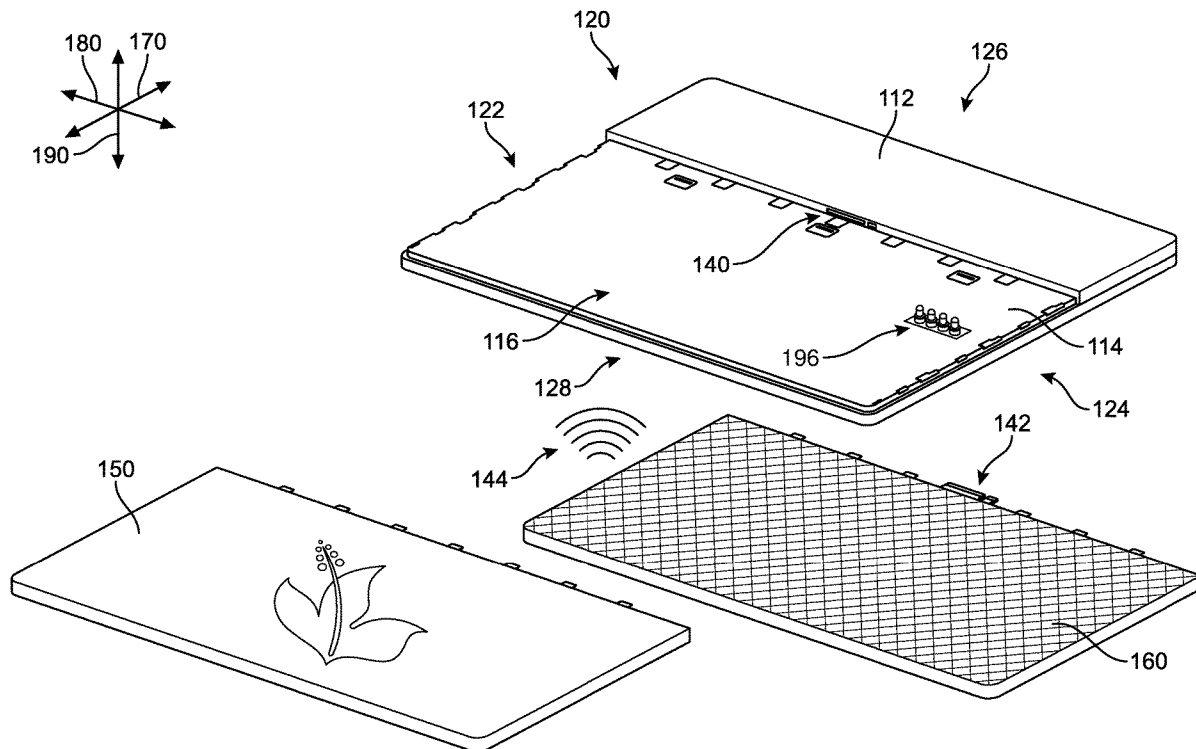




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(19) **United States**(12) **Patent Application Publication**
LANGE et al.(10) **Pub. No.: US 2020/0371560 A1**(43) **Pub. Date: Nov. 26, 2020**(54) **INTERCHANGEABLE HOUSING PANEL
WITH RECHARGEABLE POWER,
NETWORK CONNECTIVITY, AND MEMORY
FOR USE WITH PORTABLE COMPUTING
DEVICES****H05K 5/02** (2006.01)**H05K 5/03** (2006.01)(52) **U.S. CL.**CPC **G06F 1/1656** (2013.01); **G06F 1/1698**
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5/0256 (2013.01); **H05K 5/0239** (2013.01);
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G06F 1/16 (2006.01)
H01Q 1/22 (2006.01)(57) **ABSTRACT**

Interchangeable housing panel components for a display housing of a portable computing device with a cellular data module, power source, and memory. The interchangeable housing panel component is sized and dimensioned to be received by a receiving portion of the computing device. An interchangeable housing panel component is quickly installed by a user to customize the appearance of their computing device and, when desired, is also quickly removed, from the computing device. The interchangeable housing panel component further includes a cellular data module that is configured to provide the portable computing device with access to cellular networks. When desired, the interchangeable housing panel component can be removed and another interchangeable housing panel component can be installed. The housing panel components and computing device include provisions for easy removal and installation of the components.



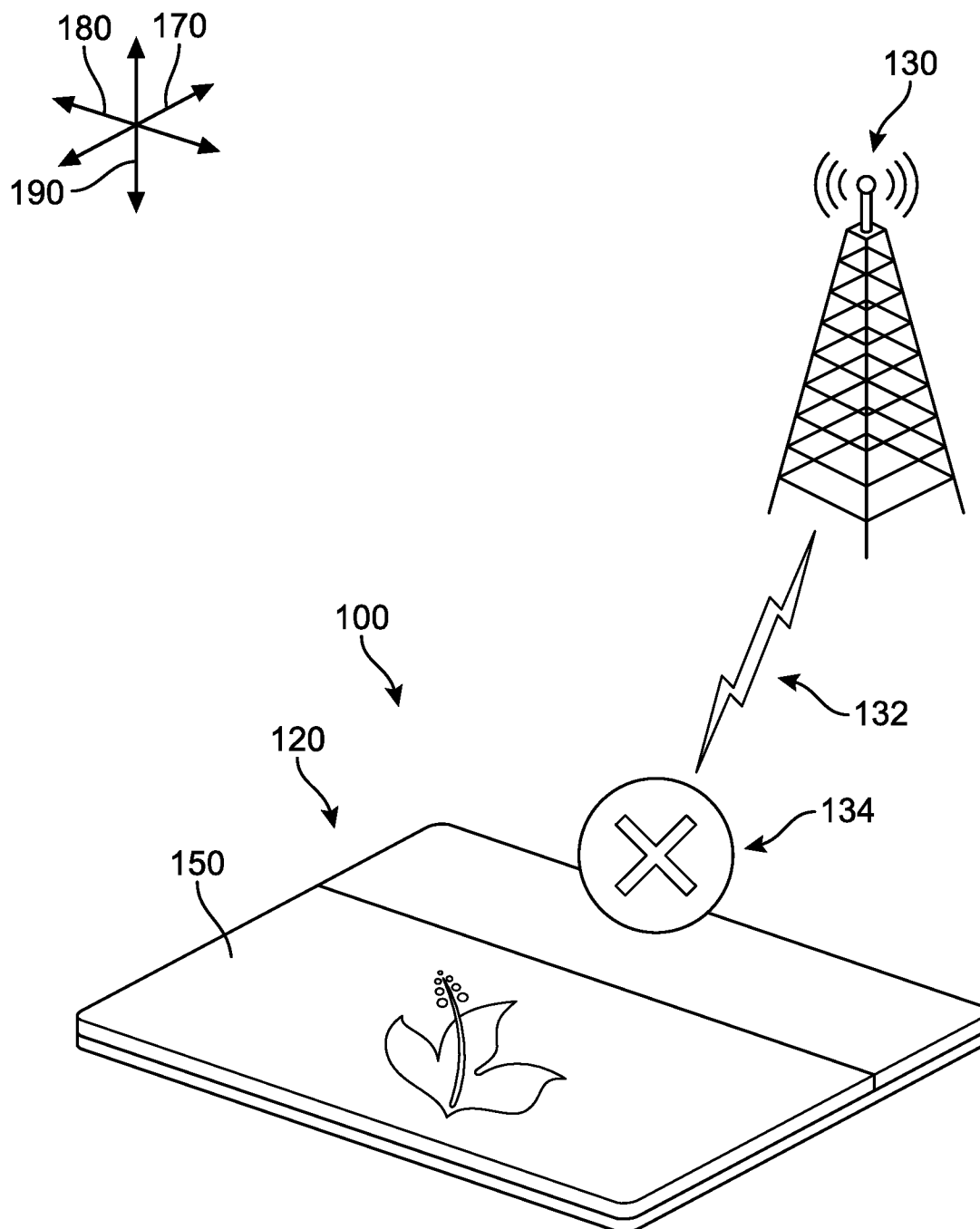


FIG. 1A

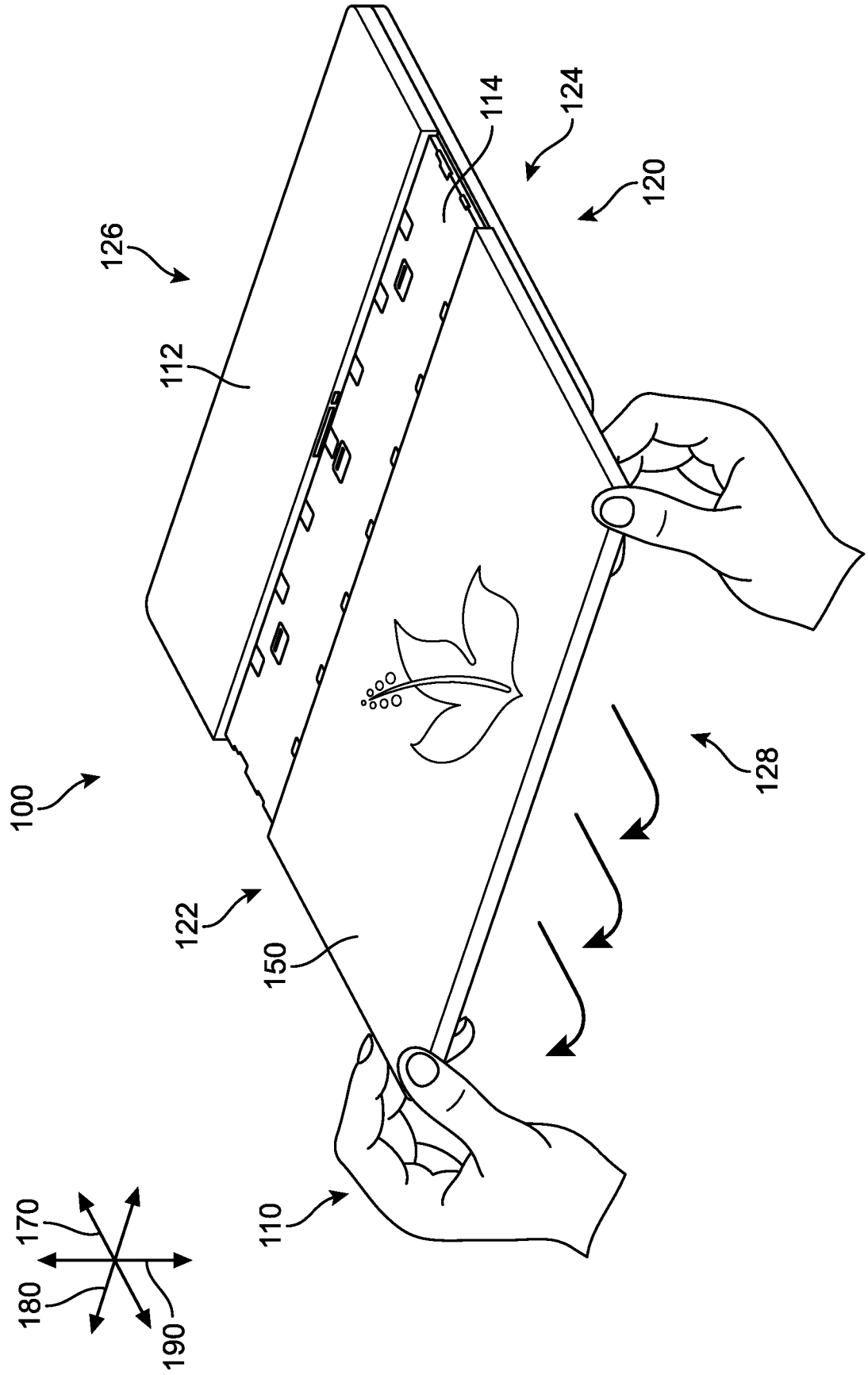


FIG. 1B

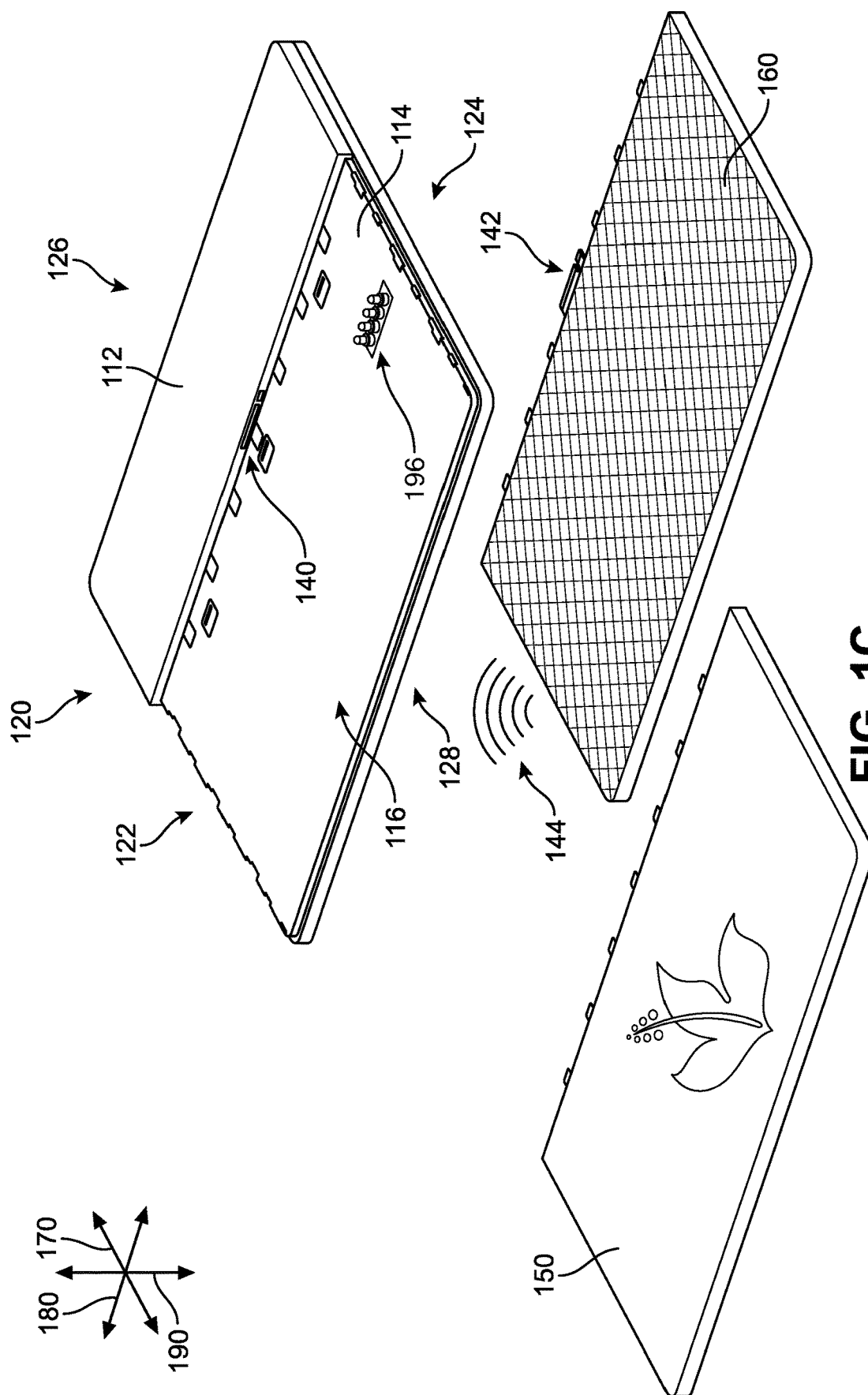


FIG. 1C

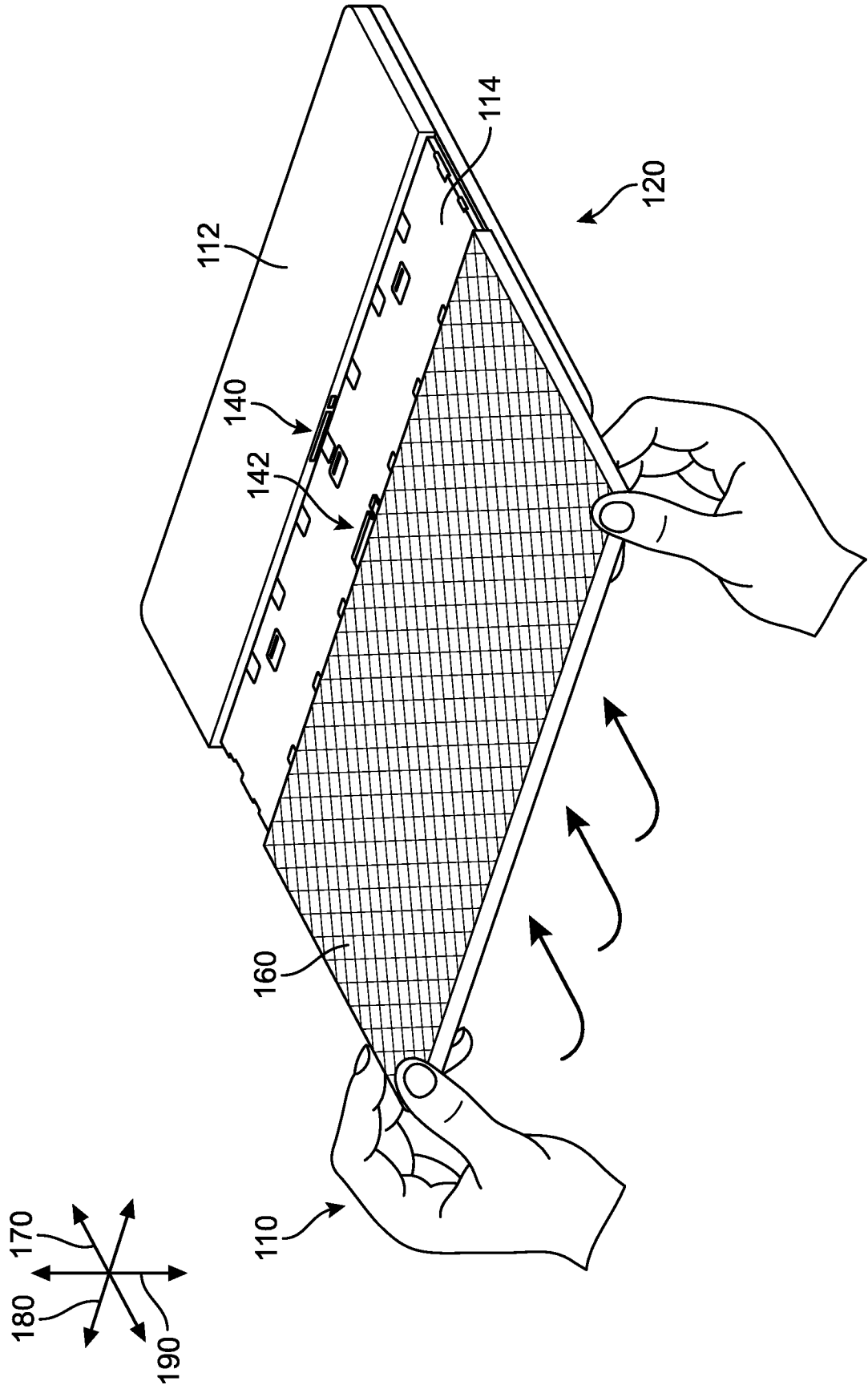


FIG. 1D

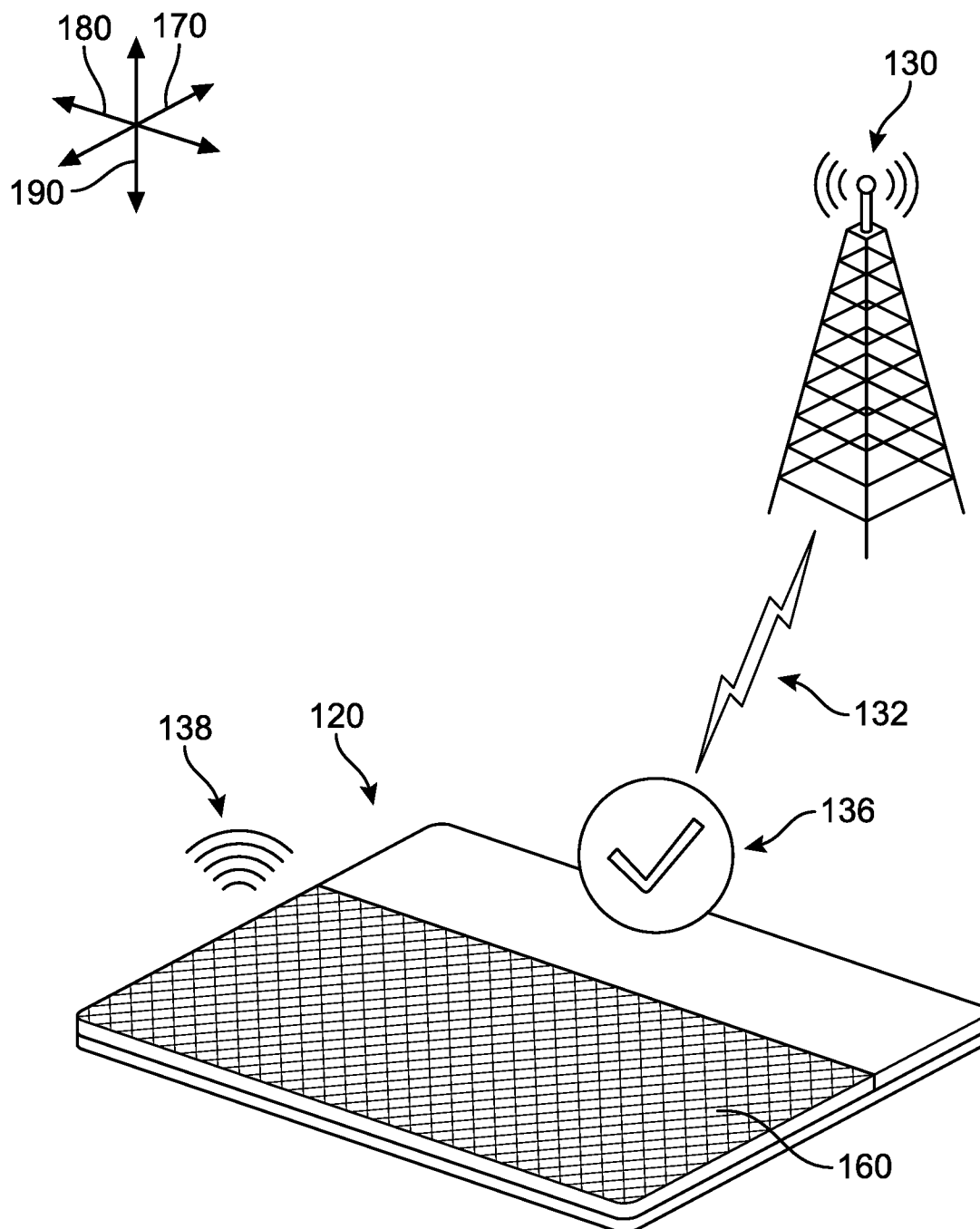
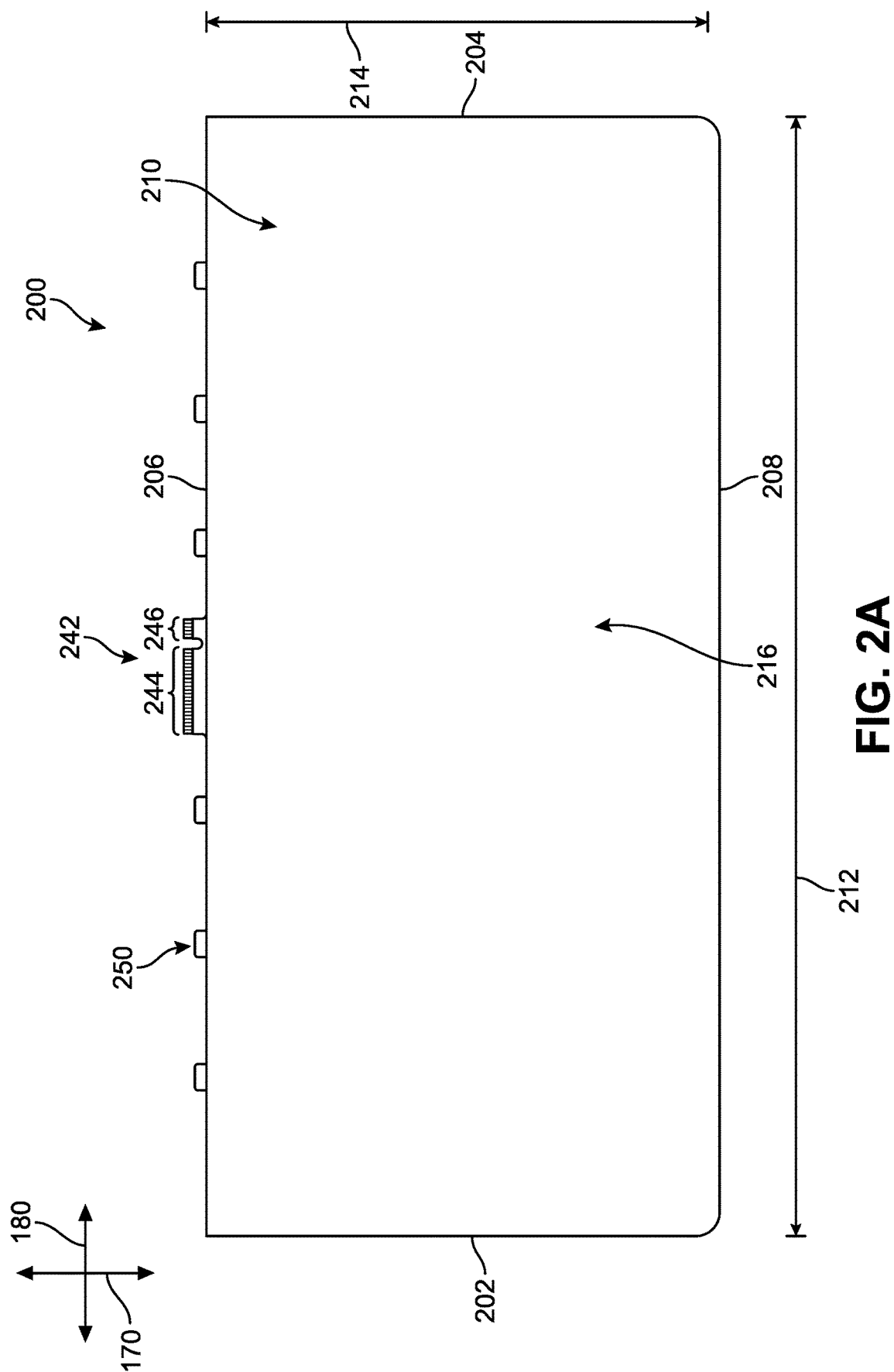


FIG. 1E



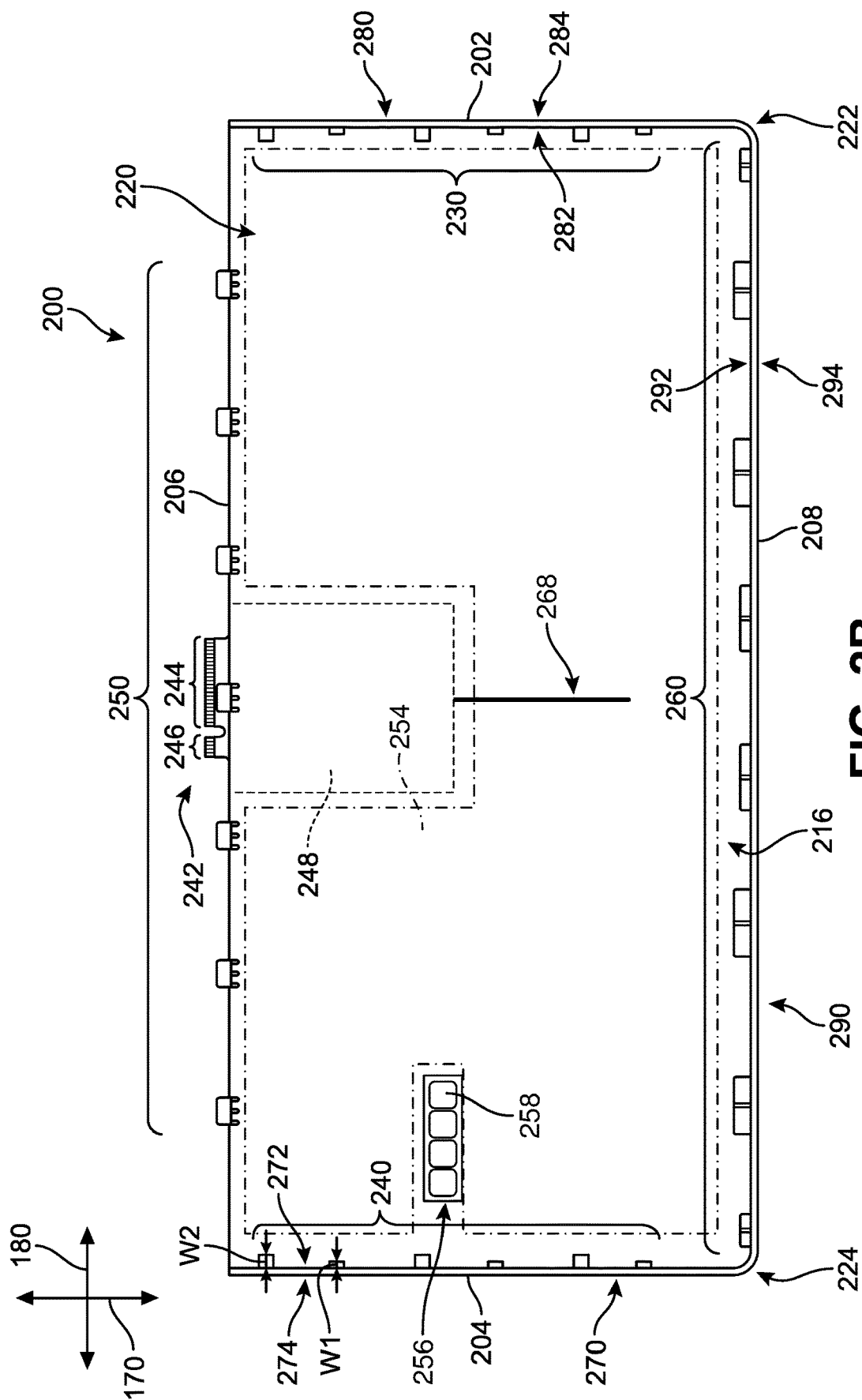


FIG. 2B

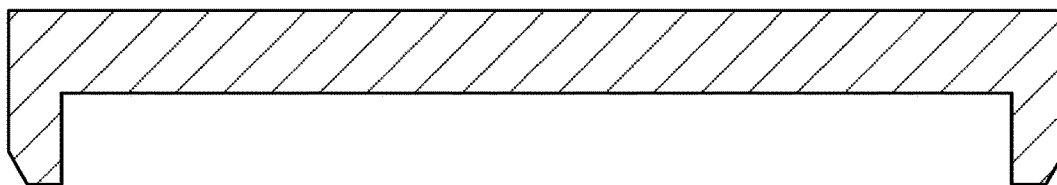


FIG. 2C

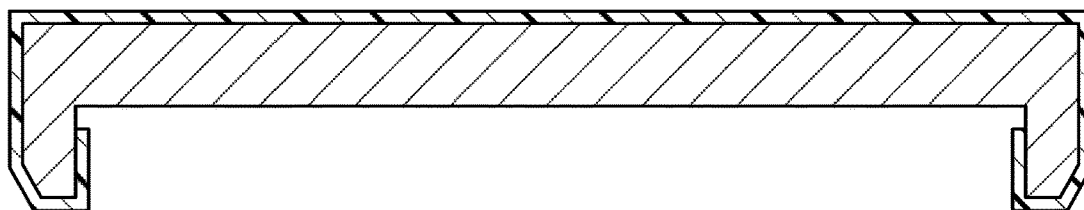


FIG. 2D

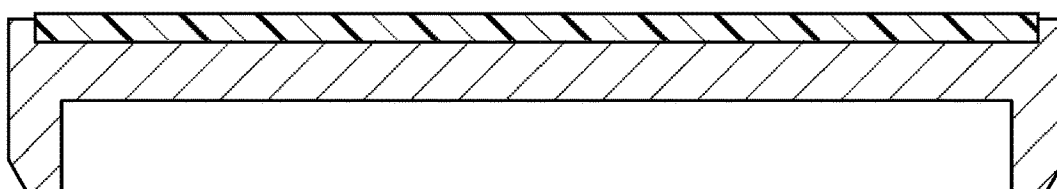


FIG. 2E

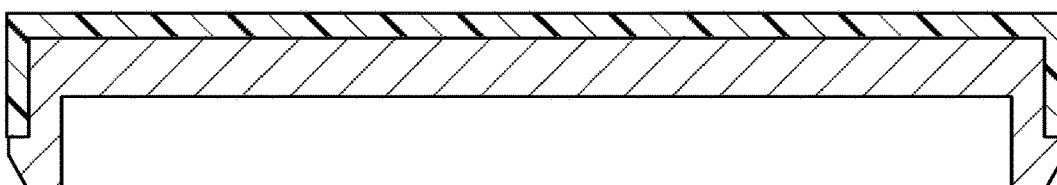


FIG. 2F

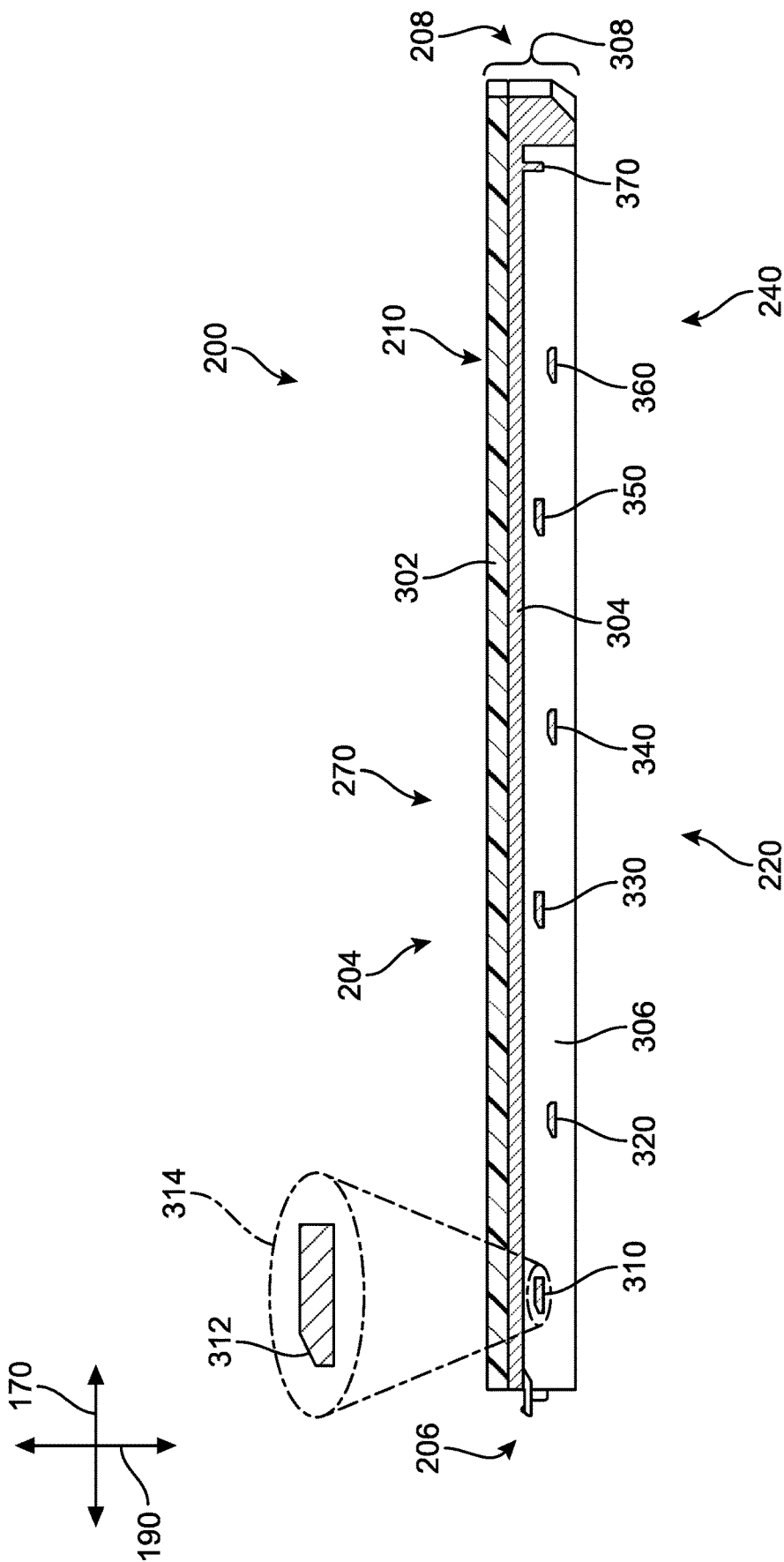


FIG. 3A

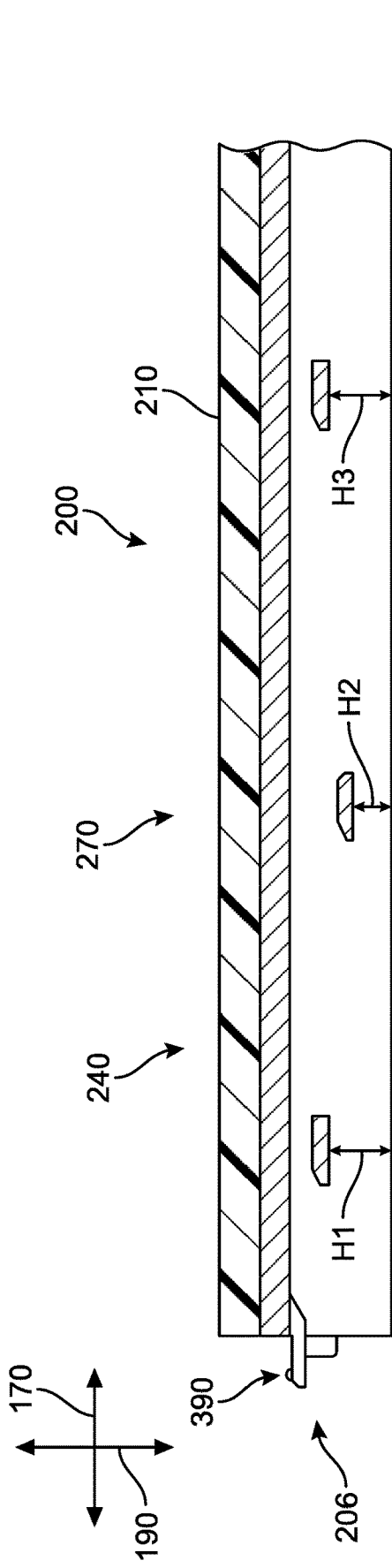


FIG. 3B

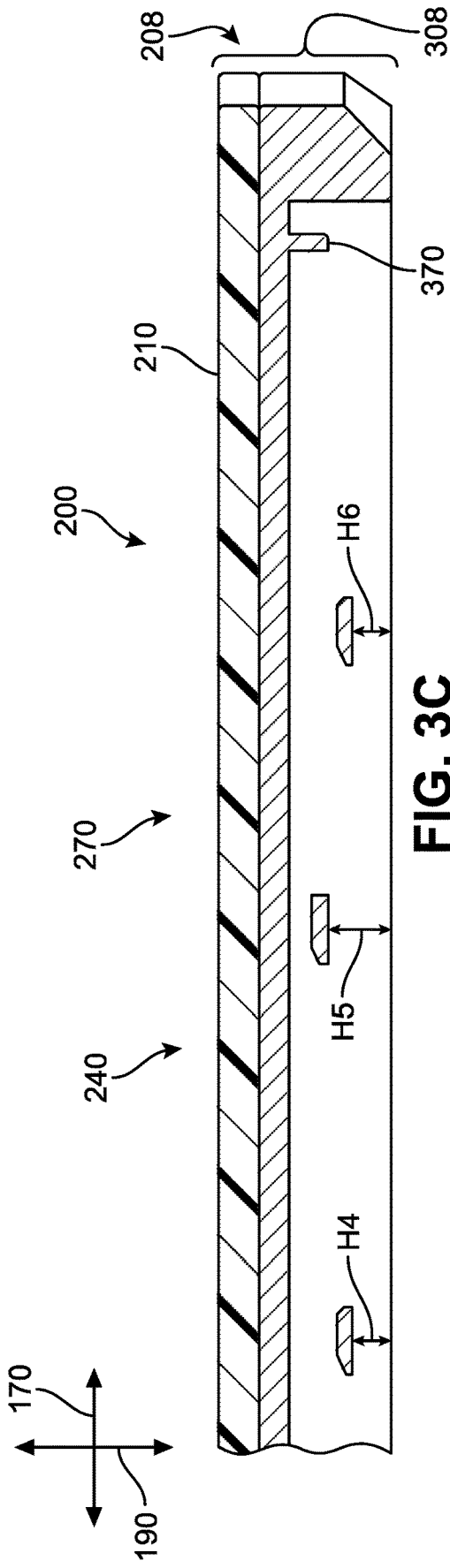


FIG. 3C

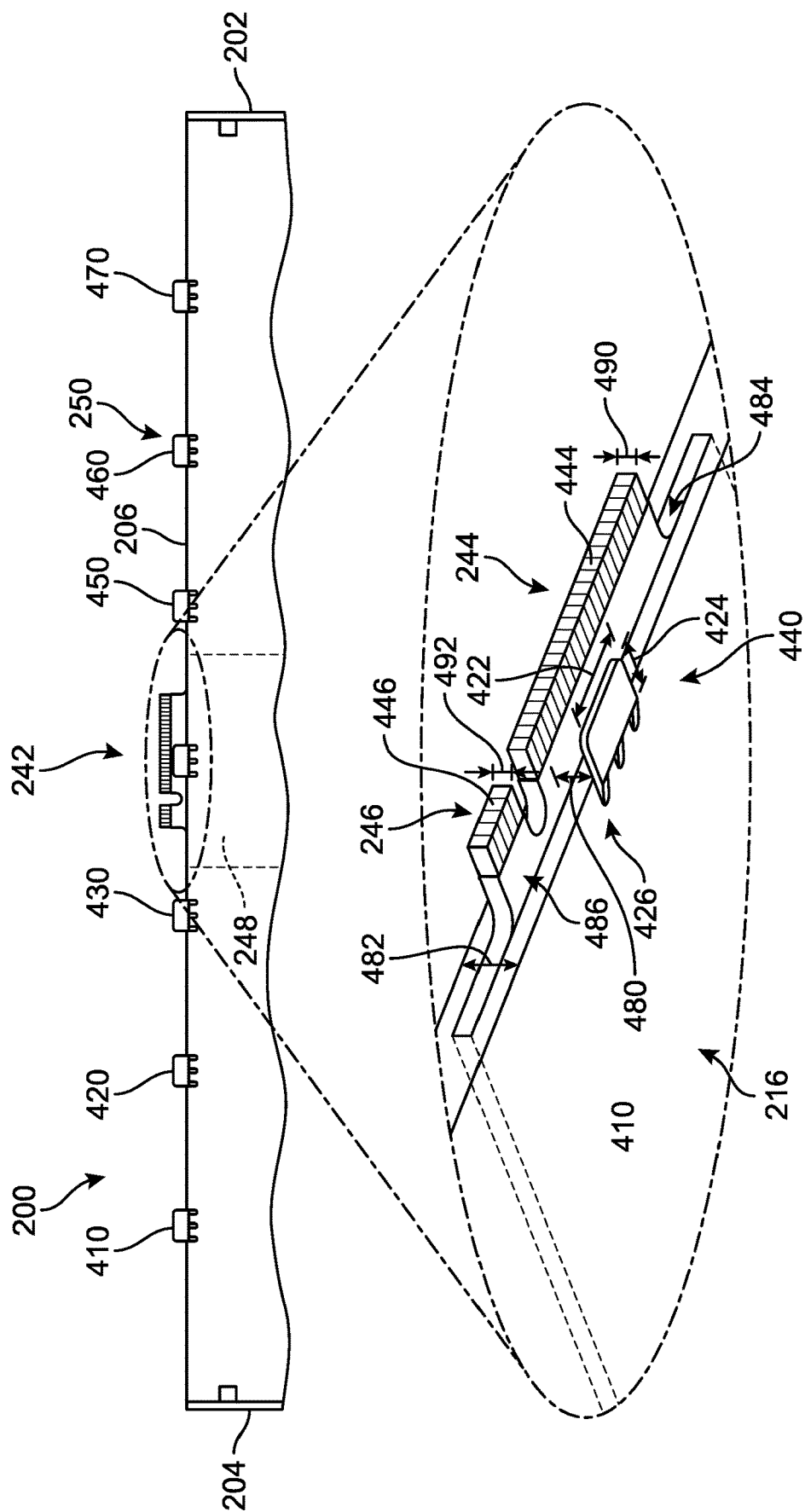
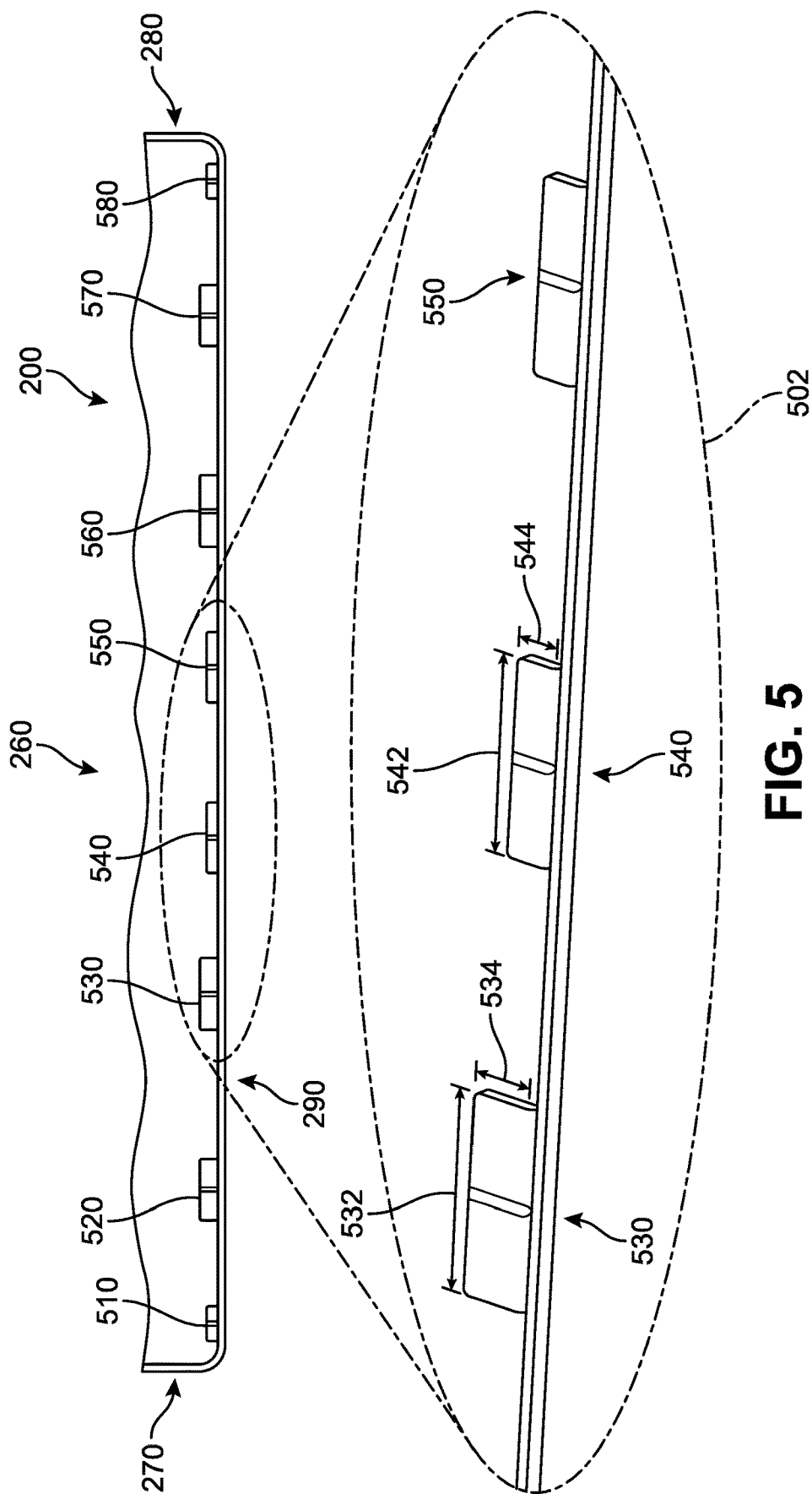
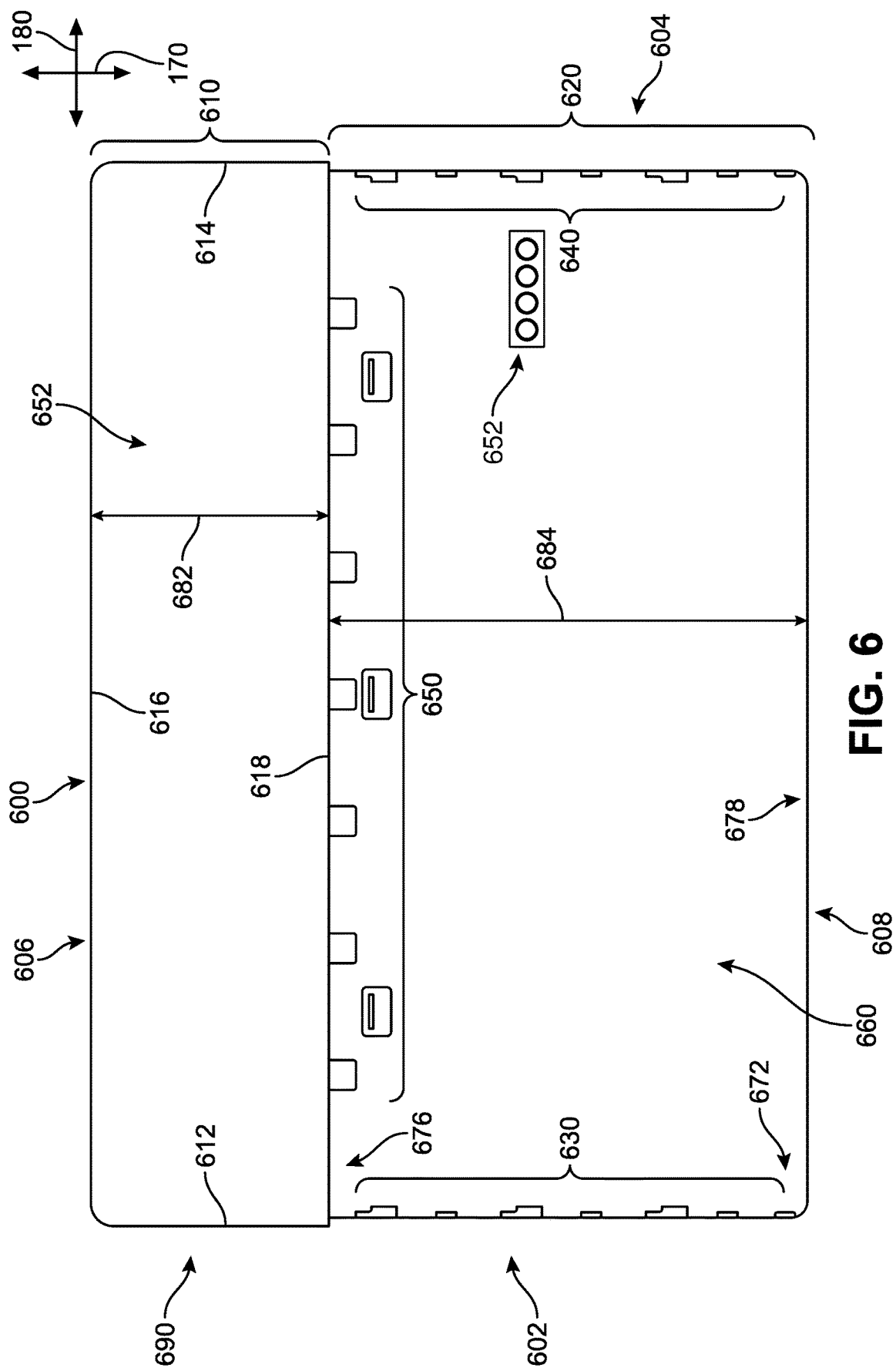
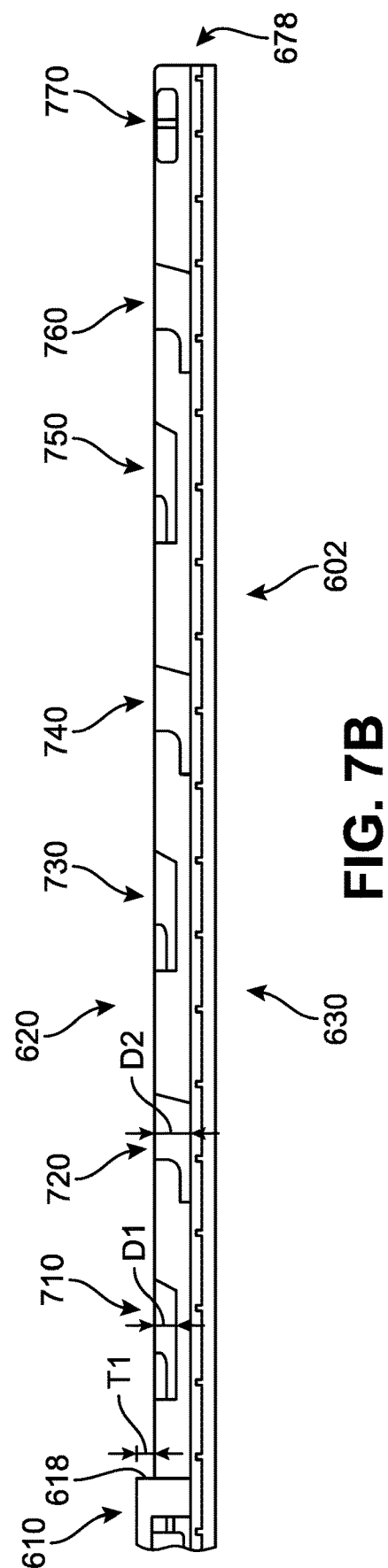
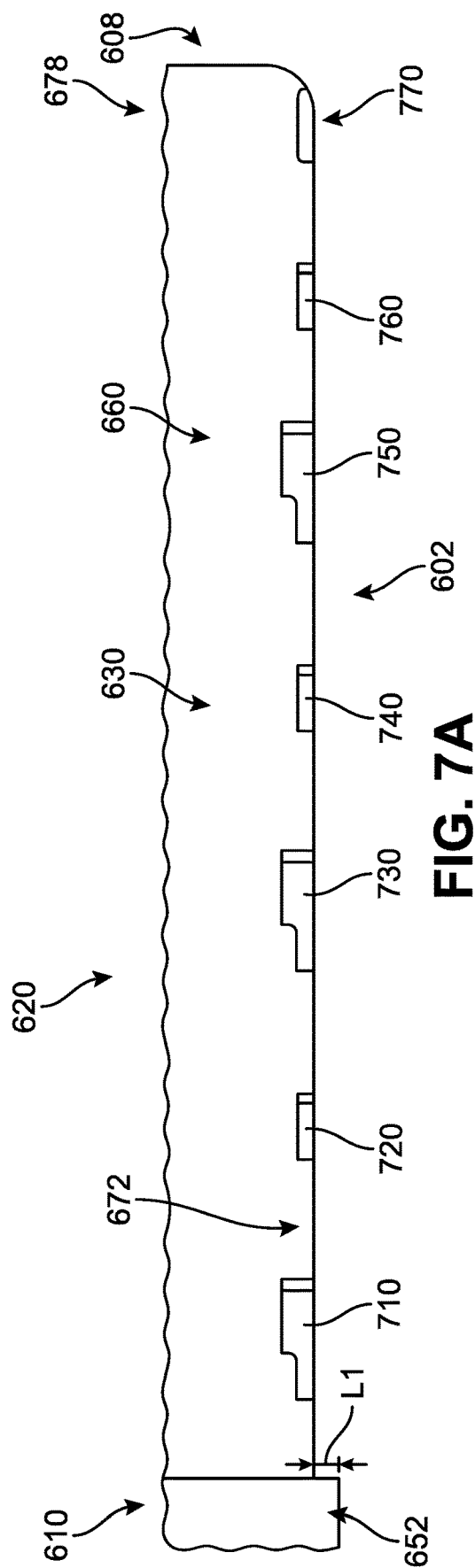
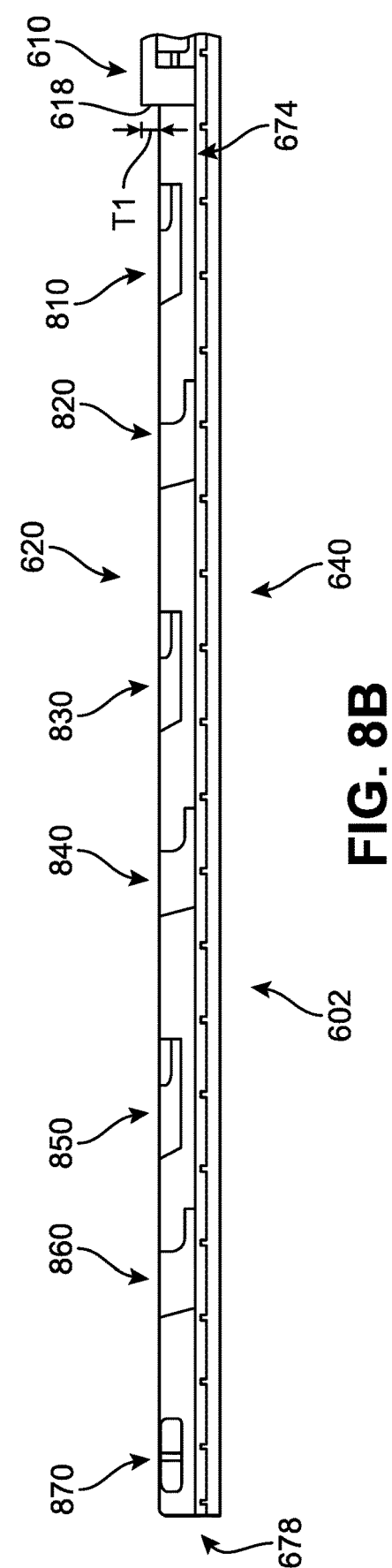
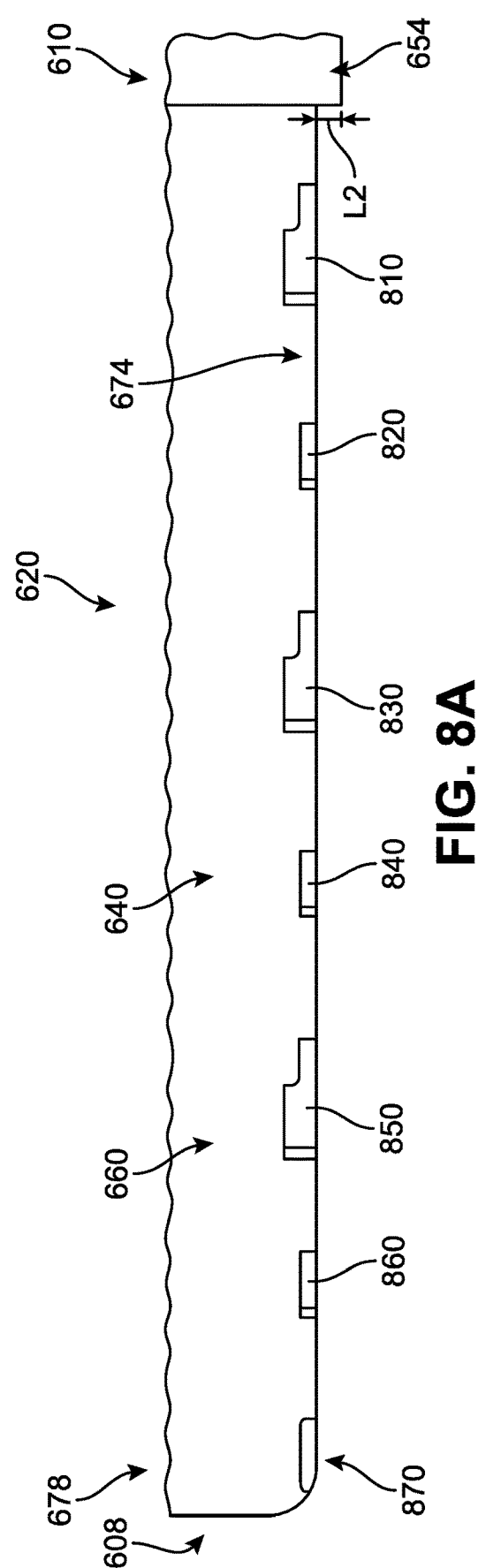


FIG. 4









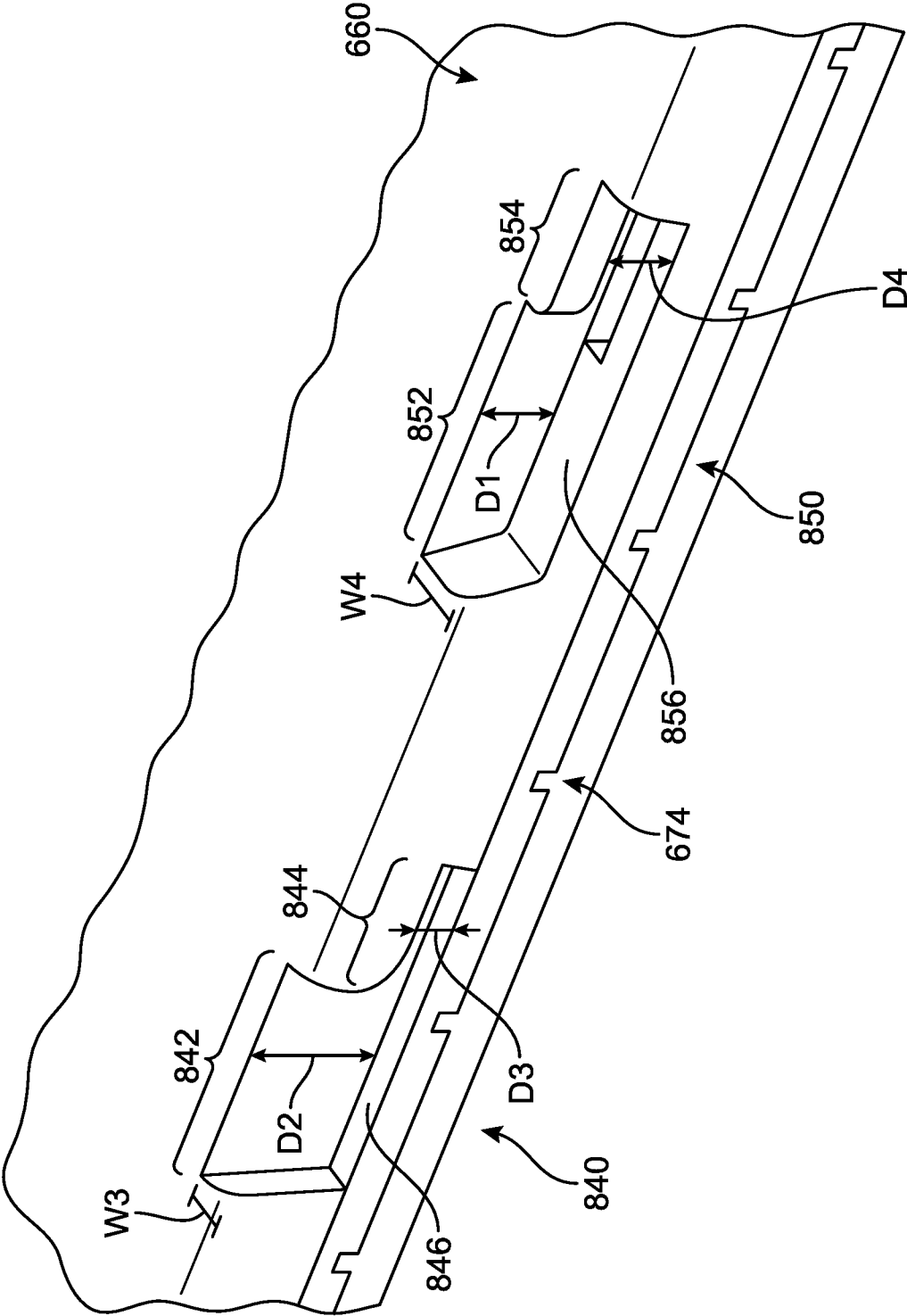
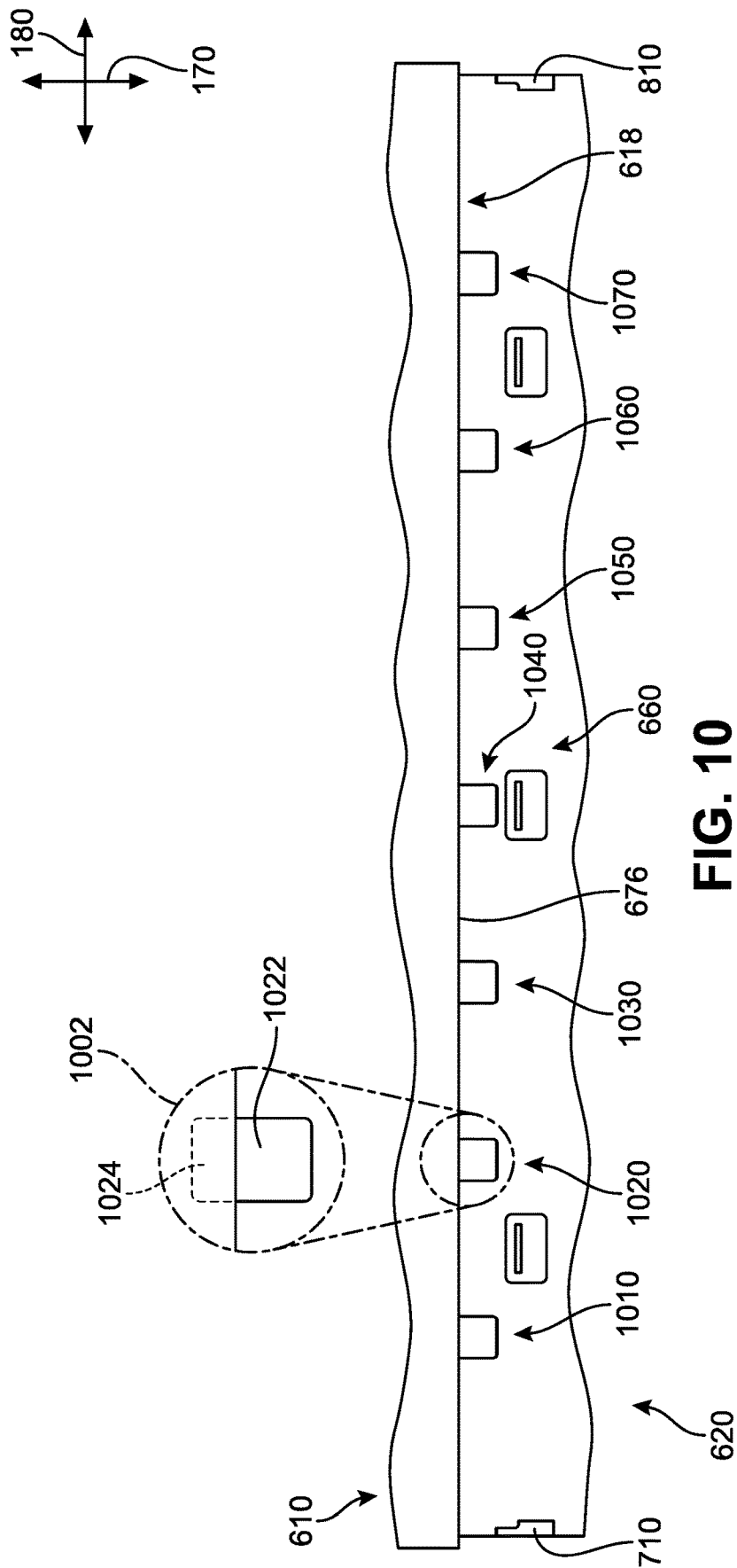
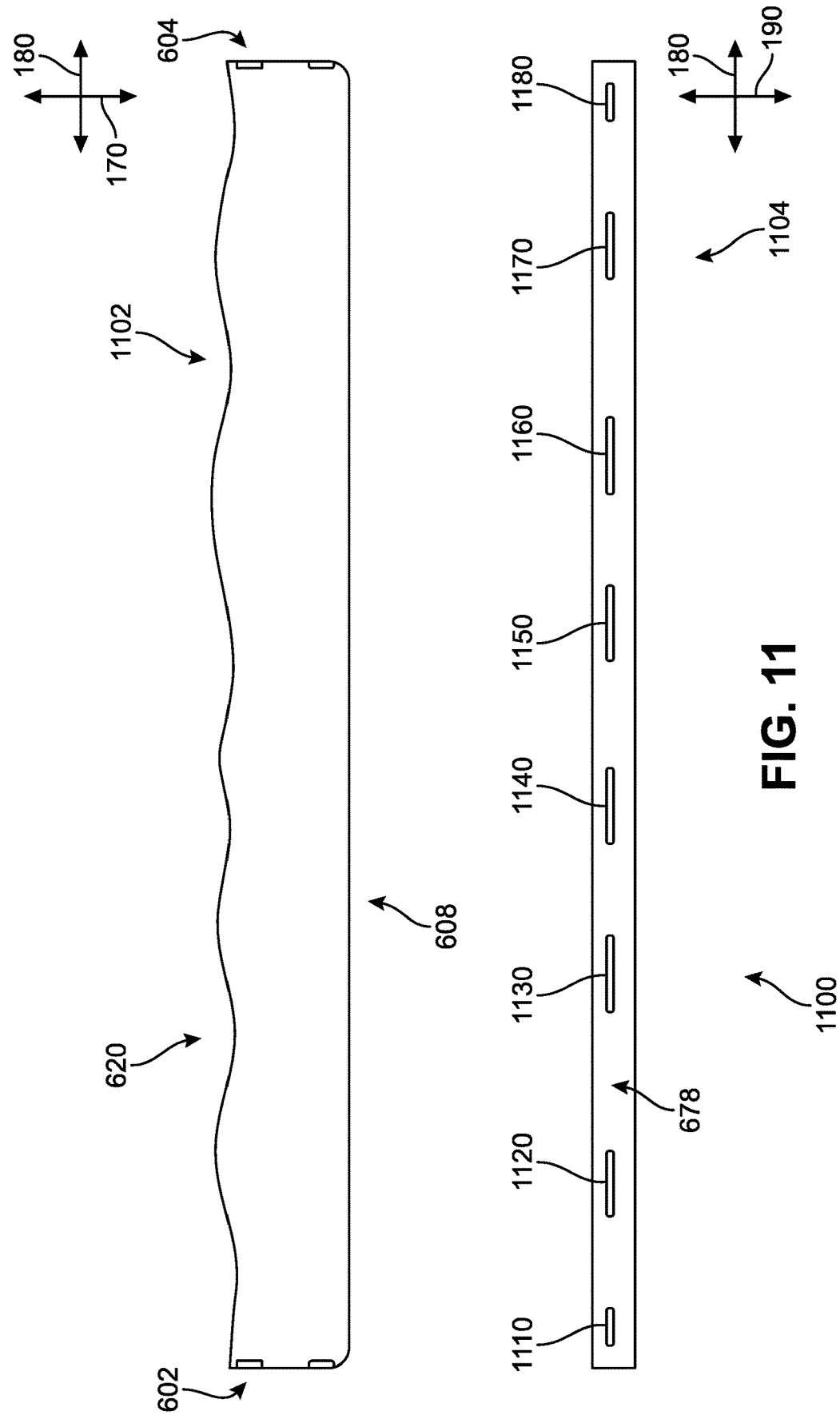
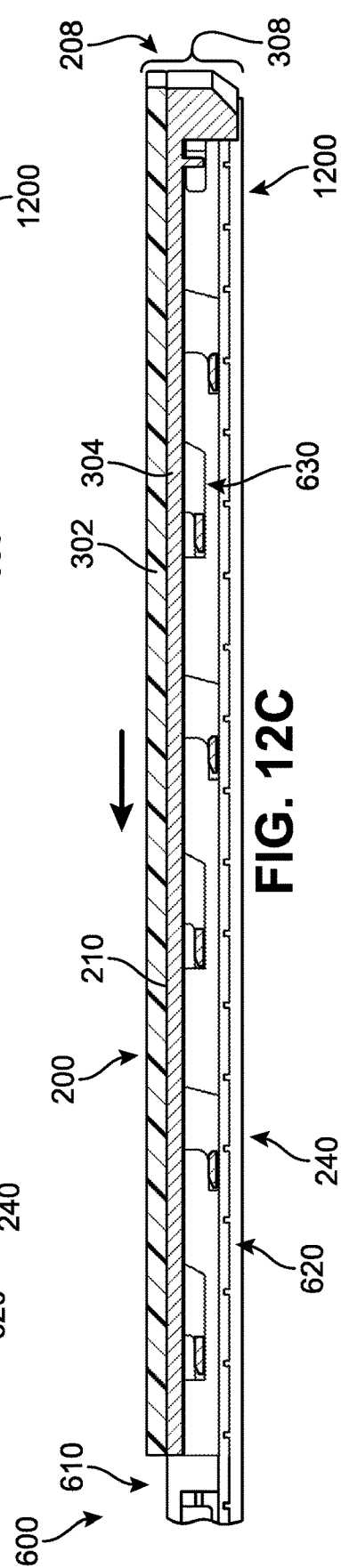
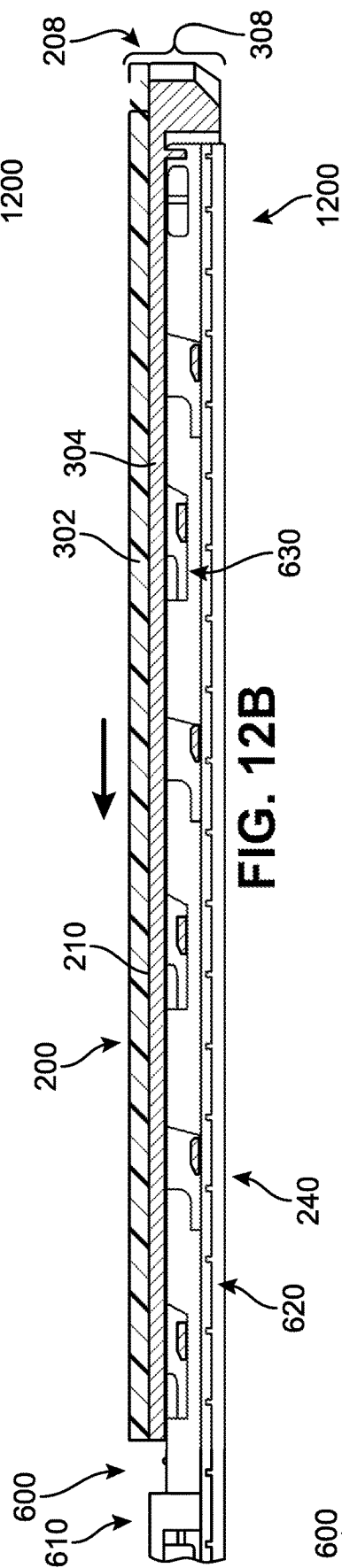
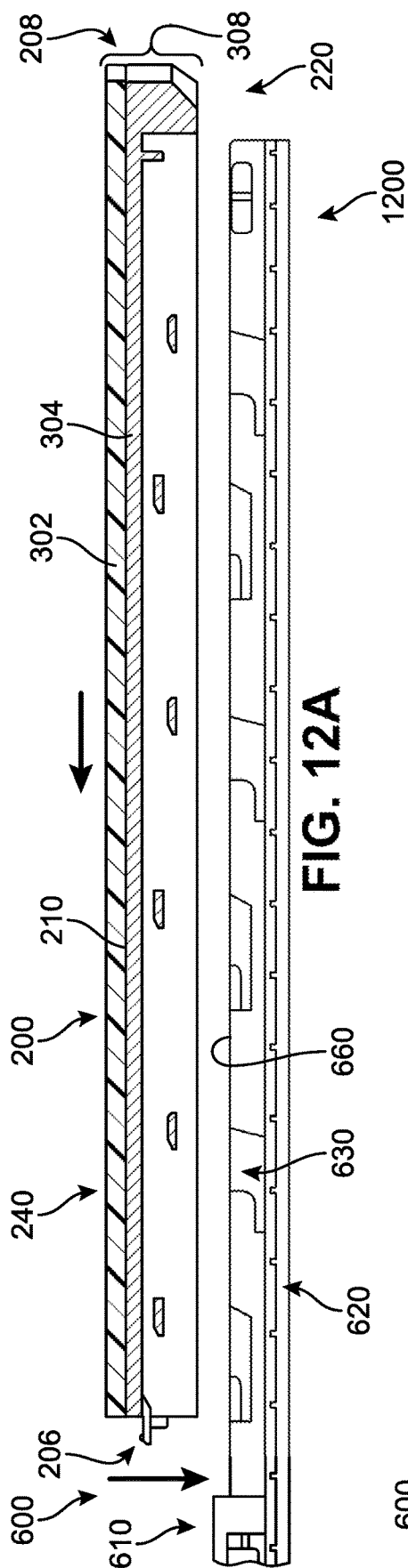


FIG. 9







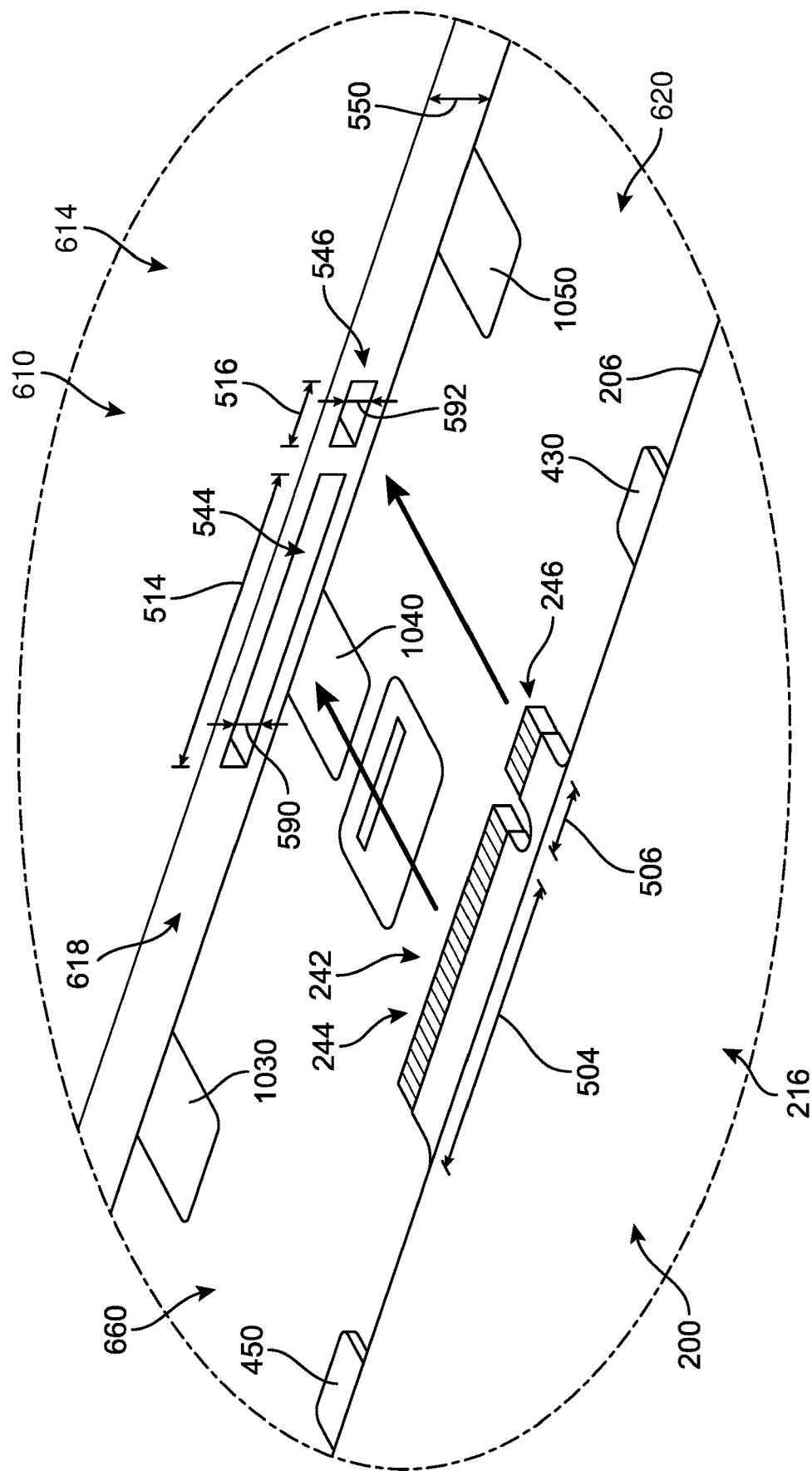


FIG. 12D

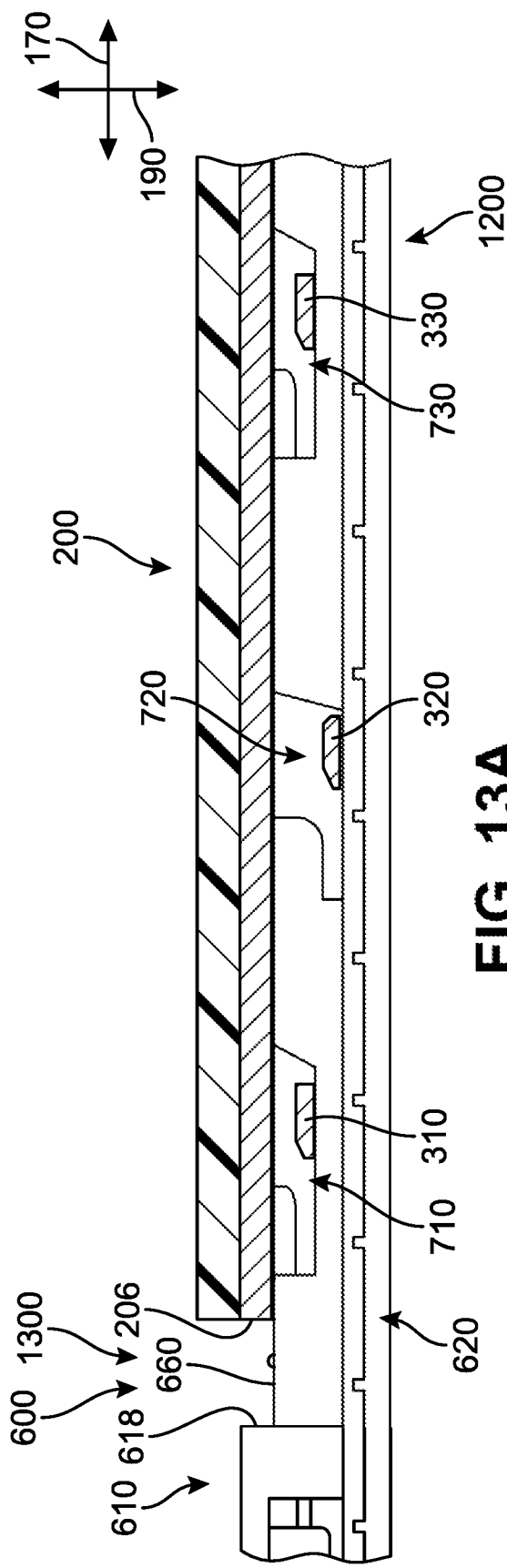


FIG. 13A

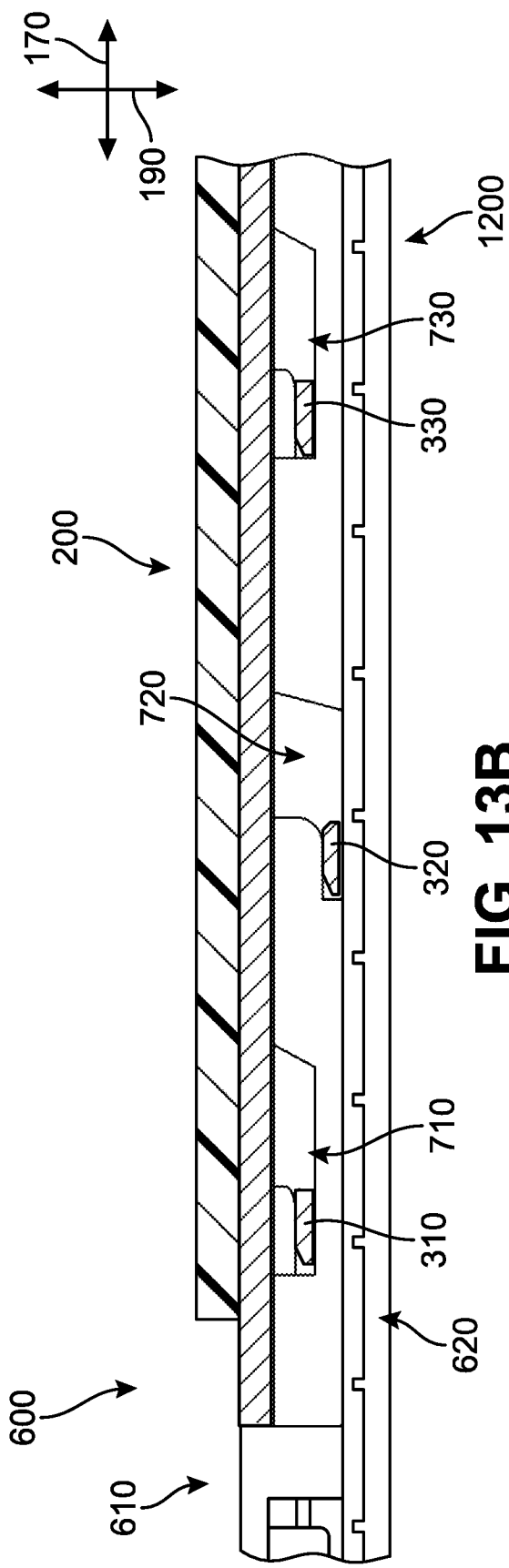
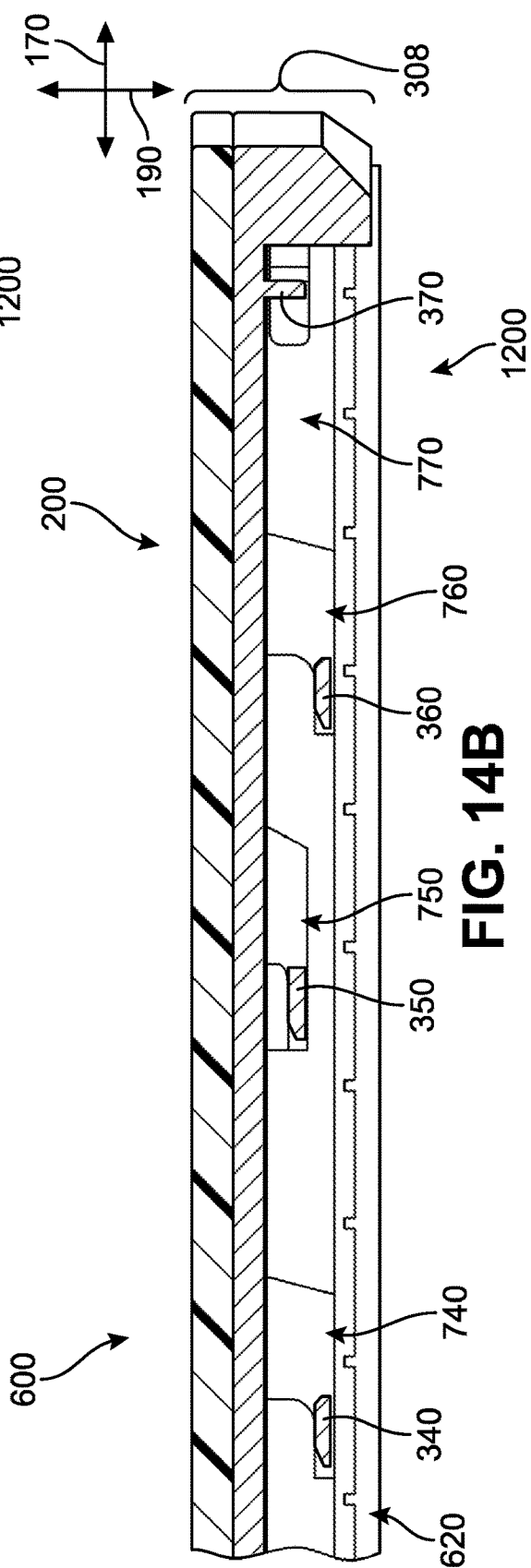
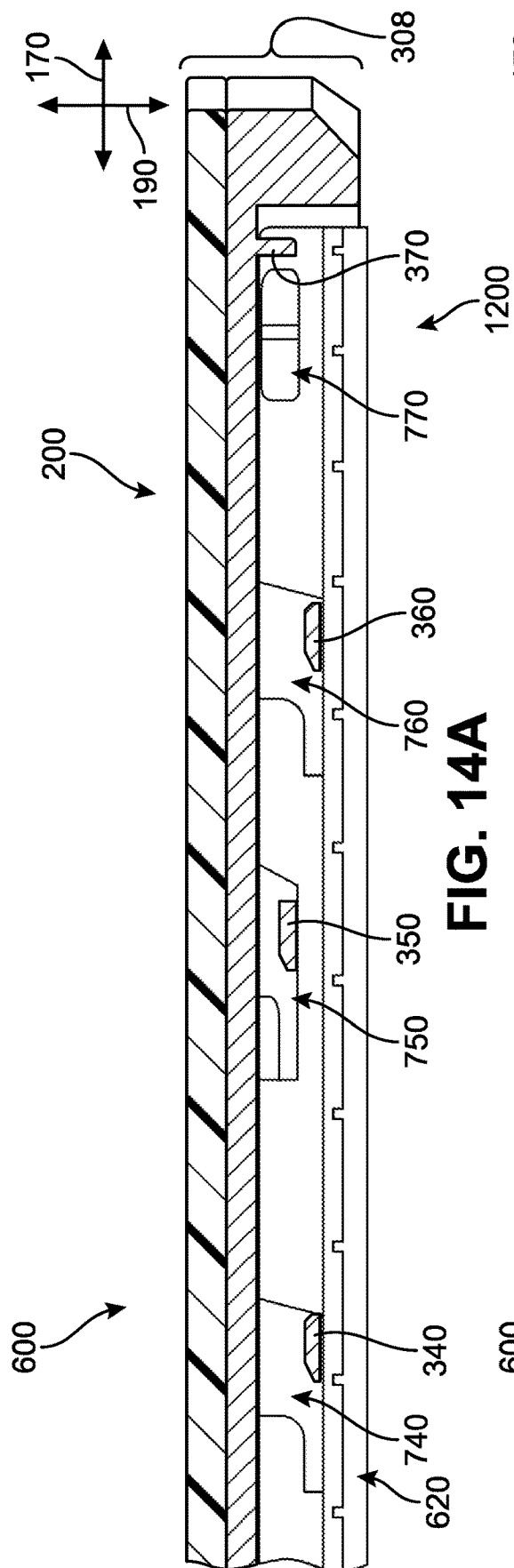


FIG. 13B



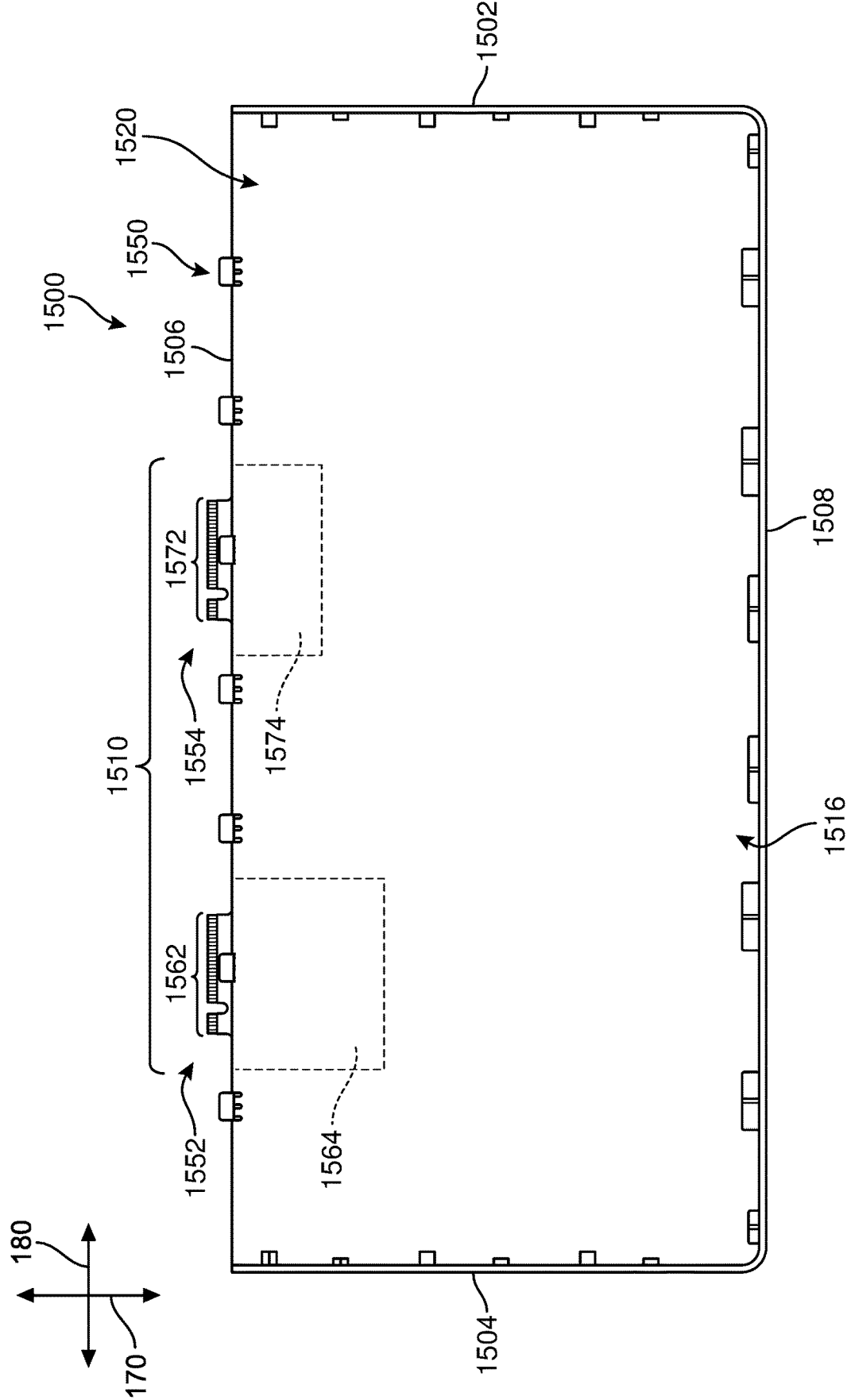


FIG. 15

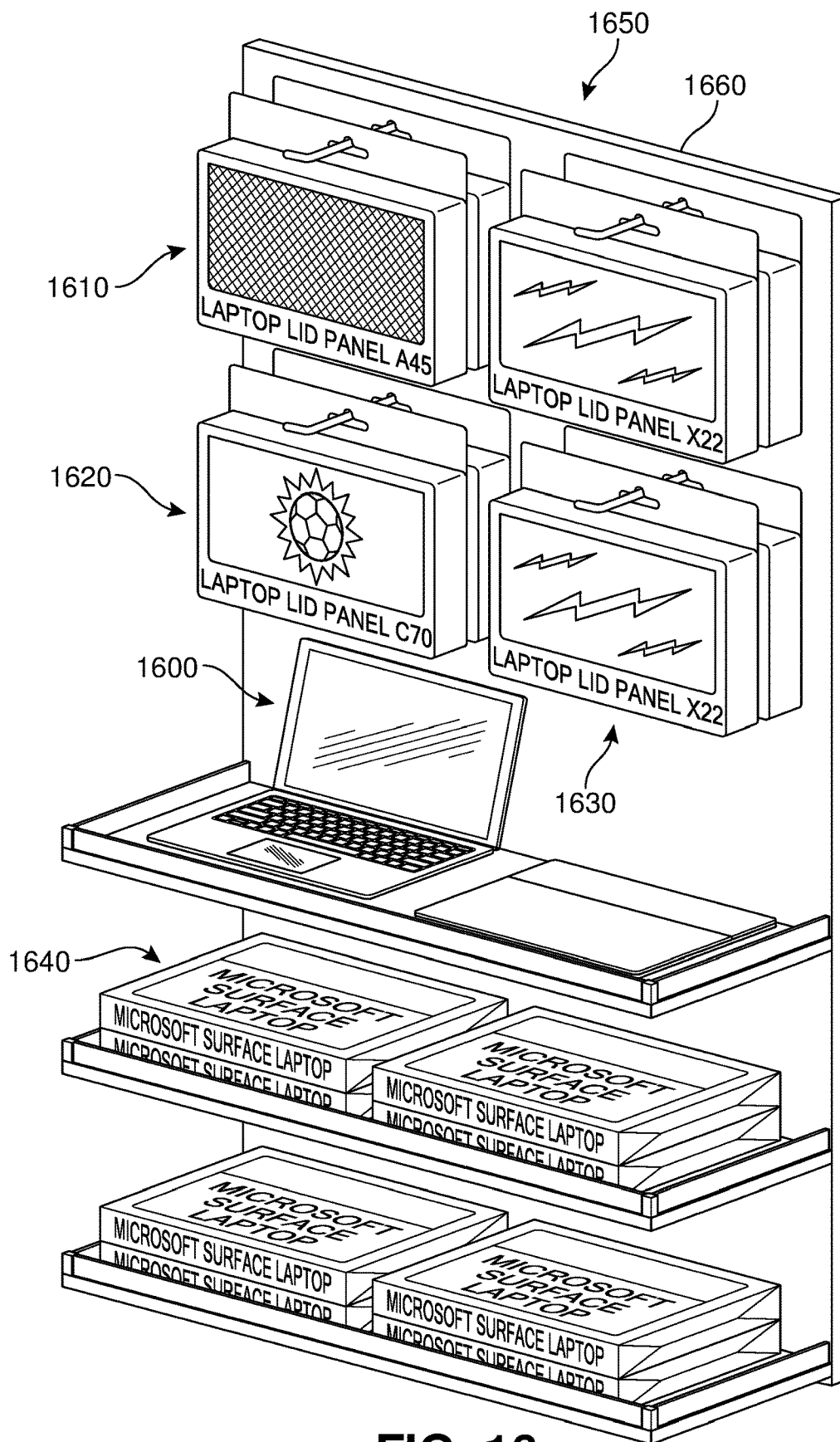


FIG. 16

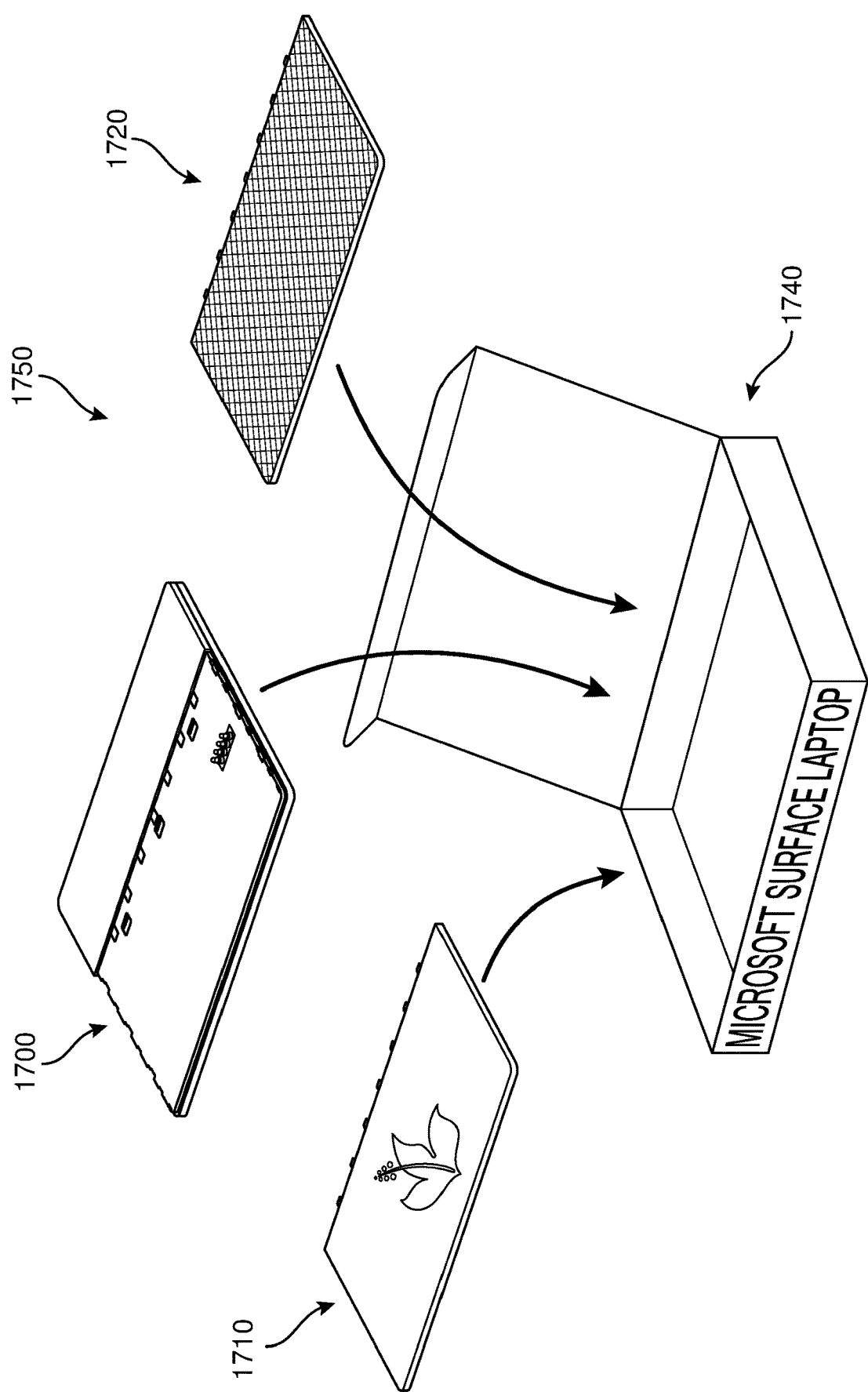


FIG. 17

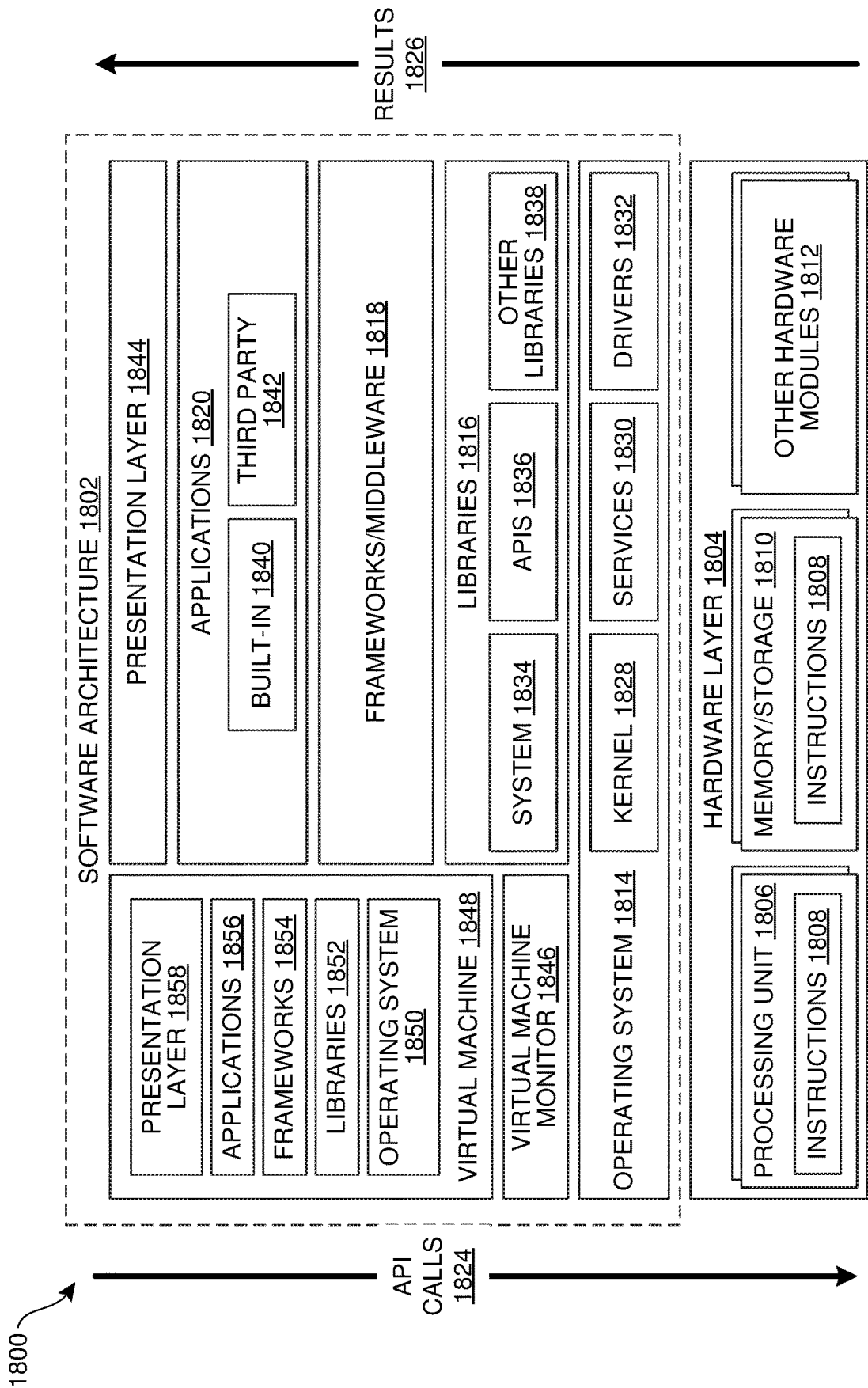


FIG. 18

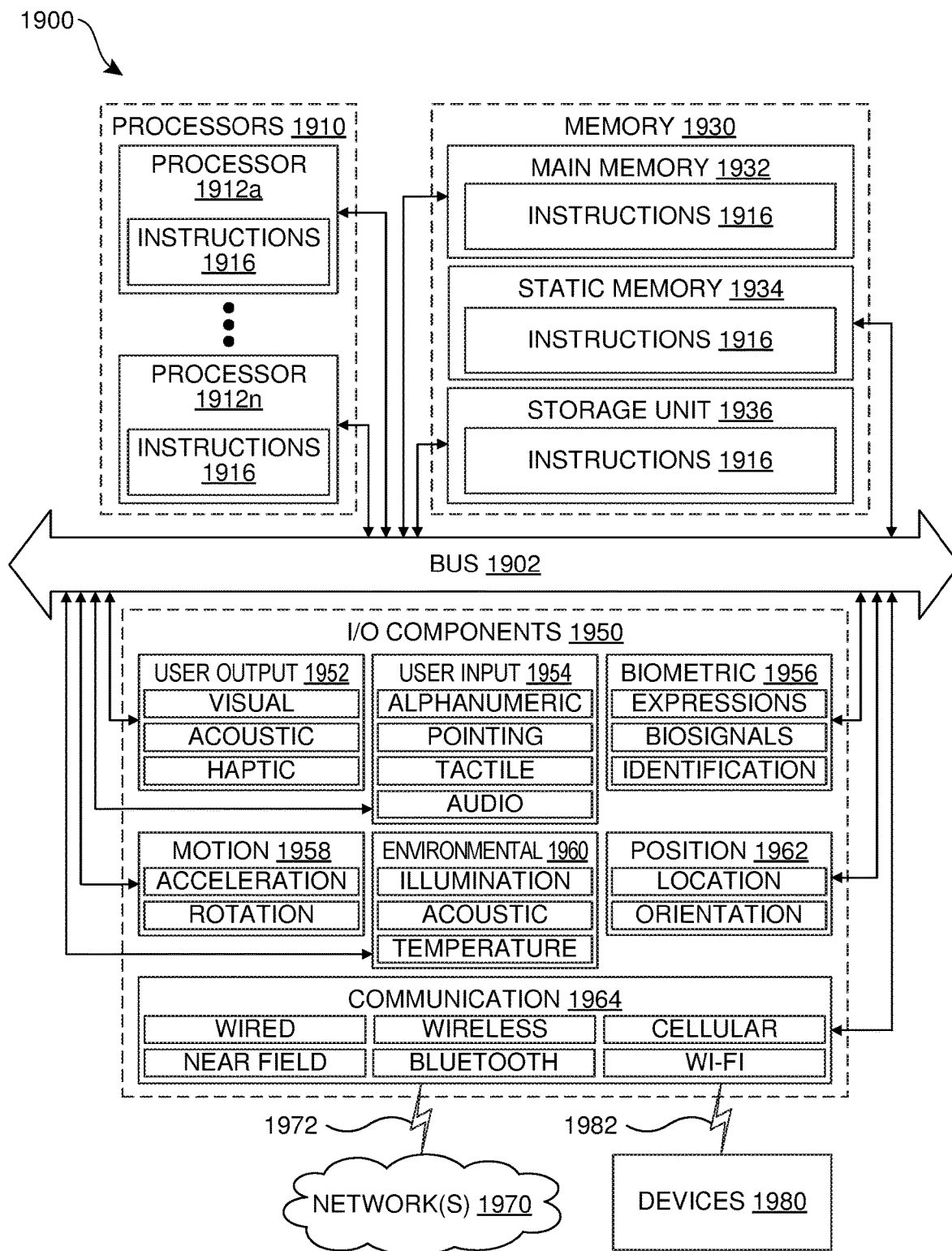


FIG. 19

**INTERCHANGEABLE HOUSING PANEL
WITH RECHARGEABLE POWER,
NETWORK CONNECTIVITY, AND MEMORY
FOR USE WITH PORTABLE COMPUTING
DEVICES**

BACKGROUND

[0001] With the proliferation of smartphones, tablets, and other connected mobile devices, wireless consumers are increasingly using the mobile Web as a primary gateway to the Internet. A smartphone is a mobile phone built on a mobile operating system, with more advanced computing capability and connectivity than a feature phone. Later models of smartphones include the functionality of portable media players, low-end compact digital cameras, pocket video cameras, and GPS navigation units to form one multi-use device. Conventional smartphones also include high-resolution touchscreens and web browsers that display standard web pages as well as mobile-optimized sites.

[0002] 4G is also known as Long Term Evolution (LTE) and 3rd Generation Partnership Project (3GPP). 4G is the fourth generation of cellular wireless standards that is a successor to the 3G and 2G families of standards. In year 2009, the ITU-R organization specified the IMT-Advanced (International Mobile Telecommunications Advanced) requirements for 4G standards, setting peak speed requirements for 4G service at 100 Mbit/s for high mobility communication (such as from trains and cars) and 1 Gbit/s for low mobility communication (such as pedestrians and stationary users). 4G features includes smooth handoff across heterogeneous networks, seamless connectivity and global roaming across multiple networks, high quality of service for next generation multimedia support (real time audio, high speed data, HDTV video content, mobile TV, etc.), interoperability with existing wireless standards, an all IP, packet switched network, IP-based femtocells (home nodes connected to fixed Internet broadband infrastructure).

[0003] Although smartphones have benefited from access to such improvements in cellular wireless standards, other portable computing devices have mainly relied on Wi-Fi. A device that can use Wi-Fi (such as a personal computer, video game console, smartphone, tablet, or digital audio player) can connect to a network resource such as the Internet via a wireless network access point (AP). Such an access point (or hotspot) has a range of about 20 meters (65 feet) indoors and a greater range outdoors. Hotspot coverage can comprise an area as small as a single room with walls that block radio waves, or as large as many square miles, which is achieved by using multiple overlapping access points.

[0004] The popularization of portable computing devices such as laptops and tablets has also increased a desire for availability of such devices that are also configured to provide mobile data access, in a manner similar to smartphones. However, many portable computing devices do not offer a wireless data card configured to access such networks, and options addressing this deficiency often involve cumbersome external modems or an installation process that is challenging for the typical end-user. Thus, there remain significant areas for new and improved ideas for simplified mechanisms by which to connect a portable computing device to 3G, LTE, 4G, CDMA, or other mobile wireless networks.

SUMMARY

[0005] An interchangeable housing component for a portable computing device with a cellular data module, in accordance with a first aspect of this disclosure, has a body portion including an upper surface, an opposite-facing lower surface, and a forward edge, a rearward edge, a first side edge, and a second side edge. In addition, the cellular data module has a module board and a first contact region extending from the module board. The first contact region extends proximally outward from the rearward edge of the body portion, and the module board is in contact with the lower surface of the body portion.

[0006] A kit of parts, in accordance with a second aspect of this disclosure, includes a portable computing device with a lid including a display housing comprising a first side and an opposite-facing second side, the first side including a base portion and a receiving portion that is recessed relative to the base portion, the second side including a display panel. The kit of parts also includes a first interchangeable housing component sized and dimensioned to be removably attached to the receiving portion. The first interchangeable housing component includes a body portion with an upper surface, an opposite-facing lower surface, and a forward edge, a rearward edge, a first side edge, and a second side edge, as well as a cellular data module, where a first contact region of the cellular data module extends proximally outward from the rearward edge of the body portion.

[0007] This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter. Furthermore, the claimed subject matter is not limited to implementations that solve any or all disadvantages noted in any part of this disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The drawing figures depict one or more implementations in accord with the present teachings, by way of example only, not by way of limitation. In the figures, like reference numerals refer to the same or similar elements. Furthermore, it should be understood that the drawings are not necessarily to scale.

[0009] FIGS. 1A-1E are a sequence of drawings illustrating an example of a computing device and a pair of interchangeable housing panel components, where one of the components provides cellular modem functionality;

[0010] FIG. 2A is a top-down view of an implementation of a first housing panel component;

[0011] FIG. 2B is a bottom-up view of an implementation of the first housing panel component;

[0012] FIGS. 2C-2F are simplified cross-sectional views of a housing panel component in which structural cover variations are implemented to change the appearance of the housing panel component;

[0013] FIGS. 3A-3C are side-views of an implementation of a sidewall of the first housing panel component comprising a set of raised portions;

[0014] FIG. 4 is an isolated view of an implementation of a plurality of tab portions for the first housing panel component as well as an enlarged view of the cellular data module;

[0015] FIG. 5 is an isolated view of an implementation of a group of protruding portions for the first housing panel component;

[0016] FIG. 6 is a top-down view of a display housing for a portable computing device;

[0017] FIG. 7A is a top-down view of a first periphery of a receiving portion for the portable computing device, and FIG. 7B is a side view of the first periphery depicting grooves configured to receive raised portions of a housing panel component;

[0018] FIG. 8A is a top-down view of a second periphery of a receiving portion for the portable computing device, and FIG. 8B is a side view of the second periphery depicting grooves configured to receive raised portions of a housing panel component;

[0019] FIG. 9 is an isometric enlarged view of an implementation of two grooves formed along a periphery of the receiving portion;

[0020] FIG. 10 is an isolated view of a third periphery of the receiving portion including a plurality of recessed slots;

[0021] FIG. 11 is an isolated view of a fourth periphery of the receiving portion including a plurality of apertures;

[0022] FIGS. 12A-12C are a sequence of drawings illustrating an example of the installation process of a housing panel component with a display housing of a device;

[0023] FIG. 12D is an enlarged, isometric view of an implementation of a mating process between the cellular data module of the first housing panel component and a portable computing device;

[0024] FIGS. 13A and 13B depict an enlarged isolated view of a rear portion of a housing panel component and a rear portion of a display housing during the installation process;

[0025] FIGS. 14A and 14B depict an enlarged isolated view of a forward portion of a housing panel component and a forward portion of a display housing during the installation process;

[0026] FIG. 15 is a bottom-up view of an implementation of a second, alternate housing panel component;

[0027] FIG. 16 is an isometric view of an example of a retail system;

[0028] FIG. 17 is an isometric view of an example of a kit of parts with two interchangeable housing panel components;

[0029] FIG. 18 is a block diagram of an example computing device, which may be used to provide implementations of the mechanisms described herein; and

[0030] FIG. 19 is a block diagram illustrating components of an example machine configured to read instructions from a machine-readable medium

not intended to indicate a required, desired, or intended orientation of the described articles.

[0032] Computing devices such as tablet computers, laptops, and other smart devices have been increasingly moving toward an all-day everyday reliance by end-users, where users carry their devices through their normal routines and activities, similar to a handbag or wallet. In addition, the device can be called upon to perform different types of tasks depending on the whereabouts of the user. However, this trend is associated with challenges, as the device is expected to morph in tune with the user's demands at the present moment. In a work meeting for example, a user may wish to produce a well-kept, professional, or otherwise clean device that is equipped with added functionalities, while at social events the same user may wish their device to showcase their interests, preferences, and/or favorite subjects while simply enjoying various software programs loaded on the device. There is an increasing need for such devices to readily adapt to modifications in appearance and functionality. The following description discloses systems and methods for providing users with simple, quick, and easy to implement changes to device appearance as well as network capability and other provisions. In different implementations, the following systems can provide a relatively simple means of switching the appearance of their device from a first 'costume' to a second 'costume' while retaining the integrated, seamless feel of the device as a whole. At the same time, a user can transition from a device with limited connectivity to a device configured to provide high-speed mobile data network access. Specifically, an easy-to-remove-and-replace reusable housing panel component for a computing device will be described. For example, a first component with a first appearance and properties can be detached from an external surface of the computing device, and a second component with a second appearance and properties can be attached to the same computing device, such that the appearance and functionality of the computing device is substantially altered. The device can also be quickly returned to its original appearance and functionality. In addition, the device can be configured to receive a plurality of different components and, with each new attachment (or re-attachment), appear to become for all intents and purposes a different device. This can allow a user to enjoy the benefit of a single device with the ability to rapidly morph in appearance and functionality to better reflect the user's expectations across a wide range of occasions. Furthermore, this type of arrangement allow the user to more readily express individuation, art, or advertising that is functional, removable, and compatible with the computer's functions, screen visibility, ability to close, and ability to be transported with ease.

[0033] It should be understood that while the following implementations will be described in the general context of a laptop computer, the systems may be applicable to numerous other electronic devices such as PDAs, MP3 players, remote controls, gaming interfaces, digital cameras, mobile phones, tablets, and other computer related devices such as flat panel monitors, computer monitors, medical devices, point of sale terminals, and other relatively man-portable or mobile computing devices.

[0034] The following description presents interchangeable housing systems for use with computing devices. In order to better introduce the systems and methods to the reader, FIGS. 1A-1E present a high-level example of a representative system 100 providing an interchangeable housing com-

DETAILED DESCRIPTION

[0031] In the following detailed description, numerous specific details are set forth by way of examples in order to provide a thorough understanding of the relevant teachings. However, it should be apparent that the present teachings may be practiced without such details. In other instances, well known methods, procedures, components, and/or circuitry have been described at a relatively high-level, without detail, in order to avoid unnecessarily obscuring aspects of the present teachings. In the following material, indications of direction, such as "top" or "left," are merely to provide a frame of reference during the following discussion, and are

ponent with enhanced functionality for a portable computing device (“device”) **120**. For purposes of illustration, FIG. 1A shows the device **120** as being unable to access a signal **132** for a cellular or mobile data network **130**, as represented by an unavailable symbol **134**. In this case, the device **120** includes a first component **150** that serves as a portion of the larger housing for the lid (e.g., the display unit) of the device **120**, where the lid contains or houses a display panel for the device **120**, and is joined (for example, by a hinge or other pivoting connection mechanism) to a keyboard and/or main body unit of the computing device. Additional description related to some portable computing devices can be found in U.S. Patent Publication Number 2008/0239641 to Sato et al., entitled “Method of Manufacturing Electronic Apparatus, Electronic Apparatus, and Subassembly Product” published on Oct. 2, 2008, the disclosure of which is herein incorporated by reference in its entirety.

[0035] In different implementations, the first component **150** of the device **120** can be configured for release or detachment from the remainder of the larger display housing. FIG. 1B depicts one implementation of the device **120** with a display housing that has an outer or external upper section (first side) comprising a base portion **112** and an adjacent receiving portion **114**. In some implementations, the receiving portion **114** is recessed relative to the base portion **112**, and is also configured to receive and secure an additional component (here, an interchangeable housing panel component). In different implementations, the receiving portion **114** can be sized and dimensioned to receive and/or be detached from an interchangeable housing component. In some implementations, the device **120** will not appear ‘complete’ or fully assembled until a candidate housing panel component is also secured to the receiving portion and covers the exposed region. The sequence of FIGS. 1B-1E present one example of a process in which a first housing component that was installed on the device **120** is replaced by a second, different housing component. The display housing of the device **120** also includes an opposite-facing second side that can support, frame, contain, enclose, and/or house the display panel for the computing device. In other words, the first side of the display housing comprises the backside or rear structure of the display panel for the device. Thus, although the drawings do not illustrate in detail the display panel, it is to be understood that all computing devices described herein include a computing display-screen panel. The interchangeable housing panel components refers to candidate housing cover components that may be installed on the display housing that is supporting, surrounding, enclosing and/or containing an integrated display panel for viewing content being displayed by the device (such as a lid for a laptop or notebook computing device).

[0036] In FIG. 1B, a first component **150** is being pulled or slid distally outward by a user **110** (e.g., toward the body of the user **110**), or along a direction moving away from the device **120** that is generally aligned with a lateral axis **170**. In some cases, the user **110** may first exert a gentle downward pressure on the first component **150** (i.e., in a downward direction generally aligned with a vertical axis **190**) prior to or as the first component **150** is slid away from the device **120** in order to facilitate release of the first component **150** from the attachment mechanisms that were securing the first component **150** to the receiving portion **114** of the device **120**. In another example, the user **110** may exert

a gentle inward or proximal pressure on the first component **150** (i.e., in a downward pressing in towards the center of the component) prior to or as the first component **150** is slid away from the device **120** in order to facilitate release of the first component **150** from the attachment mechanisms that were securing the first component **150** to the receiving portion **114** of the device **120**. Once the first component **150** is loosened or detached from the device **120**, it may be pulled upward as well to fully remove or uninstall the housing component, revealing or exposing an outer surface of the receiving portion **114**.

[0037] For consistency and convenience, some directional adjectives are employed throughout this detailed description corresponding to the illustrated embodiments. The term “longitudinal” as used throughout this detailed description and in the claims refers to a direction extending a length of a component. For example, the longitudinal direction of the first component **150** and/or device **120** may extend between a first side **122** and a second side **124**. Also, the term “lateral” as used throughout this detailed description and in the claims refers to a direction extending along a width of a component. For example, the lateral direction of the first component **150** and/or device **120** may extend between a rearward side **126** and a forward side **128**. Additionally, the term “vertical” as used throughout this detailed description and in the claims refers to a direction that is perpendicular to both the longitudinal and lateral directions. For example, the vertical direction of sole system **110** may extend through the thickness of the first component **150** and/or device **120**. In addition, the term “proximal” refers to a portion of a component that is closer to a central region of the component. Likewise, the term proximal direction refers to a direction oriented towards the central region. The term “distal” refers to a portion of a component that is further from the central region. The distal direction refers to a direction oriented away from the central region. As used herein, the “central region” could be the center of mass and/or a central plane and/or another centrally located reference surface of the component or device.

[0038] In FIG. 1C, the first component **150** has been removed from the device **120**, and the receiving portion **114** now presents an exposed surface **116** that was previously disposed beneath, adjacent to, facing toward and/or contacting the lower surface or underside of the first component **150**. A contact connector component **196** is also visible and will be discussed in further detail with respect to FIG. 6. A second component **160** is also introduced, with similar proportions to the first component **150**. However, it may be understood that although the first component **150** and the second component **160** can include similar fastening or attachment mechanisms (as will be described in greater detail herein), each component can otherwise differ greatly in appearance, material composition, and other physical or structural properties. Simply as an example, the first component **150** may comprise a rigid external material that is hard to the touch, while the second component **160** may comprise a fabric, or other more compressible or elastic material. In another example, the first component **150** may include a printing, tint, logo, or other artistic illustration or ornamentation, while the second component **160** includes embroidery or different textile-based designs and/or patterns (or vice-versa).

[0039] Furthermore, the second component **160** can offer additional functionality that was not available with the first

component 150. In this case, the second component 160 includes a cellular data module 142, configured to provide access to a cellular network (symbolized as a network indication 144). In different implementations, the device 120 can be configured to receive the cellular data module 142 via a receptacle port 140 formed in the base portion 112 of the device 120. As a general matter, the cellular data module 142 can be understood to comprise a type of electrical connector with contacts for providing power and exchanging data with the computing device. Further details regarding this mechanism will be provided below.

[0040] In FIG. 1D, an installation or attachment stage is depicted, in which the second component 160 is now being slid or otherwise connected with the device 120. The second component 160 may be an entirely new component (i.e., has never been used with this device before) or may be a component that was previously attached to this device but was removed and is now being re-used. In this example, the second component 160 is being pushed or slid onto the receiving portion 114 by the user 110 in a direction away from the body of the user 110, or along a direction toward the device 120 that is generally aligned with a lateral axis 170. In some cases, the user 110 may also exert a gentle downward pressure on the second component 160 (i.e., in a downward direction generally aligned with a vertical axis 190) prior to or as the second component 160 is slid onto or toward the device 120 in order to facilitate a latching or secure receipt of the second component 160 via the same or substantially similar attachment mechanisms that were securing the first component 150 to the receiving portion 114 of the device 120 earlier. During this same process, the cellular data module 142 can be snugly received within the receptacle port 140, and become a fully functioning cellular modem for use by the device 120.

[0041] Thus, as will be described in greater detail below, a display housing of the device 120 can be configured to receive and integrate multiple types of display housing components that can significantly affect the external appearance and internal performance of the device. In other words, there can be a plurality of interchangeable housing components that can each be removably or releasably attached to the device. For purposes of comparison, FIG. 1E depicts the device 120 with the second component 160 installed. In contrast to FIG. 1A, where the device 120 was unable to access a cellular network, the same device 120 as shown FIG. 1E with the second component 160 attached is configured to access signal 132 of cellular network 130 via the now installed cellular data module 142, as represented by an available symbol 136, allowing the user to enjoy the option of joining the cellular network 130 and exchange broadband data 138.

[0042] As a general matter, the phrase “removably attached” or interchangeable refers to components that are designed for repeated installation and removal. Thus, “removably attached” shall refer to the joining of two components in a manner such that the two components are secured together, but may be readily detached from one another, and again secured together if so desired. Non-limiting examples of removable attachment mechanisms may include hook and loop fasteners, friction fit connections, interference fit connections, threaded connectors, cam-locking connectors, and other such readily detachable

connectors. Similarly, “removably disposed” shall refer to the assembly of two components in a non-permanent fashion.

[0043] In contrast, the term “fixedly attached” shall refer to two components joined in a manner such that the components may not be readily separated (for example, without destroying one or both of the components). Exemplary non-limiting modalities of fixed attachment may include joining with permanent adhesive, rivets, stitches, nails, staples, welding or other thermal bonding, or other joining techniques. In addition, two components may be “fixedly attached” by virtue of being integrally formed, for example, in a molding process.

[0044] In other words, the interchangeable components described herein are configured to be repeatedly fasten or be secured to a device via various attachment mechanisms, and are further configured for repeated release or detachment from the device. Furthermore, the components may be installed on one device, and then removed and installed on a second, different device. As an example, a user may swap housing components between two laptops, or share components with friends or other users with devices configured to connect to the interchangeable components. In some implementations, the devices described herein may be understood to comprise a female connector or mechanism that is configured to receive the housing component comprising a corresponding ‘male’ connector. More specifically, the interchangeable component can be configured to be received by the ‘receptacle’ of the female-end provided by the receiving portion of the device. In other words, the device (in this case, the receiving portion) and interchangeable component may each be sized and dimensioned to permit the interchangeable component to be snugly inserted and/or securely received by the device.

[0045] In different implementations, the cellular data modules described herein refer to modems configured to provide a particular set of functions that enable mobile data network access to a computing device. It can be understood that these modems are one type of mechanism for providing computing devices with connectivity to wireless broadband networks. Unlike Wi-Fi, broadband networks use spectrum licensed by a service provider. In order to provide access, the broadband service providers usually charge an access fee. While in the cases of consumer devices such as mobile phones the hardware to access the broadband network is typically embedded into the device, other portable computing devices may not include such hardware.

[0046] Thus, in some implementations, cellular data modules as used herein can include a hardware modem that are configured with electrical connector interfaces such as USB, PCMCIA, PCIA or mini-PCI (and others). To control access, either a connection manager software is provided by the service provider that authenticates a user using user-id and password and/or a more secure authentication software is used (such as X.509 certificates). This software is typically installed on the computing device together with the access driver for the hardware. In some options, the default connection manager provided by the operating system of the computing device (such as Windows XP®/Vista®/MacOS®, etc.) can be used. In many cases, traditional computing devices lack PCMCIA or other convenient external expansion ports where broadband modem hardware could be inserted by a user. The present disclosure addresses this with inclusion of an expansion port that is formed in the upper

surface of the device lid and a corresponding cellular data module that is inserted into the expansion port when the interchangeable housing panel component is installed.

[0047] In different implementations, the cellular data module is a device component that is sized and dimensioned for insertion into a corresponding receptacle of a consumer host device and access or otherwise execute services (e.g., receive broadband internet connection, upload data to Internet, access streaming media content and others) on behalf of the consumer host device. In some implementations, the cellular data module may be provided as a PCI card, PCI Express card, PCI Express Mini Card, PCI-eXtended card, ISI card, AGP card, SD card, mini SD card, micro SD card configured to access broadband technologies such as General Packet Radio Service (GPRS), High-Speed Downlink Packet Access (HSDPA), High Speed Packet Access (HSPA), Evolution-Data Optimized (EV-DO), Evolution Data/Voice (EV-DV), Ultra Mobile Broadband (UMB), Worldwide Interoperability for Microwave Access (WiMAX), 2G, 3G, 4G, CDMA, Long Term Evolution (LTE), other 802.1x based access networks and other IP based wireless broadband networks, and/or any other broadband technology.

[0048] The cellular data module as provided by the interchangeable housing panel components can be used on different devices (e.g., switched from one laptop to another), readily removed and re-installed, while retaining the device's overall smooth and compact appearance. For example, the cellular data module, by being incorporated directly in the housing panel component, will be hidden from view, rather than 'sticking out' or protruding in a cumbersome or unsightly manner from the computing device. In addition, such an arrangement reassures the user that the cellular data module will not be misplaced, or lost, or damaged. The user can also leave the cellular data module connected when the computing device is not being used or is being transported. When the housing panel component is installed, the cellular data module is simultaneously or concurrently inserted into the expansion port. This mechanism reduces the time and effort expended by the user in adding such functionality, and enables the host computing device to communicate with additional wireless broadband technologies such as 2G, 2.5G, 3G, GSM, TDMA, CDMA, PCS, GPRS, WAP, GPS, mesh networks, satellite radio & video, AM, FM, FRS, RFID, ZigBee, optical IR, and the like.

[0049] In order to provide further context for the uses and applications of the systems described herein, FIGS. 2A-5 present a non-limiting example of an interchangeable housing panel component ("housing panel" or "housing component") **200** that can be used in conjunction with a housing of various computing devices. In FIG. 2A, a top-down view of the housing panel component **200** is provided, and in FIG. 2B, a bottom-up view of the housing panel component **200** is provided. In other words the two figures show two views of the same component, one directed to a top side or upper surface **210** (FIG. 2A), and the other is directed to a bottom side or a lower surface **220** (FIG. 2B). In FIG. 2A, the housing panel component **200** includes a substantially continuous peripheral (outermost) edge-band extending around the outer periphery of the panel. The edge-band can be understood to comprise a first side edge ("first edge") **202**, a second side edge ("second edge") **204**, a rearward edge **206**, and a forward edge **208** that collectively provide an

outer perimeter or boundary of a body portion **216** of the housing component. In different implementations, the upper surface **210** can include any material or design, and can be selected and/or customized to reflect the preferences of a user. Furthermore, the upper surface **210** provides the external or outermost surface of the component, such that, when installed, the upper surface **210** remains exposed or visible, while the lower surface **220** is configured to face toward the receiving portion of the device and is therefore hidden, covered, or otherwise not intended to be visible to a user once the component is installed. In addition, the housing panel component **200** can be seen to include a length **212** extending from the first edge **202** to the second edge **204** (along longitudinal axis **180**), and a width **214** extending from the rearward edge **206** to the forward edge **208** (along lateral axis **170**).

[0050] In different implementations, the housing panel component **200** can include provisions for removable attachment to a device. As a first example of such a mechanism, a plurality of tab portions **250** can be seen extending upward from the rearward edge **206** of the housing panel component **200**. These tab portions **250**, as well as other fastening mechanisms, will be described in detail below. In addition, a cellular data module ("module") **242** is also shown extending outward in the same direction as the neighboring tab portions. The module **242** in this case is a PCI Express card with an edge connector having contacts on either side. One side refers to the 'solder side' and the opposite facing side refers to the 'component side'. Additional details regarding possible connectors such as the PCI Express are provided in U.S. Pat. No. 9,710,421 to Tamarkin et al., entitled "Peripheral component interconnect express (PCIe) card having multiple PCIe connectors", and granted on Jul. 18, 2017, as well as U.S. Patent Publication Number 2006/0158864 to Gay, entitled "Circuit board adapted to couple to different types of add-in cards" and published on Jul. 20, 2006, the disclosures of which are each herein incorporated by reference in their entirety.

[0051] In FIG. 2A, the module **242** can be seen into include a module board body ("board") **248** and two contact regions (a first contact region **244** and a second contact region **246**). The isometric view of FIG. 4 illustrates an example of the sets of pins included in each contact region (i.e., a first set of pins **444** and a second set of pins **446**). In FIG. 2B, the housing component has been 'flipped' over to illustrate the lower surface **220** (an opposite facing surface relative to the upper surface) and offer the reader an introductory view of the fastening mechanisms that may be included in the housing component. In this view, a dotted line generally indicates the location of the board **248** in the housing panel component. Although a shape and size of the board **248** has been very generally represented by dotted lines in this drawing, it should be understood that this depiction is for purposes of example only, details of the board **248** are not shown, and the form factor of the cellular data modules associated with housing panel components can vary widely. For example, the module may be smaller, larger, or differ in shape from what is shown in the drawings, can include differently arranged and numbers contacts, and/or modules that are not based on the PCI Express format may be used.

[0052] In this case, it can be seen that a large portion of the module **242** is actually embedded or integrated within the body portion **216** of the housing panel component itself. For

example, the module **242** can be integrally formed with the housing panel component, as shown here. In addition, in some implementations, the housing panel component can include provisions for extending and retracting the module **242** within the body portion **216**. In some cases, a small switch or button can be supplied that allows a user to glide the module further into the housing panel component (retract) or to extend the module back out to the configuration presented in the drawings where the contact regions are exposed and ready for mating with an expansion port.

[0053] However, in other implementations the module **242** may be externally secured to the housing panel component **200**, rather than extend from within an interior of the body portion **216**. In other words, in some implementations, the module **242** can be either removably or permanently attached to the underside (i.e., lower surface **220**) of the housing panel component. The specific site or location where the module **242** is attached can be pre-assigned and clearly demarcated in order to ensure that the contact regions are correctly received and retained by the corresponding expansion port formed in the device. In some implementations, the specific site can include provisions for quickly attaching or detaching to the lower surface **220** of the housing panel component **200**, including but not limited to fasteners mechanisms such as hook and loop fasteners, clasp, clamps, or other mechanical structures such as flanges, hooks, grooves, L-shaped retaining protrusions, magnets, etc. that allow the user to quickly secure, join, or affix the module **242** to a particular site along the lower surface **220**. In some implementations, the module itself can include provisions for facilitating a secure and ready attachment (and detachment) to the housing panel component, such as fastener mechanisms complementary to those described above with respect to the housing panel component. In some implementations, the housing panel component **200** also includes an antenna **268** which may be arranged to extend out to and/or around a peripheral portion of the body portion **216**. The antenna **268** is configured to improve the range of wireless communications for the computing device and may be coupled to the cellular data module **242** and/or another wireless communication component of the computing device. In some implementations, multiple such antennas may be included in the housing panel component **200** for respective wireless communication modules.

[0054] In some implementations, various interchangeable housing panel components can include additional or alternate modules that can offer further performance benefits to the user devices. In FIG. 2B, the reader is introduced to a power supply subsystem (“power subsystem”) **252** that is also embedded, incorporated, or otherwise associated with the housing panel component **200**. It should be understood that in some implementations, the power subsystem **252** can be included in housing panel components that also include the cellular data module **242**, and in other implementations, some housing panel components can include the power subsystem **252** as an accessory separate from those housing panel components that offer the cellular data module **242**. In other words, a first interchangeable housing panel component can be provided that includes the cellular data module **242** (without a power supply subsystem), a second interchangeable housing panel component can be provided that includes the power supply subsystem **252** (without a cellular data module), and a third interchangeable housing panel

component can be provided that includes both the cellular data module **242** and the power supply subsystem **252**. For purposes of reference, the third type of housing panel component is illustrated in FIG. 2B.

[0055] In different implementations, the power supply subsystem **252** can include a battery module **254** and a contact pad region **256**. The battery module **254** in FIG. 2B is an internal battery disposed within the body portion **216** of the housing panel component **200**. In other implementations, the battery module **254** can be positioned external to the body portion **216**, for example, extending along a portion of the underside (lower surface **220**) of the body portion **216**. In such cases, the battery module **254** may be permanently attached to the lower surface **220**, or may be configured to be removable and/or replaceable, as discussed above with respect to the cellular data module **242**. In different implementations, the contact pad region **256** can include a plurality of contact pads **258** that when mated or contacted with the contact connector component of the device (see FIG. 6) provide an electrical connection between the external accessory (housing panel) and the portable computing device’s interior components. In some implementations, the contact pad region **256** can include pads on a flexible printed circuit.

[0056] Furthermore, the number of contact pads **258** can vary in order to correspond to the number of contact connectors that are included in the device (or vice-versa). Generally, the contact pads and contact connector component include gold-plated copper, copper, and/or hard nickel. In some implementations, when the contact connector component of the device (see FIG. 6) contacts the contact pad region **256**, the computing device can operate as if the current supplied is from a battery charging power supply instead of the auxiliary battery. Similarly, in different implementations, the site on which the contact pad region **256** is disposed can also vary, and is shown in the upper left hand corner region of the lower surface **220** only for purposes of example. If it is desired that the corresponding contact connector component of the device be repositioned along the receiving portion, the contact pad region **256** can also be repositioned.

[0057] In some implementations, the type of battery embedded in the housing panel component can vary. It should be understood that the battery used need not be limited to a particular type or size of battery or batteries. Generally, rechargeable batteries will be used, such as for example, lithium-ion (Li-ion), nickel cadmium (NiCad), and nickel metal hydride (NiMH). The housing panel component **200** can also include provisions for charging the battery module **254**, such as but not limited to a port configured to receive or mate with a power cord that delivers electricity from an external power source. This arrangement allows power to be transferred to a rechargeable power source (i.e., battery module **254**). In other implementations, the battery module can be associated with internal inductive loops that can be charged by an inductive charging system.

[0058] It should also be appreciated that while a dotted line indicates the general position and shape and size of the battery module **254** in FIG. 2B, in different implementations, the battery is not limited to having a rectangular body and can comprise other shapes and sizes. Similarly, a thickness of the battery module **254** can also vary, though the thickness will have a maximum thickness bounded by the overall thickness of the body portion of the housing panel component in order to provide a smooth and seamless fit between

the device and the housing panel component. As one non-limiting example, the battery module **254** can comprise an FLCB (Flexible Printed Circuit (FPC) Lithium Ceramic Battery) as produced by ProLogium™, in this case with a thickness of approximately 0.4 mm (+/-0.05) and a flexible, customizable shape that can be manufactured to accommodate the shape and size of the housing panel component.

[0059] In addition, as shown in FIG. 2B, the housing panel component **200** also includes a first sidewall **280** extending distally outward (here, in a direction vertically upward, toward the viewer) from the first edge **202** of the body portion **216**, and a second sidewall **270** extending distally outward (here, in a direction vertically upward, toward the viewer) from the second edge **204**. In addition, the housing panel component **200** includes a third sidewall **290** that extends distally outward (here, in a direction vertically upward, toward the viewer) from the forward edge **208** of the body portion **216**. In the example of FIG. 2B, both the first sidewall **280** and the second sidewall **270** extend along a direction that is aligned with the lateral axis **170**. In one implementation, the first sidewall **280** and the second sidewall **270** are substantially parallel. Furthermore, the third sidewall **290** in this example extends along a direction that is aligned with the longitudinal axis **180**. In one implementation, the third sidewall **290** can be oriented orthogonally relative to the first sidewall **280** and/or the second sidewall **270**.

[0060] In some implementations, these three sidewalls (**280**, **270**, **290**) can be joined together or otherwise be configured to extend along the peripheral edge as a single piece to form a substantially continuous, U-shaped peripheral sidewall, as shown in FIG. 2B. While in FIG. 2B, the U-shape includes curved connector regions (i.e., a first connector region **222** and a second connector region **224**), in other implementations the sidewalls may end more sharply and join or merge together at right-angles instead.

[0061] In some implementations, the sidewalls can be associated with one or more connector elements that enable or otherwise facilitate the fastening or securement between the housing panel component **200** and the device and these connector elements, together with corresponding connector elements on the device itself, serve as attachment mechanisms. As a general matter, these connector elements can involve a mating connection process, in which a first connection element of the interchangeable housing panel component is mated, inserted, joined, contacted, secured to, or otherwise becomes removably connected with a second connection element of the computing device. However, it should be understood that the connector element properties described herein can also incorporate additional fastening elements, such as but not limited to magnetic or other self-mating connector materials, clasps, hook and loop fasteners, snap fasteners, screws, buckles, sliders, or other connection components. These connector elements, as will be discussed in greater detail below, provide a balance between ease of installation and mating with a computing device, and reliability and durability of installation. In other words, the various types of connector elements described herein are (a) simple to secure together (installation involves a quick slide-and-click on process), (b) dependable once secured (e.g., remaining firmly attached to the device throughout everyday use and transport of that device, and also providing a resilient component that can be maintained for the life of the device), and (c) straightforward to remove

for a user (quick and simple disconnect process). In addition, by arranging connector elements along all four edges of the housing panel component, the stability or anchoring of the housing panel component to the device is ensured. Furthermore, the types of connector elements and their specific structures are designed to make installation straightforward and easy, but inadvertent removal much more unlikely. For example, the mechanisms are oriented in a way that requires a user to exert a specific sequence of applied pressure and force to disengage the various connector elements that have been mated with one another, such that removal or loosening of the housing panel component from the device is highly unlikely to occur accidentally.

[0062] Referring to FIG. 2B, the first sidewall **280** includes a first set of raised portions **230** protruding from a first interior surface **282** of the first sidewall **280**, where the first interior surface **282** is an opposite facing surface of a first exterior surface **284** of the first sidewall **280**. Similarly, the second sidewall **270** includes a second set of raised portions **240** protruding from a second interior surface **272** of the second sidewall **270**, where the second interior surface **272** is an opposite facing surface of a second exterior surface **274** of the second sidewall **270**. In different implementations, the third sidewall **290** includes a group of projections **260** protruding from a third interior surface **292** of the third sidewall **290**, where the third interior surface **292** is an opposite facing surface of a third exterior surface **294** of the third sidewall **290**. It can be seen that the raised portions can include different sizes or dimensions in some implementations. For example, some raised portions may extend further proximally inward than neighboring raised portions (as shown in FIG. 2B). Additional details regarding the raised portions will be provided with reference to FIGS. 3A-3C, and additional details regarding the projections **260** will be provided with reference to FIG. 5. While not shown here, the connector elements described herein can be further associated with magnetic elements that can help guide or facilitate the attachment process between the housing panel component and the display housing.

[0063] In different implementations, connector elements can also be provided that are not associated with a sidewall. For example, in FIG. 2B, the housing panel component **200** includes plurality of tab portions **250** that extend in an outward direction (distally) away from the body portion **216**. These tab portions **250** are anchored or integrally formed along the rearward edge **206**. In some implementations, the tab portions can be made of the same material as the body portion, while in other implementations, the material can differ. Additional details regarding the tab portions **250** will be provided with reference to FIG. 4.

[0064] Furthermore, in the example of FIG. 2B, the first interior surface **282** and the second interior surface **272** can be observed to face toward one another. In some implementations, these two sets of raised portions (**230**, **240**) are arranged in a substantial mirror-image positioning relative to one another. However, in other implementations, one or both of the sidewalls **270** and **280** may be oriented diagonally relative to the lateral axis **170**, or otherwise include curvature or non-linear portions, and the raised portions arranged along each sidewall can be vary in their spatial position. In another example, the two side portions as demarcated by a lateral-midline along the body portion **216** can be symmetrical with respect to one another.

[0065] Referring now to FIGS. 3A-3C, further information pertaining to the raised portions introduced above is provided. In FIG. 3A, a side view of the housing panel component 200 is illustrated along the lateral axis 170 of FIG. 2B in which the second interior surface 272 of the second sidewall 270 is visible. In FIG. 3A, the arrangement of the second set of raised portions 240 can be more clearly observed. In this specific example, the second set of raised portions 240 comprises six raised portions, including a first raised portion 310, a second raised portion 320, a third raised portion 330, a fourth raised portion 340, a fifth raised portion 350, and a sixth raised portion 360. In different implementations, there may be fewer or greater number of raised portions. In addition, it may be seen that each raised portion is substantially similar in three-dimensional shape relative to the other raised portions. In this case, each raised portion has a generally trapezoidal or quadrangular shape. However, as shown in FIG. 2B, the extent that each raised portion is 'raised' beyond the sidewall surface or otherwise protrudes can differ. Though not observable in the side views of FIGS. 3A-3C, referring back to FIG. 2B, it may be seen that first raised portion 310, third raised portion 330, and fifth raised portion 350 each have a first width W1 and the second raised portion 320, fourth raised portion 340, and sixth raised portion 360 each have a larger, second width W2. Thus, an internal volume of each of the first raised portion 310, third raised portion 330, and fifth raised portion 350 will be smaller than an internal volume of each of the second raised portion 320, fourth raised portion 340, and sixth raised portion 360. In other words, the extent that each raised portion protrudes outward or away from the sidewall can vary.

[0066] As depicted in an enlarged view 314 of the first raised portion 310, the raised portion may include a slanted or sloped edge 312 that is oriented diagonally relative to the remaining three edges. This sloped edge 312 is provided toward the side that will initially engage with the corresponding mechanisms of the receiving portion of a device, and can allow the slide-in and slide-out processes to occur more smoothly and easily for the user. In other words, the direction of the slant, where the sloped edge increases in height from a lower point to a higher point, is configured to enable or facilitate the guidance of the raised portion into the specially shaped recesses that may be formed in the receiving portion of the device (see FIGS. 12A-12C). In some other implementations, the raised portion may include curved or rounded, rather than sharp, edges. In addition, it may be understood that the thickness of each raised portion can vary and can be configured to match or generally 'fit' the depth of its corresponding recess in the receiving portion.

[0067] Furthermore, in different implementations, the materials comprising the housing panel component 200 can vary, and may incorporate a single primary material, or multiple materials with varying properties. In FIG. 3A, for purposes of illustration, the housing panel component 200 includes three materials, including a first material 302 corresponding to the upper (outermost, exposed, or external) surface 210 that extends across the body portion 216 and in some cases over the edges and along the surfaces of the sidewalls (see FIGS. 2D, 2E, and 2F), a second material 304 corresponding to an intermediate or substrate layer of the component. In some implementations, another, third material 306 corresponding to the material of the sidewalls can also be used. It is to be understood that the differences in

cross-hatching are presented for purposes of example only, and in different implementations, the material comprising the entirety or substantial entirety of the housing panel component 200 can be a single, uniform material (see FIG. 2C), or only two materials (see FIGS. 2D, 2E, and 2F), or three or more materials. In this example, the first material 302 may be a soft fabric or textile, wood (or artificial wood laminate or other laminates), thermoplastic, or leather, the second material 304 may be configured to provide structural support (such as a plastic molding), and an optional third material may be more rigid to withstand the repeated engagements as it functions to support various attachment mechanisms.

[0068] In different embodiments, each of the materials can include various properties. In some implementations, the various portions of the housing panel component may be formed from one or more of a plurality of material elements (e.g., textiles, polymer sheets, foam layers, leather, synthetic leather, knitted fabrics, etc.) that are stitched together or otherwise laid or disposed adjacent to one another to form the housing panel component. Other materials that could be used in various implementations include, but are not limited to: expanded rubber, foam rubber, various kinds of foams, polyurethane, nylon, Gore-Tex, leather, plastic, textiles, as well as possibly other materials. Other parts of the housing panel components may be made from any of a plurality of materials or combination of materials, such as leather, leather-like materials, polymer materials, plastic materials, and textile fabrics and materials. Such materials can offer a more pleasing aesthetic appearance and feel to the housing panel component, which can be of great importance to a user.

[0069] In addition, each of the layers comprising the housing panel component may be formed from any generally two-dimensional material. As utilized with respect to the present invention, the term "two-dimensional material" or variants thereof is intended to encompass generally flat materials exhibiting a length and a width that are substantially greater than a thickness. Accordingly, suitable materials for at least the body portion of the housing panel component (whether comprising one or multiple layers), and/or the sidewalls, include various textiles, polymer sheets, or combinations of textiles and polymer sheets, for example.

[0070] Textiles are generally manufactured from fibers, filaments, or yarns that are, for example, either (a) produced directly from webs of fibers by bonding, fusing, or interlocking to construct non-woven fabrics and felts or (b) formed through a mechanical manipulation of yarn to produce a woven or knitted fabric. The textiles may incorporate fibers that are arranged to impart one-directional stretch or multidirectional stretch, and the textiles may include coatings that form a breathable and water-resistant barrier, for example. The polymer sheets may be extruded, rolled, or otherwise formed from a polymer material to exhibit a generally flat aspect. Two-dimensional materials may also encompass laminated or otherwise layered materials that include two or more layers of textiles, polymer sheets, or combinations of textiles and polymer sheets. In addition to textiles and polymer sheets, other two-dimensional materials may be utilized for housing panel component or portions thereof (e.g., the outermost covering or first layer 302). Although two-dimensional materials may have smooth or generally untextured surfaces, some two-dimensional mate-

rials will exhibit textures or other surface characteristics, such as dimpling, protrusions, ribs, or various patterns, for example. Despite the presence of surface characteristics, two-dimensional materials remain generally flat and exhibit a length and a width that are substantially greater than a thickness. In some configurations, mesh materials or perforated materials may be utilized in the housing panel component.

[0071] Furthermore, in some implementations, at least the outer surface of the housing panel component (the surface that is visible after installment on a device) can be treated to provide various external appearances to the material. For example, a molding texture, embossing, metal wire drawing, painting, printing, water transfer printing, hot press forming, texturing (e.g. leather grain), hot stamping, laser engraving, metal etching, metal stamping, silk-screen printing, and/or techniques based on IML (In Molding Label), IMF (In Molding Film), IMR (In Molding Roller), OMD (over-molding or high-pressure transfer), OMR (over-molding release or release film) VCM plates and boards (vinyl chloride), and/or CNC machining.

[0072] In some implementations, dissimilar materials described herein may be attached by fusing or welding. As utilized herein, the terms “fusing” and “welding” (and variants thereof) are defined as a securing technique between two elements that involves a softening or melting of the material of at least one of the elements such that the materials of the elements are secured to each other when cooled. Similarly, the term “weld” or variants thereof is defined as the bond, link, or structure that joins two elements through a process that involves a softening or melting of material within at least one of the elements such that the elements are secured to each other when cooled. Welding may involve the melting or softening of two components such that the materials from each component intermingle with each other, that is, the materials may diffuse across a boundary layer (or “heat affected zone”) between the materials, and are secured together when cooled. Alternatively, welding may involve the melting or softening of a material in a first component such that the material extends into or infiltrates the structure of a second component, for example, infiltrating crevices or cavities in the second component or extending around or bonding with filaments or fibers in the second component to secure the components together when cooled. Thus, welding of two components together may occur when material from one or both of the components melts or softens. Accordingly, a weldable material, such as a polymer material, may be provided in one or both of the components. Additionally, welding does not generally involve the use of stitching or adhesives, but involves directly bonding components to each other with heat. In some situations, however, stitching or adhesives may be utilized to supplement the weld or the joining of the components through welding. Components that have been welded together will be understood to be “fused” together.

[0073] In different implementations, modern embroidery techniques may be utilized to autonomously create an embroidery pattern on a sheet of textile materials that is incorporated into the outermost surface of the housing panel component. Textile materials include fabrics such as cotton, wool or silk, as well as leather, foam, polymer sheets, and synthetic equivalents. Other examples of materials that may be utilized include polyester, nylon, polypropylene, polyethylene, acrylics, wool, acetate, polyacrylonitrile, and com-

binations thereof. Natural fibers may also be used, such as cellulosic fibers (e.g., cotton, bamboo) or protein fibers (e.g., wool, silk, and soybean).

[0074] On the textile materials, a number of stitch techniques may be used. For example, depending on the purpose of the embroidery, the chain stitch, the buttonhole or blanket stitch, the running stitch, the satin stitch, or the cross stitch may be used to produce various designs. The stitching techniques may be used in combination to form a variety of set patterns. The stitching patterns may be decorative, for example the pattern may form a flower or series of flowers, logos, alphanumeric symbols, customized designs, or other patterns. Alternatively the stitching may be structural, such as stitching along the edges of a garment to reinforce the seams. In further cases the stitching may be both decorative and functional, such as the use of a floral pattern use to reinforce a patch.

[0075] Typically a thread or yarn is used as the stitching material and stitched into the textile. Commonly the thread or yarn may be made of cotton or rayon, as well as traditional materials like wool, linen or silk. However, embroidery may also sew in dissimilar materials to the textile, usually for decorative purposes. For example, thread created out of precious metals such as gold or silver may be embroidered within more traditional fabrics such as silk. Additionally, additional elements may be sewn in during embroidery, such as beads, quills, sequins, pearls or entire strips of metal. These elements may be sewn in along with yarn or thread using variety of stitching techniques depending on the desired placements of the elements.

[0076] In other examples, the materials can be arranged differently. For example, the outermost covering can include a material that only serves as the upper surface **210**, while the exterior surfaces of the sidewalls are formed of a different material. In other implementations, the outermost covering can include a material that covers the upper surface **210** and also curves or wraps around (or “hugs”) some or all of the exterior surfaces of the first and second sidewalls, providing a more continuous interface. For example, a ledge portion **308** extending toward the forward edge **208** configured to form a forward facing exterior surface (e.g., a surface facing toward the user **110** of FIG. 1) can include the same material extending along the upper surface **210**, or—as shown in FIG. 3A—can be of a different material entirely. In some other implementations, the two materials may be similar, but be of different colors or patterns, providing users with greater design choices. In addition, in some implementations, the raised portions can include a fourth type of material, or may extend outward from the sidewall with the same material as the sidewall. In another example the raised portions may be formed of the material providing the substrate and the sidewalls may include a plurality of apertures shaped and sized to allow the raised portions to pass through the apertures as they extend outward from the substrate.

[0077] It can further be understood that when multiple layers of materials are incorporated into an interchangeable housing component, the materials can vary in their relative thicknesses. It should also be understood that the interchangeable cover dimensions can be adjusted to accommodate different sized laptops or other computing devices for which the housing panel component is desired. Any other sized-computing device can also benefit from these inter-

changeable components; as the device size increases, the housing panel component dimensions can also change.

[0078] With respect to interchangeable housing panel components that are integrally formed (i.e., as one piece or primarily being made of a single material), for example by plastic molding, the thickness of the plastic can vary relative to the computing device dimensions (see FIG. 2C). As a specific example, a Z-height (vertical axis) of a first computing device may be around 17.9 mm, and a corresponding interchangeable housing panel component may have a thickness of approximately 1.6 mm. In another example, a Z-height (vertical axis) of a second computing device may be around 18.9 mm, and a corresponding interchangeable housing panel component may have a thickness of approximately 1.7 mm.

[0079] With respect to interchangeable housing panel components that include an outer cover material and an internal substrate or support structure, the dimensions can vary to accommodate the differences in materials. For example, a first housing panel component can include an upper surface wrap cover that includes two primary materials, where a soft, flexible material, such as a fabric, is wrapped around a more rigid supporting base (see FIG. 2D). In another example, a second housing panel component can include a primary surface recessed design, where there is a slight recessed region along the upper surface of rigid supporting base that is configured to receive versatile decorated materials of a thickness matching the depth of the recess (see FIG. 2E). As a further example, a third housing panel component can be configured to receive a ‘wrap around cover’ that extends around the sidewalls as well as the upper surface (see FIG. 2F), suitable for soft, flexible material(s) being wrapped around a more rigid supporting base. These softer covers can have a smaller thickness relative to the more rigid substrate. For example, the softer outer material can have a thickness of approximately 0.1 mm to 0.5 mm, and a substrate thickness ranging between 1 mm and 1.5 mm. Where the first computing device had a Z-height of around 17.9 mm, the corresponding interchangeable housing panel component comprising two materials may have a first material thickness of approximately 1.1 mm and a second material thickness of approximately 0.3 or 0.4 mm. In another example, where the Z-height (vertical axis) of the second computing device is around 18.9 mm, the corresponding interchangeable housing panel component comprising two materials may have a first material thickness of approximately 1.2 mm and a second material thickness of around 0.2 or 0.3 mm. Such dimensions can provide a balance between the durability and sturdiness of the housing panel component, as it undergoes repeated removals and installations, as well as an outer appearance and texture that is pleasing to the user.

[0080] While the bottom-up view of FIG. 2B appeared to show the raised portions on each of the first sidewall 280 and the second sidewall 270 as being arranged in a single line, FIGS. 3A-3C more clearly shows that in some implementations, the arrangement can vary widely. Specifically, in FIGS. 3B and 3C, the second sidewall 270 is shown in two parts to better illustrate one possible arrangement of the raised portions. In FIG. 3B a forward portion of the housing component is shown and in FIG. 3C a rearward portion of the housing component is shown. The second sidewall 270 includes the six raised portions of the second set of raised portions 240. It can be seen that in different implementa-

tions, two or more of the raised portions can be disposed at varying heights along the sidewall relative to vertical axis 190.

[0081] For purposes of reference, in FIG. 3B, the first raised portion 310 is disposed at a first height H1 along the second sidewall 270, the second raised portion 320 is disposed at a second height H2, the third raised portion 330 is disposed at a third height H3. Similarly, in FIG. 3C the fourth raised portion 340 is disposed at a fourth height H4 along the second sidewall 270, the fifth raised portion 350 is disposed at a fifth height H5, and the sixth raised portion 360 is disposed at a sixth height H6. While in some implementations the heights H1-H6 can be the same, in other implementations, two or more may differ. In FIG. 3B, while the first height H1 and the third height H3 are substantially similar or equal, the second height H2 is smaller than either H1 or H3. In addition, in FIG. 3C, while the fourth height H4 and the sixth height H6 are substantially similar or equal, the fifth height H5 is greater than either H4 or H6. In addition, in this example, heights H1, H3, and H5 are approximately equal, and heights H2, H4, and H6 are approximately equal. This produces a staggered height pattern, and in this specific case, a repeated “high-low” alternating pattern for the raised portions. This pattern will be again reflected in the discussion of the receiving portion for the device (see FIGS. 7B and 8B). In other words, the raised portions can be arranged to correspond to any spatial pattern that will align with, for example, the arrangement of corresponding receiving notches or recesses in the device to ensure a secure connection between the two sections (see FIGS. 12A-12C).

[0082] Furthermore, in some implementations, the second sidewall 270 may also include additional fastening mechanisms. In FIGS. 3A and 3B an elongated flange portion 370 is depicted near the forward edge 208, spaced apart slightly from the ledge portion 308. As will be illustrated further below, the flange portion 370 can be sized and dimensioned to slide into a corresponding channel of the device (see FIGS. 12A-12C) and help complete or finalize the connection process.

[0083] As introduced above, the housing panel component 200 also includes the plurality of tab portions 250 arranged along the forward edge 206. As the housing panel component 200 is inserted onto or into the receiving portion of a device, when it nears the base portion, the tab portions 250 can be aligned with corresponding recessed slots formed in portions of both of the rearmost surface of the receiving portion as well as the base portion (see FIG. 10). In one implementation, the tab portions can be configured to provide a snap-fit connection with the recessed slots. Referring to the isolated view of FIG. 4, in this case the tab portions 250 include a first tab 410, a second tab 420, a third tab 430, a fourth tab 440, a fifth tab 450, a sixth tab 460, and a seventh tab 470. In different implementations, there may be fewer or greater number of tab portions. In addition, it may be seen that each tab portion is substantially similar in three-dimensional size and dimensions relative to the other tab portions. In this case, each tab portion has a generally rounded rectangular (tab) shape.

[0084] In FIG. 4, the fourth tab 440 and the module 242 are illustrated in an enlarged isometric view for the reader's benefit. The fourth tab 440 has a length 422 extending along the longitudinal axis 180 that is greater than its width 424 extending along the lateral axis 170. In different implementations, the length 422 will be similar to a length of a

recessed slot in the device configured to receive the tab portion, and the width **424** will be similar to a width of the recessed slot. In some other implementations, though, the width **424** may be smaller than the width of the recessed slot, whereby the recessed slot is slightly larger to allow for the smooth passage of the tab into the rearmost portion of the recessed slot. Furthermore, an overall thickness of the tab portion can be similar to the depth of the recessed slot such that there is a flush and secure fit when the two pieces are joined.

[0085] Each of the tab portions are joined to the rearward edge **206** by a series of rib elements. For example, in the enlarged view **402**, three rib elements **426** extend distally outward from the lower surface **220** of the body portion **216**. A back edge **480** of the fourth tab **440** is then integrally attached with a distal end of each of the three rib elements **426**. This type of elastic strut-like mechanical structure is important in that it allows the tab portion to move up and down within a limited range of flexibility to facilitate the insertion of the tabs into their corresponding recessed slots that are disposed or formed below the larger outer surface of the receiving portion of the device. For example, if the ribs instead comprised a larger, one-piece or otherwise bulkier ‘bridge’, there might be a greater likelihood of damage or break between a tab and the body portion **216**. This rib arrangement permits gentle ‘bounce’ or yielding as the user slides the housing panel component into place. Once the tabs are received by the recessed slots, there may be a click, or locking step.

[0086] In addition, in this case, it can be understood that each of the plurality of tabs **250** lie along a different horizontal plane (lower with respect to the vertical axis) than the horizontal plane of the body portion **216**. Such an arrangement also allows the final connection between the housing panel component and the device to appear more seamless, as the tabs are received by slots that are at least partially beneath or within the base portion and therefore hidden from view once the housing panel component is fully connected.

[0087] While in some implementations, the fourth tab **440** may be removed to provide full clearance to the module **242**, in FIG. **4**, it can be seen that the module **242** can be disposed directly adjacent and above the fourth tab **440**, spaced apart by a distance **480**. The distance **480** can be adjusted to correspond to the exact location of the corresponding receiving ports formed in the base portion (see FIG. **12D**). In other implementations, the module **242** can be repositioned such that, rather than occupy a centrally located site along the rearward edge **206**, the module **242** is disposed closer to a first edge **202** or closer to a second edge **204**. In the implementation of FIG. **4**, the module **242** is integrated within a thickness **482** of the body portion **216**; however, as noted earlier, in other implementations, the module **242** can be external to the material of the housing panel components (e.g., attached directly to the underside of the body portion).

[0088] In addition, for purposes of reference the module **242** includes externally exposed surfaces such as a first surface **486** generally oriented along a horizontal plane (e.g., facing downward toward the interface surface during installation), and a second surface **484** generally oriented along a vertical plane (e.g., the surface facing toward the base portion during installation). Thus, most of the module **242** remains enclosed or in direct contact within the underside of

body portion **216**, while only the two contact regions (**244**, **246**) protrude outward and are exposed.

[0089] The housing panel components described herein can include additional fastening mechanisms. As introduced above, the housing panel component **200** includes the group of protruding portions **260** arranged along the forward edge **206**. As the housing panel component **200** is inserted onto or into the receiving portion of a device, when it nears the final stage of installation, the protruding portions **260** can be aligned with corresponding apertures that are formed in the forward-facing side of the receiving portion (see FIG. **11**).

[0090] Referring to the isolated view of FIG. **5**, in this case the protruding portions **260** include a first protruding portion **510**, a second protruding portion **520**, a third protruding portion **530**, a fourth protruding portion **540**, a fifth protruding portion **550**, a sixth protruding portion **560**, a seventh protruding portion **570**, and an eighth protruding portion **580**. In different implementations, there may be fewer or greater number of protruding portions. In addition, it may be seen that while some protruding portions are substantially similar in three-dimensional size and dimensions relative to other protruding portions, other protruding portions differ. In this case, each protruding portion has a generally rounded prism shape. In addition, second protruding portion **520**, third protruding portion **530**, sixth protruding portion **560**, and seventh protruding portion **570** are substantially equal in size and shape, while being larger in thickness, length, and width from the other four protruding portions. Similarly, fourth protruding portion **540** and fifth protruding portion **550** are substantially equal in size and shape, while being smaller in thickness and width from the four protruding portions **520**, **530**, **560**, and **570**. Finally, first protruding portion **510** and eighth protruding portion **580** are substantially equal in size and shape, while being smaller in thickness, length, and width from the two protruding portions **540** and **550**. In some implementations, the arrangement of the protruding portions as demarcated by a lateral-midline along the body portion **216** can be symmetrical with respect to one another, as shown in FIG. **5**, providing a more even weight distribution that can improve user experience during installation and removal operations.

[0091] In FIG. **5**, the third protruding portion **530**, fourth protruding portion **540**, and fifth protruding portion **550** are shown in an enlarged view **502** for the reader’s benefit. The third protruding portion **530** has a first length **532** extending along the longitudinal axis **180** that is greater than its first width **534** extending along the lateral axis **170**. Similarly, the fourth protruding portion **540** has a second length **542** that is greater than its second width **536**. Relative to one another, the first length **532** is similar to the second length **534**; however, the first width **534** is larger than the second width **544**. In different implementations, as will be discussed below with reference to FIG. **11**, the apertures formed in the device configured to receive each of these protruding portions can be sized and dimensioned to snugly match the particular three-dimensional shape and size of each corresponding protruding portion and permit a secure lock between the two components.

[0092] Referring now to FIGS. **6-11**, the sequence of drawings present a non-limiting example of a housing for a device that can be used in conjunction with the interchangeable housing panel components described herein. In FIG. **6**, a top-down view of a portable computing device (“device”) **600** is shown (without the housing panel), including a

display housing (e.g., the housing portion for the lid of the device that holds the display screen) that comprises both a base portion 610 and a receiving portion 620. In different implementations, the proportion of surface area associated with each portion can differ. For example, in FIG. 6, the base portion 610 has a first surface area that extends across a first lateral distance 682, and the receiving portion 620 has a second, larger surface area that extends across a second lateral distance 684. In some implementations, the first surface area of the base portion 610 can be equal to or less than the second surface area of the receiving portion. This arrangement can ensure that a significant extent of the lid is customizable with an interchangeable housing panel component. In FIG. 6, the second surface area of the receiving portion 620 is approximately twice as large as the first surface area of the base portion 610. In other words, the first surface area comprises approximately $\frac{1}{3}$ of the total surface area of the exterior surface of the display rear (backside of the display) housing or lid portion 690, and the second surface area comprises approximately $\frac{2}{3}$ of the total surface area for the lid portion 690.

[0093] In addition, as noted earlier with respect to FIG. 2B, in different implementations, the systems described herein can be configured to transfer electrical current between an external or auxiliary battery and a contact connector component. In different implementations, the contact connector component can comprise pogo pins or other spring-loaded electrical connector(s), as well as other probe and spring-loaded contacts. In FIG. 6, a connector pin region 652 is shown disposed on an upward facing interface surface 660 that is configured to receive and/or mate with the contact pad region 256 shown in FIG. 2B. The connector pin region 652 can be positioned at a specific site that will line up with the corresponding contact pad region when the installation of a housing panel component occurs. In other words, when the housing panel component is installed on the receiving portion 620 of the device, the connector pin region 652 and the contact pad region 256 are aligned and directly face and come into contact with one another. The spring-loaded pins are pushed down and press against the complementary surfaces provided by the contact pads. A backside of the connector pin region 652 (not shown) is configured with connections that lead to the internal components of the computing device. Such an arrangement enables a flow of current to travel from the battery module in the housing panel component to the internal components of the computing device.

[0094] For purposes of reference, the device 600 has a first side 602, a second side 604, a rearward side 606, and a forward side 608. The base portion 610 is disposed nearer the rearward side 606 of the device 600 and the receiving portion 620 is disposed nearer the forward side 608 of the device 600. In addition, the base portion 610 includes a generally rectangular prism shape, and comprises a plurality of external surfaces. In this example, the base portion 610 has a top surface 652 that extends between a first side surface 612 (disposed along the first side 602 of the device 600) and a second side surface 614 (disposed along the second side 604 of the device 600) relative to the longitudinal axis 180. In addition, the top surface 652 of the base portion 610 extends between a third side surface 616 (disposed along the rearward side 606), and a fourth side surface 618 (disposed directly adjacent to the receiving portion 620) relative to the lateral axis 170. Each of the side surfaces

extend along a generally vertical plane, in contrast to the top surface 652 which extends along a generally horizontal plane. The fourth side surface 618 can be configured to receive or be pressed against a rearward edge 206 (see FIG. 2A) of the housing panel component when the housing panel component is installed.

[0095] In other words, the base portion 610 is thicker than the receiving portion 620 (i.e., relative to the vertical axis), and the receiving portion 620 is recessed or 'thinner' relative to the base portion 610. In some implementations, the difference in thickness between the receiving portion 620 and the base portion 610 can correspond to a thickness of the housing panel component that is to be accommodated by the device, resulting in a smooth, flush interface between the outer surface of the rearward edge of the housing panel component and the fourth side surface 618. Thus, when there is no housing panel component installed, the fourth side surface 618 is exposed and visible, and when a housing panel component is installed, the fourth side surface 618 is no longer visible. This can be seen more clearly in the views provided by FIGS. 7B and 8B, where a thickness T1 and a thickness T2 are labeled for purposes of clarity to highlight the difference in thickness between the base portion 610 and the adjacent receiving portion 620.

[0096] Similarly, in some implementations, the length of the base portion 610 (relative to the longitudinal axis 180) can be greater than a length of the receiving portion 620. This can be observed in FIG. 7A along the first side 602, where a first side portion 652 of the base portion 610 extends a first length L1 distally outward, and in FIG. 8A along the second side 604, where a second side portion 654 of the base portion 610 extends a second length L2 distally outward, relative to the receiving portion 620. In other words, each of the two side portions of the base portion 610 jut outward relative to the receiving portion 620, each with surface areas sufficient to provide an interface for the rearmost ends of the first and second sidewalls of the housing panel component when the housing panel component is installed.

[0097] An introductory view of the fastening mechanisms that may be incorporated in device 600 for attachment to a housing panel component is also provided in FIG. 6. In this example, the receiving portion 620 has interface surface 660 that is configured to face toward, receive, and/or contact the lower surface 220 of the housing panel component. The interface surface 660 extends between a first periphery 672 (disposed along the first side 602 of the device 600) and a second periphery 674 (disposed along the second side 604 of the device 600) relative to the longitudinal axis 180. In addition, the interface surface 660 of the receiving portion 620 extends between a third periphery 676 (disposed adjacent to the fourth side surface 618 of the base portion 610), and a fourth periphery 678 (disposed along the forward side 608) relative to the lateral axis 170.

[0098] As noted earlier, the receiving portion 620 can include provisions for removable attachment with an interchangeable housing panel component. In general, these provisions can be arranged to correspond directly with specific connector elements formed on the housing panel component. Some examples of these provisions include a plurality of recessed slots ("slots") 650 arranged along the border associated with third periphery 676. In some implementations, the slots 650 can extend beyond the region corresponding to the receiving portion 620 and be formed within parts of the base portion itself (see FIG. 10 below).

In addition, along the first periphery 672 of the receiving portion 620, a first set of grooves 630 is formed, and along the second periphery 674 a second set of grooves 640 is formed. As a general matter, these grooves can be positioned to receive the raised portions described earlier with respect to FIGS. 3A-3C. Furthermore, though not visible in FIG. 6, a group of apertures can also be formed along the fourth periphery 678 of the receiving portion 620 that are configured to snugly receive the group of protruding portions of the housing panel component (see FIG. 5).

[0099] Referring now to FIGS. 7A-9, further information pertaining to the sets of grooves introduced above is provided. In FIG. 7A, an isolated top-down view of the first periphery 672 of the receiving portion 620 is shown, and in FIG. 7B, a side view of the first periphery 672 is shown. The first set of grooves 630 comprises six grooves, including a first groove 710, a second groove 720, a third groove 730, a fourth groove 740, a fifth groove 750, and a sixth groove 760. While in some implementations the grooves can be substantially similar in size and shape, in this case, it can be seen that the relative positions and sizes of the grooves vary in an alternating pattern, similar to that described earlier with respect to the raised portions of FIGS. 3B and 3C. As a first example, the first groove 710 has a first depth D1, and the second groove 720 has a second depth D2. In this case, the second depth D2 is deeper or extends further than the first depth D1. This arrangement is repeated, where it may be understood that third groove 730 and fifth groove 750 also each have a depth corresponding to the first depth D1, and the fourth groove 740 and sixth groove 760 each have a depth corresponding to the second depth D2. This variation in depths permits the raised portions—positioned at varying heights along the sidewalls of the housing panel component, to be received by the groove during the initial stage of the installation process and appropriately guided into their respective secured positions, as will be discussed below with reference to FIGS. 12A-12C.

[0100] In some implementations, the receiving portion 620 may also include provisions for ‘locking’ or finalizing the connection between the housing panel component and the device. As described earlier in FIGS. 3A-3C, in some implementations, the housing panel component can include a flange portion disposed toward the forward edge near the first sidewall and/or a flange portion disposed toward the forward edge near the second sidewall. In one implementation, the receiving portion can include a channel 770 along the first periphery 672 (toward the forward side 608) configured to receive a first flange portion and, as shown in FIG. 8B, a second channel 870 along the second periphery 674 configured to receive a second flange portion. In different implementations, such flange portions can be sized and dimensioned to bend elastically before being received by the channels.

[0101] For purposes of comparison, in FIG. 8A, an isolated top-down view of the second periphery 674 of the receiving portion 620 is shown, and in FIG. 8B, a side view of the second periphery 674 is shown. The second set of grooves 640 comprises six grooves, including a seventh groove 810, an eighth groove 820, a ninth groove 830, a tenth groove 840, an eleventh groove 850, and a twelfth groove 860. In some implementations, the two sides depicted in FIGS. 7A-8B can be understood to represent structural mirror-images of one another. However, in other implementations, each side can include variations in struc-

ture, and be modified as needed to correspond to changes in the size, shape, or positions of the raised portions along the sidewalls of the housing component.

[0102] In order to provide the reader with a greater appreciation of the function of each groove, an isolated isometric view of two of the grooves is illustrated in FIG. 9. In this example, the tenth groove 840 and neighboring eleventh groove 850 are shown. The isometric view reveals more clearly the L-shape of each groove. In other words, each groove includes a main chamber or first segment that is in direct fluid communication with the opening formed on the upward-facing interface surface 660 and extends downward through the side of the receiving portion, as well as a more elongated arm chamber that extends in a rearward direction from and in fluid communication with the main chamber. In FIG. 9, the tenth groove 840 has a first receiving segment 842 (main chamber) and a first securing segment 844 (arm chamber), and the eleventh groove 850 has a second receiving segment 852 (main chamber) and a second securing segment 854 (arm chamber). Each of the main chambers can differ in shape, but can be generally configured to serve as the initial receiving region of the raised portion during installation, as well as the removal route for the same raised portion during removal. Similarly, each of the arm chambers can differ in shape, but can be generally configured to serve as the final locking region once the housing panel component is installed, and will hold or be a receptacle for the raised portion during the duration of the housing panel component’s installation on the device.

[0103] In FIG. 9, the first receiving segment 842 has a depth corresponding to second depth D2 and the second receiving segment 852 has a depth corresponding to first depth D1, which is smaller than second depth D2. In addition, the first securing segment 844 has a depth corresponding to a third depth D3, and the second securing segment 854 has a depth corresponding to a fourth depth D4. In different implementations, the depth D3 can be approximately equal to a total height of the raised portion that is to be inserted into the first securing segment 844. Similarly, the depth D4 can be approximately equal to a total height of the raised portion that is to be inserted into the second securing segment 854. In some implementations, depths D3 and D4 can be similar. The first depth D1 extends from the interface surface 660 to a first bottom surface 856, and the second depth D2 extends from the interface surface 660 to a second bottom surface 846. Similarly, the third depth D3 extends from a topmost surface of the first securing segment 844 to the second bottom surface 856, and the fourth depth D4 extends from a topmost surface of the second securing segment 854 to the first bottom surface 846. Finally, the 840 is associated with a third width W3 and the 850 is associated with a fourth width W4. In this case, third width W3 is smaller than fourth width W4. These widths can correspond to the relative widths of the raised portions, as described above with respect to FIGS. 2B-3C. In other words, the raised portions that protrude outward less (e.g., first raised portion 310, third raised portion 330, and fifth raised portion 350 with a first width W1) will be received by a correspondingly narrower groove (e.g., with width W3), and the raised portions that protrude outward further (e.g., second raised portion 320, fourth raised portion 340, and sixth raised portion 360 with larger, second width W2) will each be

received by a correspondingly wider groove (e.g., with width W4) to ensure a snug fit for each sized-connector element.

[0104] Referring now to FIG. 10, further information about the plurality of recessed slots 650 arranged along the border associated with third periphery 676 is provided. In this example, the slots 650 include a first slot 1010, a second slot 1020, a third slot 1030, a fourth slot 1040, a fifth slot 1050, a sixth slot 1060, and a seventh slot 1070. In different implementations, there may be fewer or greater number of recessed slots. In addition, in FIG. 10, each slot is substantially similar in three-dimensional shape and size relative to the other slots. In this example, each slot has a generally rectangular cross-sectional shape, and has a similar depth as its neighboring slots. However, in other implementations, the extent that each slot is recessed relative to the interface surface 660 can vary in order to accommodate any corresponding variations in the thickness of a tab portion that will be received by the slot (see FIG. 4).

[0105] As noted above, in some implementations, the slots 650 can extend beyond the receiving portion 620 and be formed within parts of the base portion 610 itself. An enlarged transparent view 1002 of second slot 1020 is provided as a simplified example. In view 1002, the second slot 620 has a first portion 622 associated with or formed in the receiving portion 620, and a second portion 624 that is in fluid communication with the first portion 622 but is associated with or formed in the base portion 610 (now transparent). In other words, the recessed slot can extend further inward, into the base portion 610. Thus, when a tab portion is inserted into the recessed slot during an installation, the tab portion will initially slide or move through the first portion 622 and then be at least partially received by the second portion 624.

[0106] FIG. 11 offers additional detail regarding a group of apertures 1100 formed in the fourth periphery 678 of the receiving portion 620 in a top-down view 1102 and a side view 1104. These apertures 1100 can be sized and dimensioned to receive or mate with the group of protruding portions extending from the rearward edge of the housing panel component (see FIG. 5). Thus, for each protruding portion, there is a corresponding aperture. In this example, as there were eight protruding portions described earlier, there are now eight apertures, including a first aperture 1110, a second aperture 1120, a third aperture 1130, a fourth aperture 1140, a fifth aperture 1150, a sixth aperture 1160, a seventh aperture 1170, and an eighth aperture 1180. The number and placement of each aperture can vary in different implementations to correspond to the arrangement of protruding portions for the housing component. It may further be understood that while some apertures are substantially similar in three-dimensional size and dimensions relative to other apertures, other apertures differ. In this case, each aperture has a generally rectangular cross-sectional shape. In addition, second aperture 1120, third aperture 1130, sixth aperture 1160, and seventh aperture 1170 are substantially equal in size and shape, while being larger in depth (volume) from the other four protruding portions. Similarly, fourth aperture 1140 and fifth aperture 1150 are substantially equal in size and shape, while being smaller in depth (volume) from the four apertures 1120, 1130, 1160, and 1170. Finally, first aperture 1110 and eighth aperture 1180 are substantially equal in size and shape, while being smaller in volume from the two apertures 1140 and 1150.

[0107] For purposes of clarity, the installation process is depicted in greater detail with reference to FIGS. 12A-14B. In FIGS. 12A-12C, an overview of the process in three general stages is shown with a series of side views. A first stage in FIG. 12A represents an initial stage during which the two components (e.g., housing panel component 200 and a display housing or lid portion 1200 of device 600) are moved toward one another. In this example, the housing panel component 200 approaches the lid portion 1200 and is also moved in a downward direction toward the interface surface 660 of the receiving portion 620. The two components can also be oriented together along the horizontal axis, such that the edges are generally aligned. The second stage of FIG. 12B represents an intermediate or transition stage during which the connection elements are initially inserted or where the male connection element begins a final approach toward its corresponding female receptacle. This stage usually is associated with a termination of the movement of the components toward one another along the vertical axis. The third stage of FIG. 12C represents the secure or installed stage in which the housing panel component 200 is moved into a final position by a last push inward or a movement of the components toward one another along the lateral axis. During the third stage the housing panel component 200 is securely attached to the lid portion 1200 of the device 600. In order to release the housing panel component, the sequence can be reversed, whereby the housing panel component 200 is pulled outward or away from its secure connection with the lid portion 1200 (FIG. 12C), shown loosened in the second stage (FIG. 12B), and removed with an upward and away motion back to the uninstalled or initial stage (FIG. 12A). However, the removal will also require the application of a gentle pressure inward, applied against the first side and the second side (e.g. along a horizontal direction, proximally inward) to loosen the attachment mechanisms prior to and/or during the removal process. Thus, in different implementations, while the installation can involve a more straightforward 'sliding on until secure' process, the removal (sliding off) cannot be initiated until a gentle pressure is also applied along both of the first sidewall and the second sidewall. This pressure loosens or de-couples the mating between the raised portions and their corresponding grooves and ensures that removal does not occur inadvertently.

[0108] In FIG. 12D, an enlarged, isometric view of an implementation of the mating process between the module 242 of housing panel component 200 and the device 600 is shown. In this drawing, the rearward edge 206 of the housing panel component 200 is approaching the fourth side surface 618 of the base portion 610. As described earlier with respect to FIG. 4, the module 242 can be positioned such that installation of the housing panel component 200 on the device 600 can simultaneously or concurrently align the contact regions (244, 246) with corresponding port receptacles ("ports") formed in the base portion 610. For example, the view of FIG. 12D allows the reader to appreciate the alignment between the first contact region 244 and a first port 544, as well as the alignment between the second contact region 246 and a second port 544. Each of the two ports are sized and dimensioned such that their corresponding contact regions can be snugly, fully, and securely received by the device 200, and allow for automatic connection and activation of the module 242 for purposes of the device operation. Specifically, the first port 544 has a first

port length **544** that is approximately equal to a first length **504** of the first contact region **244**. Similarly, the second port **544** has a second port length **516** that is approximately equal to a second length **506** of the second contact region **246**. In addition, the opening formed in the base portion **610** associated with the first port **544** has a first height **590** that corresponds to a first thickness **490** of the first contact region **244** (see FIG. 4) and the opening formed in the base portion **610** associated with the second port **544** has a second height **592** that corresponds to a second thickness **492** of the second contact region **246** (see FIG. 4). As the module **242** is installed, it can be understood that the other various connector elements described herein will also be fastened. For example, the tab portions can be inserted into their corresponding recessed slots. In FIG. 12D, fifth tab **450** will be inserted into fifth slot **1030** and third tab **430** will be inserted into fifth slot **1050**. Similarly, though not visible, the fourth tab **440** will be inserted into fourth slot **1040**, directly adjacent to and partially beneath the first port **544**.

[0109] It should be understood that each of the first port **544** and second port **544** include provisions for establishing an electrical connection with the module **242**. In different implementations, the base portion of the device may include only one port or more than two ports, depending on the type of module **242** that is being used. In addition, the size of a port will also vary in order to accommodate the choices made for the module itself. As a general matter, the ports can be configured as a “bus”, “expansion port”, or “expansion slot” that is compatible with the type of module **242** associated with the housing panel component. The port receptacles serve as ports that connect to a motherboard or riser board that allows a computer hardware expansion card (here, the module **242**) to be connected.

[0110] Once a selected housing panel component containing a cellular data module is secured to the device, the cellular data module is also automatically installed on the device. Such an arrangement can reduce manufacturing, packaging, and distribution costs relative to individually packaged PCM-type card, or other devices such as flash memory sticks, GPS receivers, mini hard drives, and network hubs. The use of a modular housing enclosure for the cellular data module also saves on the overall costs to the user in time and money as users do not need to disassemble the device and/or remove internal parts to enjoy the benefits of the cellular data module, the module can be swapped across and used with multiple devices, and any repairs are vastly simplified. By application of the present disclosure there is no longer a need to install a separate wireless network adapter (e.g., PCI card, PCMCIA card, or stand-alone USB wireless adapters) at the host PC. This mechanism enables the user to simplify their approach to adding various accessories to their device. The housing panel component is an attractive alternative for users who desire convenience and may also be made available in libraries, hotels, restaurants, parks, bars, and other locations to allow patrons to access a cellular network.

[0111] For purposes of clarity, FIGS. 13A-14B provide an enlarged view of the second and third stages shown in FIGS. 12B and 12C. For clarity in the illustration, the housing panel component and device lid portion have been segmented into two portions (a rear portion and a forward portion). In FIGS. 13A and 13B, a rear portion of the housing panel component **200** and a rear portion of the lid portion **1200** are shown, and in FIGS. 14A and 14B, the

remaining or corresponding forward portion of the housing panel component **200** and a forward portion of the lid portion **1200** are shown. Referring first to FIG. 13A, the rear portion of the housing panel component **200** has been slid, pressed, inserted, ‘dropped’, or otherwise conveyed onto the rear portion of the interface surface **660** of the receiving portion **620** with respect to the vertical axis **190**. Each raised portion of the second set of raised portions protruding from the second sidewall has been introduced into their corresponding grooves. Specifically, in FIG. 13A, the first raised portion **310** has been received by the first groove **710**, the second raised portion **320** has been received by the second groove **720**, and the third raised portion **330** has been received by the third groove **730**. At this time, although some of the connecting elements have been inserted into or made contact with their respective receptacles, the housing panel component **200** remains unsecured, and a gap **1300** between the fourth side surface **618** of the base portion **610** and the rearward **206** of the housing panel component **200** remains in which a portion of the interface surface **660** is exposed. In FIG. 13B, following a final push or gentle force applied to continue the attachment process, it can be observed that the three raised portions have been guided further into the groove, and moved a distance in a rearward direction along the lateral axis **170** into the respective securing segments of each of the grooves (see FIG. 9). Once this occurs, the raised portion is ‘locked’ in place, the housing panel component **200** has been fully fastened, and the two component remain mated, unless a force is applied to remove the housing panel component **200** from the device **600** (e.g., during an un-installment).

[0112] At the same time, referring to FIG. 14A, the forward portion of the housing panel component **200** is depicted slid, pressed, inserted, ‘dropped’, or otherwise conveyed onto the forward portion of the receiving portion **620**. Each raised portion of the second set of raised portions protruding from the second sidewall has been guided into their corresponding grooves. Specifically, in FIG. 14A, the fourth raised portion **340** has been received by the fourth groove **740**, the fifth raised portion **350** has been received by the fifth groove **750**, and the sixth raised portion **360** has been received by the sixth groove **760**. At this time, although some of the connecting elements have been inserted into or made contact with their respective receptacles, the housing panel component **200** remains unsecured or only partially installed. In FIG. 13B, following a final push or gentle force applied to continue the attachment process, it can be observed that the three raised portions have been guided further into the groove, and moved a distance in a rearward direction along the lateral axis **170** into the respective securing segments of each of the grooves (see FIG. 9). Once this occurs, the raised portion is ‘locked’ in place, the housing panel component **200** has been fully fastened, and the two component remain mated, unless a force is applied to remove the housing panel component **200** from the device **600** (e.g., during an un-installment). In some implementations, the flange portion **370** can also be received by the channel **770** which can help anchor the ledge portion **308** of the housing panel component **200**. It is to be understood that while only the raised portions along one sidewall were illustrated for purposes of simplicity, the other connector elements (i.e., tab portions and recessed slots, protruding portions and apertures, and the raised portions of the opposing sidewall with their corresponding grooves), will also be

joined together during this process, and secured as described herein. In other implementations, fewer types of fastening mechanism may be used than what is shown in the drawings. For example, in some implementations, a housing panel component may only include the raised portions, without the tab portions or the protruding portions. In another example, a housing panel component may not include the protruding portions. In some implementations, the tab portions and protruding portions may be included, while no raised portions are present. The device's receiving portion can be configured according to the desired connection mechanisms formed in the housing panel components.

[0113] In different implementations, other types of auxiliary functionality can be offered in conjunction with the interchangeable housing panel components described herein. As noted earlier, various interchangeable housing panel components can include additional or alternate modules that can offer further performance benefits to the user devices. In FIG. 15, the reader is introduced to a memory subsystem 1510 that is also embedded, incorporated, or otherwise associated with an alternate housing panel component 1500. It should be understood that in some implementations, the memory subsystem 1510 can be integrated or otherwise included in interchangeable housing panel components that also include the cellular data module and/or the power supply subsystem (see FIG. 2B above), and in other implementations, some housing panel components can include the memory subsystem 1510 as an accessory separate from those housing panel components that offer the cellular data module and/or the power supply subsystem. In other words, a first interchangeable housing panel component can be provided that includes the cellular data module (without either a power supply subsystem or a memory subsystem), a second interchangeable housing panel component can be provided that includes the power supply subsystem (without either a cellular data module or a memory subsystem), a third interchangeable housing panel component can be provided that includes the memory subsystem 1510 (without either a cellular data module or a power supply subsystem), a fourth interchangeable housing panel component can be provided that includes both the cellular data module and the power supply subsystem (without a memory subsystem), a fifth interchangeable housing panel component can be provided that includes both the cellular data module and the memory subsystem (without a power supply subsystem), and a sixth interchangeable housing panel component can be provided that includes each of the power supply module, the power supply subsystem, and the memory subsystem.

[0114] For purposes of simplicity, the third type of housing panel component is illustrated in FIG. 15. In this example, the alternate housing panel component 1500 includes a mechanical structure substantially similar to that described above with respect to FIGS. 2A and 2B. Thus, terms used to describe aspects and features of the housing panel component 200 may be understood to refer to similar aspects and features of the alternate housing panel component 1500 in FIG. 15. For example, the alternate housing panel component 1500 include a body portion 1516 with an upper surface (not shown) and an opposite facing lower surface 1520, as well as a first side edge ("first edge") 1502, a second side edge ("second edge") 1504, a rearward edge 1506, and a forward edge 1508 that collectively provide an outer perimeter or boundary of the body portion 1516. In addition, the

alternate housing panel component 1500 can include provisions for removable attachment to a computing device as described above with respect to housing panel component 200, including a plurality of tab portions, a group of protruding portions, and the sets of raised portions.

[0115] Furthermore, the alternate housing panel component 1500 includes the memory subsystem 1510, here comprising a first storage module 1552 and a second storage module 1554. While two storage modules are shown in FIG. 15 for purposes of illustration, it should be understood that in other implementations, only one storage module may be included, or there may be greater than two storage modules. Each of the first storage module 1552 and second storage module 1554 are shown extending outward in the same direction as neighboring tab portions 1550. The modules 1552 and 1554 in this case are each PCI Express cards with an edge connector having contacts on either side. In some other implementations, the storage modules can be configured as M.2 connector types.

[0116] Furthermore, the first storage module 1552 includes a first module board body ("first board") 1562 and a first set of contact regions 1564, and the second storage module 1554 includes a second module board body ("second board") 1572 and a second set of contact regions 1574.

[0117] In this view, a dotted line generally indicates the location of each of the first board 1562 and the second board 1564 within the body portion of the alternate housing panel component 1500. Although a shape and size of the boards has been very generally represented by dotted lines in this drawing, it should be understood that this depiction is for purposes of example only, details of the boards are not shown, and the form factor of the storage modules associated with housing panel components can vary widely. For example, the module may be smaller, larger, or differ in shape from what is shown in the drawings, can include differently arranged and numbers contacts, and/or modules that are not based on the PCI Express format may be used (e.g., can instead include storage modules configured as M.2 connectors, or a PCI card, PCI Express Mini Card, PCI-eXtended card, ISI card, AGP card, SD card, mini SD card, or micro SD card). Furthermore, the type of memory provided by either of the storage modules can vary, and can include a volatile and/or non-volatile memory, or any other memory type described herein (see, for example, FIGS. 18 and 19).

[0118] In this case, it can be seen that a large portion of each of the modules 1552 and 1554 are actually embedded or integrated within the body portion 1516 of the alternate housing panel component itself. In some other implementations, the housing panel component can include provisions for extending and retracting the module(s) within the body portion 1516. In some cases, a small switch or button can be supplied that allows a user to glide the module further into the housing panel component (retract) or to extend the module back out to the configuration presented in the drawings where the contact region(s) are exposed and ready for mating with an expansion port.

[0119] However, in other implementations the modules 1552 and/or 1554 may be externally secured to the housing panel component, rather than extend from within an interior of the body portion 1516. In other words, in some implementations, the modules 1552 and/or 1554 can be either removably or permanently attached to the underside (i.e., lower surface 1520) of the housing panel component. The

specific sites or locations where the modules **1552** and/or **1554** are attached can be pre-assigned and clearly demarcated in order to ensure that the contact regions are correctly received and retained by the corresponding expansion ports formed in the device. In some implementations, the specific sites can include provisions for quickly attaching or detaching to the lower surface **1520** of the alternate housing panel component **1500**, including but not limited to fasteners mechanisms such as hook and loop fasteners, clasp, clamps, or other mechanical structures such as flanges, hooks, grooves, L-shaped retaining protrusions, magnets, etc. that allow the user to quickly secure, join, or affix the modules **1552** and/or **1554** to a particular site along the lower surface **1520**. In some implementations, the module itself can include provisions for facilitating a secure and ready attachment (and detachment) to the housing panel component, such as fastener mechanisms complementary to those described above with respect to the housing panel component.

[0120] Referring now to FIG. 16, one implementation of a retail system **1650** is depicted. In some implementations, portable computing devices **1640** are sold simultaneously with complementary pre-packaged interchangeable housing panel components of varying appearance, comprising varying materials, and including different combinations of device enhancing accessories. In this figure, the retail system **1650** is shown as part of a wall **1660**. In different implementations, this wall **1660** would be a portion of a retail store or other sale place for merchandise. In other implementations of a retail system there may be no wall **1660**, or the components may be displayed or offered by other means. The portable computing devices and associated components are shown generically in FIG. 16 only for the purpose of illustration. In some embodiments, the housing panel components may be different styles and colors. Each pre-packaged interchangeable housing panel component (here a first housing panel component **1610**, a second housing panel component **1620**, and a third housing panel component **1630**) includes a ready-to-install housing panel component that reflects a particular design or appearance type.

[0121] In different implementations, using a retail system, a user could purchase a computing device, and select an additional housing panel component from the group of housing panel components that have been designed and pre-packaged as per their preference. By associating a housing panel component with a device, and attaching that housing panel component by the mechanisms described herein, the user may modify a device themselves, to provide varying appearance and texture types.

[0122] In some situations, it may be preferable for a user to purchase multiple pre-packaged housing panel components, such as first housing panel component **1610** and second housing panel component **1620**, at one time. Using a retail system like the one illustrated in FIG. 16, a user could purchase a computing device **1600** and two or more pre-packaged housing panel components. This would permit the user to swap the housing panel components at desired occasions, and return the device to its original appearance at any time. Additionally, housing panel components can be easily portable in the sense that they are small compared to the size of the computing devices, which is already being transported by the user. This feature may allow the user to modify the appearance of the device at any time and at various locations and/or events.

[0123] For purposes of illustration, with reference to FIG. 16, it may be understood that the first housing panel component **1610** includes a cellular data module (see FIGS. 1A-1E, 2A, and 2B) configured to provide cellular network access to a computing device **1600**. In another example, the second housing panel component **1620** includes a memory subsystem (see FIG. 15) configured to increase the memory storage and performance capacity of the device **1600**. As yet another example, the third housing panel component **1630** includes a power supply subsystem (see FIG. 2B) configured to provide additional battery capacity to the device **1600**. In other implementations, a fourth housing panel component (not shown) can include each of the cellular data module, the memory subsystem, and the power supply subsystem, install the panel, and enjoy their corresponding functionalities as their device is automatically upgraded. In other implementations, any two of the three features can be embedded or otherwise attached to the housing panel component and offered to a user.

[0124] FIG. 17 illustrates an isometric view of a kit of parts ("kit") **1750**. In some implementations, the kit may comprise at least one computing device **1700**, accessories for the computing device (here interchangeable components including a first housing panel component **1710** and a second, different housing panel component **1720**), and/or a container **1740** for storing the device and accessories. In other implementations, kit could include any other provisions not discussed below including but not limited to: instructions, electrical connectors and cords, headsets, speakers, various kinds of media (such as CDs, DVDs, etc.), additional storage containers for storing device **1700** and/or device accessories as well as any other provisions. Generally, the device **1700** associated with the kit may be any type of computing device configured to accommodate the housing panel components described herein.

[0125] Kit **1750** may be offered for sale at a retail location, as discussed previously. Kit may also be offered for sale at a kiosk, factory outlet, manufacturing store, and/or through an online vendor. In some implementations, the various parts of kit are sold together. In other implementations, some parts of kit may be sold separately. As an example, the current implementation of FIG. 17 depicts kit of parts **1750** including container **1740**, computing device **1700**, first housing panel component **1710**, and second housing panel component **1720**. In other embodiments, a retailer could sell a kit including device **1700** and only one housing panel component. In other cases, a retailer could sell a kit including device **1700** and three or more housing panel components. In other implementations, the retailer could sell one or more other housing panel components separately from the kit. The first housing panel component **1710** can include one or more of the additional functionalities as described herein, while the second housing panel component **1720** may only include the housing appearance desired by the user, without the added functionality.

[0126] Furthermore, the kit **1750** may include container **1700**. Container **1700** can be any type of container configured to store computing device and accessories. In some embodiments, container **1700** may be a box. In one embodiment, container **1700** may be a carrying case that is configured to transport the computing device and accessories. In some embodiments, container **1700** may have a generally rectangular shape, and can include a lower portion and a lid. In other embodiments, container **1700** could be a bag, sack,

or other type of container. In other embodiments, the various items in the kit may not be provided in a container **1700**.

[0127] The detailed examples of systems, devices, and techniques described in connection with FIGS. **1-17** are presented herein for illustration of the disclosure and its benefits. Such examples of use should not be construed to be limitations on the logical process implementations of the disclosure, nor should variations of user interface methods from those described herein be considered outside the scope of the present disclosure. In some implementations, various features described in FIGS. **1-17** are implemented in respective modules, which may also be referred to as, and/or include, logic, components, units, and/or mechanisms. Modules may constitute either software modules (for example, code embodied on a machine-readable medium) or hardware modules.

[0128] In some examples, a hardware module may be implemented mechanically, electronically, or with any suitable combination thereof. For example, a hardware module may include dedicated circuitry or logic that is configured to perform certain operations. For example, a hardware module may include a special-purpose processor, such as a field-programmable gate array (FPGA) or an Application Specific Integrated Circuit (ASIC). A hardware module may also include programmable logic or circuitry that is temporarily configured by software to perform certain operations, and may include a portion of machine-readable medium data and/or instructions for such configuration. For example, a hardware module may include software encompassed within a programmable processor configured to execute a set of software instructions. It will be appreciated that the decision to implement a hardware module mechanically, in dedicated and permanently configured circuitry, or in temporarily configured circuitry (for example, configured by software) may be driven by cost, time, support, and engineering considerations.

[0129] Accordingly, the phrase “hardware module” should be understood to encompass a tangible entity capable of performing certain operations and may be configured or arranged in a certain physical manner, be that an entity that is physically constructed, permanently configured (for example, hardwired), and/or temporarily configured (for example, programmed) to operate in a certain manner or to perform certain operations described herein. As used herein, “hardware-implemented module” refers to a hardware module. Considering examples in which hardware modules are temporarily configured (for example, programmed), each of the hardware modules need not be configured or instantiated at any one instance in time. For example, where a hardware module includes a programmable processor configured by software to become a special-purpose processor, the programmable processor may be configured as respectively different special-purpose processors (for example, including different hardware modules) at different times. Software may accordingly configure a particular processor or processors, for example, to constitute a particular hardware module at one instance of time and to constitute a different hardware module at a different instance of time. A hardware module implemented using processors may be referred to as being “processor implemented” or “computer implemented.”

[0130] Hardware modules can provide information to, and receive information from, other hardware modules. Accordingly, the described hardware modules may be regarded as being communicatively coupled. Where multiple hardware

modules exist contemporaneously, communications may be achieved through signal transmission (for example, over appropriate circuits and buses) between or among two or more of the hardware modules. In implementations in which multiple hardware modules are configured or instantiated at different times, communications between such hardware modules may be achieved, for example, through the storage and retrieval of information in memory devices to which the multiple hardware modules have access. For example, one hardware module may perform an operation and store the output in a memory device, and another hardware module may then access the memory device to retrieve and process the stored output.

[0131] In some examples, at least some of the operations of a method may be performed by one or more processors or processor-implemented modules. Moreover, the one or more processors may also operate to support performance of the relevant operations in a “cloud computing” environment or as a “software as a service” (SaaS). For example, at least some of the operations may be performed by, and/or among, multiple computers (as examples of machines including processors), with these operations being accessible via a network (for example, the Internet) and/or via one or more software interfaces (for example, an application program interface (API)). The performance of certain of the operations may be distributed among the processors, not only residing within a single machine, but deployed across a number of machines. Processors or processor-implemented modules may be located in a single geographic location (for example, within a home or office environment, or a server farm), or may be distributed across multiple geographic locations.

[0132] FIG. **18** is a block diagram **1800** illustrating an example software architecture **1802**, various portions of which may be used in conjunction with various hardware architectures herein described, which may implement any of the above-described features. FIG. **18** is a non-limiting example of a software architecture and it will be appreciated that many other architectures may be implemented to facilitate the functionality described herein. The software architecture **1802** may execute on hardware that includes, among other things, document storage, processors, memory, and input/output (I/O) components. A representative hardware layer **1804** is illustrated and can represent, a computing device. The representative hardware layer **1804** includes a processing unit **1806** and associated executable instructions **1808**. The executable instructions **1808** represent executable instructions of the software architecture **1802**, including implementation of the methods, modules and so forth described herein. The hardware layer **1804** also includes a memory/storage **1810**, which also includes the executable instructions **1808** and accompanying data. The hardware layer **1804** may also include other hardware modules **1812**. Instructions **1808** held by processing unit **1808** may be portions of instructions **1808** held by the memory/storage **1810**.

[0133] The example software architecture **1802** may be conceptualized as layers, each providing various functionality. For example, the software architecture **1802** may include layers and components such as an operating system (OS) **1814**, libraries **1816**, frameworks **1818**, applications **1820**, and a presentation layer **1844**. Operationally, the applications **1820** and/or other components within the layers may invoke API calls **1824** to other layers and receive

corresponding results **1826**. The layers illustrated are representative in nature and other software architectures may include additional or different layers. For example, some mobile or special purpose operating systems may not provide the frameworks/middleware **1818**.

[0134] The OS **1814** may manage hardware resources and provide common services. The OS **1814** may include, for example, a kernel **1828**, services **1830**, and drivers **1832**. The kernel **1828** may act as an abstraction layer between the hardware layer **1804** and other software layers. For example, the kernel **1828** may be responsible for memory management, processor management (for example, scheduling), component management, networking, security settings, and so on. The services **1830** may provide other common services for the other software layers. The drivers **1832** may be responsible for controlling or interfacing with the underlying hardware layer **1804**. For instance, the drivers **1832** may include display drivers, camera drivers, memory/storage drivers, peripheral device drivers (for example, via Universal Serial Bus (USB)), network and/or wireless communication drivers, audio drivers, and so forth depending on the hardware and/or software configuration.

[0135] The libraries **1816** may provide a common infrastructure that may be used by the applications **1820** and/or other components and/or layers. The libraries **1816** typically provide functionality for use by other software modules to perform tasks, rather than interacting directly with the OS **1814**. The libraries **1816** may include system libraries **1834** (for example, C standard library) that may provide functions such as memory allocation, string manipulation, file operations. In addition, the libraries **1816** may include API libraries **1836** such as media libraries (for example, supporting presentation and manipulation of image, sound, and/or video data formats), graphics libraries (for example, an OpenGL library for rendering 2D and 3D graphics on a display), database libraries (for example, SQLite or other relational database functions), and web libraries (for example, WebKit that may provide web browsing functionality). The libraries **1816** may also include a wide variety of other libraries **1838** to provide many functions for applications **1820** and other software modules.

[0136] The frameworks **1818** (also sometimes referred to as middleware) provide a higher-level common infrastructure that may be used by the applications **1820** and/or other software modules. For example, the frameworks **1818** may provide various graphic user interface (GUI) functions, high-level resource management, or high-level location services. The frameworks **1818** may provide a broad spectrum of other APIs for applications **1820** and/or other software modules.

[0137] The applications **1820** include built-in applications **1840** and/or third-party applications **1842**. Examples of built-in applications **1840** may include, but are not limited to, a contacts application, a browser application, a location application, a media application, a messaging application, and/or a game application. Third-party applications **1842** may include any applications developed by an entity other than the vendor of the particular platform. The applications **1820** may use functions available via OS **1814**, libraries **1816**, frameworks **1818**, and presentation layer **1844** to create user interfaces to interact with users.

[0138] Some software architectures use virtual machines, as illustrated by a virtual machine **1848**. The virtual machine **1848** provides an execution environment where applica-

tions/modules can execute as if they were executing on a hardware machine (such as the machine **1000** of FIG. **10**, for example). The virtual machine **1848** may be hosted by a host OS (for example, OS **1814**) or hypervisor, and may have a virtual machine monitor **1846** which manages operation of the virtual machine **1848** and interoperation with the host operating system. A software architecture, which may be different from software architecture **1802** outside of the virtual machine, executes within the virtual machine **1848** such as an OS **1850**, libraries **1852**, frameworks **1854**, applications **1856**, and/or a presentation layer **1858**.

[0139] FIG. **19** is a block diagram illustrating components of an example machine **1900** configured to read instructions from a machine-readable medium (for example, a machine-readable storage medium) and perform any of the features described herein. It is to be understood that the phrase “machine-readable medium” and “computer-readable medium” are interchangeable in their usage herein. The example machine **1900** is in a form of a computer system, within which instructions **1916** (for example, in the form of software components) for causing the machine **1900** to perform any of the features described herein may be executed. As such, the instructions **1916** may be used to implement modules or components described herein. The instructions **1916** cause unprogrammed and/or unconfigured machine **1900** to operate as a particular machine configured to carry out the described features. The machine **1900** may be configured to operate as a standalone device or may be coupled (for example, networked) to other machines. In a networked deployment, the machine **1900** may operate in the capacity of a server machine or a client machine in a server-client network environment, or as a node in a peer-to-peer or distributed network environment. Machine **1900** may be embodied as, for example, a server computer, a client computer, a personal computer (PC), a tablet computer, a laptop computer, a netbook, a set-top box (STB), a gaming and/or entertainment system, a smart phone, a mobile device, a wearable device (for example, a smart watch), and an Internet of Things (IoT) device. Further, although only a single machine **1900** is illustrated, the term “machine” includes a collection of machines that individually or jointly execute the instructions **1916**.

[0140] The machine **1900** may include processors **1910**, memory **1930**, and I/O components **1950**, which may be communicatively coupled via, for example, a bus **1902**. The bus **1902** may include multiple buses coupling various elements of machine **1900** via various bus technologies and protocols. In an example, the processors **1910** (including, for example, a central processing unit (CPU), a graphics processing unit (GPU), a digital signal processor (DSP), an ASIC, or a suitable combination thereof) may include one or more processors **1912a** to **1912n** that may execute the instructions **1916** and process data. In some examples, one or more processors **1910** may execute instructions provided or identified by one or more other processors **1910**. The term “processor” includes a multi-core processor including cores that may execute instructions contemporaneously. Although FIG. **19** shows multiple processors, the machine **1900** may include a single processor with a single core, a single processor with multiple cores (for example, a multi-core processor), multiple processors each with a single core, multiple processors each with multiple cores, or any com-

bination thereof. In some examples, the machine 1900 may include multiple processors distributed among multiple machines.

[0141] The memory/storage 1930 may include a main memory 1932, a static memory 1934, or other memory, and a storage unit 1936, both accessible to the processors 1910 such as via the bus 1902. The storage unit 1936 and memory 1932, 1934 store instructions 1916 embodying any one or more of the functions described herein. The memory/storage 1930 may also store temporary, intermediate, and/or long-term data for processors 1910. The instructions 1916 may also reside, completely or partially, within the memory 1932, 1934, within the storage unit 1936, within at least one of the processors 1910 (for example, within a command buffer or cache memory), within memory at least one of I/O components 1950, or any suitable combination thereof, during execution thereof. Accordingly, the memory 1932, 1934, the storage unit 1936, memory in processors 1910, and memory in I/O components 1950 are examples of machine-readable medium.

[0142] As used herein, “machine-readable medium” refers to a device able to temporarily or permanently store instructions and data that cause machine 1900 to operate in a specific fashion. The term “machine-readable medium,” as used herein, does not encompass transitory electrical or electromagnetic signals per se (such as on a carrier wave propagating through a medium); the term “machine-readable medium” may therefore be considered tangible and non-transitory. Non-limiting examples of a non-transitory, tangible machine-readable medium may include, but are not limited to, nonvolatile memory (such as flash memory or read-only memory (ROM)), volatile memory (such as a static random-access memory (RAM) or a dynamic RAM), buffer memory, cache memory, optical storage media, magnetic storage media and devices, network-accessible or cloud storage, other types of storage, and/or any suitable combination thereof. The term “machine-readable medium” applies to a single medium, or combination of multiple media, used to store instructions (for example, instructions 1916) for execution by a machine 1900 such that the instructions, when executed by one or more processors 1910 of the machine 1900, cause the machine 1900 to perform and one or more of the features described herein. Accordingly, a “machine-readable medium” may refer to a single storage device, as well as “cloud-based” storage systems or storage networks that include multiple storage apparatus or devices.

[0143] The I/O components 1950 may include a wide variety of hardware components adapted to receive input, provide output, produce output, transmit information, exchange information, capture measurements, and so on. The specific I/O components 1950 included in a particular machine will depend on the type and/or function of the machine. For example, mobile devices such as mobile phones may include a touch input device, whereas a headless server or IoT device may not include such a touch input device. The particular examples of I/O components illustrated in FIG. 19 are in no way limiting, and other types of components may be included in machine 1900. The grouping of I/O components 1950 are merely for simplifying this discussion, and the grouping is in no way limiting. In various examples, the I/O components 1950 may include user output components 1952 and user input components 1954. User output components 1952 may include, for example, display components for displaying information (for example, a

liquid crystal display (LCD) or a projector), acoustic components (for example, speakers), haptic components (for example, a vibratory motor or force-feedback device), and/or other signal generators. User input components 1954 may include, for example, alphanumeric input components (for example, a keyboard or a touch screen), pointing components (for example, a mouse device, a touchpad, or another pointing instrument), and/or tactile input components (for example, a physical button or a touch screen that provides location and/or force of touches or touch gestures) configured for receiving various user inputs, such as user commands and/or selections.

[0144] In some examples, the I/O components 1950 may include biometric components 1956 and/or position components 1962, among a wide array of other environmental sensor components. The biometric components 1956 may include, for example, components to detect body expressions (for example, facial expressions, vocal expressions, hand or body gestures, or eye tracking), measure biosignals (for example, heart rate or brain waves), and identify a person (for example, via voice-, retina-, and/or facial-based identification). The position components 1962 may include, for example, location sensors (for example, a Global Positioning System (GPS) receiver), altitude sensors (for example, an air pressure sensor from which altitude may be derived), and/or orientation sensors (for example, magnetometers).

[0145] The I/O components 1950 may include communication components 1964, implementing a wide variety of technologies operable to couple the machine 1900 to network(s) 1970 and/or device(s) 1980 via respective communicative couplings 1972 and 1982. The communication components 1964 may include one or more network interface components or other suitable devices to interface with the network(s) 1970. The communication components 1964 may include, for example, components adapted to provide wired communication, wireless communication, cellular communication, Near Field Communication (NFC), Bluetooth communication, Wi-Fi, and/or communication via other modalities. The device(s) 1980 may include other machines or various peripheral devices (for example, coupled via USB).

[0146] In some examples, the communication components 1964 may detect identifiers or include components adapted to detect identifiers. For example, the communication components 1964 may include Radio Frequency Identification (RFID) tag readers, NFC detectors, optical sensors (for example, one- or multi-dimensional bar codes, or other optical codes), and/or acoustic detectors (for example, microphones to identify tagged audio signals). In some examples, location information may be determined based on information from the communication components 1962, such as, but not limited to, geo-location via Internet Protocol (IP) address, location via Wi-Fi, cellular, NFC, Bluetooth, or other wireless station identification and/or signal triangulation.

[0147] While various embodiments have been described, the description is intended to be exemplary, rather than limiting, and it is understood that many more embodiments and implementations are possible that are within the scope of the embodiments. Although many possible combinations of features are shown in the accompanying figures and discussed in this detailed description, many other combinations of the disclosed features are possible. Any feature of any embodiment may be used in combination with or

substituted for any other feature or element in any other embodiment unless specifically restricted. Therefore, it will be understood that any of the features shown and/or discussed in the present disclosure may be implemented together in any suitable combination. Accordingly, the embodiments are not to be restricted except in light of the attached claims and their equivalents. Also, various modifications and changes may be made within the scope of the attached claims.

[0148] While the foregoing has described what are considered to be the best mode and/or other examples, it is understood that various modifications may be made therein and that the subject matter disclosed herein may be implemented in various forms and examples, and that the teachings may be applied in numerous applications, only some of which have been described herein. It is intended by the following claims to claim any and all applications, modifications and variations that fall within the true scope of the present teachings.

[0149] Unless otherwise stated, all measurements, values, ratings, positions, magnitudes, sizes, and other specifications that are set forth in this specification, including in the claims that follow, are approximate, not exact. They are intended to have a reasonable range that is consistent with the functions to which they relate and with what is customary in the art to which they pertain.

[0150] The scope of protection is limited solely by the claims that now follow. That scope is intended and should be interpreted to be as broad as is consistent with the ordinary meaning of the language that is used in the claims when interpreted in light of this specification and the prosecution history that follows and to encompass all structural and functional equivalents. Notwithstanding, none of the claims are intended to embrace subject matter that fails to satisfy the requirement of Sections 101, 102, or 103 of the patent Act, nor should they be interpreted in such a way. Any unintended embracement of such subject matter is hereby disclaimed.

[0151] Except as stated immediately above, nothing that has been stated or illustrated is intended or should be interpreted to cause a dedication of any component, step, feature, object, benefit, advantage, or equivalent to the public, regardless of whether it is or is not recited in the claims.

[0152] It will be understood that the terms and expressions used herein have the ordinary meaning as is accorded to such terms and expressions with respect to their corresponding respective areas of inquiry and study except where specific meanings have otherwise been set forth herein. Relational terms such as first and second and the like may be used solely to distinguish one entity or action from another without necessarily requiring or implying any actual such relationship or order between such entities or actions. The terms “comprises,” “comprising,” or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that comprises a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus. An element preceded by “a” or “an” does not, without further constraints, preclude the existence of additional identical elements in the process, method, article, or apparatus that comprises the element.

[0153] The Abstract of the Disclosure is provided to allow the reader to quickly ascertain the nature of the technical disclosure. It is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims. In addition, in the foregoing Detailed Description, it can be seen that various features are grouped together in various examples for the purpose of streamlining the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the claims require more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive subject matter lies in less than all features of a single disclosed example. Thus the following claims are hereby incorporated into the Detailed Description, with each claim standing on its own as a separately claimed subject matter.

1. An interchangeable housing component for a portable computing device including a cellular data module, the component comprising:

a body portion including:

an upper surface,

an opposite-facing lower surface disposed on an opposite side of the body portion from the upper surface, and

a forward edge, a rearward edge, a first side edge, and a second side edge, wherein the forward edge, the rearward edge, the first side edge, and the second side edge are disposed between the upper surface and the opposite-facing lower surface;

the cellular data module including a module board and a contact region extending from the module board, where the contact region extends proximally outward from the rearward edge of the body portion and the module board is secured to the body portion,

wherein the body portion of the interchangeable housing component is configured to be removably affixed to a housing of the portable computing device by a plurality of first connector elements disposed along two or more of the forward edge, the rearward edge, the first side edge, or the second side edge, wherein the first plurality of connector elements are removably affixed to a plurality of second connector elements disposed on the housing of the portable computing device, and wherein the interchangeable housing component is configured to cover, when affixed to the housing, a portion of the portable computing device exposed by the housing of the portable computing device.

2. The interchangeable housing component of claim 1, wherein the cellular data module is a modem configured to provide network connectivity to 2G, 3G, 4G, LTE, or CDMA networks.

3. The interchangeable housing component of claim 1, further comprising an auxiliary power supply that includes a battery module and a contact pads region, where the battery module is embedded in the body portion and the contact pads region is attached to the lower surface of the body portion.

4. The interchangeable housing component of claim 1, wherein the board of the cellular data module is embedded within a thickness of the body portion.

5. The interchangeable housing component of claim 1, wherein the board of the cellular data module is attached to the lower surface of the body portion.

6. The interchangeable housing component of claim 1, wherein the contact region of the cellular data module is arranged adjacent to a plurality of tab portions that extend distally outward from the rearward edge of the body portion.

7. The interchangeable housing component of claim 1, further comprising a first sidewall extending outward from the first side edge of the body portion, and a second sidewall extending outward from the second side edge of the body portion.

8. The interchangeable housing component of claim 6, wherein the plurality of tab portions includes a first tab portion that is aligned with a first horizontal plane, the cellular data module is aligned with a second horizontal plane, and the second horizontal plane is offset relative to the first horizontal plane.

9. An interchangeable housing component for a portable computing device including an auxiliary memory system, the component comprising:

a body portion including:

an upper surface,

an opposite-facing lower surface disposed on an opposite side of the body portion from the upper surface, and

a forward edge, a rearward edge, a first side edge, and a second side edge,

wherein the forward edge, the rearward edge, the first side edge, and the second side edge are disposed between the upper surface and the opposite-facing lower surface;

the auxiliary memory system including a first storage module comprising a first module board and a first contact region extending from the first module board, where the first contact region extends proximally outward from the rearward edge of the body portion and the first module board is secured to the body portion, wherein the body portion of the interchangeable housing component is configured to be removably affixed to a housing of the portable computing device by a plurality of first connector elements disposed along two or more of the forward edge, the rearward edge, the first side edge, or the second side edge, wherein the first plurality of connector elements are removably affixed to a plurality of second connector elements disposed on the housing of the portable computing device, and wherein the interchangeable housing component is configured to cover, when affixed to the housing, a portion of the portable computing device exposed by the housing of the portable computing device.

10. The interchangeable housing component of claim 9, wherein the first storage module includes a non-volatile memory and/or a volatile memory.

11. The interchangeable housing component of claim 9, wherein the first module board of the first storage module is embedded within a thickness of the body portion.

12. The interchangeable housing component of claim 9, wherein the first module board of the first storage module is attached to the lower surface of the body portion.

13. The interchangeable housing component of claim 9, wherein the first contact region of the first storage module is arranged adjacent to a plurality of tab portions that extend distally outward from the rearward edge of the body portion.

14. The interchangeable housing component of claim 9, wherein the auxiliary memory system further comprises a second storage module including a second module board and

a second contact region extending from the second module board, where the second contact region extends proximally outward from the rearward edge of the body portion and the second module board is in contact with the lower surface of the body portion.

15. An interchangeable housing component for a portable computing device including an auxiliary power supply, the component comprising:

a body portion including:

an upper surface,

an opposite-facing lower surface disposed on an opposite side of the body portion from the upper surface, and

a forward edge, a rearward edge, a first side edge, and a second side edge,

wherein the forward edge, the rearward edge, the first side edge, and the second side edge are disposed between the upper surface and the opposite-facing lower surface;

the auxiliary power supply including a battery module and a contact pads region, where the battery module is embedded in the body portion and the contact pads region is secured to the lower surface of the body portion,

wherein the body portion of the interchangeable housing component is configured to be removably affixed to a housing of the portable computing device by a plurality of first connector elements disposed along two or more of the forward edge, the rearward edge, the first side edge, or the second side edge, wherein the first plurality of connector elements are removably affixed to a plurality of second connector elements disposed on the housing of the portable computing device, and wherein the interchangeable housing component is configured to cover, when affixed to the housing, a portion of the portable computing device exposed by the housing of the portable computing device.

16. The interchangeable housing component of claim 15, further comprising a plurality of connector elements protruding from at least the forward edge of the body portion.

17. A kit of parts comprising:

one or more interchangeable lid panels, including at least a first interchangeable lid panel comprising the interchangeable housing component of claim 1; and

a portable computing device, wherein a display housing of the portable computing device comprises a first side and an opposite-facing second side, the first side including a base portion and a receiving portion that is recessed relative to the base portion, the second side including a display panel, and the receiving portion including the first plurality of connector elements configured to removably secure the one or more interchangeable lid panels to the display housing.

18. The kit of parts of claim 17, wherein a forward side surface of the base portion includes at least a first port sized and dimensioned to receive the first contact region, and wherein the cellular data module is concurrently inserted into the first port when the interchangeable housing component is installed in the display housing.

19. The kit of parts of claim 17, further comprising a second interchangeable lid panel including an auxiliary memory system, the auxiliary memory system including a storage module comprising a first module board and a contact region extending from the first module board, where

the contact region extends proximally outward from a rearward edge of a second body portion of the second interchangeable lid panel and the module board is in contact with a lower surface of the second body portion.

20. The kit of parts of claim **17**, further comprising a second interchangeable lid panel including an auxiliary power supply system, the auxiliary power supply system including a battery module and a contact pads region, where the battery module is embedded in a second body portion of the second interchangeable lid panel and the contact pads region is secured to the lower surface of the second body portion.

21. The interchangeable housing component of claim **1**, wherein the plurality of first connector elements comprise friction fit connectors, interference fit connectors, cam-locking connectors, or hook and loop fasteners.

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