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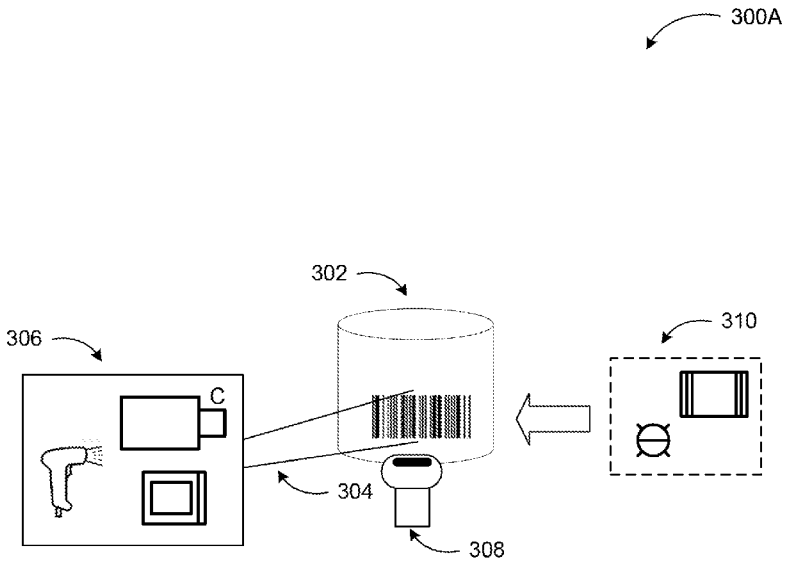

FIG. 3A

(57) Abstract: Technologies are generally described for modification of physical visual codes. In some examples, information encoded in a physical visual code may be extracted upon capturing of an image of the code or scanning of the code. A transaction associated with the extracted information may be determined and a change to the information may be determined based on the transaction, for example, confirmation of the performance of the transaction. A physical modification may then be made on the visual code based on the determined change. For example, content of the physical visual code may be modified or another (e.g., semi-transparent) visual code may be printed onto the physical visual code. The physical visual code may be of any type. The modification may be through printing (e.g., visual, thermochromic, or photochromic ink), etching, embossing, painting, etc.

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MODIFIABLE PHYSICAL VISUAL CODE AND METHODS

BACKGROUND

[0001] Unless otherwise indicated herein, the materials described in this section are not prior art to the claims in this application and are not admitted to be prior art by inclusion in this section.

[0002] Visual codes such as barcodes or quick response codes (QR-codes) are used to keep track of transactions such as financial transactions. In a typical use scenario, a visual code printed on an item or document is scanned, the contained information extracted and submitted to a network. A database record associated with the extracted information is then updated. If further tracking for the transaction is needed, another visual code may be printed for future use. Thus, conventional use of visual codes in conjunction with transactions requires a backbone system of computing devices, network connections, etc.

SUMMARY

[0003] The present disclosure generally describes techniques for modification of physical visual codes.

[0004] According to some examples, a system to modify physical visual codes is described. The system may include an image capture device configured to capture a physical visual code with information encoded therein. The system may also include a control device configured to extract the information encoded in the physical visual code; determine a transaction from the information encoded in the physical visual code; and determine a change to the information encoded in the physical visual code. The system may further include an output device configured to modify the information encoded in the physical visual code.

[0005] According to other examples a modifiable physical visual code is described. The modifiable physical visual code may include a first layer of content; a second layer of content comprising security information; a third layer of content comprising transaction information; and a fourth layer of content comprising iteration information, where one or more of the first, second, third, and fourth layers include a physical modification to the physical visual code.

[0006] According to further examples, a method to modify visual codes is described. The method may include extracting information encoded in a physical visual code; determining a transaction from the information encoded in the physical visual code; determining a change to the information encoded in the physical visual code; and modifying the information encoded in the physical visual code based on the determined change.

[0007] The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, embodiments, and features described above, further aspects, embodiments, and features will become apparent by reference to the drawings and the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The foregoing and other features of this disclosure will become more fully apparent from the following description and appended claims, taken in conjunction with the accompanying drawings. Understanding that these drawings depict only several embodiments in accordance with the disclosure and are, therefore, not to be considered limiting of its scope, the disclosure will be described with additional specificity and detail through use of the accompanying drawings, in which:

FIG. 1 includes examples of visual codes;

FIG. 2A includes an illustration of a structure of a linear barcode;

FIG. 2B, 2C, and 2D include illustrations of example modifications on the linear barcode of FIG. 2A;

FIG. 2E includes an illustration of a structure of a two-dimensional barcode (QR-code);

FIG. 2F and 2G include illustrations of example modifications on the two-dimensional barcode of FIG. 2E;

FIG. 3A includes a conceptual illustration of modules involved in modification of a visual code, for example, a linear barcode;

FIG. 3B includes a conceptual illustration of medium iteration in capturing and modification of encoded information in a physical visual code;

FIG. 3C includes a conceptual illustration of capture and modification of encoded information in a physical visual code in a beverage purchase transaction scenario;

FIG. 3D includes a conceptual illustration of capture and modification of encoded information in a physical visual code in another beverage purchase transaction scenario;

FIG. 3E includes a conceptual illustration of capture and modification of encoded information in a physical visual code in yet another beverage purchase transaction scenario with cup position re-iteration;

FIG. 4 includes an illustration of two example configurations of a multi-layered modifiable physical visual code;

FIG. 5 illustrates major components of an example system for modification of physical visual codes;

FIG. 6 illustrates a computing device, which may be used to manage a system utilizing modification of physical visual codes;

FIG. 7 is a flow diagram illustrating an example method to manage modification of physical visual codes that may be performed by a computing device such as the computing device in FIG. 6; and

FIG. 8 illustrates a block diagram of an example computer program product,

some of which are arranged in accordance with at least some embodiments described herein.

DETAILED DESCRIPTION

[0009] In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, similar symbols typically identify similar components, unless context dictates otherwise. The illustrative embodiments described in the detailed description, drawings, and claims are not meant to be limiting. Other embodiments may be utilized, and other changes may be made, without departing from the spirit or scope of the subject matter presented herein. The aspects of the present disclosure, as generally described herein, and illustrated in the Figures, can be arranged, substituted, combined, separated, and designed in a wide variety of different configurations, all of which are explicitly contemplated herein.

[0010] This disclosure is generally drawn, *inter alia*, to methods, apparatus, systems, devices, and/or computer program products related to modifiable physical visual codes and modification of such codes.

[0011] Briefly stated, technologies are generally described for modification of physical visual codes. In some examples, information encoded in a physical visual code may be extracted upon capturing of an image of the code or scanning of the code. A transaction associated with the extracted information may be determined and a change to the information may be determined based on the transaction, for example, confirmation of the performance of the transaction. A physical modification may then be made on the visual code based on the determined change. For example, content of the physical visual code may be modified or another (e.g., semi-transparent) visual code may be printed onto the physical visual code. The physical visual code may be of any type. The modification may be through printing (e.g., visual, thermochromic, or photochromic ink), etching, embossing, painting, etc.

[0012] FIG. 1 includes examples of visual codes that may be employed for modification, in accordance with at least some embodiments described herein.

[0013] Visual codes may be of any shape, form, and content. While at the simplest level, any symbol may be interpreted as a visual code and encode information, typical visual codes include encoded information along with security and/or error correction features. To encode larger amounts of information, two-dimensional visual codes have been developed.

[0014] Diagram 100 illustrates some example two-dimensional visual codes and a linear code (barcode). An Aztec code 101 is built on a square grid with a bulls-eye pattern at its center for locating the code. Data is encoded in concentric square rings around the bulls-eye pattern. Corners of the core include orientation marks, allowing the code to be read if rotated or reflected. CrontoSign 102 is a code developed for secure financial transactions and utilizes a unique visual challenge contained in a graphical cryptogram consisting of a matrix of colored dots displayed on a customer's computer screen. The customer may use a camera to capture this cryptogram by photographing the screen, instantly decoding, decrypting, and displaying transaction details for user verification. A data matrix 103 is a two-dimensional code consisting of black and white cells or dots arranged in either a square or rectangular pattern, also known as a matrix. The information to be encoded may be text or numeric data. A size of the encoded data depends on the number of cells in the matrix.

[0015] A ShotCode 104 is a circular barcode and uses a dartboard-like circle, with a bullseye in the center and data circles surrounding it. Data bits may be read from the data circles by measuring an angle and distance from the bullseye for each. ShotCodes differ from matrix

barcodes in that they do not store regular data. Rather, a look up number consisting of 40 bits of data is stored, which needs to be sent to a server that holds information regarding where to download the data. High Capacity Color Barcode 105 encodes data in a two-dimensional barcode using clusters of colored triangles instead of the square pixels conventionally associated with two-dimensional barcodes. Data density may be increased by using a palette of 4 or 8 colors for the triangles, although black and white may also be used. Han Xin Barcode 106 is a two-dimensional matrix symbology made up of an array of square modules arranged in an overall square pattern. Unique finder patterns assist in easy location of its position, size and inclination. The code is preferred for its ability to encode double-byte Chinese characters.

[0016] MaxiCode 107 is designed for tracking and managing the shipment of packages. Resembling a barcode, but using dots arranged in a hexagonal grid instead of bars, MaxiCodes can be chained together to convey more data. Stacked barcode 108, also known as PDF417 code, is a combination of two-dimensional barcode and linear barcode formats used in a variety of applications such as transport, identification cards, and inventory management. The 417 in its name signifies that each pattern in the code consists of 4 bars and spaces in a pattern that is 17 units (modules) long. The linear barcode bars are used as start and stop patterns, whereas data and structure/error correction information are encoded two-dimensionally between the linear bars. Barcode 114 represents data by varying the widths and spacings of parallel lines (bars) and is widely used in a variety of implementations. QR-code (Quick Response code) 112 is a type of matrix barcode (or two-dimensional barcode). QR-code includes black squares arranged in a square grid on a white background, which can be read by an imaging device such as a camera and processed.

[0017] FIG. 2A includes an illustration of a structure of a linear barcode, in accordance with at least some embodiments described herein.

[0018] In some examples, a physical visual code, for example, a barcode or similar affixed on an item associated with a transaction, a wearable item, a card, a packaging, or a container may encode information associated with the transaction. The transaction may include, but is not limited to, a financial transaction, a processing transaction, a dispensing transaction, an authorization transaction, or a documentation transaction. A system may confirm or receive confirmation of performance of the transaction and determine a change to the physical code based on the performed transaction. The change may include modification of a data portion of

the physical visual code to reflect a different data value, addition of another visual code (transparent or semi-transparent) over the physical visual code, for example.

[0019] In the examples of linear or two-dimensional barcodes, the change may be modification of a symbol in a data portion of the barcode by printing over the barcode, where the modified symbol reflects a modified bit value. Diagram 200A of FIG. 2A shows the structure of a linear barcode to provide context for the changes discussed herein. A length of the barcode may determine an amount of data to be encoded. A height of the barcode may be selected based on application (e.g., item size) and readability requirements. For ease of machine-readability and standardization, two quiet zones 202 may be placed on either side of the linear barcode. The barcode symbols 204 may include a start character 206 (to indicate to the reading machine where the data symbols begin), data message 208, a check digit 210 (for error correction), and a stop character 212 (to indicate to the reading machine where the data symbols end). A number and width of the black and white (dark and light) bars may represent values for each character. The black and white (dark and light) bars may be affixed through printing, painting, stamping, imprinting, engraving, embossing, or etching.

[0020] FIG. 2B, 2C, and 2D include illustrations of example modifications on the linear barcode of FIG. 2A, in accordance with at least some embodiments described herein.

[0021] Diagram 200B shows a first example modification, where a white space 224 in a portion 222 of a linear barcode may be inserted a black line 228 in the modified portion 226 of the same linear barcode, thus changing the value represented by the portion of the linear barcode. The change may be made using the same technique as the one used to affix the original barcode. For example, the barcode may be printed using visual ink and the modification may be made using the same. In other examples, the modification may be made using a different technique. For example, the added line 228 may be printed using thermochromic or photochromic ink. Thus, the modification may be visible only if the barcode is heated or subjected to a specific wavelength of light.

[0022] Diagram 200C shows a second example modification, where a transparent or semi-transparent second visual code 234 may be superimposed over the original physical visual code (linear barcode 232). The second visual code 232 may be placed over a portion of the original physical visual code that includes data or other information. The second visual code 234 may be any type of visual code. Diagram 200C shows a simple code, where the color or darkness (or

simply the presence) of the code may represent the information that the transaction has been performed. In other examples, the second visual code may be a more complex code (e.g., a QR-code) and contain more complex information. As with the content modification of the code in FIG. 2A, the second visual code may be affixed using the same technique or a different technique. For example, the second visual code 234 may be printed using thermochromic or photochromic ink. Thus, the second visual code 234 may be visible only if the barcode is heated or subjected to a specific wavelength of light.

[0023] Diagram 200D of FIG. 2D shows a variation of the scheme in FIG. 2C. One or more second visual codes 238 may be added in a vicinity or in a quiet area of the original physical visual code (linear barcode 236). In the shown example, the number of the dots may represent information associated with the performance of the transaction. For example, the linear barcode may represent information associated with a person and an amount of funds in their account. Upon purchasing an item (e.g., a beverage), the barcode may be modified to reflect the funds spent (or number of beverages that can still be purchased). The original barcode and the modifications may be printed on a beverage container, a bracelet for the person, a card, etc. Thus, the person may perform one or more beverage purchasing transactions, and a system to keep track of those transactions may simply include an image capture device to read the barcode and a printhead to print the modifications. No network connections, backend servers, etc. may be needed to manage the transactions.

[0024] FIG. 2E includes an illustration of a structure of a two-dimensional barcode (QR-code), in accordance with at least some embodiments described herein.

[0025] Diagram 200E shows the structure of a two-dimensional barcode to provide context for the changes discussed herein. The two-dimensional barcode may include a quiet zone 240 around the perimeter for ease of machine-reading. Several position and/or alignment symbols 244 may allow machine-reading even if the code is rotated or tilted. Version information 241 may be encoded to identify the version of the standard with which the code is compliant. Format information 242 may provide specific formatting details about the code. Timing symbols 243 may be included for machine-reading purposes. Data may be encoded in individual data fields 246 (DXX), where a pattern of dark and light squares may reflect bit values. Similarly, a pattern of dark and light squares may reflect bit values for error correction information encoded in the error data fields 248 (EXX).

[0026] FIG. 2F and 2G include illustrations of example modifications on the two-dimensional barcode of FIG. 2E, in accordance with at least some embodiments described herein.

[0027] In diagram 200F, a specific data field 254 of a two-dimensional barcode 252 is shown with an example pattern of dark and light squares reflecting a specific bit value. Upon confirmation of performance of the transaction, the pattern may be modified as shown in data field 258 of two-dimensional barcode 256 reflecting a different bit value. The change may be made using the same technique as the one used to affix the original two-dimensional barcode. For example, the two-dimensional barcode may be printed using visual ink and the modification may be made using the same. In other examples, the modification may be made using a different technique. For example, the new square pattern may be printed using thermochromic or photochromic ink. Thus, the modification may be visible only if the two-dimensional barcode is heated or subjected to a specific wavelength of light.

[0028] Diagram 200G shows two other example modifications similar to those shown in FIG. 2C and 2D, where a transparent or semi-transparent second visual code 264 may be superimposed over the original physical visual code (two-dimensional barcode 262). Alternatively, one or more second visual codes 268 may be added in a vicinity or in a quiet area of the original physical visual code (two-dimensional barcode 266), where the number, shape, and/or content of the dots may represent information associated with the performance of the transaction.

[0029] The second visual code(s) may be affixed using the same technique used for the two-dimensional barcode or a different technique. For example, the second visual code 264 or 268 may be printed using thermochromic or photochromic ink. Thus, the second visual code 264 or 268 may be visible only if the barcode is heated or subjected to a specific wavelength of light.

[0030] FIG. 3A includes a conceptual illustration of modules involved in modification of a visual code, for example, a linear barcode, in accordance with at least some embodiments described herein.

[0031] As shown in diagram 300A, a physical visual code (e.g., a barcode) may be affixed on an item 302 associated with the transaction, a wearable item, a card, a packaging, or a container. The visual code may also be affixed to a person's body (e.g., temporary tattoo on an arm), a document, a physical device, etc. To extract the information encoded in the physical

visual code, an image capture device 306 may capture 304 a visual image, an infrared image, and/or an ultraviolet image of the physical visual code, as well as, capture a laser scan. Thus, the image capture device 306 may include a still-image camera, a video camera, a scanner, a handheld scanner, and similar devices.

[0032] An output device 308 may be used to print, paint, stamp, imprint, engrave, emboss, etch, or otherwise affix the physical visual code and/or any modifications. The output device 308 may be a printer, a printhead, a paint sprayer, a stamper, an imprint device, an engraver, an embosser, an etcher, or similar devices. A system according to embodiments may also include an optional light or heat source 310. In case of photochromic or thermochromic ink modifications, the light source or the heat source may be used to render the modifications visible.

[0033] FIG. 3B includes a conceptual illustration of medium iteration in capturing and modification of encoded information in a physical visual code, in accordance with at least some embodiments described herein.

[0034] Depending on an implementation, components of a visual code based transaction management system may be configured and installed to operate individually or integrated into a self-contained module. For example, for food, electronic, or chemical industry applications, the system may be configured as an easily-cleanable module that complies with relevant standards. Through the capability of using printing, painting, stamping, imprinting, engraving, embossing, etching, or similar methods to affix the visual code(s), the system may allow use of the described technologies on curved or planar surfaces, wet or otherwise irregular surfaces, and under different environmental conditions (e.g., lighting, temperature, humidity, dust content, etc.). The visual code(s) and modifications may be affixed on plastic, metal, wood, paper, and other types of materials with soft or hard surfaces, including tattooing on human (or animal) skin. In some examples, the visual code(s) and modifications may be printed or otherwise affixed on a sticker or tag and the sticker or tag attached to an item (or person).

[0035] A system according to embodiments may be configured to operate under varying lighting conditions, be resistant to spillages or other dirty conditions, and may also be abuse resistant (e.g., impact, scratch, or other environmental effects). Depending on application, one or more of the components may be configured as a movable part to allow for reading of the physical visual code or printing of the code in an unstable environment (i.e., where the item is moving).

[0036] Diagram 300B shows components of an example visual code based transaction management system in different configurations. The specific example scenario is for a beverage container (e.g., cup) with the visual code printed at a bottom surface. In configuration 312, the medium 326 for the physical visual code is the bottom surface of the cup, which may be paper, plastic, metal, or comparable materials. Camera 324 may be positioned below the cup to capture a full view of the bottom surface. A printhead 322 may be positioned below the cup near the rim in an idle position. As shown in configuration 314, the printhead 322 may be moved toward the center of the bottom surface during a linear print process. To print the visual code or modifications to the visual code, the printhead 322 may be moved back-and-forth across the bottom surface. Configuration 316 shows a circular print process, where the printhead 322 may be moved in a circular motion around the cup (below the bottom surface) to print a circular visual code or modifications thereof.

[0037] FIG. 3C includes a conceptual illustration of capture and modification of encoded information in a physical visual code in a beverage purchase transaction scenario, in accordance with at least some embodiments described herein.

[0038] Diagram 300C shows positions of the components in one example configuration from different views. Bottom view 332 shows printhead 322 positioned near the rim of the cup at the bottom surface (idle position) and the camera 324 is positioned substantially centered below the bottom surface (medium 326). Side view 334 shows the printhead 322 below the bottom surface and the camera 324 below the cup bottom surface with a field of view to capture the visual code on the bottom surface. A distance of the camera to the bottom surface (and/or a position relative to a center of the bottom surface) may be selected based on the type of visual code, a resolution of the visual code, and/or an environment in which the code is to be read (e.g., lighting).

[0039] FIG. 3D includes a conceptual illustration of capture and modification of encoded information in a physical visual code in another beverage purchase transaction scenario, in accordance with at least some embodiments described herein.

[0040] Diagram 300D shows positions of the components in another example configuration from different views. In the example configuration, the visual code may be printed on a side surface of the cup (medium 346). As shown in side view 342, camera 324 and printhead 322 may be positioned on a side of the cup (e.g., near the bottom). Bottom view 344 shows printhead 322

and camera 324 positioned side-by-side along a side surface of the cup (medium 346). A distance and position of the camera and printhead to the side surface may be selected based on the type of visual code, a resolution of the visual code, and/or an environment in which the code is to be read (e.g., lighting).

[0041] FIG. 3E includes a conceptual illustration of capture and modification of encoded information in a physical visual code in yet another beverage purchase transaction scenario with cup position re-iteration, in accordance with at least some embodiments described herein.

[0042] In some implementations, the item to which the physical visual code is affixed to may not be accessible in a single position. For example, as shown in diagram 300E, the medium may be a beverage cup, which may be placed in a defined area, but in different positions 356. Thus, as shown in side view 352, camera 324 may be positioned with a wider field of view 332 to capture the visual code printed on a bottom surface of the cup. The printhead 322 may be movable across the bottom surface of the cup 346 to print any modifications over the visual code. The side view 352 also shows a beverage dispenser 350.

[0043] Bottom view 354 shows how an iteration process may be used to focus on the medium 346 (bottom surface of the cup). In some examples, upon reading the visual code at the bottom surface of a cup in any one of the possible positions, the system may move the cup to a center position, for example, through a moving surface 358. Alternatively, a motion range of the printhead 322 may be determined based on the camera's reading of the visual code and determination of the cup position.

[0044] FIG. 4 includes an illustration of two example configurations of a multi-layered modifiable physical visual code, in accordance with at least some embodiments described herein.

[0045] As discussed previously, modifiable physical visual codes according to some embodiments may be planarly arranged. Visual code 402 shown in diagram 400 is an example modifiable physical visual code structure, which includes a user data layer 412 at its center. User data layer 412 may include encoded information about a person or item, for example, account information, identification information, and any other information that may be relevant for the transaction(s) associated with the person or item. User data layer 412 may also include symbols or shapes for machine-reading purposes (alignment, positioning markers), error-correction information, and/or one or more visual security keys for security purposes. A buffer layer 414

may surround the user data layer 412 and include additional information and/or quiet zones, where secondary visual codes may be added as discussed herein.

[0046] Further layers in the visual code 402 may include, but are not limited to, a pre-printed security layer 416 containing security information, transaction layer 418 containing information associated with the transaction(s), and iteration layer 420, where iteration information may be encoded. For example, multiple transactions may be performed and performance of each one recorded by modifying a portion of the iteration layer 420. Visual key layer 422 may include further security information such as a ciphered security key.

[0047] Visual code 402 may be scalable, that is, the code may be reduced or enlarged in size by modifying size of its contents (symbols, shapes, etc.). Visual code 402 may be composed of symbols, shapes (e.g., bars, squares, dots), and variations of black and white, gray scale colors, different colors, or combinations thereof. Visual code 402 represents a linear structure, where the different layers (with the exception of buffer layer, which may be excluded) are arranged linearly on a plane.

[0048] Visual code 404 has a similar structure to the visual code 402, where the buffer layer 414, pre-printed security layer 416, transaction layer 418, iteration layer 420, and the visual key layer 422 are arranged to surround the user data layer 422 and each other. A size (i.e., width) of each layer may be selected based on a scale and/or a content of the visual code. While visual code 404 is shown in circular form, other forms such as square, rectangular, hexagonal, and comparable ones may also be used. Similarly, visual code 402 may be arranged in any suitable form.

[0049] FIG. 5 illustrates major components of an example system for modification of physical visual codes, in accordance with at least some embodiments described herein.

[0050] As shown in diagram 500, a visual code management system 522 may be controlled locally via a controller 524 and/or via a remote controller 540. The remote controller 540 may be communicatively coupled to a data store 560, where information associated with a visual code, associated transaction(s), etc. may be stored. The remote controller 540 may communicate with the controller 524 through a system controller 520 over one or more networks 510. The controllers may communicate via a wired network, a direct-wired connection, or a wireless network such as acoustic, radio frequency (RF), microwave, infrared (IR) network, etc. The visual code management system 522 may optionally include a display 526 (e.g., to show

progress of visual code reading, modification, transaction information, etc.), an input device (a keyboard, etc.), and other suitable accessory devices.

[0051] Controller 524 may communicate with and control operations of an image capture device 532, an output device 534, and an optional heat source or light source 536. The image capture device 532 may include a still-image camera, a video camera, a scanner, a handheld scanner, and similar devices, and may be used to capture a visual image, an infrared image, and/or an ultraviolet image of the physical visual code, as well as, to capture a laser scan. The output device 534 may include a printer, a printhead, a paint sprayer, a stamper, an imprint device, an engraver, an embosser, an etcher, or similar devices, and may be used to print, paint, stamp, imprint, engrave, emboss, etch, or otherwise affix the physical visual code and/or any modifications. In cases, where thermochromic or photochromic ink is used to modify a physical visual code, the optional heat or light source 536 may be used to expose a modified physical visual code to heat or light of a specific wavelength in order to see the modification.

[0052] In one example scenario, a beverage dispensing system may dispense beverage containers, for example, cups with a QR-code printed on a side or at the bottom. The QR-code may include information identifying a customer and funds available in the customer's account to purchase beverages. When the customer fills the cup with beverage at the same or another system, a camera may read the QR-code and determine that the transaction is subtraction of the dispensed beverage's value from the customer's account. A processor of the system may then determine how to change the QR-code based on the transaction. For example, the change may be modifying a data field using black ink to represent bit "1" instead of bit "0", or a bit value may be printed on an empty data field using a photochromic (e.g., ultraviolet "UV"-sensitive ink). Next time the customer takes the cup to the same dispensing system or a different dispensing system, the camera may read the QR-code again. In case of the modification with the photochromic ink, a UV light source may shine UV light on the code for the camera to be able to read the modification. Based on the modification, the processor of the system may determine that one beverage has already been dispensed and allow dispensing of another beverage (or not) based on remaining funds in the customer's account. To perform the described operations, the dispensing system may not need to be connected to any network. All operations may be performed locally.

[0053] In another example scenario, workstations on a production line may be equipped with visual code processing systems that include a scanner, an etcher, and a processor. The production line may be used for manufacturing a metal-enclosure device. At the first workstation, a metal tag may be etched with a linear barcode identifying the metal-enclosure device to be manufactured. At each workstation thereafter, the camera may scan the etched barcode. Upon confirming performance of the work for each particular workstation, the etcher may modify the code by etching over one of the data characters (e.g., change a wide space to a narrow line and narrow space) or by adding a smaller linear barcode under or over the original barcode. This way, the metal-enclosure device may be manufactured by confirming at each workstation that prior manufacturing steps have been performed. The visual code processing systems may each be self-contained modules without a need for network connection. The advantage of such a system is its efficiency in confirming individual transactions, as well as, its flexibility. Because no network connection or backend servers are needed, the system may be modified with minimal effort. For example, individual visual code processing systems may be moved around, removed, or added without any structural changes.

[0054] FIG. 6 illustrates a computing device, which may be used to manage a system utilizing modification of physical visual codes, arranged in accordance with at least some embodiments described herein.

[0055] In an example basic configuration 602, the computing device 600 may include one or more processors 604 and a system memory 606. A memory bus 608 may be used to communicate between the processor 604 and the system memory 606. The basic configuration 602 is illustrated in FIG. 6 by those components within the inner dashed line.

[0056] Depending on the desired configuration, the processor 604 may be of any type, including but not limited to a microprocessor (μP), a microcontroller (μC), a digital signal processor (DSP), or any combination thereof. The processor 604 may include one or more levels of caching, such as a cache memory 612, a processor core 614, and registers 616. The example processor core 614 may include an arithmetic logic unit (ALU), a floating point unit (FPU), a digital signal processing core (DSP core), or any combination thereof. An example memory controller 618 may also be used with the processor 604, or in some implementations, the memory controller 618 may be an internal part of the processor 604.

[0057] Depending on the desired configuration, the system memory 606 may be of any type including but not limited to volatile memory (such as random-access memory "RAM"), non-volatile memory (such as read-only memory "ROM", flash memory, etc.) or any combination thereof. The system memory 606 may include an operating system 620, a visual code management application 622, and program data 624. The visual code management application 622 may include imaging and/or print management modules 626. The visual code management application 622 may be configured to manage a system, where information encoded in a physical visual code may be extracted upon capturing of an image of the code or scanning of the code, a transaction associated with the extracted information may be determined, and a change to the information may be determined based on the transaction, for example, confirmation of the performance of the transaction. The system may then modify the physical visual code based on the determined change. For example, content of the physical visual code may be modified or another (e.g., semi-transparent) visual code may be printed onto the physical visual code. The program data 624 may include transaction data 628, among other data, as described herein.

[0058] The computing device 600 may have additional features or functionality, and additional interfaces to facilitate communications between the basic configuration 602 and any desired devices and interfaces. For example, a bus/interface controller 630 may be used to facilitate communications between the basic configuration 602 and one or more data storage devices 632 via a storage interface bus 634. The data storage devices 632 may be one or more removable storage devices 636, one or more non-removable storage devices 638, or a combination thereof. Examples of the removable storage and the non-removable storage devices include magnetic disk devices such as flexible disk drives and hard-disk drives (HDDs), optical disk drives such as compact disc (CD) drives or digital versatile disk (DVD) drives, solid state drives (SSDs), and tape drives to name a few. Example computer storage media may include volatile and nonvolatile, removable and non-removable media implemented in any method or technology for storage of information, such as computer readable instructions, data structures, program modules, or other data.

[0059] The system memory 606, the removable storage devices 636 and the non-removable storage devices 638 are examples of computer storage media. Computer storage media includes, but is not limited to, RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile disks (DVDs), solid state drives (SSDs), or other optical storage,

magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which may be used to store the desired information and which may be accessed by the computing device 600. Any such computer storage media may be part of the computing device 600.

[0060] The computing device 600 may also include an interface bus 640 for facilitating communication from various interface devices (e.g., one or more output devices 642, one or more peripheral interfaces 650, and one or more communication devices 660) to the basic configuration 602 via the bus/interface controller 630. Some of the example output devices 642 include a graphics processing unit 644 and an audio processing unit 646, which may be configured to communicate to various external devices such as a display or speakers via one or more A/V ports 648. One or more example peripheral interfaces 650 may include a serial interface controller 654 or a parallel interface controller 656, which may be configured to communicate with external devices such as input devices (e.g., keyboard, mouse, pen, voice input device, touch input device, etc.) or other peripheral devices (e.g., printer, scanner, etc.) via one or more I/O ports 658. An example communication device 660 includes a network controller 662, which may be arranged to facilitate communications with one or more other computing devices 666 over a network communication link via one or more communication ports 664. The one or more other computing devices 666 may include servers at a datacenter, customer equipment, and comparable devices.

[0061] The network communication link may be one example of a communication media. Communication media may be embodied by computer readable instructions, data structures, program modules, or other data in a modulated data signal, such as a carrier wave or other transport mechanism, and may include any information delivery media. A "modulated data signal" may be a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation, communication media may include wired media such as a wired network or direct-wired connection, and wireless media such as acoustic, radio frequency (RF), microwave, infrared (IR) and other wireless media. The term computer readable media as used herein may include non-transitory storage media.

[0062] The computing device 600 may be implemented as a part of a specialized server, mainframe, or similar computer that includes any of the above functions. The computing device

600 may also be implemented as a personal computer including both laptop computer and non-laptop computer configurations.

[0063] FIG. 7 is a flow diagram illustrating an example method to manage modification of physical visual codes that may be performed by a computing device such as the computing device in FIG. 6, arranged in accordance with at least some embodiments described herein.

[0064] Example methods may include one or more operations, functions, or actions as illustrated by one or more of blocks 722, 724, 726, 728, and 730 may in some embodiments be performed by a computing device such as the computing device 600 in FIG. 6. Such operations, functions, or actions in FIG. 6 and in the other figures, in some embodiments, may be combined, eliminated, modified, and/or supplemented with other operations, functions or actions, and need not necessarily be performed in the exact sequence as shown. The operations described in the blocks 722-730 may be implemented through execution of computer-executable instructions stored in a computer-readable medium such as a computer-readable medium 720 of a computing device 710.

[0065] An example process to modify physical visual codes may begin with optional block 722, "CAPTURE IMAGE OF PHYSICAL VISUAL CODE", where an image capture device may be used to capture a visual image, an infrared image, and/or an ultraviolet image of a physical visual code, as well as, to capture a laser scan. The physical visual code may include one or more of: a linear barcode, a data matrix code, a QR-code, a circular barcode, a MaxiCode, or a high capacity color barcode.

[0066] Optional block 722 may be followed by block 724, "EXTRACT INFORMATION ENCODED IN THE PHYSICAL VISUAL CODE", where a control device may extract information encoded in the captured visual code. The information may be associated with an item, a person, a transaction, or similar, and may also include error correction information, security information, etc.

[0067] Block 724 may be followed by block 726, "DETERMINE A TRANSACTION FROM THE INFORMATION ENCODED IN THE PHYSICAL VISUAL CODE", where the control device may determine the transaction associated with the physical visual code from the extracted information. The transaction may include a financial transaction, a processing transaction, a dispensing transaction, an authorization transaction, and/or a documentation transaction.

[0068] Block 726 may be followed by block 728, "DETERMINE A CHANGE TO THE INFORMATION ENCODED IN THE PHYSICAL VISUAL CODE", where the controller may determine a change to be made to the physical visual code, that is, a change to the information encoded in the physical visual code. For example, the change may be based on performance of the transaction or another operation associated with the transaction.

[0069] Block 728 may be followed by block 730, "MODIFY THE INFORMATION ENCODED IN THE PHYSICAL VISUAL CODE BASED ON THE DETERMINED CHANGE", where the information encoded in the physical visual code may be modified by modification of content of the physical visual code or addition of a second physical virtual code over the physical visual code. The second physical virtual code may be transparent or semi-transparent. Modification of the content of the physical visual code may be by printing over the physical visual code using a visual ink, a thermochromic ink, and/or a photochromic ink. Modification of the content of the physical visual code or addition of the second physical virtual code over the physical visual code may also be performed through printing, painting, stamping, imprinting, engraving, embossing, and/or etching.

[0070] The operations included in the process of FIG. 7 are for illustration purposes. Modification of physical visual codes may be implemented by similar processes with fewer or additional operations, as well as in different order of operations using the principles described herein. The operations described herein may be executed by one or more processors operated on one or more computing devices, one or more processor cores, and/or specialized processing devices, among other examples.

[0071] FIG. 8 illustrates a block diagram of an example computer program product, arranged in accordance with at least some embodiments described herein.

[0072] In some examples, as shown in FIG. 8, a computer program product 800 may include a signal bearing medium 802 that may also include one or more machine readable instructions 804 that, in response to execution by, for example, a processor may provide the functionality described herein. Thus, for example, referring to the processor 604 in FIG. 6, the visual code management application 622 may perform or control performance of one or more of the tasks shown in FIG. 8 in response to the instructions 804 conveyed to the processor 604 by the signal bearing medium 802 to perform actions associated with the modification of physical visual codes as described herein. Some of those instructions may include, for example, capture

image of physical visual code; extract information encoded in the physical visual code; determine a transaction from the information encoded in the physical visual code; determine a change to the information encoded in the physical visual code; and/or modify the information encoded in the physical visual code based on the determined change, according to some embodiments described herein.

[0073] In some implementations, the signal bearing medium 802 depicted in FIG. 8 may encompass computer-readable medium 806, such as, but not limited to, a hard disk drive (HDD), a solid state drive (SSD), a compact disc (CD), a digital versatile disk (DVD), a digital tape, memory, and comparable non-transitory computer-readable storage media. In some implementations, the signal bearing medium 802 may encompass recordable medium 808, such as, but not limited to, memory, read/write (R/W) CDs, R/W DVDs, etc. In some implementations, the signal bearing medium 802 may encompass communications medium 810, such as, but not limited to, a digital and/or an analog communication medium (e.g., a fiber optic cable, a waveguide, a wired communication link, a wireless communication link, etc.). Thus, for example, the computer program product 800 may be conveyed to one or more modules of the processor 604 by an RF signal bearing medium, where the signal bearing medium 802 is conveyed by the communications medium 810 (e.g., a wireless communications medium conforming with the IEEE 802.11 standard).

[0074] According to some examples, a system to modify physical visual codes is described. The system may include an image capture device configured to capture a physical visual code with information encoded therein. The system may also include a control device configured to extract the information encoded in the physical visual code; determine a transaction from the information encoded in the physical visual code; and determine a change to the information encoded in the physical visual code. The system may further include an output device configured to modify the information encoded in the physical visual code.

[0075] According to other examples, the control device may be further configured to receive confirmation that the transaction has been performed; and instruct the output device to modify the information encoded in the physical visual code. The image capture device may be configured to capture one or more of: a visual image, an infrared image, or an ultraviolet image of the physical visual code. The image capture device may also be configured to capture a laser scan of the physical visual code. The output device may be configured to modify the information

encoded in the physical visual code through one or more of: modification of content of the physical visual code or addition of a second physical virtual code over the physical visual code. The second physical virtual code may be transparent or semi-transparent. The output device may be configured to modify the content of the physical visual code by printing over the physical visual code with one or more of: a visual ink, a thermochromic ink, or a photochromic ink. The output device may be configured to modify the content of the physical visual code or add the second physical virtual code over the physical visual code through one or more of: printing, painting, stamping, imprinting, engraving, embossing, or etching.

[0076] According to further examples, the system may also include a light source configured to provide one or more of visual light, infrared light, or ultraviolet light onto the physical visual code. The system may further include a heat source configured to provide heat energy onto the physical visual. The output device may be configured to modify the information encoded in the physical visual code through modification of a data portion of the physical visual code . The physical visual code may be on an item associated with the transaction, a wearable item, a card, a packaging, or a container. The physical visual code may include one or more of: a linear barcode, a data matrix code, a QR-code, a circular barcode, a MaxiCode, or a high capacity color barcode. The output device may be configured to modify the information encoded in the physical visual code through modification of a symbol in a data portion of the physical visual code by printing over the physical visual code, wherein the modified symbol reflects a modified bit value. The physical visual code may include a first layer of original content, a second layer of security information, a third layer of transaction information, and a fourth layer of iteration information. The first, second, third, and fourth layers may be arranged planarly. The first, second, third, and fourth layers may be arranged linearly or circularly.

[0077] According to other examples a modifiable physical visual code is described. The modifiable physical visual code may include a first layer of content; a second layer of content comprising security information; a third layer of content comprising transaction information; and a fourth layer of content comprising iteration information, where one or more of the first, second, third, and fourth layers include a physical modification to the physical visual code.

[0078] According to some examples, the modification may be associated with a transaction. The modification may be performed upon confirmation of performance of the transaction. The transaction may include one or more of: a financial transaction, a processing transaction, a

dispensing transaction, an authorization transaction, or a documentation transaction. The modification may include modification of content of one or more of the first, second, third, and fourth layers through printing with one or more of a visible ink, photochromic ink, or thermochromic ink. The modification may also include modification of content of one or more of the first, second, third, and fourth layers through one or more of: painting, stamping, imprinting, engraving, embossing, or etching. The modification may include printing over content of one or more of the first, second, third, and fourth layers a second physical visual code. The second physical visual code may be transparent or semi-transparent. The modification may include modification of a data portion of the first layer of the physical visual code . The physical visual code may be on an item associated with the transaction, a wearable item, a card, a packaging, or a container. The physical visual code may include one or more of: a linear barcode, a data matrix code, a QR-code, a circular barcode, a MaxiCode, or a high capacity color barcode.

[0079] According to further examples, a method to modify visual codes is described. The method may include extracting information encoded in a physical visual code; determining a transaction from the information encoded in the physical visual code; determining a change to the information encoded in the physical visual code; and modifying the information encoded in the physical visual code based on the determined change.

[0080] According to other examples, the method may further include receiving confirmation that the transaction has been performed. Extracting the information encoded in the physical visual code may include one or more of: capturing a visual image of the physical visual code; capturing an infrared image of the physical visual code; capturing an ultraviolet image of the physical visual code; or capturing a laser scan of the physical visual code. Modifying the information encoded in the physical visual code may include one or more of: modifying content of the physical visual code or adding a second physical virtual code over the physical visual code, wherein the second physical virtual code is transparent or semi-transparent. Modifying the content of the physical visual code or adding the second physical virtual code over the physical visual code may include employing one or more of: printing, painting, stamping, imprinting, engraving, embossing, or etching. Printing may include one or more of visual ink printing, thermochromic printing, or photochromic printing.

[0081] Modifying the content of the physical visual code may include modifying a data portion of the physical visual code . The physical visual code may include on an item associated

with the transaction, a wearable item, a card, a packaging, or a container. The physical visual code may include one or more of: a linear barcode, a data matrix code, a QR-code, a circular barcode, a MaxiCode, or a high capacity color barcode. Modifying the information encoded in the physical visual code may include modifying a symbol in a data portion of the physical visual code by printing over the physical visual code, where the modified symbol reflects a modified bit value. The transaction may include one or more of: a financial transaction, a processing transaction, a dispensing transaction, an authorization transaction, or a documentation transaction.

[0082] There are various vehicles by which processes and/or systems and/or other technologies described herein may be affected (e.g., hardware, software, and/or firmware), and the preferred vehicle will vary with the context in which the processes and/or systems and/or other technologies are deployed. For example, if an implementer determines that speed and accuracy are paramount, the implementer may opt for mainly hardware and/or firmware vehicle; if flexibility is paramount, the implementer may opt for mainly software implementation; or, yet again alternatively, the implementer may opt for some combination of hardware, software, and/or firmware.

[0083] The foregoing detailed description has set forth various embodiments of the devices and/or processes via the use of block diagrams, flowcharts, and/or examples. Insofar as such block diagrams, flowcharts, and/or examples contain one or more functions and/or operations, each function and/or operation within such block diagrams, flowcharts, or examples may be implemented, individually and/or collectively, by a wide range of hardware, software, firmware, or virtually any combination thereof. In one embodiment, several portions of the subject matter described herein may be implemented via application specific integrated circuits (ASICs), field programmable gate arrays (FPGAs), digital signal processors (DSPs), or other integrated formats. However, t some aspects of the embodiments disclosed herein, in whole or in part, may be equivalently implemented in integrated circuits, as one or more computer programs executing on one or more computers (e.g., as one or more programs executing on one or more computer systems), as one or more programs executing on one or more processors (e.g., as one or more programs executing on one or more microprocessors), as firmware, or as virtually any combination thereof, and that designing the circuitry and/or writing the code for the software and/or firmware are possible in light of this disclosure.

[0084] The present disclosure is not to be limited in terms of the particular embodiments described in this application, which are intended as illustrations of various aspects. Many modifications and variations can be made without departing from its spirit and scope. Functionally equivalent methods and apparatuses within the scope of the disclosure, in addition to those enumerated herein, are possible from the foregoing descriptions. Such modifications and variations are intended to fall within the scope of the appended claims. The present disclosure is to be limited only by the terms of the appended claims, along with the full scope of equivalents to which such claims are entitled. The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting.

[0085] In addition, the mechanisms of the subject matter described herein are capable of being distributed as a program product in a variety of forms, and that an illustrative embodiment of the subject matter described herein applies regardless of the particular type of signal bearing medium used to actually carry out the distribution. Examples of a signal bearing medium include, but are not limited to, the following: a recordable type medium such as a floppy disk, a hard disk drive (HDD), a compact disc (CD), a digital versatile disk (DVD), a digital tape, a computer memory, a solid state drive (SSD), etc.; and a transmission type medium such as a digital and/or an analog communication medium (e.g., a fiber optic cable, a waveguide, a wired communication link, a wireless communication link, etc.).

[0086] It is common within the art to describe devices and/or processes in the fashion set forth herein, and thereafter use engineering practices to integrate such described devices and/or processes into data processing systems. That is, at least a portion of the devices and/or processes described herein may be integrated into a data processing system via a reasonable amount of experimentation. A data processing system may include one or more of a system unit housing, a video display device, a memory such as volatile and non-volatile memory, processors such as microprocessors and digital signal processors, computational entities such as operating systems, drivers, graphical user interfaces, and applications programs, one or more interaction devices, such as a touch pad or screen, and/or control systems including feedback loops and control motors.

[0087] A data processing system may be implemented utilizing any suitable commercially available components, such as those found in data computing/communication and/or network computing/communication systems. The herein described subject matter sometimes illustrates

different components contained within, or connected with, different other components. Such depicted architectures are merely exemplary, and in fact, many other architectures may be implemented which achieve the same functionality. In a conceptual sense, any arrangement of components to achieve the same functionality is effectively "associated" such that the desired functionality is achieved. Hence, any two components herein combined to achieve a particular functionality may be seen as "associated with" each other such that the desired functionality is achieved, irrespective of architectures or intermediate components. Likewise, any two components so associated may also be viewed as being "operably connected", or "operably coupled", to each other to achieve the desired functionality, and any two components capable of being so associated may also be viewed as being "operably couplable", to each other to achieve the desired functionality. Specific examples of operably couplable include but are not limited to physically connectable and/or physically interacting components and/or wirelessly interactable and/or wirelessly interacting components and/or logically interacting and/or logically interactable components.

[0088] With respect to the use of substantially any plural and/or singular terms herein, those having skill in the art can translate from the plural to the singular and/or from the singular to the plural as is appropriate to the context and/or application. The various singular/plural permutations may be expressly set forth herein for sake of clarity.

[0089] In general, terms used herein, and especially in the appended claims (e.g., bodies of the appended claims) are generally intended as “open” terms (e.g., the term “including” should be interpreted as “including but not limited to,” the term “having” should be interpreted as “having at least,” the term “includes” should be interpreted as “includes but is not limited to,” etc.). It will be further understood by those within the art that if a specific number of an introduced claim recitation is intended, such an intent will be explicitly recited in the claim, and in the absence of such recitation, no such intent is present. For example, as an aid to understanding, the following appended claims may contain usage of the introductory phrases "at least one" and "one or more" to introduce claim recitations. However, the use of such phrases should not be construed to imply that the introduction of a claim recitation by the indefinite articles "a" or "an" limits any particular claim containing such introduced claim recitation to embodiments containing only one such recitation, even when the same claim includes the introductory phrases "one or more" or "at least one" and indefinite articles such as "a" or "an"

(e.g., “a” and/or “an” should be interpreted to mean “at least one” or “one or more”); the same holds true for the use of definite articles used to introduce claim recitations. In addition, even if a specific number of an introduced claim recitation is explicitly recited, those skilled in the art will recognize that such recitation should be interpreted to mean at least the recited number (e.g., the bare recitation of "two recitations," without other modifiers, means at least two recitations, or two or more recitations).

[0090] Furthermore, in those instances where a convention analogous to “at least one of A, B, and C, etc.” is used, in general, such a construction is intended in the sense one having skill in the art would understand the convention (e.g., “a system having at least one of A, B, and C” would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). It will be further understood by those within the art that virtually any disjunctive word and/or phrase presenting two or more alternative terms, whether in the description, claims, or drawings, should be understood to contemplate the possibilities of including one of the terms, either of the terms, or both terms. For example, the phrase “A or B” will be understood to include the possibilities of “A” or “B” or “A and B.”

[0091] For any and all purposes, such as in terms of providing a written description, all ranges disclosed herein also encompass any and all possible subranges and combinations of subranges thereof. Any listed range can be easily recognized as sufficiently describing and enabling the same range being broken down into at least equal halves, thirds, quarters, fifths, tenths, etc. As a non-limiting example, each range discussed herein can be readily broken down into a lower third, middle third and upper third, etc. As will also be understood by one skilled in the art all language such as “up to,” “at least,” “greater than,” “less than,” and the like include the number recited and refer to ranges which can be subsequently broken down into subranges as discussed above. Finally, a range includes each individual member. Thus, for example, a group having 1-3 cells refers to groups having 1, 2, or 3 cells. Similarly, a group having 1-5 cells refers to groups having 1, 2, 3, 4, or 5 cells, and so forth.

[0092] While various aspects and embodiments have been disclosed herein, other aspects and embodiments are possible. The various aspects and embodiments disclosed herein are for purposes of illustration and are not intended to be limiting, with the true scope and spirit being indicated by the following claims.

CLAIMS

WHAT IS CLAIMED IS:

1. A system to modify physical visual codes, the system comprising:

an image capture device configured to capture a physical visual code with information encoded therein;

a control device configured to:

extract the information encoded in the physical visual code;

determine a transaction from the information encoded in the physical visual code; and

determine a change to the information encoded in the physical visual code; and

an output device configured to modify the information encoded in the physical visual code.

2. The system of claim 1, wherein the control device is further configured to:

receive confirmation that the transaction has been performed; and

instruct the output device to modify the information encoded in the physical visual code.

3. The system of claim 1, wherein the image capture device is configured to capture one or more of: a visual image, an infrared image, or an ultraviolet image of the physical visual code.

4. The system of claim 1, wherein the image capture device is configured to capture a laser scan of the physical visual code.

5. The system of claim 1, wherein the output device is configured to modify the information encoded in the physical visual code through one or more of: modification of content of the physical visual code or addition of a second physical virtual code over the physical visual code.

6. The system of claim 5, wherein the second physical virtual code is transparent or semi-transparent.

7. The system of claim 5, wherein the output device is configured to modify the content of the physical visual code by printing over the physical visual code with one or more of: a visual ink, a thermochromic ink, or a photochromic ink.

8. The system of claim 5, wherein the output device is configured to modify the content of the physical visual code or add the second physical virtual code over the physical visual code through one or more of: printing, painting, stamping, imprinting, engraving, embossing, or etching.

9. The system of claim 1, further comprising:

a light source configured to provide one or more of visual light, infrared light, or ultraviolet light onto the physical visual code.

10. The system of claim 1, further comprising:

a heat source configured to provide heat energy onto the physical visual.

11. The system of claim 1, wherein the output device is configured to modify the information encoded in the physical visual code through modification of a data portion of the physical visual code .

12. The system of claim 1, wherein the physical visual code is on an item associated with the transaction, a wearable item, a card, a packaging, or a container.

13. The system of claim 1, wherein the physical visual code includes one or more of: a linear barcode, a data matrix code, a QR-code, a circular barcode, a MaxiCode, or a high capacity color barcode.

14. The system of claim 13, wherein the output device is configured to modify the information encoded in the physical visual code through modification of a symbol in a data

portion of the physical visual code by printing over the physical visual code, wherein the modified symbol reflects a modified bit value.

15. The system of claim 1, wherein the physical visual code comprises a first layer of original content, a second layer of security information, a third layer of transaction information, and a fourth layer of iteration information.

16. The system of claim 15, wherein the first, second, third, and fourth layers are arranged planarly.

17. The system of claim 16, wherein the first, second, third, and fourth layers are arranged linearly or circularly.

18. A modifiable physical visual code, comprising:

a first layer of content;

a second layer of content comprising security information;

a third layer of content comprising transaction information; and

a fourth layer of content comprising iteration information, wherein one or more of the first, second, third, and fourth layers include a physical modification to the physical visual code.

19. The modifiable physical visual code of claim 18, wherein the modification is associated with a transaction.

20. The modifiable physical visual code of claim 19, wherein the modification is performed upon confirmation of performance of the transaction.

21. The modifiable physical visual code of claim 19, wherein the transaction includes one or more of: a financial transaction, a processing transaction, a dispensing transaction, an authorization transaction, or a documentation transaction.

22. The modifiable physical visual code of claim 18, wherein the modification comprises modification of content of one or more of the first, second, third, and fourth layers through printing with one or more of a visible ink, photochromic ink, or thermochromic ink.

23. The modifiable physical visual code of claim 18, wherein the modification comprises modification of content of one or more of the first, second, third, and fourth layers through one or more of: painting, stamping, imprinting, engraving, embossing, or etching.

24. The modifiable physical visual code of claim 18, wherein the modification comprises printing over content of one or more of the first, second, third, and fourth layers a second physical visual code.

25. The modifiable physical visual code of claim 24, wherein the second physical visual code is transparent or semi-transparent.

26. The modifiable physical visual code of claim 18, wherein the modification comprises modification of a data portion of the first layer of the physical visual code .

27. The modifiable physical visual code of claim 18, wherein the physical visual code is on an item associated with the transaction, a wearable item, a card, a packaging, or a container.

28. The modifiable physical visual code of claim 18, wherein the physical visual code includes one or more of: a linear barcode, a data matrix code, a QR-code, a circular barcode, a MaxiCode, or a high capacity color barcode.

29. A method to modify visual codes, the method comprising:
extracting information encoded in a physical visual code;
determining a transaction from the information encoded in the physical visual code;
determining a change to the information encoded in the physical visual code; and
modifying the information encoded in the physical visual code based on the determined change.

30. The method of claim 29, further comprising:
receiving confirmation that the transaction has been performed.

31. The method of claim 29, wherein extracting the information encoded in the physical visual code comprises one or more of:
capturing a visual image of the physical visual code;
capturing an infrared image of the physical visual code;
capturing an ultraviolet image of the physical visual code; or
capturing a laser scan of the physical visual code.

32. The method of claim 29, wherein modifying the information encoded in the physical visual code comprises one or more of: modifying content of the physical visual code or adding a second physical virtual code over the physical visual code, wherein the second physical virtual code is transparent or semi-transparent.

33. The method of claim 32, wherein modifying the content of the physical visual code or adding the second physical virtual code over the physical visual code comprises employing one or more of: printing, painting, stamping, imprinting, engraving, embossing, or etching.

34. The method of claim 33, wherein printing comprises:
one or more of visual ink printing, thermochromic printing, or photochromic printing.

35. The method of claim 32, wherein modifying the content of the physical visual code comprises:
modifying a data portion of the physical visual code .

36. The method of claim 29, wherein the physical visual code is on an item associated with the transaction, a wearable item, a card, a packaging, or a container.

37. The method of claim 29, wherein the physical visual code includes one or more of: a linear barcode, a data matrix code, a QR-code, a circular barcode, a MaxiCode, or a high capacity color barcode.

38. The method of claim 37, wherein modifying the information encoded in the physical visual code comprises:

modifying a symbol in a data portion of the physical visual code by printing over the physical visual code, wherein the modified symbol reflects a modified bit value.

39. The method of claim 29, wherein the transaction includes one or more of: a financial transaction, a processing transaction, a dispensing transaction, an authorization transaction, or a documentation transaction.

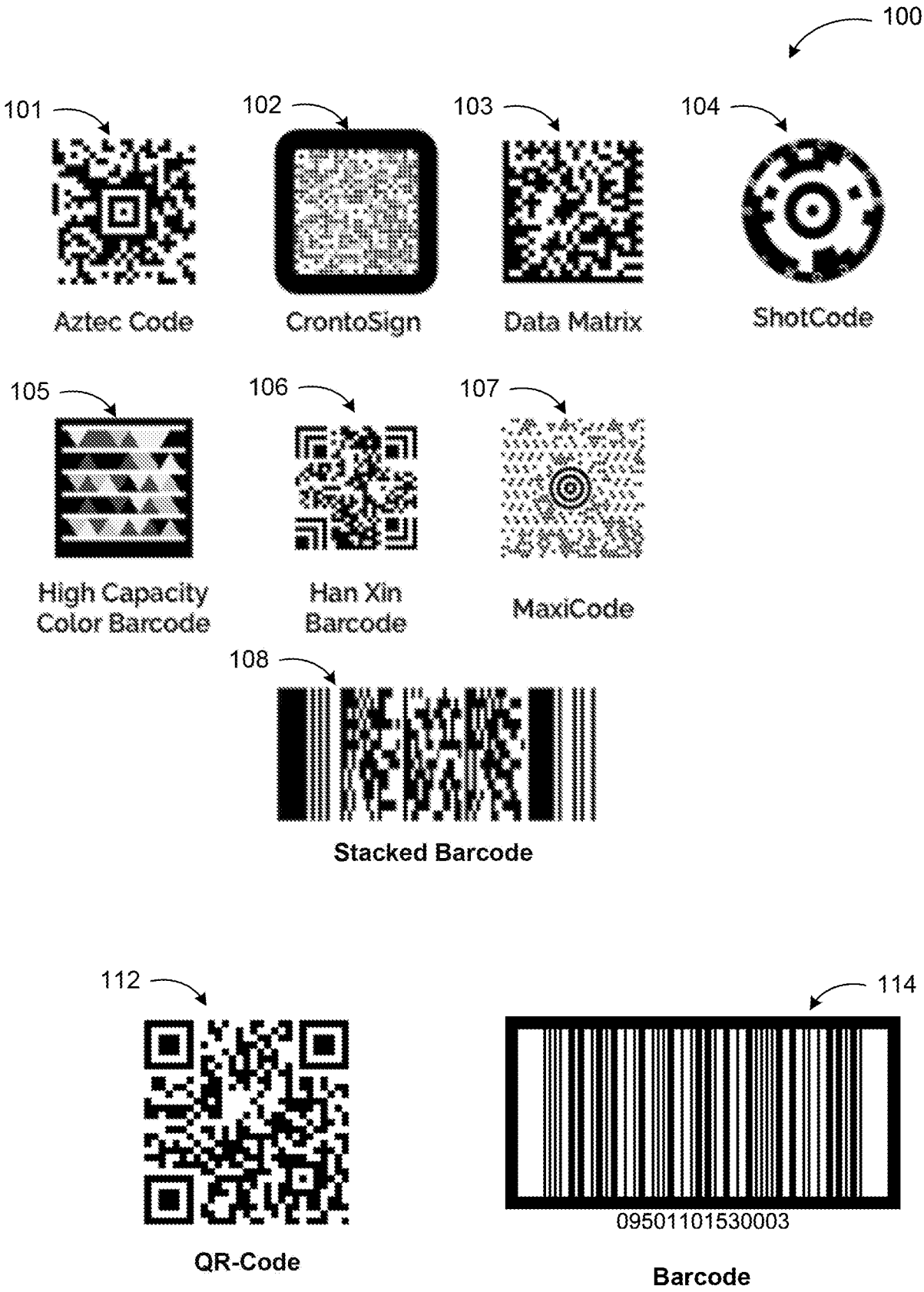

100
101
Aztec Code
102
CrontoSign
103
Data Matrix
104
ShotCode
105
High Capacity Color Barcode
106
Han Xin Barcode
107
MaxiCode
108
Stacked Barcode
112
QR-Code
114
09501101530003
Barcode

FIG. 1

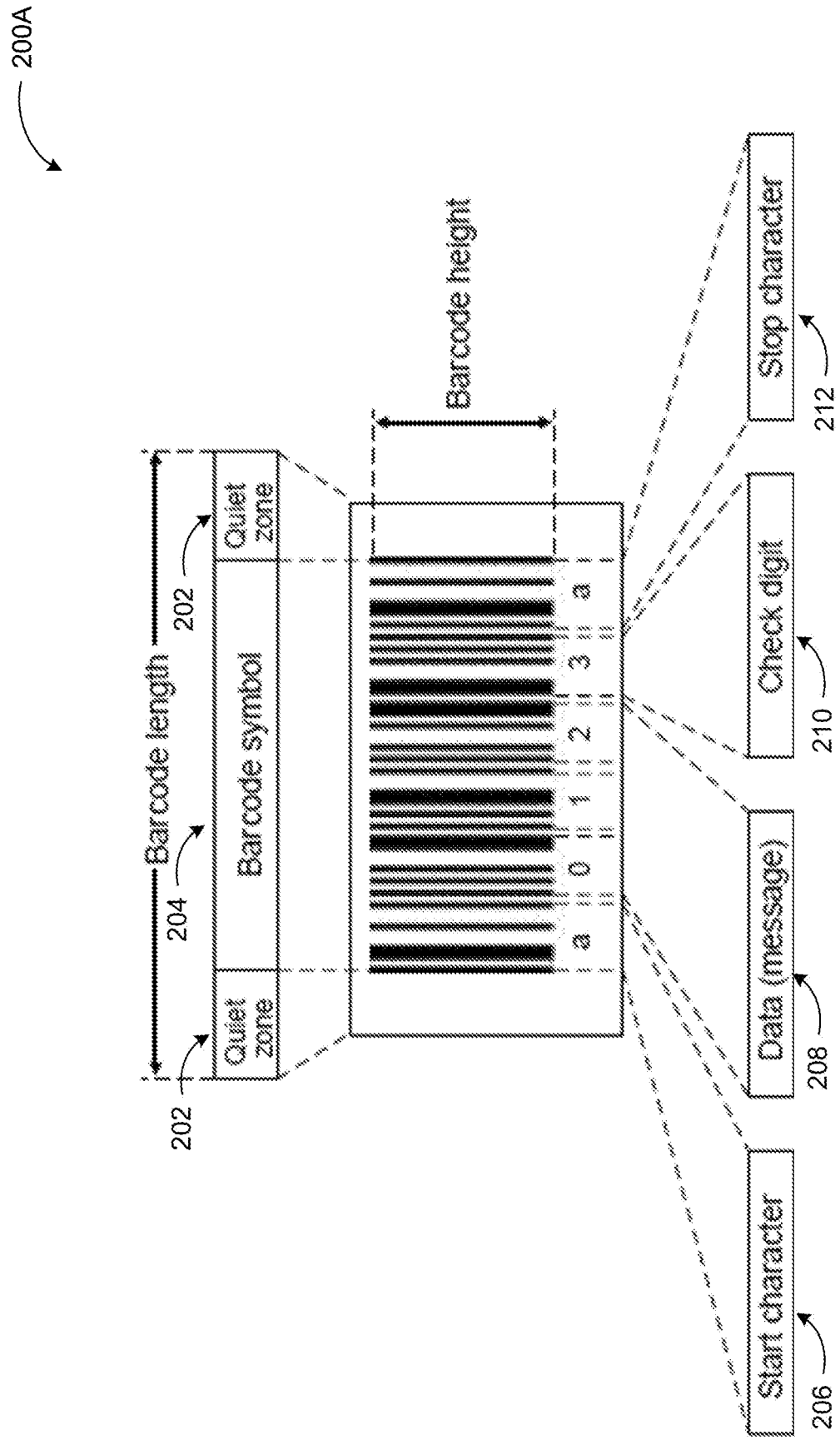

200A
Barcode length
204
Barcode symbol
Quiet zone
Quiet zone
202
202
Barcode height
a 0 1 2 3 a
Stop character
212
Check digit
210
Data (message)
208
Start character
206

FIG. 2A

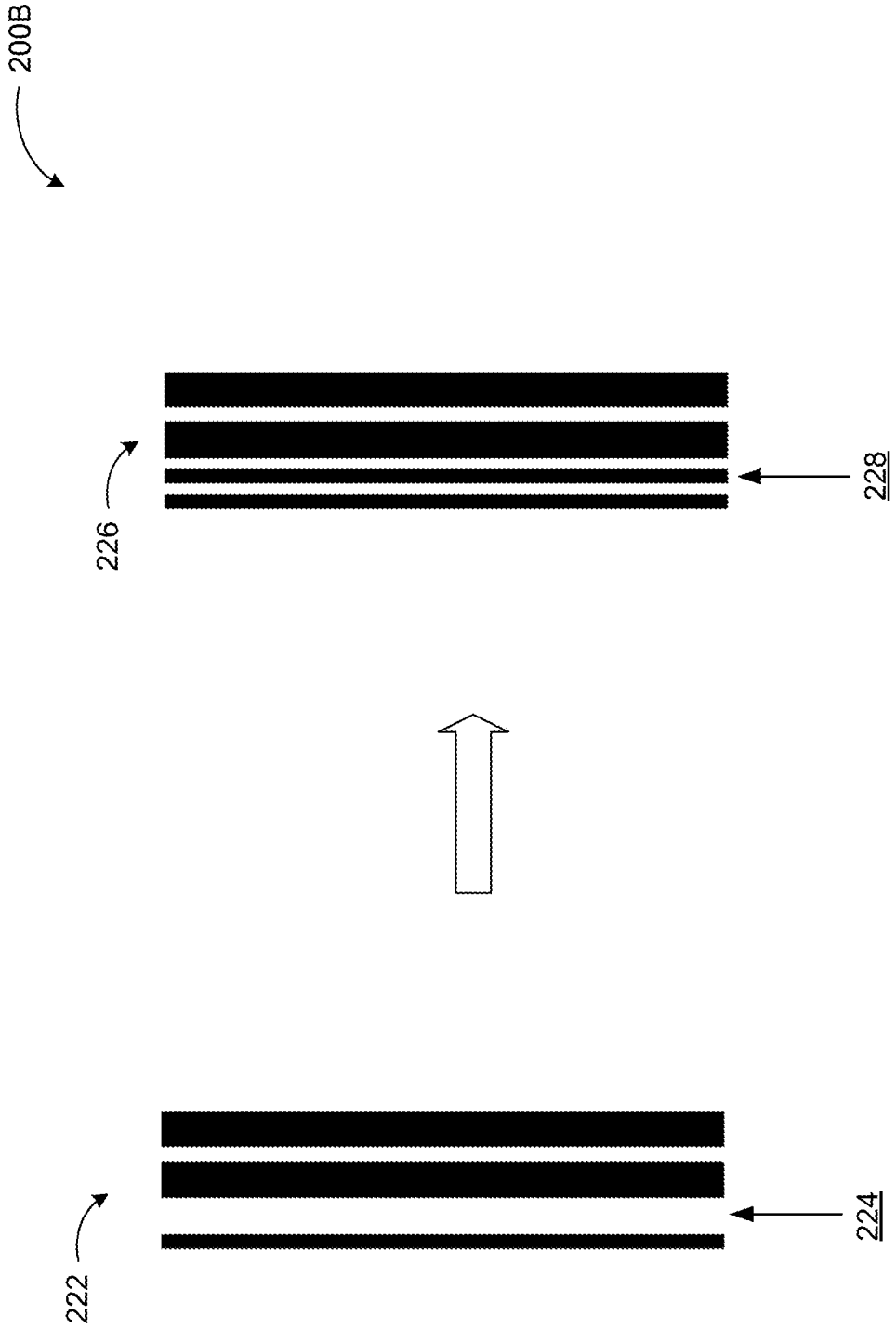


FIG. 2B

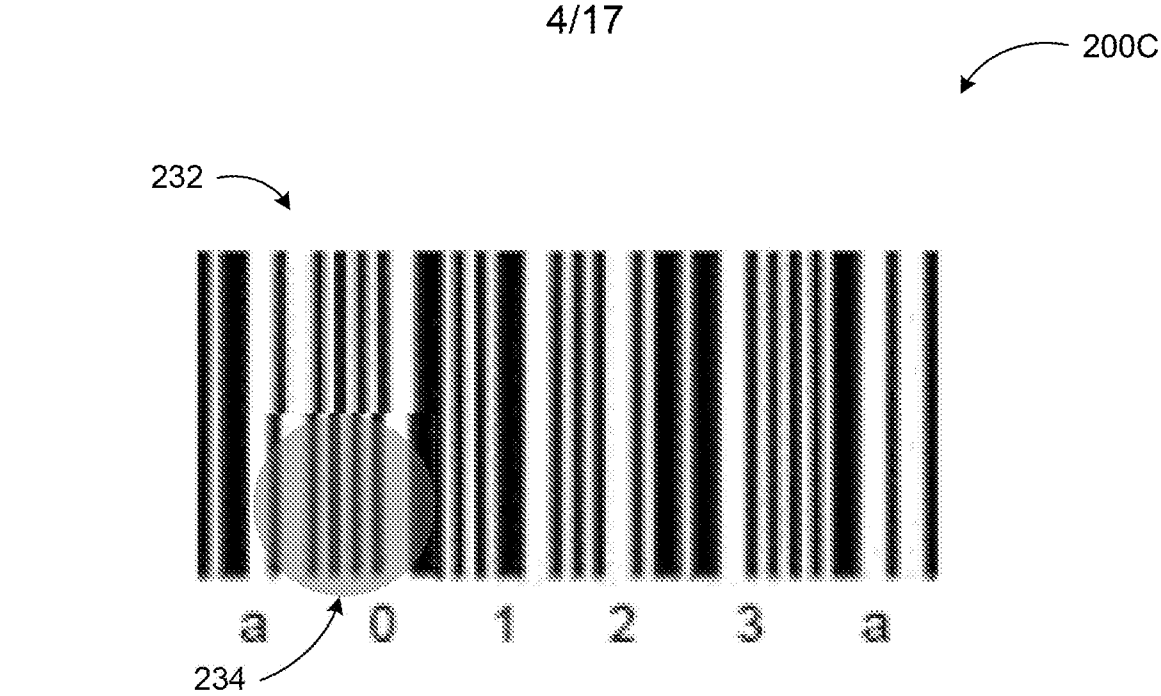


FIG. 2C

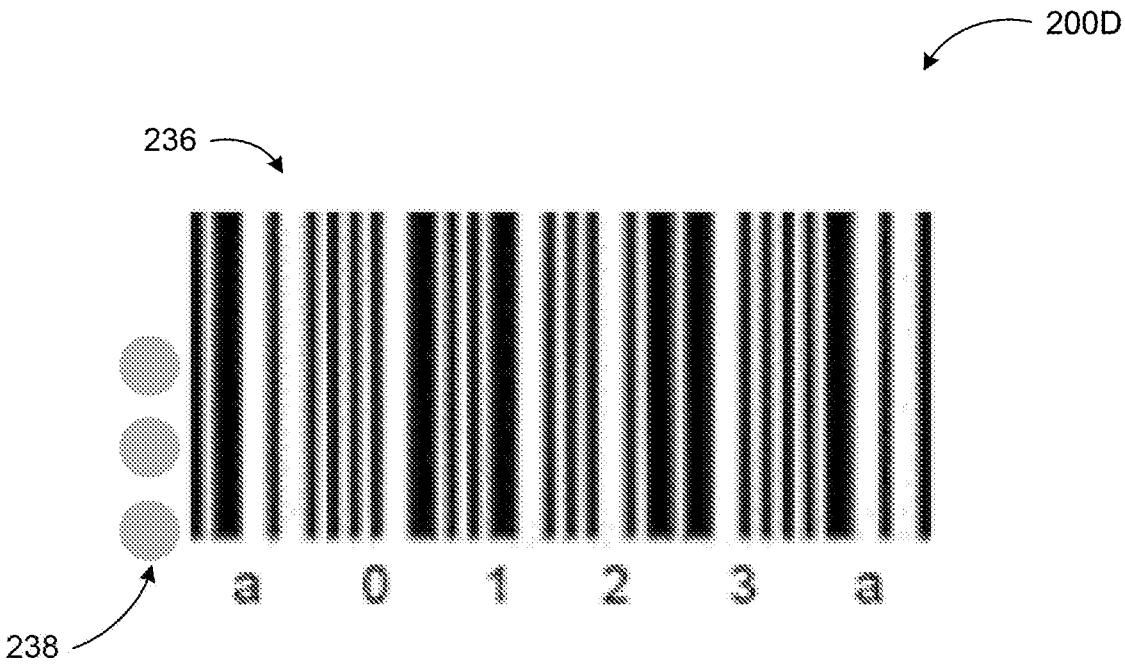


FIG. 2D

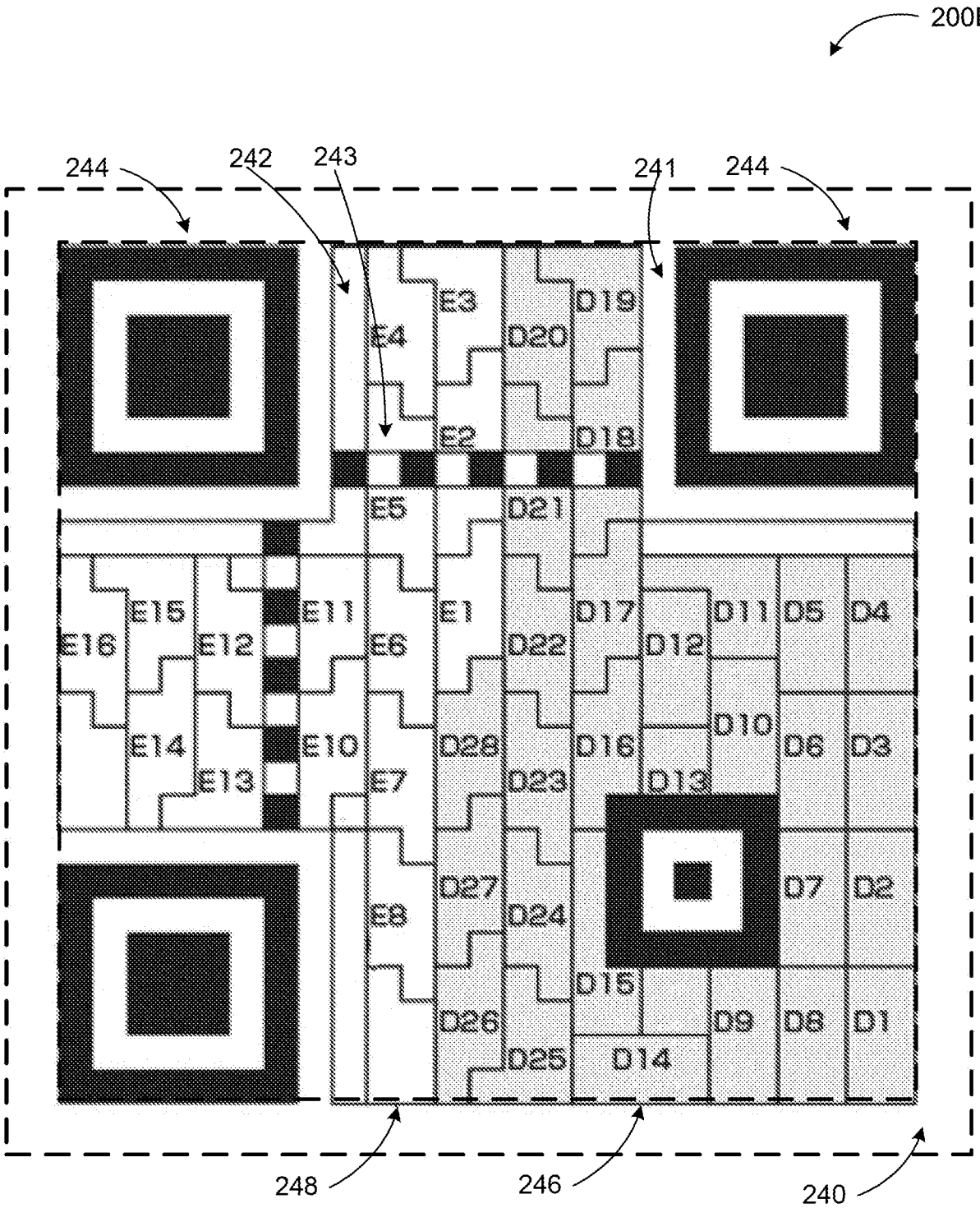

200E
244
242
243
241
244
E3
D19
E4
D20
E2
D19
E5
D21
E15
E11
E1
D17
D11
D5
D4
E16
E12
E6
D22
D12
E14
E10
D28
D16
D10
D6
D3
E13
E7
D23
D13
D27
D7
D2
E8
D24
D15
D26
D9
D8
D1
D25
D14
248
246
240

FIG. 2E

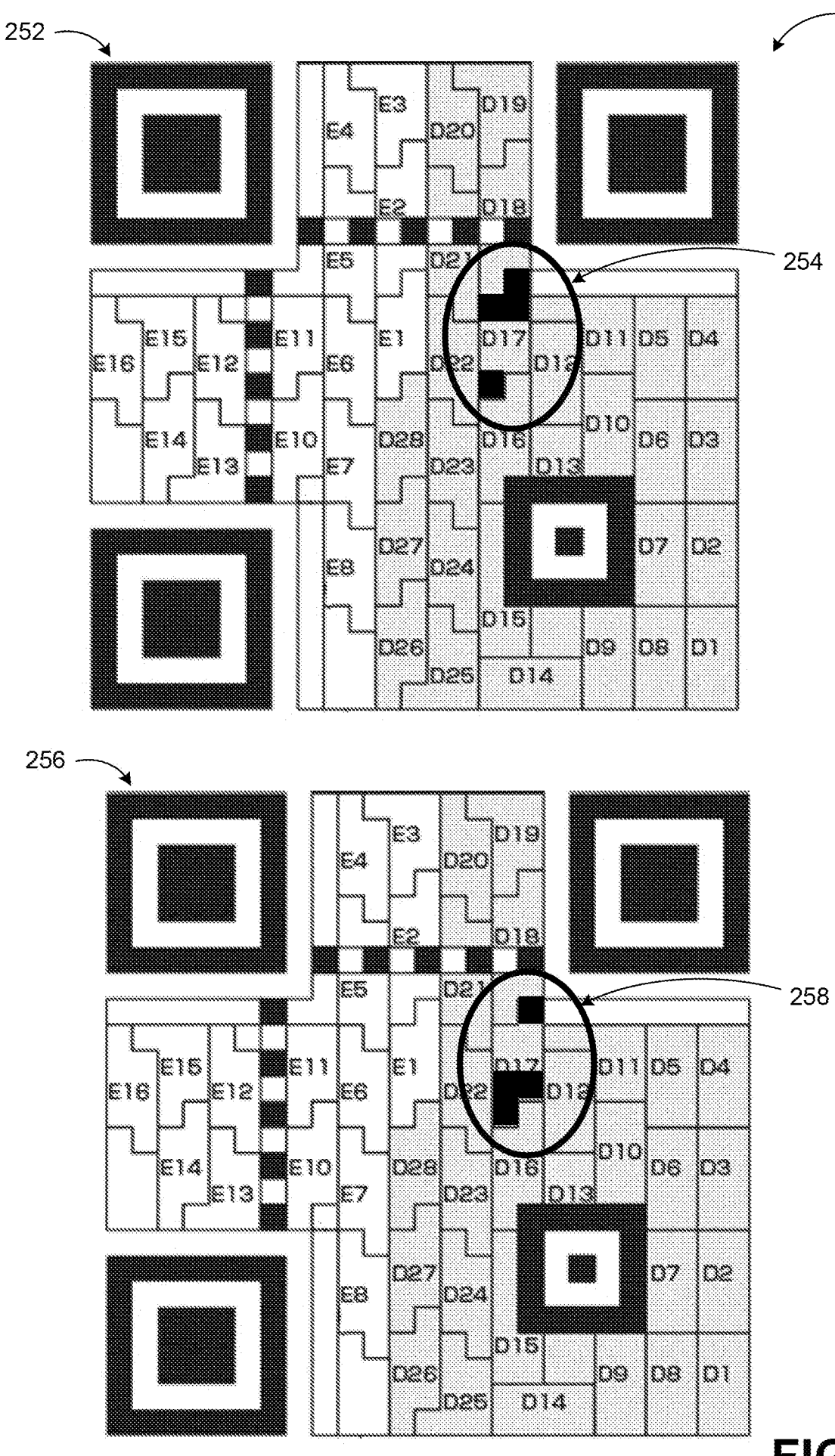

200F
252
254
256
258
E1
E2
E3
E4
E5
E6
E7
E8
E10
E11
E12
E13
E14
E15
E16
D1
D2
D3
D4
D5
D6
D7
D8
D9
D10
D11
D12
D13
D14
D15
D16
D17
D18
D19
D20
D21
D22
D23
D24
D25
D26
D27
D28

FIG. 2F

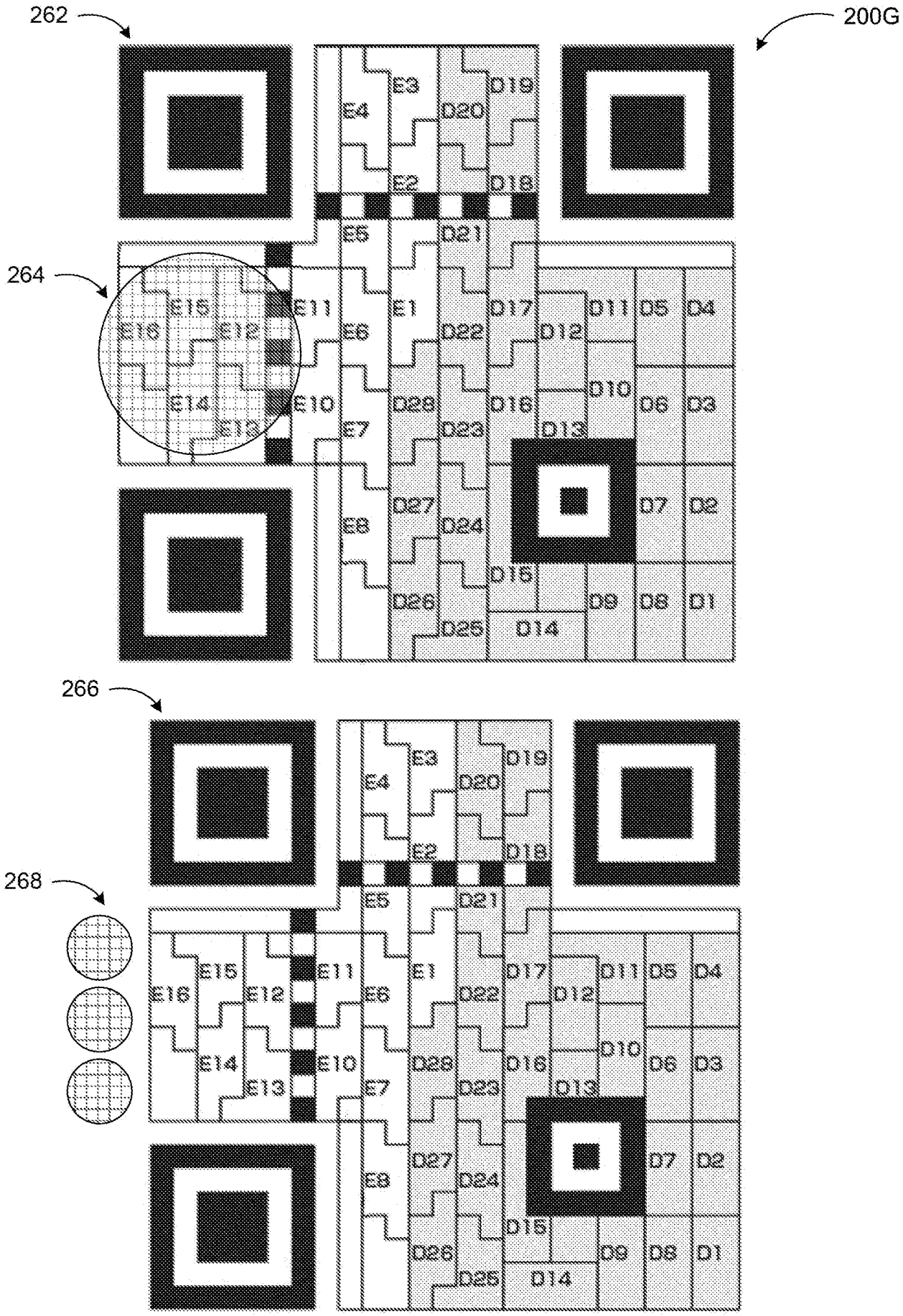

262
200G
264
266
268
E3
D19
E4
D20
E2
D18
E5
D21
E15
E11
E1
D17
D11
D5
D4
E16
E12
E6
D22
D12
E14
E10
D28
D16
D10
D6
D3
E13
E7
D23
D13
D27
D7
D2
E8
D24
D15
D26
D9
D8
D1
D25
D14

FIG. 2G

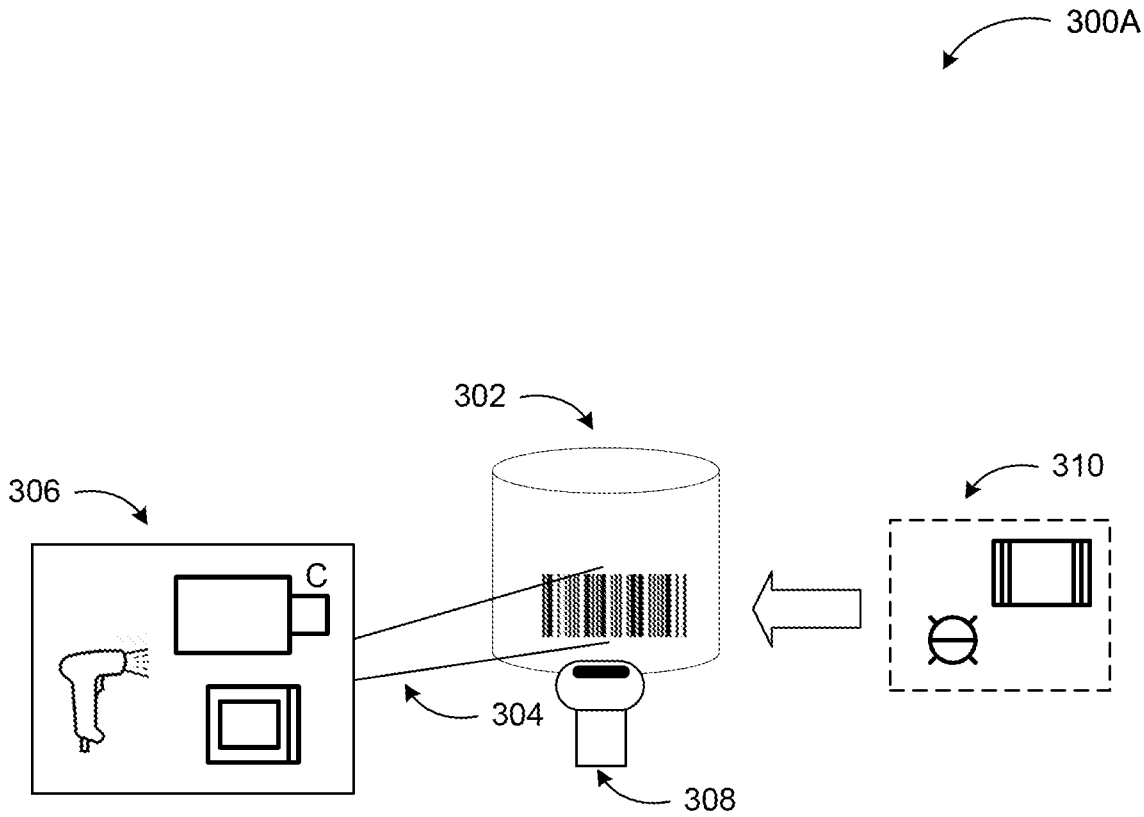


FIG. 3A

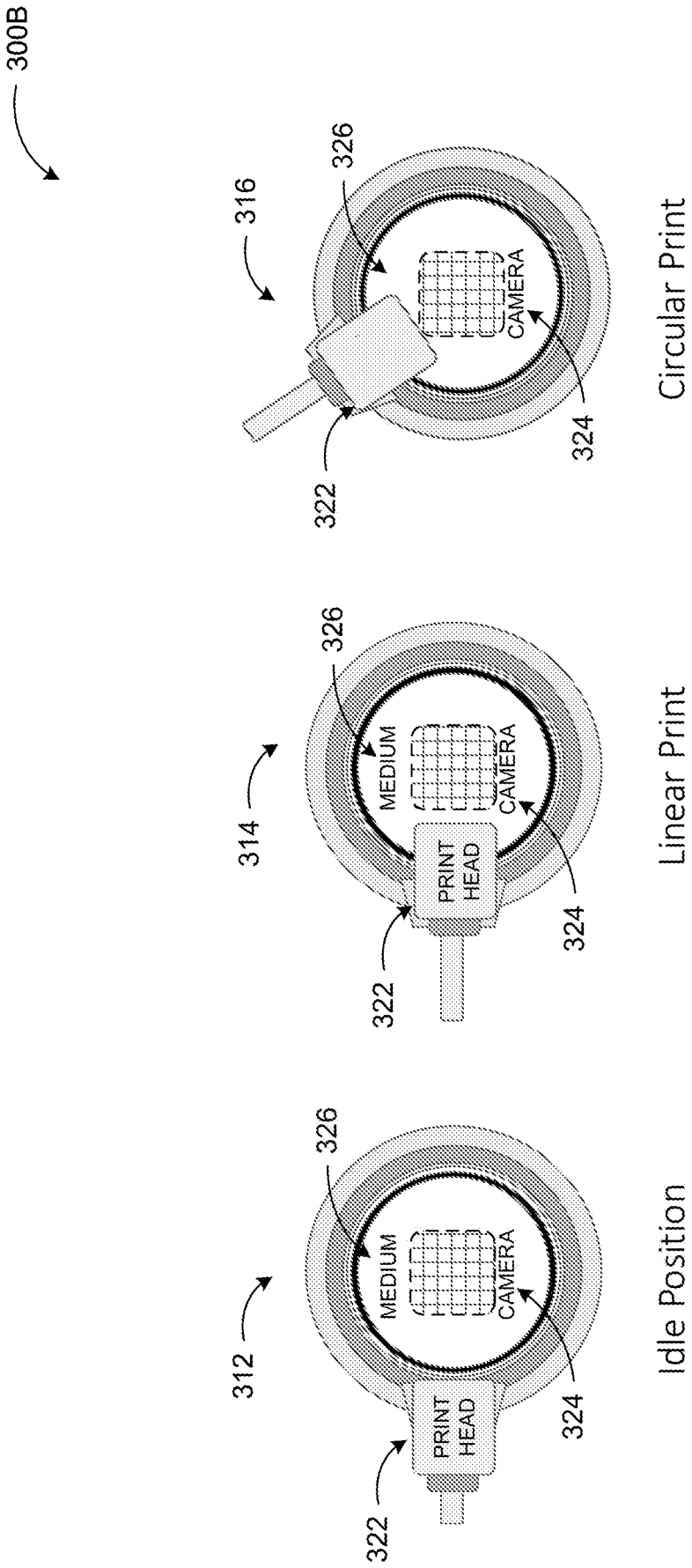

300B
316
326
CAMERA
324
322
Circular Print
314
326
MEDIUM
CAMERA
PRINT HEAD
324
322
Linear Print
312
326
MEDIUM
CAMERA
PRINT HEAD
324
322
Idle Position

FIG. 3B

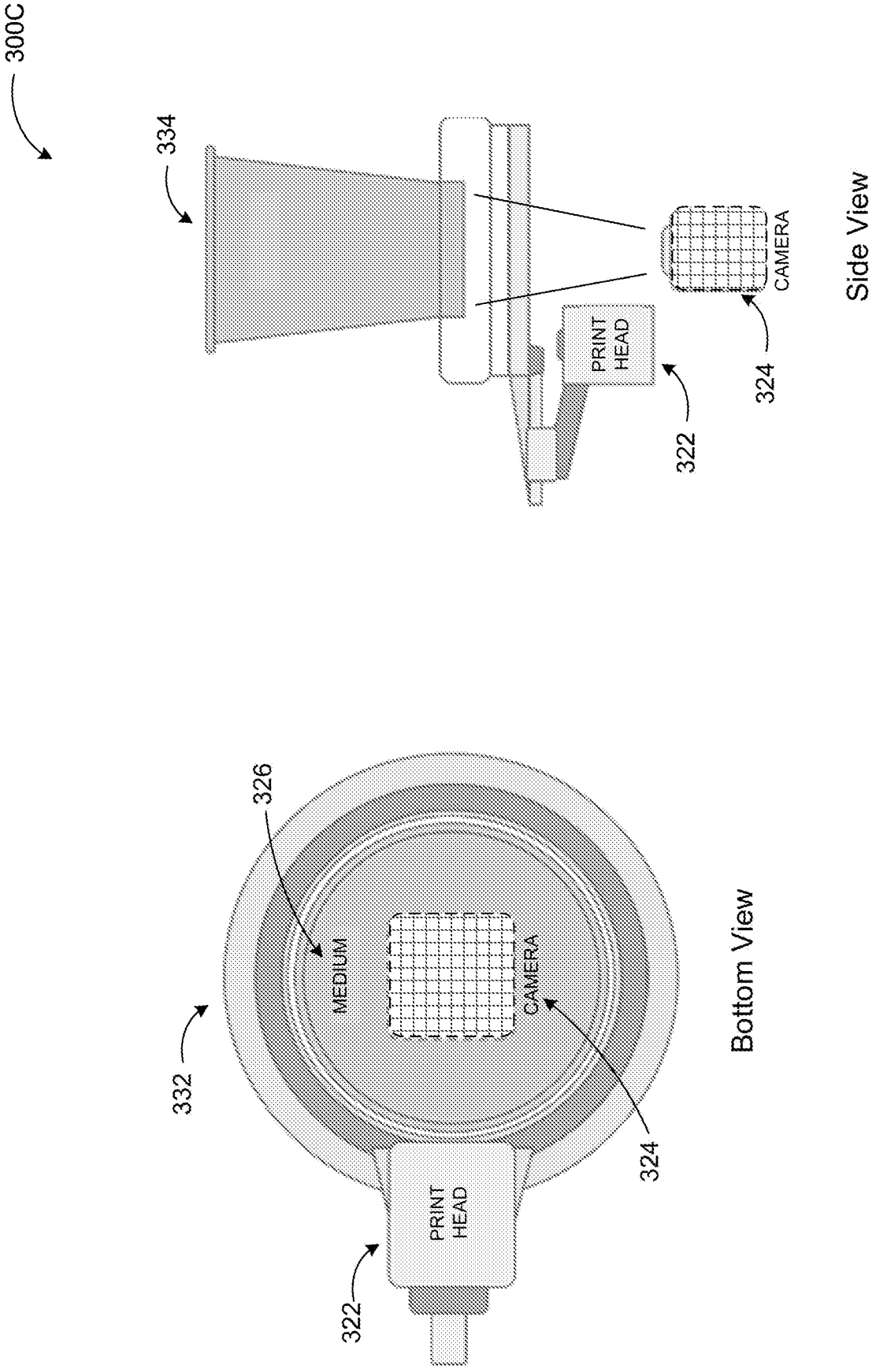

300C
334
PRINT HEAD
CAMERA
322
324
Side View
326
MEDIUM
CAMERA
332
PRINT HEAD
322
324
Bottom View

FIG. 3C

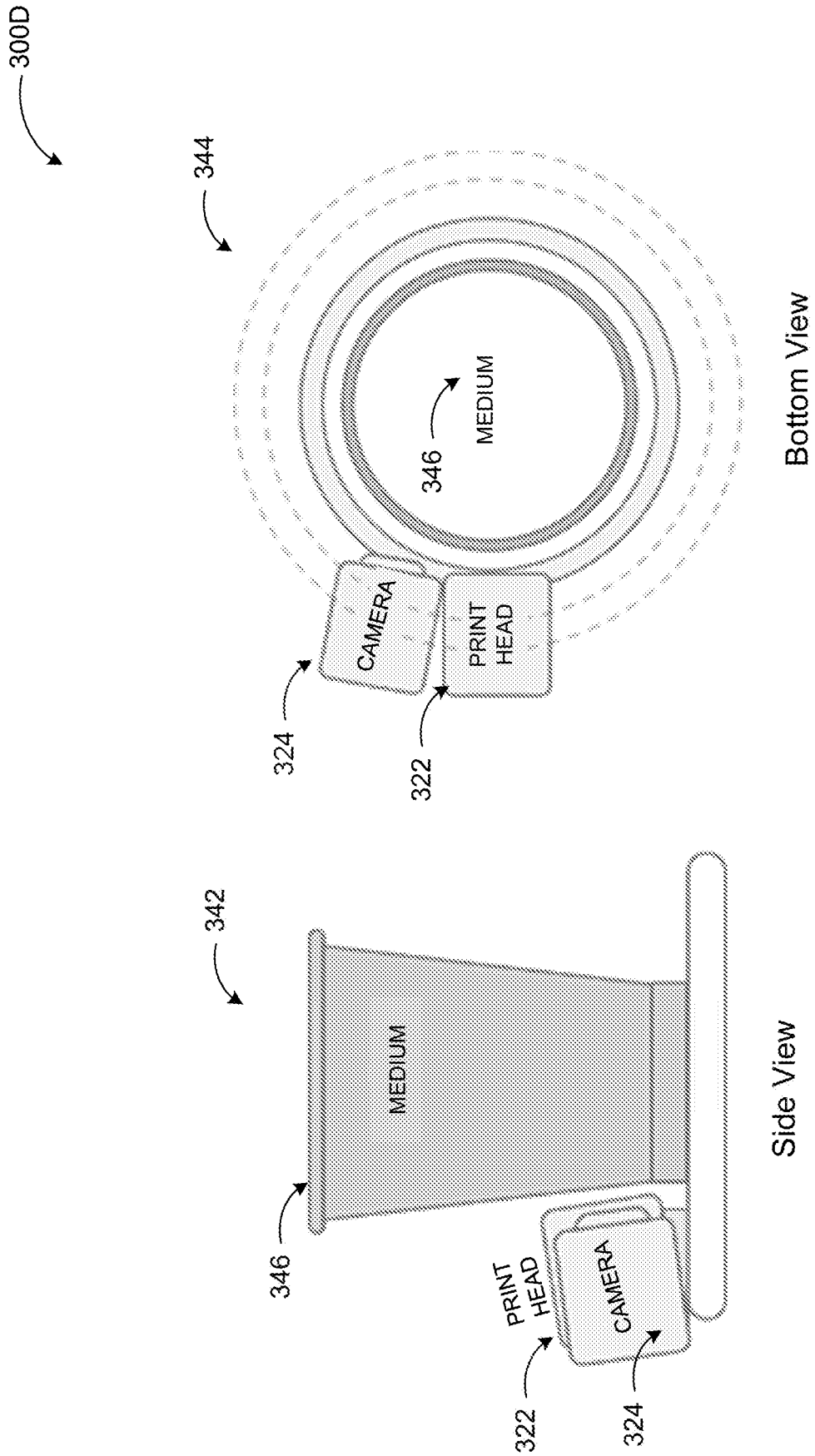
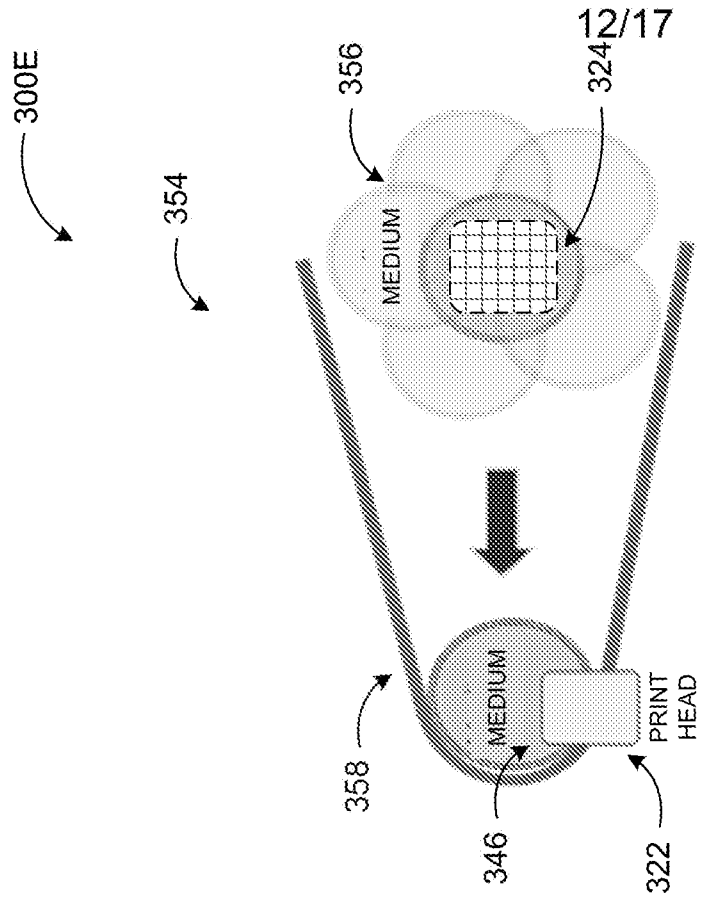

300D
344
346
MEDIUM
Bottom View
CAMERA
PRINT HEAD
324
322
342
MEDIUM
346
PRINT HEAD
CAMERA
322
324
Side View

FIG. 3D


300E
354
356
324
MEDIUM
Bottom View
358
MEDIUM
PRINT HEAD
346
322

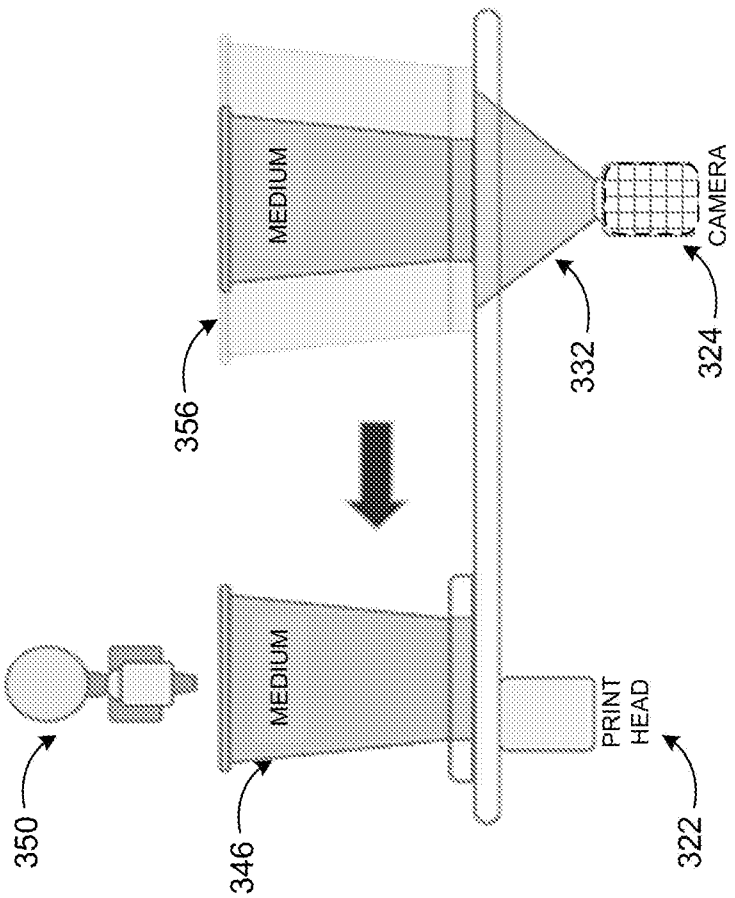
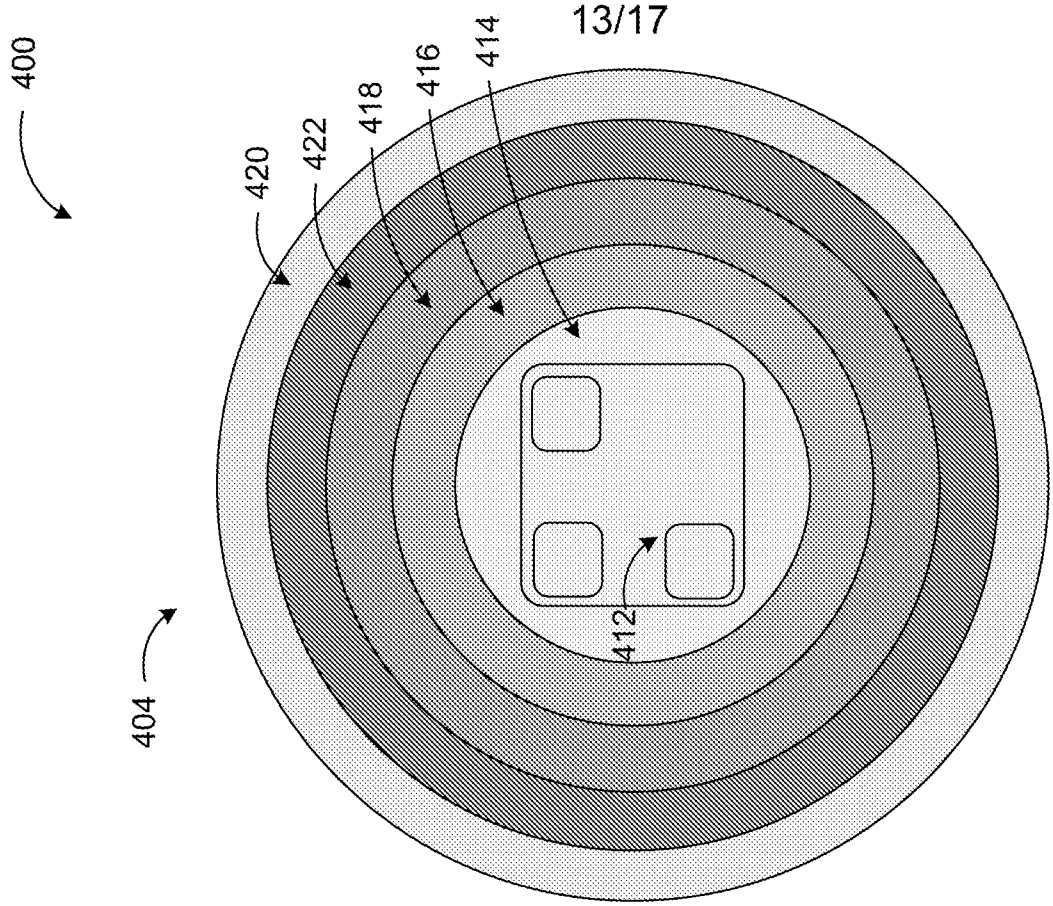

352
MEDIUM
356
332
CAMERA
324
MEDIUM
PRINT HEAD
350
346
322
Side View

FIG. 3E


400
404
420
422
418
416
414
412

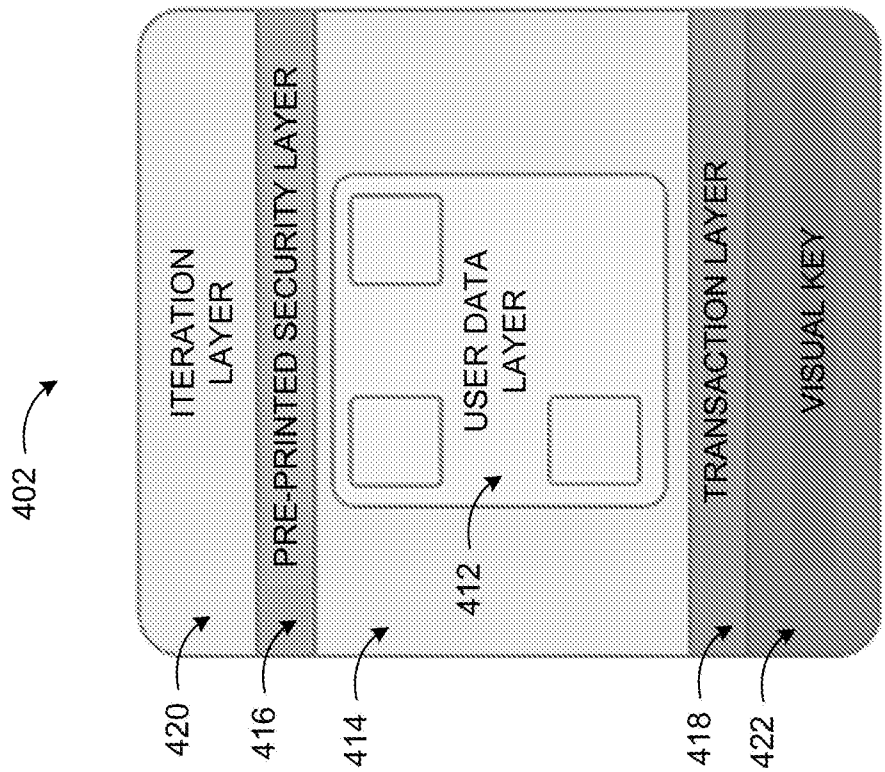

402
ITERATION LAYER
PRE-PRINTED SECURITY LAYER
USER DATA LAYER
TRANSACTION LAYER
VISUAL KEY
420
416
414
412
418
422

FIG. 4

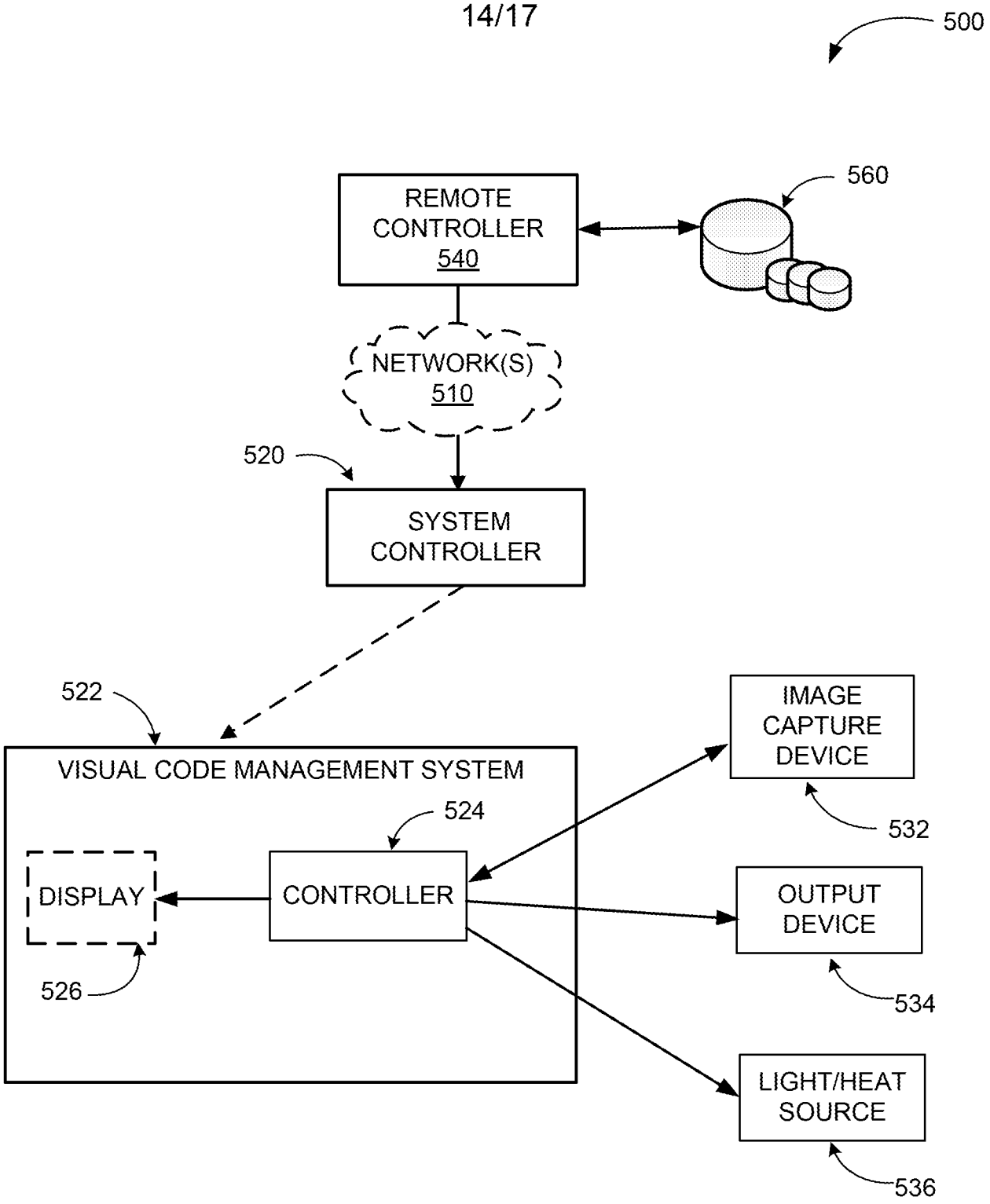

500
REMOTE CONTROLLER 540
560
NETWORK(S) 510
520
SYSTEM CONTROLLER
522
VISUAL CODE MANAGEMENT SYSTEM
524
DISPLAY
CONTROLLER
526
IMAGE CAPTURE DEVICE
532
OUTPUT DEVICE
534
LIGHT/HEAT SOURCE
536

FIG. 5

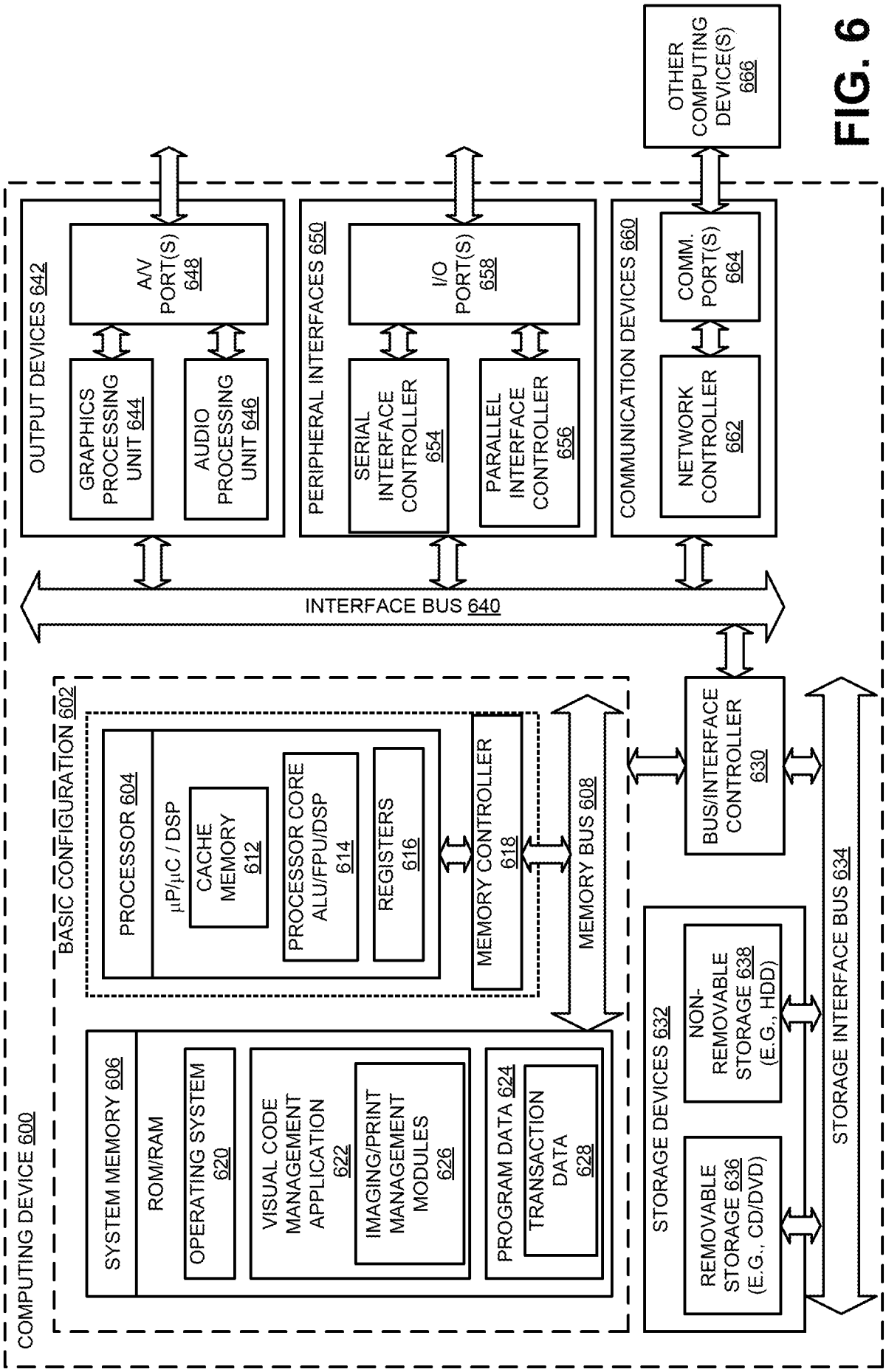

COMPUTING DEVICE 600
BASIC CONFIGURATION 602
PROCESSOR 604
μP/μC / DSP
CACHE MEMORY 612
PROCESSOR CORE ALU/FPU/DSP 614
REGISTERS 616
MEMORY CONTROLLER 618
MEMORY BUS 608
SYSTEM MEMORY 606
ROM/RAM
OPERATING SYSTEM 620
VISUAL CODE MANAGEMENT APPLICATION 622
IMAGING/PRINT MANAGEMENT MODULES 626
PROGRAM DATA 624
TRANSACTION DATA 628
OUTPUT DEVICES 642
A/V PORT(S) 648
GRAPHICS PROCESSING UNIT 644
AUDIO PROCESSING UNIT 646
PERIPHERAL INTERFACES 650
I/O PORT(S) 658
SERIAL INTERFACE CONTROLLER 654
PARALLEL INTERFACE CONTROLLER 656
COMMUNICATION DEVICES 660
COMM. PORT(S) 664
NETWORK CONTROLLER 662
OTHER COMPUTING DEVICE(S) 666
INTERFACE BUS 640
BUS/INTERFACE CONTROLLER 630
STORAGE DEVICES 632
REMOVABLE STORAGE 636 (E.G., CD/DVD)
NON-REMOVABLE STORAGE 638 (E.G., HDD)
STORAGE INTERFACE BUS 634

FIG. 6

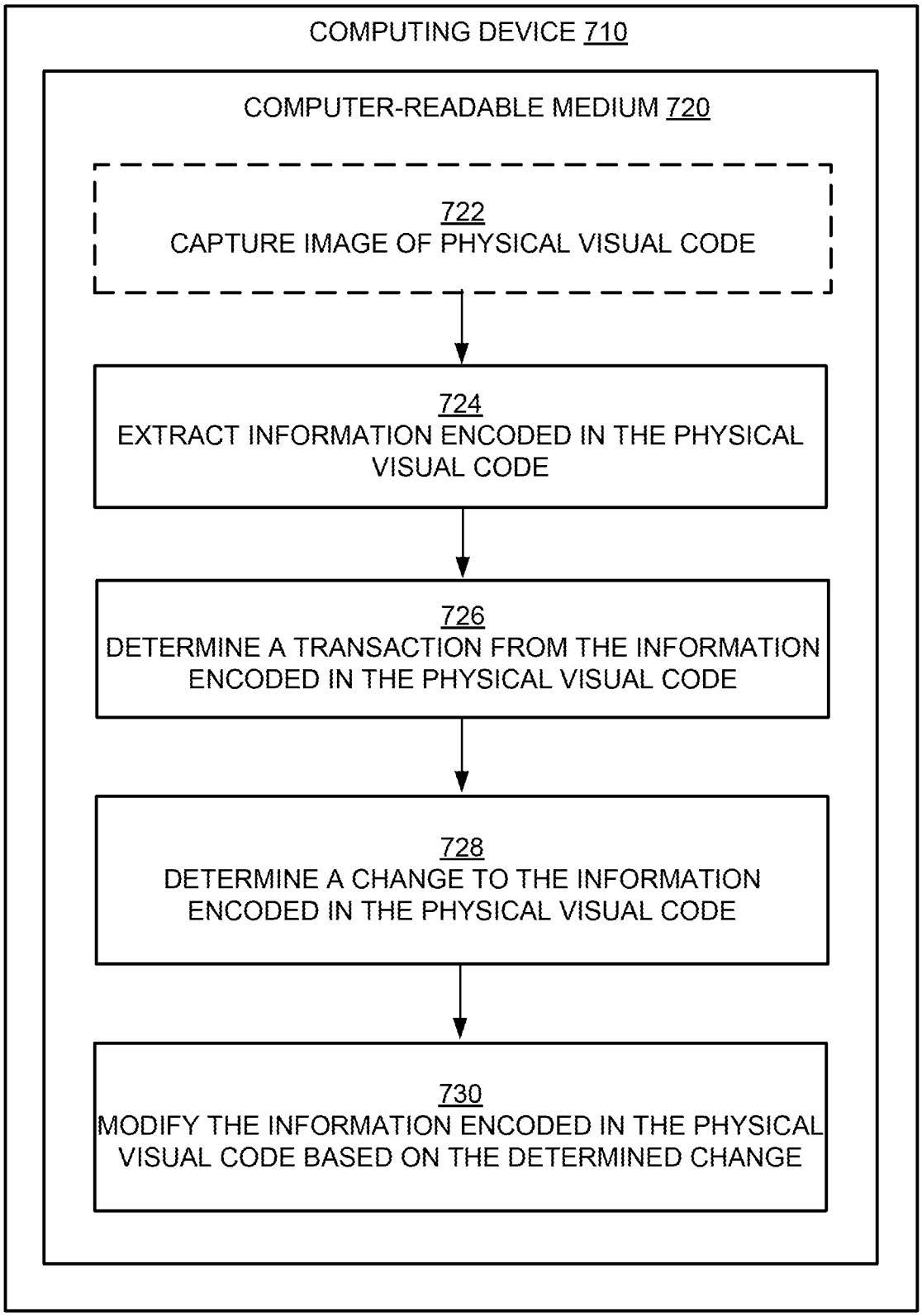

COMPUTING DEVICE 710
COMPUTER-READABLE MEDIUM 720
722
CAPTURE IMAGE OF PHYSICAL VISUAL CODE
724
EXTRACT INFORMATION ENCODED IN THE PHYSICAL VISUAL CODE
726
DETERMINE A TRANSACTION FROM THE INFORMATION ENCODED IN THE PHYSICAL VISUAL CODE
728
DETERMINE A CHANGE TO THE INFORMATION ENCODED IN THE PHYSICAL VISUAL CODE
730
MODIFY THE INFORMATION ENCODED IN THE PHYSICAL VISUAL CODE BASED ON THE DETERMINED CHANGE

FIG. 7

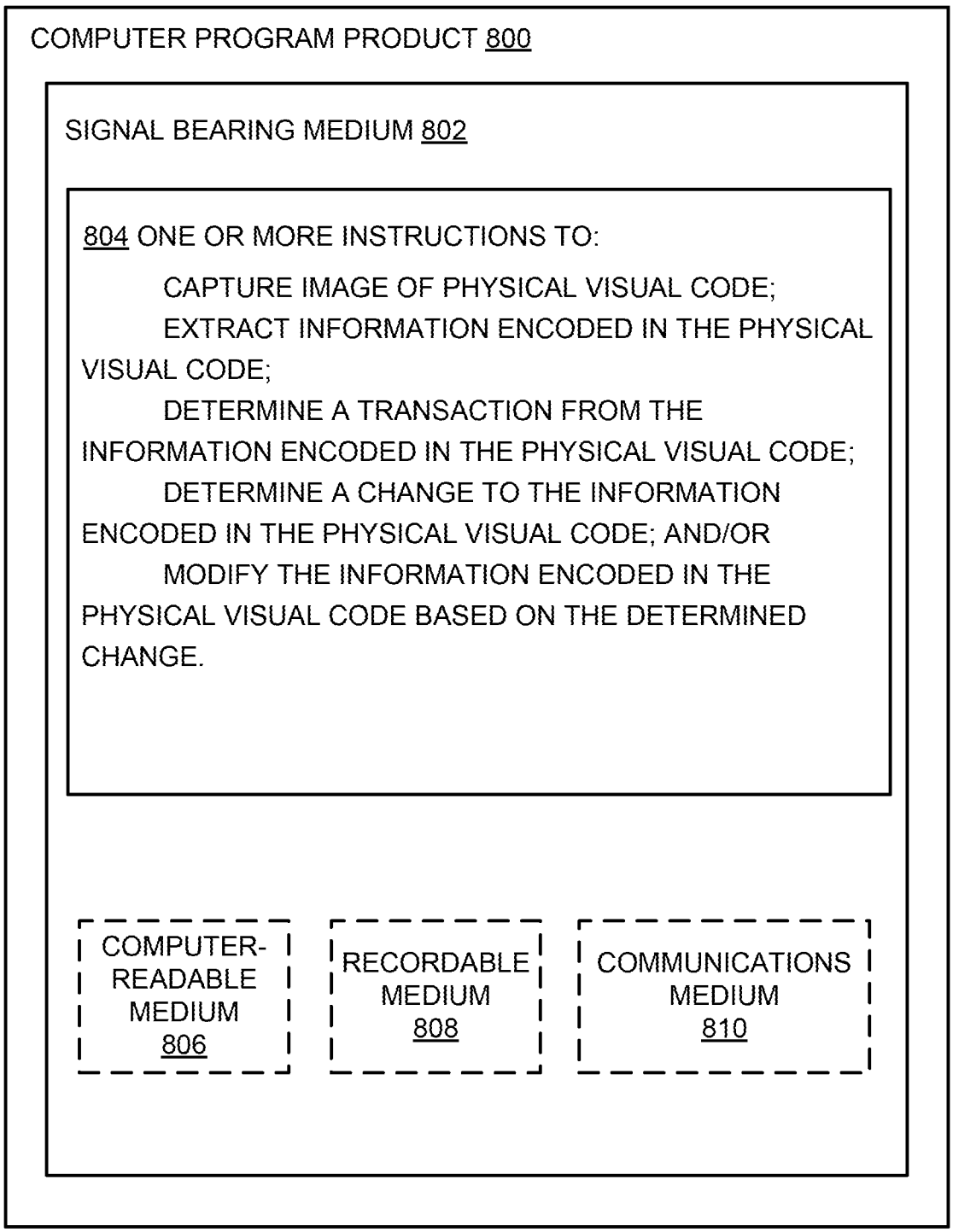

COMPUTER PROGRAM PRODUCT 800
SIGNAL BEARING MEDIUM 802
804 ONE OR MORE INSTRUCTIONS TO:
CAPTURE IMAGE OF PHYSICAL VISUAL CODE;
EXTRACT INFORMATION ENCODED IN THE PHYSICAL VISUAL CODE;
DETERMINE A TRANSACTION FROM THE INFORMATION ENCODED IN THE PHYSICAL VISUAL CODE;
DETERMINE A CHANGE TO THE INFORMATION ENCODED IN THE PHYSICAL VISUAL CODE; AND/OR
MODIFY THE INFORMATION ENCODED IN THE PHYSICAL VISUAL CODE BASED ON THE DETERMINED CHANGE.
COMPUTER-READABLE MEDIUM 806
RECORDABLE MEDIUM 808
COMMUNICATIONS MEDIUM 810

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2019/052320

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
See extra sheet(s).

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-17, 29-39

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2019/052320

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B65C 9/46; G06K 1/12; G06K 19/06 (2019.01)
CPC - G06K 1/12; G06F 3/1237; G06K 1/14; G06K 17/00; G06K 19/06103 (2019.08)

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)
See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 235/494; 235/462.15 (keyword delimited)

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,602,377 A (BELLER et al) 11 February 1997 (11.02.1997) entire document	1-4, 9-13, 29-31, 36, 37, 39
---		---
Y		5-8, 14, 32-35, 38
Y	EP 1605396 A2 (PITNEY BOWES INC.) 14 December 2005 (14.12.2005) entire document	5-8, 14, 32-35, 38
A	US 2011/0000958 A1 (HERZIG) 06 January 2011 (06.01.2011) entire document	1-17, 29-39
A	US 2013/0112760 A1 (SCHORY et al) 09 May 2013 (09.05.2013) entire document	1-17, 29-39

☐ 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	Date of mailing of the international search report
25 December 2019	14 JAN 2020
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	Authorized officer Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2019/052320

Continued from Box No. III Observations where unity of invention is lacking

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claims 1-17 and 29-39, are drawn to a system to modify physical visual codes, the system comprising: an image capture device configured to capture a physical visual code with information encoded therein.

Group II, claims 18-28, are drawn to a modifiable physical visual code, comprising: a first layer of content.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the special technical feature of the Group I invention: an image capture device configured to capture a physical visual code with information encoded therein; a control device configured to: extract the information encoded in the physical visual code; determine a transaction from the information encoded in the physical visual code; and determine a change to the information encoded in the physical visual code; and an output device configured to modify the information encoded in the physical visual code as claimed therein is not present in the invention of Group II. The special technical feature of the Group II invention: a first layer of content; a second layer of content comprising security information; a third layer of content comprising transaction information; and a fourth layer of content comprising iteration information, wherein one or more of the first, second, third, and fourth layers include a physical modification to the physical visual code as claimed therein is not present in the invention of Group I.

Groups I and II lack unity of invention because even though the inventions of these groups require the technical feature of a modified physical visual code, this technical feature is not a special technical feature as it does not make a contribution over the prior art.

Specifically, US 5,602,377 to Beller et al. teaches a modified physical visual code (col. 4, lines 18-25).

Since none of the special technical features of the Group I or II inventions are found in more than one of the inventions, unity of invention is lacking.