magnet 306 and magnetic-field directors 308 proximate diametrically magnetized magnet 306. Note that switchable magnetic lock 302 can include an actuator that is capable of rotating diametrically magnetized magnet 306 between a first position and a second position, the first position causing magnetic-field directors 308 to null the magnetic field and the second position causing magnetic-field directors 308 to direct the magnetic field to retention structure 204 and thus portion 304. Directing the magnetic field is described in greater detail below.

[0023] Portion 304 and its magnetically permeable material can be located in multiple parts of stylus 202. Thus, assume that two portions 304 are included within stylus 202. In such a case, a user may select to lock stylus 202 into retention structure 204 such that stylus 202 does not project from smart phone 102-3 or does project some amount from smart phone 102-3. Thus, multiple portions 304 within stylus 202 permit a user to select to lock stylus 202 flush with smart phone 102-3 or projecting from smart phone 102-3. The projecting end of stylus 202 may enable a user to more easily locate and remove stylus 202, especially if the user cannot see or does not wish to focus on smart phone 102-3 or stylus 202. The magnetically permeable material can vary in these portions 304, or controller 108 may determine which portion 304 is proximate magnetic field directors 308, effective to vary a holding force based on which portion 304, and thus the location of stylus 202 relative to smart phone 102-3.

[0024] Further, and as noted in part above, smart phone 102-3 includes controller 108 (not shown), which is capable of powering the actuator to rotate diametrically magnetized magnet 306. In so doing, the rotation acts to release stylus 202 by releasing the magnetically permeable material of portion 304 from retention structure 204 or locks the magnetically permeable material of portion 304 to retention structure 204, depending on the rotation.

[0025] By way of further illustration, consider Fig. 4, which illustrates simplified, cross-section views 402 and 404 of switchable magnetic lock 302 sectioned across a long axis of diametrically magnetized magnet 306 and the length of stylus 202 (for cross-section view 402). Cross-section view 402 illustrates switchable magnetic lock 302 in a directed state, the directed state directing a magnetic field of diametrically magnetized magnet 306 toward retention structure 204 and thus portion 304 of stylus 202. This directed state locks stylus 202 to retention structure 204. Field directors 406 direct this magnetic field as shown at direction 408.

[0026] Cross-section view 404 illustrates switchable magnetic lock 302 in a null state, the null state nulling the magnetic field of diametrically magnetized magnet 306 through field directors 406 as shown at nulling directions 410. Directions and manners in which the magnetic field is nulled may vary, including through a magnetic circuit disparate (e.g., opposite) from stylus 202. In this null state, stylus 202 is released and therefore unlocked. Low-power permanent magnet 206 of Fig. 2 may hold stylus 202 to retention structure 204 with low power sufficient to prevent stylus 202 from falling off of smart phone 102-3 but enable a user to easily remove stylus 202. Note that diametrically magnetized magnet 306 is rotated about 90 degrees from the directed state shown in cross-section 402 to the null state shown in cross-section 404.

[0027] In this example of switchable magnetic lock 302 shown in Fig. 4, each of field directors 406 has an isolated magnetic circuit. This isolated magnetic circuit is capable of directing the magnetic field of diametrically magnetized magnet 306 in direction 408 and nulling direction 410 as shown in cross-sections 402 and 404, respectively.

[0028] Fig. 5 illustrates a simplified cross-section of all-in-one computer 102-4 of Fig. 1 in a null state. All-in-one computer 102-4 is illustrated with a base 502 and a display 504 connected through a hinge 506. Base 502 has a surface 508 and a switchable magnetic lock 510. Display 504 has a surface 512 and a magnetically permeable material 514. Note that while display 504 is illustrated with magnetically permeable material 514 and base 502 is illustrated with switchable magnetic lock 510, these may be reversed and still be effective to lock and unlock display 504 to and from base 502.

[0029] Switchable magnetic lock 510 is configured to switch being a lock state and an unlock state. In an unlock state 516, which is illustrated in Fig. 5 as space between surfaces, switchable magnetic lock 510 does not lock surface 508 to surface 512. This unlock state is created by a complete magnetic circuit, shown with magnetic field directions 518, which is effective to null a magnetic field of a permanent magnet 520 of switchable magnetic lock 510 using magnetic-field directors 522 and without using magnetically permeable material 514.

[0030] Hinge 506 is configured to rotate display 504 to and from base 502 and, when closed, contact surface 508 with surface 512. In some embodiments, hinge 506 is configured to include a spring, the spring causing display 504 to separate from surface 508 from surface 512 through a hinge force caused by the spring. This hinge force is insufficient to separate surface 508 and 512 when switchable magnetic lock 510 is in the lock state but is sufficient to separate surface 508 and 512 when in an unlock state. This hinge force is shown acting in two directions, an upward direction 524 and a downward direction 526.

[0031] Fig. 6 illustrates a simplified cross-section of all-in-one computer 102-4 in a lock state 602. In this lock state 602, switchable magnetic lock 510 locks surface 508 to surface 512 by completing a magnetic circuit between permanent magnet 520 of switchable magnetic lock 510 and magnetically permeable material 514 using magnetic-field directors 522 when surface 508 and surface 512 are made proximate, such as through hinge 506. The directed magnetic field of this lock state 602 is shown with magnetic field directions 524.

[0032] Note that switchable magnetic lock 510 locks base 502 to display 504 without mechanical dents, detents, or latches. This switchable magnetic lock 510 may also do so without being visible at all, as the magnetic field may pass through a smooth, seamless surfaces (e.g., surfaces 508 and 512) on base 502 and display 504.

[0033] While not shown in Figs. 5 and 6, locking and unlocking can be performed by a controller using an actuator, such as one or more of the above-noted example controllers and actuators. Thus, in a case where permanent magnet 520 is a diametrically magnetized magnet, a controller of switchable magnetic lock 510 may power an actuator to rotate the diametrically magnetized magnet between positions, such as a position shown in Fig. 5 resulting in a null state and another position as shown in Fig. 6 that directs the magnetic field to display 504 and will lock display 504 to base 502 when magnetically permeable material 514 is near to field directors 522. Likewise, the controller can power an actuator to release display 504.

[0034] In this powered example case, a controller can receive selections in the various manners set forth above. Thus, the controller may receive an indication that a user has touched one of capacitive sensors 604 or a button 606 on display 504, which may indicate that the user wishes to unlock switchable magnetic lock 510. Alternatively or additionally, the controller may sense that surface 508 and surface 512 are near to each other, such as through a proximity sensor or a sensor that determines when hinge 506 is closed or nearly closed. This indicates that switchable magnetic lock 510 should be switched to a lock state, and so forth.

[0035] In another embodiment of hinge 506, hinge 506 includes a counter-balance rather than the spring described above. This counter-balance enables substantially forceless separation of surface 508 from surface 512 when switchable magnetic lock 510 is in the unlock state. A controller of switchable magnetic lock 510 may sense that a user wishes to open all-in-one computer 102-4 and, responsive to that sensing, unlock display 504 from base 502. The counter-balance then enables a user to almost effortlessly move display 504 relative to base 502. This can be performed through implicit sensing, such as through a capacitive sensor or proximity sensor or explicitly through a raised button, voice command, and so forth.

[0036] These and other capabilities and configurations, as well as ways in which entities of Figs. 1-6 act and interact, are set forth in greater detail below. These entities may be further divided, combined, and so on. The environment 100 of Fig. 1 and the detailed illustrations of Figs. 2-6 illustrate some of many possible environments and devices capable of employing the described techniques.

Example Methods Using Switchable Magnetic Lock

[0037] Fig. 7 depicts methods 700 enabling use of a switchable magnetic lock. These methods are shown as sets of blocks that specify operations performed but are not necessarily limited to the order shown for performing the operations by the respective blocks. In portions of the following discussion reference may be made to environment 100 of Fig. 1 and entities detailed in Figs. 2-6, reference to which is made for example only. The techniques are not limited to performance by one entity or multiple entities operating on one device.

[0038] Block 702 receives a selection to switch a magnetic lock between a lock state and an unlock state. This switchable magnetic lock can be embodied in one of the many manners set forth above, such as with a permanent magnet having a magnetic field and magnetic-field directors proximate the permanent magnet, each of the field directors configured to selectably direct a magnetic field of the permanent magnet, a first direction nulling the magnetic field to provide the unlock state and a second direction redirecting the magnetic field to provide the lock state. The selection received may be implicit or explicit, such as with one of the various sensing devices and manners set forth above.

[0039] Block 704, responsive to the selection, moves the permanent magnet relative to the magnetic-field directors or the magnetic-field directors relative to the permanent magnet effective to direct the magnetic field to a lock or unlock state. This moving of the permanent magnet or magnetic-field directors may be a rotation along a long axis of the permanent magnet. The moving can instead be a lateral movement relative to multiple sets of magnetic-field directors, such as by moving one set of magnetic-field directors that null the magnetic field proximate or distant the permanent magnet and distant or proximate another set directing the magnetic field to a magnetically permeable material. Various other movements based on other structures of permanent magnets and magnetic-field directors are also envisioned.

[0040] As noted above, the techniques permit locking and unlocking of devices, such as computing devices and peripherals, though other devices may be used. Further, the techniques permit this locking and unlocking seamlessly on devices and also permit, in some embodiments, implicit selection by a user. Methods 700 can be performed using the various controllers, sensors, and actuators noted herein (e.g., controller 108 based on data sensed by sensors 106 and by controlling actuator 114).

[0041] The preceding discussion describes methods relating to switchable magnetic locks, as well as other methods and techniques. Aspects of these methods may be implemented in hardware (*e.g.*, fixed logic circuitry), firmware, software, manual processing, or any combination thereof. A software implementation represents program code that performs specified tasks when executed by a computer processor. The example methods may be described in the general context of computer-executable instructions, which can include software, applications, routines, programs, objects, components, data structures, procedures, modules, functions, and the like. The program code can be stored in one or more computer-readable memory devices, both local and/or remote to a computer processor. The methods may also be practiced in a distributed computing mode by multiple computing devices. Further, the features described herein are platform-independent and can be implemented on a variety of computing platforms having a variety of processors.

[0042] These techniques may be embodied on one or more of the entities shown in Figs. 1-6 and 8 (device 800 is described below), which may be further divided, combined, and so on. Thus, these figures illustrate some of the many possible systems or apparatuses capable of employing the described techniques. The entities of these figures generally represent software, firmware, hardware, whole devices or networks, or a combination thereof. In the case of a software implementation, for instance, the entities (*e.g.*, controller 108) represent program code that performs specified tasks when executed on a processor (*e.g.*, processor(s) 118). The program code can be stored in one or more computer-readable memory devices, such as media 116 or computer-readable media 814 of Fig. 8.

Example Device

[0043] Fig. 8 illustrates various components of example device 800 that can be implemented as any type of client, server, and/or computing device as described with reference to the previous Figs. 1-7 to implement techniques enabling switchable magnetic locks. In embodiments, device 800 can be implemented as one or a combination of a wired and/or wireless device, as a form of television mobile computing device (*e.g.*, television set-top box, digital video recorder (DVR), etc.), consumer device, computer device, server device, portable computer device, user device, communication device, video processing and/or rendering device, appliance device, gaming device, electronic device, System-on-Chip (SoC), and/or as another type of device or portion thereof. Device 800 may also be associated with a user (*e.g.,* a person) and/or an entity that operates the device such that a device describes logical devices that include users, software, firmware, and/or a combination of devices.

[0044] Device 800 includes communication devices 802 that enable wired and/or wireless communication of device data 804 (*e.g.*, received data, data that is being received, data scheduled for broadcast, data packets of the data, etc.). Device data 804 or other device content can include configuration settings of the device, media content stored on the device, and/or information associated with a user of the device. Media content stored on device 800 can include any type of audio, video, and/or image data. Device 800 includes one or more data inputs 806 via which any type of data, media content, and/or inputs can be received, such as human utterances, user-selectable inputs (explicit or implicit), messages, music, television media content, recorded video content, and any other type of audio, video, and/or image data received from any content and/or data source.

[0045] Device 800 also includes communication interfaces 808, which can be implemented as any one or more of a serial and/or parallel interface, a wireless interface, any type of network interface, a modem, and as any other type of communication interface. Communication interfaces 808 provide a connection and/or communication links between device 800 and a communication network by which other electronic, computing, and communication devices communicate data with device 800.

[0046] Device 800 includes one or more processors 810 (*e.g.*, any of microprocessors, controllers, and the like), which process various computer-executable instructions to control the operation of device 800 and to enable techniques for switchable magnetic locks. Alternatively or in addition, device 800 can be implemented with any one or combination of hardware, firmware, or fixed logic circuitry that is implemented in connection with processing and control circuits which are generally identified at 812. Although not shown, device 800 can include a system bus or data transfer system that couples the various components within the device. A system bus can include any one or combination of different bus structures, such as a memory bus or memory controller, a peripheral bus, a universal serial bus, and/or a processor or local bus that utilizes any of a variety of bus architectures.

[0047] Device 800 also includes computer-readable storage media 814, such as one or more memory devices that enable persistent and/or non-transitory data storage (*i.e.*, in contrast to mere signal transmission), examples of which include random access memory (RAM), non-volatile memory (*e.g.*, any one or more of a read-only memory (ROM), flash memory, EPROM, EEPROM, etc.), and a disk storage device. A disk storage device may be implemented as any type of magnetic or optical storage device, such as a hard disk drive, a recordable and/or rewriteable compact disc (CD), any type of a digital versatile disc (DVD), and the like. Device 800 can also include a mass storage media device 816.

[0048] Computer-readable storage media 814 provides data storage mechanisms to store device data 804, as well as various device applications 818 and any other types of information and/or data related to operational aspects of device 800. For example, an operating system 820 can be maintained as a computer application with computer-readable storage media 814 and executed on processors 810. Device applications 818 may include a device manager, such as any form of a control application, software application, signal-processing and control module, code that is native to a particular device, a hardware abstraction layer for a particular device, and so on.

[0049] Device applications 818 also include any system components, engines, or modules to implement techniques enabling switchable magnetic locks. In this example, device applications 818 include controller 108.

Conclusion

[0050] Although embodiments of techniques using, and apparatuses including, switchable magnetic locks have been described in language specific to features and/or methods, it is to be understood that the subject of the appended claims is not necessarily limited to the specific features or methods described. Rather, the specific features and methods are disclosed as example implementations of switchable magnetic locks.

CLAIMS

1. An apparatus comprising:

a retention structure;

a diametrically magnetized magnet having a magnetic field;

magnetic-field directors proximate the diametrically magnetized magnet and the retention structure;

an actuator capable of rotating the diametrically magnetized magnet between a first position and a second position, the first position causing the magnetic-field directors to null or substantially weaken the magnetic field and the second position causing the magnetic-field directors to direct the magnetic field to the retention structure; and

a controller capable of powering the actuator to rotate the diametrically magnetized magnet between the first position and the second position, the rotation capable of releasing a device having a magnetically permeable material from the retention structure or locking the device having the magnetically permeable material to the retention structure.

2. An apparatus as described in claim 1, wherein the apparatus is capable of maintaining a lock of the device having the magnetically permeable material to the retention structure without using power.

3. An apparatus as described in claim 1, wherein the controller is further capable of receiving a selection, the selection to lock or unlock the device having the magnetically permeable material, and, responsive to the selection, powering the actuator.

4. An apparatus as described in claim 3, further comprising a magnetic load sensor capable of sensing a proximity of the device having the magnetically permeable material, and wherein the selection is receivable from the magnetic load sensor and the controller is capable of powering the actuator effective to lock the device having the magnetically permeable material to the retention structure responsive to the selection.

5. An apparatus as described in claim 1, wherein each of the field directors has an isolated magnetic circuit, the isolated magnetic circuits capable of directing the magnetic field of the diametrically magnetized magnet in a first direction nulling the magnetic field

when in the first position and a second direction directing the magnetic field to the retention structure when in the second position.

6. A computing device comprising:

a base having a first surface and a switchable magnetic lock or a magnetically permeable material;

a display having a second surface and whichever of the switchable magnetic lock or the magnetically permeable material that is not in the base; and

a hinge connecting the base and the display, the hinge configured to rotate the display relative to the base effective to rotate the second surface to and from the first surface,

the switchable magnetic lock configured to switch between a lock state and an unlock state:

the lock state locking the first surface to the second surface by completing a first magnetic circuit between a permanent magnet of the switchable magnetic lock and the magnetically permeable material using magnetic-field directors when the first surface and the second surface are made proximate by the hinge; and

the unlock state not locking the first surface to the second surface by completing a second magnetic circuit between the permanent magnet and the magnetic-field directors without the magnetically permeable material.

7. A computing device as described in claim 6, wherein the permanent magnet is a diametrically magnetized magnet having a magnetic field and each of the magnetic-field directors has an isolated magnetic circuit configured to selectably direct the magnetic field to and away from the magnetically permeable material.

8. A computing device as described in claim 7, wherein the switchable magnetic lock further comprises an actuator capable of rotating the diametrically magnetized magnet between a first position and a second position, the first position causing the magnetic-field directors to complete the second magnetic circuit effective to null the magnetic field and the second position causing the magnetic-field directors to direct the magnetic field effective to attract the magnetically permeable material.

9. A computing device as described in claim 8, wherein the switchable magnetic lock draws power when switching between the lock state and the unlock state but does not draw power to maintain the lock state or the unlock state.

10. A computing device as described in claim 6, wherein the display is further configured to include a counter-balance, the counter-balance enabling the hinge to provide substantially forceless separation of the first surface from the second surface when the switchable magnetic lock is in the unlock state.

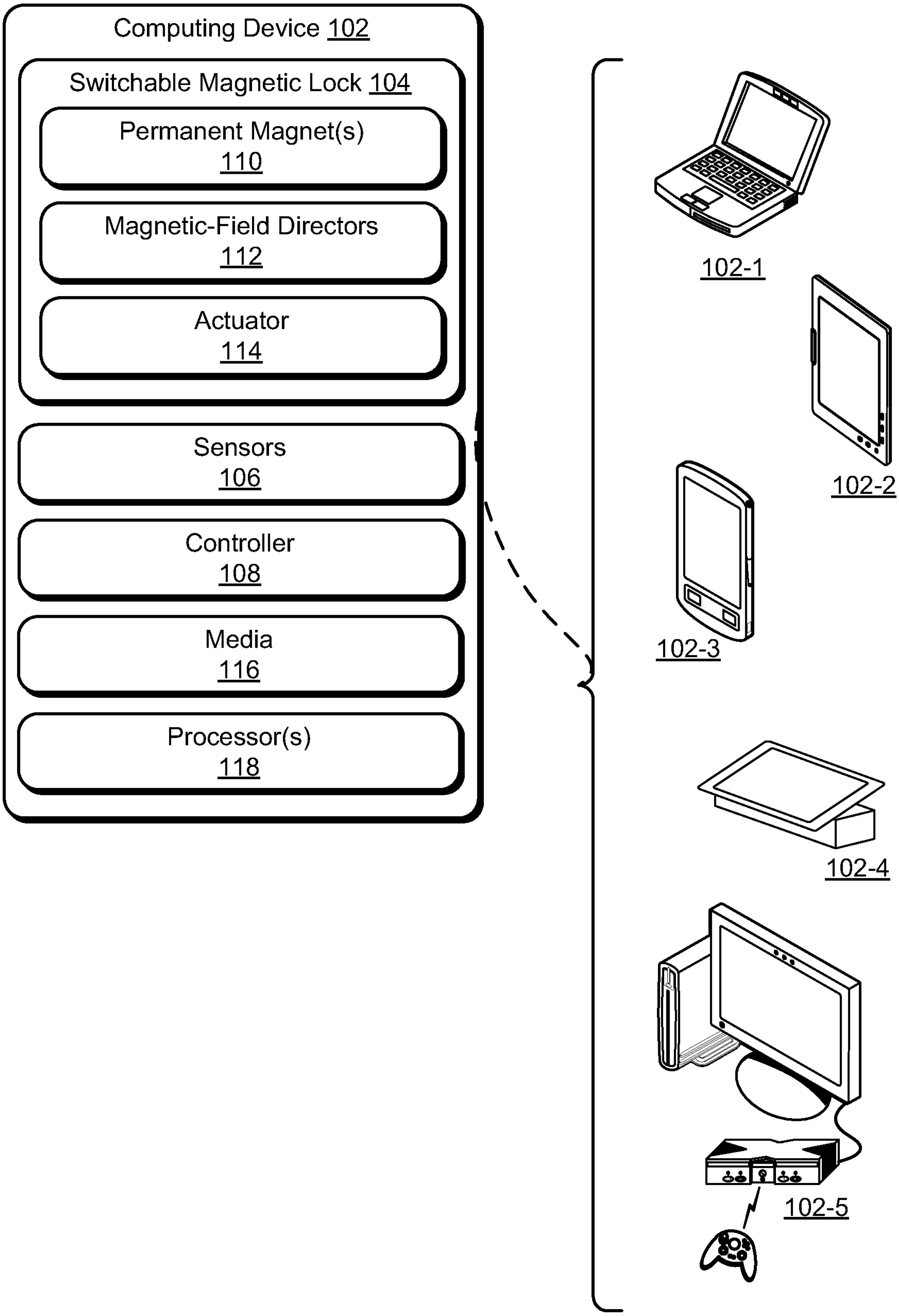

Computing Device 102
Switchable Magnetic Lock 104
Permanent Magnet(s) 110
Magnetic-Field Directors 112
Actuator 114
Sensors 106
Controller 108
Media 116
Processor(s) 118
102-1
102-2
102-3
102-4
102-5

Fig. 1

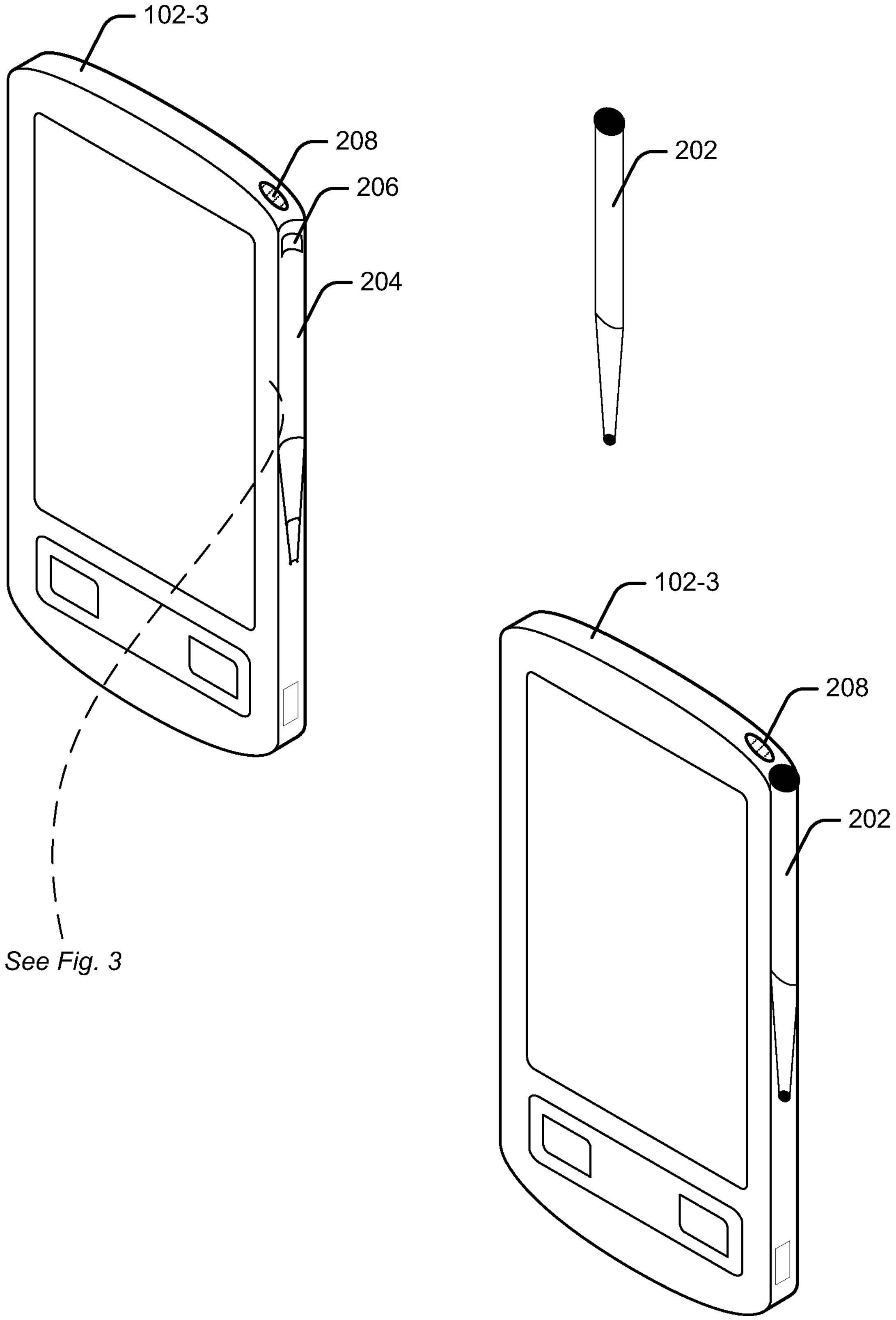


Fig. 2

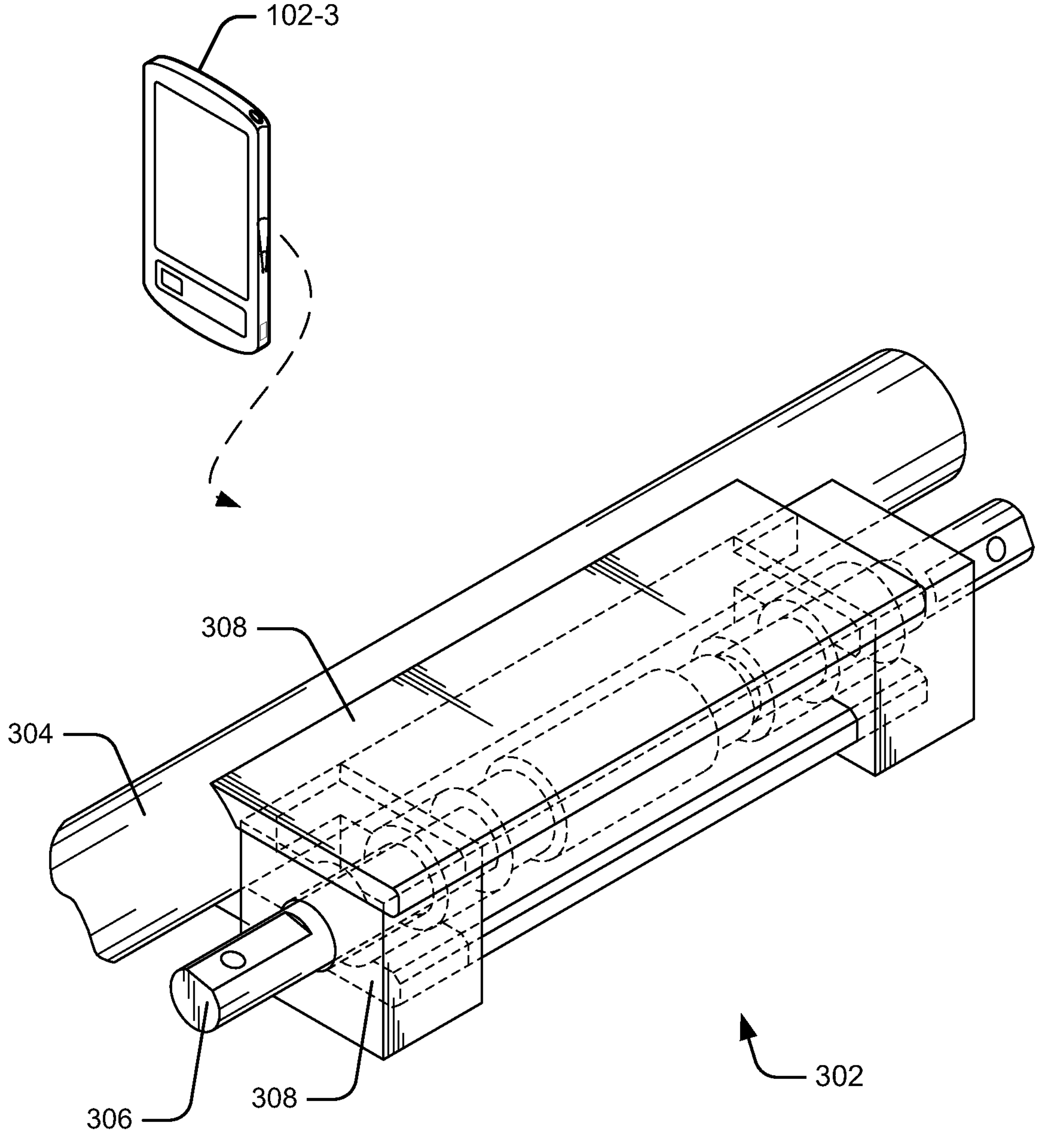
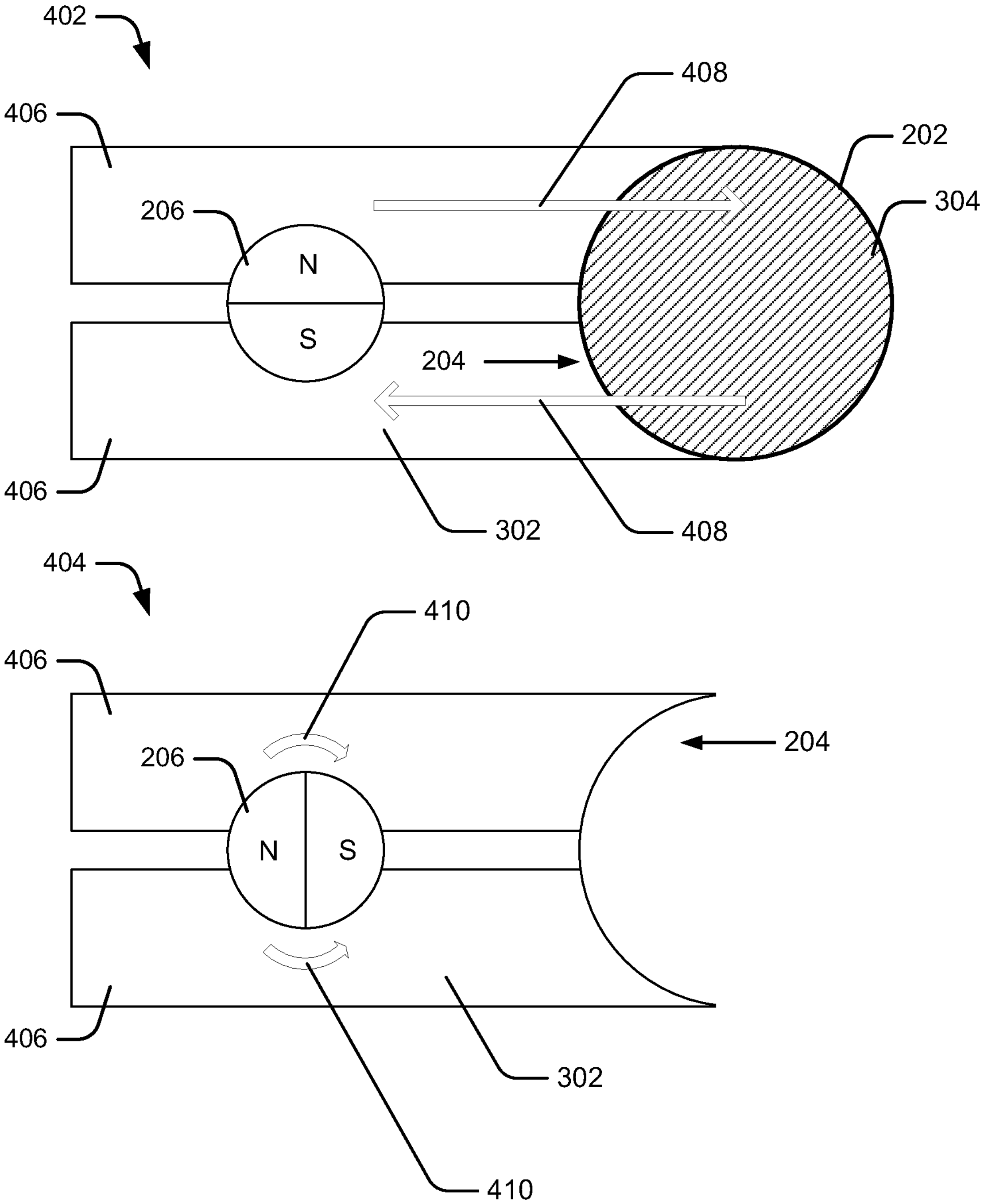


Fig. 3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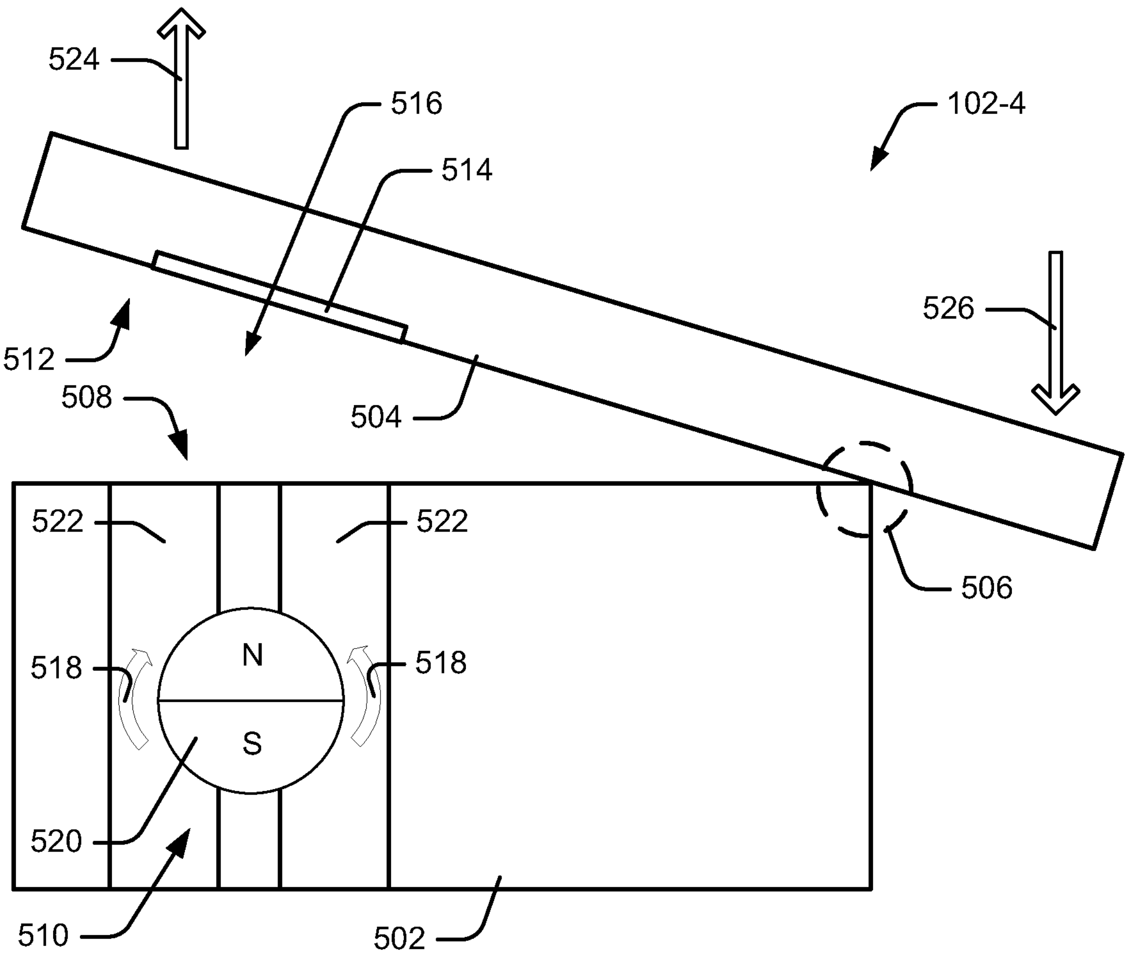
410

Fig. 4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522
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518
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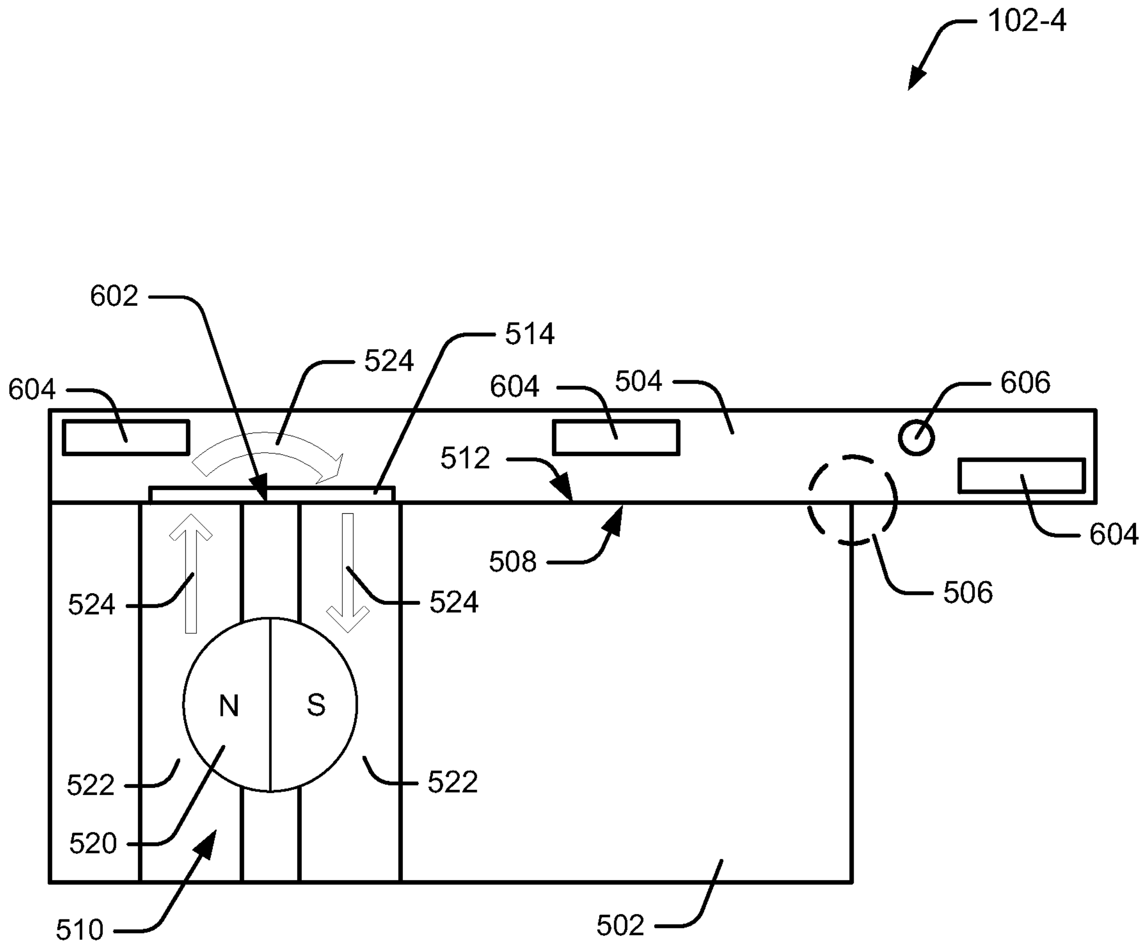
518
S
520
510
502

Fig. 5


102-4
602
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502

Fig. 6

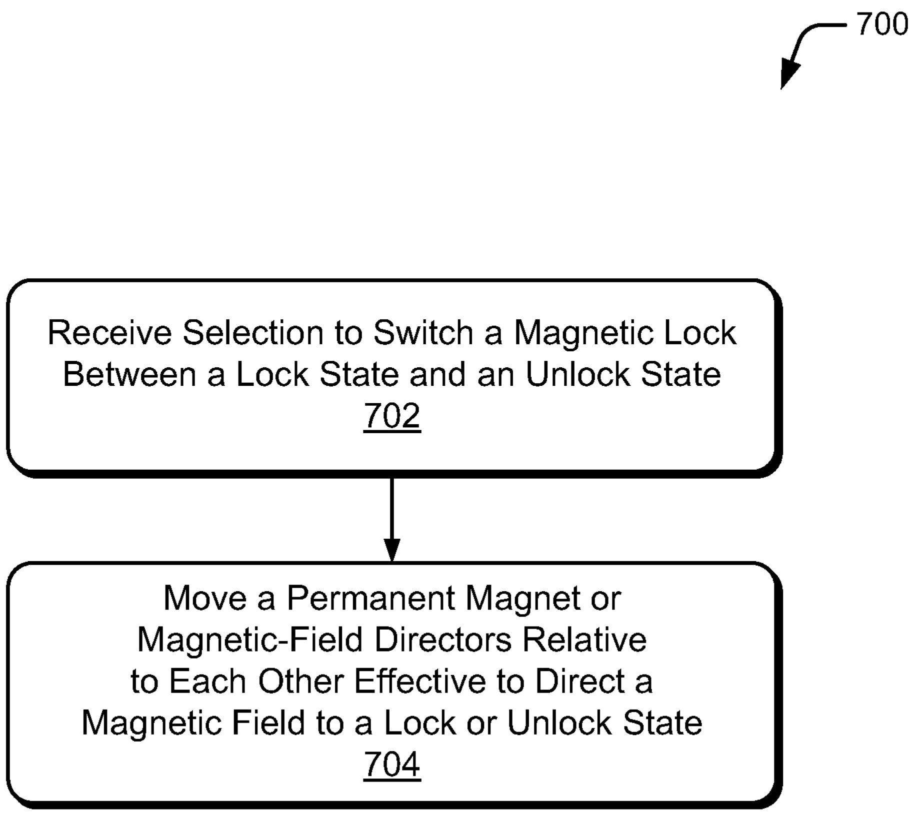
700
Receive Selection to Switch a Magnetic Lock Between a Lock State and an Unlock State
702
Move a Permanent Magnet or Magnetic-Field Directors Relative to Each Other Effective to Direct a Magnetic Field to a Lock or Unlock State
704

Fig. 7

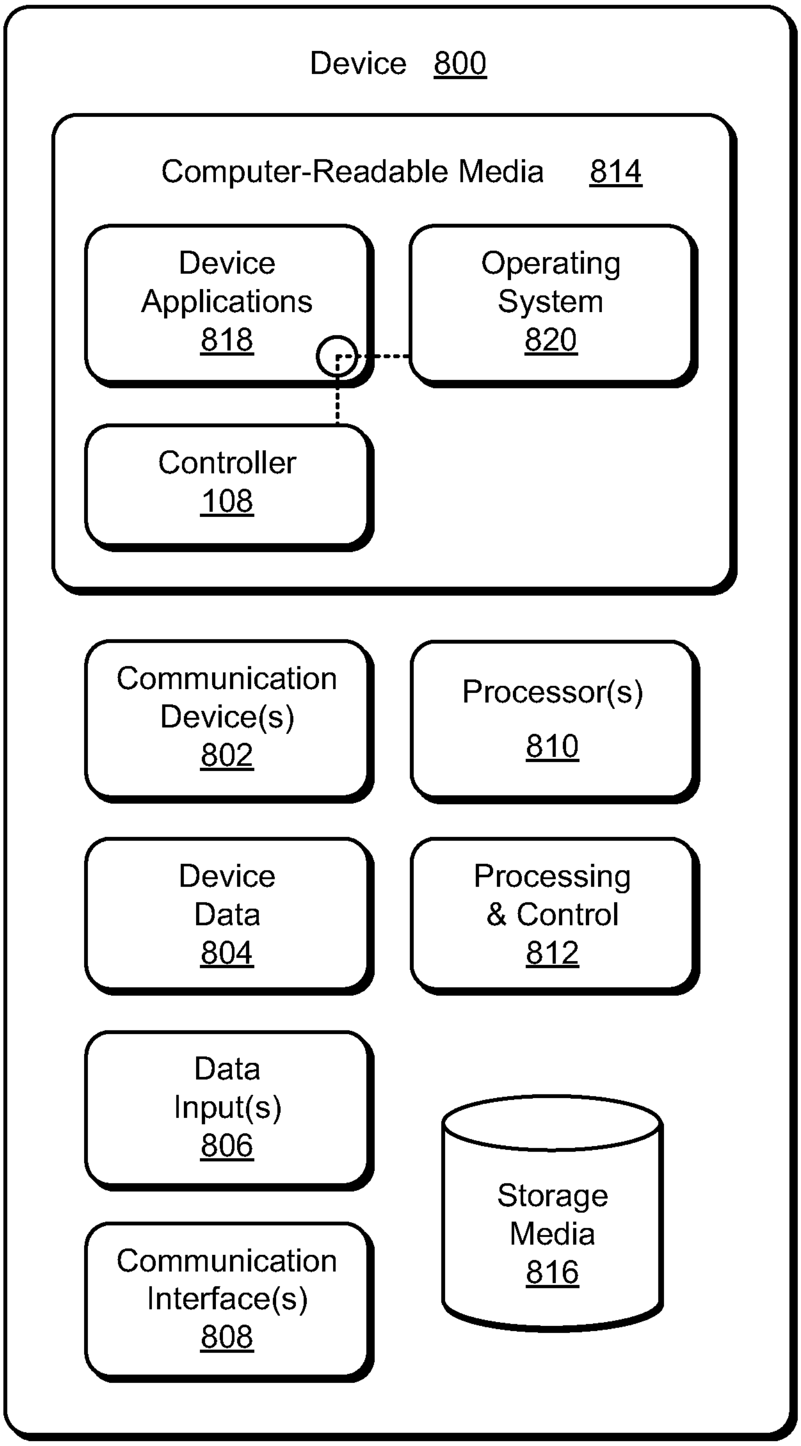
Device 800
Computer-Readable Media 814
Device Applications 818
Operating System 820
Controller 108
Communication Device(s) 802
Processor(s) 810
Device Data 804
Processing & Control 812
Data Input(s) 806
Storage Media 816
Communication Interface(s) 808

Fig. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/054812

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06F1/16
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G06F E05C E05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2011/162425 A1 (CHOI TAE KWANG [KR]) 29 December 2011 (2011-12-29) abstract figures 1-23	1-10
X	US 2006/006674 A1 (KANG LUNWEI [TW] ET AL) 12 January 2006 (2006-01-12) the whole document	1-10
X	US 2005/023841 A1 (CHEN HSIANG [TW]) 3 February 2005 (2005-02-03) the whole document	1-10
A	WO 02/04773 A1 (GANZI EITAN [IL]; GANZI YARON [IL]) 17 January 2002 (2002-01-17) the whole document	1-10

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 October 2013	12/11/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Vieira, Alexandre

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/054812

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3 326 588 A (MELVILLE CLARK ANGUS GORDON) 20 June 1967 (1967-06-20) the whole document -----	1-10
A	US 2002/190823 A1 (YAP BENG TIEK [SG]) 19 December 2002 (2002-12-19) the whole document -----	1-10

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2013/054812

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
WO 2011162425	A1	29-12-2011	KR	20110139632	A	29-12-2011
			WO	2011162425	A1	29-12-2011
US 2006006674	A1	12-01-2006	NONE			
US 2005023841	A1	03-02-2005	NONE			
WO 0204773	A1	17-01-2002	AU	7095701	A	21-01-2002
			WO	0204773	A1	17-01-2002
US 3326588	A	20-06-1967	GB	1104933	A	06-03-1968
			US	3326588	A	20-06-1967
US 2002190823	A1	19-12-2002	JP	3515774	B2	05-04-2004
			JP	2003058312	A	28-02-2003
			US	2002190823	A1	19-12-2002