(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
28 April 2022 (28.04.2022)

WIPO | PCT

(10) International Publication Number
WO 2022/086624 A1

(51) International Patent Classification:
G06K 19/07 (2006.01) *G06K 9/00* (2006.01)

(21) International Application Number:
PCT/US2021/047398

(22) International Filing Date:
24 August 2021 (24.08.2021)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
63/105,171 23 October 2020 (23.10.2020) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, IT, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,

(54) **Title:** INTEGRATED BIOMETRIC SENSOR AND MEMORY FOR BIOMETRIC CARD

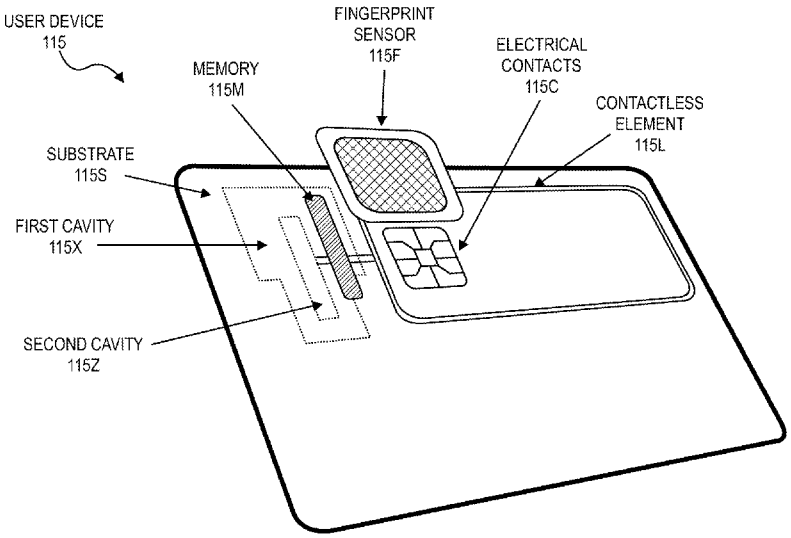


FIG. 3

(57) **Abstract:** Embodiments of the invention are directed to a user device. A fingerprint sensor can be located adjacent to electrical contacts. As a result, both the fingerprint sensor and the electrical contacts can be directly connected to an underlying memory within the user device. The direct connection allows the user device to be free of wires.

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TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

— *with international search report (Art. 21(3))*

INTEGRATED BIOMETRIC SENSOR AND MEMORY FOR BIOMETRIC CARD

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This application is an international application of and claims the benefit of the filing date of U.S. Provisional Application No. 63/105,171, filed on October 23, 2020, which is herein incorporated by reference in its entirety for all purposes.

BACKGROUND

[0002] User devices in the form of cards can include a number of electrical components. While modern user devices have many functionalities, the various complex components make the user devices expensive and difficult to produce, and often cause high failure rates. For example, including various electrical components on the user device often requires using wires to connect the electrical components so that they can communicate. Such wires are prone to failure and complicate manufacturing processes.

[0003] Embodiments of the present invention address these problems and other problems, individually and collectively.

SUMMARY

[0004] Embodiments of the present invention are directed to a user device with components that are positioned adjacent to each other. For example, a fingerprint sensor can be positioned adjacent to a memory and/or electrical contacts. Adjacent positioning of the components allows the components to be electrically connected without the use of extra wires. Reducing the number of wires in a user device improves the reliability of the user device, reduces the complexity of the user device, and reduces cost of manufacturing the user device.

[0005] One embodiment of the invention is directed to a user device comprising a substrate. There is a first cavity in the substrate and a second cavity in the substrate, the second cavity being adjacent to the first cavity in the substrate.

The user device also comprises a memory within the second cavity, electrical contacts within the first cavity, where the electrical contacts at least partially overlap the memory, and a fingerprint sensor within the first cavity, where the fingerprint sensor at least partially overlaps the memory. The user device further includes a first electrical connection between the memory and the electrical contacts, the first electrical connection enabling communication between the memory and the electrical contacts, as well as a second electrical connection between the memory and the fingerprint sensor, the second electrical connection enabling communication between the memory and the fingerprint sensor.

[0006] One embodiment of the invention is directed to a method of manufacture comprising creating a substrate, creating a first cavity within the substrate, and creating a second cavity within the substrate, the second cavity being adjacent to the first cavity. The method further includes inserting a memory into the second cavity, inserting a fingerprint sensor into the first cavity, the fingerprint sensor at least partially overlapping the memory, where the fingerprint sensor is electrically coupled to at least one first electrical connector connecting the fingerprint sensor to the memory, and providing electrical contacts in the first cavity, the electrical contacts at least partially overlapping the memory, where one or more of the electrical contacts are electrically coupled to at least one second electrical connector connecting the electrical contacts to the memory.

[0007] Further details regarding embodiments of the invention can be found in the Detailed Description and the Figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] **FIG. 1** shows a diagram of a front surface of a convention user device with a typical configuration of components.

[0009] **FIG. 2** shows a diagram of a front surface of a user device , according to embodiments of the invention.

[0010] **FIG. 3** shows an exploded-view illustration of a user device, according to embodiments of the invention.

[0011] **FIG. 4** shows of a cross-sectional view of a user device, according to embodiments of the invention.

[0012] **FIGS. 5A-5B** show diagrams of a user device with additional possible configurations of components, according to embodiments of the invention.

[0013] **FIG. 6** shows a diagram with dimensions of an example user device, according to embodiments of the invention.

[0014] **FIG. 7** shows a flow diagram illustrating a method for manufacturing a user device, according to embodiments of the invention.

[0015] **FIG. 8** shows an example of a system, according to embodiments of the invention.

DETAILED DESCRIPTION

[0016] Embodiments of the present invention are directed to a user device with components that are positioned adjacent to each other. For example, a fingerprint sensor can be positioned adjacent to a memory and/or electrical contacts in the user device. Positioning the components in a user device adjacent to each other allows the components to be electrically connected to each other without the use of extra wires. Reducing the number wires or eliminating them improves the reliability of the user device, reduces the complexity of the user device, and reduces the cost of manufacturing.

[0017] A “user device” may be a tool used by a user to gain access, such as access to information, physical space, public transit, goods, services, etc. A user device may include evidence that the user is permitted to gain access. A user device can be configured to provide some information about the user and/or the user’s access permissions. In some embodiments, the user device can communicate electronically with an access control terminal in order to prove that the user is permitted to gain access. User devices can be in the form of cards, and specific examples of user devices can include access badges, transit fare cards,

payment cards such as credit, debit, and prepaid card, loyalty cards, IDs such as drivers licenses, etc.

[0018] In some embodiments, a user device may comprise a substrate such as a paper or plastic card. Information may be printed, embossed, encoded, or otherwise included at or near a surface of the substrate. The user device may include circuitry with, for example, permanent voltage values for storing information. Suitable user devices can be hand-held and compact so that they can fit into a user's wallet and/or pocket (e.g., pocket-sized). The user device may be able to operate in a contact mode and/or a contactless mode. As an example, a user device can include a smart card. In some embodiments, a smart card can serve as a security card, a payment card, an access card, or any other suitable type of card.

[0019] **FIG. 1** shows a diagram of a front surface of a conventional user device **15**. The user device **15** can take the form of a card comprising a substrate **15S**. The user device **15** can further include a fingerprint sensor **15F**, a plate of electrical contacts **15C**, and wires **15W**, each of which may be embedded within or on the substrate **15S**.

[0020] As shown in **FIG. 1**, the fingerprint sensor **15F** is located on the opposite side of the user device **15** relative to the electrical contacts **15C**. Specifically, the electrical contacts **15C** are located near the left side of the front surface of the user device **15**, while the fingerprint sensor **15F** is shown near the bottom right corner of the front surface of the user device **15**.

[0021] The fingerprint sensor **15F** may interact with a memory during a biometric authentication process. In some embodiments, a memory (not shown) may be located within the substrate **15S** and underneath the electrical contacts **15C**, on the opposite side of the user device **15** relative to the fingerprint sensor **15F**. Accordingly, in order to provide power and a communication pathway between the fingerprint sensor **15F** and the memory, the wires **15W** are included.

[0022] The wires **15W** provide electrical connections for communications between the fingerprint sensor **15F** and the memory in the substrate **15S** proximate

the electrical contacts **15C**, and for providing power to the fingerprint sensor **15F**. A first wire provides power and a second wire provides communication signals. Additional wires, such as a clock wire, may also be included. The wires **15W** may comprise metal. The wires **15W** may extend laterally across body of the user device **15** from the fingerprint sensor **15F** to the memory.

[0023] When the user device **15** is initially created, a first set of electrical and mechanical attachments may be created between the first ends of the wires **15W** and the fingerprint sensor **15F**, and a second set of electrical and mechanical attachments may be created between a second ends of the wires **15W** and the memory.

[0024] The wires **15W** typically do not connect the fingerprint sensor **15F** directly to the electrical contacts **15C**. While the depiction of the wires **15W** shown in **FIG. 1** show the wires **15W** in electrical contact with the electrical contacts **15C**, the wires **15W** can lead to the memory (not shown in **FIG. 1**) in the user device **15** underneath the electrical contacts **15C**.

[0025] The configuration of the components in the user device **15** in **FIG. 1** has disadvantages. For example, it is difficult to manufacture user devices with wires, such as the wires **15W**. As explained above, two steps are performed for each of the wires **15W**, to connect each end of the wire to components at opposite ends of the wire (e.g., the fingerprint sensor **15F** and the memory). For example, two separate solder connections (e.g., via ultrasound soldering) must be made to connect the ends of the first wire to respective components, and two more solder connections are made to connect the ends of the second wire to respective components. The wires **15W** and the connected ends (e.g., soldered connections) need to be produced in such a way that they are strong, resilient, and have high endurance (e.g., against physical effects such as bend, against weather such as humidity, etc.). As a result, the production cost of this type of user device **15** is high, the yield rate is high, and the connection failure rate is high.

[0026] The wires **15W** can also have parasitic effects on the electrical circuitry of the user device **15**. Conductive wires can introduce unwanted resistance and

inductive capacitance, which can cause delays in signal transmission, increased power demands, and increased signal noise.

[0027] Embodiments of the invention address these and other problems, individually and collectively.

[0028] **FIG. 2** shows a diagram of a front surface of a user device **115** according to an embodiment of the invention. The user device **115** shown in **FIG. 2** is in the form of a card, and includes a substrate **115S**, a fingerprint sensor **115F**, electrical contacts **115C**. The user device **115** can also include a memory and/or a contactless element that are not shown in **FIG. 2**, but are embedded in the substrate **115S**. The substrate **115S** can include one or more layers of material. The one or more layers may comprise plastic, metal, or other suitable material.

[0029] As shown in **FIG. 2**, when viewed from a top plan view, the fingerprint sensor **115F** is located adjacent to the electrical contacts **115C**. In this example, the fingerprint sensor **115F** is located above the electrical contacts **115C** and near the top-left corner of the user device **115**. Due to this position, the fingerprint sensor **115F** can overlap with an underlying memory within the substrate **115S**, which thereby allows the fingerprint sensor **115F** to be directly connected (e.g., via soldering) to the memory without the use of wires.

[0030] In some embodiments, the fingerprint sensor **115F** may directly abut the electrical contacts **115C** so that the two components are flush. In other embodiments, the fingerprint sensor **115F** is slightly spaced from the electrical contacts **115C**, and may be separated by an insulator such as plastic. For example, the distance separating the fingerprint sensor **115F** and electrical contacts **115C** can be from 0-5 mm in some embodiments. The space between the electrical contacts **115C** and the fingerprint sensor **115F** may be less than the width of the memory (e.g., 20 mm), so that both the fingerprint sensor **115F** and the electrical contacts **115C** can overlap the underlying memory with the substrate **115S**.

[0031] As shown in **FIG. 2**, the wires **15W** illustrated in **FIG. 1** are not needed. When the wires are removed, the manufacturing process for the user device **115** is

simplified and is more efficient. Further, using embodiments of the invention, the number of parts needed to create the user device **115** is reduced relative to the user device **15** in **FIG. 1**. As a result, the failure rate of the user device **115** is reduced compared with the design shown in **FIG. 1**. For example, instead of performing two soldering steps for each wire (e.g., to connect the fingerprint sensor **15F** to one end of the wire and the memory to the other end of the wire), embodiments of the invention can perform one soldering step for each connection (e.g., signal connection, power connection) between the fingerprint sensor **115F** to an underlying memory. Further, because the wires **15W** are not present in the embodiment in **FIG. 2**, the electrical problems associated with wires is not present in the embodiment in **FIG. 2**.

[0032] The configuration of components shown in **FIG. 2** can be further described and understood by the depiction in **FIG. 3**. **FIG. 3** shows the same user device as **FIG. 2**, but as an exploded-view illustration, according to some embodiments.

[0033] In the illustration of **FIG. 3**, the fingerprint sensor **115F** and electrical contacts **115C** are shown. A memory **115M** is embedded in the user device **115**, and is shown as being under the fingerprint sensor **115F** and electrical contacts **115C**.

[0034] There are at least two cavities within the user device **115**. A first cavity **115X** is a cavity in the substrate **115S** of the user device **115**. The first cavity **115X** has a shape (e.g., height, width, and depth) and a configuration that can accommodate the fingerprint sensor **115F** and the electrical contacts **115C**. The fingerprint sensor **115F** and electrical contacts **115C** may lie in the same plane, and together may be cooperatively structured with respect to the lateral walls defining the first cavity **115X.** As shown, when the fingerprint sensor **115F** and the electrical contacts **115C** are placed in the first cavity **115X**, they are positioned adjacent to one another within the same plane. In this example, the first cavity **115X** has six lateral walls, and a bottom plane. Part of the bottom plane is defined by a bottom wall and part is defined by an upper plane forming an opening of the second cavity **115Z**.

[0035] The second cavity **115Z** is another cavity in the substrate **115S** of the user device **115**. The second cavity **115Z** is adjacent to the first cavity **115X**. For example, as shown in **FIG. 3**, second cavity **115Z** is underneath the first cavity **115X**, and the second cavity **115Z** extends deeper into the substrate **115S** than the shallower first cavity **115X**. The second cavity **115Z** has a shape (e.g., height, width, and depth) and configuration to accommodate the memory **115M**. In this example, the lateral shape of the second cavity **115Z** is shown as being in the form of a rectangle, and the lateral dimensions of the second cavity **115Z** are smaller than the lateral dimensions of the first cavity **115X**. The memory **115M** may fit within the second cavity **115Z** so that it is close to or in contact with the side walls defining the second cavity **115Z**. In some embodiments, the walls including the side walls and bottom wall defining the second cavity can be cooperatively structured with the memory **115M**. When the memory **115M** is placed in the second cavity **115Z**, it becomes positioned in a second plane that is underneath the plane of the fingerprint sensor **115F** and the electrical contacts **115C**. The second cavity **115Z** in **FIG. 2** defined by four internal walls in the substrate **115S**, and a bottom internal wall in the substrate **115S**. A plane defining an opening of the second cavity **115Z** can coincide with a bottom wall of the first cavity **115X**.

[0036] When the user device **115** is assembled, the memory **115M** is located in the second cavity **115Z**, and the fingerprint sensor **115F** and electrical contacts **115C** are located in the first cavity **115X**. Due to the relative shapes and locations of the first cavity **115X** and the second cavity **115Z**, the memory **115M** can be positioned so that it is at least partially underneath both of the fingerprint sensor **115F** and the electrical contacts **115C**. This at least partial-overlapping arrangement allows the memory **115M** to be in more direct electrical and mechanical contact with both of the fingerprint sensor **115F** and the electrical contacts **115C** as compared to the user device **15** illustrated in **FIG. 1**. Electrical connections such as solder connections (e.g., solder balls) can be made between the memory **115M** and the fingerprint sensor **115F**, as well as the memory **115M** and the electrical contacts **115C**.

[0037] In some embodiments, the memory **115M**, and at least one of the fingerprint sensor **115F**, and/or the electrical contacts **115C** can be soldered or packaged together (or otherwise manufactured together as one component) before being inserted into the user device **115**, so that one fully-connected semiconductor chip component is inserted into the user device **115**.

[0038] According to various embodiments, the locations, shapes, and configuration of the cavities can vary. For example, variations in the design of the memory **115M**, the fingerprint sensor **115F**, and/or the electrical contacts **115C** can result in variations to the layout the user device **115** and/or the shapes of the cavities. As shown in **FIG. 3**, the first cavity **115X** is larger than second cavity **115Z**. In other embodiments, the second cavity **115Z** may be larger than the first cavity **115X**. This may be the case, if, for example, the memory **115M** is larger than the fingerprint sensor **115F** and electrical contacts **115C**.

[0039] The memory **115M** can include a computer readable medium and/or one or more hardware processers. For example, the memory **115M** can include one or more packaged integrated circuit chips and may include suitable volatile and non-volatile memories including DRAMs, EEPROMs, etc. The memory **115M** may also comprise a data processor. In some embodiments, the memory **115M** is a secure element chip. The memory **115M** can store data and computer code as well as execute the computer code to complete a task. For example, the memory **115M** can store cryptographic keys, one or more access applications, access credentials, and other suitable data for interacting with an access device to gain access to a desired resource. The memory **115M** can also store personal information such as a name, address, email address, phone number, or any other suitable identification information of one or more users. To execute an access transaction, the memory **115M** can provide access data (e.g., credentials) to an access device through multiple channels (e.g., in conjunction with the electrical contacts **115C** or the contactless element **115L**). A credential may include any suitable information that serves as reliable evidence of worth, ownership, identity, or authority, such as a string of numbers, letters, or any other suitable characters.

[0040] The electrical contacts **115C** may be in the form of electrically conductive lands, pads, or plates with any suitable configuration and shape. The electrical contacts **115C** can include conductive materials, such as copper, aluminum, gold, silver, or alloys. In some embodiments, the electrical contacts **115C** are configured according to the ISO/IEC 7816 standards. The electrical contacts **115C** can be electrically connected to the memory **115M** so that the memory **115M** can communicate with external devices via the electrical contacts **115C**. Through the electrical contacts **115C**, the user device **115** can interface and communicate with an access device (e.g., through a physical contact connection between the electrical contacts **115C** and a contact chip reader at the access device). The electrical contacts **115C** may be printed electrical circuits produced by known circuit printing techniques.

[0041] The contactless element **115L**, which can be present on or embedded within the substrate **115S**, may include any suitable type of wireless transceiver, such as an antenna. In some embodiments, the contactless element **115L** conforms to the ISO/IEC 14443 standard. The contactless element **115L** can be electrically connected to the memory **115M** so that the memory **115M** can communicate with external devices via the contactless element **115L**. The contactless element **115L** enables the user device **115** to communicate with the access device through over-the-air communications (e.g., short range wireless communications) with a contactless reader at the access device. “Short range communication” or “short range wireless communication” may comprise any method of providing short-range contact or contactless communications capability, such as RFID, BluetoothTM, infra-red, or other data transfer capability that can be used to exchange data between a user device and an access device. In some embodiments, short range communications may be in conformance with a standardized protocol or data transfer mechanism (e.g., ISO 14443/NFC). Short range communication typically comprises communications at a range of less than 2 meters. In some embodiments, it may be preferable to limit the range of short range communications (e.g., to a range of less than 1 meter, less than 10 centimeters, or less than 2.54 centimeters) for security, technical, and/or practical considerations.

[0042] The contactless element **115L** is shown in **FIG. 3** in the form of an antenna. As shown, the contactless element **115L** can be electrically connected to the to the memory **115M**. Accordingly, all three components (e.g., the contactless element **115L**, the fingerprint sensor **115F**, and the electrical contacts **115C**) can be (e.g., mechanically and electrically) connected to the memory **115M**.

[0043] The fingerprint sensor **115F** can be used to biometrically authenticate the user. The fingerprint sensor **115F** can be any suitable sensor, such as the FPC1300-SERIES by Fingerprint Cards™ or the VFS75xx by Synaptics™. The fingerprint sensor **115F** can be electrically connected to the memory **115M** so that captured biometric data can be provided to the memory **115M** for processing. Successful biometric authentication can cause the user device **115** to activate and perform operations for gaining access. For example, in some embodiments, the fingerprint sensor **115F** can be used to activate the contactless element **115L** for a contactless communications (e.g., in conjunction with the memory **115M**). In some embodiments, other types of biometric sensors can be incorporated instead of or in addition to the fingerprint sensor **115F**, such sensors for recognizing a person's voice, speech patterns, retina, iris, face, DNA, hand geometry, palm print, gait, certain behaviors, etc.

[0044] In some embodiments, the fingerprint sensor **115F** can be part of a package that includes a fingerprint microcontroller unit (MCU) that is connected to the fingerprint sensor **115F**. The fingerprint MCU can store an enrolled fingerprint template, extract a captured fingerprint template from a fingerprint image captured by the fingerprint sensor **115F**, determine whether the captured fingerprint template matches the enrolled fingerprint image, and then notify an application running on the memory **115M**) about the match result (e.g., in order to activate the contactless element **115L** or the electrical contacts **115C**).

[0045] In some embodiments, a magnetic stripe (not shown) may also be present on the substrate **115S**. The magnetic stripe may enable the user device **115** to provide information to the access device via a magnetic stripe reader at the access device.

[0046] In some embodiments, identification information (not shown) may also be printed or embossed on the user device **115**. Identification information can include, for example, an account number, expiration date, and/or a user name.

[0047] Another advantage of the configuration shown in **FIGS. 2-3** is that multiple separate semiconductor chip components can be integrated into a single semiconductor chip component or package. For example, the configuration shown in **FIG. 1** involves both the memory as a first semiconductor chip component and a separate fingerprint MCU at the fingerprint sensor **15F** as a second semiconductor chip component. In contrast, the configuration shown in **FIGS. 2-3** allows the fingerprint MCU to be combined with the memory **115M** to create a single combined semiconductor chip component. Producing one semiconductor chip component instead of separately producing and then connecting two provides a further improvement to manufacturing efficiency and simplicity.

[0048] In some embodiments, the functionality of the fingerprint microcontroller unit (MCU) can be incorporated into the memory **115M**. Accordingly, one combined semiconductor chip component can include the functionality and operability of the memory **115M** (e.g., executing contact and contactless access applications) as well as the functionality and operability of the fingerprint MCU (e.g., biometric authentication processing).

[0049] In some embodiments, the memory **115M** and fingerprint MCU remain as separate chips with separate logic, while still being physically combined into a single die. A die, in the context of integrated circuits, is a small block of semiconducting material on which a given functional circuit is fabricated. If in the form of separate chips with separate logic, the memory **115M** and fingerprint MCU can still be communicatively and operatively connected.

[0050] In some embodiments, the user device **115** can be configured so that different actions activate different communication modes. For example, a first type of action can be inserting the user device **115** into a contact reader at an access device. This first type of action can cause the electrical contacts **115C** and/or a corresponding application to be activated (e.g., by the memory **115M**). When the

user device **115** is inserted into the contact reader, electrical communication signals from the contact reader may be received by the electrical contacts **115C** and transmitted to the memory **115M**, which may in turn initiate a contact-based access process. A second type of action can be providing biometric input. This second type of action can cause the contactless element **115L** and/or a corresponding application to be activated (e.g., by the memory **115M**). For example, a fingerprint applied to the fingerprint sensor **115F** may cause the memory **115M** to activate the contactless element **115L** and/or a corresponding application, and otherwise initiate a contactless-based access process. In this way, embodiments allow different modes of communication to be associated with and activated by different inputs to the user device **115**.

[0051] **FIG. 4** shows a cross sectional view of the user device **115**, according to embodiments of the invention. This cross section shows the first cavity **115X** and the second cavity **115Z** formed in the substrate **115S**. The memory **115M** can be placed within the first cavity **115X**, and the fingerprint sensor **115F** and/or the electrical contacts **115C** can be placed within the second cavity **115Z**. Additionally, two connectors **771** and **772** are shown in between the first cavity **115X** and the second cavity **115Z**. These connectors can represent solder balls (or solder bumps), or any other suitable means for providing a direct electrical connection between components, and additional connectors may be present in the user device **115** to connect the components.

[0052] For example, the first connector **771** can represent a soldered connection between the memory **115M** and the fingerprint sensor **115F**, and the second connector **772** can represent a soldered connection between the memory **115M** and the electrical contacts **115C**. While a single soldered connection is shown for fingerprint sensor **115F**, and another single soldered connection is shown for electrical contacts **115C**, there may be more than one soldered connection for each component, in some embodiments. For example, the first connector **771** can represent a soldered connection for providing electrical signal communications between the memory **115M** and the fingerprint sensor **115F**, and another soldered connection (not shown) can be included to provide power to the fingerprint sensor

115F. Similarly, the second connector **772** can represent a soldered connection for providing electrical signal communications between the memory **115M** and the electrical contacts **115C**, and another soldered connection (not shown) can be included to provide power to the electrical contacts **115C**.

[0053] Accordingly, as shown by the connectors **771** and **772**, each of the fingerprint sensor **115F** and the electrical contacts **115C** can be connected to the memory **115M** without wires. As a result, the fingerprint sensor **115F** can be connected to the memory **115M** through non-wire connectors (e.g., solder balls). This is in contrast to the user device **15** shown in **FIG. 1**, where the wires **15W** connect the fingerprint sensor **15F** to the memory. As mentioned above, when wires are used, two different connection processes are required for each wired connection, whereas one connection process can be used for each direct, non-wired connection in embodiments of the invention.

[0054] **FIG. 4** also shows fill material **115G**. The fill material **115G** (e.g., a thermoset plastic such as polyimide) can be inserted into gap spaces between the components in order to reduce empty spaces and secure the components. For example, there may be excess space to be filled between the electrical contacts **115C**, the fingerprint sensor **115F**, the memory **115M**, one or more walls of the first cavity **115X**, and/or one or more walls of the second cavity **115Z**. The fill material **115G** can be any suitable material, such as injected plastic material. The fill material 115G may be provided into two or more steps as components are placed in the cavities **115X**, **115Z**.

[0055] Embodiments allow the fingerprint sensor **115F** and/or electrical contacts **115C** to be in different positions on the user device **115**, but still adjacent to one another and overlapping the memory **115M** so that the benefits described with respect to **FIGS. 2-4** still apply. For example, **FIGS**. **5A-5B** show additional examples of possible card configurations, according to embodiments of the invention.

[0056] While **FIG. 2** shows the fingerprint sensor **115F** positioned above of the electrical contacts **115C**, **FIG. 5A** shows the fingerprint sensor **115F** positioned

below the electrical contacts **115C**, and **FIG. 5B** shows the fingerprint sensor **115F** positioned to the right of the electrical contacts **115C**. Embodiments allow the fingerprint sensor **115F** to be in any other suitable position, such as to the left of the electrical contacts **115C**, diagonal of the electrical contacts **115C**, or at any suitable angle relative to the electrical contacts **115C**. The locations, shapes, and orientations of cavities described above with respect to **FIGS. 3** and **4** can also be modified to accommodate the desired positions of the fingerprint sensor **115F** and the electrical contacts **115C**.

[0057] While the illustrated examples show the fingerprint sensor **115F** and the electrical contacts **115C** both located near the left side of the card, embodiments allow both to be located together in other areas of the card, such as near the right side of the card, near the center of the card, near the top of the card, near the bottom of the card, and/or at any intermediary zones of the card. The fingerprint sensor **115F** may be near a card edge, but preferably spaced at least 5 millimeters from the closest card edge. In landscape orientation, it is preferred to space the fingerprint sensor **115F** at least 5 millimeters from the top edge of the card (e.g., when the fingerprint sensor **115F** is located near the top of the card), at least 5 millimeters from the bottom edge of the card (e.g., when the fingerprint sensor **115F** is located near the bottom of the card), and at least 5 millimeters from the right edge of the card (e.g., when the fingerprint sensor **115F** is located near the right side of the card), and at least 8.5 millimeters from the left edge of the card (e.g., when the fingerprint sensor **115F** is located near the left side of the card).

[0058] In some embodiments, certain positions may be preferred, although embodiments are not limited thereto. For example, if the fingerprint sensor **115F** is located to the left of the electrical contacts **115C** (e.g., between the electrical contacts **115C** and the nearest horizontal card-edge), the fingerprint sensor **115F** may interfere with contact communications where the electrical contacts **115C** comes into contact with a contact reader. Similarly, if the fingerprint sensor **115F** is located to above the electrical contacts **115C** (e.g., as shown in **FIGS. 2 and 3**), the fingerprint sensor **115F** may interfere with a magnetic stripe which is typically located in or near that same area (e.g., on the backside of the card). Accordingly, it may be

preferable to have the fingerprint sensor **115F** located in other areas, such as below the electrical contacts **115C** (e.g., as shown in **FIG. 5A**) or to the right of the electrical contacts **115C** (e.g., as shown in **FIG. 5B**).

[0059] **FIG. 6** shows an example of dimensions of a user device **115** and several components of the user device **115**, according to embodiments of the invention. The dimensions can vary in any suitable manner. As shown, the user device **115** may have a horizontal width of 85.6 millimeters and a vertical height of 54 millimeters. The electrical contacts **115C** may have a width in the range of 12 to 20 millimeters and a height in the range of 12 to 20 millimeters. Similarly, the fingerprint sensor **115F** may have a width in the range of 12 to 20 millimeters and a height in the range of 12 to 20 millimeters. The left edges of the electrical contacts **115C** and fingerprint sensor **115F** may be spaced from the left edge of the card by a distance of 8.5 millimeters, and the right edges of the electrical contacts **115C** and fingerprint sensor **115F** may be spaced from the left edge of the card that same distance plus the width of the components (e.g., which may total 22 millimeters, as shown in the figure).

[0060] The electrical contacts **115C** may be spaced from the top edge of the card by a distance of 18 millimeters, and the fingerprint sensor **115F** may be spaced from the top edge of the card by a distance of 30 millimeters. In this case, if the electrical contacts **115C** have a height of 12 millimeters, then the fingerprint sensor **115F** would be directly adjacent to, or even contacting, the electrical contacts **115C** (e.g., because 18 millimeters + 12 millimeters = 30 millimeters). Embodiments allow the electrical contacts **115C** and fingerprint sensor **115F** to be very close. Even if not directly in contact, the distance between the electrical contacts **115C** and the fingerprint sensor **115F** may be negligible (e.g., 1 millimeter or less than 1 millimeter) compared to the other distances and dimensions of the card shown in **FIG. 6**.

[0061] The contactless element **115L** may be an antenna in the form of a single-turn coil, in some embodiments. In the example shown in **FIG. 6**, the coil is rectangular with a width of 72 millimeters and a height of 42 millimeters. Embodiments allow the coil dimensions to vary in any suitable manner. For

example, the coil can be larger if allowed by the size of the user device **115**, or smaller if required by the size of the user device **115**. While the contactless element **115L** is shown to the right of the electrical contacts **115C** and fingerprint sensor **115F** in **FIG. 6**, the contactless element **115L** may alternatively extend further to the left of the user device **115** and encircle the electrical contacts **115C** and fingerprint sensor **115F**. The contactless element **115L** may thereby utilize more of the available width of the user device **115** so that a coil with a rectangular width of 72 millimeters can fit on a user device **115** width of 85.6 millimeters.

[0062] A method according to embodiments of the invention can be described with respect to **FIG. 7**.

[0063] A user device **115**, according to embodiments described above, can be created through a method **700** of manufacturing.

[0064] At step **S701**, a substrate **115S** can be created, for example by molding, cutting, shaping, or otherwise manipulating any suitable material (e.g., plastic or metal) into a thin rectangular form. The substrate **115S** can include one or more layers, and one or more types of material. Suitable methods may include press molding and injection molding.

[0065] At step **S702**, a first cavity **115X** can be created within the substrate **115S**. For example, a rectangular (or any other suitable shaped) cavity can be etched (e.g., laser etching or chemical etching with lithography), drilled, or otherwise formed by removing portion of the substrate **115S**.

[0066] At step **S703**, a second cavity **115Z** can be created within the substrate **115S**. The second cavity **115Z** can be an additional cavity that is located adjacent to the first cavity **115X**. For example, the second cavity **115Z** can be positioned underneath the first cavity **115X** so that it is deeper than the first cavity **115X**. The second cavity **115Z** may be created in the same way or a different way than the first cavity **115X**. For example, the part forming the opening of the second cavity **115Z** can be open, while the remainder of the substrate **115S** can be masked. The

exposed area of the substrate **115S** can etched to the desired depth to form the second cavity **115Z**, and the mask can then be removed.

[0067] At step **S704**, one or more components can be inserted into the second cavity **115Z**. For example, a memory **115M** can be inserted into the second cavity **115Z**. A bonding material or adhesive may be on the memory **115M** so that it adheres to the bottom surface of the second cavity **115Z**.

[0068] At step **S705**, one or more electrical connectors can be provided on the memory. For example, one or more solder balls can be placed at the memory so that other components (e.g., the electrical contacts **115C** and the fingerprint sensor **115F**) can be electrically connected to the memory when they are placed on top of the memory (e.g., in step **S706**). Alternatively, solder can a printed on the contacts **115C** or the fingerprint sensor **115F** and they may be mounted in the first cavity **115X** and attached to the memory **115M**.

[0069] At step **S706**, one or more components can be provided into the first cavity **115X**. For example, pre-existing components such as electrical contacts **115C** and a fingerprint sensor **115F** can be inserted into the first cavity **115X** (e.g., above the first cavity **115X** and the memory **115M**). In some embodiments, the electrical contacts **115C** may not be a separate pre-existing component that is inserted into the first cavity **115X**, and instead may be printed onto the first cavity **115X** or otherwise fabricated while being applied to the first cavity **115X**.

[0070] In some embodiments, when the electrical contacts **115C** and the fingerprint sensor **115F** are placed or otherwise provided at the first cavity **115X**, they may contact the solder balls from step **S705**. As a result, the electrical contacts **115C** and the fingerprint sensor **115F** can become soldered to the memory **115M** when placed into the first cavity **115X** in step **S706**. This results in a first physical and/or electrical connection that is created between the memory **115M** and the fingerprint sensor **115F**, and a second physical and/or electrical connection that is created between the memory **115M** and the electrical contacts **115C**. Once connected, the memory **115M** can be communicatively and operatively connected to

the electrical contacts **115C**. The memory **115M** can also be communicatively and operatively connected to the fingerprint sensor **115F**.

[0071] At step **S707**, gap spaces between the components (e.g., the memory **115M**, electrical contacts **115C**, the fingerprint sensor **115F**, and cavity walls) can be filled using, for example, a plastic filling material. For example, there may be spaces to fill between the memory **115M** and the bottom surface forming the second cavity **115Z**, between the memory **115M** and one or more lateral walls defining the second cavity **115Z**, between the contact element **115C** and the fingerprint sensor **115F**, between the contact element **115C** and one or more lateral walls defining the first cavity **115X**, and/or between the fingerprint sensor **115F** and one or more lateral walls defining the first cavity **115X**. A vacuum injection process can be used to inject a filling material into the gaps and the filling material may subsequently be cured. In some embodiments, a protective plastic cover layer exposing the fingerprint sensor **115X**, the contacts **115C**, and any other functional components. may also be applied to the user device **115** in some cases.

[0072] Additionally, at this point or at another suitable (e.g., earlier) time, information can be loaded onto the memory **115M**. This can include one or more access applications, credentials, one or more encryption keys, a biometric template (e.g., fingerprint template), and/or any other suitable data.

[0073] In some embodiments, the user device **115** can be assembled in alternative manners. For example, the memory **115M** may all be electrically connected (e.g., via soldering) to the electrical contacts **115C** and the fingerprint sensor **115F** when these components are separate from the substrate **115S**. In such embodiments, a single combined package can be created that includes the memory **115M**, the electrical contacts **115C**, and the fingerprint sensor **115F**. The combined package can then be inserted all together into the cavities of the substrate **115S** at the same time.

[0074] **FIG. 8** shows an example of a system, according to embodiments of the invention. The system **800** includes a user device **115** in communication with an

access device **125**. The user device **115** can interact with the access device **125** in order to gain access.

[0075] The access device **125** may be any suitable device that provides access and/or determines whether access is to be granted. As examples, the access device **125** can provide access to physical space, information, a remote system, etc. The access device **125** may be in any suitable form. Some examples of access devices include kiosks, security systems, access systems, cellular phones, PDAs, personal computers (PCs), tablet PCs, hand-held specialized readers, set-top boxes, POS or point of sale devices (e.g., POS terminals), electronic cash registers (ECRs), automated teller machines (ATMs), virtual cash registers (VCRs), and the like. An access device may use any suitable contact or contactless mode of operation to send or receive data from, or associated with, the user device **115**. The access device **125** may include a reader, a processor, a computer-readable medium, input elements (e.g., buttons), and/or a network interface. A reader may include any suitable contact or contactless mode of operation. For example, exemplary card readers can include contactless readers (e.g., radio frequency (RF) antennas), contact chip readers, optical scanners, bar code readers, or magnetic stripe readers to interact with the user device **115**.

[0076] Embodiments of the invention have a number of advantages. For example, in embodiments of the invention, a user device is provided that can be manufactured and produced on a large-scale more efficiently and less costly in comparison with prior user devices. By placing certain components in the same area of the user device instead of in separate areas of the user device, wires can be reduced and/or removed, soldering points can be reduced, multiple integrated circuits can be combined into one, and manufacturing steps reduced and/or simplified. The elimination of wires can reduce undesirable electromagnetic effects, such as resistance and inductive capacitance, and thereby improve power efficiency and signal integrity. Additionally, the more compact and simple configuration can create a user device that is less error-prone and more resistant to damage.

[0077] A computer system will now be described that may be used to implement any of the entities or components described herein. Subsystems in the computer system are interconnected via a system bus. Additional subsystems include a printer, a keyboard, a fixed disk, and a monitor which can be coupled to a display adapter. Peripherals and input/output (I/O) devices, which can couple to an I/O controller, can be connected to the computer system by any number of means known in the art, such as a serial port. For example, a serial port or external interface can be used to connect the computer apparatus to a wide area network such as the Internet, a mouse input device, or a scanner. The interconnection via system bus allows the central processor to communicate with each subsystem and to control the execution of instructions from system memory or the fixed disk, as well as the exchange of information between subsystems. The system memory and/or the fixed disk may embody a computer-readable medium.

[0078] As described, the inventive service may involve implementing one or more functions, processes, operations or method steps. In some embodiments, the functions, processes, operations or method steps may be implemented as a result of the execution of a set of instructions or software code by a suitably-programmed computing device, microprocessor, data processor, or the like. The set of instructions or software code may be stored in a memory or other form of data storage element which is accessed by the computing device, microprocessor, etc. In other embodiments, the functions, processes, operations or method steps may be implemented by firmware or a dedicated processor, integrated circuit, etc.

[0079] Any of the software components or functions described in this application may be implemented as software code to be executed by a processor using any suitable computer language such as, for example, Java, C++ or Perl using, for example, conventional or object-oriented techniques. The software code may be stored as a series of instructions, or commands on a computer-readable medium, such as a random access memory (RAM), a read-only memory (ROM), a magnetic medium such as a hard-drive or a floppy disk, or an optical medium such as a CD-ROM. Any such computer-readable medium may reside on or within a

single computational apparatus, and may be present on or within different computational apparatuses within a system or network.

[0080] While certain exemplary embodiments have been described in detail and shown in the accompanying drawings, it is to be understood that such embodiments are merely illustrative of and not intended to be restrictive of the broad invention, and that this invention is not to be limited to the specific arrangements and constructions shown and described, since various other modifications may occur to those with ordinary skill in the art.

[0081] As used herein, the use of "a", "an" or "the" is intended to mean "at least one", unless specifically indicated to the contrary.

WHAT IS CLAIMED IS:

1. A user device comprising:

a substrate;

a first cavity in the substrate;

a second cavity in the substrate, the second cavity being adjacent to the first cavity in the substrate;

a memory within the second cavity;

electrical contacts within the first cavity, the electrical contacts at least partially overlapping the memory;

a fingerprint sensor within the first cavity, the fingerprint sensor at least partially overlapping the memory;

a first electrical connection between the memory and the electrical contacts, the first electrical connection enabling communication between the memory and the electrical contacts; and

a second electrical connection between the memory and the fingerprint sensor, the second electrical connection enabling communication between the memory and the fingerprint sensor.

2. The user device of claim 1, wherein the first cavity is larger than the second cavity.

3. The user device of claim 1, wherein the first and second electrical connections comprise soldered connections.

4. The user device of claim 3, wherein the second electrical connection includes a solder ball that contacts both the memory and the fingerprint sensor, and wherein the second electrical connection does not include a wire external to the memory and the fingerprint sensor.

5. The user device of claim 1, wherein the substrate is plastic card.

6. The user device of claim 1, wherein the memory includes a secure element.

7. The user device of claim 1, wherein walls defining the second cavity are cooperatively structured with the memory.

8. The user device of claim 1, wherein walls defining the first cavity are cooperatively structured with the electrical contacts and the fingerprint sensor when the electrical contacts and the fingerprint sensor are within the same plane, and wherein the electrical contacts are spaced less than 5 millimeters from the fingerprint sensor.

9. The user device of claim 1, wherein the memory is directly connected to the electrical contacts and the fingerprint sensor.

10. The user device of claim 1, further comprising:

plastic material filling gap spaces between the memory, the electrical contacts, the fingerprint sensor, and the substrate.

11. A method of manufacturing a user device, the method comprising:

creating a substrate;

creating a first cavity within the substrate;

creating a second cavity within the substrate, the second cavity being adjacent to the first cavity;

inserting a memory into the second cavity;

inserting a fingerprint sensor into the first cavity, the fingerprint sensor at least partially overlapping the memory, where the fingerprint sensor is electrically coupled to at least one first electrical connector connecting the fingerprint sensor to the memory; and

providing electrical contacts in the first cavity, the electrical contacts at least partially overlapping the memory, where one or more of the electrical contacts are electrically coupled to at least one second electrical connector connecting the electrical contacts to the memory.

12. The method of claim 11, further comprising:

filling gap spaces between the memory, the electrical contacts, the fingerprint sensor, and the substrate.

13. The method of claim 12, wherein filling the gap spaces includes inserting plastic material into the gap spaces.

14. The method of claim 11, further comprising:

loading a credential onto the memory.

15. The method of claim 11, further comprising:

loading a fingerprint template onto the memory.

16. The method of claim 11, wherein the first electrical connector and the second electrical connector comprise solder.

17. The method of claim 11, wherein a first set of walls defining the first cavity are cooperatively structured with the electrical contacts and the fingerprint sensor, and a second set of walls defining the second cavity are cooperatively structured with the memory.

18. The method of claim 11, wherein the user device is an access card.

19. The method of claim 11, wherein the substrate comprises plastic and is in the form of a card, and the memory includes a secure element.

20. The method of claim 11, wherein the first cavity is larger than the second cavity, and wherein the electrical contacts are laterally adjacent to the fingerprint sensor.

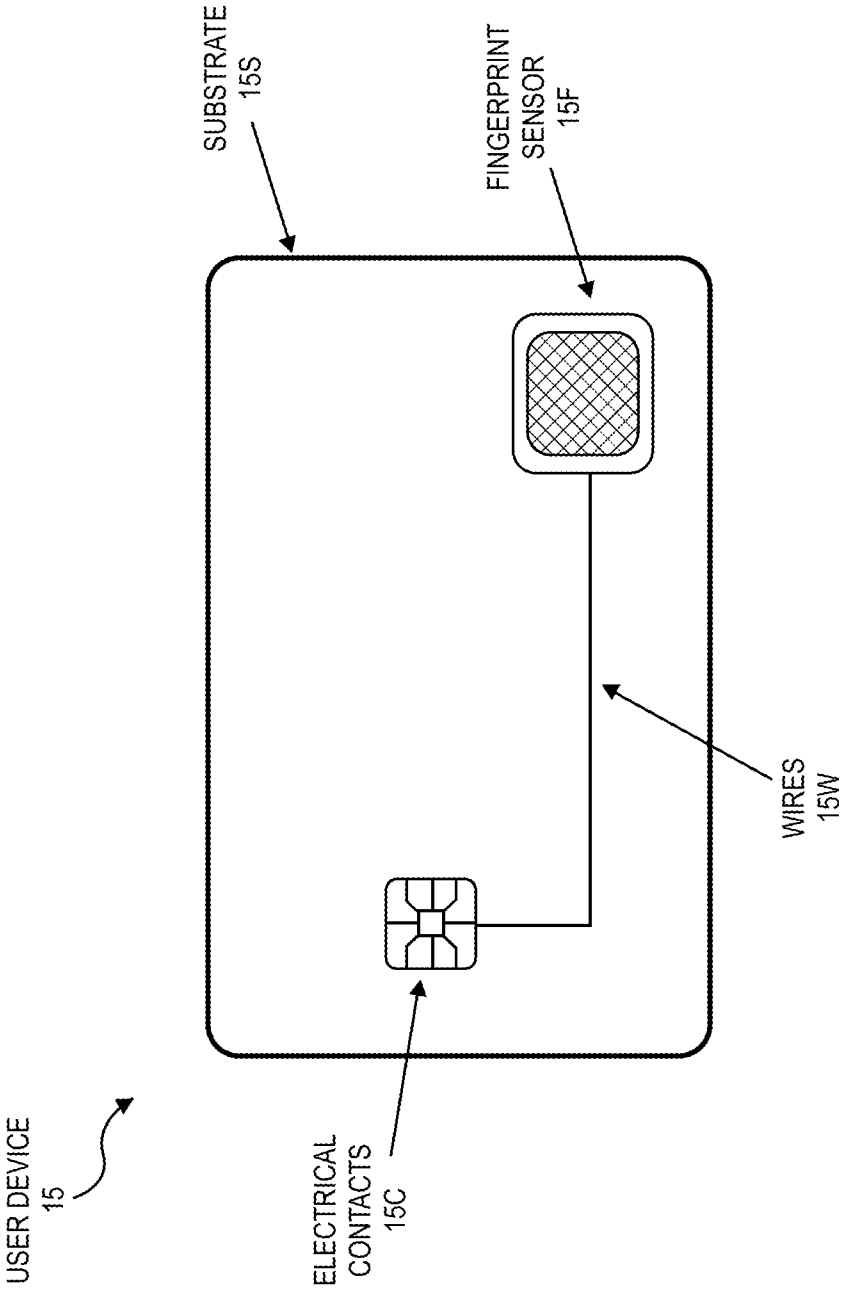

SUBSTRATE
15S
FINGERPRINT
SENSOR
15F
WIRES
15W
ELECTRICAL
CONTACTS
15C
USER DEVICE
15

FIG. 1

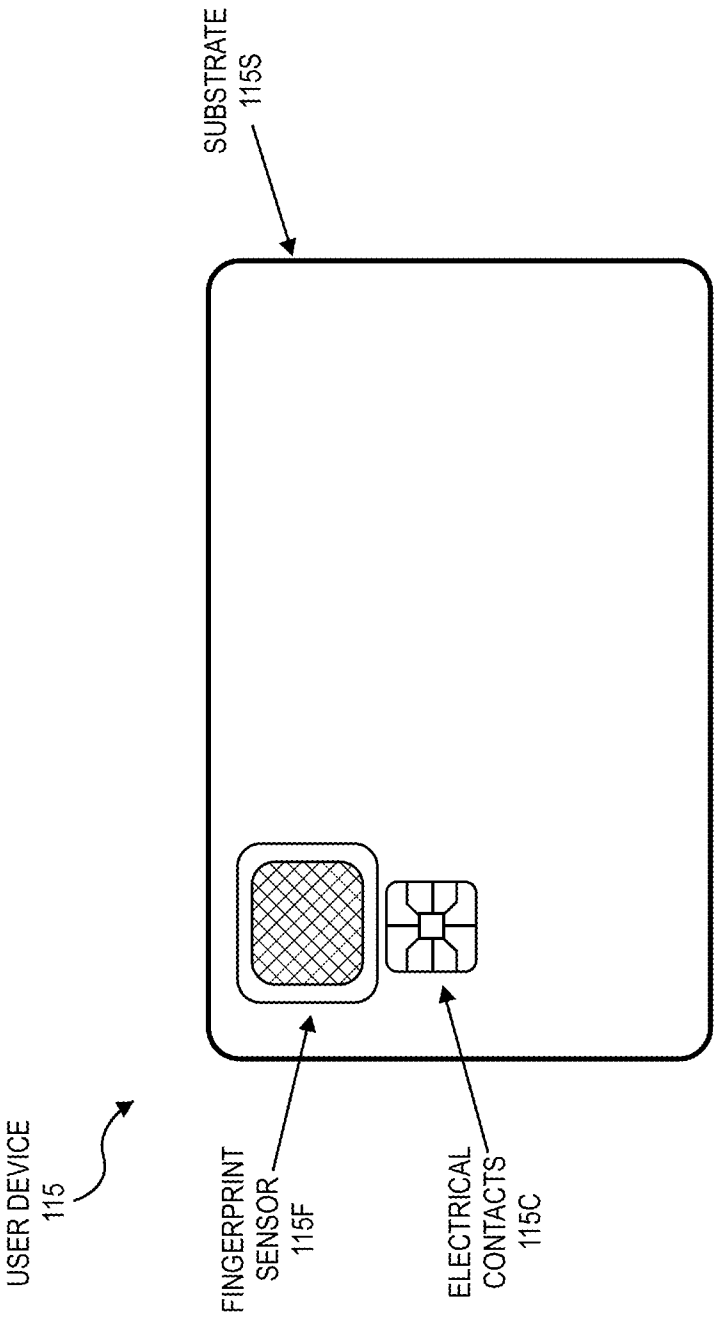

SUBSTRATE
115S
USER DEVICE
115
FINGERPRINT
SENSOR
115F
ELECTRICAL
CONTACTS
115C

FIG. 2

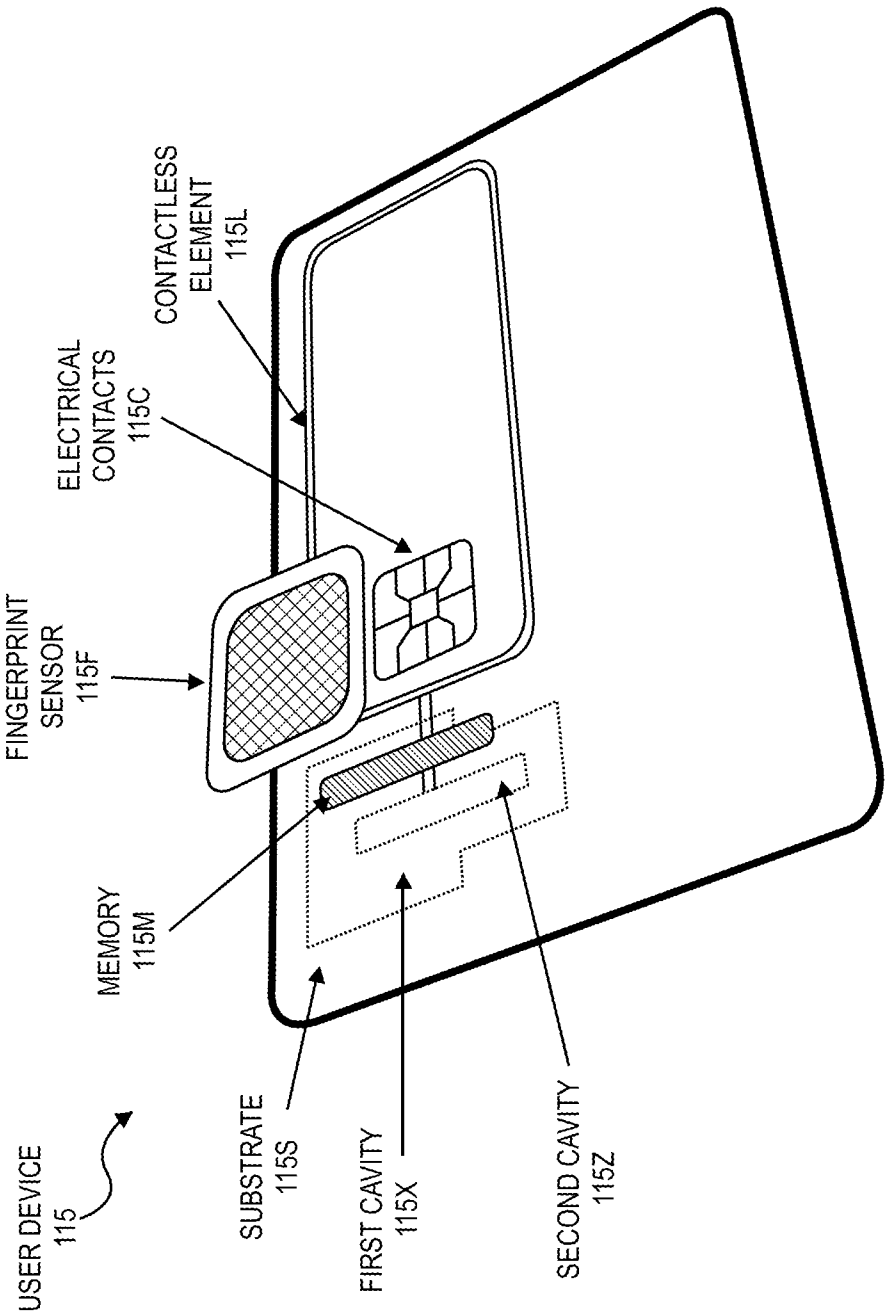

CONTACTLESS ELEMENT 115L
ELECTRICAL CONTACTS 115C
FINGERPRINT SENSOR 115F
MEMORY 115M
USER DEVICE 115
SUBSTRATE 115S
FIRST CAVITY 115X
SECOND CAVITY 115Z

FIG. 3

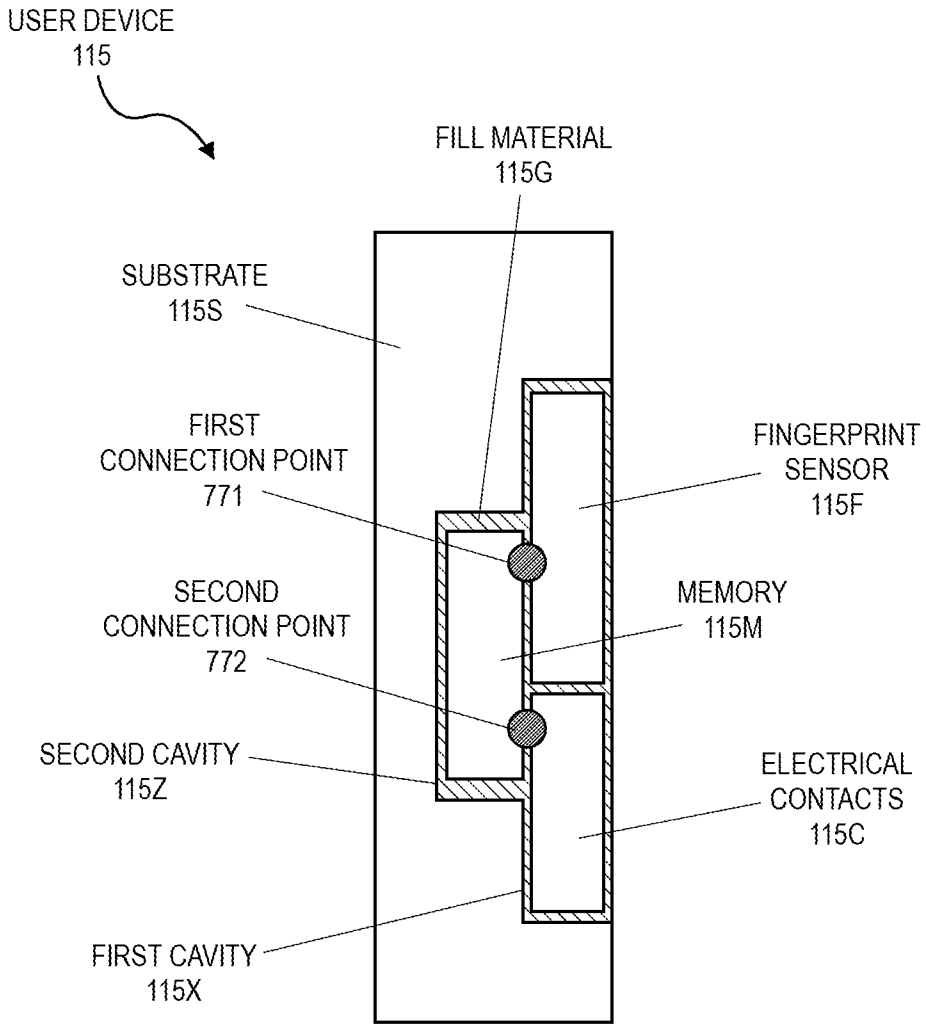

USER DEVICE
115
FILL MATERIAL
115G
SUBSTRATE
115S
FIRST
CONNECTION POINT
771
FINGERPRINT
SENSOR
115F
SECOND
CONNECTION POINT
772
MEMORY
115M
SECOND CAVITY
115Z
ELECTRICAL
CONTACTS
115C
FIRST CAVITY
115X

FIG. 4

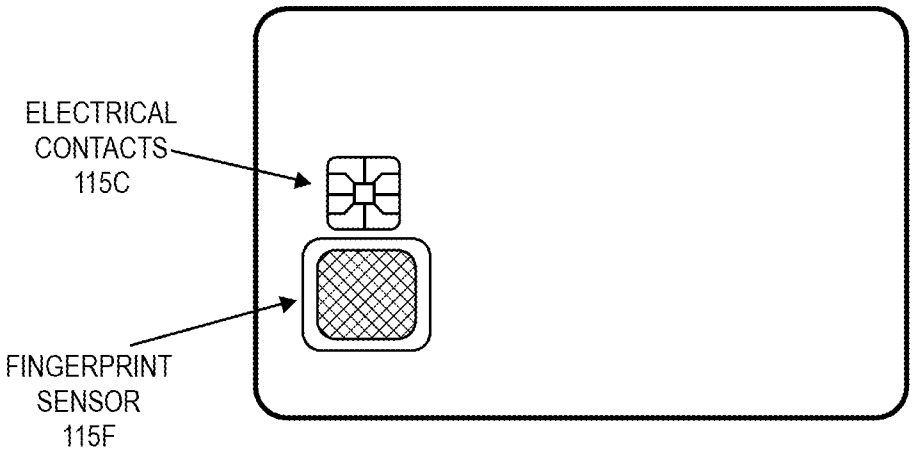

ELECTRICAL
CONTACTS
115C
FINGERPRINT
SENSOR
115F

FIG. 5A

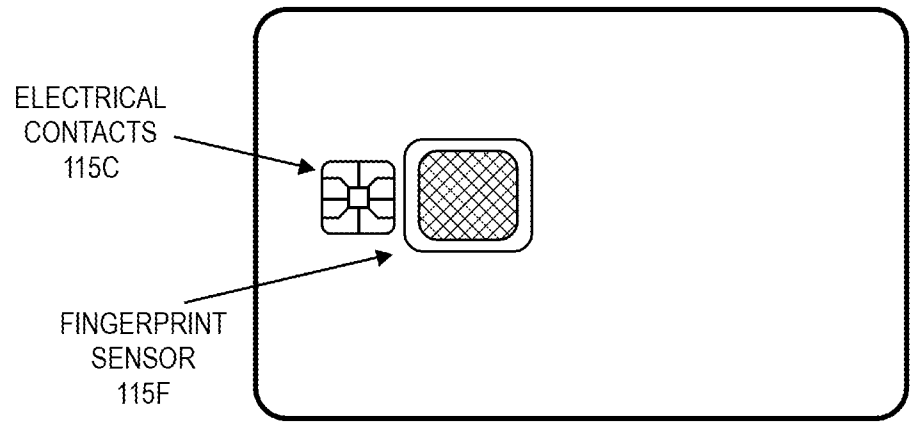

ELECTRICAL
CONTACTS
115C
FINGERPRINT
SENSOR
115F

FIG. 5B

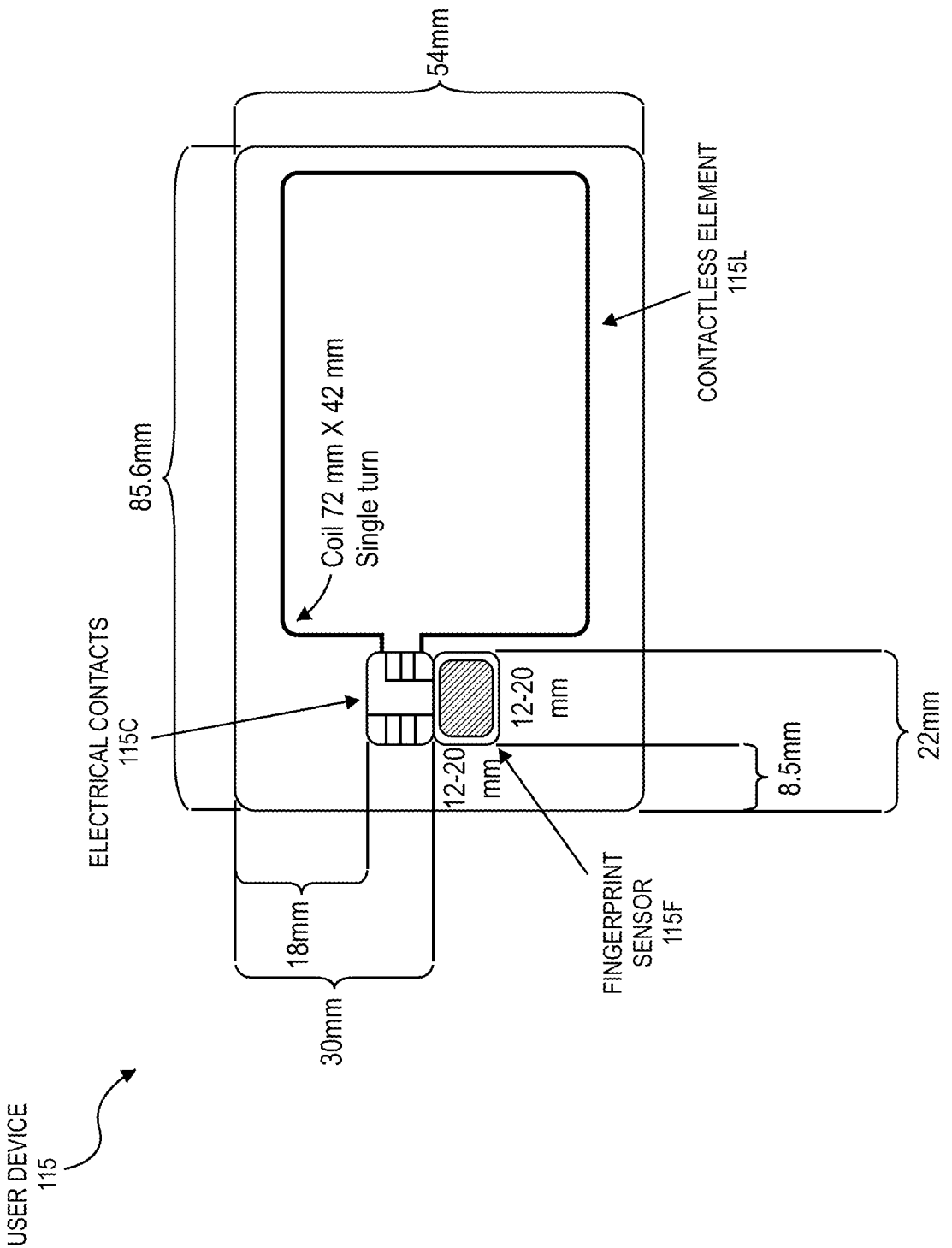

USER DEVICE
115
54mm
85.6mm
Coil 72 mm X 42 mm
Single turn
CONTACTLESS ELEMENT
115L
ELECTRICAL CONTACTS
115C
12-20
mm
12-20
mm
8.5mm
22mm
18mm
30mm
FINGERPRINT
SENSOR
115F

FIG. 6

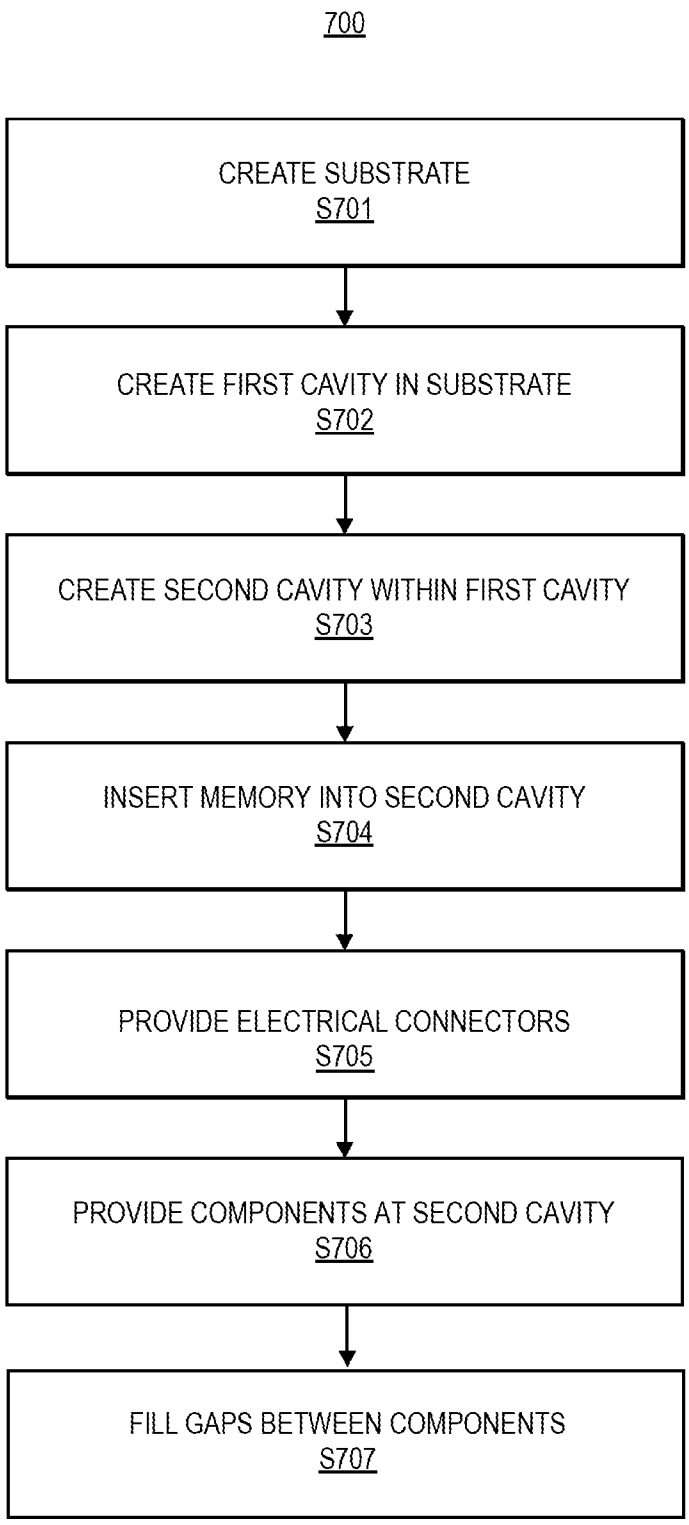

700
CREATE SUBSTRATE
S701
CREATE FIRST CAVITY IN SUBSTRATE
S702
CREATE SECOND CAVITY WITHIN FIRST CAVITY
S703
INSERT MEMORY INTO SECOND CAVITY
S704
PROVIDE ELECTRICAL CONNECTORS
S705
PROVIDE COMPONENTS AT SECOND CAVITY
S706
FILL GAPS BETWEEN COMPONENTS
S707

FIG. 7

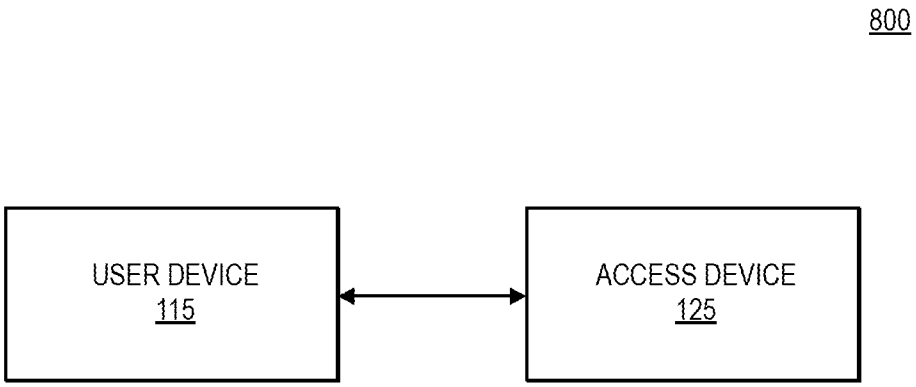


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2021/047398

A. CLASSIFICATION OF SUBJECT MATTER

G06K 19/07(2006.01)i; **G06K 9/00**(2006.01)i

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)

G06K 19/07(2006.01); G06F 21/32(2013.01); G06F 21/34(2013.01); G06K 19/077(2006.01); G06K 19/14(2006.01); G06K 7/10(2006.01); G06K 9/00(2006.01); H01Q 1/22(2006.01)

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

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: card, substrate, cavity, electrical contacts, fingerprint sensor

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2018-0174018 A1 (FINGERPRINT CARDS AB) 21 June 2018 (2018-06-21) paragraphs [0064]-[0067], claim 21 and figures 7a-7g	1-20
A	US 2020-0226443 A1 (MUSTAFA LOTYA et al.) 16 July 2020 (2020-07-16) the entire document	1-20
A	WO 2017-162311 A1 (ZWIPE AS) 28 September 2017 (2017-09-28) the entire document	1-20
A	KR 10-2018-0041014 A (KONA I CO., LTD.) 23 April 2018 (2018-04-23) the entire document	1-20
A	US 2019-0340398 A1 (CPI CARD GROUP - COLORADO, INC.) 07 November 2019 (2019-11-07) the entire document	1-20

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"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 November 2021	**30 November 2021**

Name and mailing address of the ISA/KR	Authorized officer
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/US2021/047398

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
US 2018-0174018 A1	21 June 2018	CN 108229340 A	29 June 2018
		CN 108229340 B	30 July 2021
		CN 207601824 U	10 July 2018
		EP 3336759 A1	20 June 2018
		EP 3336759 B1	19 June 2019
		EP 3564852 A1	06 November 2019
		JP 2020-503606 A	30 January 2020
		KR 10-2019-0096977 A	20 August 2019
		US 10395164 B2	27 August 2019
		US 2019-0340406 A1	07 November 2019
		WO 2018-111174 A1	21 June 2018
US 2020-0226443 A1	16 July 2020	US 10789524 B2	29 September 2020
WO 2017-162311 A1	28 September 2017	GB 2548637 A	27 September 2017
KR 10-2018-0041014 A	23 April 2018	CN 107944332 A	20 April 2018
		JP 2018-063688 A	19 April 2018
		JP 2019-160304 A	19 September 2019
		JP 6486974 B2	20 March 2019
		KR 10-1913110 B1	28 December 2018
		KR 10-2018-0118583 A	31 October 2018
		TW 201814594 A	16 April 2018
		TW I643133 B	01 December 2018
		US 10262322 B2	16 April 2019
		US 2018-0108018 A1	19 April 2018
US 2019-0340398 A1	07 November 2019	US 10783337 B2	22 September 2020
		WO 2018-035258 A1	22 February 2018