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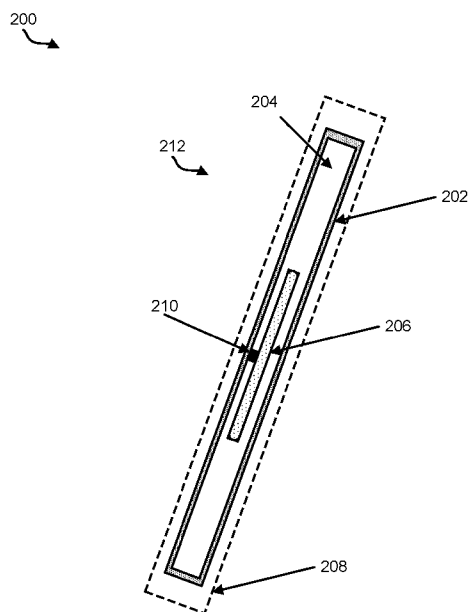


FIG. 2

(57) Abstract: A security tag includes: an inlay; an antenna mounted on the inlay; a radio frequency identifier (RFID) circuit coupled with the antenna; a sleeve encompassing the RFID circuit, the antenna, and the inlay; and at least one of: the RFID circuit, antenna, and inlay configured to be movable within the sleeve; a plurality of openings along a portion of a length of the antenna; a flexible seal at one or both ends of the sleeve; or a reinforcement layer adjacent to the inlay or the RFID chip.

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SECURITY TAG

CROSS REFERENCE TO RELATED APPLICATIONS

- [0001] The current application claims priority to, and the benefit of, United States Provisional Application No. 63/613,046 filed December 20, 2023 and entitled “Security Tag,” the contents of which are hereby incorporated by reference in their entireties.

FIELD

- [0002] The present disclosure relates generally to security tags, and more particularly to a electronic article surveillance tag.

BACKGROUND

- [0003] Electronic Article Surveillance (EAS) systems are commonly used in retail stores and other settings to prevent the unauthorized removal of goods from a protected area. Typically, a detection system is configured at an exit from the protected area, which comprises one or more transmitters and antennas (“pedestals”) capable of generating an electromagnetic field across the exit, known as the “interrogation zone.” Articles to be protected are tagged with a security tag (such as a radio frequency identification (RFID) and/or an acousto-magnetic (AM) tag), also known as an EAS marker, that, when active, generates a response signal when passed through this interrogation zone. An antenna and receiver in the same or another “pedestal” detect this response signal and generate an alarm.
- [0004] Additionally, permanent hidden/embedded tags in goods could be used for other purposes, such as, but not limited to, circular economy applications (new business models like renting clothes, or selling second hand clothes with known authenticity and pedigree). In many cases the same tag can be used for multiple purposes: security (anti-theft), circular economy, supply chain management, and/or inventory management.
- [0005] Thus, improvements in security tags are desired.

SUMMARY

- [0006] The following presents a simplified summary of one or more aspects in order to provide a basic understanding of such aspects. This summary is not an extensive

overview of all contemplated aspects, and is intended to neither identify key or critical elements of all aspects nor delineate the scope of any or all aspects. Its sole purpose is to present some concepts of one or more aspects in a simplified form as a prelude to the more detailed description that is presented later.

[0007] In an aspect, a security tag includes: an inlay; an antenna mounted on the inlay; a radio frequency identifier (RFID) circuit coupled with the antenna; a sleeve encompassing the RFID circuit, the antenna, and the inlay; and at least one of: the RFID circuit, antenna, and inlay configured to be movable within the sleeve; a plurality of openings along a portion of a length of the antenna; a flexible seal at one or both ends of the sleeve; or a reinforcement layer adjacent to the inlay or the RFID chip.

[0008] To the accomplishment of the foregoing and related ends, the one or more aspects comprise the features hereinafter fully described and particularly pointed out in the claims. The following description and the annexed drawings set forth in detail certain illustrative features of the one or more aspects. These features are indicative, however, of but a few of the various ways in which the principles of various aspects may be employed, and this description is intended to include all such aspects and their equivalents.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The disclosed aspects will hereinafter be described in conjunction with the appended drawings, provided to illustrate and not to limit the disclosed aspects, wherein like designations denote like elements, and in which:

[0010] FIG. 1 is a block diagram of an example architecture for a system according to some present aspects;

[0011] FIG. 2 is a top view, with an outer sleeve removed and represented by a dashed line, of an example architecture for a security tag according to some present aspects;

[0012] FIG. 3 is an exploded perspective view of the architecture of FIG. 2, according to some present aspects;

[0013] FIG. 4 is a top view, with an outer sleeve removed and represented by a dashed line, of an alternative architecture for a security tag according to some present aspects;

[0014] FIG. 5 is an isometric view of a security tag having a sleeve attached at a weld line, according to some present aspects;

- [0015] FIG. 6 is a top view of another example security tag, similar to security tag of FIG. 2, with the sensor portion of the tag contained within a sleeve and thus illustrated with dashed lines;
- [0016] FIG. 7 is a front exploded perspective view of the another example security tag, similar to security tag of FIG. 2;
- [0017] FIG. 8 is a top view of the security tag of FIG. 7;
- [0018] FIG. 9 is a side view of the security tag of FIG. 7;
- [0019] FIG. 10 is a top view of a process of separating a roll of sleeves and sensors into a plurality of security tags similar to the security tag of FIG. 7;
- [0020] FIG. 11 is another top view of the roll of sleeves and sensors that can be separated into a plurality of security tags, similar to FIG. 10, but including details of rounded ends formed by a sleeve cutter at a separation line between tags;
- [0021] FIG. 12 is a detailed view of the area around separation line in FIG. 11, with a portion of the top layer of the sleeve removed exposing the sensor;
- [0022] FIG. 13 is an enlarged top view of a portion of the end of the security tag, as identified in FIG. 12, including a plurality of spaced apart welds;
- [0023] FIG. 14 is an enlarged cross-sectional view along line 14-14 of FIG. 11;
- [0024] FIG. 15 is a top view of a version of the security tag of FIG. 7, with a portion of the sleeve removed to expose an example of an antenna having a plurality of notches to improve durability;
- [0025] FIG. 16 is a top view of a version of the security tag of FIG. 7, with a portion of the sleeve removed to expose an example of an antenna having a plurality of perforations to improve durability;
- [0026] FIG. 17 is a partial top view of an antenna, similar to the antenna of the security tag of FIG. 7, but formed from one example of a mesh structure to improve durability;
- [0027] FIG. 18 is a top perspective view of an antenna, similar to the antenna of the security tag of FIG. 7, but in a curved state and formed from another example of a mesh structure to improve durability;
- [0028] FIG. 19 is a partial bottom view a version of the security tag of FIG. 7, with a portion of the sleeve removed to expose an example of an additional reinforcement layer adjacent to the inlay; and

- [0029] FIG. 20 is exploded perspective view of an example security tag having an additional reinforcement layer adjacent to the inlay.

DETAILED DESCRIPTION

- [0030] The detailed description set forth below in connection with the appended drawings is intended as a description of various configurations and is not intended to represent the only configurations in which the concepts described herein may be practiced. The detailed description includes specific details for the purpose of providing a thorough understanding of various concepts. However, it will be apparent to those skilled in the art that these concepts may be practiced without these specific details. In some instances, well known components may be shown in block diagram form in order to avoid obscuring such concepts.
- [0031] Aspects of the present disclosure provide a security tag, such as a passive radio frequency identification (RFID) tag, which is designed to be physically capable of withstanding tensile, compressive, and/or abrasive forces which occur while positioning and/or affixing the security tag into an item, or while an item is in use, yet is sufficiently flexible and/or soft so as to not be noticeable to a person wearing the item.
- [0032] For example, in an aspect, the security tag is configured to be movable within an outer sleeve, which may improve durability of the security tag. For instance, enabling movement of the security tag within the sleeve enclosing or encasing the security tag may help to avoid damage to the security tag due to bending of the tag, sleeve, and/or the item to which the tag or sleeve is applied, as the bending or flexing forces applied to the tag, sleeve, or item may be reduced or eliminated from being applied and/or transferred to the security tag by freeing the security tag from being constrained by the sleeve. As such, in this aspect, the security tag may be referred to as a free-floating tag (or sensor).
- [0033] In an alternative or additional aspect, for example, the security tag includes an antenna and/or inlay having a plurality of openings along all or portion of a length of the antenna/inlay, which may improve durability of the security tag. For instance, the plurality of openings may avoid damage to the security tag by providing stress relief during the bending of the tag, the sleeve, and/or the item to which the tag is applied.

- [0034] Additionally, in another alternative or additional aspect, the security tag includes a sleeve having a flexible seal at one or both longitudinal ends for improved flexibility. The flexible seal may provide a softer feel to the ends of the security tag, as perceived by a user wearing an item, e.g., an article of clothing, to which the security tag is attached. For example, the flexible seal may comprise a plurality of seal points, which may be movable relative to one another, thereby providing a less stiff end, e.g., having a softer feel to a user, as compared to existing end seals that seal across a majority of the length of the end of the security tag.
- [0035] Moreover, in a further alternative or additional aspect, the security tag includes a reinforcement layer to provide support to the antenna and RFID chip, thereby reducing bending forces applied to the antenna and RFID chip.
- [0036] Turning now to the figures, example aspects are depicted with reference to one or more components described herein, where components in dashed lines may be optional.
- [0037] Referring now to FIG. 1, there is provided a schematic illustration of an example system 100 that is useful for understanding the present aspects. The present aspects are described herein in relation to a retail store environment. The present aspects are not limited in this regard and can be used in other environments. For example, the present aspects can be used in distribution centers, factories, and other commercial environments. Notably, the present aspects can be employed in any environment in which objects and/or items need to be located and/or tracked.
- [0038] The system 100 is generally configured to allow: (a) improved inventory counts and surveillance of objects and/or items located within a facility, and/or (b) improved customer experiences. As shown in FIG. 1, in one example implementation, system 100 comprises a Retail Store Facility (“RSF”) 128 in which display equipment 102₁-102_M are disposed. The display equipment are provided for displaying objects (or items) 110₁-110_N, 116₁-116_X to customers of the RSF 128. The display equipment may include, but are not limited to, shelves, article display cabinets, promotional displays, fixtures, and/or equipment securing areas of the RSF 128. The RSF 128 can also include emergency equipment (not shown), checkout counters, video cameras, people counters, and conventional electronic article surveillance (EAS) systems well known in the art, and therefore will not be described herein.

- [0039] At least one tag reader 120 is provided to assist in counting and tracking locations of the objects 110₁-110_N, 116₁-116_X within the RSF 128, and/or to perform a checkout process associated with a user purchasing a respective object. The tag reader 120 may comprise an RFID reader configured to read RFID tags. Such a tag read may include the tag reader 120 receiving an identifier (e.g., a unique identifier) of a respective RFID tag 112, which may be associated with an identifier of the object 110 to which the RFID tag 112 is attached.
- [0040] RFID tags 112₁-112_N, 118₁-118_X are respectively attached to the objects 110₁-110_N, 116₁-116_X as described below. This attachment may be achieved by a structural configuration of the RFID tag to enable the attachment. The RFID tags 112₁-112_N, 118₁-118_X can alternatively or additionally comprise dual-technology tags that have both EAS and RFID capabilities as described herein. In examples of the technology disclosed herein, the RFID tag is sewn or otherwise affixed into an object 110, for example into an interface between layers of the fabric/cloth of the object 110, which may be clothing or which may be another retail item.
- [0041] Notably, the tag reader 120 may be placed at a known location within the RSF 128, for example, at an exit/entrance. By correlating the RFID tag reads of the tag reader 120 and the known location of the tag reader 120 within the RSF 128, the general location of objects 110₁, . . . , 110_N, 116₁, . . . , 116_X may be determined within the RSF 128. The known coverage area of the tag reader 120 also facilitates object location determinations. Accordingly, RFID tag read information and tag reader location information is stored in a datastore 126. This information may be stored in the datastore 126 using a server 124 and a network 144 (e.g., an Intranet and/or Internet). Additionally, the tag reader 120 or another computer device, such as but not limited to a point of sale terminal, may read a respective RFID tag 112 during a check-out or payment process and confirm that the object 110 to which the RFID tag 112 is attached is the object being paid for in the check-out or point of sale transaction.
- [0042] System 100 may also comprise a Mobile Communication Device ("MCD") 130. MCD 130 includes, but is not limited to, a cell phone, a smart phone, a table computer, a personal digital assistant, and/or a wearable device (e.g., a smart watch). In accordance with some examples, the MCD 130 has a software application installed thereon that is operative to facilitate the provision of various information (e.g., 134,

136, 138, 140, and/or 142) to the individual 152 and/or to facilitate the sale or purchase transaction.

[0043] The MCD 130 may generally be configured to provide a visual and/or auditory output of item level information 134, accessory information 136, related product information 138, discount information 140, and/or customer related information 142.

[0044] The MCD 130 may also be configured to read barcodes and/or the RFID tag 112. Information obtained from the barcode and/or RFID tag reads may be communicated from the MCD 130 to the server 124 via network 144. Similarly, the stored information (e.g., 134, 136, 138, 140, and/or 142) may be provided from the server 124 to the MCD 130 via the network 144. The network 144 may include an Intranet and/or the Internet.

[0045] Server 124 may be local to the RSF 128 as shown in FIG. 1 or remote from the RSF 128. It should be understood that server 124 may be configured to: write data to and read data from datastore 126, RFID tags 112₁-112_N, 118₁-118_X, and/or MCD 130; perform language and currency conversion operations using item level information 134 and/or accessory information 136 obtained from the datastore 126, RFID tags 112₁-112_N, 118₁-118_X, and/or MCD 130; perform data analytics based on inventory information (e.g., 134, 136, 138, 140, and/or 142), tag read information, MCD tracking information, and/or information 134-142; perform image processing using images captured by camera(s) 148; and/or determine locations of RFID tags 112₁-112_N, 118₁-118_X and/or MCDs 130 in the RSF 128 using beacon(s) 146, tag reader 120, or other devices having known locations and/or antenna patterns.

[0046] In some examples, one or more beacons 146 transmitting a radio frequency (RF) signal (e.g., a second RF signal) other than the RFID interrogation signal are placed to cover a zone of interest (which in some cases may be also covered by a tag reader 120 placed to cover an RFID interrogation zone), e.g., at a portal (such as an entrance or exit) of the RSF 128.

[0047] The server 124 may update the information (e.g., 134, 136, 138, 140, and/or 142) output from the MCD 130 and/or the tag reader 120 and/or any other terminal and/or point of sale device that interacts with the RFID tag 112. Such information updating may be performed in response to instructions received from an associate (e.g., a retail store employee 132), in response to a detected change in the item level information 134, accessory information 136, and/or related product information 138,

in response to a detection that an individual is in proximity to an RFID tag, and/or in response to any motion or movement of the RFID tag. For example, if a certain product is placed on sale, then the sale price for that product may be transmitted to MCD 130 via network 144 and/or RFID tag 112/118. The sale price may then be output from the MCD 130. It should be noted that the present aspects are not limited to the particulars of this example.

[0048] Although a single MCD 130 and/or a single server 124 is (are) shown in FIG. 1, the present aspects are not limited in this regard. More than one computing device may be implemented. In addition, the present aspects are not limited to the example system architecture described in relation to FIG. 1.

[0049] In some aspects, during operation of system 100, the content displayed on the display screen of the MCD 130 may be dynamically controlled based upon various tag or item related information and/or customer related information (e.g., mobile device identifier, mobile device location in RSF 128, and/or customer loyalty level). Tag or item level information 134 may include, but is not limited to, one or more of first information indicating that an RFID tag 112/118 is in motion or that an object is being handled by an individual 152, second information indicating a current location of the RFID tag 112/118 and/or the MCD 130, third information indicating an accessory or related product of the object to which the moving RFID tag is coupled, and/or fourth information indicating the relative locations of the accessory and the moving RFID tag 112/118 and/or the relative locations of the related product and the moving RFID tag 112/118. The first, second, and fourth information may be derived based on sensor data generated by one or more sensors 150 local to the RFID tag. In other words, in some cases, the RFID tags 112₁-112_N, 118₁-118_X may include one or more sensors 150 to detect their current locations, detect any individual in proximity thereto, and/or detect any motion or movement thereof. The sensors 150 may include, but are not limited to, an Inertial Measurement Unit (“IMU”), a vibration sensor, a light sensor, an accelerometer, a gyroscope, a proximity sensor, a microphone, and/or a beacon communication device. The third information may be stored local to the RFID tag(s) or in a remote datastore 126 as information 136, 138.

[0050] In those or other scenarios, a sensor embedded in the RFID tag 112/118 may detect when an individual 152 is handling the object in which the RFID tag 112/118 is inserted. When such a detection is made, the RFID tag 112/118 may retrieve the

object's unique identifier from its local memory, and wirelessly communicates the same to the tag reader 120. The tag reader 120 may then pass the information to the server 124. The server 124 may use the object's unique identifier and the item/accessory relationship information (e.g., table) 136 to determine if there are any accessories associated therewith. If no accessories exist for the object, the server 124 may use the item level information 134 to determine one or more characteristics of the object. For example, the object may comprise a product of a specific brand. The server 124 may then use the item/related product information (e.g., table) 138 to identify: other products of the same type with the same characteristics; and/or other products that are typically used in conjunction with the object. Related product information for the identified related products may then be retrieved and provided to the MCD 130. The MCD 130 may output the related product information in a visual format and/or an auditory format. The individual 152 may perform user-software interactions with the MCD 130 to obtain further information related to the product of interest. The present solution is not limited to the particulars of this scenario.

[0051] Referring to FIGS. 2-5, an example architecture for a security tag 200 is shown. RFID tags 112₁-112_N, 118₁-118_X are the same as or similar to security tag 200. As such, the discussion of security tag 200 is sufficient for understanding the RFID tags 112₁-112_N, 118₁-118_X of FIG. 1. In some implementations, security tag 200 may be configured to perform operations such as but not limited to: (a) minimize power usage so as to extend a power source's life (e.g., a battery or a capacitor), (b) minimize collisions with other tags so that the tag of interest can be seen at given times, and/or (c) optimize useful information within an inventory system (e.g., communicate useful change information to a tag reader)

[0052] Notably, the security tag 200 may be designed to be relatively thin and relatively flexible so that it is hard to feel when inserted into an item (e.g., object 110₁, . . . , 110_N, 116₁, . . . , or 116_X of FIG. 1). The object may include, but is not limited to, an article of clothing. In an aspect, the security tag 200 is configured to be movable within an outer sleeve, which may improve durability of the security tag 200, for instance, to avoid damage to the security tag 200 due to bending of the tag or the item to which the tag is applied. As such, in this aspect, the security tag 200 may be referred to as a free-floating tag (or sensor). In an alternative or additional aspect, the security

tag 200 includes an inlay having a plurality of openings along all or portion of a length of the inlay, which may improve durability of the security tag 200, for instance, to avoid damage to the security tag 200 due to bending of the tag or the item to which the tag is applied. In an alternative or additional aspect, the security tag 200 includes a sleeve having flexible seal at one or both longitudinal ends, which may provide a softer feel to the ends of the security tag 200, as perceived by a user wearing an item, e.g., an article of clothing, to which the security tag 200 is attached. Also, in a further alternative or additional aspect, the security tag includes a reinforcement layer to provide support to the antenna and RFID chip, thereby reducing bending forces applied to the antenna and RFID chip.

[0053] Security tag 200 may include, for example, a semiconductor integrated circuit 210, e.g., an RFID chip, which provides the RFID-based functionality described above, electrically connected to a tunable antenna 204 that enables the circuit 210 to receive and/or transmit signals, and that may be mounted on an inlay 202. In an aspect, the semiconductor integrated circuit 210, tunable antenna 204, and inlay 202 are contained within a sleeve 208. For example, the sleeve 208 may be formed by opposing material layers, which may be separate layers affixed at the ends and sides, or a single layer of material folded over and fixed together at the ends and the one open longitudinal side. As noted, a longitudinal length of the sleeve 208 may be greater than the longitudinal length of the combined semiconductor integrated circuit 210, tunable antenna 204, and inlay 202, which collectively may be referred to as the sensor 212, such that the sensor 212 may be movable within the sleeve 208.

[0054] The tunable antenna 204 may include a gap, straddled by the RFID chip, that opens to a loop portion 206. The tunable antenna 204 may be tuned to a desired operating frequency by adjusting the length of the tunable antenna 204. The range of operating frequencies may vary. In one aspect, for example, the tunable antenna 204 may be tuned to operate within an RFID operating frequency.

[0055] The inlay 202 to which the semiconductor integrated circuit 210 and the tunable antenna 204 are attached may be a relatively thin, narrow, light-weight substrate. In one aspect, the inlay 202 may be an elongated inlay 202 having a length substantially equal to or slightly greater than a length of the tunable antenna 204. In other words, the longitudinal length of the elongated inlay 202 and the longitudinal length of the tunable antenna 204 may be substantially equal.

- [0056] The inlay 202 may include, but is not limited to, any type of plastic material, woven or non-woven fabric material, a biodegradable material, or other type of film material. In some aspects, the fabric material may be a cold water soluble nonwoven material manufactured from partially hydrolyzed polyvinyl alcohol fibers (a PVA fabric). In an aspect, the PVA fabric may substantially retain water until the water soluble material of the inlay 202 disintegrates during a wash cycle. In an aspect, the biodegradable material may be a biodegradable paper material or another hydrophilic material. A thickness of the inlay 202 may be selected so that the inlay 202 has a physical strength that allows a threshold amount of tension and/or compression to be maintained on the security tag 200 while attaching the tag to an object 110/116. For example, but not limited hereto, the thickness can have a value between approximately 10um and approximately 200um. Further, for example but not limited hereto, a width of the inlay 202 may be between approximately 2.5mm and approximately 5mm, which is small enough so that the security tag 200 is not felt by humans when inserted into an item worn by the human. It should be understood that the present solution is not limited to the particulars of this example.
- [0057] In some aspects, the inlay 202 may comprise a polyester (e.g., PET) substrate.
- [0058] In some aspects, at least a portion of the tunable antenna 204 of the security tag 200 may be formed as one or more conductive trace(s) (also see conductive traces 402 of FIG. 4) via etching. The conductive trace/layer may be, but is not limited to, aluminum or some other electrically and/or magnetically conductive material.
- [0059] Generally speaking, the resonance characteristics and tuning (and tunability) of the tunable antenna 204 may be determined not only by the antenna geometric shape and dimensions, material layering and construction, and fabrication materials, but also by the characteristics of the environment surrounding the antenna. Types of antennas that may be used in the security tag 200 may include dipole antennas, patch antennas, slot antennas, and many other types and variations of these types. In an aspect, the tunable antenna 204 may be designed so that the operating frequency of the security tag 200 is an ultra-high frequency (UHF).
- [0060] The tunable antenna 204 may be configured to electrically couple with the circuit 210, such as but not limited to via inductance. The tunable antenna 204 may longitudinally extend across substantially the entire length of the security tag 200, although, preferably, the length of the antenna is less than a length of the security tag 200 to

allow the . The tunable antenna 204 may be fabricated by positioning a water-soluble conducting ink on the inlay 202. Materials used for the conductive ink may include, but are not limited to, a metal particle, including but not limited to, silver, copper, graphene, a flux, a dispersing agent, an inorganic binder, a metal oxide, an organic metal compound, or a mixture of two or more thereof. However, in various implementations, the tunable antenna 204 may be made of conductive wire, like copper wire, steel wire, and the like.

[0061] In some aspects, but not limited hereto, the tunable antenna 204 may extend along the security tag 200 in a longitudinal direction and may have a diameter around 100 microns.

[0062] Additionally, as noted above, the security tag 200 may further include an elongated protective sleeve 208 which substantially encapsulates the inlay 202, the tunable antenna 204, the loop portion 206, and the circuit 210. In an aspect, the sleeve 208 forms a pocket within which the inlay 202, the tunable antenna 204, the loop portion 206, and the circuit 210 are movable, which may help reduce stress on the sensor during bending or stretching of the sleeve 208 or the item to which the sleeve 208 is attached. The protective sleeve 208 may be formed of a fabric or a plastic material, and may be a single sheet wrapped around the internal components and sealed or fixed together on one side, or two opposing sheets sealed or fixed together on each side. The protective sleeve 208 may comprise an ultrasonically weldable thermoplastic material, such as, but not limited to, nylon, combination of polyester and cotton, and the like. Although the protective sleeve 208 in this example is illustrated using dashed lines as a single layer, it should be understood that the protective sleeve 208 forms an outer layer including a top layer and a bottom layer. In one implementation, the elongated protective sleeve 208 includes a single textile sheet having a first longitudinal side fixedly attached to an opposite, second longitudinal side, and affixed at each longitudinal end.

[0063] In the present aspects, the security tag 200 may be flexible, bendable, stretchable, or otherwise configured and/or constructed to sustain deformations. Further, for example but not limited hereto, a width of the security tag 200 may be between 3.5 mm and 6 mm, and a length of the security tag 200 may be between 80 mm and 145 mm which is small enough so that the tag is not felt by humans when inserted into an item. The present aspects are not limited to the particulars of this example. Also, the flexibility

of the security tag 200 allows for the security tag 200 to be constructed and arranged so that the aforementioned deformations do not negatively affect the functionality and operation of the electronic components disposed within the security tag 200. In some aspects, electronic components are positioned on one side off a center of the security tag 200, so that a stitching lane (see, e.g., Fig. 5) may be created for secure attachment of the security tag 200 to an article of clothing. In some aspects, the security tag 200 may be manufactured to satisfy standards of environmental sustainability. For example, in some aspects, a natural-fiber fabric, recycled materials, or bio-based materials may be used as the inlay 202 (or as a portion of the inlay 202) so that the security tag 200 incorporates less plastic material than conventional security tags. Recycled materials may include, but are not limited to, recycled polyester or recycled paper, and bio-materials may include, but are not limited to, biopolymers or paper.

- [0064] Referring specifically to FIG. 4, an example of an alternative architecture for the security tag 200 is provided. In this example architecture, the integrated circuit 210 and the loop portion 206 may be incorporated into the design of the tunable antenna 204. In an aspect, the tunable antenna 204 may include a rectangular loop antenna, which is inherently differential.
- [0065] The inlay 202 material may include, but is not limited to, standard paper or water dissolvable paper. It should be noted that portions of the paper which are not completely dissolved during a wash cycle may remain inside the protective sleeve 208.
- [0066] In summary, the security tag 200 may be produced by combining different material and/or component layers, such as the tunable antenna 204 attached to the inlay 202, the intermediate layer including a semiconductor integrated circuit 210 electrically coupled with a loop portion 206, such as via inductive coupling, and the outer layer including an elongated protective sleeve 208, such as formed from a fabric, that covers the semiconductor integrated circuit 210, the tunable antenna 204, and the inlay 202. Advantageously, the tunable antenna 204 is designed to be very narrow as compared to typical RFID antennas.
- [0067] It should be understood, however, that the various layers may be manufactured and/or assembled in a different manner and/or in a different order and/or by different entities (e.g., antenna manufacturer, tag manufacturer, tag converter entities).

- [0068] Thus, the methods and structures herein provide a flexible, fabric-like, narrow security tag 200 that can be easily and efficiently attached (sewn) into a space between seams that connect two adjacent layers of material of an article of clothing. The two layers of the article of clothing may be stitched together by overlock stitches. However, in various aspects, the security tag 200 may be sewn, glued, or welded onto any other portion of an article of clothing.
- [0069] Referring specifically to FIG. 5, a completed welded security tag, such a security tag 200, includes the electronic components being positioned on one side 502 off a center of the security tag 200, so that a continuous stitching lane 504 may be created for secure attachment of the security tag 200 to an article of clothing. In other words, since the electronic components are situated on one side of the security tag 200, they are less likely to be damaged by sewing needles when the security tag 200 is attached to an article of clothing, and/or by sewing or welding of the opposing longitudinal edges of the material of sleeve 208, e.g., when a single layer of material is folded over to form the sleeve 208.
- [0070] The disclosed aspects provide a soft, easy to attach, discreet, high-performing, durable, and economical RFID security tag having one or more water soluble components. In an aspect, such a tag can be attached to an overlock seam of the article. For example, some disclosed aspects replace a majority of a PET inlay with a water soluble inlay having a conductive ink antenna in the core of a fabric sleeve. Advantageously, the disclosed aspects enable tagging of thin, lightweight, one-ply garments, which are difficult to tag with any existing tagging solutions. As yet another advantage, the disclosed tag can be easily disabled during a first wash cycle of the garment.
- [0071] Referring to FIGS. 6-20, additional aspects of a security tag similar to the security tag of FIGS. 2-5 include one or more features, which can be combined in any way, which improve the ability of the security tag to withstand bending or other forces. Thus, a security tag including one of more of the features of FIGS. 6-20 enables the sensor portion of the security tag to maintain operational performance despite being subjected to such forces.
- [0072] Referring to FIG. 6, in an aspect, an example security tag 600 is configured to have sensor 212 (e.g., semiconductor integrated circuit 210, tunable antenna 204, loop 206, and inlay 202) movable within the outer sleeve 208, which may improve durability of

the security tag 600, for instance, to avoid damage to the security tag 600 due to bending of the tag or the item to which the tag is applied. For example, the sleeve 208 may have a longitudinal length 602 that is greater than a longitudinal length 604 of the sensor 212, thereby leaving distance 606 at each end 608 within which the sensor 212 may move. The distance 606 defines a free space 610 within the pocket or enclosure formed by the sleeve 208. In some aspects, the sensor 212 may move into all or some portion of the free space 610 when subjected to a force, such as a bending force, thereby moving independently from sleeve 208 and resulting in less stress to the sensor 212. In other aspects, the free space 610 can result in increased flexibility of the end portions of the security tag 600, as compared to a tag where the sensor extends all the way or nearly all the way to the ends, thereby softening a feel of each end 608 of the security tag 600. Further, the ends 608 may be curved, which also provides a softer feel to the ends relative to a security tag having flat ends.

[0073] In any case, due to the ability of the sensor 212 to move relative to the sleeve 208, the security tag 600 may be referred to as a free-floating tag or free-floating sensor. In other words, the free-floating sensor 212 can move, e.g., “float,” within the sleeve 208 to allow more flexibility of the sensor 212 and reduce the effects of being stretched, bent, pulled, or twisted by the sleeve 208 to reduce damage caused by these actions, whether an item (e.g., garment) to which the security tag 600 is attached is washed, tried on or being handled. In one use case, for instance, the ‘floating’ aspect of the sensor 212 within the sleeve 208 “shifts” the sensor 212 within the sleeve 208, which greatly minimizes direct, constant, predictable contact of any one particular area of the sensor 212 with the harsh surfaces of the industrial wash equipment. As a result, use of security tag 600 helps to produce near perfect final product yields, i.e., no breaks and/or tears to the coupling antenna and/or the inductive loop after washing, and/or product handling. Thus, in this aspect, the sensor 212 can move independently within the sleeve 208.

[0074] Referring to FIGS. 7-20, in an aspect, another example security tag 700, which is similar to security tag 200 and/or security tag 600, also enables the sensor 212 to move relative to the sleeve 208 and additionally may include one or more features to soften the ends and/or improve the durability of the sensor 212.

[0075] In an aspect, the opposing longitudinal ends 608 and the lengthwise edge 702 of the folded over material of the sleeve 208 are affixed via fixation mechanisms 704 and

706, respectively. In an aspect, fixation mechanisms 704 and 706 are sonic welds, but they can alternatively include sewn seams, adhesively connected seams, or any other type of connecting mechanism. As described above, sensor 212 is located off-center within the sleeve 208, e.g., away from lengthwise edge 702, which avoids interference and/or damage by fixation mechanism 706 that extends along one side of the length of the sleeve 208, e.g., within the stitching lane 504.

- [0076] Referring specifically to FIG. 10, in an aspect, like the other security tags described herein, security tag 700 may be formed from a length 1000 of a plurality of sensors 212 within a length of the sleeve material 208 dispensed from a reel. In this example, a sonic welder and/or a cutting machine executes a separation process, represented by arrow 1002, to form individual security tags 700.
- [0077] Referring specifically to FIGS. 11 and 12, the opposing layers of the sleeve 208 of adjacent security tags 700 may be affixed across an end connection zone 1202, and then separated along separation line 1204. The separation process may include rounding the ends of the adjacent security tags 700 and forming a notch having a width 1206 on opposing ends of the separation line 1204, which may allow for slight variability in the separating process to make the separation along separation line 1204. Additionally, the separation line 1204 is located a spaced apart distance 1208 from an end of each respective sensor 212 so as to avoid damaging the respective sensors 212. Moreover, the end connection zone 612 leaves free space 610 within the sleeve 208 for each sensor 212 to move.
- [0078] Referring specifically to FIGS. 12 and 13, the fixation mechanism 704 at the end welding zone 1202 may have a different fixation pattern 1300 or characteristic than the fixation mechanism 706 along the side 702. For instance, rather than having a relatively long, contiguous fixation pattern, the fixation pattern 1300 may include a plurality of relatively smaller fixation areas 1302 distributed across the end. Further, the plurality of relatively smaller fixation areas 1302 may be spaced apart from one another. Additionally, the plurality of relatively smaller fixation areas 1302 may be spaced apart from and/or adjacent to a plurality of opposing areas 1304. For example, the plurality of opposing areas 1304 may be affixed areas having a pattern that is opposite to, or inverted relative to, the plurality of relatively smaller fixation areas 1302. Alternatively, in an aspect, the plurality of opposing areas 1304 may be non-affixed areas that provide a spacing between the fixation areas 1302. For instance, in

an implementation where the fixation mechanism 704 is a sonic weld, the fixation pattern 1300 may be a waffle-like pattern. The non-contiguous, spaced apart fixation areas that form fixation pattern 1300 can improve the seal reliability at the ends of the security tag 700, and also provide improved touch and feel, e.g., a softer, more flexible end, due to the increase flexibility provided by the spacing and/or the configuration of opposing fixation areas.

[0079] Referring specifically to FIG. 14, in some aspects, the sensor 212 may include an optional protective layer 1402 on a top surface, which can be affixed to the substrate via an optional adhesive layer 1404. The protective layer 1402 may be a plastic material, such as but not limited to a polyethylene terephthalate material, or any other type of material that may protect the sensor 212 from impacts, and optionally resist absorption of water or fluid that may damage the sensor 212. The adhesive layer 1404 may be any type of elastomeric compound or rubber compound or any other bonding material. Thus, in this alternative or additional aspect, the security tag 700 includes flexible seals at one or both longitudinal ends, which may provide a softer feel to the ends of the security tag 700, as perceived by a user wearing an item, e.g., an article of clothing, to which the security tag 700 is attached.

[0080] Referring to FIGS. 15-18, the security tag 700 may include one of a plurality of different types of enhanced flexibility antennas 204 and/or inlays 202, such as patterned antennas/inlays 1502, 1602, 1702, and 1802, respectively, which including stress-relief spacings between the material forming the antenna 204 (and optionally within the inlay 202). As described above, the antenna 204 is a metallic layer on the inlay 202. Traditional security tags have a solid layer of metallic material that forms the antenna 204, and this solid layer may crack when subjected to bending or other forces, which may hamper the performance of the sensor 212 and/or cause the semiconductor integrated circuit 210, e.g., the RFID chip, to become disconnected from the antenna 204. In contrast, for example, the plurality of stress-relief spacings in patterned antennas/inlays 1502, 1602, 1702, and 1802, respectively, avoid the build-up of stresses that can cause cracking in the layer of material forming the antenna 204.

[0081] In one implementation, referring to FIG. 15, the antenna 204 (and, optionally, the inlay 202) includes a notch pattern 1502 of a plurality of notches 1504 extending laterally across one or more portions the antenna 204. For instance, the notches 1504

may extend transverse to the longitudinal length of the antenna 204, such as from one longitudinal side toward the middle. In another aspects, similar transverse notches 1504 may extend from both longitudinal sides toward the middle. The length of the notches 1504, and spacing between the notches 1504, may be configurable depending on expected stress in a given area. As such, the notches 1504 may be equally distributed or concentrated more in some areas than other areas. In other words, the notches 1504 are provided in the material layer of the antenna 204 for reducing development of stress during bending of the layer. During bending, the material layer of the antenna 204 can get bent at one or more locations of one or more notches 1504, thereby preventing development of cracks in the layer. Alternatively, or in addition, the notches 1504 can prevent the propagation of a crack.

[0082] Additionally, or alternatively, referring to FIG. 16, the antenna 204 (and, optionally, the inlay 202) includes a perforation pattern 1602 of a plurality of perforations 1604 across one or more portions the antenna 204. The perforations 1604 may be provided on the material layer of the antenna 204 to reduce stress on the layer. Like notches 1504, the perforations 1604 provide a pathway for releasing stress and preventing development of cracks in the material layer of the antenna 204. Alternatively, or in addition, the perforations 1604 can prevent the propagation of a crack.

[0083] Thus, the aspects of FIGS. 15-18 provide the security tag 700 with an antenna 204 and/or inlay 202 having a plurality of openings along all or portion of the longitudinal length, which may improve durability of the security tag 700, for instance, to avoid damage to the security tag 700 due to bending of the tag or the item to which the tag is applied.

[0084] Referring to FIGS. 17 and 18, in another alternative or additional implementation, the material of the antenna 204 (and, optionally, the inlay 202) may be in the form of a mesh or net pattern 1702 or 1802, respectively. The mesh/net pattern 1702 may be a repeating, equally distributed angular pattern, while the mesh/net pattern 1802 may be one or more linear patterns. The mesh/net patterns 1702 and 1802 are only examples, and the present disclosure contemplates other configurations. The mesh/net patterns 1702 and 1802 provide the antenna 204 with increased flexibility, thereby reducing the likelihood of cracking or breaking.

[0085] Referring to FIGS. 19 and 20, in a further alternative or additional implementation, the security tag 700, includes an additional reinforcement layer 1902 adjacent to the

inlay 202. The additional reinforcement layer 1902 may have a same material and/or thickness and/or flexibility as inlay 202, or a different material and/or thickness and/or flexibility. For instance, the reinforcement layer 1902 may be stiffer than the inlay 202. The additional reinforcement layer 1902 is provided to support the area of the antenna 204 and the semiconductor integrated circuit 210, e.g., the RFID chip, to provide stiffness to the delicate part of the sensor 212, but still allowing flexibility at the ends of the security tag 700. The reinforcement layer 1902 can be made of any suitable material, such as but not limited to a plastic, e.g., polyethylene terephthalate (PET) or polypropylene (PP). The reinforcement layer 1902 may be provided between the semiconductor integrated circuit 210 and material layer forming the antenna 204 and/or inlay 202, or below the layer of the antenna 204 and/or inlay 202, or above the semiconductor integrated circuit 210. The reinforcement layer 1902 can be attached to the adjacent layers using a suitable adhesive. Thus, the reinforcement layer 1902 provides additional stiffness to prevent excessive bending of the metallic layer of the antenna 204 and the semiconductor integrated circuit 210 during use.

- [0086] Thus, the present disclosure includes one or any combination of the following aspects.
- [0087] One aspect of the security tag includes: an elongated inlay portion; an antenna mounted on the elongated inlay portion; and a radio frequency identifier (RFID) circuit coupled with the antenna. The security tag may be encapsulated within an elongated textile protective sleeve. At least one of the elongated inlay portions, the antenna, or the RFID circuit are adapted to dissolve in water.
- [0088] In one or any combination of these aspects, the antenna is configured to operate at ultra-high frequency (UHF).
- [0089] In one or any combination of these aspects, the elongated inlay portion includes at least one of: a biodegradable material and a water soluble material.
- [0090] In one or any combination of these aspects, the water soluble material includes at least one of: a nonwoven material and a film material.
- [0091] In one or any combination of these aspects, the textile protective sleeve includes a non-soluble material.
- [0092] In one or any combination of these aspects, the antenna is attached to an induction loop and the antenna extends along the security tag in a longitudinal direction, wherein

the antenna includes a water soluble material and wherein the induction loop includes a non-soluble material.

- [0093] In one or any combination of these aspects, the antenna is mounted using a water soluble conductive ink.
- [0094] In one or any combination of these aspects, the elongated textile protective sleeve includes a single textile sheet having a first longitudinal side fixedly attached to an opposite, second longitudinal side.
- [0095] In one or any combination of these aspects, the elongated textile protective sleeve includes a single textile sheet having a first longitudinal sides fixedly attached to an opposite, second longitudinal side on a first longitudinal tag side off a center of the security tag, and wherein the antenna and the RFID circuit are positioned on a second longitudinal tag side opposite the first longitudinal tag side.
- [0096] In one or any combination of these aspects, the security tag is configured to be positioned into an interface space between two layers of an article of clothing.
- [0097] In one or any combination of these aspects, the security tag is configured to be positioned on top of an overlock seam of an article of clothing.
- [0098] Another aspect of a security tag include: an elongated inlay portion; an antenna mounted on the elongated inlay portion; and a radio frequency identifier (RFID) circuit coupled with the antenna, wherein at least a portion of the security tag is adapted to dissolve in water.
- [0099] In one or any combination of these aspects, the portion comprises the elongated inlay portion.
- [0100] In one or any combination of these aspects, the portion comprises the antenna.
- [0101] In one or any combination of these aspects, the portion comprises the RFID circuit.
- [0102] In one or any combination of these aspects, the portion comprises at least one of: a biodegradable material and a water soluble material.
- [0103] In one or any combination of these aspects, the water soluble material comprises at least one of: a nonwoven material and a film material.
- [0104] Aspects of the present disclosure include a security tag having an inlay, an antenna mounted on the inlay, a radio frequency identifier (RFID) circuit coupled with the antenna, and a sleeve encompassing the RFID circuit, the antenna, and the inlay,

wherein the RFID circuit, antenna, and inlay is configured to be movable within the sleeve.

- [00105] Aspects of the present disclosure include the security tag above, further comprising one or more fixation mechanisms configured to affix the sleeve.
- [00106] Aspects of the present disclosure include any of the security tags above, wherein the one or more fixation mechanisms include one or more of sonic welds, sewn seams, or adhesively connected seams.
- [00107] Aspects of the present disclosure include any of the security tags above, wherein the RFID circuit is disposed off-center within the sleeve.
- [00108] Aspects of the present disclosure include any of the security tags above, wherein the RFID circuit is disposed away from the one or more fixation mechanisms within the sleeve.
- [00109] Aspects of the present disclosure include any of the security tags above, wherein the one or more fixation mechanisms include a waffle-like pattern.
- [00110] Aspects of the present disclosure include any of the security tags above, further comprising a protective layer disposed over the RFID circuit.
- [00111] Aspects of the present disclosure include any of the security tags above, wherein the protective layer may include a plastic material or a polyethylene terephthalate material.
- [00112] Aspects of the present disclosure include any of the security tags above, wherein the protective layer is configured to resist absorption of water.
- [00113] Aspects of the present disclosure include a method of manufacturing a security tag including mounting an antenna onto an inlay, coupling a radio frequency identifier (RFID) circuit with the antenna, disposing the RFID circuit, the antenna, and the inlay into a sleeve, and wherein the RFID circuit, the antenna, and the inlay are configured to be movable within the sleeve.
- [00114] Aspects of the present disclosure include the method above, further comprising affixing one or more fixation mechanisms to the sleeve.

- [00115] Aspects of the present disclosure include any of the methods above, wherein the one or more fixation mechanisms include one or more of sonic welds, sewn seams, or adhesively connected seams.
- [00116] Aspects of the present disclosure include any of the methods above, wherein disposing the RFID circuit, the antenna, and the inlay into the sleeve further comprises disposing the RFID circuit off-center within the sleeve.
- [00117] Aspects of the present disclosure include any of the methods above, wherein disposing the RFID circuit, the antenna, and the inlay into the sleeve further comprises disposing the RFID circuit away from the one or more fixation mechanisms within the sleeve.
- [00118] Aspects of the present disclosure include any of the methods above, wherein the one or more fixation mechanisms include a waffle-like pattern.
- [00119] Aspects of the present disclosure include any of the methods above, further comprising disposing a protective layer over the RFID circuit.
- [00120] Aspects of the present disclosure include any of the methods above, wherein the protective layer may include a plastic material or a polyethylene terephthalate material.
- [00121] Aspects of the present disclosure include any of the methods above, wherein the protective layer is configured to resist absorption of water.
- [00122] The previous description is provided to enable any person skilled in the art to practice the various aspects described herein. Various modifications to these aspects will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects. Thus, the claims are not intended to be limited to the aspects shown herein, but is to be accorded the full scope consistent with the language claims, wherein reference to an element in the singular is not intended to mean “one and only one” unless specifically so stated, but rather “one or more.” The word “exemplary” is used herein to mean “serving as an example, instance, or illustration.” Any aspect described herein as “exemplary” is not necessarily to be construed as preferred or advantageous over other aspects. Unless specifically stated otherwise, the term “some” refers to one or more. Combinations such as “at least one of A, B, or C,” “one or more of A, B, or C,” “at least one of A, B, and C,” “one or more of A, B, and C,” and “A, B, C, or any combination thereof” include any combination of A, B, and/or C, and may include multiples of A, multiples of B, or

multiples of C. Specifically, combinations such as “at least one of A, B, or C,” “one or more of A, B, or C,” “at least one of A, B, and C,” “one or more of A, B, and C,” and “A, B, C, or any combination thereof” may be A only, B only, C only, A and B, A and C, B and C, or A and B and C, where any such combinations may contain one or more member or members of A, B, or C. All structural and functional equivalents to the elements of the various aspects described throughout this disclosure that are known or later come to be known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the claims. Moreover, nothing disclosed herein is intended to be dedicated to the public regardless of whether such disclosure is explicitly recited in the claims. The words “module,” “mechanism,” “element,” “device,” and the like may not be a substitute for the word “means.” As such, no claim element is to be construed as a means plus function unless the element is expressly recited using the phrase “means for.”

CLAIMS

WHAT IS CLAIMED IS:

1. A security tag, comprising:
an inlay;
an antenna mounted on the inlay;
a radio frequency identifier (RFID) circuit coupled with the antenna; and
a sleeve encompassing the RFID circuit, the antenna, and the inlay;
wherein the RFID circuit, the antenna, and the inlay are configured to be movable within the sleeve.
2. The security tag of claim 1, further comprising one or more fixation mechanisms configured to affix the sleeve.
3. The security tag of claim 2, wherein the one or more fixation mechanisms include one or more of sonic welds, sewn seams, or adhesively connected seams.
4. The security tag of claim 3, wherein the RFID circuit is disposed off-center within the sleeve.
5. The security tag of claim 4, wherein the RFID circuit is disposed away from the one or more fixation mechanisms within the sleeve.
6. The security tag of claim 2, wherein the one or more fixation mechanisms include a waffle-like pattern.
7. The security tag of claim 1, further comprising a protective layer disposed over the RFID circuit.
8. The security tag of claim 7, wherein the protective layer may include a plastic material or a polyethylene terephthalate material.
9. The security tag of claim 7, wherein the protective layer is configured to resist absorption of water.

10. The security tag of claim 1, wherein the inlay comprises a polyester substrate.

11. The security tag of claim 1, wherein a material of the sleeve comprises one or more of polyester or cotton.

12. A method of manufacturing a security tag, comprising:
mounting an antenna onto an inlay;
coupling a radio frequency identifier (RFID) circuit with the antenna; and
disposing the RFID circuit, the antenna, and the inlay into a sleeve;
wherein the RFID circuit, the antenna, and the inlay are configured to be movable within the sleeve.

13. The method of claim 12, further comprising affixing one or more fixation mechanisms to the sleeve.

14. The method of claim 13, wherein the one or more fixation mechanisms include one or more of sonic welds, sewn seams, or adhesively connected seams.

15. The method of claim 14, wherein disposing the RFID circuit, the antenna, and the inlay into the sleeve further comprises disposing the RFID circuit off-center within the sleeve.

16. The method of claim 15, wherein disposing the RFID circuit, the antenna, and the inlay into the sleeve further comprises disposing the RFID circuit away from the one or more fixation mechanisms within the sleeve.

17. The method of claim 13, wherein the one or more fixation mechanisms include a waffle-like pattern.

18. The method of claim 12, further comprising disposing a protective layer over the RFID circuit.

19. The method of claim 18, wherein the protective layer may include a plastic material or a polyethylene terephthalate material.

20. The method of claim 18, wherein the protective layer is configured to resist absorption of water.

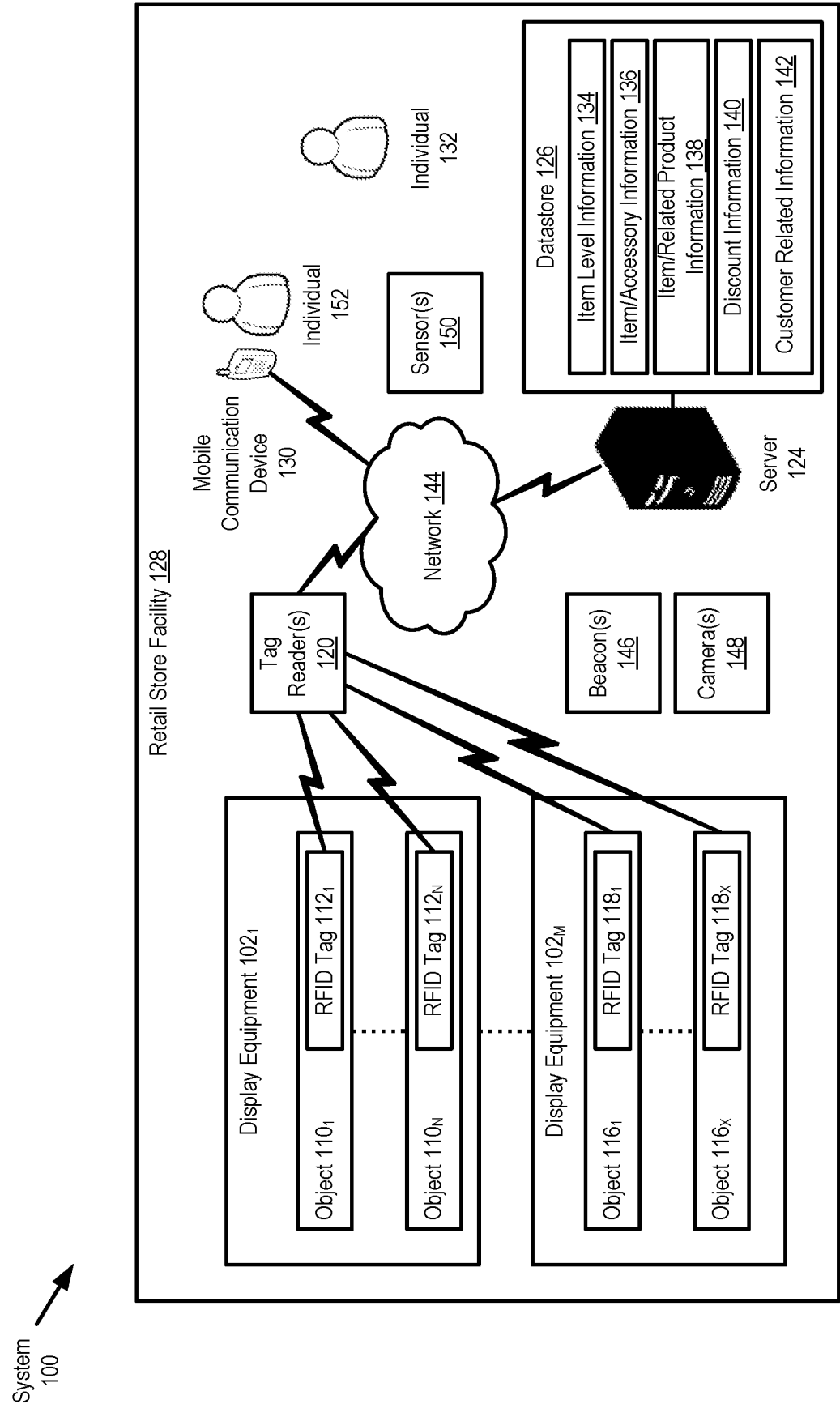


FIG. 1

200

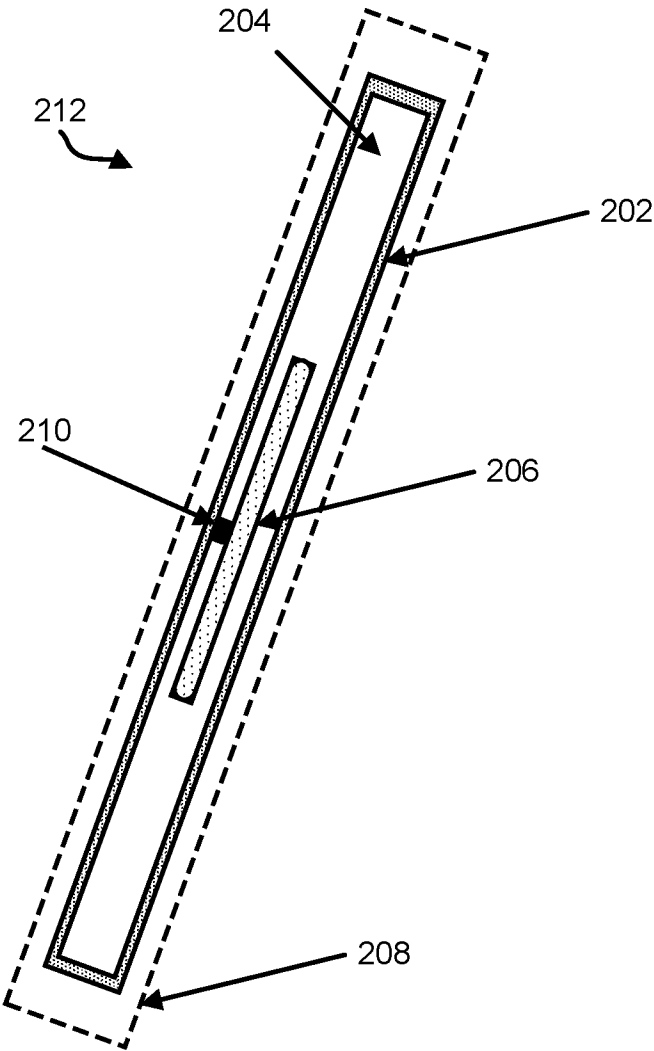


FIG. 2

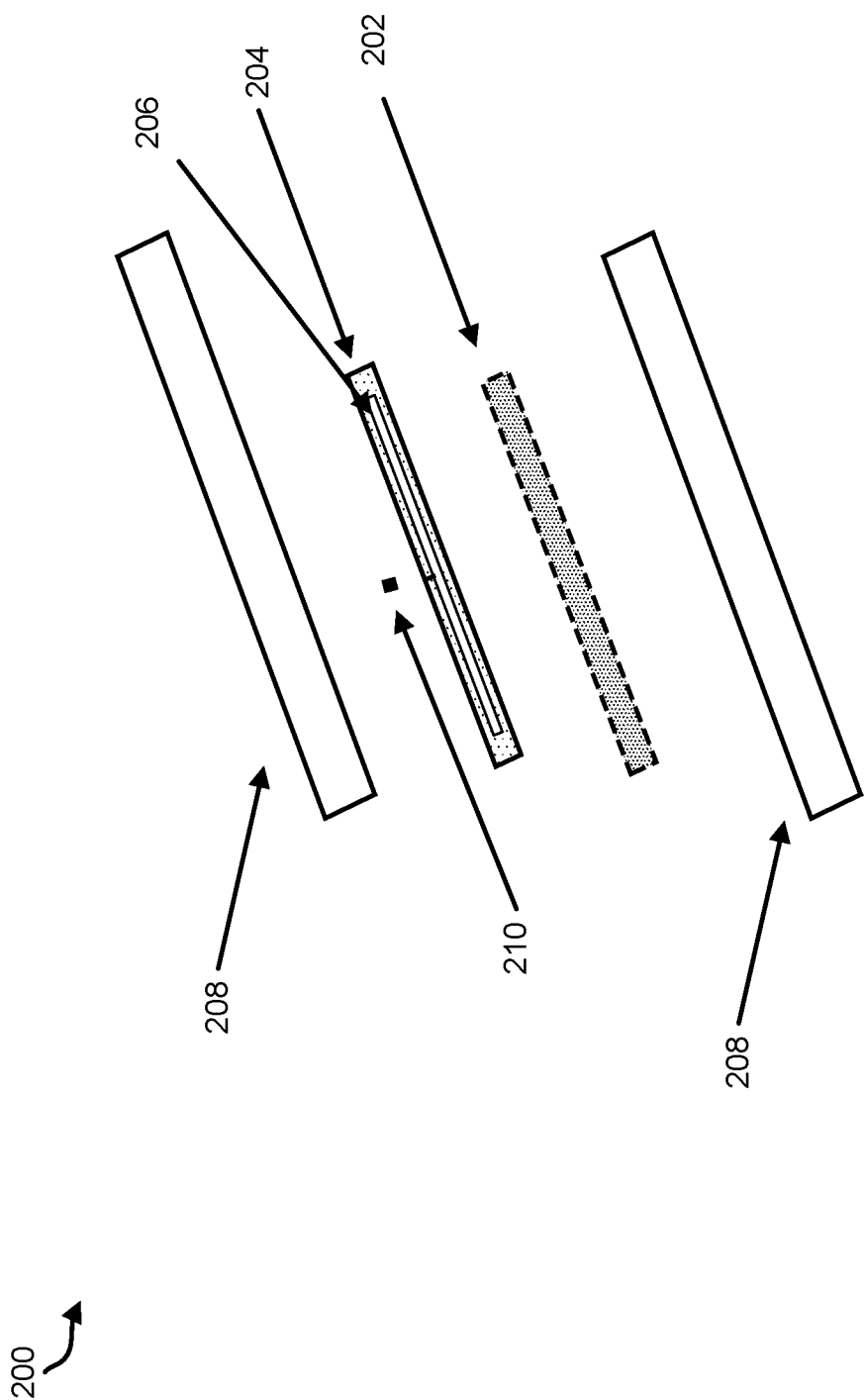


FIG. 3

4/15

200

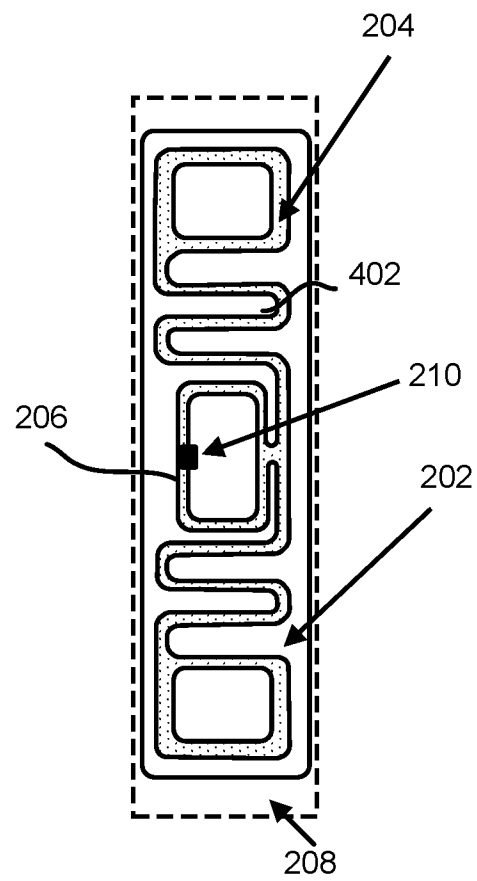



FIG. 4

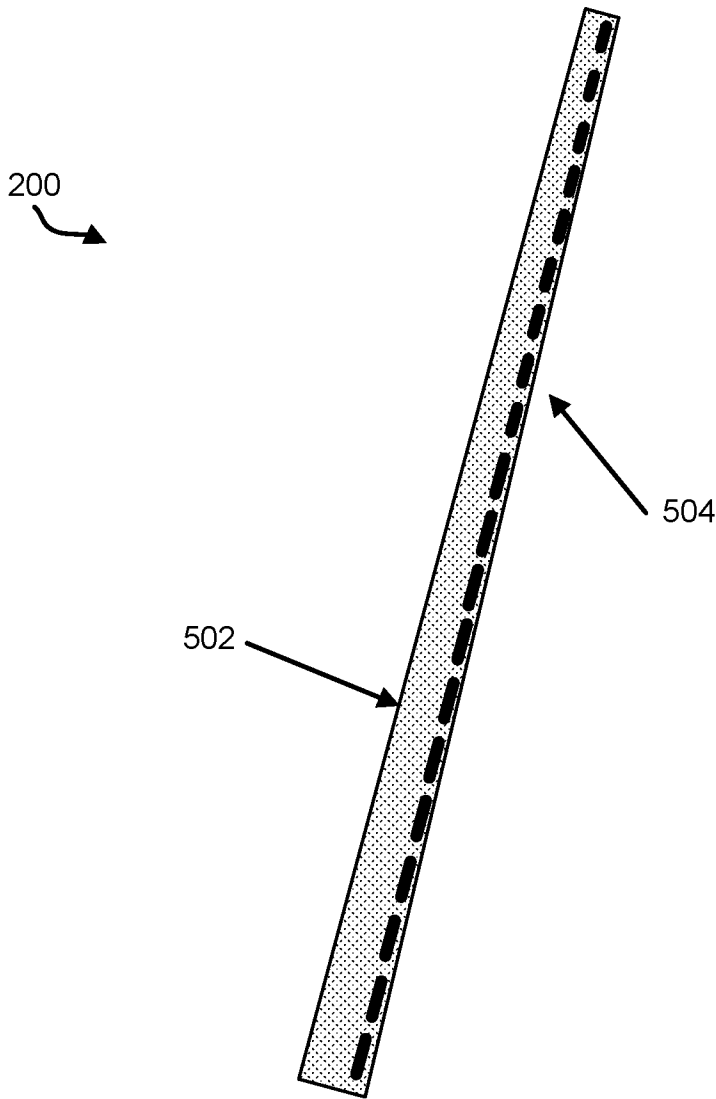


FIG. 5

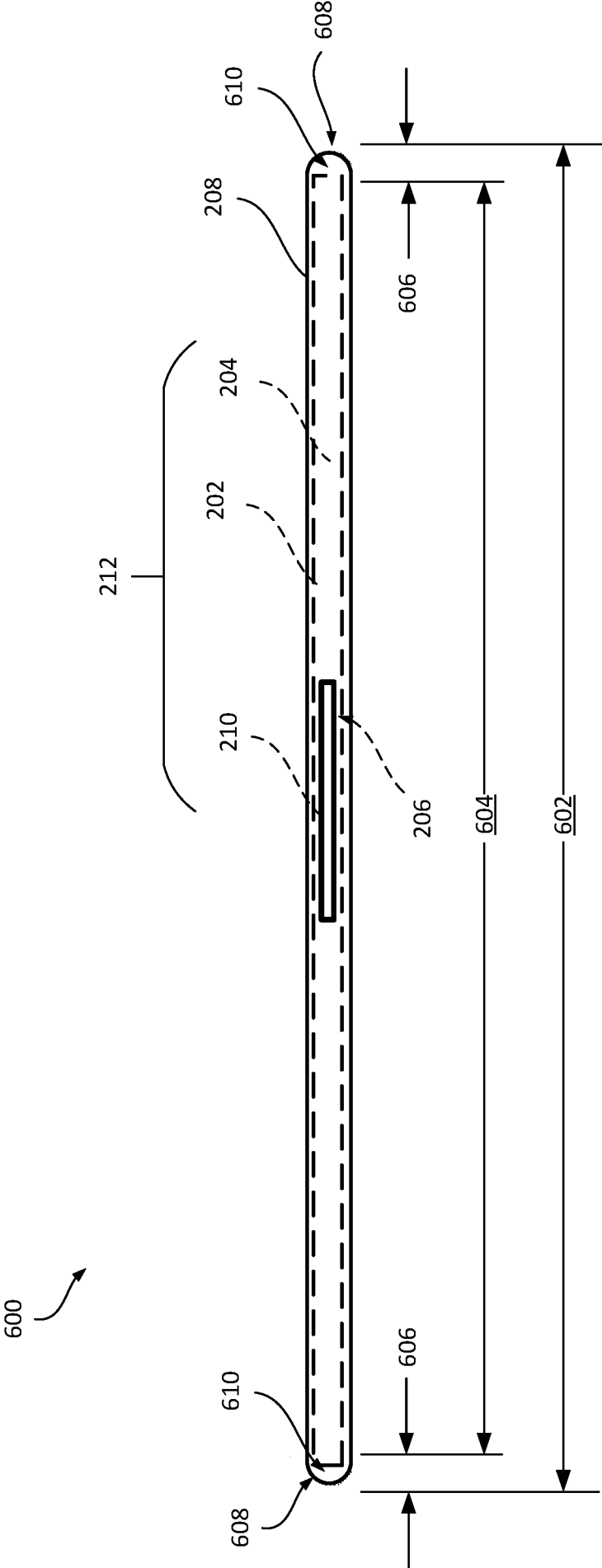


FIG. 6

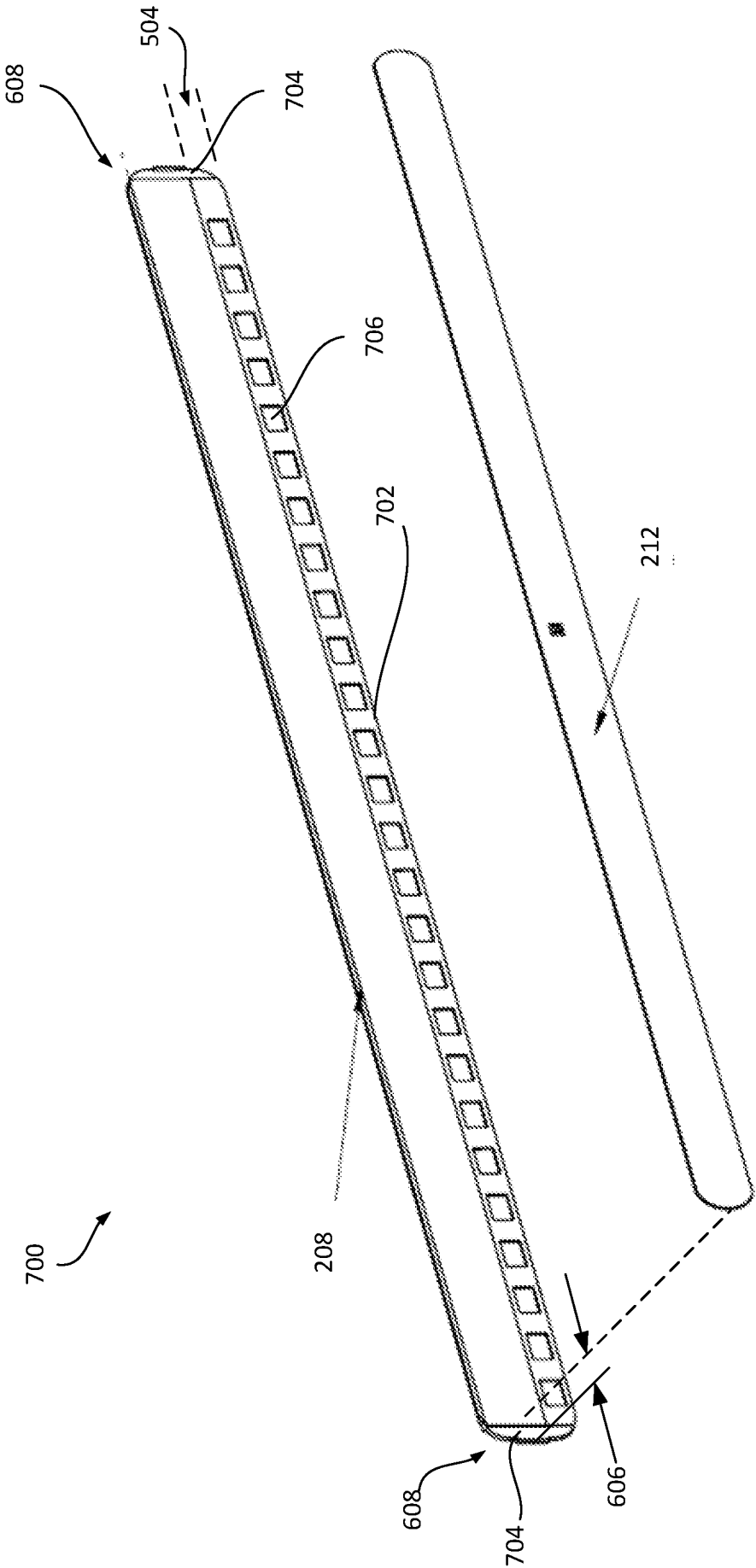


FIG. 7

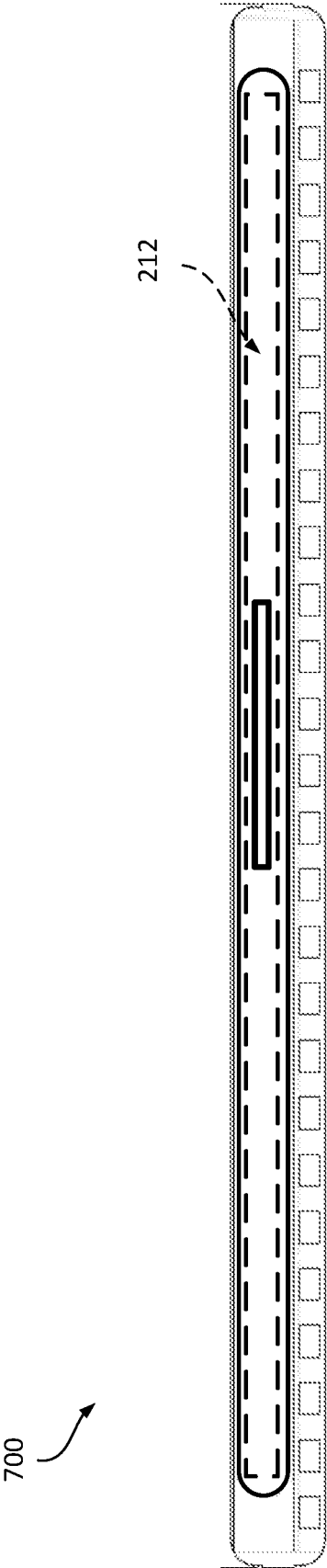


FIG. 8

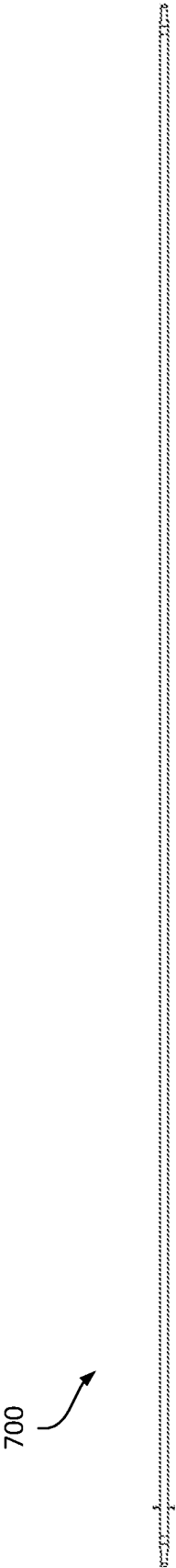


FIG. 9

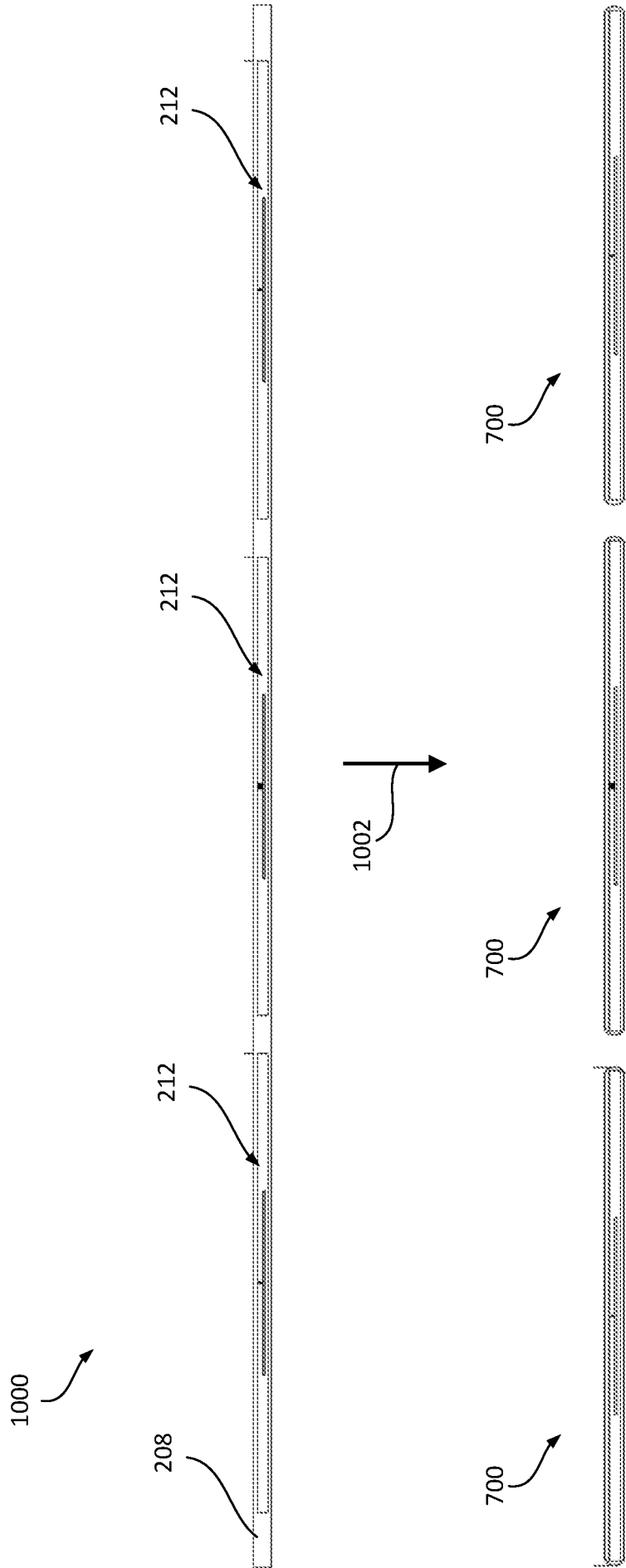


FIG. 10

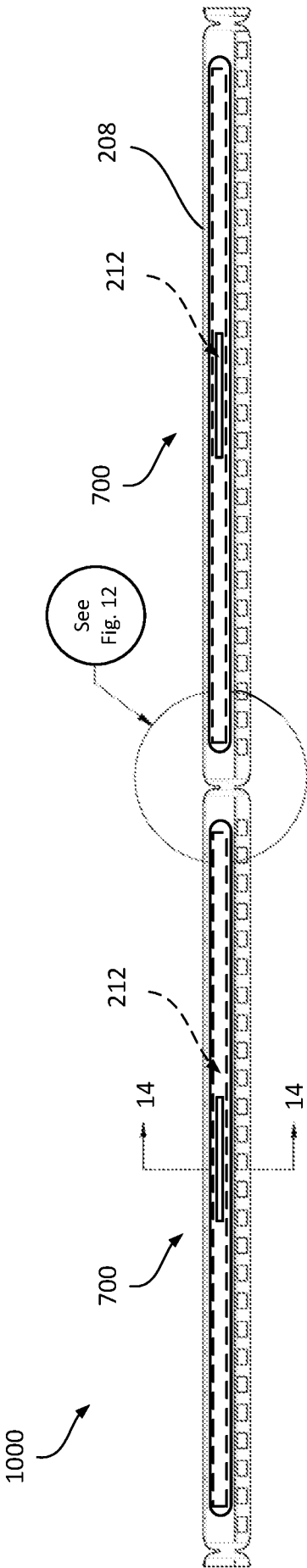


FIG. 11

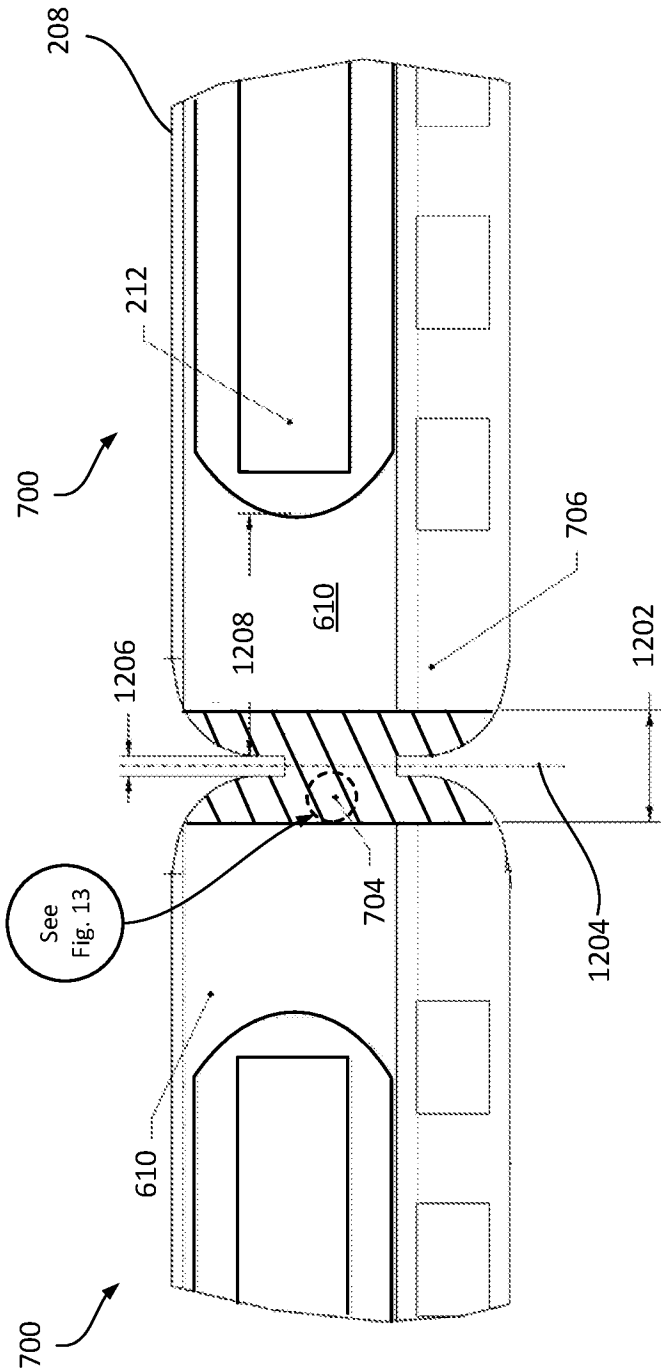


FIG. 12

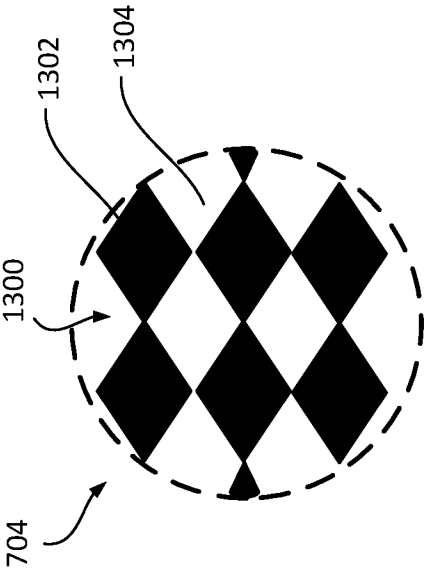


FIG. 13

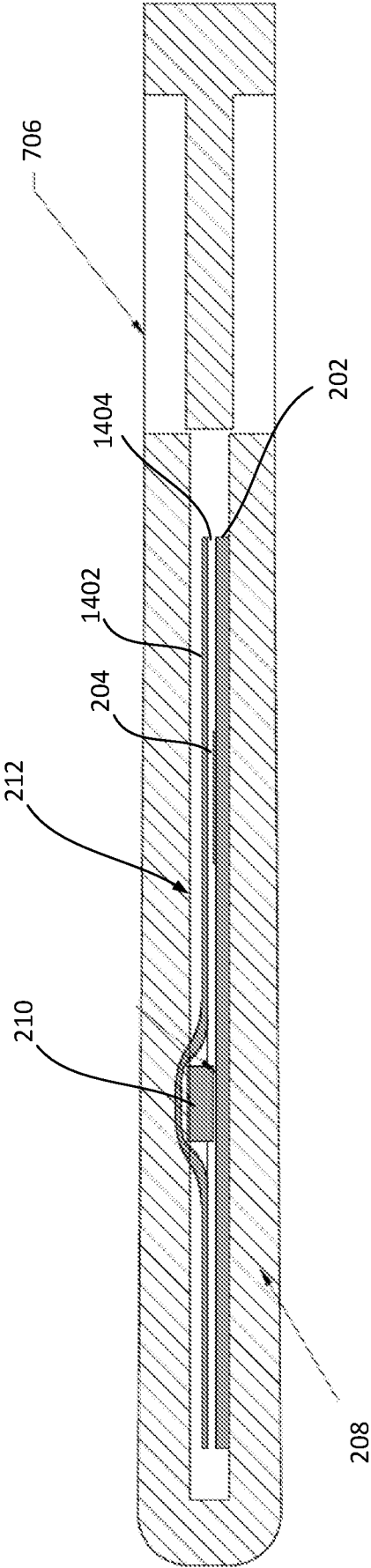


FIG. 14

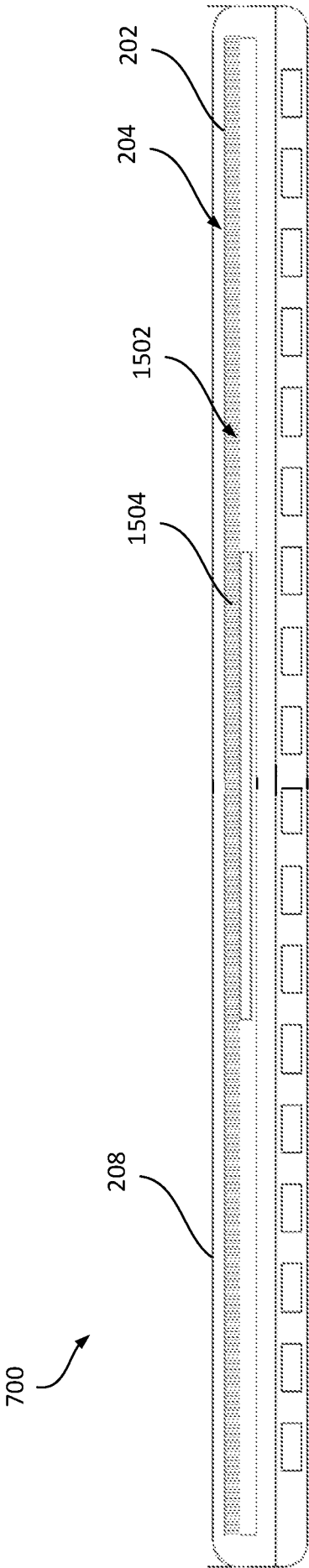


FIG. 15

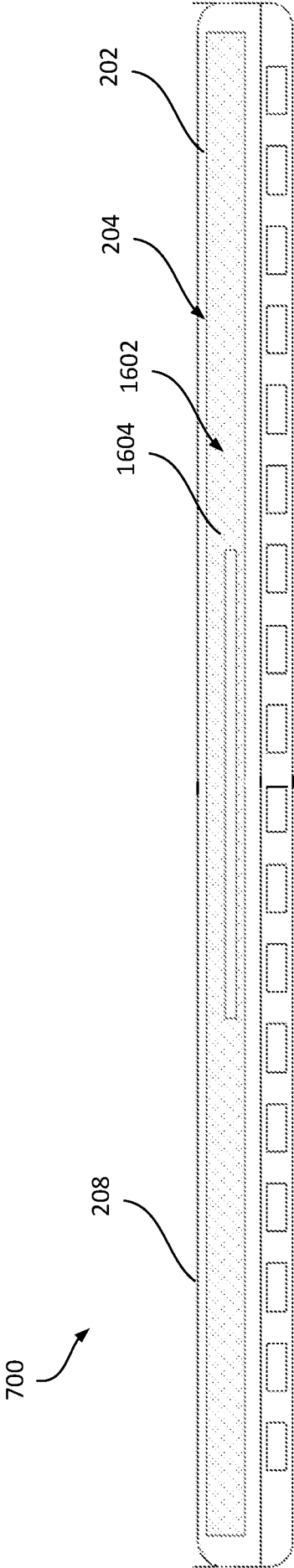


FIG. 16

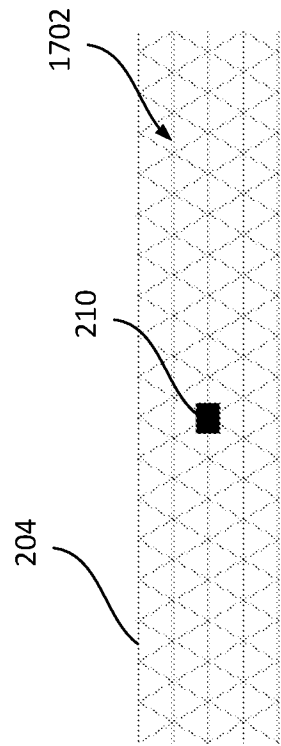


FIG. 17

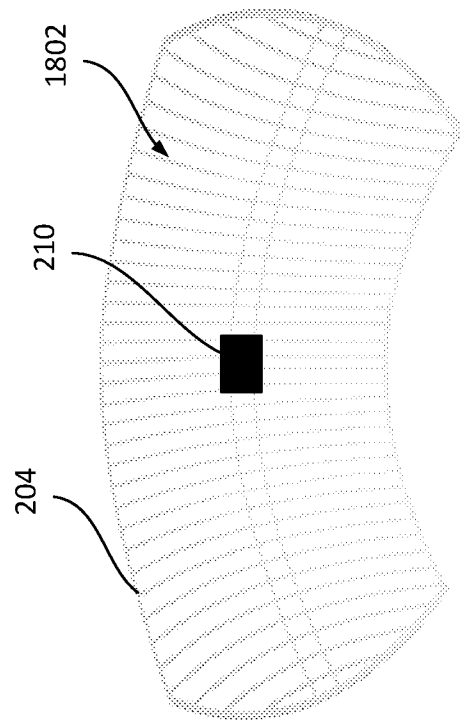


FIG. 18

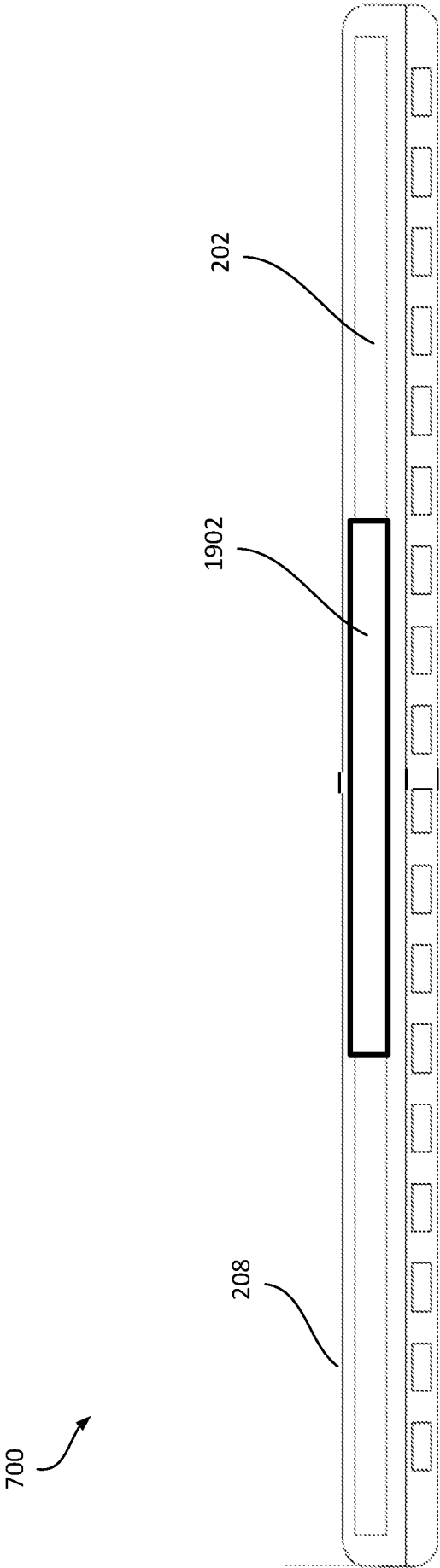


FIG. 19

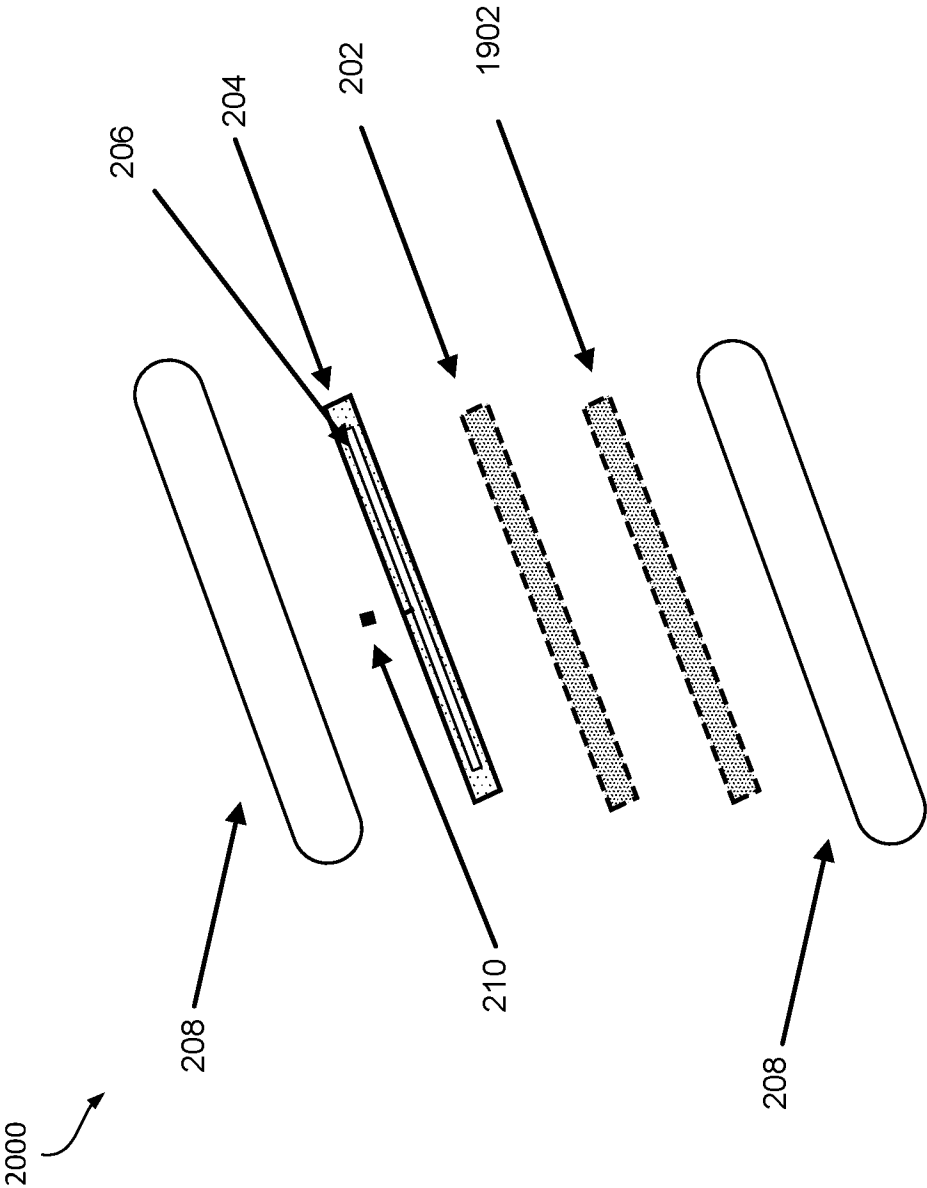


FIG. 20

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2024/061150

A. CLASSIFICATION OF SUBJECT MATTER INV. G06K19/02 G06K19/077 G08B13/24 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) G06K G08B Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2016/210548 A1 (BLAIR WILLIAM A [US]) 21 July 2016 (2016-07-21) abstract paragraphs [0002], [0016] - [0028], [0098] - [0110], [0119] - [0131], [0161] figures 3-4,12-13 -----	1-20
X	DE 10 2004 027978 A1 (SOKYMAT GMBH [DE]) 29 December 2005 (2005-12-29) abstract paragraphs [0023] - [0035] figures 1-4 -----	1-20
A	EP 2 504 796 B1 (AVERY DENNISON CORP [US]) 16 September 2015 (2015-09-16) paragraphs [0020] - [0023] figures 1-5 ----- -/-	1-20
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 26 March 2025		Date of mailing of the international search report 07/04/2025
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Castagnola, Bruno

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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