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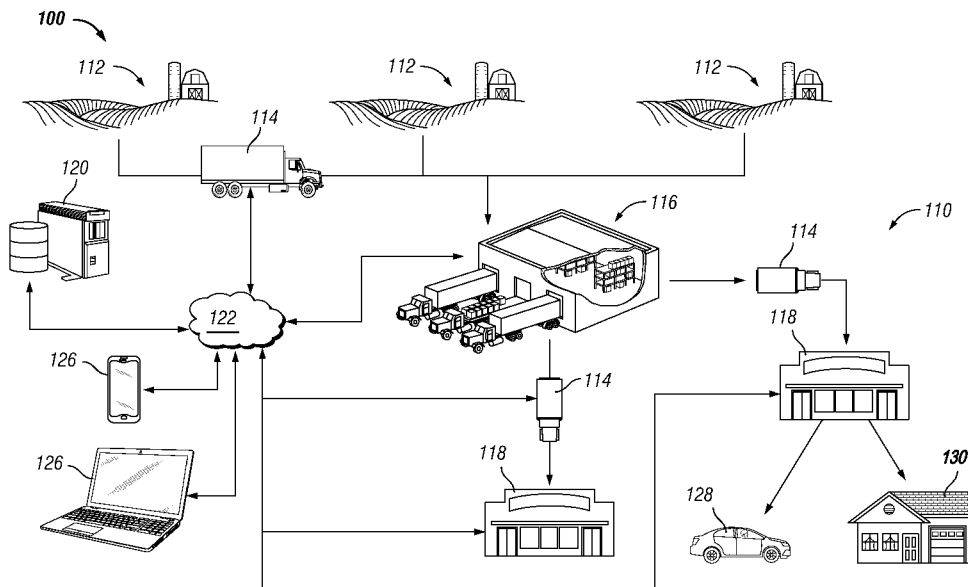


FIG. 1

(57) Abstract: Systems, methods and apparatus for monitoring and reporting on the condition of individual items of sale throughout a supply chain are disclosed. An example method may include associate a micro-climate sensor with a corresponding individual item of sale at an early point in the supply chain and generating, via the micro-climate sensor, product flow data. The example method may further include determining flow analysis data from the product flow data. An example apparatus may include a SOP data processing circuit to interpret SOP data and a SOP deviation circuit to determine deviation data based on product flow data and SOP data.



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SYSTEMS AND METHODS FOR TRACKING PRODUCT ENVIRONMENT THROUGHOUT A SUPPLY CHAIN

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority to U.S. Provisional Patent Application Serial No. 62/902,175 (Attorney Docket No. FEED-0006-P01), filed September 18, 2019, and entitled “SYSTEMS AND METHODS FOR MONITORING PERISHABLE GOODS”.

[0002] The foregoing application is incorporated herein by reference in its entirety.

BACKGROUND

Field:

[0003] This system relates to monitoring quality of perishable goods/items throughout the distribution and retail lifecycles.

Description of the Related Art:

[0005] Current approaches produce limited data regarding perishable items because all aspects of the item’s lifecycle are not monitored, reported, or otherwise analyzed. There is a need for a system to monitor the variable conditions to which items are exposed as they move from a distribution center to a retail location, and then through and after disposition. Further, there remains a need to provide retailers with insight into the quality of goods being received, the quality of goods being disposed of, and assistance in identifying contributory factors related to the quality of the item.

SUMMARY

[0006] Currently, there is a need to provide retailers with insight and data regarding how foods or goods are being handled and their environment throughout their life cycle, from a point of production, such as a farm, through transportation, and distribution center, to a store display case, including in store handling. Further, a retailer would benefit from being able to link the environmental and handling data to information regarding standard operating procedures (SOPs), human behavior and potential deviations from SOPs. While there are some systems that may provide information at specific points in time, e.g., the temperature of a freezer, or a transport vehicle, this data is not linked with human behavior. There is a need to be able to link the environmental data to SOPs and human behavior to facilitate the ability to take corrective action based on the data.

[0007] An example method for monitoring and reporting on the condition of a plurality of individual items of sale throughout a supply chain may include associating at least one micro-

climate sensor with a corresponding individual item of sale in the plurality and then generating, via the plurality of micro-climate sensors, product flow data for each corresponding item of sale. In some embodiments, the reference to micro-climate sensors may include mobile sensors and/or facility sensors. Mobile sensors may include micro-climate sensors that are mobile and travel with their corresponding individual item of sale for a period of time. Facility sensors may include micro-climate sensors that remain stationary and provide data regarding environment, and/or equipment related data, e.g., power usage of a cooler, associated with the items of sale. The example method may further include determining flow analysis data from the product flow data for each corresponding item of sale and transmitting the flow analysis data.

[0008] An example apparatus may include a product flow data processing circuit to interpret product flow generated from each of a plurality of items of sale flowing through a supply chain and a standard operating procedure (SOP) data processing circuit to interpret SOP data. The example apparatus may further include a flow analysis circuit to determine flow analysis data in response to the product flow data, and an SOP deviation circuit to determine deviation data based at least in part on the flow analysis data and the SOP data, wherein the deviation data indicates a deviation from the SOP data. The example apparatus may further include a deviation provisioning circuit structured to transmit the deviation data.

[0009] An example method may include associating at least one micro-climate sensor with a corresponding item of sale of a first plurality of items of sale, generating, via the at least one micro-climate sensor, first product flow data for the first plurality of items of sale while flowing through a supply chain, and removing of the at least one micro-climate sensor from the corresponding item of sale of the first plurality. The example method may further include associating the at least one micro-climate sensor with a corresponding item of sale of a second plurality of items of sale, generating, via the at least one micro-climate sensor, second product flow data for each of the second plurality of items of sale while flowing through the supply chain, and determining product flow analysis data based on the first and the second product flow data. The example method may further include transmitting the product flow analysis data.

[0010] A method of decommissioning a plurality of micro-climate sensors for generating product flow data for each of a plurality items of sale flowing through a supply chain is disclosed. An example method may include receiving at an opening of a repository device, at least one micro-climate sensor of the plurality, and detecting, via a plurality of sensors, a presence of the at least one micro-climate sensor. An example method may further include

generating, in response to detecting the presence of the at least one micro-climate sensor, a decommission command value, transmitting the decommission command value to the at least one micro-climate sensor, wherein the decommission command value transitions the at least one micro-climate sensor to a decommissioned mode, and storing the at least one micro-climate sensor in a space of the repository device.

[0011] A store for vending a plurality of items of sale is disclosed. An example store may include a floor with one or more containers disposed on the floor and structured for presenting the plurality of items of sale. The store may further include a plurality of micro-climate sensors disposed on the floor and structured to generate store floor data corresponding to each of the plurality of items of sale. The store may further include a server structured to determine, based at least in part on standard operating procedure (SOP) data corresponding to a SOP of the store, store analysis data from the store floor data. The server may be further structured to transmit the store analysis data, wherein the store analysis data comprises a measure value of the store's compliance with the SOP. The store may further include an in-store network structured to transmit the store floor data from the plurality of micro-climate sensors to the server.

[0012] A system is disclosed. An example system may include: an electronic mobile device structured to generate visual disposition data from a plurality of items of sale in a store; and a server. The server of the example system may generate processed disposition data via image processing the visual disposition data, determine disposition analysis data from the processed disposition data, and transmit the disposition analysis data. In the example system, the disposition analysis data may include an indication of a causal event for a disposal of at least one item of sale of the plurality.

[0013] A method is disclosed. An example method may include interpreting flow analysis data corresponding to a plurality of items of sale flowing through a supply chain for an entity, and interpreting store analysis data corresponding to the plurality of items of sale while disposed on a floor of a store. The example method may further include interpreting disposition analysis data corresponding to disposal of some of the plurality of items of sale, and determining a score value based at least in part on the flow analysis data, the store analysis data, and the disposition analysis data.

[0014] A system is disclosed. An example system may include a first plurality of micro-climate sensors each associated with a corresponding individual item of sale and structured to generate and transmit product flow data of the individual item of sale of a plurality of items of sale flowing through a supply chain for an entity and a second plurality of micro-climate

sensors disposed on a floor of a store and structured to generate floor data corresponding to the plurality of items of sale while disposed on the floor. The system may further include: a mobile electronic device structured to generate visual disposition data from at least some of the plurality of items of sale; and a server. The server may be structured to: determine flow analysis data from the product flow data; determine store analysis data from the floor data; and determine a score value based at least in part on the product flow data, the floor data, and the visual disposition data.

[0015] These and other systems, methods, objects, features, and advantages of the present disclosure will be apparent to those skilled in the art from the following detailed description of the preferred embodiment and the drawings.

[0016] All documents mentioned herein are hereby incorporated in their entirety by reference. References to items in the singular should be understood to include items in the plural, and vice versa, unless explicitly stated otherwise or clear from the text. Grammatical conjunctions are intended to express any and all disjunctive and conjunctive combinations of conjoined clauses, sentences, words, and the like, unless otherwise stated or clear from the context.

BRIEF DESCRIPTION OF THE FIGURES

[0017] The disclosure and the following detailed description of certain embodiments thereof may be understood by reference to the following figures:

[0018] Fig. 1 is a schematic diagram of an embodiment of a system for product management;

[0019] Fig. 2 is a schematic diagram of a vehicle in accordance with an embodiment of the system for product management;

[0020] Fig. 3 is a schematic diagram of a store in accordance with an embodiment of the system for product management;

[0021] Fig. 4 is a schematic diagram of a container for presenting items of sale in accordance with an embodiment of the system for product management;

[0022] Fig. 5 is a schematic diagram of a sever in accordance with an embodiment of the system for product management;

[0023] Fig. 6 is a schematic diagram of an electronic device in accordance with an embodiment of the system for product management;

[0024] Fig. 7 is a schematic diagram of a repository device in accordance with an embodiment of the system for product management;

- [0025] Fig. 8 is a schematic diagram of a supply flow chain in accordance with an embodiment of the system for product management;
- [0026] Fig. 9 is a block diagram of a standard operating procedure data in accordance with an embodiment of the system for product management;
- [0027] Fig. 10 depicts components of an embodiment of the system for product management;
- [0028] Fig. 11 shows an example of a time to shelf graph in accordance with an embodiment of the system for product management;
- [0029] Fig. 12 shows an example of micro-climate sensor data in accordance with an embodiment of the system for product management;
- [0030] Fig. 13 depicts example data from a set of micro-climate sensors in accordance with an embodiment of the system for product management;
- [0031] Fig. 14 depicts an example temperature profile with notation regarding key product quality transitions;
- [0032] Fig. 15 depicts an embodiment of a micro-climate sensor in accordance with an embodiment of the system for product management;
- [0033] Fig. 16 depicts an example of position dependency of micro-climate sensor data in accordance with an embodiment of the system for product management;
- [0034] Fig. 17 depicts components of a receiving system in accordance with an embodiment of the system for product management;
- [0035] Fig. 18 depicts an example work-flow utilizing a receiving system in accordance with an embodiment of the system for product management;
- [0036] Fig. 19 depicts components of an in-take system in accordance with an embodiment of the system for product management;
- [0037] Fig. 20 depicts an example work-flow utilizing an in-take system in accordance with an embodiment of the system for product management;
- [0038] Fig. 21 depicts a method in accordance with an embodiment of the system for product management;
- [0039] Fig. 22 depicts another method in accordance with an embodiment of the system for product management;
- [0040] Fig. 23 depicts a method in accordance with an embodiment of the system for product management;
- [0041] Fig. 24 depicts a deviation message in accordance with an embodiment of the system for product management;

- [0042] Fig. 25 depicts a sale-improvement action in accordance with an embodiment of the system for product management;
- [0043] Fig. 26 depicts an apparatus in accordance with an embodiment of the system for product management;
- [0044] Fig. 27 depicts a method in accordance with an embodiment of the system for product management;
- [0045] Fig. 28 depicts an apparatus in accordance with an embodiment of the system for product management;
- [0046] Fig. 29 depicts an apparatus in accordance with an embodiment of the system for product management;
- [0047] Fig. 30 depicts a method in accordance with an embodiment of the system for product management;
- [0048] Fig. 31 depicts a method in accordance with an embodiment of the system for product management;
- [0049] Fig. 32 depicts a method in accordance with an embodiment of the system for product management;
- [0050] Fig. 33 depicts a method in accordance with an embodiment of the system for product management;
- [0051] Fig. 34 depicts a method in accordance with an embodiment of the system for product management;
- [0052] Fig. 35 depicts a method in accordance with an embodiment of the system for product management;
- [0053] Fig. 36 depicts an apparatus in accordance with an embodiment of the system for product management;
- [0054] Fig. 37 depicts an apparatus in accordance with an embodiment of the system for product management;
- [0055] Fig. 38 depicts a method in accordance with an embodiment of the system for product management;
- [0056] Fig. 39 depicts a method in accordance with an embodiment of the system for product management;
- [0057] Fig. 40 depicts an apparatus in accordance with an embodiment of the system for product management;
- [0058] Fig. 41 depicts an apparatus in accordance with an embodiment of the system for product management;

- [0059] Fig. 42 depicts an apparatus in accordance with an embodiment of the system for product management;
- [0060] Fig. 43 depicts an apparatus in accordance with an embodiment of the system for product management;
- [0061] Fig. 44 depicts a method in accordance with an embodiment of the system for product management;
- [0062] Fig. 45 depicts a method in accordance with an embodiment of the system for product management;
- [0063] Fig. 46 depicts components of an embodiment of a disposition system;
- [0064] Fig. 47 depicts an example of an embodiment of a disposition system;
- [0065] Fig. 48 shows an image of an example embodiment of a disposition system;
- [0066] Fig. 49 shows an example of an embodiment of a disposition system;
- [0067] Fig. 50 depicts an activity flow chart of product disposition in an embodiment of the system described herein;
- [0068] Fig. 51 depicts an activity flow chart for the determination of appropriateness of product disposition;
- [0069] Fig. 52 shows an example screenshot identifying a bar code label in an embodiment of the system described herein;
- [0070] Fig. 53 shows an example of a data code;
- [0071] Fig. 54 shows an example of a markdown sticker;
- [0072] Fig. 55 shows an example screenshot capturing an item defect in an embodiment of the system described herein
- [0073] Fig. 56 depicts a method in accordance with an embodiment of the system for product management;
- [0074] Fig. 57 depicts a method in accordance with an embodiment of the system for product management;
- [0075] Fig. 58 depicts a method in accordance with an embodiment of the system for product management;
- [0076] Fig. 59 depicts a method in accordance with an embodiment of the system for product management;
- [0077] Fig. 60 depicts a method in accordance with an embodiment of the system for product management;
- [0078] Fig. 61 depicts an apparatus in accordance with an embodiment of the system for product management;

- [0079] Fig. 62 depicts a method in accordance with an embodiment of the system for product management;
- [0080] Fig. 63 depicts a method in accordance with an embodiment of the system for product management;
- [0081] Fig. 64 depicts an apparatus in accordance with an embodiment of the system for product management;
- [0082] Fig. 65 depicts an example user interface connectivity in an embodiment of the system described herein;
- [0083] Fig. 66 depicts components of a system server in an embodiment of the system described herein;
- [0084] Fig. 67 depicts a partial summary of metadata associated with a dispositioned item;
- [0085] Fig. 68 shows example packages of greens in different conditions;
- [0086] Fig. 69 depicts an example flowchart for introducing sensors to a product shipment for a specific store in an embodiment of the system disclosed herein;
- [0087] Fig. 70 shows an example of an alert generated by an instore sensor;
- [0088] Fig. 71 shows an example of an alert generated by an instore sensor;
- [0089] Fig. 72 shows an example of underlying data associated with an alert;
- [0090] Fig. 73 shows an example of a store report;
- [0091] Fig. 74 shows an example of an event report;
- [0092] Fig. 75 shows an example of a dashboard;
- [0093] Fig. 76 shows an example of a product temperature profile;
- [0094] Fig. 77 depicts an example of a problem, how it is identified by the system described herein, and the problem resolution;
- [0095] Fig. 78 shows examples of differences in temperature profile based on location in a produce cooler;
- [0096] Fig. 79 depicts an example of a problem, how it is identified by the system described herein, and the problem resolution;
- [0097] Fig. 80 depicts an example of a report that may be generated by the system described herein;
- [0098] Fig. 81 depicts an example of a report that may be generated by the system described herein;
- [0099] Fig. 82 depicts an example of a report that may be generated by the system described herein; and

[0100] Fig. 83 depicts an example of a report that may be generated by the system described herein.

DETAILED DESCRIPTION

[0101] References herein to systems, modules, circuits, or engines, are meant to include PCB circuits, ASICs, FPGAs, mixed hardware and software implementations and the like. The term “flowing”, as used with respect to an item of sale (and/or product) and a flow chain, refers to the movement of the item of sale across and/or storage at locations/positions of the supply chain, e.g., source, transportation, distribution center, store, a location in a store, a customer location, and/or any location therebetween where items of sale may be acted upon by supply chain staff and/or other entities. A customer location may include a customer in store, a customer’s vehicle, a customer’s residence or workplace or a location therebetween, and the like. A “sale-improvement” action, as used herein, may include any type of action performed to increase the likelihood that one or more items of sale may be consumed (purchased) by an end user (customer). Non-limiting examples of sale-improvement actions may include moving an item of sale to a new location and/or discounting the item of sale. A “deviation”, as used herein, may include any occurrence that is not in conformance with an intended course of action, e.g., a SOP. Non-limiting examples may include delays in a supply chain, exposure of an item of sale to non-SOP compliant environment (e.g. temperature or humidity deviations), excessive storage time of an item of sale in a storage unit, failure to discount an item of sale with respect to a particular time period or event, e.g., failure to coupon a bag of lettuce if it is within X number of days of a corresponding sell-by date or after experiencing a life shortening event. A “product-life shortening event” or “product-quality reducing” event, as used herein, includes any type of occurrence that may reduce the commercial appeal of an item of sale. Non-limiting examples include exposure to non-SOP compliant temperatures and/or handling practices, damage to product packaging and/or a consumable portion of an item of sale, delays in supply chain, etc. “Product flow data” may include any type of data associated with one or more items of sale flowing through a supply chain. Non-limiting examples may include temperatures, humidity, travel and/or storage times, shape, color (e.g., ripeness or bruising) both as a profile over time, cumulative data, summarized data, statistics or derivatives associated with same, and the like. “Flow analysis data”, as used herein, may include processed and/or analyzed product flow data. Non-limiting examples include contiguous data with respect to travel and/or storage times, temperatures, ripeness, actionable items, etc. An “actionable item”, as used herein, may refer

to a combination of different types of data, e.g., temperature, time and location, that provide an indication of causal event and/or process that may result in a deviation. Non-limiting examples may include an indication that items of sale are spending more time on a loading dock than allowed for in a corresponding SOP which is resulting in the items of sale experiencing life-shortening events due to non-SOP compliant temperatures. A “stocking event”, as used herein, may include an event involving: loading an item of sale onto transport at a producer (source), receiving an item of sale at a distribution center, storage of an item of sale at a distribution center, packing an item of sale at a distribution center, loading an item of sale onto a transport vehicle at the distribution center, repositioning of an item on the transport vehicle during the movement of the item of sale from the distribution center to the final store location; receiving an item of sale at a store location, moving an item of sale from the receiving dock to an appropriate location (e.g., a freezer, cold store, back room storage, and the like), positioning an item of sale on the display floor, movement of an item of sale between the display floor and a back storage area such as a produce cooler, movement of an item of sale between locations on the display floor, movement of an item of sale as part of assembly of a customer order, transport and holding of a customer order in-store for pick-up, transport of a customer order to a customer site, and/or the like.

[0102] Further, while the present disclosure describes a system for product management with respect to perishable goods, it is to be understood that embodiments of the present disclosure may be applicable to other scenarios wherein the conditions surrounding the generation, transport and/or delivery of an item/object need to be monitored.

[0103] Referring now to Fig. 1, an embodiment of a product management system is shown 100 for monitoring and/or reporting on the condition of a plurality of individual items of sale 210 (Fig. 2) throughout a supply chain 110 is shown. The supply chain 110 may include one or more sources 112, transportation vehicles 114, distribution centers 116, and/or stores 118, locations in stores, holding area for customer pickup (curbside 128 or in-store), transportation vehicle to a customer’s location 130, and locations therebetween. An item of sale 210 may be a commercial product generated by the sources 112. Non-limiting examples of items of sale 210 include produce products, dairy products, meat products, fish products, and/or any other type of consumable product which is subject to spoilage, e.g., perishable, including frozen products. In embodiments, an item of sale 210 may include a discrete amount of a product, e.g., a box of bananas. In embodiments, the item of sale 210 may be a stock keeping unit (SKU). In embodiments, an item of sale 210 may be an entire pallet of a

product. In embodiments, wherein the discrete amount is a box or a pallet of product, the product associated with the box or pallet may be of different types.

[0104] In embodiments, the sources 112 may be farms, factories, packaging centers, and/or any type of facility that generates an item of sale 210 or a product that will form part of an item of sale 210, e.g., a product prior to being packaged for shipment and/or sale. Once generated by a source 112, the items of sale 210 may be loaded on to a transportation vehicle 114 for transportation to the distribution center 116 or for transportation directly to a store 118. A store 118 may be any type of facility structured to distribute and/or sell an item of sale 210 to an end consumer of the item of sale 210. Non-limiting examples of stores 118 may include supermarkets, farmer's markets, food pantries, cafeterias, restaurants, and/or food stands.

[0105] Turning briefly to Fig. 2, the product management system 100 (Fig. 1) may include one or more micro-climate sensors 212 which are associated with corresponding items of sale 210. As will be explained in greater detail below, the micro-climate sensors 212 generate and transmit product flow data. While Fig. 2 depicts the micro-climate sensors 212 within a vehicle 114, it is to be understood that the micro-climate sensors 212 may be associated with, and/or attached to, the items of sale 210 at any portion of the supply chain 110, e.g., at a source 112, distribution center 116, store 118, a location in a store, a customer location, and/or any point/location therebetween.

[0106] Returning to Fig. 1, the product management system 100 may further include one or more servers 120 in communication with the micro-climate sensors 212 via a network 122. The one or more servers 120 may be structured to interpret the product flow data and determine flow analysis data. The product management system 100 may further include one or more electronic devices 126, e.g., desktops, laptops, smart phones, tablets, and/or other types of smart devices, that communicate with the one or more servers 120 via the network 122. In embodiments, the one or more servers 120 may transmit the flow analysis data to the one or more electronic devices 126 which may be structured to interpret and display the flow analysis data and/or data derived therefrom.

[0107] Moving to Fig. 3, a non-limiting example of a store 118 is shown. The store 118 may include a floor 310, a backroom 312, a main entrance 314, a loading dock 316 (also referred to herein as a receiving dock or a holding dock), one or more containers 318 for presenting the items of sale 210, one or more of the servers 120, and/or an in-store network 320. The store 118 may further include a walk-in refrigerator 322 (also referred to as a

cooler, a walk-in cooler, a produce cooler, a store room, a storage facility, and the like), and/or a repository device 324.

[0108] The floor 310 may be a front portion of the store 118 where the containers 318 present the items of sale 210 to customers for purchase. The floor 310 may include the main entrance 314. The floor 310 may be connected to the backroom 312 via an entryway/door 326.

[0109] The backroom 312 may be a location in the store 118 where items of sale 210 are stored until needed on the floor 310, wherein items of sale 210 may be moved from the backroom 312 to the containers 318 via “u-boats” 333. The backroom 312 may be connected to the loading dock 316 via entryway/door 328.

[0110] The loading dock 316 may be a portion of the store 118 structured to facilitate loading and/or unloading of items of sale 210 from a transportation vehicle 114.

[0111] A non-limiting example of a container 318 is illustrated in Fig. 4. The container 318 may include one or more spaces 410 for one or more items of sale 210. The container 318 may further include one or more micro-climate sensors 212 for monitoring the items of sale 210 while in the container 318. In embodiments, the container 318 may be climate controlled, e.g., refrigerated/cooled or heated. The micro-climate sensors 212 may be disposed at various locations on, under, within, and/or near the container 318. The container 318 may include a network communication device 412 for placing the micro-climate sensors 212 in communication with the servers 120 via the in-store network 320 and/or network 122.

[0112] As shown in Fig. 5, the one or more servers 120 may include one or more processors/CPUs 510 and memory 512. The one or more servers 120 may further include one or more network cards 514. The one or more servers 120 may further communicate with a local and/or remote data base 516.

[0113] Fig. 6 depicts a non-limiting example of an electronic device 126 for use in the product management system 100. The electronic device 126 may include one or more processors/CPUs 610, memory 612, and/or networking devices 614. In embodiments, the electronic device 126 may include a camera 616 and/or bar-code scanner/reader 618.

[0114] Illustrated in Fig. 7 is a non-limiting example of the repository device 324. The repository device 324 may include a body 710 that defines a space 712 for holding/containing/storing one or more micro-climate sensors 212. The body 710 may have an opening 722 (e.g., a covered opening) for receiving micro-climate sensors 212 that are to be decommissioned (permanently or temporarily). In embodiments, decommissioning of a micro-climate sensor 212 may refer to transitioning the sensor 212 to a state where the sensor

212 does not collect and/or transmit data from an item of sale 210. In embodiments, decommissioning of a micro-climate sensor 212 may refer to placing a marker in the data collected by the micro-climate sensor 212 indicating that data after that point in the data is not valid. The body 710 may further include an opening 720 (e.g., a covered opening) that provides access to remove decommissioned micro-climate sensors 212 from the space 712. The repository device 324 may include a network device 718 structured to communicate with the one or more servers 120 and/or electronic devices 126 via the networks 320 and/or 122. The repository device 324 may include one or more sensors 714 structured to detect the presence of a micro-climate sensor 212 within, or near, the space 712. The one or more sensors 714 may be laser-based, radar-based, sonar-based, visual-imagery based, e.g., optical cameras, magnetic based, RFID based and/or any other type of sensing device capable of detecting the presence of another object. The repository device 324 may further include one or more sensor communication devices 716 structured to communicate with the one or more micro-climate sensors 212. In a non-limiting example, a micro-climate sensor 212 may be passed through the opening 722 into the space 712 where it is detected by the one or more sensors 714. Upon detection of the micro-climate sensors 212, the one or more sensor communication devices 716 may transmit a decommission command to the micro-climate sensor 212 and/or the one or more servers 120. In embodiments, the one or more sensors 714 may be further structured to detect whether the space 712 is full or empty and/or other properties, e.g., a status, of the repository device 324. In embodiments, the repository device 324 may transmit a message to the one or more servers 120 and/or electronic devices 126 indicating a status of the repository device 324, e.g., full, empty, etc. As will be understood, the repository device 324 may provide for collection and decommissioning of the micro-climate sensors 212 as part of recycling of the micro-climate sensors 212. For example, the repository device 324 may detect when it is full and send a notification message to initiate pickup, e.g., backhauling and/or mailing, of the micro-climate sensors 212.

[0115] Turning to Fig 8, in view of the disclosure herein, a flowchart depicting a method 800 of moving items of sale 210 through the supply chain 110 (Fig. 1) is shown in accordance with an embodiment of the present disclosure. It is to be understood that embodiments of the method 800 may include fewer or additional stages than the ones depicted in Fig. 8. Accordingly, in embodiments, the method 800 may include harvesting 810 product, e.g., produce, that will form an item of sale 210. Harvesting 810 may be accomplished at a source 112. The harvested product may then be accumulated 812 in a field and transported 814 to a cooler. The product may be staged outside 816 and/or inside 818 of

the cooler. Further staging 820 may be performed followed by force air cooling 822. The method 800 may further include determining 824 whether modified atmosphere assistance (MA) is required, and if so, performing 826 a modified atmosphere pallet bag application. The method 800 may further include storing 828 the product in a cooler. The method 800 may further include another determination 830 of whether modified atmosphere (MA) is required and, if so, performing 832 performing another modified atmosphere (MA) bag application. The method 800 may further include staging 834 the product for loading, loading 836 the product, and/or transporting 838 the product (as items of sale 210) to a distribution center 116. The method 800 may further include unloading 840 the items of sale 210 at the distribution center 116 and/or holding 842 the items of sale on a dock of the distribution center 116. The method may further include storing 844 the items of sale at the distribution center 116. The method 800 may further include staging 846 the items of sale on the distribution center dock and then loading 848 the items of sale, e.g., on a vehicle 114 for transport 850 to a store 118. The method 800 may further include unloading 852 the items of sale 210 on loading dock 316 of the store 118. The method 800 may include holding 854 of the items of sale on the loading dock 316. The method 800 may further include storing 856 the items of sale 210 in a walk-in cooler 322. The method 800 may further include stocking 858 the items of sale 210 for display 860 in a container 318 to consumers. In embodiments, the method 800 may further include assembling a customer order 870 by picking items of sale 210 for a customer's order from a floor 310 or a backroom 312 in a store 118. The method 800 may further include either delivering the customer order 872 to a customer location 130 or placing the customer orders in a holding area 874 for in-store or curbside pickup 128 by the customer.

[0116] As will be understood, one or more of the above stages for the method 800 may be governed by one or more SOPs 900 (Fig. 9). A SOP may be a collection of rules and/or guidelines with respect to transportation, handling, storing, and/or other actions associated with items of sale 210. SOPs 900 may be based at least in part on one or more of organizational regulations 910, e.g., company policy, state and/or federal agency regulations 912, scientific data 914 and/or consensus, and/or other sources of information regarding the handling of items of sale. A SOP 900 may define ranges of conditions, e.g., temperature, moisture, color, etc., for a particular type of product. The ranges may correspond to certain points in the products lifespan and/or position in the supply chain 110. The SOP may define time periods for certain portions, e.g., the stages in method 800, of the supply chain 110. For example, a SOP may define that an item of sale of strawberries may not be left on a loading

dock 316 for more than thirty (30) minutes. A SOP may further define that an item of sale 210 should be discounted (or disposed) if the items of sale 210 has not sold within a certain numbers of days of being in a container 318 and/or within a storage area, e.g., 322. A SOP may further define a length of time from when a customer order is assembled to when it is received by the customer.

[0117] Referring now to Fig. 10, a block diagram of an embodiment of the product management system 100 is depicted. The product management system 100 may include a plurality of in-store systems 1002, distributed across a plurality of retail locations. An in-store system 1002 may include a receiving system 1006 for accepting incoming goods, a disposition system 1004, which enables the capture of data regarding products that are being discarded, an in-store network 1009, which may be the same and/or different than network 320 (Fig. 3), and a variety of micro-climate sensors 212, which may be the micro-climate sensors, e.g., sensors 212 in Figs. 3 and 4, deployed throughout the store, e.g., in containers 318 or store rooms 322. In addition, the product management system 100 may include a plurality of micro-climate sensors 212, which may be the same and/or different from micro-climate sensors 212, which are placed on or in proximity to transported goods during transport between the distribution center and a plurality of stores. Such sensors may provide transport and in-store product data, such as the examples shown in Figs. 1, 2, and 3. In addition, the product management system 100 may include a plurality of micro-climate sensors 212 which monitor environmental data, such as temperature, humidity, light level, and the like, as well as situational information such as location of a product in store, movement information regarding infra-structure components (e.g. status of freezer or cooler door), status of in store equipment (e.g., cycling as produce misters, or run-time on a freezer), product movement, and/or the like. Micro-climate sensors 212 may be associated with a profile indicating what is being measured and where it is located. The micro-climate sensors 212 may be placed in such a way that it detects and/or records the conditions “experienced” by the product being monitored. In an illustrative example, a micro-climate sensor 212 may be placed in a freezer. It may be preferable to place the micro-climate sensor 212 on a shelf, similar to a frozen product, rather than attaching it to a large surface in the freezer, such as a side of the freezer, which may act like a cold sink and be less likely to reflect temperature fluctuations seen by corresponding products/items of sale.

[0118] Data from the sensors described herein may be communicated to the system server 1010, e.g., as floor data, and, in some embodiments, directly to the disposition system 1004. The system server 1010 may be one of the one or more servers 120 (Fig. 1). Data may be

communicated using the in-store network 1009 which may be an existing cellular network using 3G, 4G, or 5G and the like, a local WiFi network (IEEE 802.11x), a short range network (e.g., Bluetooth, Bluetooth Low Energy, ZigBee, 6LoWPan, LTE-M1, NB-IoT, and the like), and the like. The system server 1010, e.g., one of the servers 120 (Fig. 3), may be co-located with the disposition system 1004, at a distribution center 116, at a remote location, or distributed between locations. The system server 1010 may receive the data from the disposition system 1004, from micro-climate sensors 212 associated with the sensor, located in-store, and located on transport vehicles, related product systems such as point of sale data, ordering data, delivery data, and the like.

[0119] The product management system 100 may include a distribution center system 1060. A distribution center system 1060 may include an in-take system 1026, a user interface 1028, and a distribution center network 1027. The distribution center may store received goods 1025 which are subsequently distributed across a plurality of outbound shipments 1024 intended for different locations. The product management system 100 further includes a plurality of micro-climate sensors 212 which may be placed in with specific goods in the outbound shipments 1024 to evaluate conditions seen by the specific good during transport to a store. Data may be communicated between the in-take system 1026, the system server 1010, micro-climate sensors 212 and user interface 1028 using network 1027 which may be an existing cellular network using 3G, 4G, or 5G and the like, a local WiFi network (IEEE 802.11x), a short range network (e.g. Bluetooth, Bluetooth Low Energy, ZigBee, 6LoWPan, LTE-M1, NB-IoT, and the like), and the like. The distribution center may include a plurality of received goods 1025.

[0120] At the distribution center, a plurality of the micro-climate sensors 212 may be placed in with a specific good, e.g., item of sale 210, in the outbound shipments 1024 to evaluate conditions to which that specific good is exposed during transport to the store. The micro-climate sensors 212 may be designed to measure local environmental data for a specific SKU, a type of item (e.g., strawberries or berries where there may be more than a single SKU), or other subset of items of sale. In an illustrative and non-limiting example, a micro-climate sensor 212 may be placed on or in proximity to the pallet or case of strawberry clam shells to measure the conditions to which the pallet or case is exposed. In embodiments, a sensor 212 could be placed in the clamshell(s) themselves to measure the specific temperature and humidity experienced by the strawberries. Micro-climate sensors 212 may be placed with goods based on value of goods, sensitivity of goods (e.g., leafy greens and avocados are very sensitive to environment), disposition history for a type of good

at a specific store, store configuration and sales data, and the like. A disposition history for a type of good at a store may show the frequency with which a given item type is thrown away, reasons for disposition (e.g., items past sell-by data, items damaged, items spoiled), and in what quantities. Using this data, the system server 1010 may look for outliers (e.g., for a given item across stores, relative to historical store data for that item type, relative to disposition rates for similar items at the same store, and the like) and correlate the disposition history with changes in related data such as transportation history for the outliers, changes in climate correlating with the outliers, and the like.

[0121] For example, turning to Fig. 11, a data chart showing the distribution of time to shelf for a perishable good, e.g., item of sale 210 is shown. While there may be some variability in the time to load a store trailer and transport the good to a store, there is often a large variability in the amount of time a particular good spends in a “store back room 1002”, e.g., 312 in Fig. 3. In particular, the time spent in the back room for Store D may be significantly longer than that of other stores. Fig. 12 shows the micro-climate sensor 212 data associated with a perishable good at Store D. The uptick in temperature and humidity 1204 may indicate arrival at the store, followed by a decrease in temperature 1206 as the item is moved into storage in the produce cooler. The movement data 1208 indicates that the item was largely stationary in the cooler for four (4) days, while other items were stacked on top as indicated by the occasional movement spikes.

[0122] Referring to Fig. 13, an example of a temperature graph 1350 showing temperatures measured by a series of micro-climate sensors 212 associated with a quantity of a single produce item (e.g., bagged lettuce or strawberry clam shells) over time as they travel from producer to distribution center (DC) to individual stores is depicted. An associated variability graph 1352 depicts an increase in variability at the stores. However, the data for the individual stores shown in the temperature graph 1350 indicates that there may be individual stores (e.g. “Store E data” 1354E and “Store H” 1354H) which show higher than average temperature variability. If this higher temperature variability correlates with higher disposition rates, additional data, such as location correlated with the higher temperatures, may be identified and recommendations made. As an illustrative example, the gradual increase in temperature shown in the data for “Store E” 1354E may occur while the item is sitting in a case, e.g., container 318, on the retail floor, possibly indicating a problem with the case or that the item is being left on the floor too long. As an illustrative example, the rapid increase in temperature shown in the date for Store H” may indicate that the item was left on a loading dock or other location with no environmental control. Temperature data may be

combined with additional data to facilitate overall understanding. In an illustrative example, data may include movement or vibration data where a change may indicate a change in transportation status (e.g., arrival or departure from a location), stacking of containers (either within a storage area or onto a U-boat 333 (Fig. 3) for stocking), and the like. Micro-climate sensors 212 may provide data regarding how the equipment is working (e.g., is the cooling cycling appropriately), whether doors have been left open, and the like. Additional data may include light levels indicating when a box has been opened or an item is on display.

Additional data may include humidity data that may provide insight into whether misting complies with SOP, overall environmental conditions, and the like. Additional data may include EMF data for proximity sensing to assist in location identification. Additional data may come from others systems such as order data, inventory data, and the like.

[0123] Fig. 14 depicts an example temperature profile for a product indicating differences in temperature based on placement of micro-climate sensors 212 the with notation regarding key product quality transitions.

[0124] Referring to Fig. 15, a micro-climate sensor 212 may include one or more sensors 1502, a data storage 1504, a communications facility 1508, a unique sensor ID 1514, a battery 1520, and/or an antenna 1510. There may be a processor 1512 to interpret the data from the sensors 1502 and, in some embodiments, activate an alarm 1518. In embodiments, the communications facility 1508 and antenna 1510 may support communication with an RFID reader. In embodiments, the communications facility 1508 and antenna 1510 may support network communications with a system server 1010 or a disposition system 1004 using the in-store network 1009 which may be an existing cellular network using 3G, 4G, or 5G and the like, a local WiFi network (IEEE 802.11x), a short range network (e.g. Bluetooth, Bluetooth Low Energy, ZigBee, 6LoWPan, LTE-M1, NB-IoT, and the like), and the like. The sensors 1502 may include a thermometer and a humidity sensor, a light sensor (both intensity and color temperature), an accelerometer, a proximity sensor and the like. The battery 1520 may be rechargeable, or replaceable. The micro-climate sensors 212 may be reusable. A micro-climate sensor 212 may be strategically packed with targeted goods being shipped to a store (e.g., in a cardboard tray holding clamshell of strawberries). As will be described in greater detail below, in embodiments, a micro-climate sensor 212 may be removed from the incoming shipment for return to the distribution center after the targeted goods have been unloaded, after they have been shelved, upon sale, upon disposition, or the like. In embodiments, upon receipt by the store, some of the micro-climate sensors 212 may

no longer be needed and may be returned to the distribution center as part of a back-haul operation, others may be collected when product is placed on shelves or sold.

[0125] In embodiments, there may be calibrations associated with individual micro-climate sensors 212 or sensors 1502. In embodiments, there may be profiles or models that map the target product being measured with the micro-climate sensor 212 to the environment being experienced by the product being monitored. For example, product in the center of a container of perishable goods may have a different thermodynamic profile and response times than that of product or a micro-climate sensor at the top of the container. If a micro-climate sensor 212 is placed at the top of the container, a calibration may predict the environment seen by product at the center of the container as shown in Fig. 16. In an illustrative and non-limiting example, Fig. 16 depicts the temperature at the top of the container 1606A, which may be a container 318 (Figs. 3 and 4) and the temperature at the center of the same container 1606B over time. In the example shown in Fig. 16, the temperature at the top of container 1606A (and product/item of sale 210 positioned there) may increase more rapidly than the temperature at the center of the container 1606B (and product/item of sale 210 positioned there). Product at the top of the container may cross a temperature threshold 1602 at which point the product deteriorates (e.g., the produce outgasses, starts to mold, and the like) earlier than that of product at the center of the container. A micro-climate sensor 212 may have different alarm or alert conditions for identifying when product in the container may be approaching the temperature threshold 1602 based on the location of the micro-climate sensor 212 in the container. In the example of Fig. 16, for an alarm or alert to be initiated at a given time 1604 before any of the product crosses the temperature threshold 1602, a micro-climate sensor 212 may trigger the alarm at a different temperature 1606A, 1606B depending on a calibration for the micro-climate sensors which is based, at least in part, on location in the container.

[0126] A micro-climate sensor 212 may store measure and store data from one or more of its sensors 1502 on a periodic or scheduled basis or in response to a measurement from the specific sensor 1502 or a related sensor 1502 (e.g. measuring the same item of sale, a related item of sale, a transport of facilities sensor and the like), a query from the system, and the like. The standards used for measuring and storing data may be based on industry specifications, criteria provided by a receiving store or chain, and the like. In an illustrative example, temperature and humidity may be recorded every five (5) minutes under normal conditions but every minute once a threshold temperature or humidity has been reached.

[0127] Referring to Figs. 17-18, a receiving system 1006 may include a label reader 1702, a display 1708, a processor 1716, a communications system 1710, and/or a user interface 1718. In some embodiments a receiving system 1006 may also include an image capture device 1704 and/or a lighting system 1712. Micro-climate sensors 212 associated with a transport vehicle 114 may be in communication with the receiving system, via the in-store network 1009, which may be the same as network 320 (Fig. 3), with the system server 1010, which may be the same as server 120, with a distribution center system 1060, via a distribution center network 1027, or with any of the above using an existing cellular network using 3G, 4G, or 5G and the like. In this way, data from the micro-climate sensors 212, e.g., micro-climate sensors 212 within the supply chain 110, may be collected at 1802 (Fig. 18). As goods are unloaded from the transport, e.g., 114, data may be collected from micro-climate sensors 212 (step 1804) embedded with the goods being unloaded using the in-store network 1009 to communicate data to the receiving system 1006 and/or the system server 1010. An optional picture of the incoming item, e.g., 210, may be obtained 1808. The image may be obtained as part of standard operating procedure (e.g. take pictures of incoming fruit), in response to a suggestion based on data from the micro-climate sensors 212 and/or the transport sensors 132, and the like. An employee receiving the goods may also provide user input 1810 regarding the state of an item (e.g. received poor quality, received out of code, product out of temperature, product out of code, and the like) and a count of the item. Depending on user input, additional images may be requested.

[0128] A decision 1812 regarding acceptability of an incoming item, e.g., an item of sale 210, may be made as described elsewhere herein. In an illustrative example, data from the micro-climate sensors 212 may result in the product being rejected for food safety reasons, which may be based at least in part on a SOP 900 (Fig. 9) associated with transport such as temperature out of range, amount of time above or below a threshold, and the like. The rejection may be for both the product with which the micro-climate sensors 212 are associated (e.g. leafy greens) and/or for goods in close proximity during transit. In an illustrative example, a micro-climate sensor 212 associated with strawberry clamshells may show a temperature out of range. While there may not be a micro-climate sensor 212 associated with nearby blueberries, they may also be assumed to have been out of temperature. While the blueberries may not be rejected outright on the basis of data from sensors associated with other produce in near proximity, the blueberries may be subject to additional scrutiny. Additionally, if the two products or types or products are transported on

a common pallet, insight may be gained into whether the handling of the blueberries is in compliance with an SOP.

[0129] If an item, e.g., 210, is determined to be unacceptable, it may be redirected 1814. Redirection may include disposal if the item is completely unsalvageable. Redirection may include donation to a food pantry, for example, if shelf life is determined to be shortened given transport history, as determined by transport sensors 132 and micro-climate sensors 212, but where the item is still edible. If an item is determined to be unacceptable at receiving, data that contributed to the determination as well as other, related, data (e.g., producer, data from other micro-climate sensors associated with that transport (either for that store or intended for another store but on the same transport), store infrastructure and the like) may be provided to the system server 1010 where the system server 1010 may calculate analytics, add the material to a training set for the machine learning module 6602 (Fig. 66), disposition history 6610 (Fig. 66), and the like. The machine learning module 6602 may also be referred to as a machine learning circuit, a machine learning engine, and the like herein. Further, the data may be analyzed for trends across stores, trends associated with a particular supplier, transporter, transporter route, and the like to determine contributory conditions.

[0130] If an item, e.g., 210, is determined to be acceptable, the item may be received 1816 by the store. Once the item has been received, it may be logged in the store's inventory, moved to appropriate storage (e.g. a freezer, cooler, back room, and the like). Data about the received item may be provided to a store manager, item specific manager (e.g. produce manager, dairy manager), and recommendations made regarding the item. In an example, data from the micro-climate sensors 212 and/or transport sensors may result in an alert or recommendation associated with certain goods such as an indication of reduced shelf life due to transport conditions (e.g. extended time above a threshold temperature) and the need to sell the item quickly. This may include recommendations to shelve the items directly rather than storing and shelving according to a "first in first out" (FIFO) procedure. A recommendation may include a mark-down sticker, promotion, an impromptu sale on the item, changes in future ordering, and the like. A recommendation may include a recommendation to file a claim against a vendor, request credit from a vendor, and the like.

[0131] In embodiments, a subset of the micro-climate sensors 212 received with incoming goods/items of sale 210 may be removed and returned to the distribution center with the return of the transport, e.g., 114, to the distribution center. In embodiments, a subset of the micro-climate sensors 212 may remain with the incoming product and continue to monitor the environment being experienced by the product from receipt until sale or

disposition. Upon completion of the in-store life cycle of the product, the associated micro-climate sensors 212 may be collected and returned to the distribution center where they may be reused.

[0132] Referring to Fig. 19, an in-take system 1026 at the distribution center 116 may evaluate goods being received at the distribution center in a similar fashion to the receiving system 1006 at a store. An in-take system 1026 may include a label reader 1902, a display 1908, a processor 1916, a communications system 1910, and/or a user interface 1918. In some embodiments an in-take system 1026 may also include an image capture device 1904 and/or a lighting system 1912.

[0133] Referring to Fig. 20, upon arrival of a delivery at the distribution center, a label associated with the item, e.g., item of sale 210, may be read 2022 and any data from sensors provided by the producer collected 2024. In some embodiments, an image of the item may be obtained 2028 and/or input from the receiving employee 2030. All of this data may be associated with the item being received at the distribution center, and an evaluation made 1812 regarding the acceptability of the item as described elsewhere herein. If the item is deemed acceptable it may be received 1816 and stored with received goods 1025 in appropriate conditions (e.g., freezer, cooler, and the like). If the item is not deemed acceptable or deemed marginally acceptable the item may be redirected 1814. Unacceptable items may be refused and returned to the producer or discarded. Vendor credit may be requested based on unacceptable or marginally acceptable items. Repeated examples may result in negotiations with the vendor regarding ongoing product quality issues. Marginally acceptable items with shorted shelf life or reduced quality may be received and given expedited handling such as direct placement on shelves rather than first in/first out stocking, marked down, couponed, and the like.

[0134] Referring now to Fig. 21, a method 2100 for monitoring and reporting on the condition of a plurality of individual items of sale 210 throughout a supply chain 110 is shown. The method 2100 may include associating 2110 at least one micro-climate sensor 212 with a corresponding individual item of sale 210 in the plurality. In embodiments, the micro-climate sensors 212 may be associated with a selectable subset of the items of sale 210 of the plurality. The method 2100 may further include generating 2112, via the plurality of micro-climate sensors, product flow data for each corresponding item of sale 210. The method 2100 may further include determining 2114 flow analysis data from the product flow data. The flow analysis data may be for an individual item of sale 210 and/or for multiple items of sale 210. In embodiments, the flow analysis data is for a type of product represented

by the individual item of sale 210. In embodiments, each of the items of sale 210 of the plurality is a SKU. The method 2100 may further include transmitting 2116 the flow analysis data.

[0135] Turning now to Fig. 22, in embodiments, method 2100 may further include generating 2118, via the plurality of micro-climate sensors 212, subsequent product flow data for each of a subsequent plurality of items of sale 210 flowing through the supply chain 110; and determining 2220 subsequent flow analysis data from the subsequent flow data. In embodiments, the supply chain 110 may include a source 112, e.g., a farm. In embodiments, the supply chain 110 may include a distribution center 116 and/or a store 118. In embodiments, the supply chain 110 may include a source 112, a distribution center 116, a transport vehicle 114, a store 118, locations within a store 118, transport to a customer location 130, and locations therebetween.

[0136] Turning now to FIG. 23, the method 2100 may include generating 2310, based at least in part on the flow analysis data, a graphical user interface that depicts a contiguous view of the flow analysis data for at least one of the items of sale 210 of the plurality along the supply chain 110. For example, in embodiments, the graphical user interface provides a view of the condition of an item of sale from the source all the way to the store floor. In embodiments, the flow analysis data may include an indication that an item of sale 210 has experienced a product-life shortening event or product-quality reduction event, e.g., exposure to temperature non-compliant with a SOP. Non-limiting examples of product-life shortening events or product-quality reduction events may include non-SOP compliant temperatures, detection of moisture within a product packaging, detection of outgassing due to product decay and/or damage to the product packaging and/or consumable portion of the item of sale 210.

[0137] In embodiments, the method 2100 may include storing 2312 SOP data, corresponding to a SOP, and/or determining 2314 a deviation from the SOP data based at least in part on the flow analysis data. In embodiments, determining 2314 the deviation may include comparing 2316 the flow analysis data to the SOP data. In embodiments, the deviation may be based at least in part on a time of transit of at least one item of sale 210 along the supply chain 110. For example, it may be determined that a door to a vehicle 114 (FIG. 1) was left open too long, thus exposing items of sale 210 within the vehicle to non-SOP compliant temperatures. In embodiments, the deviation may be based at least in part on a time period of unloading an item of sale 210 at a point along the supply chain 110, e.g., loading dock 316 (Fig. 3), and/or a stocking event. In embodiments, the deviation may be

based at least in part on a temperature of at least one item of sale 210 at a point along the supply chain 110. For example, in embodiments, an item of sale 210 may experience a temperature that is non-compliant with a SOP while being unloaded from a vehicle 114 and/or while being stocked into a container 318. For example, in embodiments, a customer order may experience a time that is non-compliant with an SOP while being transported from a store 118 to a customer location 130.

[0138] In embodiments, the method 2100 may include, in response to determining 2314 the deviation, generating 2318 a sale-improvement action for at least one item of sale 210. In embodiments, the sale-improvement action may be moving the at least one item of sale 210 and/or discounting the at least one item of sale 210. In embodiments, the method 2100 may further include determining 2320 that at least one item of sale 210 should be disposed of and, if so, disposing 2322 of the at least one item of sale 210.

[0139] In embodiments, the method 2100 may further include generating and transmitting 2324 a deviation message 2400 (Fig. 24) that corresponds to the deviation. The deviation message may include an indication 2410 of the deviation to include identifying the affected items of sale 2410, 210. The deviation message may include an indication 2412 of the portion of the SOP that has been deviated from. The deviation message 2400 may include an indication of a product-life shortening or product-quality reducing event 2414, which may be a non-SOP compliant environmental temperature 2416, detected moisture 2418, and/or damage 2420, as described here and in other portions of this disclosure. The deviation message 2400 may further include location data 2422 corresponding to the location of the event giving rise to the deviation. The deviation message 2400 may include an indication 2424 of a sale-improvement action 2500 (Fig. 25). The sale-improvement action may include moving 2510 and/or discounting 2512 an item of sale 210 and/or any other sale-improvement action described herein. Generation and transmission 2326 of the deviation message 2400 may occur before substantial injury is imparted on an associated item of sale 210.

[0140] In embodiments, the method 2100 may further include generating 2326 and transmitting an alert message in response to determining 2314 the deviation. The alert message may include an indication of the deviation. The alert message may correspond to, and/or be structured to generate, a visual indication, an audio indication, and/or a text-based indication. The alert message may correspond to, and/or be structured to provide a micro-training event such as how to prevent future occurrences. The alert message may include a location of an item of sale 210 associated with the deviation. The alert message may be generated and transmitted 2326 when immediate, or near immediate, action, e.g.,

counteracting the condition giving rise to the deviation, needs to be taken to prevent substantial injury to an associated item of sale 210. For example, a server, e.g., 120 (Fig. 1) may determine that a box of strawberries is presently being exposed to temperatures above those specified in a SOP, wherein the server 120 proceeds to generate and send an alert message to a mobile electronic device, e.g., 126 (Fig. 3) in the possession of a store 118 employee 340. Upon receiving the alert, the employee 340 of the store 118 may then evaluate the strawberries and either dispose of them or apply a sale-improvement action, e.g., discount them or move them to a colder location. The method 2100 may further include displaying 2328 the flow analysis data, e.g., on a graphical interface in accordance with those described herein. The method 2100 may further include generating and displaying a micro-training event 2330, e.g., on a graphical interface in accordance with those described herein.

[0141] Referring to Fig. 26, a non-limiting example of a system may be implemented using apparatus 2600 for processing product flow data 2610. The apparatus 2600 may be a server 120 and/or an electronic device 126. The apparatus 2600 may include a product flow data processing circuit 2612 to interpret product flow data 2610 generated from each of a plurality of items of sale 210 (Fig. 2) flowing through a supply chain 110 (Fig. 1). The apparatus 2600 may include a standard operating procedure (SOP) data processing circuit 2614 to interpret SOP data 2616, which may result in processed SOP data 2626. The apparatus 2600 may include a flow analysis circuit 2618 to determine flow analysis data 2620 in response to the product flow data 2622. The apparatus 2600 may include a SOP deviation circuit 2624 to determine deviation data 2628 based at least in part on the flow analysis data 2622 and the processed SOP data 2626, wherein the deviation data 2628 indicates a deviation from the SOP data. The SOP deviation circuit 2624 may compare the flow analysis data 2622 to the processed SOP data 2626. The apparatus 2600 may include a flow analysis provisioning circuit 2634 to transmit flow analysis data 2622.

[0142] The apparatus 2600 may further include a deviation provisioning circuit 2630 structured to transmit the deviation data 2632. The deviation data 2632 may include an indication of a location in the supply chain 110 such as a source, a farm 112, a distribution center 116, a store 118, a location in a store, a holding area for delivery to a customer (either in-store or curbside 128), a transport vehicle 114 between locations such as source (e.g., farm 112) to distribution center 116, distribution center 116 to store 118, store 118 to customer 128, 130, and locations therebetween.

[0143] As shown in Fig. 28, the apparatus 2600 may further include a flow visualization circuit structured 2832 to generate visualized flow data 2834 for depicting a contiguous view

of the flow analysis data for at least one of the plurality of items of sale along the supply chain 110, where the supply chain includes two or more of a source such as a farm, a distribution center, a transport vehicle, a store, a location within a store, a transport vehicle to a customer location, locations therebetween, and the like. The items of sale may be a SKU, a produce product, a meat product, a dairy product, a fish product, a frozen product, or the like.

[0144] The deviation data 2830 (2628 in Fig. 26) may be based, at least in part on: a time of transit of at least one of the plurality of items of sale along the supply chain; a time period of at least one of: unloading at least one item of sale of the plurality at a point along the supply chain, or a stocking event corresponding to at least one item of sale of the plurality; and/or the like. The deviation data may include an indication that at least one item of sale of the plurality has experienced a product-life shortening or a product-quality reducing event such as: an environmental temperature that is out of compliance with the SOP data; detection of moisture within a product packaging of the at least one item of sale; damage to a product packaging of the at least one item of sale; or the like.

[0145] Turning to Fig. 29, a further portion 2900 of the apparatus 2600 (Fig. 26) may further include a recommendation circuit 2912 to generate, in response to the deviation data 2910, a recommended action value 2914. The recommended action value 2914 may correspond to a sale-improvement action to be taken with respect to at least one of the plurality of items of sale. The sale-improvement action may include: moving the at least one item of sale to a location; placing the at least one item of sale directly on the floor; discounting the at least one item of sale; or the like. The recommended action value may correspond to an indication that at least one of the plurality of items of sale is to be disposed.

[0146] The apparatus 2900 may further include an alert circuit 2916 to generate, in response to the deviation data 2910, alert data 2922, which may include an indication of the deviation, and an alert provisioning circuit 2924 structured to transit the alert data. The alert data 2922 may correspond to a visual indication; an audio indication, a text-based indication, a haptic indication, and the like. In embodiments, the alert may include a micro-training event. A micro-training event may include a brief indication of how to avoid the conditions which led to the alert. The indication may be a simple reminder to close the cooler door or a statement of a particular SOP showing a deviation in practice. The brief indication may be audible, a short video, or a written indication.

[0147] Referring to Fig. 27, a method 2700 for determining and transmitting deviation data is depicted. The method 2700 may include interpreting product flow data 2710 and interpreting standard operating procedure data 2712. The method 2700 may further include

determining flow analysis data 2714. The method 2700 may further include determining deviation data 2716 and transmitting deviation data 2718.

[0148] Referring to Fig. 28, a portion of the apparatus 2600 may include a product flow data processing circuit 2810 to condition product flow data 2812, resulting in processed flow data 2814. Conditioning may include associating portions of the product flow data related to a common sensor. The apparatus 2600 may further include a standard operating procedure data processing circuit 2816 to transform standard operating procedure data 2818 into processed standard operating procedure data 2820. The apparatus 2600 may further include a flow analysis circuit 2822 to derive flow analysis data 2824 from processed flow data 2814. A flow analysis provisioning circuit 2826 may transmit the flow analysis data 2824. The apparatus 2600 may further include a standard operating procedure deviation circuit 2828 which may determine deviation data 2830 from flow analysis data 2824 and processed standard operating procedure data 2820. A deviation provisioning circuit 2840 may transmit deviation data 2830 to a mobile device, a display, a user interface, or the like. A flow visualization circuit 2832 may determine visualized flow data 2834 from deviation data 2830, flow analysis data 2824, and processed standard operating procedure data 2820. A flow visualization provisioning circuit 2836 may transmit visualized flow data 2838 to a mobile device, an electronic device, a display, a user interface, or the like, to interpret and display the visualized flow data 2838.

[0149] Continuing to Fig. 29, a portion 2900 of the apparatus 2600 (Fig. 26) may include a recommendation circuit 2912 to generate, in response to the deviation data 2910, a recommended action value 2914. A recommended action value provisioning circuit 2918 may transmit the recommended action value 2914 to an electronic device, mobile device, or the like to interpret and display the recommended action value 2914. The recommendation action value 2914 may correspond to a sale-improvement action to be taken with respect to at least one of the plurality of items of sale. The sale-improvement action may include moving the at least one item of sale to a location or discounting the at least one item of sale. The recommendation action value 2914 may indicate that at least one of the plurality of items of sale is to be disposed.

[0150] The portion 2900 of the apparatus 2600 may include an alert circuit 2916 to generate, in response to the deviation data 2910, alert data 2922 comprising an indication of the deviation. An alert provisioning circuit 2924 may transmit the alert data 2922. The alert data 2922 may include a visual indication, an audio indication, a text-based indication, a haptic indication, or the like.

[0151] Referring to Fig. 30, a method 3000 for determining deviation data is depicted. The method 3000 may include interpreting product flow data 3010 and interpreting standard operating procedure data 3012. The method 3000 may further include determining flow analysis data 3014 from the interpreted product flow data and determining deviation data 3016 from the flow analysis data and the interpreted standard operating procedure data. The method 3000 may further include transmitting deviation data 3018.

[0152] Referring to Fig. 31, a method 3100 for recommending an action based on flow data and deviation data is depicted. The method 3100 may include interpreting product flow data 3110 and interpreting standard operating procedure data 3112. The method 3100 may include determining flow analysis data 3114 and determining deviation data 3116 by comparing flow analysis data to standard operating procedure data 3118. The method 3100 may further include: generating visualized flow data 3120; generating recommended action value 3122; and generating alert data 3124. The method 3100 may further include: transmitting deviation data 3126; transmitting visualized flow data 3128; transmitting recommended action value 3130; and transmitting recommended action data 3132.

[0153] Referring to Fig. 32, a method 3200 for determining product flow analysis data based on a first and second product flow data is depicted. The method 3200 may include associating at least one micro-climate sensor with a corresponding item of sale 3210 of a first plurality of items of sale, and generating first product flow data 3212. The method 3200 further includes removing the at least one micro-climate sensor from the corresponding item of sale of the first plurality 3214; associating the at least one micro-climate sensor with a corresponding item of sale of a second plurality of items of sale 3216; and generating, via the at least one micro-climate sensor, second product flow data 3218 for each of the second plurality of items of sale while flowing through the supply chain. The method 3200 may then include determining product flow analysis data 3220 based on the first and the second product flow data.

[0154] Referring to Fig. 33, a method 3300 for determining product flow data, deviations from SOP, and determining whether to dispose of an item based on deviation data is depicted. The method 3300 may include associating at least one micro-climate sensor with a corresponding item of sale 3210 of a first plurality of items of sale, and generating first product flow data 3212. The method 3300 further includes removing the at least one micro-climate sensor from the corresponding item of sale of the first plurality 3214; associating the at least one micro-climate sensor with a corresponding item of sale of a second plurality of items of sale 3216; and generating, via the at least one micro-climate sensor, second product

flow data 3218 for each of the second plurality of items of sale while flowing through the supply chain. The method 3300 may then include determining product flow analysis data 3220 based on the first and the second product flow data. The method 3300 may further include transmitting visualized flow data 3310; and generating graphical user interface 3312. The method 3300 may include determining a deviation from the standard operating procedure data 3314 by comparing flow analysis data to standard operating procedure data 3316. The method 3300 may include determining whether to dispose of an item of sale 3318 and, if the determination is to retain the item, the method 3300 may include generating a sale-improvement action 3320 or, if the determination is to dispose of the item, disposing of the item of sale 3322.

[0155] Referring to Fig. 34, a method 3400 for decommissioning a micro-climate sensor is depicted. The method 3400 may include: detecting the presence of at least one micro-climate sensor 3410; and generating a decommissioning command value 3412. In embodiments, a decommission command value may be transmitted 3414 to the at least one micro-climate sensor 3414. In embodiments, a decommission command value may be transmitted 3416 to a system server.

[0156] Referring to Fig. 35, a method 3500 for decommissioning a micro-climate sensor is depicted. The method 3500 may include receiving at least one micro-climate sensor 3510; detecting the presence of the at least one micro-climate sensor 3512 and generating a decommission command value 3514. In embodiments, a decommission command value may be transmitted 3516 to the at least one micro-climate sensor 3414. In embodiments, a decommission command value may be transmitted 3517 to a system server. Upon receipt of the decommission command value, the server, or an associated decommissioning circuit, may note the time the decommission command was generated and ignore any data received after that time from the micro-climate sensor. Upon receipt of the decommission command value, the server, or an associated decommissioning circuit, may mark the data received from the micro-climate server where any data after that point would be considered invalid. The method 3500 may further include storing the at least one micro-climate sensor 3518, and determining the status of the repository device 3520; including determining whether the repository device is full 3522. If the repository device is full, the method 3500 may include transmitting a status of the repository device 3524; generating and transmitting an initiate a backhaul command value 3526 or generating and transmitting an initiate mailing of sensor command value 3528 and removing at least one micro-climate sensor 3530. If the repository device is

not full, the method 3500 may further include transmitting a status of the repository device 3532 and generating and transmitting an identification value 3534.

[0157] Referring to Fig. 36, an apparatus 3600 for decommissioning a micro-climate sensor is depicted. The apparatus 3600 may include a sensor data processing circuit 3610 to determine a detection value 3612 based on sensor data 3614. The apparatus 3600 may further include a sensor decommissioning circuit 3616 to generate a decommissioning command value 3618 based on the detection value 3612. A sensor communication circuit 3620 communicates the decommission command value 3618 to the micro-climate sensor 212 to turn it off, put it into a low power mode, and the like. A system communication circuit 3621 may transmit the decommission command value 3618 to a system server to indicate a point time after which the data from that sensor is no longer valid.

[0158] Referring to Fig. 37, a system 3700 for recycling sensors is depicted. The system 3700 may include a sensor data processing circuit 3710 which determines a detection value 3714 based on sensor data 3712. A sensor decommissioning circuit 3716 may generate a decommission command value 3718 based on the detection value 3714. A sensor communication circuit 3720 may transmit the decommission command value 3718 to the micro-climate sensor 212 to turn it off, put it into a low power mode, and the like. A system communication circuit 3721 may transmit the decommission command value 3718 to a system server to indicate a point time after which the data from that sensor is no longer valid. A sensor identification circuit 3720 may transmit a sensor identification value 3730. Based on the decommission command value 3718, a backhaul initiation circuit 3726 may transmit an initiate a backhaul command value 3732. Based on the decommission command value 3718, a mail sensors initiation circuit 3728 may transmit an initiate mailing of sensors command value 3734.

[0159] Referring now to Fig. 38, a method 3810 of determining a store's compliance with standard operating procedures is depicted. The standard operating procedure may be that of the store, a chain of stores of which the store is a part, a piece of equipment in the store (e.g. a freezer) or the like. An example method may include generating 3812, via a plurality of micro-climate sensors 212 disposed on a floor of a store, store floor data corresponding to a plurality of items of sale disposed on the floor. Store floor data may include temperature, humidity, location, light levels, light color temperature, operating cycles of equipment, status of doors (open or closed), vibration, movement, gas detection, and the like. In an illustrative example, a change in vibration or motion together with a change in temperature may indicate a change in location, arrival at a location or the like. Levels of ethylene may indicate a level

of ripeness for associated bananas, avocados, and the like. The example method may further include determining 3814, based at least in part on standard operating procedure (SOP) data corresponding to an SOP of the store, store analysis data from the store floor data. The store analysis data may include an indicator of a measure of the store's compliance with the standard operating procedures (SOPs). Standard operating procedures may include temperature and humidity ranges for a particular item of sale, lighting conditions for particular items of sale (e.g. potatoes which will turn green with excess light), misting conditions or cycling in a display case, amount of time in display case between time spent in cold store, temperatures for freezers, display cases and the like, time spent on loading dock, time spent in cold store, location in cold store (based on vent location, door location, product velocity, and the like), length of time doors to various freezers and cold stores may remain open or shut, and the like. Standard operating procedures may include movement of an item of sale through a store such as whether and/or how long it remains on a receiving dock, whether it traveled out to the display floor and back instead of moving only what was needed for stocking the floor, path the item of sale through the store (e.g., length of time between locations, environment profile through which the item of sale travels (e.g., don't take frozen items through warmest part of store)), and the like. Standard operating procedures may include temperature ranges for a freezer, misting cycles for a produce bin, cutting off the ends of lettuce heads when browning occurs. Standard operating procedures may apply to producers and distribution centers such as a time from harvest to distribution center, a time from harvest to store, time item of sale spends in distribution center, acceptable temperature and humidity ranges for various items of sale during transport (e.g., from source to distribution center or distribution center to store). The example method may further include transmitting 3816 the store analysis data.

[0160] Referring now to Fig. 39, a method 3910 is depicted for using store floor data and standard operating procedures to identify next actions. An example method may include generating 3812, 3912 via a plurality of micro-climate sensors disposed on a floor of a store, store floor data corresponding to a plurality of items of sale disposed on the floor. In embodiments, the method may further comply generating 3914, via at least one processor, a recommended value for the SOP data and generating a graphical user interface 3916 structured to interpret user input data that defines the SOP data. The example method may also include determining 3918, based at least in part on standard operating procedure (SOP) data corresponding to a SOP of the store, store analysis data from the store floor data; and

transmitting 3920 the store analysis data. In embodiments, the example method may further include generating 3922 a graphical user interface that depicts the store analysis data.

[0161] The store analysis data may include a measure value. The measure value may be based, at least in part, on a numerical scale between one (1) and one-hundred (100), wherein one (1) represents low compliance with the SOP and one-hundred (100) represent high compliance with the SOP. The measure value may be based at least in part on a color scale, wherein red represents low compliance with the SOP and green represents high compliance with the SOP.

[0162] The store analysis data may include an indication of a deviation from the SOP. The deviation may be based, at least in part on: a period of time that at least one item of sale has spent on the floor; a temperature experienced by at least one item of sale while on the floor; a humidity experienced by at least one item of sale while on the floor; a light profile experienced by at least one item of sale while on the floor; a temperature profile experienced by at least one item of sale while in the produce cooler; a location of at least one item of sale in the produce cooler or in a display case; a time spent by at least one item of sale while on the dock; and the like.

[0163] The store analysis data may include an indication that at least one item of sale has experienced a product-life shortening event or a product-quality reducing event. The product-life shortening or product-quality reducing event may include an environmental temperature that is out of compliance with an SOP; detection of moisture within a product packaging of the at least one item of sale; damage to a product packaging of the at least one item of sale; detection that a product is over ripe for sale; and the like.

[0164] In response to the deviation, a sale-improvement action may be generated such as moving the at least one item of sale to a location that may be different than the current location such as a sale shelf, end cap and the like. The self-improvement action may be discounting the at least one item of sale such as by placing a coupon on the packaging. In embodiments, the response to the deviation may be to dispose 3924 of the at least one item of sale.

[0165] In embodiments, an alert message may be generated and transmitted 3926 in response to determining the deviation from the SOP, wherein the alert message comprises an indication of the deviation. The alert message may include a visual indication, an audio indication, a text-based indication, a haptic indication, or the like.

[0166] Referring to Fig. 40, an apparatus 4010 for measuring a store's compliance with an SOP is depicted. The apparatus 4010 may include a store floor data processing circuit

4012 to interpret store floor data 4022 corresponding to a plurality of items of sale disposed on a floor of a store. The apparatus may include a standard operating procedure data processing circuit 4030 to take standard operating procedure data 4024 and determine processed standard operating procedure data 4032. The apparatus 4010 may further include a store analysis circuit 4014 to determine, based at least in part on processed standard operating procedure (SOP) data 4032 corresponding to a SOP of the store, store analysis data 4016 from the processed store floor data 4028. A store analysis provisioning circuit 4018 may transmit the store analysis data 4016, wherein the store analysis data 4016 indicates a measure of the store's compliance with the SOP.

[0167] Referring to Fig. 41, an apparatus 4110 for measuring a store's compliance with an SOP is depicted. The apparatus 4110 may include a store floor data processing circuit 4012 to interpret store floor data 4022 corresponding to a plurality of items of sale disposed on a floor of a store. The apparatus 4110 may also include a graphical user interface 4112 to generate graphical user interface data to generate a graphical user interface for receiving user input data 4114. A user input processing circuit interprets the user input data 4114 which is provided to a SOP determination circuit 4030 structured to determine the processed SOP data 4032 based at least in part on the user input data 4114. The apparatus 4110 may further include a store analysis circuit 4014 to determine, based at least in part on processed value for the SOP data 4032 corresponding to a SOP of the store, store analysis data 4016 from the processed store floor data 4028. A store analysis provisioning circuit 4018 may transmit the store analysis data 4016, wherein the store analysis data 4016 indicates a measure of the store's compliance with the SOP.

[0168] Referring to Fig. 42, the apparatus 4210 for measuring a store's compliance with an SOP is depicted. The apparatus 4210 may include a store floor data processing circuit 4012 to interpret store floor data 4022 corresponding to a plurality of items of sale disposed on a floor of a store. An apparatus 4210 may also include a SOP recommendation circuit 4212 to generate a recommended value for the SOP data 4214. The apparatus 4210 may further include a store analysis circuit 4014 to determine, based at least in part on recommend value for the SOP data 4214 corresponding to a SOP of the store, store analysis data 4016 from the processed store floor data 4028. A store analysis provisioning circuit 4018 may transmit the store analysis data 4016, wherein the store analysis data 4016 indicates a measure of the store's compliance with the SOP.

[0169] Referring to Fig. 43, an apparatus 4310 for measuring a store's compliance with an SOP is depicted. The apparatus 4310 may include a store floor data processing circuit

4012 to interpret store floor data 4022 corresponding to a plurality of items of sale disposed on a floor of a store. The apparatus may include a standard operating procedure data processing circuit 4030 to take standard operating procedure data 4024 and determine processed standard operating procedure data 4032. The apparatus 4010 may further include a store analysis circuit 4014 to determine, based at least in part on processed standard operating procedure (SOP) data 4032 corresponding to a SOP of the store, store analysis data 4016 from the processed store floor data 4028. A store analysis provisioning circuit 4018 may transmit the store analysis data 4016, wherein the store analysis data 4016 indicates a measure of the store's compliance with the SOP. The apparatus 4010 may also include a recommendation circuit 4314 to generate, in response to the indication of the deviation, a recommended action value 4320 corresponding to a sale-improvement action to be taken with respect to at least one of the plurality of items of sale. A sale improvement action may include: moving the at least one item of sale to a location; discounting the at least one item of sale; and the like. The recommendation circuit 4314 may further generate, in response to the indication of the deviation, a recommended action value 4320 corresponding to disposal of at least one of the plurality of items of sale. The apparatus 4310 may also include an alert circuit 4316 structured to generate alert data 4322 including an indication of the deviation and an alert provisioning circuit to transmit the alert data 4322. The alert data 4322 may include a visual indication; an audio indication; a text-based indication, a haptic indication or the like. The alert data 4322 may include a location of the item of sale with respect to the floor.

[0170] Referring to Fig. 44, a method 4410 for measuring a store's compliance with an SOP is depicted. The method 4410 may include interpreting store floor data 4412 corresponding to a plurality of items of sale disposed on a floor of a store, determining store analysis data 4414, based at least in part on standard operating procedure (SOP) data corresponding to a SOP of the store and the store floor data 4412. The method 4410 may further include transmitting the store analysis data 4416, where the store analysis data indicates a measure of the store's compliance with the SOP.

[0171] Referring to Fig. 45, a method 4510 for measuring a store's compliance with an SOP is depicted. The method 4510 may include generating graphical user interface data 4514 to generate a graphical user interface for receiving user input data and interpreting the user input data 4516. The method 4510 may include generating a recommended value for SOP data 4512 and determining the SOP data 4518 based at least in part on the user input data. The method 4510 may include interpreting store floor data 4412 corresponding to a plurality of items of sale disposed on a floor of a store, determining store analysis data 4414,

based at least in part on standard operating procedure (SOP) data corresponding to a SOP of the store and the store floor data 4412. The method 4510 may further include transmitting the store analysis data 4416, where the store analysis data indicates a measure of the store's compliance with the SOP. The method 4510 may include generating store visualization data 4520 for depicting the store analysis data and transmitting the store visualization data 4522. The store analysis data may include a measure value. The measure value may be based at least in part on a numerical scale between one (1) and one-hundred (100), wherein one (1) represents low compliance with the SOP and one-hundred (100) represents high compliance with the SOP. The measure value may be based at least in part on a color scale, wherein red represents low compliance with the SOP and green represents high compliance with the SOP. The store analysis data may include an indication of a deviation from the SOP where the deviation is based at least in part on: a period of time that at least one item of sale of the plurality has spent on the floor; an environmental temperature experienced by at least one item of sale of the plurality while on the floor; an indication that at least one item of sale of the plurality has experienced a product-life shortening event or a product-quality reducing event. A product-life shortening or product quality reducing event may include: an environmental temperature that is out of compliance with the SOP; detection of moisture within a product packaging of the at least one item of sale; damage to a product packaging of the at least one item of sale, and the like.

[0172] The method 4510 may include generating alert data 4528 and transmitting the alert data 4530. The alert data may include a visual indication,, an audio indication, a text-based indication, a haptic indication, or the like. The alert data may include a location of the item of sale with respect to the floor.

[0173] Referring to Figs. 46-49, a disposition system 1004 is depicted which may include a label reader 4602, an image capture device 4604, a display 4608, a communication system 4610, a processor 4616, a user interface 4618, and an optional lighting system 4612. The label reader 4602 may include a bar code reader, a QR code reader, an RFID reader, an OCR system for analysis of a picture of the item, or the like. In embodiments, some or all of the components of the disposition system 1004 may be incorporated into a single device. In an illustrative and non-limiting example, as shown in Figs. 47-49, a mobile device 4714 (Fig. 47) such as a tablet, smart phone, MP3 player, MP4 player, or wearable may include two or more of the image capture device 4604, the display 4608, the communication system 4610, the label reader 4602, the processor 4616, the user interface 4618, and the optional lighting system 4612. Fig. 48 shows an illustrative example of a disposition system 1004 including a

tablet 4810 mounted to a stand 4812 in a fixed location (e.g., a back room) incorporating the majority of the components in a single device. Fig. 49 shows a mobile device such as a smart phone incorporating the majority of the components in a single device which may be carried onto a display floor and used at various locations within a store. In some embodiments, the label reader 4602 may be the image capture device 4604 and the processor 4616 interpreting a bar code captured in the image acquired by the image capture device 4604. In some embodiments, the label reader 4602 may be a standalone device in communication with other components of the disposition system 1004.

[0174] The user interface 4618 may be visual, audible, haptic, or a combination thereof. In an illustrative and non-limiting example, the user interface 4618 may provide audible information to the user and receive verbal commands. In some embodiments, the user interface 4618 may provide visual information to the user using the display device 4608 and receive input from the user in the form of buttons, a touch screen, and the like. In some embodiments, there may be multiple user interfaces able to view data related to the disposition system including the user interface 4618 in the disposition system 1004 (Fig. 10) and a second user interface 1040 accessible to store management for overview purposes. The second user interface 1040, may be accessible from a variety of devices.

[0175] In some embodiments, a disposition system 1004 (Fig. 10) may be positioned in a store's non-retail area, specifically, in an area where the disposition of items occurs. In some embodiments, there may be a portable disposition system which may be used within the retail area. For example, an image may be taken of a tray of apples on a shelf and the apples evaluated for ripeness, bruising, cuts and other indicators that might make them unsalable. The user interface 4618 may indicate apples should be pulled from the display and discarded because they were no longer in saleable condition. In some embodiments, there may be a disposition system 1004 at a location, where the disposition system may or may not be mobile. In some embodiments, there may be more than one disposition system at a location, with one potentially dedicated to a discard (or disposition) area and a mobile system for reviewing produce and the like in the retail side of the store.

[0176] Referring to Figs. 50-51, a disposition workflow 5000 is depicted. A user (which may be any form of store personnel, including an employee) may identify an item (step 5002) using the label reader 1702 (e.g., scanning a barcode, reading an RFID tag, or the like) as an item is being placed in a bin for disposal. Depending on the type of item, the employee may be asked to identify the number of items being disposed of and/or a reason for disposition (step 5004) using the user interface 4618. The user interface 4618 may allow the employee

to select one or more reasons from a list, or to enter an alternate reason. In embodiments, the reasons provided for disposal may vary based on type of item. For example, perishables such as fruit and vegetables may include options such as bruising, wilting, over ripe, spoilage, and the like. Shelf stable items may include options such as expired, damaged packaging, and the like.

[0177] Based on the reason for disposition, the employee may optionally be requested to capture one or more additional images of the item. The request may include instructions regarding details to be captured in the image, an outline of the image to capture, and the like. Details to be captured may include the bar code (Fig. 52) a sell by date, a use by date (Fig. 53), a code, a mark-down sticker (Fig. 54), damage to packaging, damage to item (e.g., bruising on the produce) (Fig. 55), and the like. The request may specify a type of lighting or angle of view to be used for the image capture. In some embodiments, the disposition system 1004 may include one or more light sources. Different types of lighting, such as infrared, may provide enhanced ability to detect variations in ripeness or bruising in fruit and vegetables. Type of lighting and angle of view may allow for the capture of an image with improved feature detection such as shininess, indentations in a package, and the like.

[0178] Determination may be made regarding appropriateness of disposition (step 5008). The determination may be made locally on the disposition system 1004 based on disposition rules in the data storage 1014, remotely on the system server based on disposition rules on or accessed by the system server 1010, or similarly in the cloud, or some combination thereof. The employee's entries, the item ID, any corresponding captured images, data from micro-climate sensors 212 associated with items of sale, located in-store, located on transport vehicles, and the like may be used in the determination regarding appropriateness of disposition made as described elsewhere herein. If the determination is that the disposition is appropriate given the item's condition, store rules, and the like, the item is discarded into the bin (step 5010) with no further action being taken.

[0179] If there is a question regarding the appropriateness of the disposition, or the decision to dispose of the item is determined to be incorrect, further, real time corrective action may be taken (step 5012). Referring to Fig. 51, further actions (step 5012) may include identifying a sell by date (step 5104), determining if it is past the sell by date (step 5106). If it is still within the sell by date, a further evaluation may be undertaken (step 5108) and a new determination about the appropriateness of the disposition is made (step 5110). If the determination is that the disposition is appropriate given the item's condition, store rules, and the like, the item is discarded into the bin (step 5010) with no further action being taken.

Otherwise, the item may be further evaluated (step 5112) and a determination made regarding whether the item condition is acceptable (step 5114) based on the item's condition, store rules, and the like. If it is determined to be acceptable, further actions may include as recommending that the item be donated (food donation), recommending re-shelving, requesting an override, and the like.

[0180] In an illustrative example, if a banana appears to be fresh with no bruising or damage, the system may recommend that the banana be replaced in the store display. In other embodiments, the data regarding an inappropriate disposition may be stored and used in the future. In an example, the data regarding the inappropriate disposition may be used in training store employees, either for the majority of back room employees or, if data indicates that inappropriate disposition is associated with a single shift or employee, the training may be targeted to that employee or shift. In an illustrative example, the data regarding the inappropriate disposition may be used as the basis for revising standard operating procedures, changing staffing levels, store or employee evaluation, and the like. In another illustrative example, the data regarding the inappropriate disposition may be used as input to an ordering system, or provided to a district manager to identify individual and chainwide opportunities for improvement in training, SOPs, and the like.

[0181] Referring now to Fig. 56, a method 5610 for determining a causal event for a disposal for at least one of the plurality of items of sale is depicted. The method 5610 may include generating visual disposition data 5612 from a plurality of items of sale in a store and then image processing 5614 the visual disposition data to generate processed disposition data. Image processing as described herein may incorporate one or more of the artificial intelligence and/or machine learning algorithms described herein. The method 5610 may further include determining disposition analysis data 5616 from the processed disposition data and transmitting the disposition analysis data 5618. The disposition analysis data may include an indication of a causal event for a disposal for at least one of the plurality of items of sale.

[0182] Referring to Fig. 57, a method 5710 for determining a causal event for a disposal for at least one of the plurality of items of sale is depicted. The method 5710 may include generating visual disposition data 5612 from a plurality of items of sale in a store. At least one of the items of sale may be a produce product, a meat product, a dairy product, a fish product, or the like. At least one of the items of sale may be a frozen product. Generating visual disposition data 5612 may be performed via a handheld mobile electronic device, or via a robot 330 (Fig. 3). The method 5710 may further include image processing 5614 the

visual disposition data to generate processed disposition data. The method 5710 may further include determining 5616 disposition analysis data from the processed disposition data and transmitting 5618 the disposition analysis data. The disposition analysis data may include an indication of a causal event for a disposal for at least one of the plurality of items of sale.

[0183] The image processing 5614 may detect a presence of moisture within a product packaging of the at least one item of sale and, upon determining that a level of the detected moisture meets or exceeds a moisture level defined by a standard operating procedure 5714 for disposing of the at least one item of sale, determining that the causal event is based at least in part on the presence of the detected moisture 5712.

[0184] The image processing 5614 may detect damage to a product packaging of the at least one item of sale and, upon determining that a level of the damage to the product packaging meets or exceeds a product packaging damage level defined by a standard operating procedure 5716 for disposing of the at least one item of sale, determining that the causal event is based at least in part on the damage to the product packaging 5718.

[0185] The image processing 5614 may determine that a seal of the product packaging has been ruptured 5720 and, upon determining that the seal of the product packaging has been ruptured, determining that the causal event is based at least in part on the ruptured seal 5722.

[0186] The image processing 5614 may detect damage to a consumable portion of the at least one item of sale, and, upon determining that a level of the damage to the consumable portion meets or exceeds a consumable portion damage level defined by a standard operating procedure for disposing of the at least one item of sale 5728, determining that the causal event is based at least in part on the damage to the consumable portion 5730.

[0187] The image processing 5614 may detect outgassing from the at least one item of sale and, upon determining that the outgassing exceeds an outgassing level defined by a standard operating procedure 5724, determining that the causal even is based at least in part on level of ripeness 5726.

[0188] Referring to Fig. 58, a method 5810 for determining and transmitting disposition analysis data is depicted. The method 5810 may include interpreting visual disposition data 5812 generated from a plurality of items of sale in a store and image processing 5814 the visual disposition data to generate processed disposition data. The method 5810 may further include determining disposition analysis data 5816 from the processed disposition data and transmitting the disposition analysis data 5818. The disposition analysis data may include an indication of a causal event for a disposal for at least one of the plurality of items of sale.

[0189] Referring to Fig. 59, a method 5910 for determining and transmitting disposition analysis data is depicted. The method 5910 may include interpreting visual disposition data generated 5812 from a plurality of items of sale in a store and image processing 5814 the visual disposition data to generate processed disposition data. The method 5910 may further include determining 5816 disposition analysis data from the processed disposition data and transmitting 5818 the disposition analysis data. The disposition analysis data may include an indication of a causal event for a disposal for at least one of the plurality of items of sale.

[0190] The image processing 5814 may detect a presence of moisture within a product packaging of the at least one item of sale and, upon determining that a level of the detected moisture meets or exceeds a moisture level defined by a standard operating procedure 5914 for disposing of the at least one item of sale, determining that the causal event is based at least in part on the presence of the detected moisture 5912.

[0191] The image processing 5814 may detect damage to a product packaging of the at least one item of sale and, upon determining that a level of the damage to the product packaging meets or exceeds a product packaging damage level defined by a standard operating procedure 5916 for disposing of the at least one item of sale, determining that the causal event is based at least in part on the damage to the product packaging 5918.

[0192] The image processing 5814 may determine that a seal of the product packaging has been ruptured 5920 and, upon determining that the seal of the product packaging has been ruptured, determining that the causal event is based at least in part on the ruptured seal 5922.

[0193] The image processing 5814 may detect damage to a consumable portion of the at least one item of sale, and, upon determining that a level of the damage to the consumable portion meets or exceeds a consumable portion damage level defined by a standard operating procedure for disposing of the at least one item of sale 5928, determining that the causal event is based at least in part on the damage to the consumable portion 5930.

[0194] The image processing 5814 may detect outgassing from the at least one item of sale and, upon determining that the outgassing exceeds an outgassing level defined by a standard operating procedure 5924, determining that the causal event is based at least in part on level of ripeness 5926.

[0195] Referring to Fig. 60, a method 6010 for generating and transmitting visual disposition data is depicted. The method 6010 may include identifying 6012, in a store, at least one item of sale that is to be disposed and generating visual disposition data 6014 from the at least one item via a mobile electronic device. The method 6010 may further include transmitting the visual disposition data 6016 via the electronic device.

[0196] Referring to Fig. 61, an apparatus 6110 for determining an indication of a causal event for a disposal for the at least one item of sale is depicted. The apparatus 6110 may include a visual disposition data processing circuit 6112 to interpret visual disposition data 6114 from at least one item of sale in a store. The apparatus 6110 may include an image processing circuit 6116 to generate processed disposition data 6120 from interpreted visual disposition data 6118. The apparatus 6110 may include a disposition analysis determination circuit 6122 to generate disposition analysis data 6124 from the processed disposition data 6120. A disposition analysis provisioning circuit 6126 may transmit the disposition analysis data 6124. The disposition analysis data 6124 may include an indication of a causal event for a disposal for the at least one item of sale. The apparatus 6110 may further include a standard operating procedure data processing circuit 6130 to generate a processed standard operating procedure data 6132 from standard operating procedure data 6134. The processed standard operating procedure data 6132 may be used by the disposition analysis determination circuit 6122.

[0197] The image processing circuit 6116 may detect a presence of moisture within a product packaging of the at least one item of sale and, upon determining that a level of the detected moisture meets or exceeds a moisture level defined by a standard operating procedure for disposing of the at least one item of sale, determining that the causal event is based at least in part on the presence of the detected moisture.

[0198] The image processing circuit 6116 may detect damage to a product packaging of the at least one item of sale and, upon determining that a level of the damage to the product packaging meets or exceeds a product packaging damage level defined by a standard operating procedure for disposing of the at least one item of sale, determining that the causal event is based at least in part on the damage to the product packaging.

[0199] The image processing circuit 6116 may determine that a seal of the product packaging has been ruptured and, upon determining that the seal of the product packaging has been ruptured, determining that the causal event is based at least in part on the ruptured seal.

[0200] The image processing circuit 6116 may detect damage to a consumable portion of the at least one item of sale, and, upon determining that a level of the damage to the consumable portion meets or exceeds a consumable portion damage level defined by a standard operating procedure for disposing of the at least one item of sale, determining that the causal event is based at least in part on the damage to the consumable portion.

[0201] The image processing circuit 6116 may detect outgassing from the at least one item of sale and, upon determining that the outgassing exceeds an outgassing level defined by

a standard operating procedure, determining that the causal even is based at least in part on level of ripeness

[0202] Referring now to Fig. 62, a method 6210 for determining a score is disclosed. The method 6210 may include interpreting flow analysis data 6212 corresponding to a plurality of items of sale flowing through a supply chain for an entity (e.g., a store or a chain of stores), interpreting store analysis data 6214 corresponding to the plurality of items of sale while disposed on a floor of a store, and interpreting disposition analysis data 6216 corresponding to disposal of some of the plurality of items of sale. The method 6210 may further include determining a score value 6218 based at least in part on the flow analysis data, the store analysis data, and the disposition analysis data. The method 6210 may further include generating recommendations including actions 6220 that may be taken to improve a score value. The score value may represent a freshness score (referred to as a fresh score value elsewhere herein), a level of compliance with a single standard operating procedure, a level of compliance with a set or subset of standard operating procedures, the score value may represent an individual store, a chain of stores, a brand of stores, a subset of stores in a chain, and the like.

[0203] Referring now to Fig. 63, a method 6310 for determining and displaying a score is disclosed. The method 6310 may include interpreting flow analysis data 6212 corresponding to a plurality of items of sale flowing through a supply chain for an entity, interpreting store analysis data 6214 corresponding to the plurality of items of sale while disposed on a floor of the store, and interpreting disposition analysis data 6216 corresponding to disposal of some of the plurality of items of sale. The method 6310 may further include determining a score value 6218 based at least in part on the flow analysis data, the store analysis data, and the disposition analysis data. The method 6310 may further include generating recommendations including actions 6220 that may be taken to improve a score value. The score value may represent a freshness score (referred to as a fresh score value elsewhere herein), a level of compliance with a single standard operating procedure, a level of compliance with a set or subset of standard operating procedures, the score value may represent an individual store, a chain of stores, a brand of stores, a subset of stores in a chain, and the like. The method 6310 may also include generating a graphical user interface 6312 that depicts at least a portion of: the flow analysis data; the store analysis data; the disposition analysis data; the score value, underlying data, recommendations of actions, or the like.

[0204] The flow analysis data may include an indication of compliance of the plurality of items of sale with respect to a first standard operating procedure (SOP). The store analysis

data may include an indication of compliance of the plurality of items of sale with respect to a second SOP. The first SOP and the second SOP may be the same or the first SOP and the second SOP may form part of a third SOP. In an illustrative and non-limiting example, the first SOP may include a limit on how long an item of sale may remain on the dock. The second SOP may include a limit on the maximum temperature of the item of sale. The first and the second SOP may be part of a third SOP describing the overall handling of the item of the sale once it is received by the store.

[0205] The score value may be a fresh score value and correspond to a measure of a freshness of the items of sale where the measure of freshness is with respect to a time period. The time period may be selected or specified. The time period is the time over which the fresh score value is determined. The fresh score value may include a numerical value, where the numerical value is based at least in part on a scale between one (1) and one-hundred (100), wherein one (1) represents low freshness and one-hundred (100) represents high freshness. The fresh score value may be based at least in part on a color scale, wherein red represents low freshness and green represents high freshness.

[0206] Referring to Fig. 64, an apparatus 6410 for determining and transmitting a score value is depicted. The apparatus 6410 may include a flow analysis data processing circuit 6412 to interpret flow analysis data 6414 generated from a plurality of items of sale flowing through a portion of a supply chain. The apparatus 6410 may further include a store analysis data processing circuit 6418 structured to interpret store analysis data 6420 generated from the plurality of items of sale while disposed on a floor of a store. The apparatus 6410 may further include a disposition analysis data processing circuit 6422 structured to interpret disposition analysis data 6424 comprising one or more indications of one or more causal events for the disposal of at least some of the plurality of items of sale. The apparatus 6410 may further include a score determination circuit 6426 to determine a score value 6432 based at least in part on the processed flow analysis data 6416, the processed store analysis data 6428, and the processed disposition analysis data 6430. A score provisioning circuit 6434 may transmit the score value 6432. The score value may be a fresh score value and correspond to a measure of a freshness of the items of sale where the measure of freshness is with respect to a time period.

[0207] The apparatus 6410 may further include a graphical user interface circuit 6444 to generate graphical interface data 6446 to generate a graphical user interface that depicts at least a portion of the flow analysis data 6414; the store analysis data 6420; the disposition analysis data 6424; the score value 6432, underlying data, and the like.

[0208] The flow analysis data 6414 may include an indication of compliance of the plurality of items of sale with respect to a first standard operating procedure (SOP), and an indication of compliance of the plurality of items of sale with respect to a second SOP. In embodiments, the first SOP and the second SOP may be the same, different or form part of a third SOP.

[0209] The score value 6432 may be a fresh score value corresponding to a measure of a freshness of the items of sale where the measure of freshness is with respect to a time period. The apparatus 6410 may further include a user input circuit 6448 structured to interpret a user input data 6438 and a time period determination circuit 6442 structured to determine the time period data 6436 based at least in part on the processed user input 6440. The time period data 6436 is the time period over which the fresh score value 6432 is determined.

[0210] The fresh score value 6432 may include a numerical value, where the numerical value is based at least in part on a scale between one (1) and one-hundred (100), wherein one (1) represents low freshness and one-hundred (100) represents high freshness. The fresh score value 6432 may be based at least in part on a color scale, wherein red represents low freshness and green represents high freshness.

[0211] Referring to Fig.65, a system user interface 6516 is depicted. The system user interface 6516 may allow a user to view dashboards, images, reports, underlying data related to various components of the system, and the like. The system user interface may be able to access data from disposition systems 1004, receiving systems 1006, in-take systems 1026, sensor 212, data, store inventory systems 6502, point of sale systems 6504, ordering systems 6506, store management systems 6508 and metadata, and the like. In embodiments, the system user interface 6516 may include access control enabling users of different levels of access to data depending on their identity or role. For example, a produce manager might be limited to data related to the produce department, sensors providing produce related data, produce sales and ordering and the like. A store manager might be allowed to view all data related to the store and sensors providing data related to goods arriving at the store. Views may include live views for all the live sensors in produce or all live sensors in the store. View may include historic views from a sensor or set of sensors. Chain managers might be allowed to view individual data for multiple stores as well as data across stores (e.g. number of cases of strawberries disposed of compared across stores). The system user interface 6516, may allow for receipt and review of reports, alarms, alerts, recommendations, and the like.

[0212] In embodiments, the system user interface 6516 may include a rules entry interface 6512 for the entry of rules such store specific metadata to be included with item

data, rules for acceptability and disposition, trigger conditions, identify appropriate alert/alarm/recommendation recipients, and the like. In an illustrative example, fixed alarms such as temperature thresholds or temperature trends may be defined and recipient (e.g. store manager team, produce manager) information and contact method may be entered. In another example, there may be alarms specific to a product or product type related to velocity, light levels and the like. In an illustrative example, product sitting in a cooler exceeding a time threshold, or potatoes exceeding a light level may result in an alert to relevant personnel. Alarm conditions may be set by a user using the rules entry interface 6512 on the system user interface 6516 or based on data from the system server 1010 which may be reviewed by a user of the system user interface 6516. The system user interface 6516, may allow a user to provide training input to a machine learning circuit as described elsewhere herein.

[0213] Referring to Fig. 66, the system server 1010 may include a machine learning circuit 6602, an artificial intelligence circuit 6604, a rules database 6608, a disposition history 6610 for different types of materials, and a report engine 6618. The artificial intelligence circuit 6604 may include a disposal recommendation engine 6612, a sensor recommendation engine 6614, an acceptability analysis engine 6622, and a compliance analysis engine 6620.

[0214] In embodiments, the machine learning engine 6602 may be local to the system server 1010, distributed between product system components, located in the cloud, and the like.

[0215] The machine learning engine 6602 may be provided with a wide variety of learning sets from which to derive rules, algorithms, correlations, and the like. In embodiments, the machine learning engine 6602 may be provided with training sets of images focused specifically on a known problem, such as identifying moisture inside of plastic packaging (a clear plastic bag or a clear plastic clamshell) or a specific type of quality degradation such as browning on lettuce or the presence of mold on strawberries. In embodiments, the machine learning engine 6602 may be provided with a training set of images focused on identifying levels of ripeness of a product. For example, the degree of ripeness of a strawberry may be indicated by the deepness of the red color or the degree of ripeness of a banana may be identified by both color (shade of green, yellow, or brown) and the presence of brown spots on a yellow banana.

[0216] In an embodiment, the machine learning engine 6602 may be provided with a set of images of a specific item type at varying degrees of freshness, quality, salability and the like together with feedback regarding the acceptability of an item having that appearance or

the associated metadata. Pictures of produce and product containers may be evaluated together with input from a product manager regarding the product freshness, condition (e.g. wilted, moisture in the packaging), physical integrity of the product (e.g. is an apple bruised, corn ear is partially peeled, or a package is damaged), and the like.

[0217] In embodiments, the machine learning engine 6602 may look at a variety or combinations of image classification categories. Categories may include color (bruises, ripeness), shape (to identify type of produce), color and shape (e.g. distinguish limes and lemon) shininess (e.g. is the apple fresh), package integrity, and the like. Package integrity may include evaluation of man-made containers to determine whether it has been improperly opened, the packaging is damaged, product is missing (e.g. 2 onions in a bag of onions), there is moisture or mold present in the packaging. Package integrity may include evaluation of natural produce packaging (e.g. is a corn ear partially peeled, is a cantaloupe cracked, and the like). In an illustrative example, of an image of a product may indicate degree of ripeness (green bananas are unripe and yellow bananas with brown spots are overripe), bruising (discoloration in a portion of the item), partial peeling, browned leaves on a head of lettuce, dimples in oranges, moisture in external packaging, presence of mold in packaging or on produce, the like. Text recognition may be used to identify “Sell by Dates”, “Best by Dates”, receive codes, date produce left the farm, and the like.

[0218] In embodiments, the machine learning engine 6602 may utilize neural networks, deep learning techniques, convolution networks, and the like to develop algorithms, rules, rankings and the like for utilization by the artificial intelligence circuit 6604. In embodiments, training may be tailored for individual customers who identify specific levels of acceptability. In embodiments, training may be general to simply identify different levels of quality (e.g. a quality value) and the customer may then identify the minimum level of quality/quality value. Such a ranking scale may help remove subjectivity between employees or store locations when deciding when to discard an item.

[0219] In embodiments, the machine learning engine 6602 may leverage disposition history, images, and metadata to identify additional criteria for acceptance or rejection of an item. Metadata may include an item specific profile (e.g. different items have unique properties in terms of sensitivity and shelf life), profile for store associated with image (e.g. different stores may be laid out differently with different), profile for produce managers associated with images, transport history, sales and ordering systems, historic disposition data, historic sales data, back-end knowledge regarding the distribution center and/or store, external data such as weather, road conditions, holidays, and the like, that may cause to

deviations from normal acceptability and expected discard levels. For example, a severe storm or traffic accident may result in transport being on the road for longer periods than anticipated, potentially resulting in temperature extremes or more temperature swings. A heat wave may result in produce seeing higher than desired temperatures if the temperature exceeds the ability of the transport and store infrastructure to maintain a desired temperature. Accelerated ripening as the result of the temperature swings, may result in higher levels of discard prior to a sell by date due to produce spoiling too quickly. Metadata may include order discrepancies such as receiving a short order (less product than ordered) or distribution center pushing products and delivering more product than ordered. In an illustrative example, receipt of excess product may result in higher levels of discard for that product if the volume of excess product exceeds the sales capacity of the store for that product.

[0220] The identified image characteristics may be consolidated with other metadata to develop insights into conditions at a particular store, transport, supplier or the like. In an illustrative example, if a package of lettuce has browning on the leaves, but no evidence of moisture and it is within the date code, it may be indicative of elevated temperatures at some point in supply chain or a problem with the supplier. In an illustrative example, as shown in Fig. 67, a partial summary of the metadata 6704 associated with a dispositioned item may be derived from image processing and may include information such as store where item was dispositioned, item SKU, item description, whether or not a coupon was applied or other indicator that store protocols were being followed as well as an indication of why the item was being dispositioned, in this case due to moisture in the package. The metadata 6704 may have associated image of damage 6702 (e.g., moisture, bruising, discoloration, and the like), coupons 6710, and the like. Data from corresponding micro-climate sensors 212 associated with items of sale, located in-store, and located on transport vehicles, and the like which experienced similar conditions may provide insight as to the source of the problem. In an illustrative example, as shown in Fig. 68, both packages of greens 6810A, 6810B are documented as being within their date code 6902A, 6902B. However, one of the packages of greens 6810A shows evidence of condensation 6874 and water droplets 6802 in the packaging, indicating that it has been mishandled.

[0221] In embodiments, the sensor recommendation engine 6614 (Fig. 66) may provide recommendations to employees in the distribution center 116, via a user interface 1028, regarding deployment of micro-climate sensors 212. Recommendations may include how many micro-climate sensors to deploy in a specific shipment to a particular store 118, how many micro-climate sensors to deploy with a particular item type, which types of sensors

1502 to deploy (thermometer, humidity, movement), where to deploy the micro-climate sensors 212 (e.g. with frozen pizzas, strawberries, or canned goods), and the like.

[0222] A report engine 6618 may provide a user with summary information regarding recent data, key findings and recommendations. The report engine 6618 may show data for a single store, a plurality of peer stores, data for a chain of stores, and the like. The report engine may provide graphs and summaries showing differences in the data and any correlations with background data. The report engine may generate recommendation regarding a prioritized set of specific actions that should enable the store to improve their fresh score value based on the data. The prioritized set of specific actions would evolve as the data changes, for example in response to approved adherence to a SOP.

[0223] Referring to Fig. 69, a distribution workflow is depicted. As an employee at a distribution center 116 begins to assemble an outbound shipment 1024, they may consult, via a user interface 1028, a packing list (step 6902) indicating which goods 1025 to be included in the outbound shipment 1024, what micro-climate sensors 212 should be deployed, how the micro-sensors should be deployed, and the like. As the employee gathers the goods 1025 for a particular outbound shipment, they may log the goods assembled 1025 (step 6904) and log specific micro-climate sensors 212 to be deployed with that shipment (step 6908). The act of logging the goods 1025 and micro sensors 212 may include associating specific items of sale and specific micro-climate sensors 212 with shipment specific information such as receiving location, transport to be used, specific transport vehicle, and the like. In embodiments, the act of logging the specific micro-climate sensors 212 may include resetting the sensors. The micro-climate sensors 212 may then be incorporated into the shipment as indicated (step 6910), e.g., placed in a carton of a specific type of good, placed at a specific location on the pallet, and the like. Data measured by the logged micro-climate sensors 212 may then be read by the receiving system 1006 at the receiving location.

[0224] The artificial intelligence circuit 6604 may utilize the learnings from the machine learning circuit 6602 (e.g. algorithms, rules) to evaluate product quality based on the images. The artificial intelligence circuit 6604 may include a disposal recommendation engine 6612, an acceptability determination engine 6616, a sensor recommendation engine 6614, an improvement recommendations engine 6622, and a compliance analysis engine 6620. The artificial intelligence circuit 6604 may utilized rules from the rules database 6608, data from micro-climate sensors 212 associated with items of sale, located in-store, and located on transport vehicles,, images from disposition systems 1004, in-take systems 1026, and receiving systems 1006, sales and ordering systems providing data relevant to the store,

historic disposition data, historic sales data, back-end knowledge regarding the distribution center and/or store, external data such as weather, road conditions, holidays, and the like.

[0225] Back-end knowledge may include data specific to the location such as velocity of an item type through that store based on that store's average sales of the item, labor levels, personnel, ambient store temperature, receiving schedules (number of delivery days, days of week, time of day, and the like), whether a produce employee is on shift during delivery, identification of employee(s) on shift when item is received, employee(s) on shift when item is discarded, average delay between product arrival at store and storage in cooler, store layout, location of the store, logistic network, demographics of store customers such as age distribution, ethnicity, economic demographics, type of materials, in-store equipment (size of freezers, cases, and the like), back room size (do they have a large back room and are thus are more likely to fill a large cooler and hang onto inventory compared to a small back room necessitating perpetual inventory coming into the store), and the like. Using machine learning 6602 to analyze back end knowledge together with sensor data and disposition data correlations may be identified. Recommendations may be based on identifying difference between stores with similar backends but lower disposition rates.

[0226] In some embodiments, the back end knowledge, sensor data and disposition data may comprise a training set for the machine learning 6602 which may be supplemented by human input using the system user interface 6504, to provide data regarding solutions that had worked in similar situations in the past, recommendations and the like. This information may be provided to an improvement recommendations engine 6622 that may provide recommendations to a store, produce manager, distribution center personnel, and the like. In an illustrative example, if arriving items spending a longer time on the receiving dock before being placed in the cooler is correlated with a lack of a produce manager at receiving, a recommendation may be made to a store to have a produce manager on hand at receiving. In an illustrative example, stores with cases showing high variability may be correlated with case locations near the store doors and higher disposition rates for the items placed in those cases. For these stores, a recommendation may be made to reposition the case, move produce back to the cooler more frequently and the like.

[0227] In embodiments, the sensor recommendation engine 6614 may incorporate back-end knowledge about a given store when making recommendations regarding the deployment of micro-climate sensors 212. In an illustrative example, additional sensors may be added to shipments headed for a location where this is a distance between the loading dock and cold storage above a given threshold. In another illustrative example, additional sensors may be

added to produce being shipped to a location with a large cooler to allow ongoing monitoring while the produce is in storage. This information may enable the identification of goods that are in storage long term and whether they are retaining their freshness, seeing temperature cycles, and the like.

[0228] The disposal recommendation engine 6612 may include sliding compliance metrics based on data from external sources such as weather conditions (both local and at source location for item), seasonality, local social variants such as holidays, strikes, and the like, external events such as local traffic jams, local construction, war, and the like. In an illustrative example, the level of quality at which discarding an orange is appropriate may be lower when oranges are out of season, or when there have been freezing temperatures in the locations from which the oranges are sourced. When the weather is good and the oranges are in season, the level of quality at which discarding an orange is appropriate may be higher as customers would expect top quality in those conditions. In an illustrative and non-limiting example, local social variants such as a strike or local construction/traffic jams may reduce accessibility to, and sales at, a given location, potentially resulting in higher levels of disposition of produce at affected sites. In an illustrative and non-limiting example, a store may stock up on certain items related to a local event (e.g. a state fair) or a holiday associated with a store's customer demographics (Portuguese Festival). Depending on sales, there may be higher than normal discards related to the higher levels of inventory.

[0229] In embodiments, the rank at which an item need be pulled from the shelf may vary with the time of year, e.g., in-season produce may a higher level of quality compared to an out-of-season produce. The artificial intelligence circuit 6604 may utilize the learnings from the machine learning circuit 6602 to evaluate images as they are received to identify a quality ranking which is used. This quality ranking may be used by the disposal recommendation engine 6612 together with disposition rules from the rules database 6608, and data from micro-climate sensors 212 associated with items of sale along the supply chain or located in-store, disposition histories for the item type, store type and the like, to determine a recommendation for the disposition of an item. Recommendations for the disposition of an item may include donation of food to a shelter or food bank, restocking of the item as it is still in saleable condition, confirmation of the decision to discard the item, and the like.

[0230] The machine learning circuit 6602 may be provided with a set of test data including transport data, in-store data, images, order history, sales data, order data, micro-climate sensor 212, and data about the back room. In embodiments, the machine learning circuit 6602 may use unsupervised learning such as clustering as well as supervised learning

including classification and regression. Techniques may include k-means and k-medoids, hierarchical clustering, Gaussian mixture models, hidden Markov models, self-organizing maps, fuzzy c-means clustering, subtractive clustering, support vector machine (SVM), boosted and bagged decision trees, k-nearest neighbor, Naïve Bayes, discriminant analysis, logistic regression, and neural networks, linear models, non-linear models, regularization, stepwise regression, adaptive neuro-fuzzy learning, genetic algorithms, Bayesian networks, deep learning techniques, decision trees, and the like. In embodiments, the machine learning circuit 6602 may also allow for the input from a human regarding interpretation of the data, recommendations about specific actions, additional information regarding local events, that is influencing the data, and the like. The machine learning circuit 6602 may be trained iteratively as new variants are identified, as new products are introduced, as recommended actions are implemented, the results may be fed back into the machine learning circuit 6602. In an illustrative example, the machine learning circuit 6602 may be trained to identify moisture droplets and condensation by training on pictures combined with information regarding acceptability for disposition. Identification of acceptability may be input by a store manager by ranking images or by selecting a defined quality based on a scale developed by the machine learning system. In embodiments, the machine learning circuit 6602 may be trained to identify open packaging (either natural or manmade (e.g., a cob of corn or a banana)) using a series of images. In embodiments, the machine learning may be trained to identify between examples of customer mishandling, transport mishandling, and employee mishandling based on a training set including data and human input regarding the cause (e.g. item left out by customer, item overripe on arrival, packaging cut during unpacking of the case, and the like).

[0231] In embodiments, the sensor recommendation engine 6614 may incorporate back-end knowledge about a given store when making recommendations regarding the deployment of micro-climate sensors 212. The sensor recommendation engine 6614 may utilize the quality ranking, disposition history 6610, data from in-store and micro-climate sensors 212, and the rules database 6608, together with information regarding the outgoing shipment, to recommend the placement of micro-climate sensors 212 in a specific outgoing shipment to a given store. In embodiments, a portion of the micro-climate sensors 212 may have default locations based on either valuable items (e.g., high volume or high gross margin), items that are intrinsically sensitive to environment (e.g., as leafy greens, berries, bananas, avocados, meat, seafood, and the like) based on time of year and seasonality (e.g., strawberries in warm weather months), and the like. In embodiments, recommendations for positioning of a

portion of the micro-climate sensors 212 may be partially based on upcoming sales at the receiving store and the potential for over-orders and FIFO issues. In embodiments, recommendations for positioning of a portion of the micro-climate sensors 212 may be based on disposition history at the recipient location. For example, if a store is throwing away an unexpectedly large number of over ripe avocados, the system may recommend placing a micro-climate sensor 212 in with the avocados to assist in identifying possible factors contributing to the large number of unsold, over-ripe avocados. For example, a micro-climate sensor 212 located with the avocados may identify temperature-cycling during transit, a long wait at an ambient temperature receiving dock before movement to a store's produce cooler, unexpectedly high temperatures while the avocados are on the shelves, or the like.

[0232] In embodiments, recommendations for positioning of a portion of the micro-climate sensors 212 may be based on aspects of the receiving location such as volume and velocity of an item at that location, backroom size at store, cooler capacity, frequency of deliveries of goods to that location, culling or disposition strategies or SOP at the receiving location, store mark down and discount strategy, market positioning (premium vs. discount), and the like. Recommendations for positioning of a portion of the micro-climate sensors 212 may be based on the transportation being used, transport vehicle carrying capacity and infrastructure (e.g. cooling capacity), transport route and number of stops, store's location along the route, and the like. In embodiments, recommendations for positioning of a portion of the micro-climate sensors 212 may be based on customer buying patterns at a particular location or for a specific chain, local food offered, weather at that location, holidays, local competitors, and the like. A store might want to track these items more closely to better understand timing of sales, product quality and the like as input to improve future ordering.

[0233] In embodiments, recommendations for positioning of a portion of the micro-climate sensors 212 may be based on transport characteristics such as length of transport, number of prior deliveries during trip, location in the transport (e.g., right next to the door), and the like. References to position of a portion of the micro-climate sensors 212 may also include a recommendation regarding the number of micro-climate sensors 212 to include in a particular shipment. The number of sensors may be based on the size of the shipment, the types of items being shipped, transport characteristics (more sensors if it will be that last load to be delivered), and the like.

[0234] In embodiments, the artificial intelligence 6604 may identify unexpected dispositions and, if possible, identify probable underlying cause(s). Unexpected dispositions

may include the disposal of a shelf stable item before its expiration date, a large number of the same types of items being disposed of for ripeness issues, and the like.

[0235] The rules database 6608 may include a plurality of rules and algorithms to determine a probable cause for unexpected or non-compliant disposal. Rules and algorithms may incorporate data such as: input from point of sale information; input from inventory and ordering systems; external events; historical data regarding disposition based on that location, or item type (either at that location or across multiple locations), number of items, and the like; regulations, policies, etc.; and the like. In an illustrative example, a single frozen pizza being discarded prior to sell-by date may be determined to be the probable result of customer mishandling (e.g. removing from freezer and leaving elsewhere in store). In another example, an entire case pallet of strawberries being thrown away may indicate issues in the product ordering, product handling, transport issues of the like, the most probable issue being identified based on the larger data set including micro-climate sensor data, product ordering data, delivery data, any discrepancies between ordered product and delivered product, cross store data on similar product from the same supplier, and the like.

[0236] In embodiments, the artificial intelligence 6604 may include data regarding natural events such as the season and the weather in the evaluation of a disposition determination. In an illustrative example, a store may have stocked up on watermelon for the beginning of summer but the weather was unexpectedly cold. The resulting drop in sales from the cold and the higher than average purchasing combined may provide the explanation for a higher than average liquefaction of watermelon. In another illustrative example, oranges may be saleable at lower levels of quality in the off-season whereas the highest levels of quality must be maintained when they are in season.

[0237] In embodiments, the quality rules applied by the artificial intelligence 6604 may vary by customer and location in the supply chain. Different locations may have different minimum quality requirements based on information such as local regulations, customer demographics, chain or store mandates, and the like. For example, different stores or chains having different minimum quality requirements. Acceptable quality levels may vary based on location in the supply chain. For example, a given level of ripeness may be acceptable at a store's receiving engine given velocity of that item in the store but not for at an in-take system at the distribution center given the additional intervening time and transport before availability for customer sale.

[0238] In embodiments, rules may include input regarding social events such as national holidays, supplier strikes, local events, weather, strikes, actions by other retailers, disruptive

events such as wars, traffic jams, nearby construction, and the like. In an illustrative example, stock of cranberries may be increased in mid-November to meet the demand at Thanksgiving. However, once the holiday has passed, remaining inventory may result in higher than normal disposition levels in the future. In another illustrative example, if over-all sales fall due to near-by construction limiting access to the store, there may be an increase in the disposal of highly perishable goods until the impact of the construction on sales is used in decisions regarding ordering of new stock. If over-all produce sales fall due to the opening of a competitor nearby information regarding the quality of the store's produce at receipt and disposition may be used in input in developing a strategy to address the newly opened competitors impact on sales.

[0239] As a result of the evaluation, the system may provide feedback to the employee doing the dispositioning. For example, if an item appears to be in good condition but is not saleable for some reason, such as a sell-by date has just passed, depending on the type of item, a recommendation may be made to donate the item rather than disposing of it. In embodiments, if an item is approaching its sell-by date and is at marginal quality, a mark-down sticker might be recommended. In an embodiment, a store may have different criteria for disposal of different fruits and vegetables that may vary with season of the year, store location, and the like. These rules may include thresholds for time in store, presence of moisture in the packaging, a degree of ripeness and the like. If an item being disposed of does not meet these requirements, the system may provide a recommendation that the items not be disposed of, instructions to help the employee better understand the criteria for disposal may be provided, a request for an override, a request for additional information regarding the reason for disposal, and the like.

[0240] In embodiments, data from the disposition system 1004 may provide management with data regarding compliance with rules regarding product logistics, store merchandizing, storage and disposition. Compliance may include applying mark-down stickers close to the date code, produce being kept within an appropriate range, and the like.

[0241] Data from sensors associated transport and information regarding the receiving dock temperature and time between receipt and arrival at the produce cooler might provide insight into possible handling issues resulting in the loss of product. If a bag of lettuce is being thrown away because the lettuce has started to brown but it is still within the date code and there is indication of moisture within the package it indicates that the lettuce was held at an elevated temperature or there was a vendor issue with the product. Referencing associated sensor data can help resolve whether is an in-store issue such as higher than acceptable

temperature in the cooler or on the shelf or whether it is a vendor issue because it is being seen at multiple stores.

[0242] In embodiments, the sensor recommendation engine 6614 may provide recommendations regarding the placement of micro-climate sensors 212 into goods to be shipped to a site. Recommendations may include specific types of sensors 1502 to be deployed, locations in which to deploy sensors, number of sensors to deploy, and the like. In embodiments, the data from the micro-climate sensors 212 may provide data on transport conditions in addition to any transport sensors 132. In embodiments, this may assist in identifying whether transportation conditions are contributing to increase waste for certain items. In an illustrative and non-limiting example, the presence of a micro-climate sensor 212 in a container of strawberry clam shells may reveal that the strawberries are experiencing high levels of heat and humidity during transport, thus shortening their store shelf life. Additional transport sensors 132 may identify that the door was left open too long, the strawberries were packed too closely to the door, or the like. Alternatively, the data provided by the micro-climate sensor 212 may confirm that the strawberries were kept in appropriate conditions during transport. This data may assist and identifying potential conditions at a supplier or the distribution center as influencing the shelf life of an item such as temperature cycling, high humidity, high temperature, and the like.

[0243] The system server 1010 may leverage historical data and/or data from a plurality of stores to evaluate product trends. For example, if multiple locations are seeing higher levels of disposal for a certain item type but the distribution, transport, and store environment data is within specification for that product, there may be an issue with a supplier that needs to be addressed. If there are higher levels of discards of a certain item type at one store relative to similar stores, differences in handling, store layout, personnel and the like to help identify contributory factors in the higher discard rate. Patterns of produce items deviating from natural saleable state may be identified such as high amounts of opened corn on the cob may indicate customers are evaluating the corn and finding it unsatisfactory, resulting in a recommendation to review incoming quality from that supplier. In an illustrative example, high levels of discards of strawberries having unexpectedly short shelf life might be detected across a number of stores. After correcting for variability amount stores, the system server might determine that there are potential problems with the incoming quality of the strawberries to the distribution center. In embodiments, the data from multiple stores, discard documentation, transport and storage conditions and the like may be used, for example in negotiations for a vendor credit from supplier of the strawberries, renegotiating vendor

contracts, redefining acceptance criteria for product coming from that vendor and the like. In embodiments, the data from might trigger internal reviews of process and product at the distribution center directed to how the strawberries are being received, quality of strawberries on hand at the distribution center, and the like.

[0244] The system server 1010 may be used to identify theft based on discrepancies between arrival data and the combination of point of sale data and discard data. The system server 1010 may be used to identify customer behaviors causing shrinkage such as an item removed from the freezer and left on a bread shelf, a cereal box with both inner and outer packaging opened indicating customer snacking, and the like. Merchandizing effectiveness may be evaluated. Green on potatoes may indicate that the potatoes are not being properly rotated in the display. Bags of “pay by the pound” produce which are only partially filled may indicate that the packing size is incorrect and the customers are redistributing product between bags to obtain the desired amount.

[0245] In an illustrative use case, at a distribution center 116, a plurality of micro-climate sensors 212 may be included with a case of product in a shipment bound for a given store. The micro-climate sensors 212 may track temperature, humidity, movement, and light. As the sensor moves with the case of product the data produced may enable key transition points and length of time at a given location. For example, if a high amount of movement is seen together with an elevated temperature, and then is followed by no movement at a lower temperature it may be inferred that the product has been moved to a produce cooler. If this is followed by a little more movement and a slight increase in temperature followed by a decrease in temperature it may be inferred that the produce was brought to the sales floor, but then the product was not placed on the shelf but returned to the cooler. After a time period, the product may see additional movement, an increase in temperature, and in addition, light is now present. It may be inferred that the product is now on a shelf in the store. This real-time status tracking may enable real-time corrective action. In an example, if the product is stationary on the shelf and the temperature begins to crest above a threshold (e.g., 45 degrees) the system may send a text alert to the store and a product manager for that product informing both that the product is going out of temperature and they should take corrective action (e.g. pull the strawberries off the display and place back in the produce cooler). In another illustrative example (Fig. 70) if the temperature in a produce cooler exceeds an upper threshold 7002, a lower threshold 7004, or both thresholds, an alert 7006 may be sent to one or more individuals in a situation where they might check on the cooler (e.g. is a door ajar, is the overall cooling profile of the produce cooler incorrect, and the like) and/or initiate

maintenance, repairs, or a change in store policy. In another alert (Fig. 82) an alert 8210 may be sent if a product velocity is less than a threshold (i.e., if time on the shelf or deployed 8212 exceeds a threshold). The alert 1206 may include information about the environment (e.g., temperature 8214 in this example but not limited to temperature) seen during that time relative to a standard operating procedure limit 8216. An alert 1206, 8210, 7104 may be sent to mobile devices (Fig. 71) associated with one or more store associates. The ability to take real-time corrective action may allow product that might otherwise spoil or be left in storage until after the “sell-by” date to be “saved.” Based on this information, changes may be made to the location, additional training provided to employees and the like. Referring to Figs. 72 and 83, it may be possible to drill down into the details on the alert to see the underlying data (Fig. 72) on the product as well as underlying data on related infrastructure data such as temperature by a cooler door 8310 and temperature in the middle of a cooler 8312.

[0246] In embodiments, the system server may be used to analyze trends in store data over time and identify how trends change in response to changes in the product delivery network, changes in store personnel, changes in store infrastructure and the like. This information may assist in predicting how another store might respond to similar changes. In an illustrative example, a system server 1010 might evaluate data relating to product ordering, sales, and waste to identify changes corresponding to a change in delivery schedule such as whether there are increases in product waste with decreases in product delivery. The system may determine whether a change results in a net benefit (overall reduced costs) to the store, and whether a similar change at a different location would result in a similar benefit.

[0247] In embodiments, evaluation of data might assist in identifying unrecognized issues in infra-structure. In an illustrative example, fluctuations in temperature seen by products in a freezer in combination with freezer door data indicating that the doors have remained closed, may indicate problems with the freezer. Differences in temperature among multiple products in the freezer may indicate unacceptable temperature gradients within the freezer. In some embodiments, the system might initiate communications with a manufacturer or equipment service in addition to alerting a store manager, thus reducing e-mail overhead for the store manager. In embodiments, the system may recommend changes to the freezer settings based on the data.

[0248] In embodiments, the report engine 6618 may provide reports to individuals in different roles identify store statistics, data regarding discarded items, areas of possible concern based on received data and the like. Reports may include highest velocity items (items that are in sale and likely have microdata), differences from previous weeks reports,

graphs of fixed sensor temperatures, product sensors, and the like. Referring to Figs. 80, 81, and 73-75, examples of reports are shown. Referring to Fig. 80, a report 8010 may include a visible depiction 8012 and table summary 8014 of number of items being disposed of and the underlying cause for disposition such as visibly spoiled 8016, store damage 8018, failure of refrigeration 8022, received in poor condition 8024, out of date 8026, donation 8028, and the like. Referring to Fig. 81, a report 8110 for a given time period may include a table describing the items dispositioned for a variety of items of sale. The reports might be filtered or sorted by item description 8114, item code 8116, item category 8118, total dispositioned 8120, and the like. Referring to Figs. 73074, example reports 7304A, 7304B, 7304C may include detailed data and images 7302A, 7302B, 7302C, 7302D regarding a specific item of sale, SKU, or the like. Reports may include data from underlying sensors Reports may include detailed comparisons of multiple products. Reports may include information regarding the overall performance of a store (Fig. 75) including variance in the cold supply chain 7502, average time to shelf 7504, customer satisfaction 7506, average food loss 7508, current freshness score 7510, year over year freshness improvement 7512, and the like. Reports may include recommendations for next steps, and the like. Reports may include curated examples of discarded items where the items were being inappropriately discarded. Reports may include recommendations for personnel training regarding discard criteria, acceptance criteria, and the like.

[0249] Referring to Fig. 77, an example of a problem, how it is identified by the system described herein, and the problem resolution is depicted. In this illustrative and non-limiting example, a U-Boat received off-hours is left outside the produce cooler. This is a problem because product temperature can change drastically- potentially resulting in an increase in temperature that may reduce product shelf-life. The system of this disclosure may identify a deviation from SOP, in this example a temperature exceeding a threshold over a defined time period. The system then provides alerts to a store associate who can take action, in this case by moving the U-Boat in question into the produce cooler.

[0250] Referring to Figs. 76 and 78, example temperature profiles are depicted 7602, 7802A, 7802B, 7802C. Fig. 76 depicts a temperature profile for an individual product. Fig. 78 depicts temperature profiles 7802A, 7802B, 7802C at different locations in a produce cooler. It may be seen that the temperature profile by the front door of the cooler is consistently elevated relative to the other locations in the produce cooler.

[0251] Referring to Fig. 79, an example of a problem, how it is identified by the system described herein, and possible problem resolutions are depicted. In this illustrative and non-

limiting example, a cooler door is left open, resulting in an increase in temperature of a product in the cooler. The system of this disclosure may identify a deviation from SOP, in this example temperature fluctuations seen by the product exceeding an SOP. As result of the information, there may be heightened awareness regarding keeping the cooler door closed; the produce cooler may be rearranged to locate product sensitive to temperature fluctuations farther from the door; and the like.

[0252] The methods and systems described herein may be deployed in part or in whole through a machine that executes computer software, program codes, and/or instructions on a processor. The processor may be part of a server, client, network infrastructure, mobile computing platform, stationary computing platform, or other computing platform. A processor may be any kind of computational or processing device capable of executing program instructions, codes, binary instructions and the like. The processor may be or include a signal processor, digital processor, embedded processor, microprocessor or any variant such as a co-processor (math co-processor, graphic co-processor, communication co-processor and the like) and the like that may directly or indirectly facilitate execution of program code or program instructions stored thereon. In addition, the processor may enable execution of multiple programs, threads, and codes. The threads may be executed simultaneously to enhance the performance of the processor and to facilitate simultaneous operations of the application. By way of implementation, methods, program codes, program instructions and the like described herein may be implemented in one or more thread. The thread may spawn other threads that may have assigned priorities associated with them; the processor may execute these threads based on priority or any other order based on instructions provided in the program code. The processor may include memory that stores methods, codes, instructions and programs as described herein and elsewhere. The processor may access a storage medium through an interface that may store methods, codes, and instructions as described herein and elsewhere. The storage medium associated with the processor for storing methods, programs, codes, program instructions or other type of instructions capable of being executed by the computing or processing device may include but may not be limited to one or more of a CD-ROM, DVD, memory, hard disk, flash drive, RAM, ROM, cache and the like.

[0253] A processor may include one or more cores that may enhance speed and performance of a multiprocessor. In embodiments, the process may be a dual core processor, quad core processors, other chip-level multiprocessor and the like that combine two or more independent cores (called a die).

[0254] The methods and systems described herein may be deployed in part or in whole through a machine that executes computer software on a server, client, firewall, gateway, hub, router, or other such computer and/or networking hardware. The software program may be associated with a server that may include a file server, print server, domain server, internet server, intranet server and other variants such as secondary server, host server, distributed server and the like. The server may include one or more of memories, processors, computer readable transitory and/or non-transitory media, storage media, ports (physical and virtual), communication devices, and interfaces capable of accessing other servers, clients, machines, and devices through a wired or a wireless medium, and the like. The methods, programs or codes as described herein and elsewhere may be executed by the server. In addition, other devices required for execution of methods as described in this application may be considered as a part of the infrastructure associated with the server.

[0255] The server may provide an interface to other devices including, without limitation, clients, other servers, printers, database servers, print servers, file servers, communication servers, distributed servers and the like. Additionally, this coupling and/or connection may facilitate remote execution of program across the network. The networking of some or all of these devices may facilitate parallel processing of a program or method at one or more location without deviating from the scope of the disclosure. In addition, all the devices attached to the server through an interface may include at least one storage medium capable of storing methods, programs, code and/or instructions. A central repository may provide program instructions to be executed on different devices. In this implementation, the remote repository may act as a storage medium for program code, instructions, and programs.

[0256] The software program may be associated with a client that may include a file client, print client, domain client, internet client, intranet client and other variants such as secondary client, host client, distributed client and the like. The client may include one or more of memories, processors, computer readable transitory and/or non-transitory media, storage media, ports (physical and virtual), communication devices, and interfaces capable of accessing other clients, servers, machines, and devices through a wired or a wireless medium, and the like. The methods, programs or codes as described herein and elsewhere may be executed by the client. In addition, other devices required for execution of methods as described in this application may be considered as a part of the infrastructure associated with the client.

[0257] The client may provide an interface to other devices including, without limitation, servers, other clients, printers, database servers, print servers, file servers, communication

servers, distributed servers and the like. Additionally, this coupling and/or connection may facilitate remote execution of program across the network. The networking of some or all of these devices may facilitate parallel processing of a program or method at one or more location without deviating from the scope of the disclosure. In addition, all the devices attached to the client through an interface may include at least one storage medium capable of storing methods, programs, applications, code and/or instructions. A central repository may provide program instructions to be executed on different devices. In this implementation, the remote repository may act as a storage medium for program code, instructions, and programs.

[0258] The methods and systems described herein may be deployed in part or in whole through network infrastructures. The network infrastructure may include elements such as computing devices, servers, routers, hubs, firewalls, clients, personal computers, communication devices, routing devices and other active and passive devices, circuits and/or components as known in the art. The computing and/or non-computing device(s) associated with the network infrastructure may include, apart from other components, a storage medium such as flash memory, buffer, stack, RAM, ROM and the like. The processes, methods, program codes, instructions described herein and elsewhere may be executed by one or more of the network infrastructural elements.

[0259] The methods, program codes, and instructions described herein and elsewhere may be implemented on a cellular network having multiple cells. The cellular network may either be frequency division multiple access (FDMA) network or code division multiple access (CDMA) network. The cellular network may include mobile devices, cell sites, base stations, repeaters, antennas, towers, and the like.

[0260] The methods, programs codes, and instructions described herein and elsewhere may be implemented on or through mobile devices. The mobile devices may include navigation devices, cell phones, mobile phones, mobile personal digital assistants, laptops, palmtops, netbooks, pagers, electronic books readers, music players and the like. These devices may include, apart from other components, a storage medium such as a flash memory, buffer, RAM, ROM and one or more computing devices. The computing devices associated with mobile devices may be enabled to execute program codes, methods, and instructions stored thereon. Alternatively, the mobile devices may be configured to execute instructions in collaboration with other devices. The mobile devices may communicate with base stations interfaced with servers and configured to execute program codes. The mobile devices may communicate on a peer to peer network, mesh network, or other communications network. The program code may be stored on the storage medium

associated with the server and executed by a computing device embedded within the server. The base station may include a computing device and a storage medium. The storage device may store program codes and instructions executed by the computing devices associated with the base station.

[0261] The computer software, program codes, and/or instructions may be stored and/or accessed on machine readable transitory and/or non-transitory media that may include: computer components, devices, and recording media that retain digital data used for computing for some interval of time; semiconductor storage known as random access memory (RAM); mass storage typically for more permanent storage, such as optical discs, forms of magnetic storage like hard disks, tapes, drums, cards and other types; processor registers, cache memory, volatile memory, non-volatile memory; optical storage such as CD, DVD; removable media such as flash memory (e.g. USB sticks or keys), floppy disks, magnetic tape, paper tape, punch cards, standalone RAM disks, Zip drives, removable mass storage, off-line, and the like; other computer memory such as dynamic memory, static memory, read/write storage, mutable storage, read only, random access, sequential access, location addressable, file addressable, content addressable, network attached storage, storage area network, bar codes, magnetic ink, and the like.

[0262] The methods and systems described herein may transform physical and/or or intangible items from one state to another. The methods and systems described herein may also transform data representing physical and/or intangible items from one state to another.

[0263] The elements described and depicted herein, including in flow charts and block diagrams throughout the figures, imply logical boundaries between the elements. However, according to software or hardware engineering practices, the depicted elements and the functions thereof may be implemented on machines through computer executable transitory and/or non-transitory media having a processor capable of executing program instructions stored thereon as a monolithic software structure, as standalone software modules, or as modules that employ external routines, code, services, and so forth, or any combination of these, and all such implementations may be within the scope of the present disclosure.

Examples of such machines may include, but may not be limited to, personal digital assistants, laptops, personal computers, mobile phones, other handheld computing devices, medical equipment, wired or wireless communication devices, transducers, chips, calculators, satellites, tablet PCs, electronic books, gadgets, electronic devices, devices having artificial intelligence, computing devices, networking equipment, servers, routers and the like.

Furthermore, the elements depicted in the flow chart and block diagrams or any other logical

component may be implemented on a machine capable of executing program instructions. Thus, while the foregoing drawings and descriptions set forth functional aspects of the disclosed systems, no particular arrangement of software for implementing these functional aspects should be inferred from these descriptions unless explicitly stated or otherwise clear from the context. Similarly, it will be appreciated that the various steps identified and described above may be varied, and that the order of steps may be adapted to particular applications of the techniques disclosed herein. All such variations and modifications are intended to fall within the scope of this disclosure. As such, the depiction and/or description of an order for various steps should not be understood to require a particular order of execution for those steps, unless required by a particular application, or explicitly stated or otherwise clear from the context.

[0264] The methods and/or processes described above, and steps thereof, may be realized in hardware, software or any combination of hardware and software suitable for a particular application. The hardware may include a dedicated computing device or specific computing device or particular aspect or component of a specific computing device. The processes may be realized in one or more microprocessors, microcontrollers, embedded microcontrollers, programmable digital signal processors or other programmable device, along with internal and/or external memory. The processes may also, or instead, be embodied in an application specific integrated circuit, a programmable gate array, programmable array logic, or any other device or combination of devices that may be configured to process electronic signals. It will further be appreciated that one or more of the processes may be realized as a computer executable code capable of being executed on a machine readable medium.

[0265] The computer executable code may be created using a structured programming language such as C, an object oriented programming language such as C++, or any other high-level or low-level programming language (including assembly languages, hardware description languages, and database programming languages and technologies) that may be stored, compiled or interpreted to run on one of the above devices, as well as heterogeneous combinations of processors, processor architectures, or combinations of different hardware and software, or any other machine capable of executing program instructions.

[0266] Thus, in one aspect, each method described above and combinations thereof may be embodied in computer executable code that, when executing on one or more computing devices, performs the steps thereof. In another aspect, the methods may be embodied in systems that perform the steps thereof, and may be distributed across devices in a number of ways, or all of the functionality may be integrated into a dedicated, standalone device or other

hardware. In another aspect, the means for performing the steps associated with the processes described above may include any of the hardware and/or software described above. All such permutations and combinations are intended to fall within the scope of the present disclosure.

[0267] Accordingly, by using micro-climate sensors to collect/generate product-flow data from items of sale and transforming the product flow data into flow analysis data, some embodiments of the system for product management may provide for improved insights, e.g., presentation of actionable items, as opposed to mere display of uncorrelated data, into the causes of deviations that reduce the commercial appeal of items of sale. Further, by generating deviation and/or alert messages, as described herein, some embodiments of the system for product management may provide for corrective actions, e.g., sale-improvement actions, actions to be taken in order to eliminate and/or reduce damage to an item of sale, which may in turn improve the likelihood that the item of sale will be purchased. Further still, by providing for the generation and/or collection of disposition data, some embodiments of the system for product management may provide for improved insight into the causal reasons items of sale are being disposed of prior to being purchased, which in turn, may provide for modification of a corresponding SOP to reduce the likelihood that future items of sale will be disposed. Further, the fresh score value provided by some embodiments of the system for product management may provide for an immediate and/or near immediate evaluation of the overall/cumulative quality, e.g., freshness, of items in a particular store, or across multiple stores. As will be understood, such an evaluation may provide for a store operator to readily detect problematic stores that may need adjustments to their corresponding SOP and/or further employee training. Further still, by capturing product flow data downstream of and/or including a distribution center, some embodiments of the system for product management may provide insights into portions of a supply chain that has been overlooked by traditional approaches. Further still, by capturing product flow data including a source, such as a farm, the data can be used in negotiations regarding the quality of the product received from the vendor as it will be possible to verify that the item of sale had been handled according to SOP after it left the vendor so that if there are high levels of disposal before the sell by date there may be issues at the vendor. Further still, by reusing the micro-climate sensors, it becomes feasible to deploy them for low margin, highly environmentally sensitive items of sale.

[0268] While the disclosure has been disclosed in connection with the preferred embodiments shown and described in detail, various modifications and improvements

thereon will become readily apparent to those skilled in the art. Accordingly, the spirit and scope of the present disclosure is not to be limited by the foregoing examples, but is to be understood in the broadest sense allowable by law.

CLAIMS

1. A method for monitoring and reporting on a condition of a plurality of individual items of sale throughout a supply chain, the method comprising:
 - associating at least one micro-climate sensor with a corresponding individual item of sale in the plurality;
 - generating, via the plurality of micro-climate sensors, product flow data for each corresponding item of sale;
 - determining flow analysis data from the product flow data; and
 - transmitting the flow analysis data.
2. The method of claim 1, wherein the flow analysis data is for an individual item of sale.
3. The method of claim 1, wherein the flow analysis data is for a type of product represented by the individual item of sale.
4. The method of claim 1, wherein each of the items of sale of the plurality is a SKU.
5. The method of claim 1, further comprising:
 - generating, via the plurality of micro-climate sensors, subsequent product flow data for each of a subsequent plurality of items of sale flowing through the supply chain; and
 - determining subsequent flow analysis data from the subsequent flow data;
 - wherein each micro-climate sensor of the plurality corresponds to a different item of sale of the subsequent plurality.
6. The method of claim 1, wherein the supply chain includes a source of the plurality of items of sale.
7. The method of claim 6, wherein the source is a farm.
8. The method of claim 1, wherein the supply chain includes a distribution center.
9. The method of claim 1, wherein the supply chain includes a store.
10. The method of claim 1, wherein the supply chain includes a location in a store.
11. The method of claim 5, wherein the supply chain includes:
 - a source;
 - a distribution center;
 - a transport vehicle;

a store;
a transport to a customer; and
locations therebetween.

12. The method of claim 11 further comprising:
generating, based at least in part on the flow analysis data, a graphical user interface that depicts a contiguous view of the flow analysis data for at least one of the items of sale of the plurality along the supply chain.
13. The method of claim 1, wherein at least one of the items of sale of the plurality is at least one of:
a produce product;
a dairy product;
a meat product; or
a fish product.
14. The method of claim 1, wherein at least one of the items of sale of the plurality is a frozen product.
15. The method of claim 1, wherein at least one of the items of sale of the plurality is a produce product.
16. The method of claim 5, wherein the flow analysis data comprises an indication that an item of sale of the plurality has experienced at least one of a product-life shortening event or a product-quality reduction event.
17. The method of claim 5, further comprising:
storing standard operating procedure (SOP) data for at least one of the items of sale of the plurality.
18. The method of claim 17 further comprising:
determining a deviation from the SOP data based on least in part on the flow analysis data.
19. The method of claim 18, wherein determining the deviation comprises:
comparing the flow analysis data to the SOP data.
20. The method of claim 18, wherein the deviation is based at least in part on a time of transit of the at least one item of sale along the supply chain.

21. The method of claim 18, wherein the deviation is based at least in part on a time period of at least one:
 - unloading the at least one item of sale at a point along the supply chain; or
 - a stocking event corresponding to the at least one item of sale.
22. The method of claim 18, wherein the deviation is based at least in on a temperature of the at least one item of sale of the plurality along the supply chain.
23. The method of claim 22, wherein the temperature corresponds to at least one of:
 - an unloading of the at least one item of sale at a point along the supply chain; or
 - a stocking event corresponding to the at least one item of sale.
24. The method of claim 18, wherein the deviation comprises an indication that an item of sale of the plurality has experienced at least one of a product-life shortening event or a product-quality reducing event.
25. The method of claim 24, wherein at least one of the product-life shortening event or the product-quality reducing event is at least one of:
 - an environmental temperature that is out of compliance with the SOP data;
 - detection of moisture within a product packaging of the at least one item of sale; or
 - damage to a product packaging of the at least one item of sale.
26. The method of claim 24, further comprising:
 - in response to determining the deviation, generating a sale-improvement action for the at least one item of sale.
27. The method of claim 26, wherein the sale-improvement action is at least one of:
 - moving the at least one item of sale to a location; or
 - discounting the at least one item of sale.
28. The method of claim 24 further comprising:
 - in response to determining the deviation, disposing the at least one item of sale.
29. The method of claim 28 further comprising:
 - generating an alert message in response to determining the deviation from the SOP,
 - wherein the alert message comprises an indication of the deviation; and
 - transmitting the alert message.

30. The method of claim 29, wherein the alert message corresponds to at least one of:
 - a visual indication;
 - an audio indication; or
 - a text-based indication.
31. The method of claim 30, wherein the alert message comprises:
 - a micro-training event.
32. An apparatus comprising:
 - a product flow data processing circuit structured to interpret product flow data generated from each of a plurality of items of sale flowing through a supply chain;
 - a standard operating procedure (SOP) data processing circuit structured to interpret SOP data;
 - a flow analysis circuit structured to determine flow analysis data in response to the product flow data;
 - a SOP deviation circuit structured to determine deviation data based at least in part on the flow analysis data and the SOP data, wherein the deviation data indicates a deviation from the SOP data; and
 - a deviation provisioning circuit structured to transmit the deviation data.
33. The apparatus of claim 32, wherein each of the items of sale of the plurality is a SKU.
34. The apparatus of claim 32, wherein SOP deviation circuit is further structured to compare the flow analysis data to the SOP data.
35. The apparatus of claim 32, wherein the deviation data comprises:
 - an indication of a location in the supply chain.
36. The apparatus of claim 35, wherein the location is a source.
37. The apparatus of claim 36, wherein the source is a farm.
38. The apparatus of claim 35, wherein the location is a distribution center.
39. The apparatus of claim 35, wherein the location is a store.
40. The apparatus of claim 35, wherein the location is within a store.
41. The apparatus of claim 40, wherein the location within the store is a holding area for customer pick-up.

42. The apparatus of claim 35, wherein the location is a transport vehicle en route to at least one of: a distribution center, a store, or a customer location.
43. The apparatus of claim 32 further comprising:
a flow visualization circuit structured to generate visualized flow data for depicting a contiguous view of the flow analysis data for at least one of the plurality of items of sale along the supply chain.
44. The apparatus of claim 43, wherein the supply chain includes a source.
45. The apparatus of claim 44, wherein the source is a farm.
46. The apparatus of claim 43, wherein the supply chain includes a distribution center.
47. The apparatus of claim 43, wherein the supply chain includes a store.
48. The apparatus of claim 43, wherein the supply chain includes:
a source;
a distribution center;
a transport vehicle;
a store;

a transport to a customer location; and
locations therebetween.
49. The apparatus of claim 43, wherein the supply chain includes a location in a store.
50. The apparatus of claim 32, wherein at least one of the items of sale of the plurality is at least one of:
a produce product;
a meat product;
a dairy product; or
a fish product.
51. The apparatus of claim 50, wherein at least one of the items of sale of the plurality is a frozen product.
52. The apparatus of claim 32, wherein at least one of the items of sale of the plurality is a produce product.

53. The apparatus of claim 32, wherein the deviation is based at least in part on a time of transit of at least one of the plurality of items of sale along the supply chain.
54. The apparatus of claim 32, wherein the deviation is based at least in part on a time period of at least one of:
- unloading at least one item of sale of the plurality at a point along the supply chain; or
 - a stocking event corresponding to at least one item of sale of the plurality.
55. The apparatus of claim 32, wherein the deviation data comprises an indication that at least one item of sale of the plurality has experienced at least one of: a product-life shortening event or a product-quality reducing event.
56. The apparatus of claim 55, wherein at least one of the product-life shortening event or the product-quality reducing event is at least one of:
- an environmental temperature that is out of compliance with the SOP data;
 - detection of moisture within a product packaging of the at least one item of sale; or
 - damage to a product packaging of the at least one item of sale.
57. The apparatus of claim 32 further comprising:
- a recommendation circuit structured to generate, in response to the deviation data, a recommended action value corresponding to a sale-improvement action to be taken with respect to at least one of the plurality of items of sale.
58. The apparatus of claim 57, wherein the sale-improvement action is at least one of:
- moving the at least one item of sale to a location; or
 - discounting the at least one item of sale.
59. The apparatus of claim 32 further comprising:
- a recommendation circuit structured to generate, in response to the deviation data, a recommended action value indicating that at least one of the plurality of items of sale is to be disposed.
60. The apparatus of claim 32 further comprising:
- an alert circuit structured to generate, in response to the deviation data, alert data comprising an indication of the deviation; and
 - an alert provisioning circuit structured to transit the alert data.
61. The apparatus of claim 60, wherein the alert data is structured to corresponds to at least one of:

a visual indication;
an audio indication; or
a text-based indication.

62. A system comprising:
a plurality of reusable micro-climate sensors each structured to generate and transmit product flow data for an individual item of sale to which each reusable micro-climate sensor of the plurality is associated, the plurality of items of sale flowing through a supply chain;
a server structured to:
interpret the product flow data; and
determine and transmit flow analysis data from the product flow data; and
wherein the server is in communication with an electronic device structured to:
interpret and display the flow analysis data.
63. The system of claim 62, wherein each of the items of sale of the plurality is a SKU.
64. The system of claim 62, wherein:
the server is further structured to determine and transmit deviation data from a standard operating procedure (SOP) based at least in part on comparing the flow analysis data to the SOP data, wherein the deviation data indicates a deviation from the SOP data; and
the electronic device is further structured to interpret and display the deviation data.
65. The system of claim 64, wherein the deviation data comprises an indication of a location in the supply chain.
66. The system of claim 65, wherein the location is a source.
67. The system of claim 66, wherein the source is a farm.
68. The system of claim 65, wherein the location is a distribution center.
69. The system of claim 65, wherein the location is a store.
70. The system of claim 64, wherein the deviation is based at least in part on a time of transit of at least one of the items of sale of the plurality along the supply chain.
71. The system of claim 64, wherein the deviation is based at least in part on a time period of at least one of:
unloading at least one items of sale of the plurality at a point along the supply chain;
or
a stocking event corresponding to at least one item of sale of the plurality.

72. The system of claim 64, wherein the deviation data comprises an indication that at least one item of sale of the plurality has experienced at least one of a product-life shortening event or product-quality reducing event.

73. The system of claim 72, wherein at least one of the product-life shortening event or the product-quality reducing event is at least one of:

- an environmental temperature that is out of compliance with the SOP data;
- moisture present within a product packaging of the at least one item of sale; or
- damage to a product packaging of the at least one item of sale.

74. The system of claim 64, wherein:

the server is further structured to generate and transmit, in response to the deviation data, a recommended action value corresponding to a sale-improvement action to be taken with respect to at least one item of sale of the plurality; and

the electronic device is further structured to interpret and display the recommended action value.

75. The system of claim 74, wherein the sale-improvement action is at least one of:

- moving the at least one item of sale to a location; or
- discounting the at least one item of sale.

76. The system of claim 64, wherein:

the server is further structured to generate and transmit, in response to the deviation data, a recommended action value indicating that at least one item of the plurality is to be disposed; and

the electronic device is further structured to interpret and display the recommended action value.

77. The system of claim 64, wherein:

the server is further structured to generate and transmit, in response to the deviation data, alert data comprising an indication of the deviation; and

the electronic device is further structured to interpret and communicate the alert to a user.

78. The system of claim 77, wherein the alert data corresponds to at least one of:

- a visual indication;
- an audio indication; or
- a text-based indication.

79. The system of claim 62, wherein:
the server is further structured to generate and transmit visualized flow data for depicting a contiguous view of the flow analysis data for at least one of the plurality of items of sale along the supply chain; and
the electronic device is further structured to interpret the visualized flow data and display a visualization based at least in part on the visualized flow data.
80. The system of claim 79, wherein the supply chain includes a source.
81. The system of claim 80, wherein the source is a farm.
82. The system of claim 79, wherein the supply chain includes a distribution center.
83. The system of claim 79, wherein the supply chain includes a store.
84. The system of claim 79, wherein the supply chain includes a location within a store.
85. The system of claim 79, wherein the supply chain includes a transport to a customer location.
86. The system of claim 79, wherein the supply chain includes:
a source;
a distribution center;
a transport vehicle;
a store;
a transport to a customer location; and
locations therebetween.
87. The system of claim 79, wherein the supply chain includes a location in a store.
88. The system of claim 67, wherein at least one of the items of sale of the plurality is at least one of:
a produce product;
a meat product;
a dairy product; or
a fish product.
89. The system of claim 67, wherein at least one of the items of sale of the plurality is a frozen product.

90. The system of claim 67, wherein at least one of the items of sale of the plurality is a produce product.
91. A method comprising:
 associating at least one micro-climate sensor with a corresponding item of sale of a first plurality of items of sale;
 generating, via the at least one micro-climate sensor, first product flow data for the first plurality of items of sale while flowing through a supply chain;
 removing of the at least one micro-climate sensor from the corresponding item of sale of the first plurality;
 associating the at least one micro-climate sensor with a corresponding item of sale of a second plurality of items of sale;
 generating, via the at least one micro-climate sensor, second product flow data for each of the second plurality of items of sale while flowing through the supply chain;
 determining product flow analysis data based on the first and the second product flow data; and
 transmitting the product flow analysis data.
92. The method of claim 91, wherein each of the items of sale of the first and the second plurality is a SKU.
93. The method of claim 91, wherein the supply chain includes at least one of:
 a source of the first plurality of items of sale; and
 a source of the second plurality of items of sale.
94. The method of claim 93, wherein the source of the first plurality of items of sale and the source of the second plurality of items of sale are the same source.
95. The method of claim 93, wherein the source of the first plurality of the items of sale is different than the source of the second plurality of items of sale.
96. The method of claim 93, wherein the source of the first plurality is a farm.
97. The method of claim 91, wherein the supply chain includes:
 a source of the first plurality of items of sale;
 a source of the second plurality of items of sale;
 a distribution center;
 a transport vehicle;

a store; and
locations therebetween.

98. The method of claim 91, wherein:
disposing each of the plurality of micro-climate sensors on the corresponding item of sale of the first plurality occurs at a first location; and
removing each of the plurality of micro-climate sensors from the corresponding item of sale of the first plurality occurs at a second location different from the first location.
99. The method of claim 98, wherein the first location is a source.
100. The method of claim 99, wherein the source is a farm.
101. The method of claim 98, wherein the second location is a store.
102. The method of claim 98, wherein the second location is a location within a store.
103. The method of claim 98, wherein the first location is a farm and the second location is a store.
104. The method of claim 98, wherein disposing each of the plurality of micro-climate sensors on the corresponding item of sale of the second plurality occurs at the first location.
105. The method of claim 91 further comprising:
generating, based at least in part on the flow analysis data, a graphical user interface that depicts a contiguous view of the flow analysis data for at least one of an item of sale of the first or the second plurality.
106. The method of claim 91, wherein at least one item of sale of the first plurality and at least one item of sale of the second plurality are at least one of:
a produce product;
a dairy product;
a meat product; or
a fish product.
107. The method of claim 91, wherein at least one item of sale of the first plurality and at least one item of sale of the second plurality are frozen products.
108. The method of claim 91, wherein at least one item of sale of the first plurality and at least one item of sale of the second plurality are produce products.

109. The method of claim 91 further comprising:
determining a deviation from standard operating procedure (SOP) data by comparing the flow analysis data to the SOP data.
110. The method of claim 109, wherein the deviation is based at least in part on a time of transit of at least one item of sale of the first or the second plurality.
111. The method of claim 109, wherein the deviation is based at least in part on a time period of at least one of:
unloading at least one item of sale of the first or the second plurality at a point along the supply chain; or
a stocking event corresponding to at least one item of sale of the first or the second plurality.
112. The method of claim 109, wherein the deviation comprises an indication that at least one item of sale of the first or the second plurality has experienced a product-life shortening event.
113. The method of claim 112, wherein the product-life shortening event is at least one of:
an environmental temperature that is out of compliance with the SOP data;
detection of moisture within a product packaging of the at least one item of sale; or
damage to a product packaging of the at least one item of sale.
114. The method of claim 109 further comprising:
in response to determining the deviation, generating a sale-improvement action for at least one item of sale of the first or the second plurality.
115. The method of claim 114, wherein the sale-improvement action is at least one of:
moving the at least one item of sale to a location; or
discounting the at least one item of sale.
116. The method of claim 109 further comprising:
in response to determining the deviation, disposing at least one item of sale of the first or the second plurality.
117. A repository device for decommissioning a plurality of micro-climate sensors for generating product flow data for each of a plurality of items of sale flowing through a supply chain, the repository device comprising:
an opening for receiving at least one micro-climate sensor of the plurality;

at least one space for storing the at least micro-climate sensor;
a plurality of sensors operative to detect a presence of the at least one micro-climate sensor; and
a sensor decommission circuit structured to generate a decommission command value in response to detection of the at least one micro-climate sensor via the plurality of sensors.

118. The repository device of claim 117, further comprising a sensor communication circuit structured to transmit the decommission command value to at least one of:

the at least one micro-climate sensor; or
a server.

119. The repository device of claim 118, wherein, in response to the decommission command value, the at least one micro-climate sensor enters a decommissioned mode.

120. The repository device of claim 118, wherein the decommission command value is structured to insert a marker in the product flow data for the at least one micro-climate sensor.

121. The repository device of claim 120, wherein the marker denotes an end of valid product flow data.

122. The repository device of claim 117, wherein the plurality of sensors includes at least one of:

magnetic sensors;
optical sensors;
pressure sensors; or
RFID sensors.

123. The repository device of claim 117 further comprising:
a status circuit structured to determine and transmit a status of the repository device.

124. The repository device of claim 123, wherein the status is full, wherein full indicates the repository device contains a maximum number of micro-climate sensors.

125. The repository device of claim 123, wherein the status is empty, wherein empty indicates an absence of micro-climate sensors.

126. The repository device of claim 117 further comprising:
a sensor identification circuit structured to determine and transmit an identification value of the at least one micro-climate sensor in response to detection of the at least one micro-climate sensor.
127. The repository device of claim 117 further comprising:
a backhaul initiation circuit structured to generate an initiate backhaul command value structured to initiate a pickup of the at least one micro-climate sensor from the repository device; and
a backhaul provisioning circuit structured to transmit the initiate backhaul command value.
128. A method of decommissioning a plurality of micro-climate sensors for generating product flow data for each of a plurality items of sale flowing through a supply chain, the method comprising:
receiving at an opening of a repository device, at least one micro-climate sensor of the plurality;
detecting, via a plurality of sensors, a presence of the at least one micro-climate sensor; and
generating, in response to detecting the presence of the at least one micro-climate sensor, a decommission command value.
129. The method of claim 128, further comprising transmitting the decommission command value to a server.
130. The method of claim 128, further comprising decommissioning the at least one micro-climate sensor in response to the decommission command value.
131. The method of claim 128, further comprising inserting a marker in the product flow data for the at least one micro-climate sensor in response to the decommission command value.
132. The method of claim 128, further comprising storing the at least one micro-climate sensor in a space of the repository device.
133. The method of claim 128, wherein the plurality of sensors includes at least one of:
magnetic sensors;
optical sensors;

pressure sensors; or
RFID sensors.

134. The method of claim 128 further comprising:
generating and transmitting a status of the repository device.
135. The method of claim 134, wherein the status is full, wherein full indicates the repository device contains a maximum number of micro-climate sensors.
136. The method of claim 134, wherein the status is empty, wherein empty indicates an absence of micro-climate sensors.
137. The method of claim 128 further comprising:
identifying and transmitting an identification value of the at least one micro-climate sensor in response to detection of the at least one micro-climate sensor.
138. The method of claim 128 further comprising:
generating and transmitting an initiate backhaul command value structured to initiate a pickup of the at least one micro-climate sensor from the repository device.
139. The method of claim 138 further comprising:
in response to the initiate backhaul command value, removing the at least one micro-climate sensor from the repository device.
140. A method comprising:
interpreting product flow data generated via a plurality of micro-climate sensors each corresponding to one of a plurality of items of sale flowing through a supply chain;
identifying a deviation from a standard operating procedure (SOP) for the supply chain;
generating a deviation message corresponding to the deviation; and
transmitting the deviation message;
wherein the deviation is with respect to at least one of:
a manual process defined by the SOP; or
an automated process defined by the SOP.
141. The method of claim 140, wherein each of the items of sale of the plurality is a SKU.
142. The method of claim 140, wherein:
the deviation is with respect to the manual process; and

the manual process comprises moving at least one of the items of sale of the plurality from a receiving area to a storage area.

143. The method of claim 142, wherein the receiving and the storage areas are part of a store.

144. The method of claim 142, wherein the receiving and the storage areas are part of a distribution area.

145. The method of claim 142, wherein the receiving and the storage areas are part of a vehicle.

146. The method of claim 142, wherein the deviation message comprises an indication that the manually process took longer to complete than an amount of time defined by the SOP.

147. The method of claim 142, wherein the deviation message comprises an indication that the manual process took a shorter amount of time to complete than an amount of time defined by the SOP.

148. The method of claim 142, wherein the deviation message comprises an indication that the manual process resulted in an item of sale of the plurality being exposed to an environmental temperature out of compliance with the SOP.

149. The method of claim 142, wherein the deviation message comprises an indication that the manual process resulted in moisture developing within a product packaging of an item of sale of the plurality.

150. The method of claim 142, wherein the deviation message comprises an indication that the manual process resulted in damage to a product packaging of an item of sale of the plurality.

151. The method of claim 140, wherein:
the deviation is with respect to the manual process; and
the manual process comprises selecting a location within a storage area for storing an item of sale of the plurality.

152. The method of claim 151, wherein the deviation message comprises an indication that selection of the location resulted in an item of sale of the plurality being exposed to an environmental temperature out of compliance with the SOP.

153. The method of claim 151, wherein the deviation message comprises an indication that selection of the location resulted in moisture developing within a product packaging of an item of sale of the plurality.
154. The method of claim 151, wherein the deviation message comprises an indication that selection of the location resulted in damage to a product packaging of an item of sale of the plurality.
155. A method comprising:
generating, via a plurality of micro-climate sensors disposed on a floor of a store, store floor data corresponding to a plurality of items of sale disposed on the floor;
determining, based at least in part on standard operating procedure (SOP) data corresponding to a SOP of the store, store analysis data from the store floor data; and
transmitting the store analysis data;
wherein the store analysis data indicates a measure of the store's compliance with the SOP.
156. The method of claim 155, wherein each of the items of sale of the plurality is a SKU.
157. The method of claim 155, further comprising:
generating a graphical user interface structured to interpret user input data that defines the SOP data.
158. The method of claim 155, further comprising:
generating, via at least one processor, a recommended value for the SOP data.
159. The method of claim 155, further comprising:
generating a graphical user interface that depicts the store analysis data.
160. The method of claim 155, wherein the store analysis data comprises a measure value.
161. The method of claim 160, wherein the measure value is based at least in part on a numerical scale between 1 and 100, wherein 1 represents low compliance with the SOP and 100 represent high compliance with the SOP.
162. The method of claim 160, wherein the measure value is based at least in part on a color scale, wherein red represents low compliance with the SOP and green represents high compliance with the SOP.

163. The method of claim 155, wherein the store analysis data comprises and indication of a deviation from the SOP.
164. The method of claim 163, wherein the deviation is based at least in part on a period of time that at least one item of sale of the plurality has spent on the floor.
165. The method of claim 163, wherein the deviation is based at least in part on a temperature experienced by at least one item of sale of the plurality while on the floor.
166. The method of claim 163, wherein the store analysis data comprises an indication that at least one item of sale of the plurality has experienced a product-life shortening event.
167. The method of claim 166, wherein the product-life shortening event is at least one of:
an environmental temperature that is out of compliance with the SOP;
detection of moisture within a product packaging of the at least one item of sale; or
damage to a product packaging of the at least one item of sale.
168. The method of claim 163 further comprising:
in response to the deviation, generating a sale-improvement action for at least one item of sale of the plurality.
169. The method of claim 168, wherein the sale-improvement action is at least one of:
moving the at least one item of sale to a location; or
discounting the at least one item of sale.
170. The method of claim 163 further comprising:
in response to the deviation, disposing of at least one item of sale.
171. The method of claim 163 further comprising:
in response to the deviation, generating an alert message, wherein the alert message comprises and indication of the deviation; and
transmitting the alert message.
172. The method of claim 171, wherein the alert message corresponds to at least on of:
a visual indication;
an audio indication; or
a text-based indication.
173. The method of claim 171, wherein the alert message comprises a micro-training event.

174. The method of claim 171, wherein the alert message comprises a location of the item of sale with respect to the floor.
175. The method of claim 155, wherein the plurality of micro-climate sensors are disposed across a plurality of item presentation units structured to present the plurality of items of sale for purchase.
176. An apparatus comprising:
a store floor data processing circuit structured to interpret store floor data corresponding to a plurality of items of sale disposed on a floor of a store;
a store analysis circuit structured to determine, based at least in part on standard operating procedure (SOP) data corresponding to a SOP of the store, store analysis data from the store floor data; and
a store analysis provisioning circuit structured to transmit the store analysis data; wherein the store analysis data indicates a measure of the store's compliance with the SOP.
177. The apparatus of claim 176, wherein each of the items of sale of the plurality is a SKU.
178. The apparatus of claim 176 further comprising:
a graphical interface circuit structured to generate graphical user interface data structured to generate a graphical user interface for receiving user input data;
a user input processing circuit structured to interpret the user input data; and
a SOP determination circuit structured to determine the SOP data based at least in part on the user input data.
179. The apparatus of claim 176 further comprising:
a SOP recommendation circuit structured to generate a recommended value for the SOP data.
180. The apparatus of claim 176 further comprising:
a store analysis visualization circuit structured to generate store visualization data for depicting the store analysis data.
181. The apparatus of claim 176, wherein the store analysis data comprises a measure value.

182. The apparatus of claim 181, wherein the measure value is based at least in part on a numerical scale between 1 and 100, wherein 1 represents low compliance with the SOP and 100 represents high compliance with the SOP.
183. The apparatus of claim 181, wherein the measure value is based at least in part on a color scale, wherein red represents low compliance with the SOP and green represents high compliance with the SOP.
184. The apparatus of claim 176, wherein the store analysis data comprises an indication of a deviation from the SOP.
185. The apparatus of claim 184, wherein the deviation is based at least in part on a period of time that at least one item of sale of the plurality has spent on the floor.
186. The apparatus of claim 184, wherein the deviation is based at least in part on an environmental temperature experienced by at least one item of sale of the plurality while on the floor.
187. The apparatus of claim 184, wherein the store analysis data comprises an indication that at least one item of sale of the plurality has experienced a product-life shortening event.
188. The apparatus of claim 187, wherein the product-life shortening event is at least one of:
- an environmental temperature that is out of compliance with the SOP;
 - detection of moisture within a product packaging of the at least one item of sale; or
 - damage to a product packaging of the at least one item of sale.
189. The apparatus of claim 184 further comprising:
- a recommendation circuit structured to generate, in response to the indication of the deviation, a recommended action value corresponding to a sale-improvement action to be taken with respect to at least one of the plurality of items of sale.
190. The apparatus of claim 189, wherein the sale-improvement action is at least one of:
- moving the at least one item of sale to a location; or
 - discounting the at least one item of sale.
191. The apparatus of claim 184 further comprising:
- a recommendation circuit structured to generate, in response to the indication of the deviation, a recommended action value corresponding to disposal of at least one of the plurality of items of sale.

192. The apparatus of claim 184 further comprising:
an alert circuit structured to generate alert data comprising the indication of the deviation; and
an alert provisioning circuit structured to transmit the alert data.
193. The apparatus of claim 192, wherein the alert data corresponds to at least one of:
a visual indication;
an audio indication; or
a text-based indication.
194. The apparatus of claim 192, wherein the alert data comprises a location of the item of sale with respect to the floor.
195. A system comprising:
a plurality of micro-climate sensors disposed on a floor of a store, each of the micro-climate sensors structured to generate store floor data corresponding to a plurality of items of sale disposed on the floor; and
a server structured to:
determine, based at least in part on standard operating procedure (SOP) data corresponding to a SOP of the store, store analysis data from the store floor data; and
transmit the store analysis data;
wherein the store analysis data indicates a measure of the store's compliance with the standard operating procedure.
196. The system of claim 195, wherein each of the items of sale of the plurality is a SKU.
197. The system of claim 196 further comprising:
an electronic device structured to interpret and display the store analysis data.
198. The system of claim 197, wherein the server is further structured to:
generate and transmit graphical user interface data structured to generate a graphical user interface for receiving user input data; and
determine the SOP data based at least in part on the user input data; and
wherein the electronic device is further structured to:
interpret the graphical user interface data;
generate and display the graphical user interface;
receive the user input; and
transmit the user input to the server.

199. The system of claim 196 further comprising:
a plurality of item presentation units structured to present the plurality of items of sale for purchase, wherein each item presentation unit comprises:
a space for storing and presenting one or more of the plurality of items of sale;
at least one of the plurality of micro-climate sensors; and
a store floor data provisioning circuit structured to transmit the store floor data.
200. The system of claim 199 further comprising:
an in-store network structured to transmit the store floor data from the plurality of presentation units to the server.
201. A store for vending a plurality of items of sale, the store comprising:
a floor:
one or more containers disposed on the floor and structured for presenting the plurality of items of sale;
a plurality of micro-climate sensors disposed on the floor and structured to generate store floor data corresponding to each of the plurality of items of sale;
a server structured to:
determine, based at least in part on standard operating procedure (SOP) data corresponding to a SOP of the store, store analysis data from the store floor data;
and
transmit the store analysis data, wherein the store analysis data comprises a measure value of the store's compliance with the SOP; and
an in-store network structured to transmit the store floor data from the plurality of micro-climate sensors to the server.
202. A method comprising:
generating visual disposition data from a plurality of items of sale in a store;
image processing the visual disposition data to generate processed disposition data;
determining disposition analysis data from the processed disposition data; and
transmitting the disposition analysis data;
wherein the disposition analysis data comprises an indication of a causal event for a disposal for at least one of the plurality of items of sale.
203. The method of claim 202, wherein the causal event is a result of a deviation from a standard operating procedure.

204. The method of claim 202, wherein:
the imaging processing is structured to detect a presence of moisture within a product packaging of the at least one item of sale; and
the causal event is based at least in part on the presence of the detected moisture.
205. The method of claim 204, wherein determining the disposition analysis data comprises:
determining that a level of the detected moisture meets or exceeds a moisture level defined by a standard operating procedure for disposing of the at least one item of sale.
206. The method of claim 202, wherein:
the imaging processing is structured to detect damage to a product packaging of the at least one item of sale; and
the causal event is based at least in part on the damage to the product packaging.
207. The method of claim 206, wherein determining the disposition analysis data comprises:
determining that a level of the damage to the product packaging meets or exceeds a product packaging damage level defined by a standard operating procedure for disposing of the at least one item of sale.
208. The method of claim 206, wherein determining the disposition analysis data comprises:
determining that a seal of the product packaging has been ruptured.
209. The method of claim 202, wherein:
the imaging processing is structured to detect damage to a consumable portion of the at least one item of sale; and
the causal event is based at least in part on the damage to the consumable portion.
210. The method of claim 209, wherein determining the disposition analysis data comprises:
determining that a level of the damage to the consumable portion meets or exceeds a consumable portion damage level defined by a standard operating procedure for disposing of the at least one item of sale.
211. The method of claim 202, wherein generating the visual disposition data is performed via a handheld mobile electronic device.

212. The method of claim 202, wherein generating the visual disposition data is performed via a robot.
213. The method of claim 202, wherein the at least one item of sale is at least one of:
a produce product;
a meat product;
a dairy product; or
a fish product.
214. The method of claim 202, wherein the at least one item of sale is a frozen product.
215. The method of claim 202, wherein the at least one item of sale is a produce product.
216. A method comprising:
interpreting visual disposition data generated from a plurality of items of sale in a store;
image processing the visual disposition data to generate processed disposition data;
determining disposition analysis data from the processed disposition data; and
transmitting the disposition analysis data;
wherein the disposition analysis data comprises an indication of a causal event for a disposal for at least one of the plurality of items of sale.
217. The method of claim 216, wherein the causal event is a result of a deviation from a standard operating procedure.
218. The method of claim 216, wherein:
the imaging processing is structured to detect a presence of moisture within a product packaging of the at least one item of sale; and
the causal event is based at least in part on the presence of the detected moisture.
219. The method of claim 218, wherein determining the disposition analysis data comprises:
determining that a level of the detected moisture meets or exceeds a moisture level defined by a standard operating procedure for disposing of the at least one item of sale.
220. The method of claim 216, wherein:
the imaging processing is structured to detect damage to a product packaging of the at least one item of sale; and
the causal event is based at least in part on the damage to the product packaging.

221. The method of claim 220, wherein determining the disposition analysis data comprises:
determining that a level of the damage to the product packaging meets or exceeds a product packaging damage level defined by a standard operating procedure for disposing of the at least one item of sale.
222. The method of claim 220, wherein determining the disposition analysis data comprises:
determining that a seal of the product packaging has been ruptured.
223. The method of claim 216, wherein:
the imaging processing is structured to detect damage to a consumable portion of the at least one item of sale; and
the causal event is based at least in part on the damage to the consumable portion.
224. The method of claim 223, wherein determining the disposition analysis data comprises:
determining that a level of the damage to the consumable portion meets or exceeds a consumable portion damage level defined by a standard operating procedure for disposing of the at least one item of sale.
225. The method of claim 216, wherein:
the imaging processing is structured to detect a shape of the at least one item of sale;
and
the causal event is based at least in part on the shape of the at least one item of sale.
226. The method of claim 225, wherein determining the disposition analysis data comprises:
determining that a shape of the at least one item of sale meets or exceeds a shape defined by a standard operating procedure for disposing of the at least one item of sale.
227. The method of claim 216, wherein:
the imaging processing is structured to detect a color of the at least one item of sale;
and
the causal event is based at least in part on the color of the at least one item of sale.
228. The method of claim 227, wherein determining the disposition analysis data comprises:

determining that a color of the at least one item of sale meets or exceeds a color defined by a standard operating procedure for disposing of the at least one item of sale.

229. The method of claim 226, wherein:

the imaging processing is structured to detect bruising of the at least one item of sale;

and

the causal event is based at least in part on the bruising of the at least one item of sale.

230. The method of claim 229, wherein determining the disposition analysis data comprises:

determining that a bruising of the at least one item of sale meets or exceeds a level of bruising defined by a standard operating procedure for disposing of the at least one item of sale.

231. The method of claim 226, wherein:

the imaging processing is structured to detect wilting of the at least one item of sale;

and

the causal event is based at least in part on the wilting of the at least one item of sale.

232. The method of claim 231, wherein determining the disposition analysis data comprises:

determining that a wilting of the at least one item of sale meets or exceeds a level of wilting defined by a standard operating procedure for disposing of the at least one item of sale.

233. The method of claim 216, wherein:

the imaging processing is structured to detect a size of the at least one item of sale;

and

the causal event is based at least in part on the size of the at least one item of sale.

234. The method of claim 233, wherein determining the disposition analysis data comprises:

determining that a size of the at least one item of sale meets or exceeds a size defined by a standard operating procedure for disposing of the at least one item of sale.

235. The method of claim 216, wherein:

the imaging processing is structured to detect a date code of the at least one item of sale; and

the causal event is based at least in part on the date code of the at least one item of sale.

236. The method of claim 235, wherein determining the disposition analysis data comprises:

determining that a date code of the at least one item of sale meets or exceeds proximity to date code defined by a standard operating procedure for disposing of the at least one item of sale.

237. A method comprising:

identifying, in a store, at least one item of sale that is to be disposed;
generating visual disposition data from the at least one item via a mobile electronic device; and
transmitting the visual disposition data via the electronic device.

238. An apparatus comprising:

a visual disposition data processing circuit structure to interpret visual disposition data from at least one item of sale in a store;

an image processing circuit structured to generate processed disposition data;

a disposition analysis determination circuit structured to generate disposition analysis data from the processed disposition data; and

a disposition analysis provisioning circuit structured to transmit the disposition analysis data;

wherein the disposition analysis data comprises an indication of a causal event for a disposal for the at least one item of sale.

239. The apparatus of claim 238, wherein:

the imaging processing circuit is further structured to detect a presence of moisture within a product packaging of the at least one item of sale; and

the disposition analysis determination circuit is further structured to determine the indication of the causal event based at least in part on the presence of the detected moisture.

240. The apparatus of claim 239, wherein determining the indication of the causal event comprises:

determining that a level of the detected moisture meets or exceeds a moisture level defined by a standard operating procedure for disposing of the at least one item of sale.

241. The apparatus of claim 238, wherein:

the imaging processing circuit is further structured to detect damage to a product packaging of the at least one item of sale; and

the disposition analysis determination circuit is further structured to determine the indication of the causal event based at least in part on the damage to the product packaging.

242. The apparatus of claim 241, wherein determining the indication of the causal event comprises:

determining that a level of the damage to the product packaging meets or exceeds a product packaging damage level defined by a standard operating procedure for disposing of the at least one item of sale.

243. The apparatus of claim 241, wherein determining the indication of the causal event comprises:

determining that a seal of the product packaging has been ruptured.

244. The apparatus of claim 238, wherein:

the imaging processing circuit is further structured to detect damage to a consumable portion of the at least one item of sale; and

the disposition analysis determination circuit is further structured to determine the indication of the causal event based at least in part on the damage to the consumable portion.

245. The apparatus of claim 244, wherein determining the disposition analysis data comprises:

determining that a level of the damage to the consumable portion meets or exceeds a consumable portion damage level defined by a standard operating procedure for disposing of the at least one item of sale.

246. A system comprising:

an electronic mobile device structured to generate visual disposition data from a plurality of items of sale in a store; and

a server structured to:

generate processed disposition data via image processing the visual disposition data;

determine disposition analysis data from the processed disposition data; and
transmit the disposition analysis data;

wherein the disposition analysis data comprises an indication of a causal event for a disposal of at least one item of sale of the plurality.

247. The system of claim 246 further comprising:

a network structured to transmit the visual disposition data from the electronic mobile device to the server.

248. The system of claim 246, wherein:

the imaging processing is structured to detect a presence of moisture within a product packaging of the at least one item of sale; and

the server is further structured to determine the indication of the causal event based at least in part on the presence of the detected moisture.

249. The system of claim 248, wherein determining the disposition analysis data comprises:

determining that a level of the detected moisture meets or exceeds a moisture level defined by a standard operating procedure for disposing of the at least one item of sale.

250. The system of claim 246, wherein:

the imaging processing is structured to detect damage to a product packaging of the at least one item of sale; and

the server is further structured to determine the indication of the causal event based at least in part on the damage to the product packaging.

251. The system of claim 250 wherein determining the disposition analysis data comprises:

determining that a level of the damage to the product packaging meets or exceeds a product packaging damage level defined by a standard operating procedure for disposing of the at least one item of sale.

252. The system of claim 250, wherein determining the disposition analysis data comprises:

determining that a seal of the product packaging has been ruptured.

253. The system of claim 246, wherein:

the imaging processing is structured to detect damage to a consumable portion of the at least one item of sale; and

the server is further structured to determine the indication of the causal event based at least in part on the damage to the consumable portion.

254. The system of claim 253, wherein determining the indication of the causal event comprises:

determining that a level of the damage to the consumable portion meets or exceeds a consumable portion damage level defined by a standard operating procedure for disposing of the at least one item of sale.

255. A method comprising:

interpreting flow analysis data corresponding to a plurality of items of sale flowing through a supply chain for an entity;

interpreting store analysis data corresponding to the plurality of items of sale while disposed on a floor of a store;

interpreting disposition analysis data corresponding to disposal of some of the plurality of items of sale; and

determining a score value based at least in part on the flow analysis data, the store analysis data, and the disposition analysis data.

256. The method of claim 255, wherein the entity is the store.

257. The method of claim 255 further comprising:

generating a graphical interface that depicts at least a portion of:

the flow analysis data;

the store analysis data;

the disposition analysis data; and

the score value.

258. The method of claim 255, further comprising:

generating a set of specific actions for the entity to improve the score value, the set of specific actions based at least on part on the flow analysis data, the store analysis data, and the disposition analysis data.

259. The method of claim 258, further comprising:

prioritizing the set of specific actions based at least on part on the flow analysis data, the store analysis data, and the disposition analysis data.

260. The method of claim 258, further comprising:

revising the set of specific actions as new flow analysis data, new store analysis data, and new disposition analysis data becomes available.

261. The method of claim 255, wherein:
the flow analysis data comprises an indication of compliance of the plurality of items of sale with respect to a first standard operating procedure (SOP); and
the store analysis data comprises an indication of compliance of the plurality of items of sale with respect to a second SOP.
262. The method of claim 261, wherein:
the first SOP and the second SOP are the same; or
the first SOP and the second SOP form part of a third SOP.
263. The method of claim 255, wherein the score value comprises a fresh score value corresponding to a measure of a freshness of the items of sale.
264. The method of claim 263, wherein the measure of freshness is with respect to a time period.
265. The method of claim 264 further comprising:
selecting the time period.
266. The method of claim 264, wherein the time period is a time over which the fresh score value is determined.
267. The method of claim 263, wherein the fresh score value comprises a numerical value.
268. The method of claim 267, wherein the numerical value is based at least in part on a scale between 1 and 100, wherein 1 represents low freshness and 100 represents high freshness.
269. The method of claim 263, wherein the fresh score value is based at least in part on a color scale, wherein red represents low freshness and green represents high freshness.
270. An apparatus comprising:
a flow analysis data processing circuit structured to interpret flow analysis data generated from a plurality of items of sale flowing through a portion of a supply chain;
a store analysis data processing circuit structured to interpret store analysis data generated from the plurality of items of sale while disposed on a floor of a store;
a disposition analysis data processing circuit structured to interpret disposition analysis data comprising one or more indications of one or more causal events for the disposal of at least some of the plurality of items of sale;

a score determination circuit structured to determine a score value based at least in part on the flow analysis data, the store analysis data, and the disposition analysis data; and
a score provisioning circuit structured to transmit the score value.

271. The apparatus of claim 270, further comprising:

a graphical interface circuit structured to generate graphical interface data structured to generate a graphical user interface that depicts at least a portion of:

the flow analysis data;
the store analysis data;
the disposition analysis data; and
the score value.

272. The apparatus of claim 270, wherein:

the flow analysis data comprises and indication of compliance of the plurality of items of sale with respect to a first standard operating procedure (SOP); and

the store analysis data comprises and indication of compliance of the plurality of items of sale with respect to a second SOP.

273. The apparatus of claim 272, wherein:

the first SOP and the second SOP are the same; or
the first SOP and the second SOP form part of a third SOP.

274. The apparatus of claim 270, wherein the score value comprises a fresh score value corresponding to a measure of a freshness of the items of sale.

275. The apparatus of claim 274, wherein the measure of freshness is with respect to a time period.

276. The apparatus of claim 275 further comprising:

a user input circuit structured to interpret a user input; and
a time period determination circuit structured to determine the time period based at least in part on the user input.

277. The apparatus of claim 275, wherein the time period is the time the fresh score value is determined.

278. The apparatus of claim 274, wherein the fresh score value comprises a numerical value.

279. The apparatus of claim 278, wherein the numerical value is based at least in part on a scale between 1 and 100, wherein 1 represents low freshness and 100 represents high freshness.

280. The apparatus of claim 274, wherein the fresh score value is based at least in part on a color scale, wherein red represents low freshness and green represents high freshness.

281. A system comprising:

- a first plurality of micro-climate sensors each associated with a corresponding individual item of sale and structured to generate and transmit product flow data of the individual item of sale of a plurality of items of sale flowing through a supply chain for an entity;

- a second plurality of micro-climate sensors disposed on a floor of a store and structured to generate floor data corresponding to the plurality of items of sale while disposed on the floor;

- a mobile electronic device structured to generate visual disposition data from at least some of the plurality of items of sale; and

- a server structured to:

- determine flow analysis data from the product flow data;

- determine store analysis data from the floor data; and

- determine a score value based at least in part on the product flow data, the floor data, and the visual disposition data.

282. The system of claim 281, wherein at least one of the server or the mobile electronic device are further structured to generate a graphical interface that depicts at least a portion of:

- the flow analysis data;

- the store analysis data;

- the disposition analysis data; and

- the score value.

283. The system of claim 281, wherein:

- the flow analysis data comprises an indication of compliance of the plurality of items of sale with respect to a first standard operating procedure (SOP); and

- the store analysis data comprises an indication of compliance of the plurality of items of sale with respect to a second SOP.

284. The system of claim 283, wherein:
the first SOP and the second SOP are the same; or
the first SOP and the second SOP form part of a third SOP.
285. The system of claim 282, wherein the score value comprises a fresh score value corresponding to a measure of a freshness of the items of sale.
286. The system of claim 285, wherein the measure of freshness is with respect to a time period.
287. The system of claim 286, wherein the server is further structured to:
interpret user input data corresponding to a user input on the mobile electronic device;
and
determine the time period based at least in part on the user input data.
288. The system of claim 286, wherein the time period is the time the fresh score value is determined.
289. The system of claim 285, wherein the fresh score value comprises a numerical value.
290. The system of claim 289, wherein the numerical value is based at least in part on a scale between 1 and 100, wherein 1 represents low freshness and 100 represents high freshness.
291. The system of claim 289, wherein the fresh score value is based at least in part on a color scale, wherein red represents low freshness and green represents high freshness.

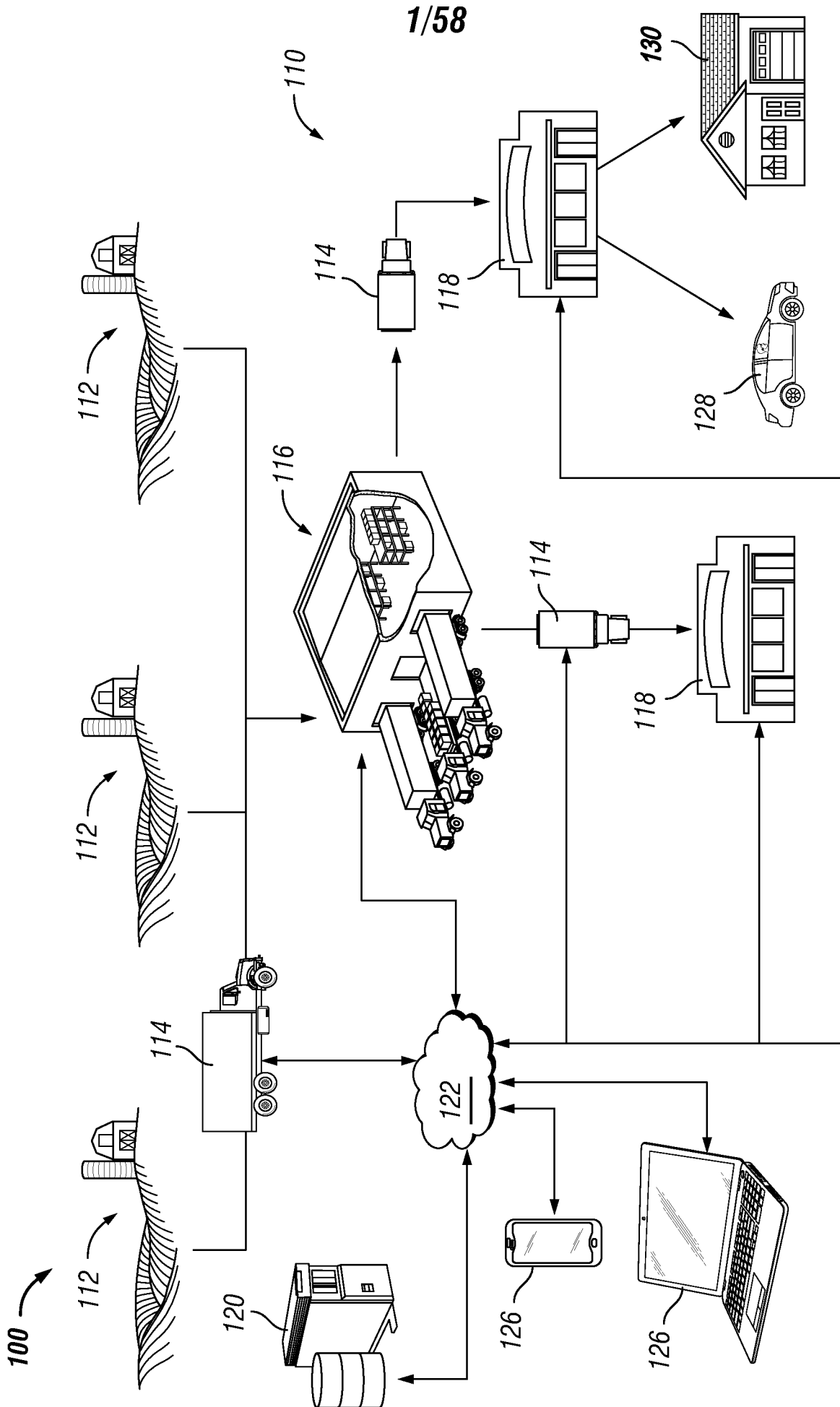
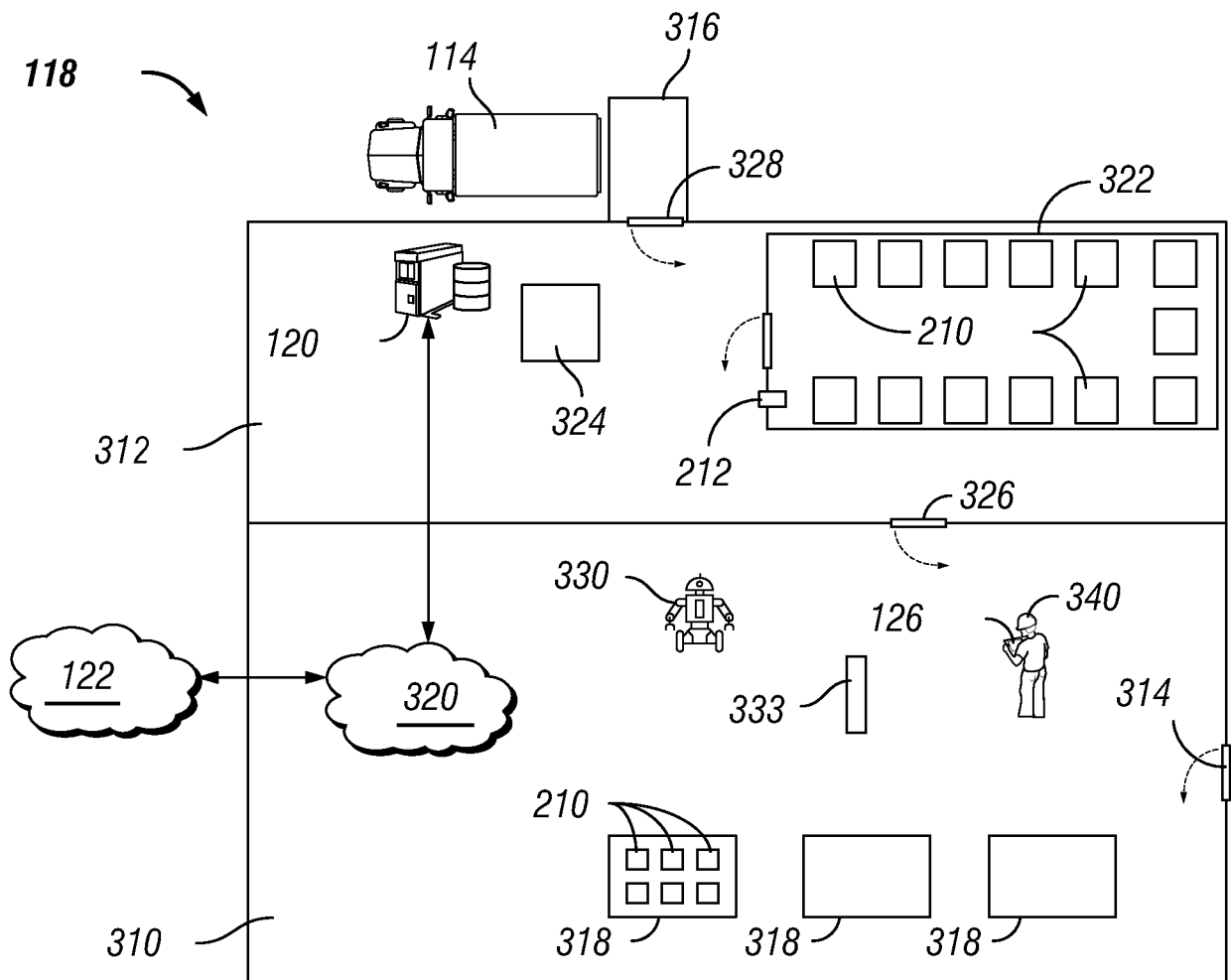
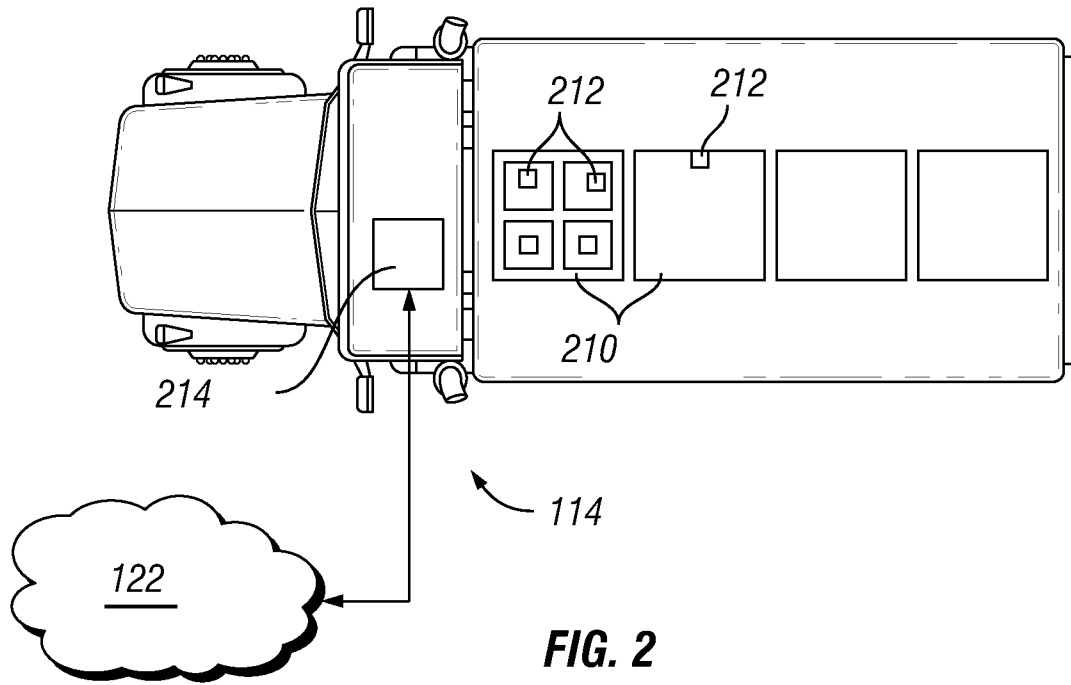


FIG. 1

2/58



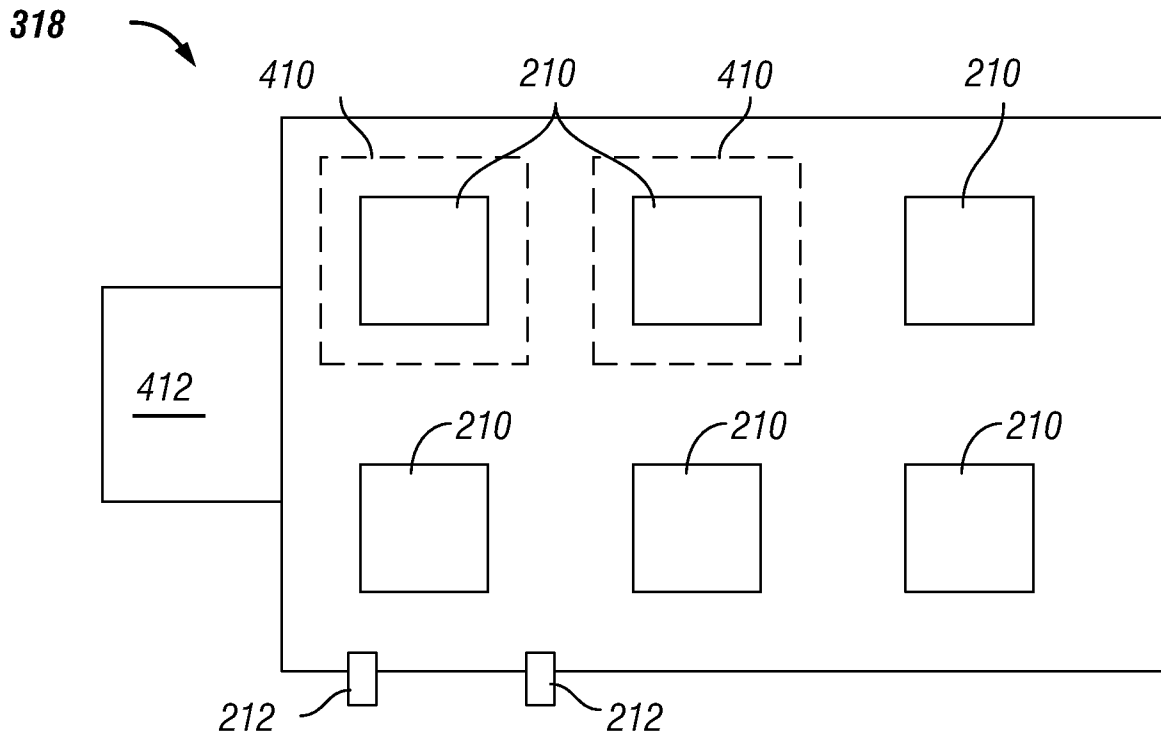


FIG. 4

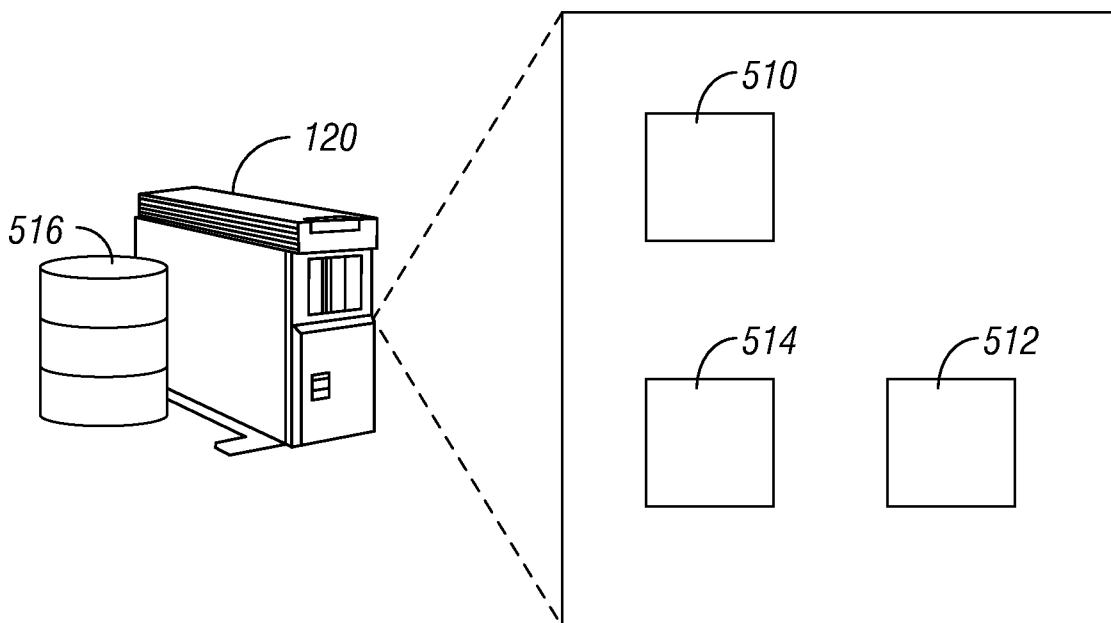


FIG. 5

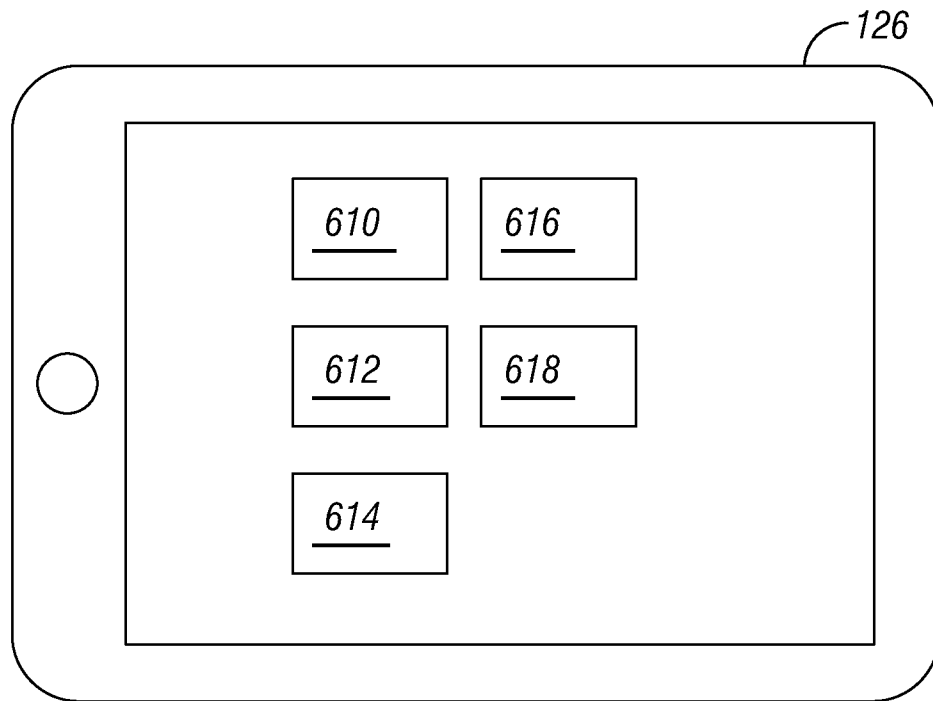


FIG. 6

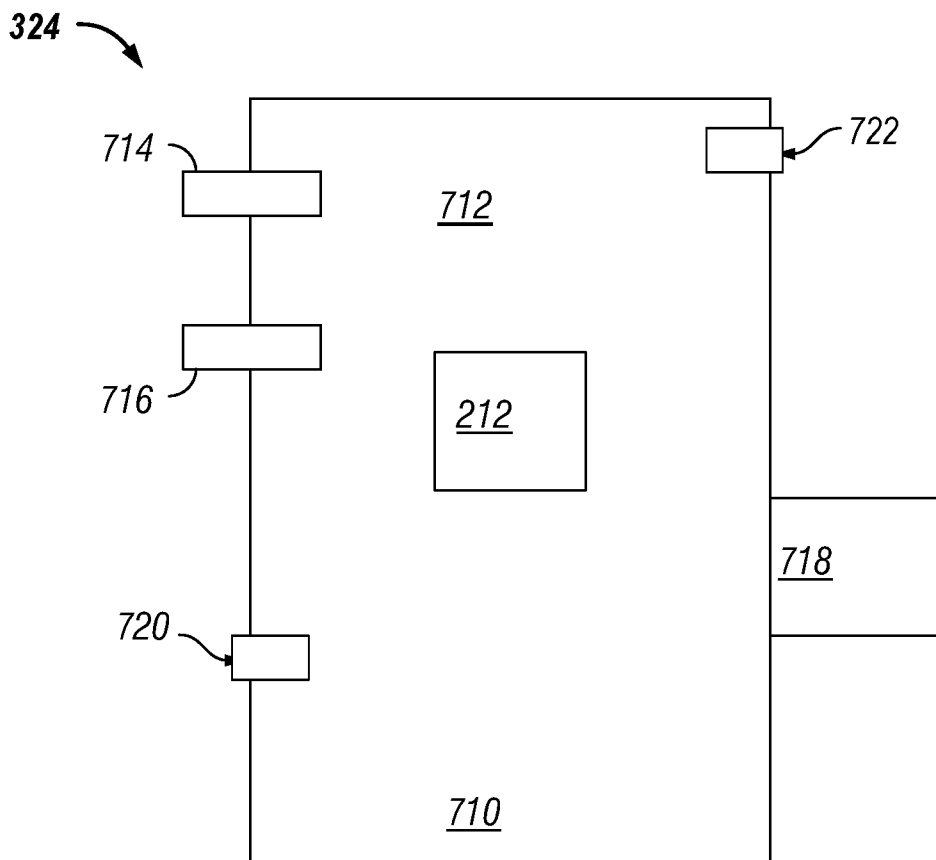


FIG. 7

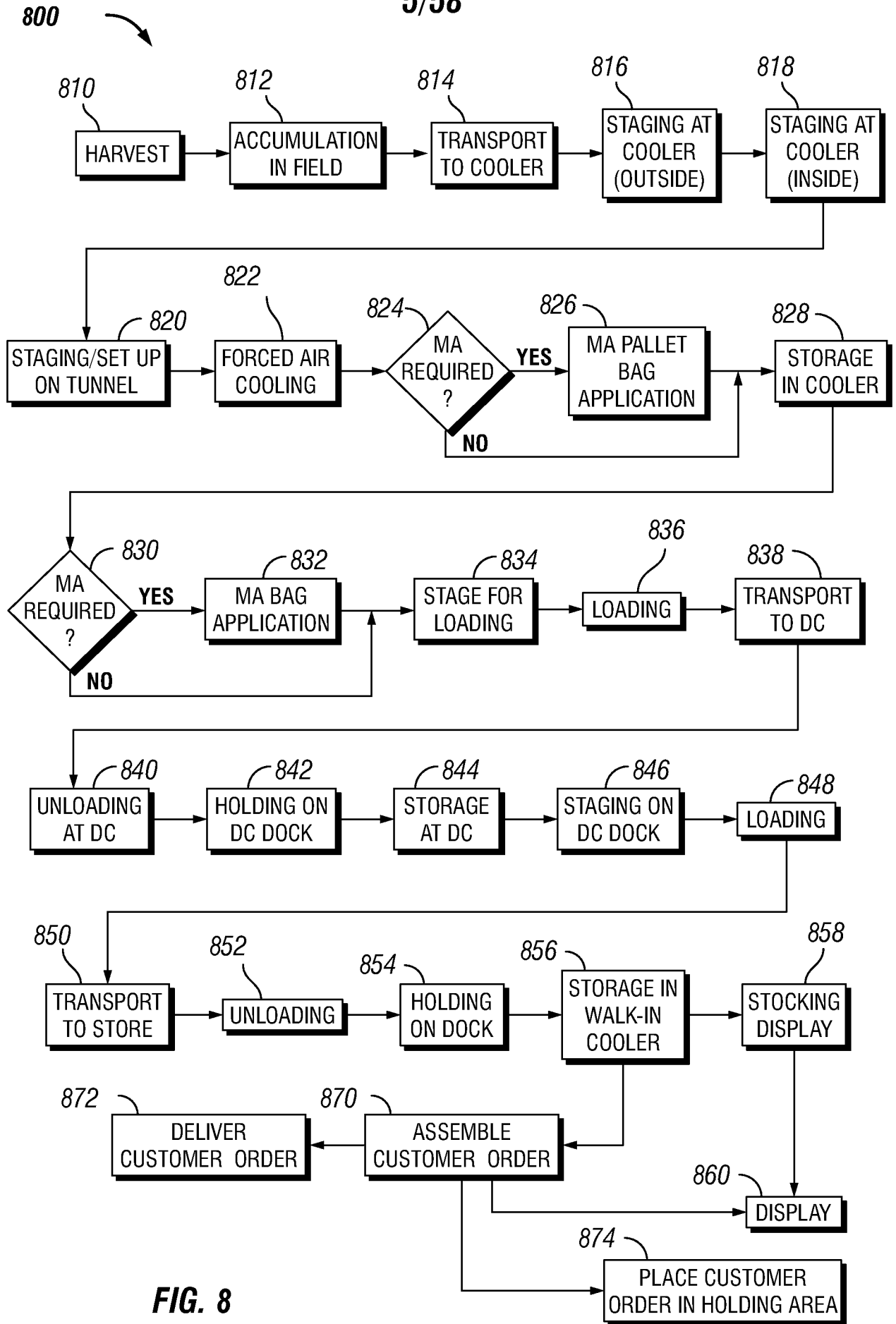


FIG. 8

900 ↘

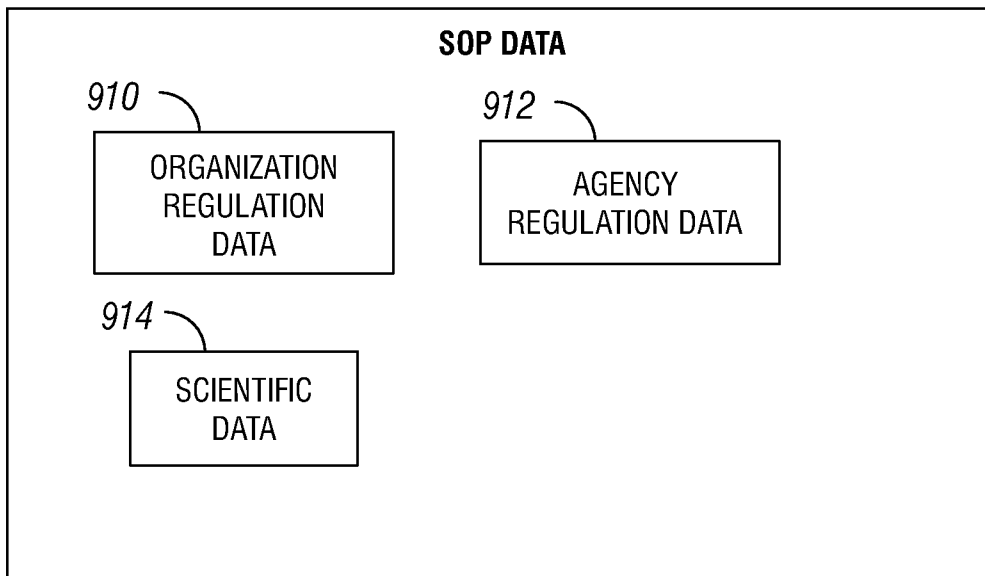


FIG. 9

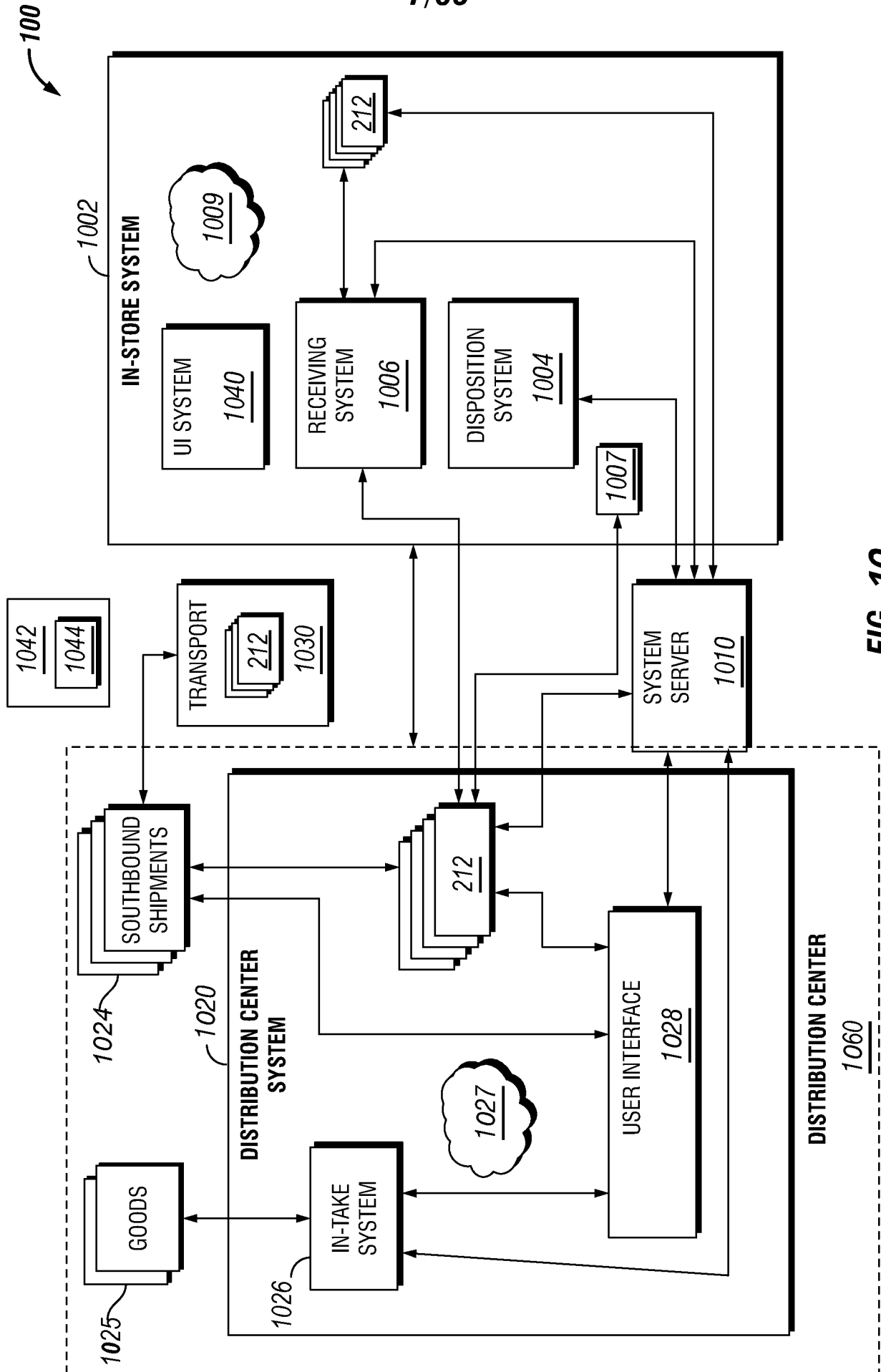
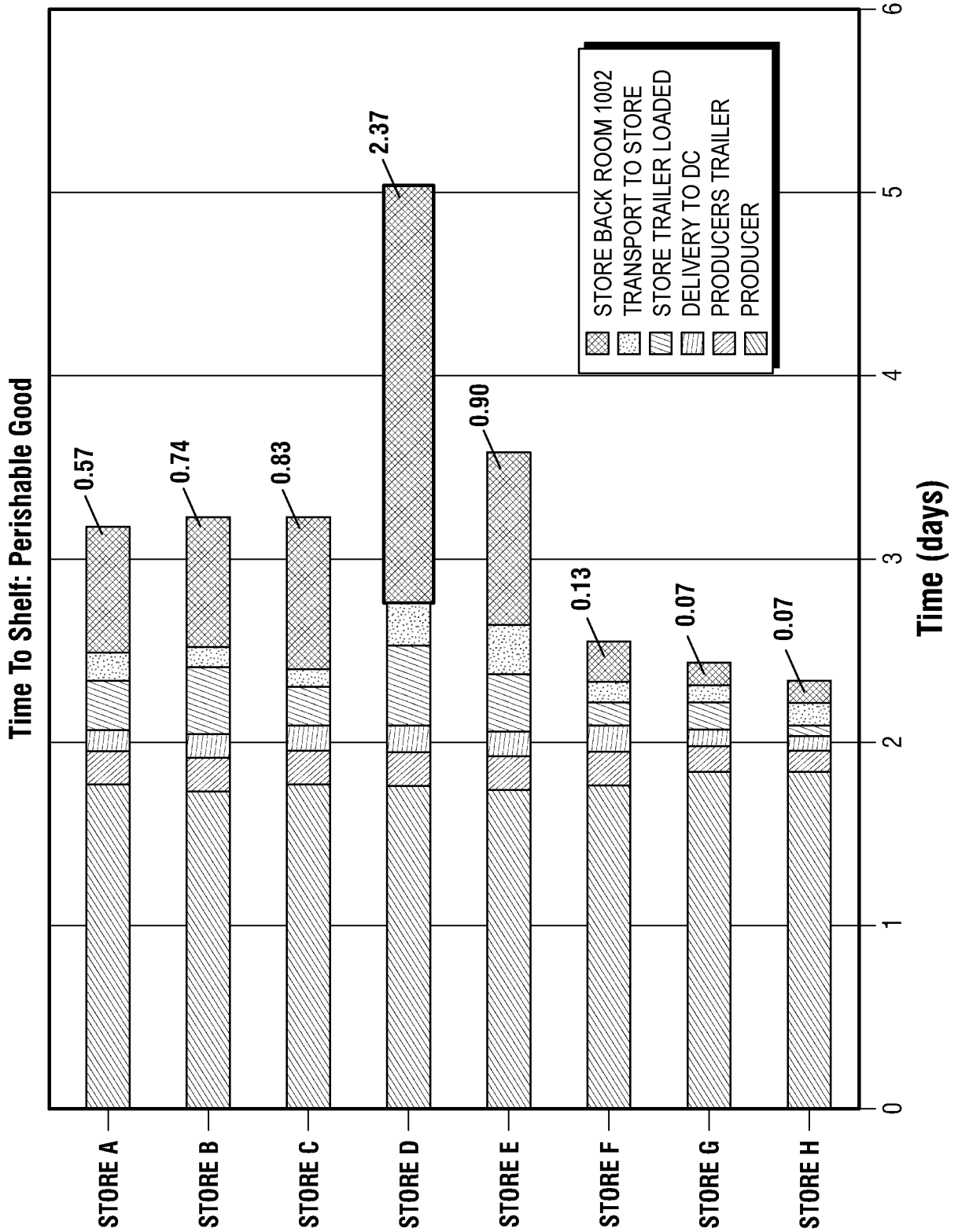


FIG. 10



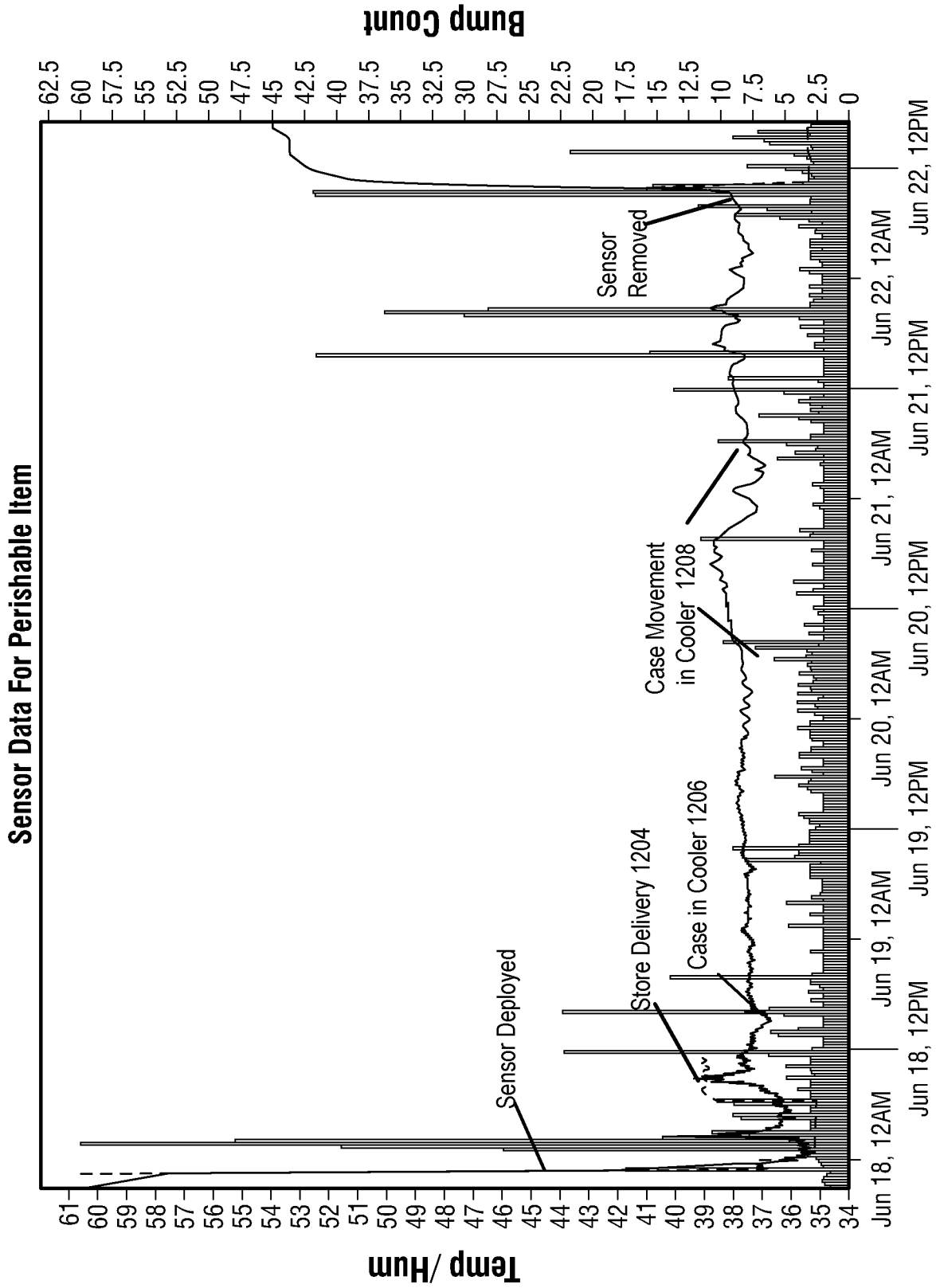


FIG. 12

10/58

Producer To Shelf Temperature: Produce Item 1

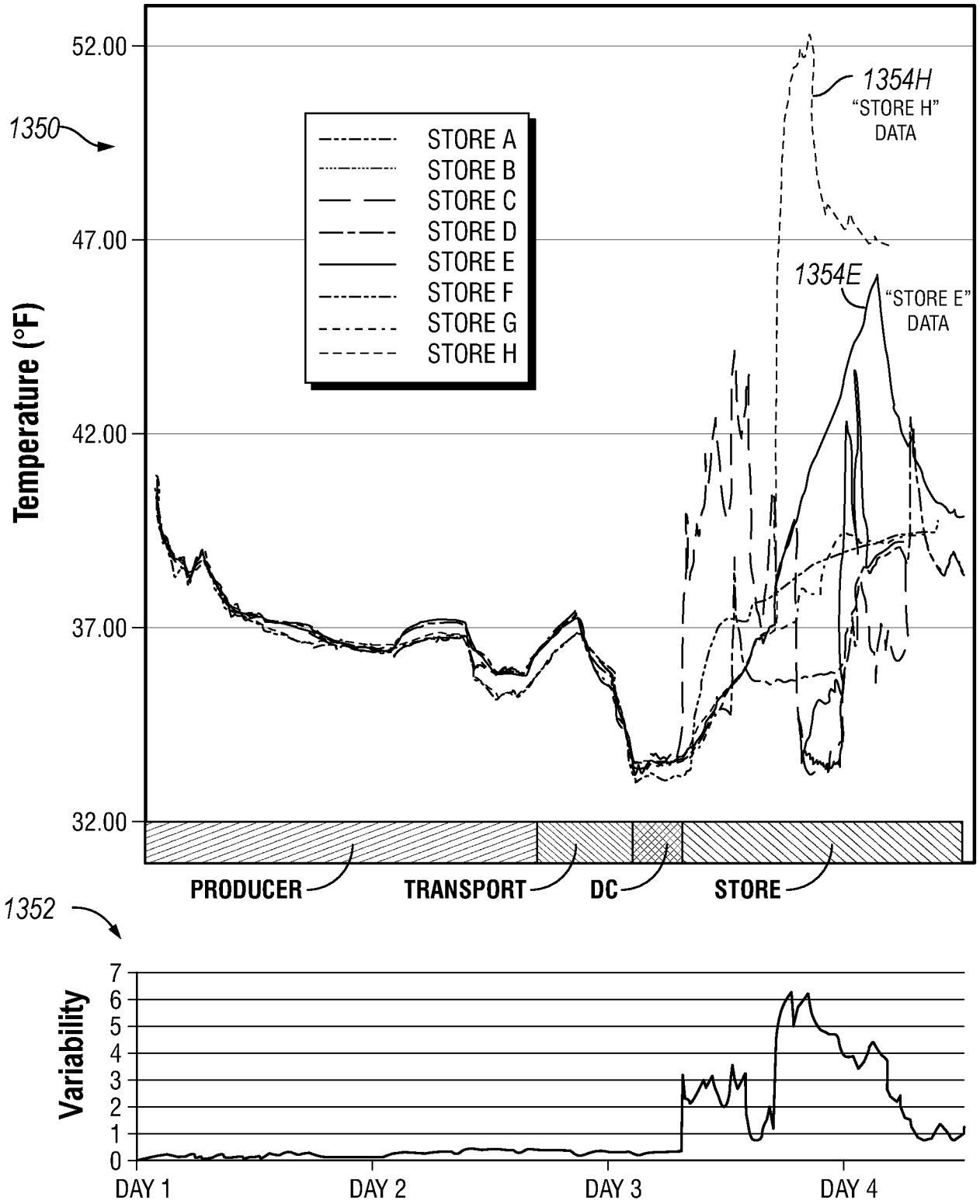


FIG. 13

11/58

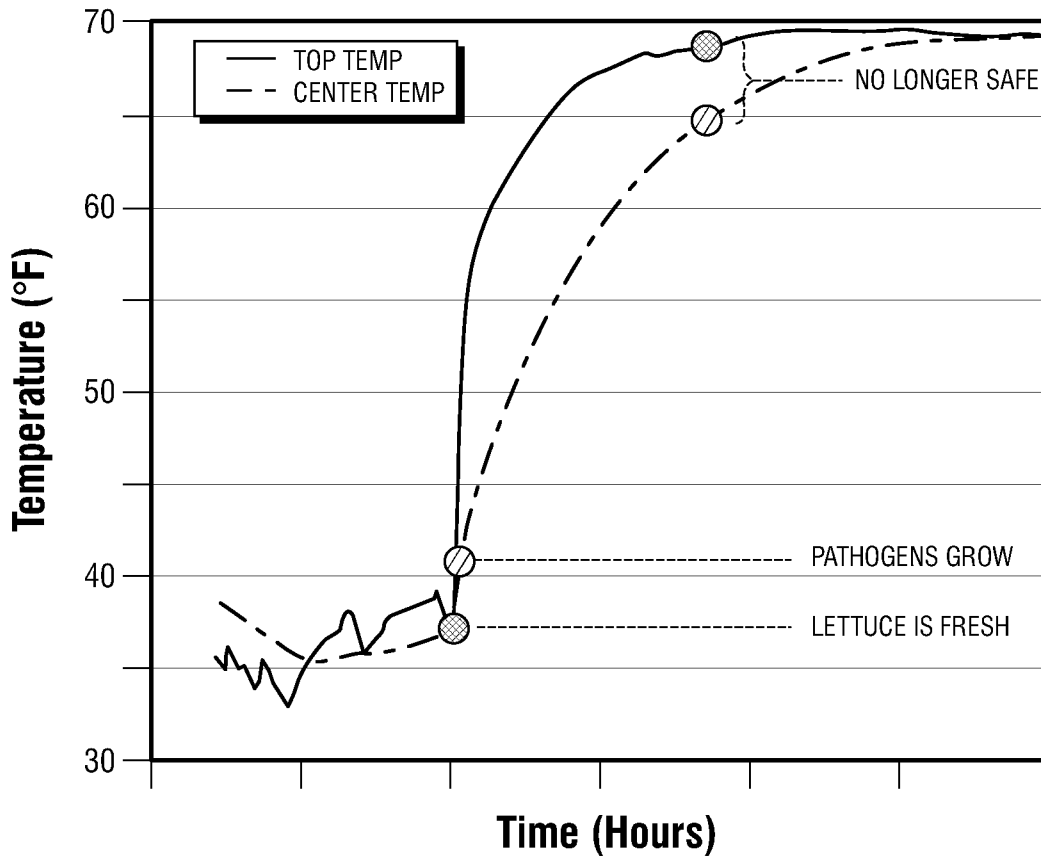


FIG. 14

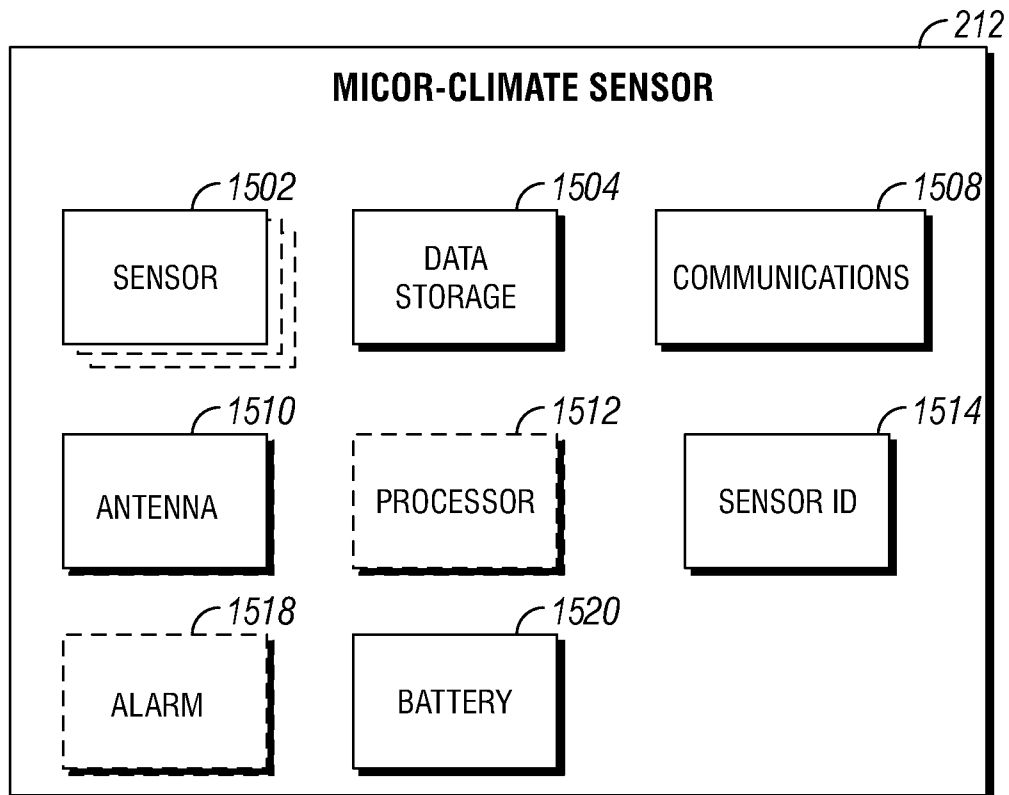


FIG. 15

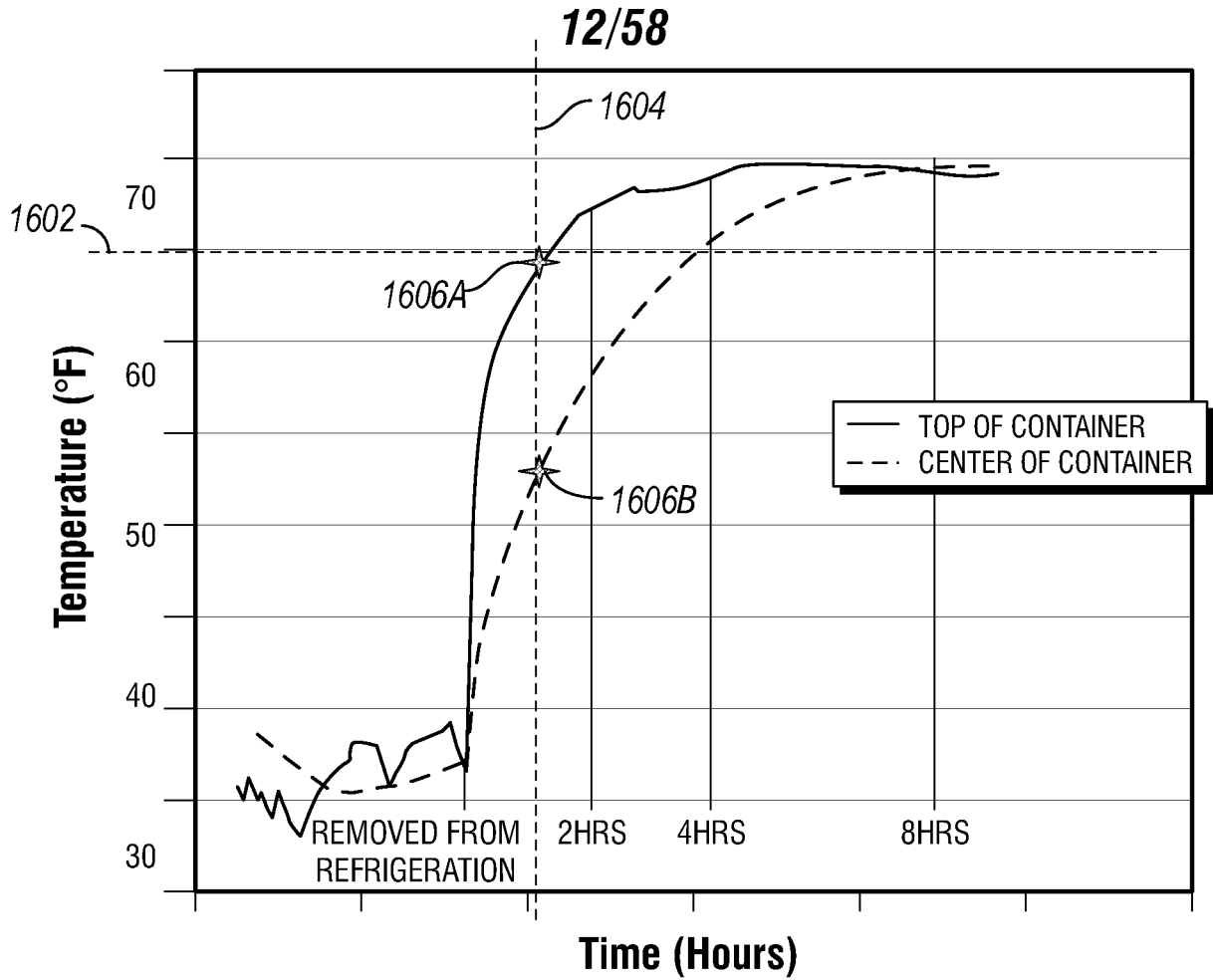


FIG. 16

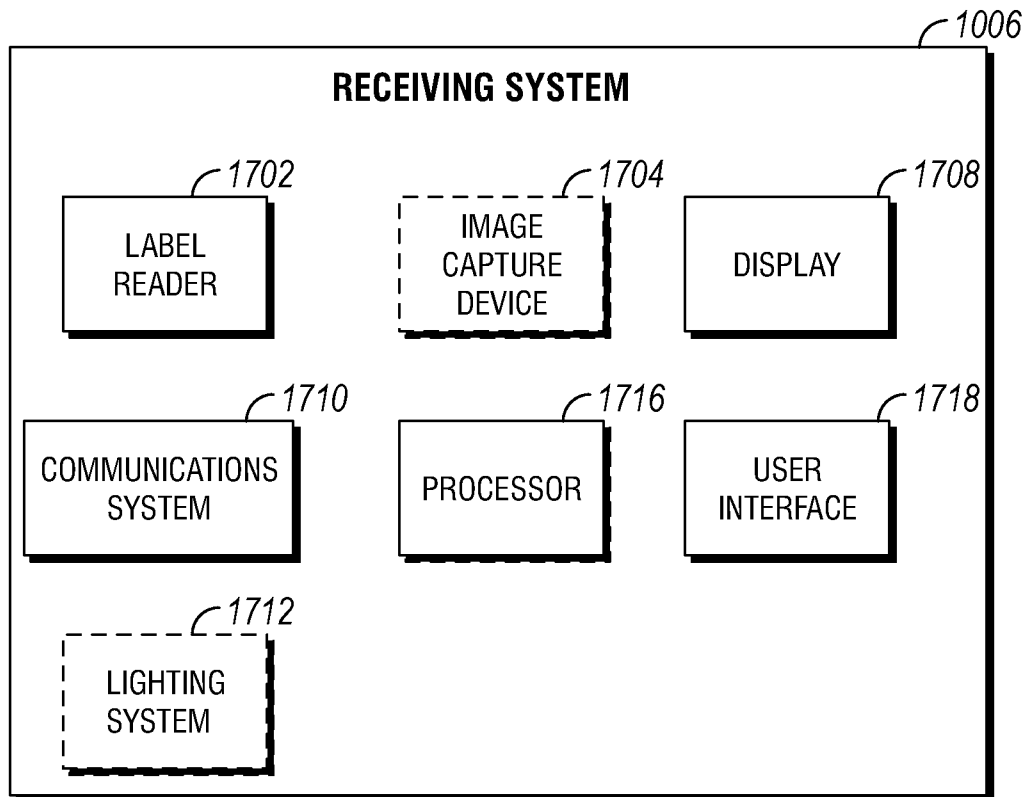


FIG. 17

13/58

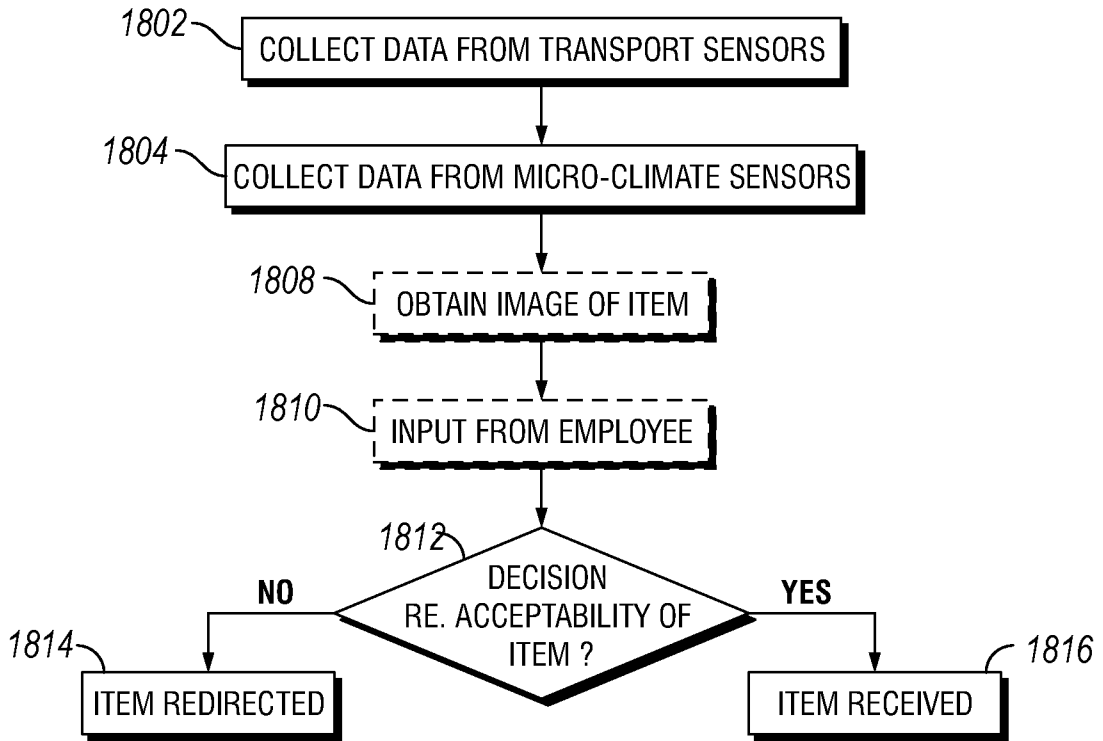


FIG. 18

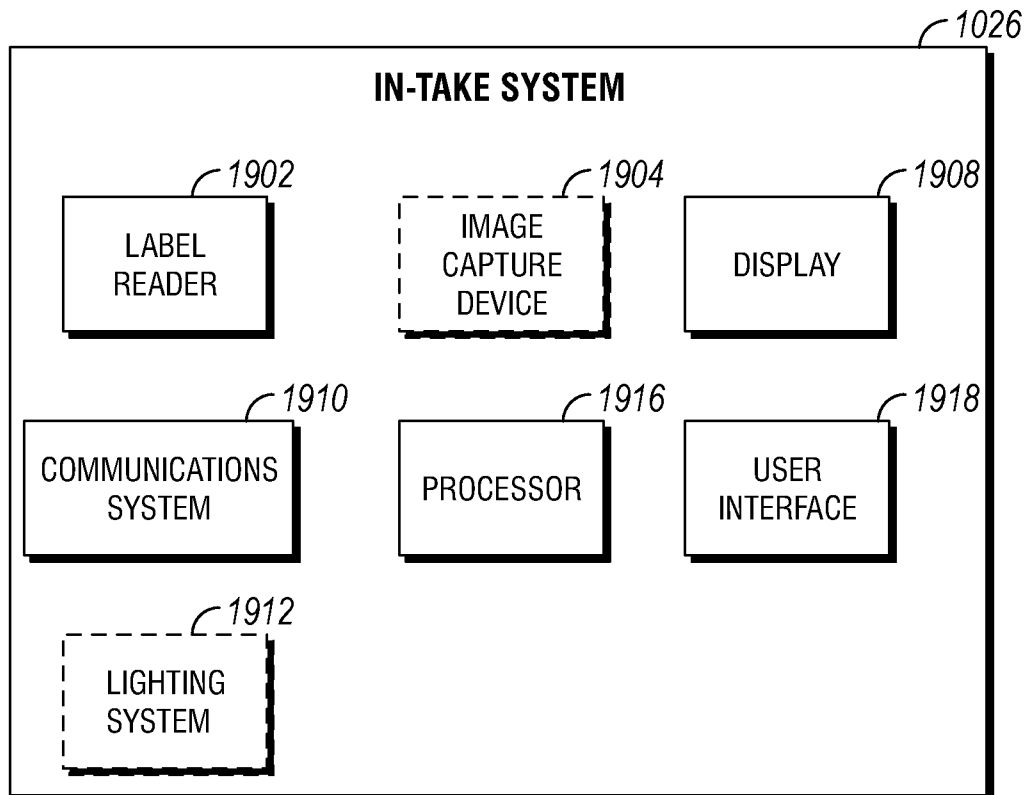


FIG. 19

14/58

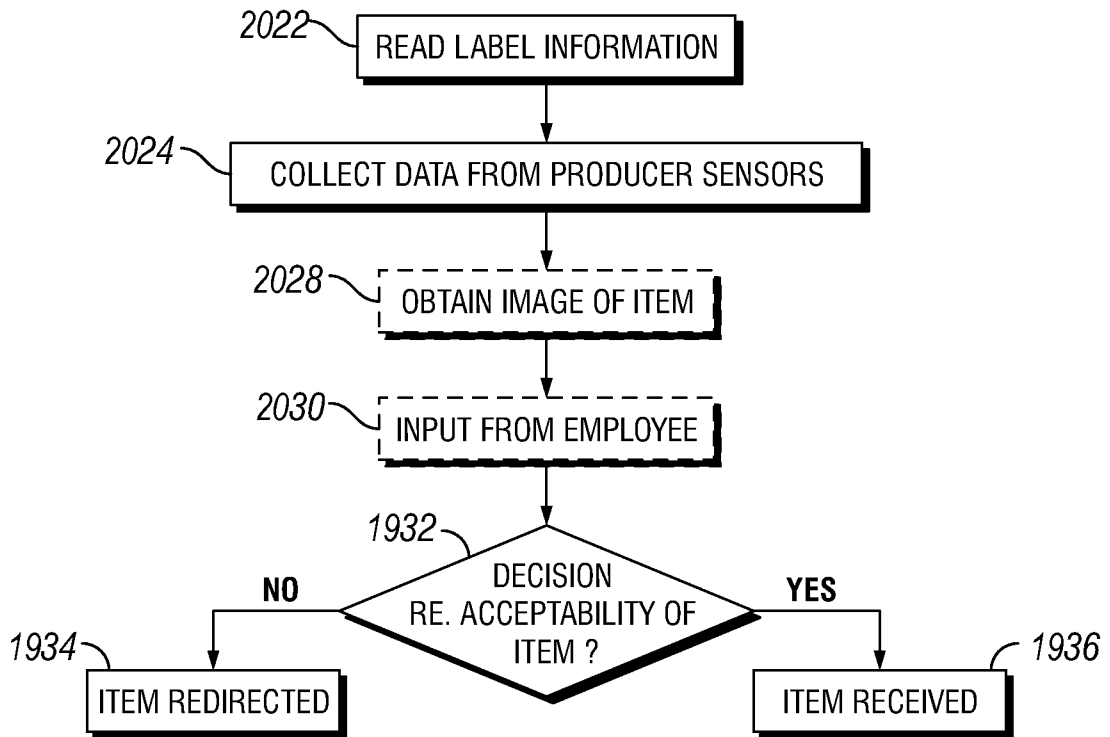


FIG. 20

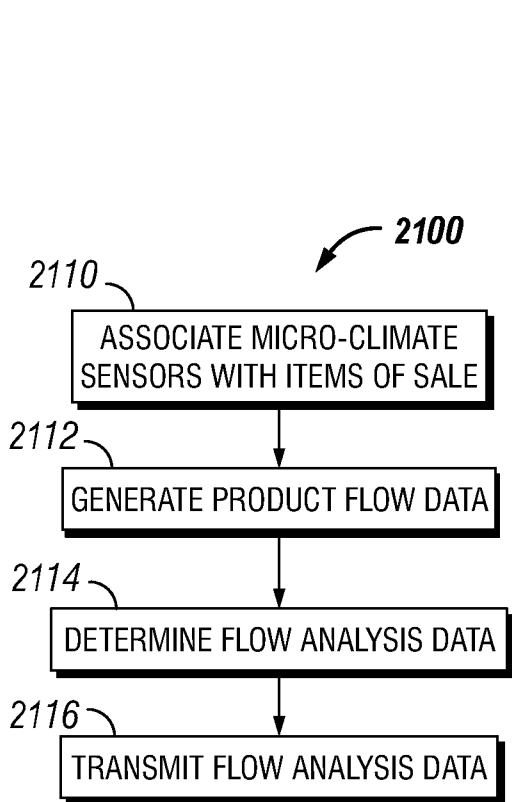


FIG. 21

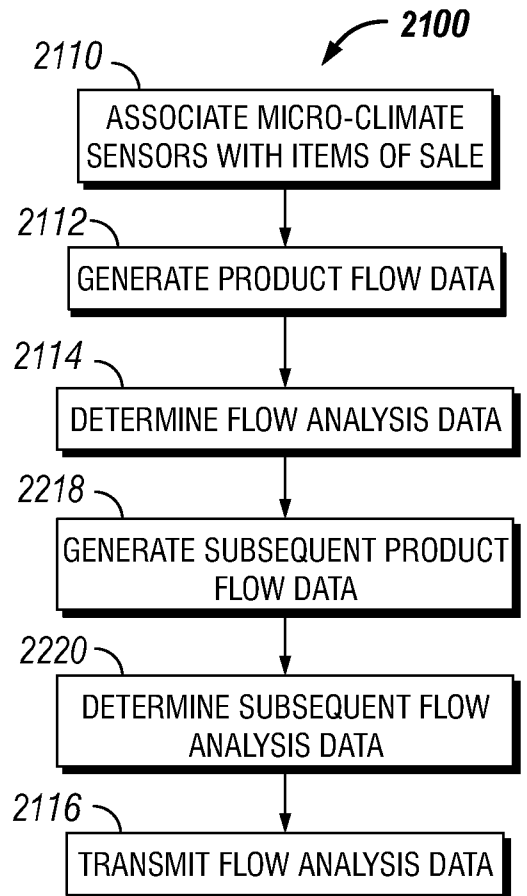


FIG. 22

15/58

2100

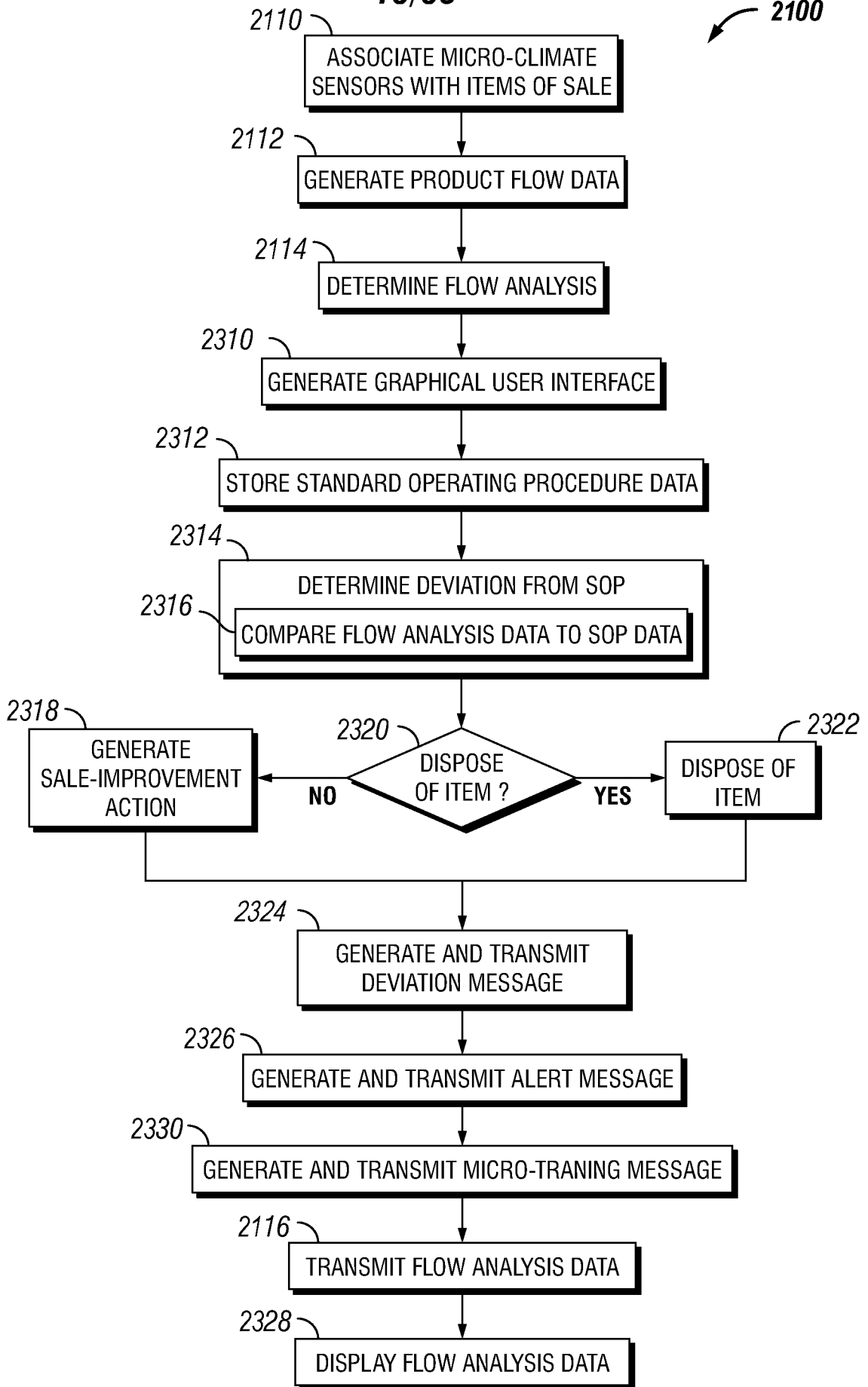


FIG. 23

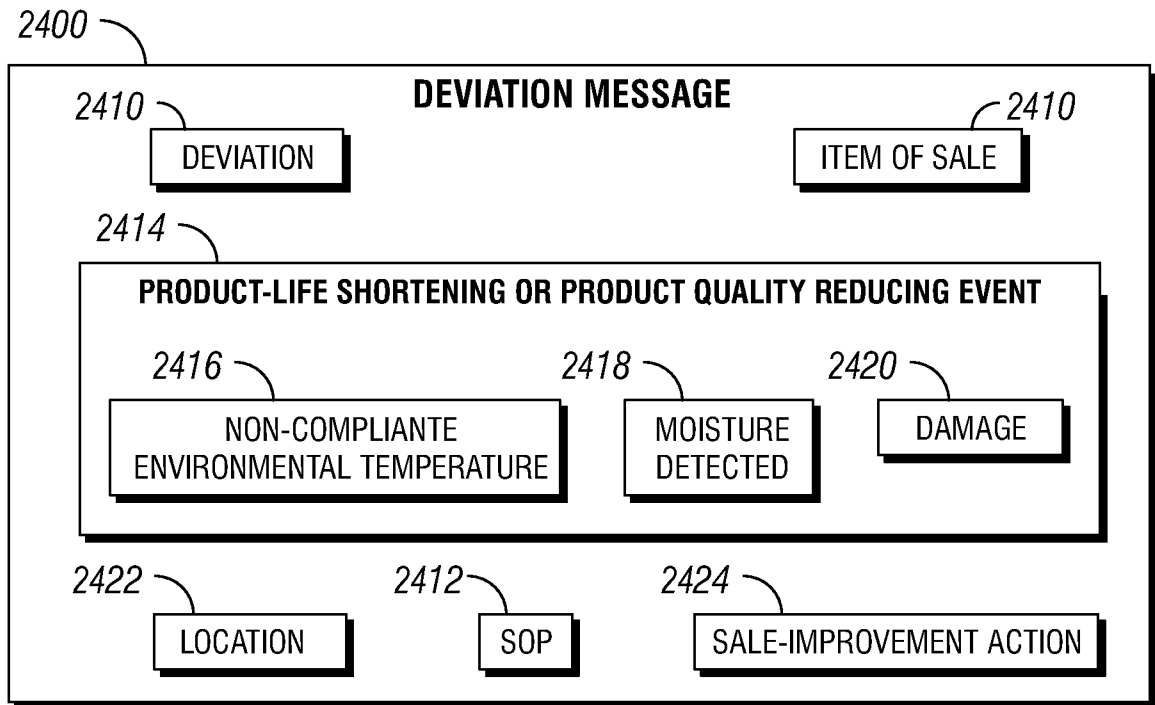


FIG. 24

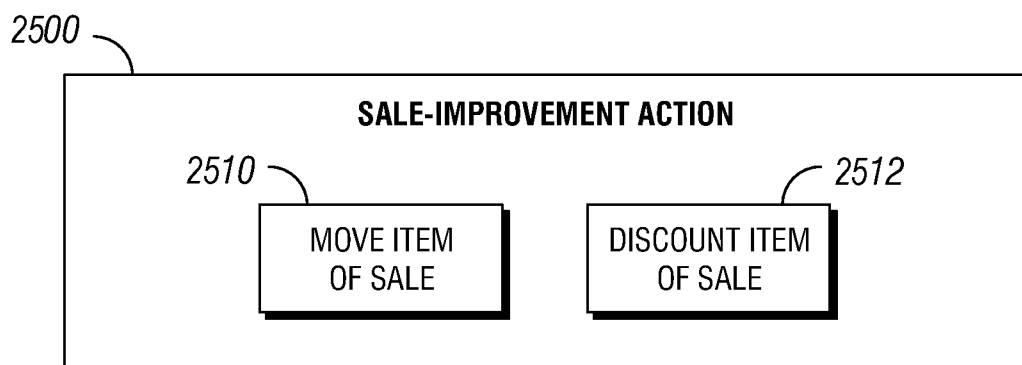


FIG. 25

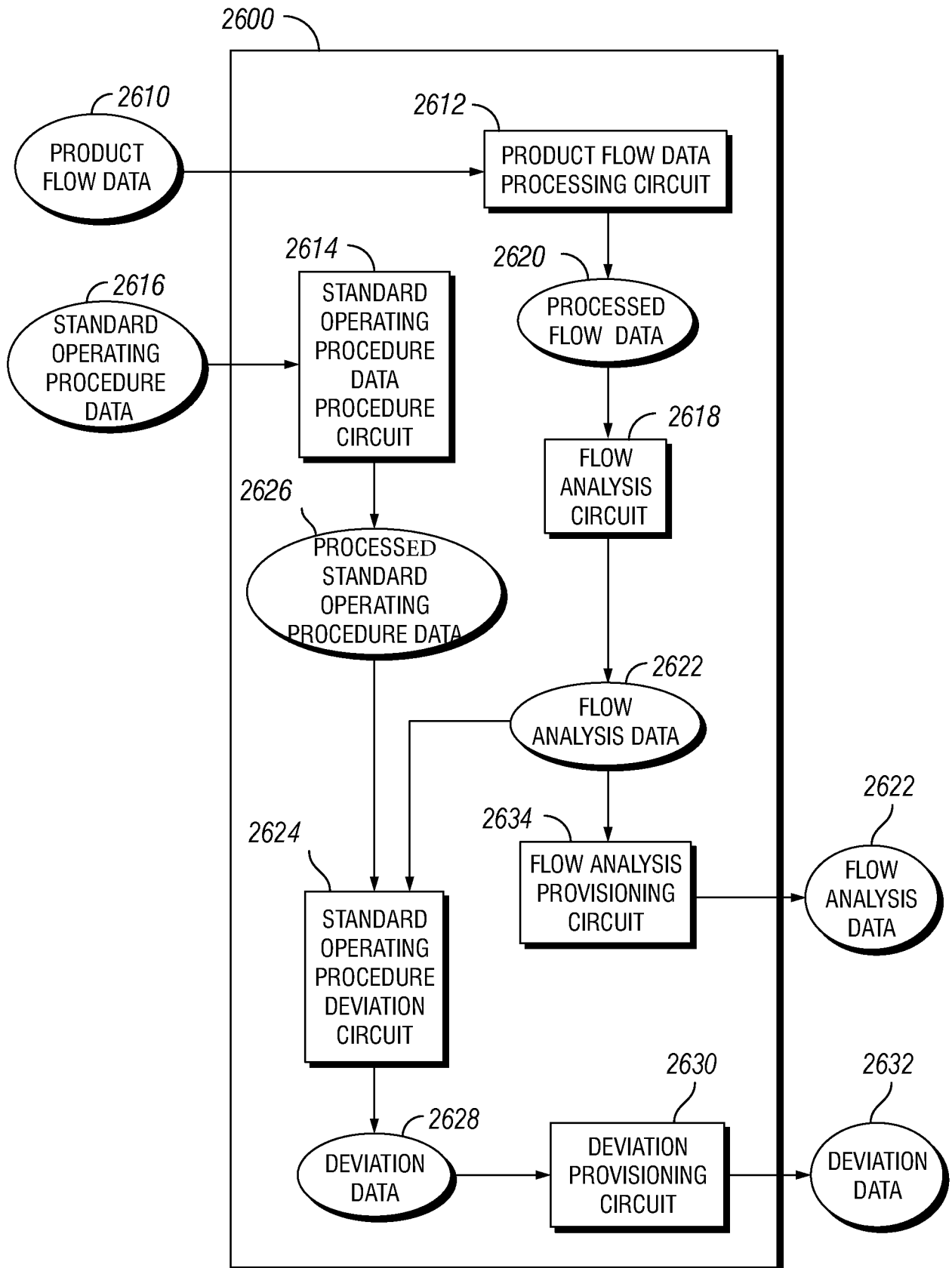


FIG. 26

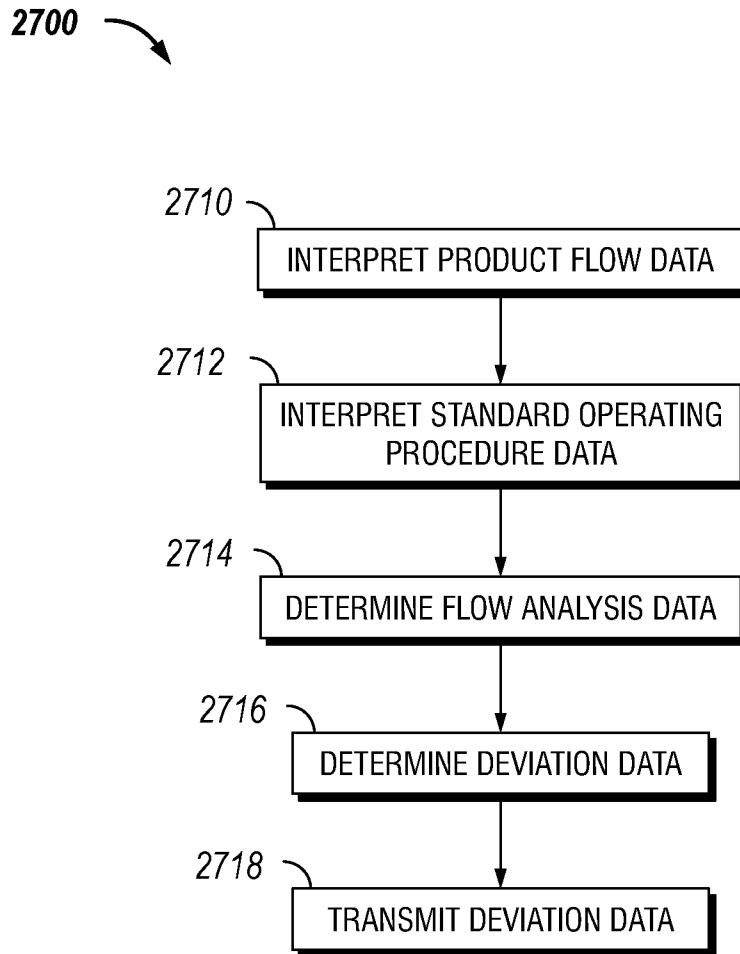


FIG. 27

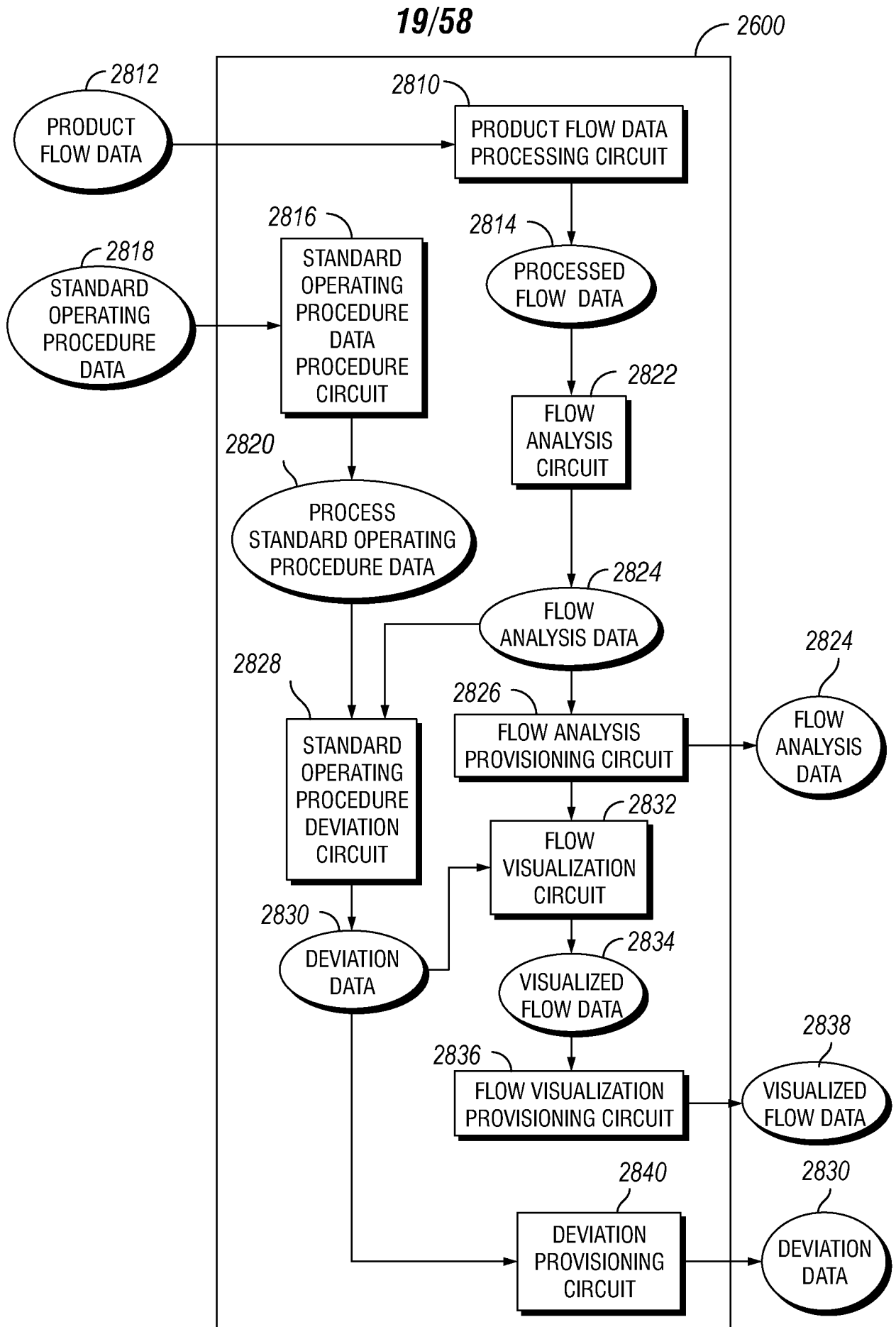


FIG. 28

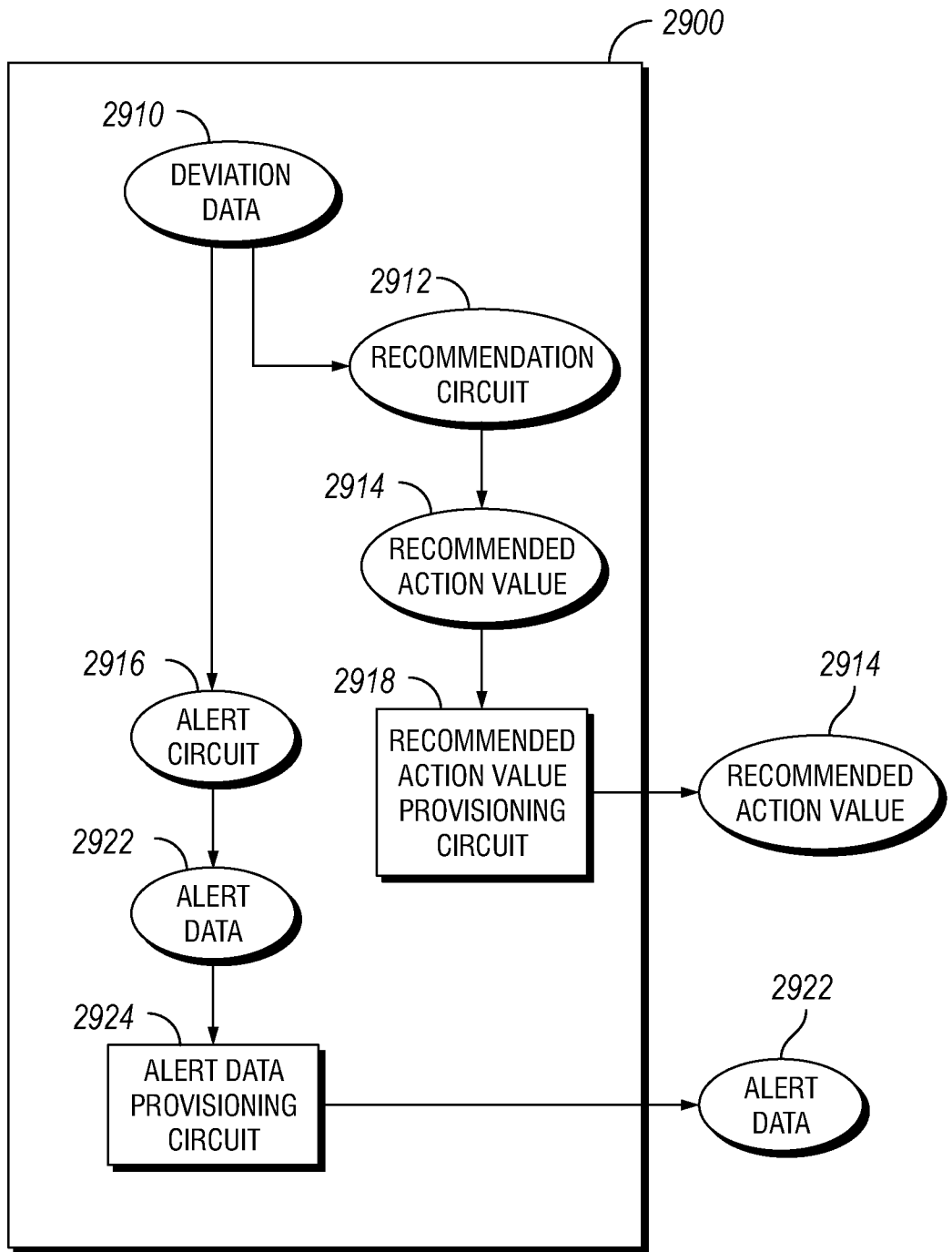


FIG. 29

21/58

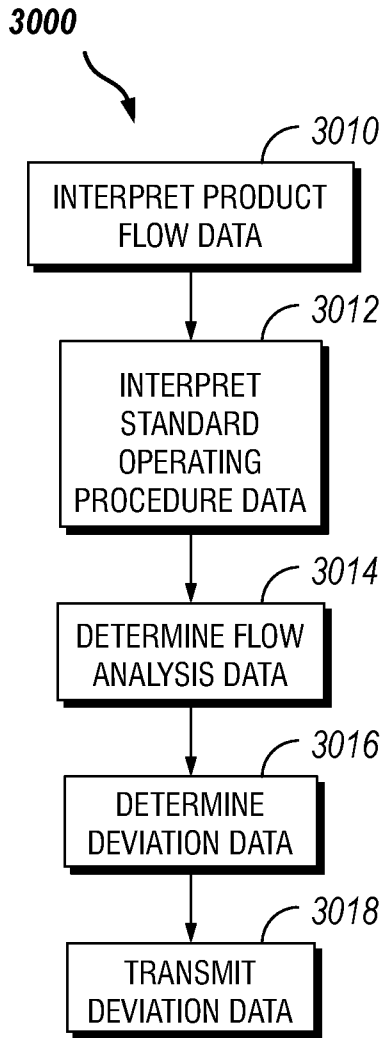


FIG. 30

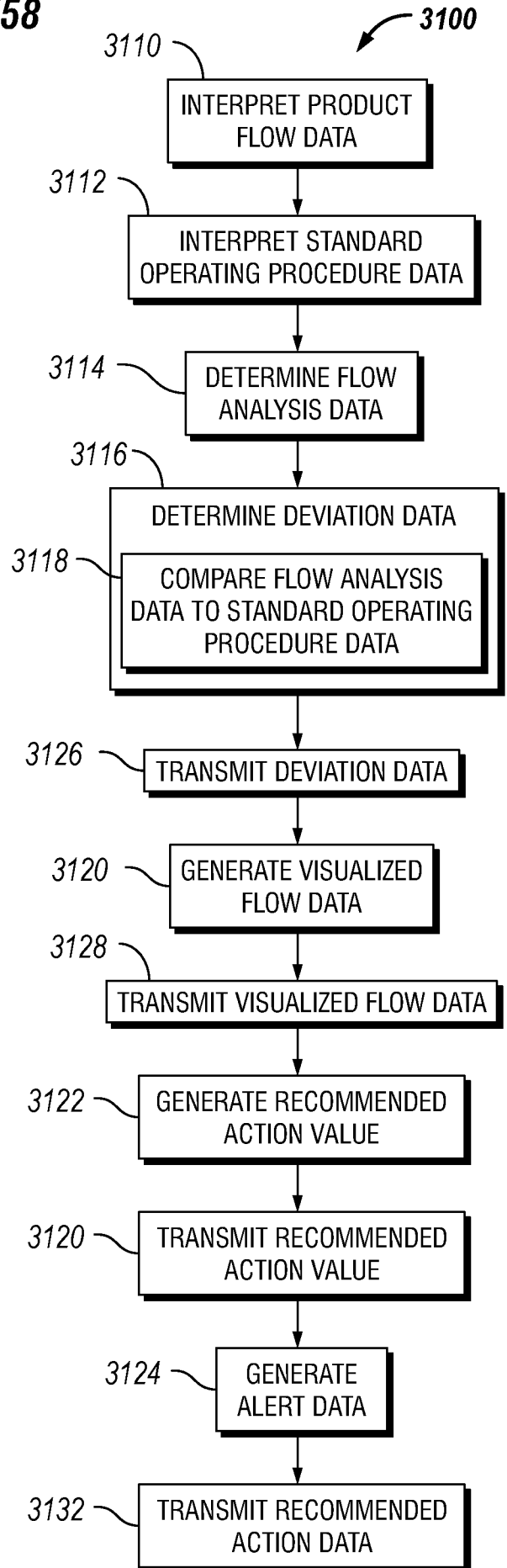


FIG. 31

3200 ↘

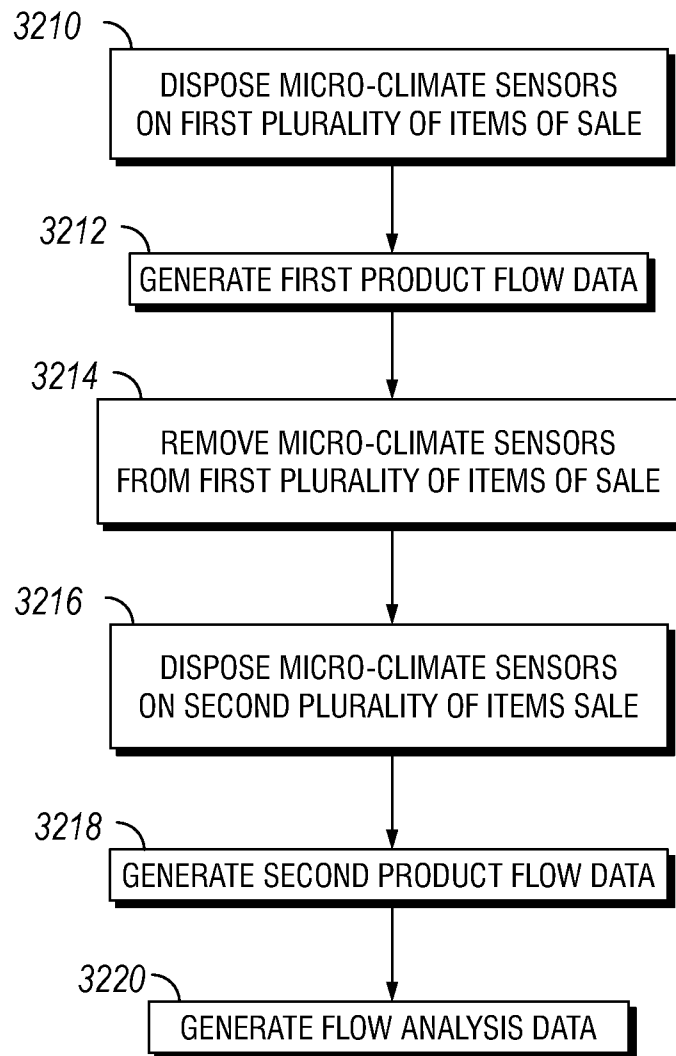


FIG. 32

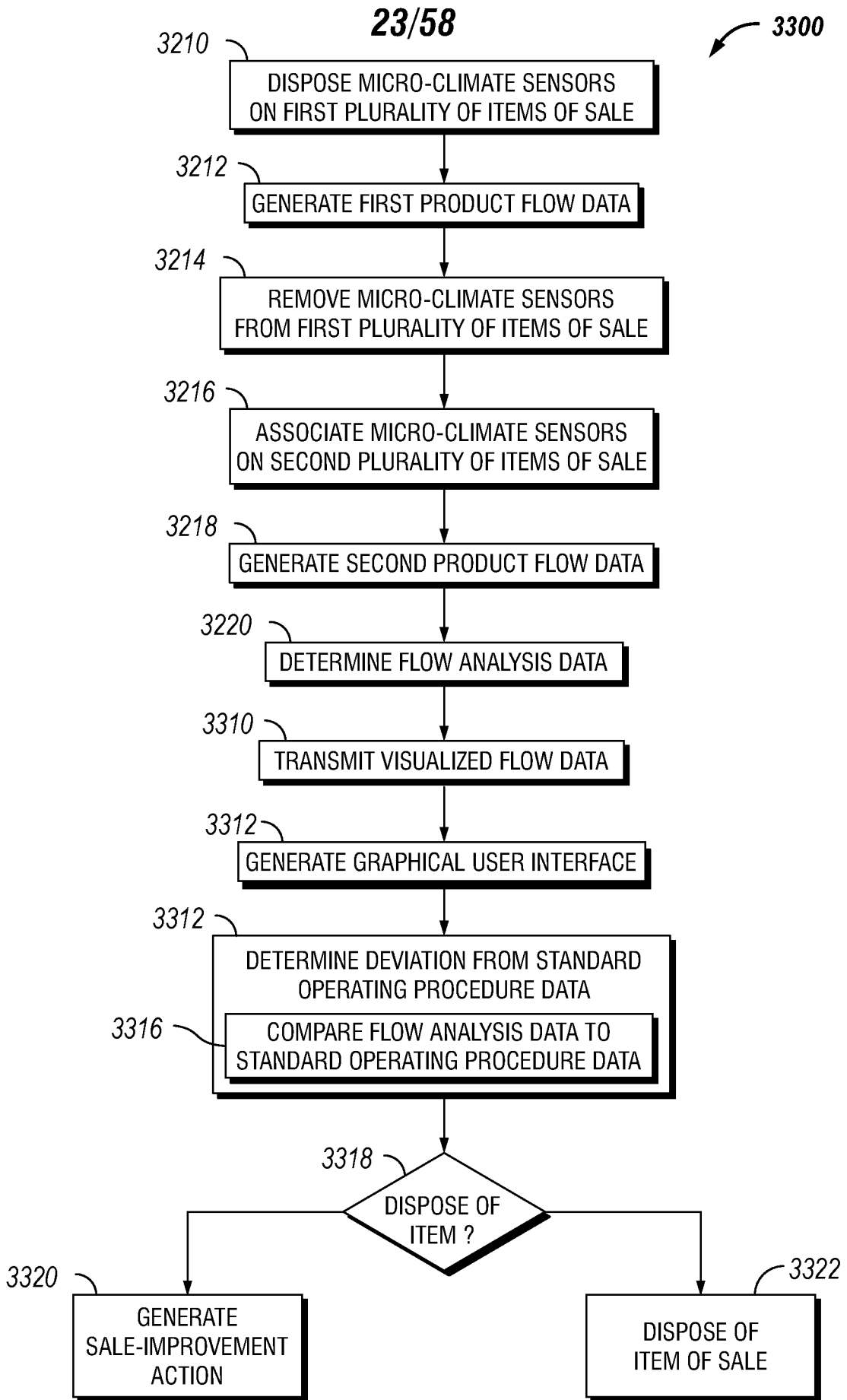


FIG. 33

24/58

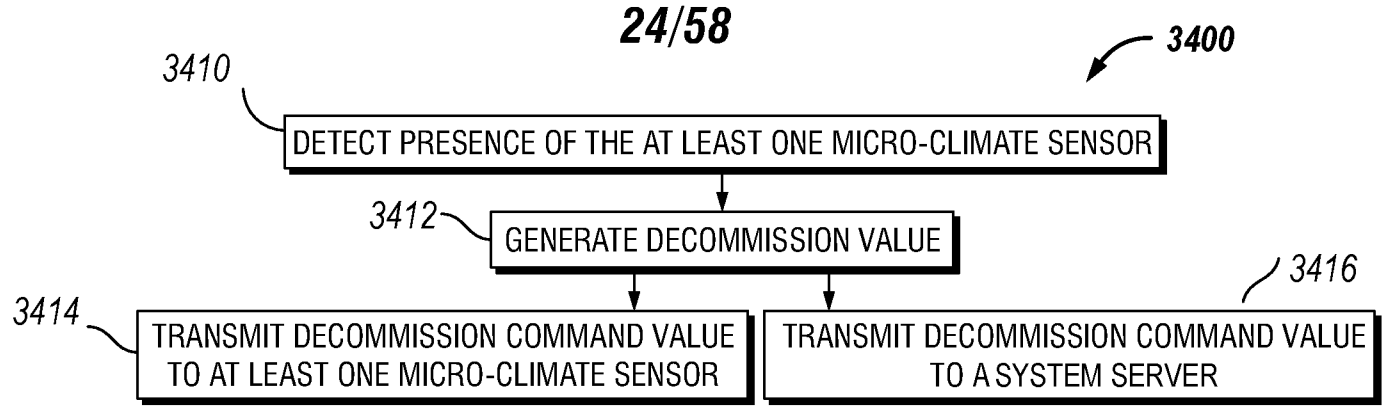


FIG. 34

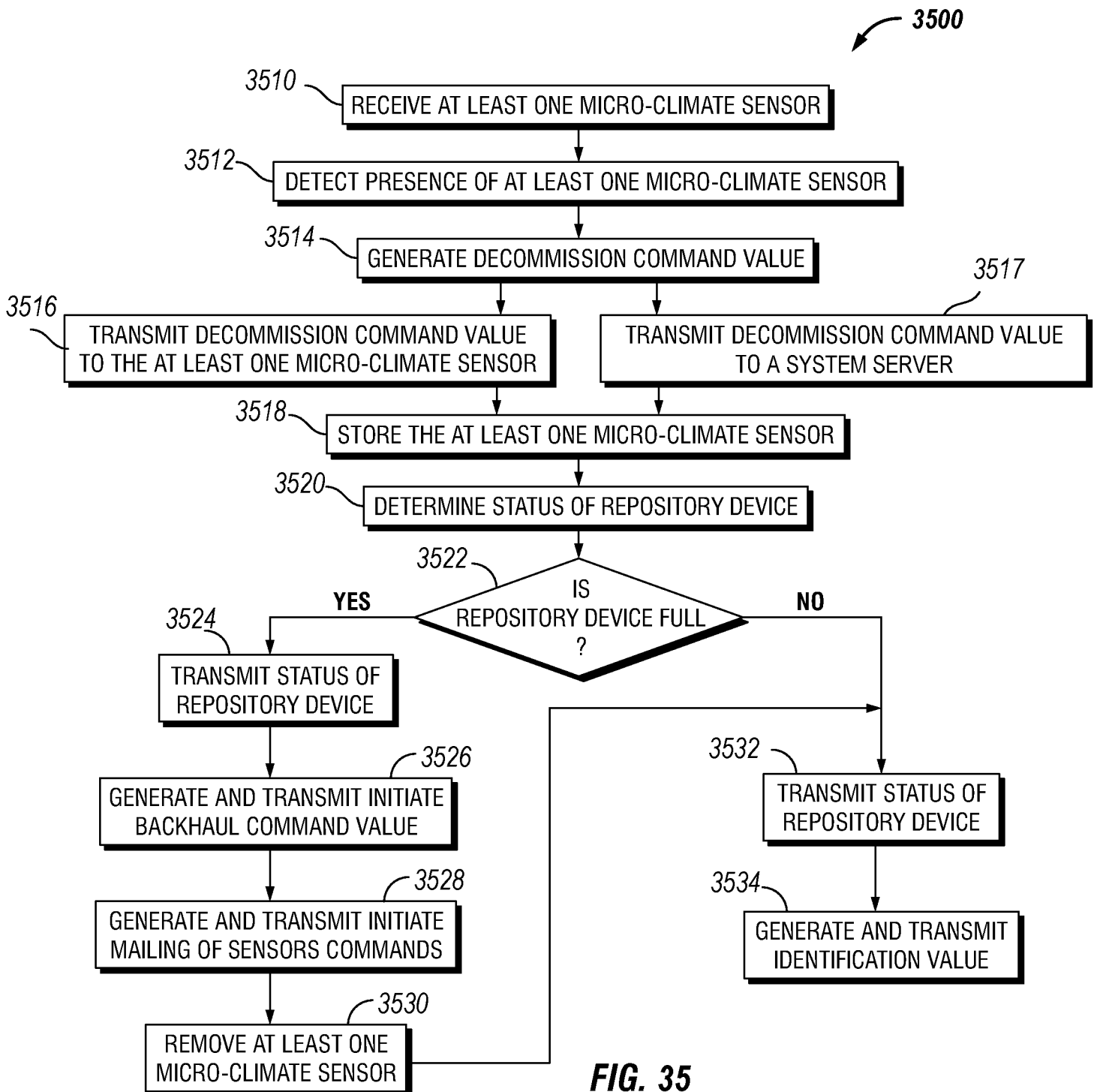


FIG. 35

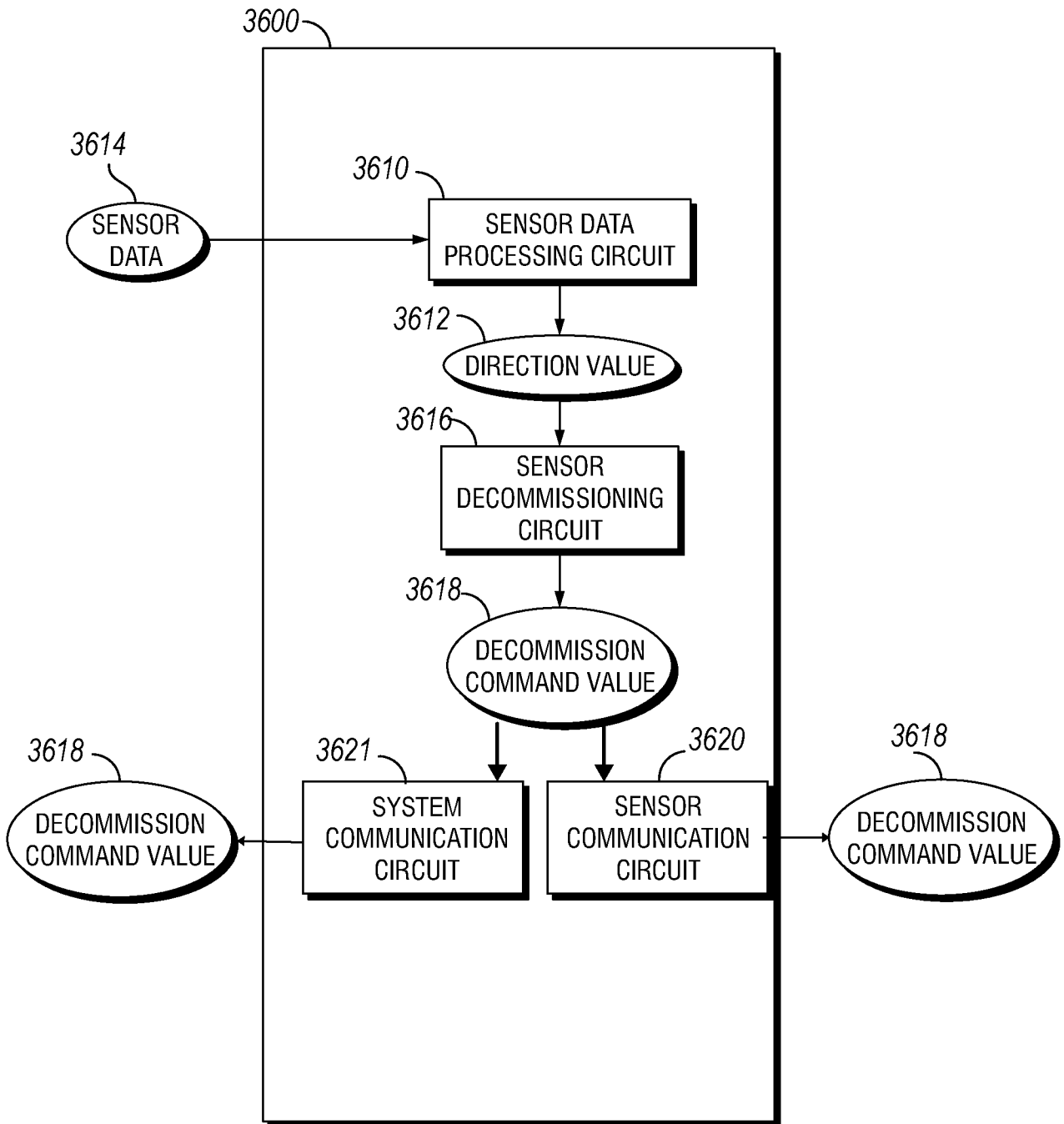


FIG. 36

26/58

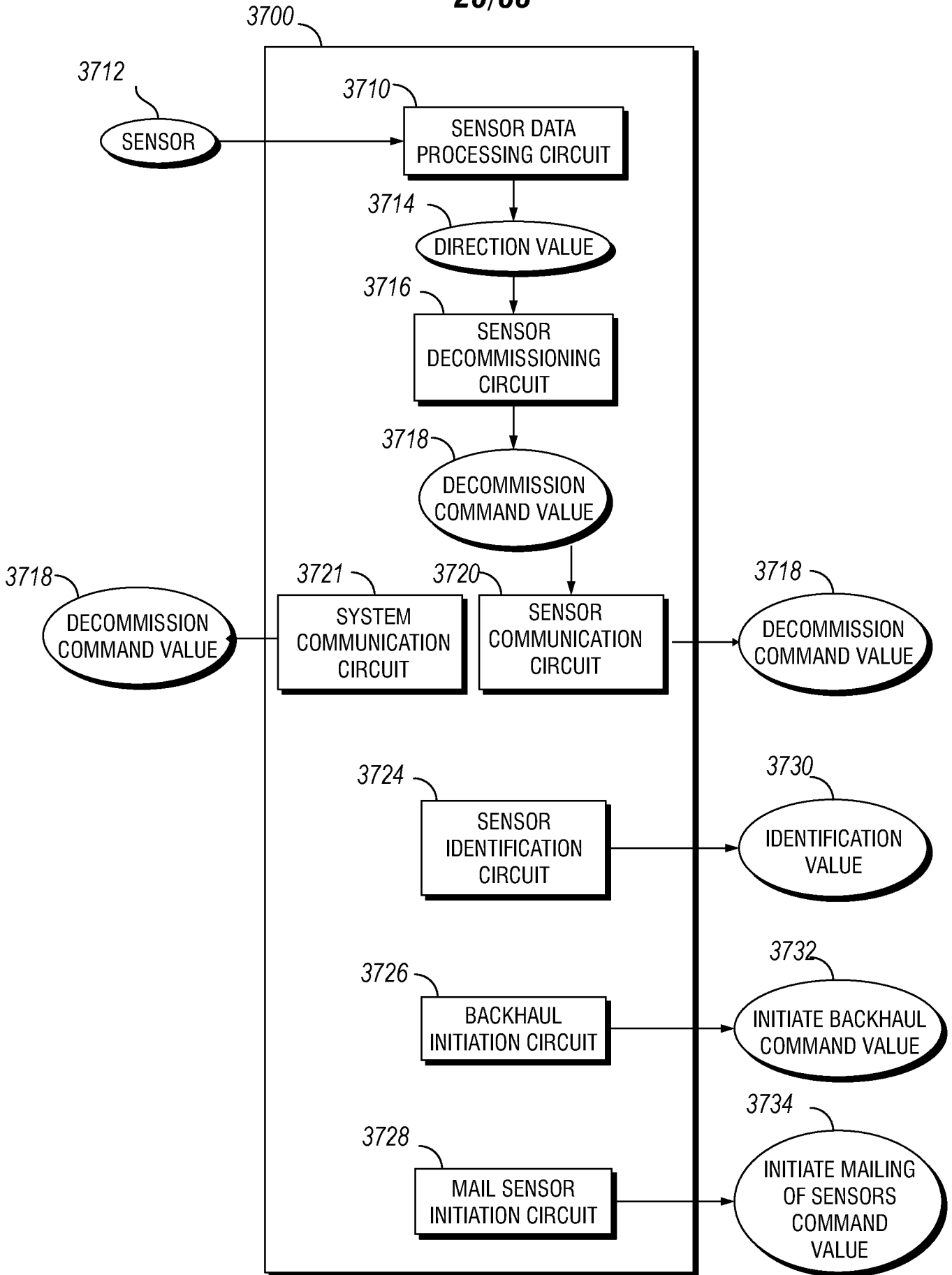


FIG. 37

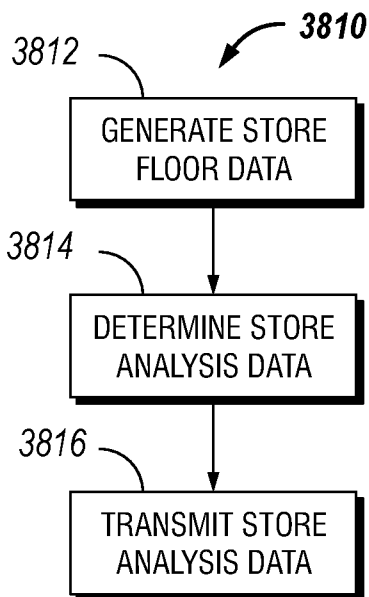


FIG. 38

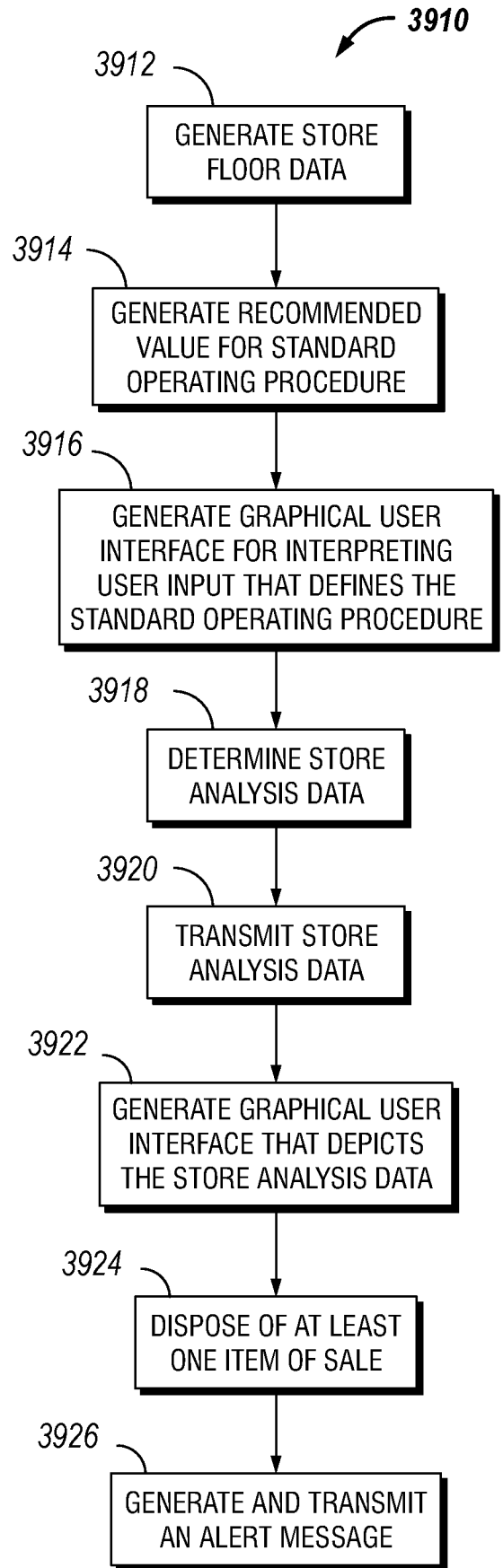


FIG. 39

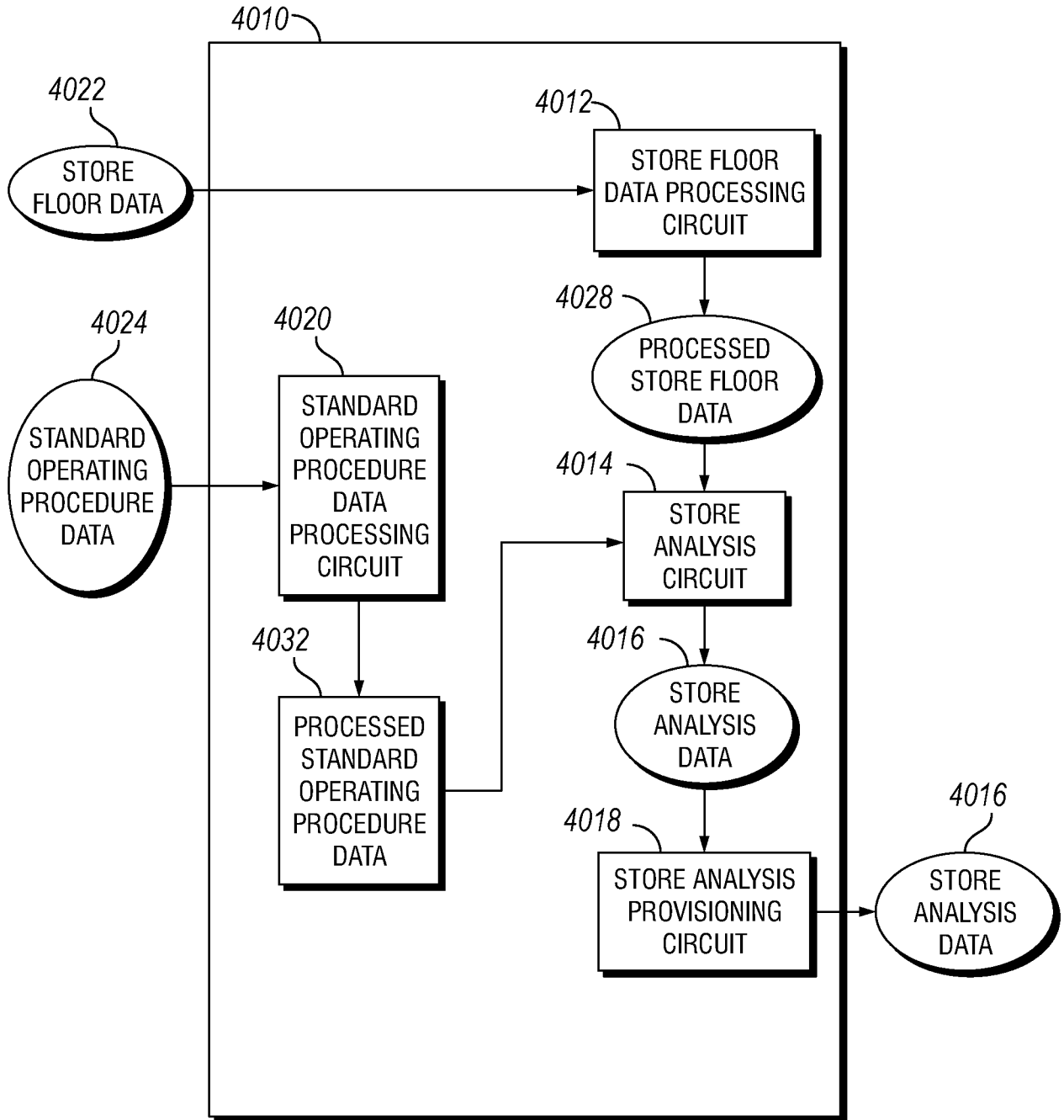


FIG. 40

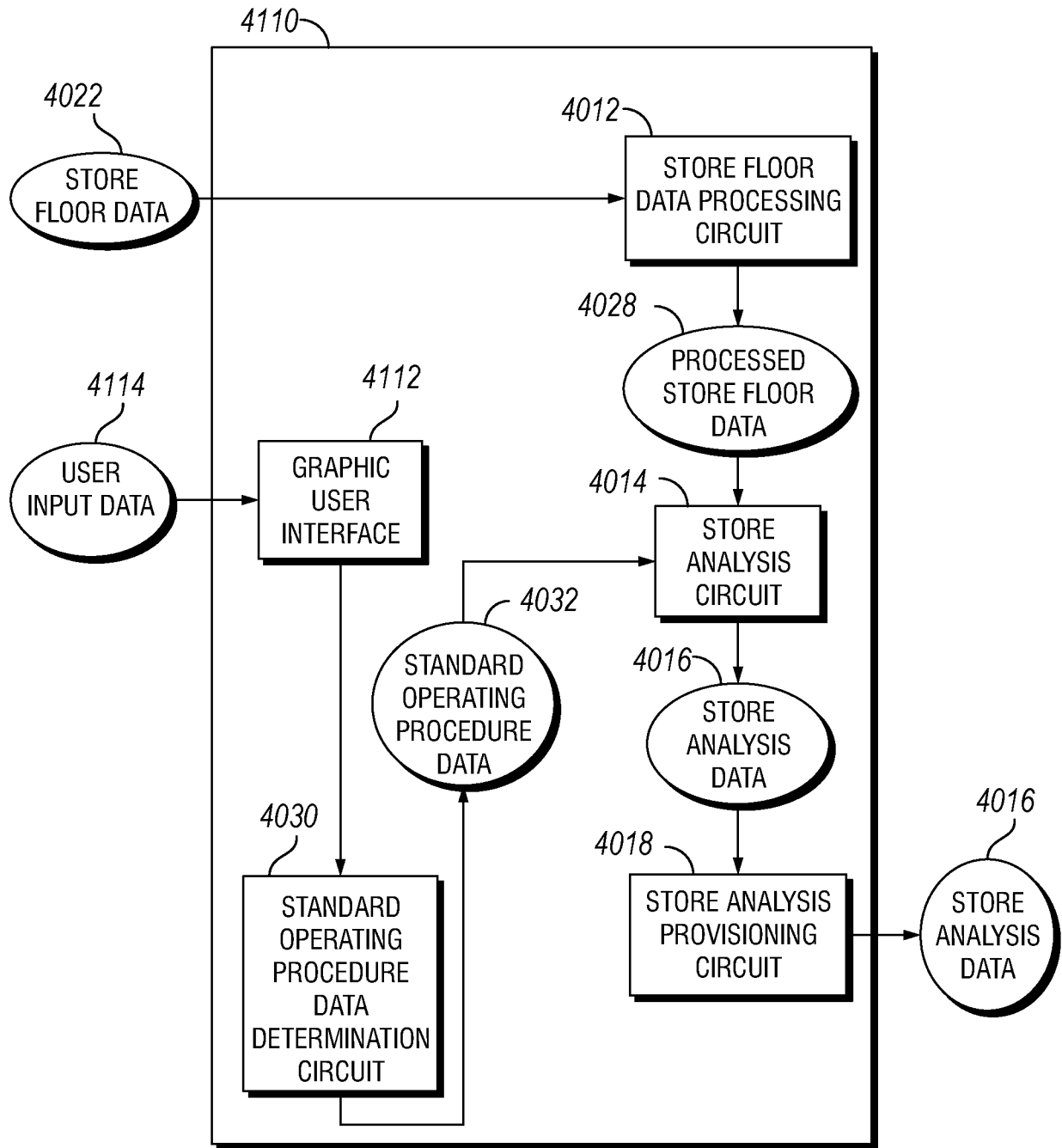


FIG. 41

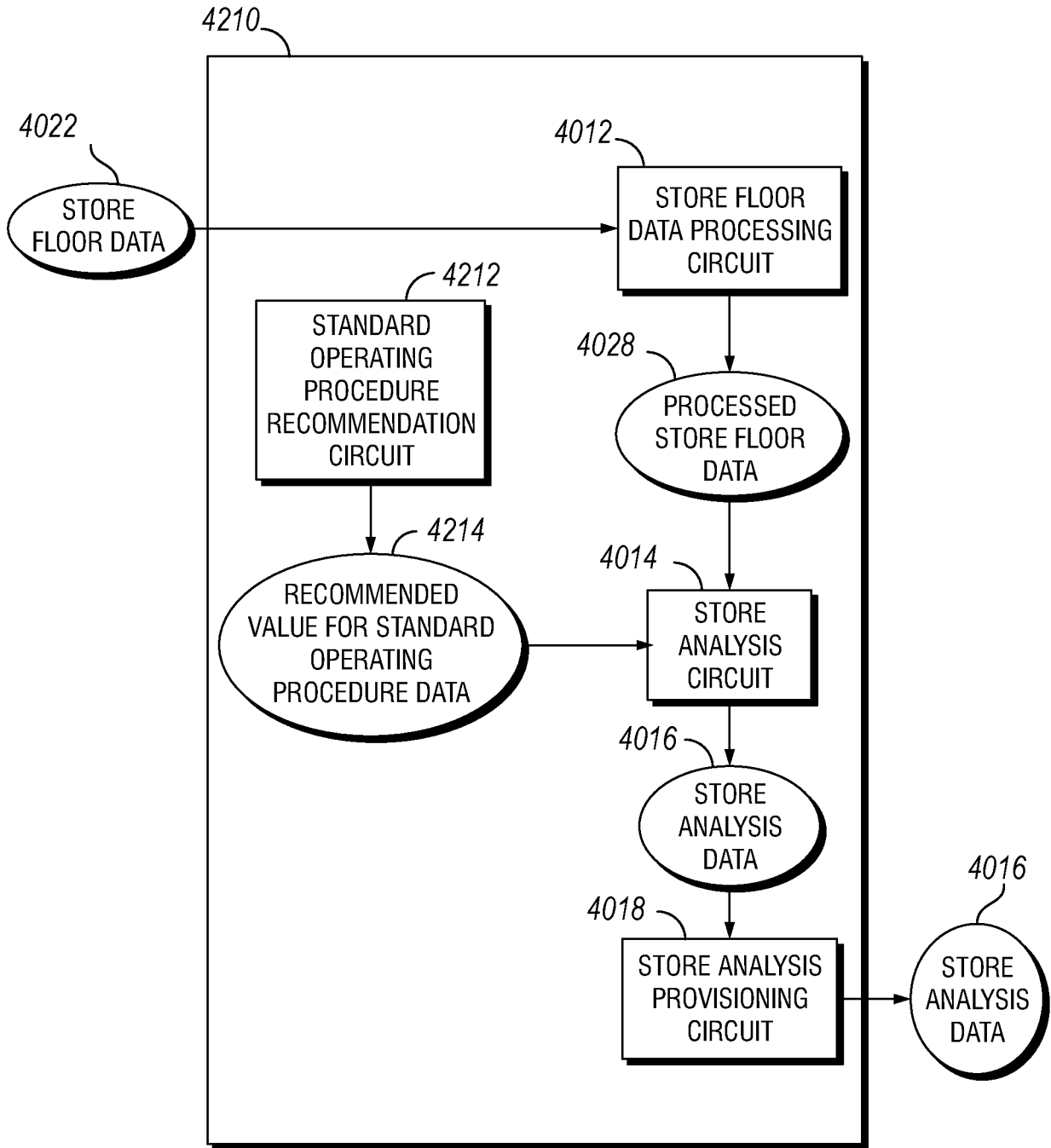


FIG. 42

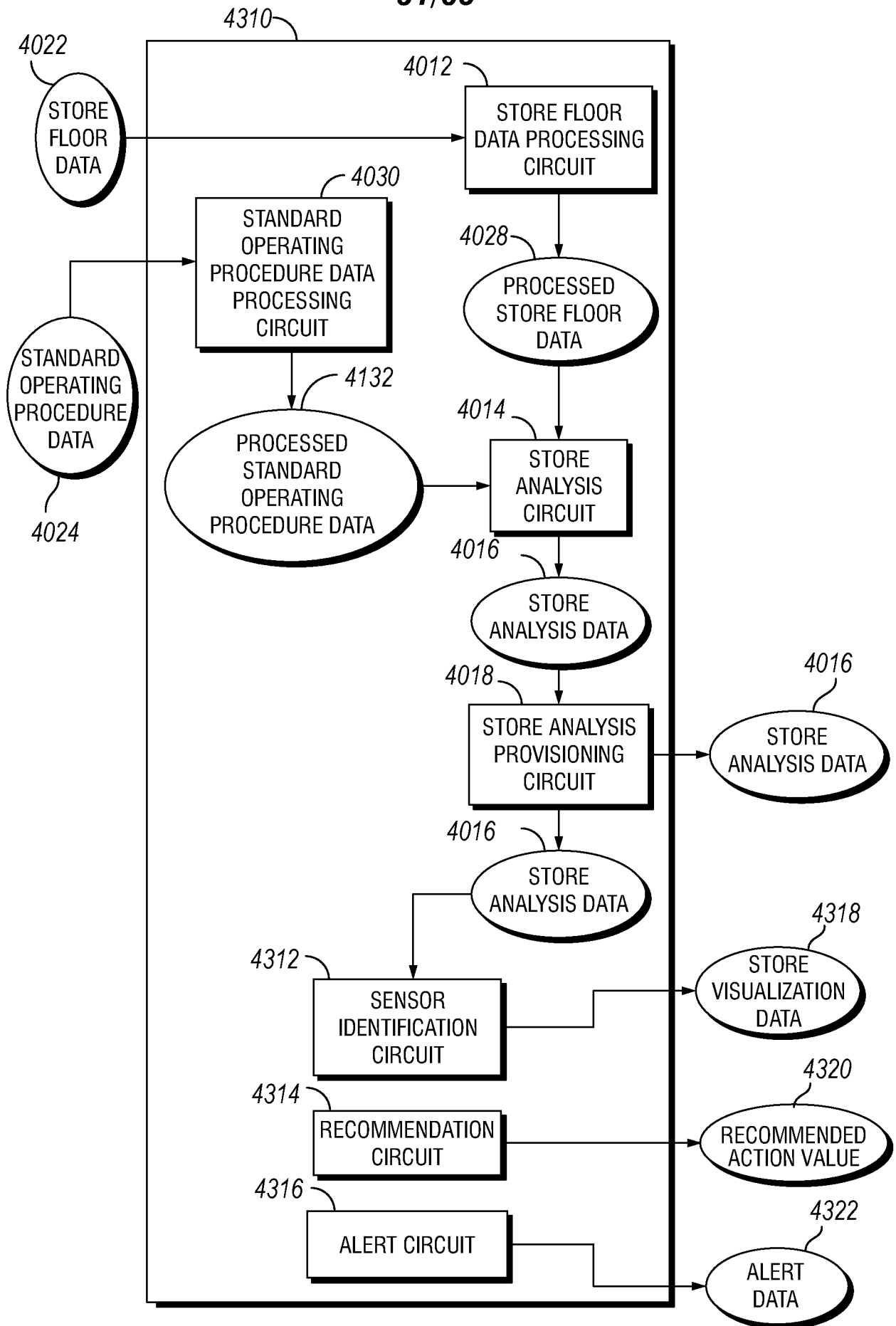


FIG. 43

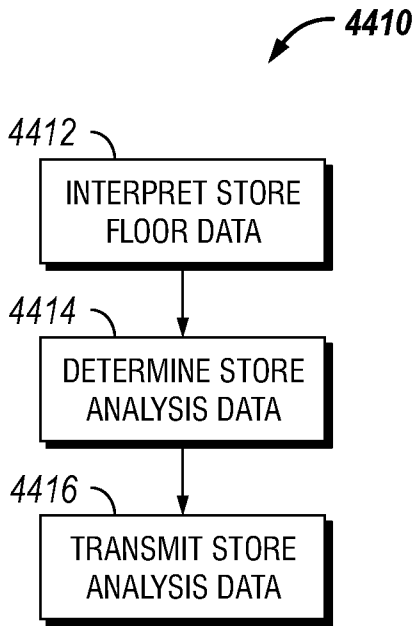


FIG. 44

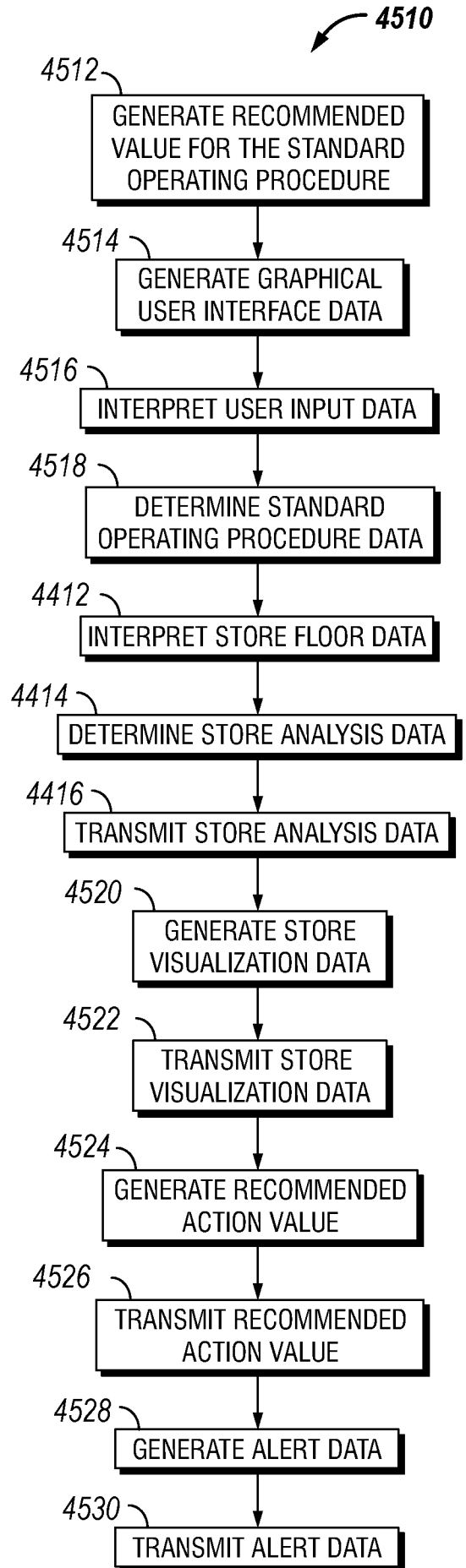


FIG. 45

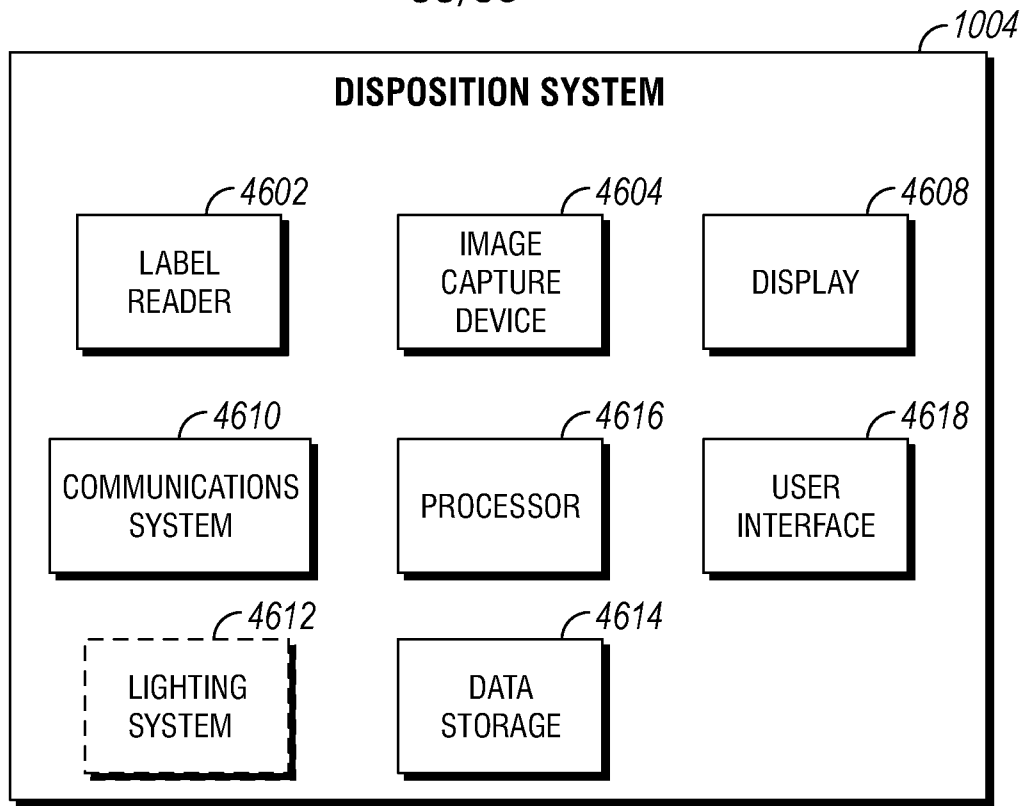


FIG. 46

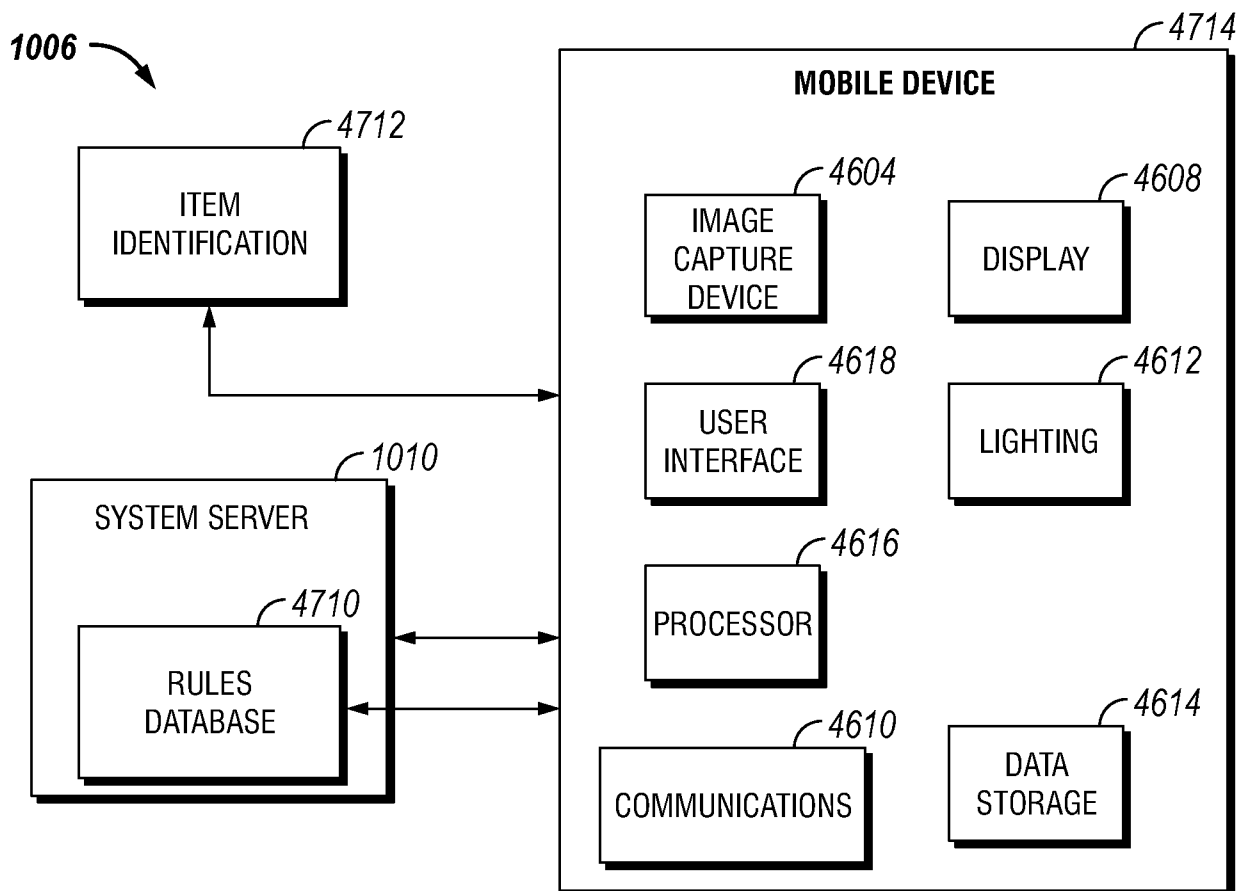


FIG. 47

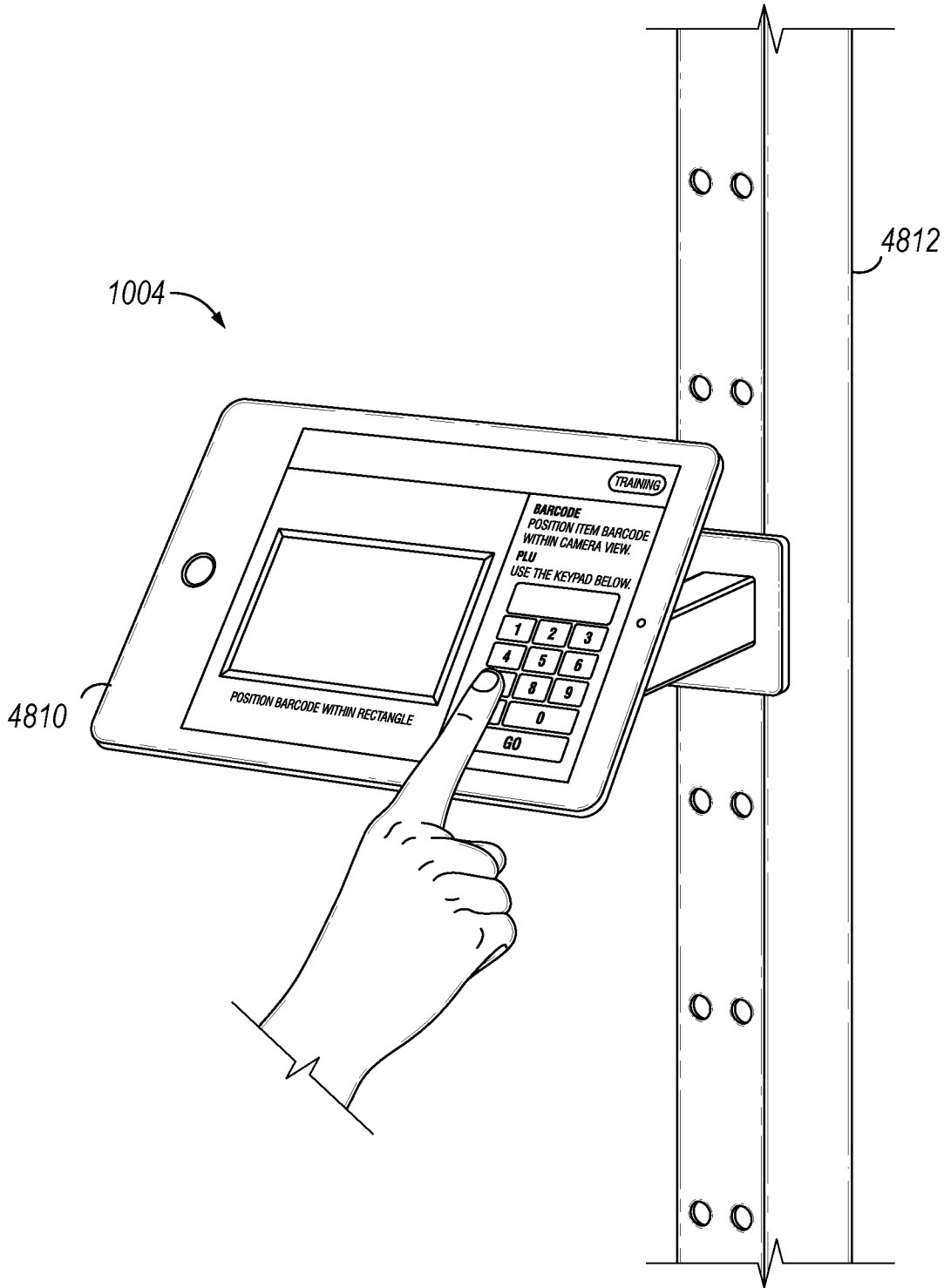


FIG. 48

35/58

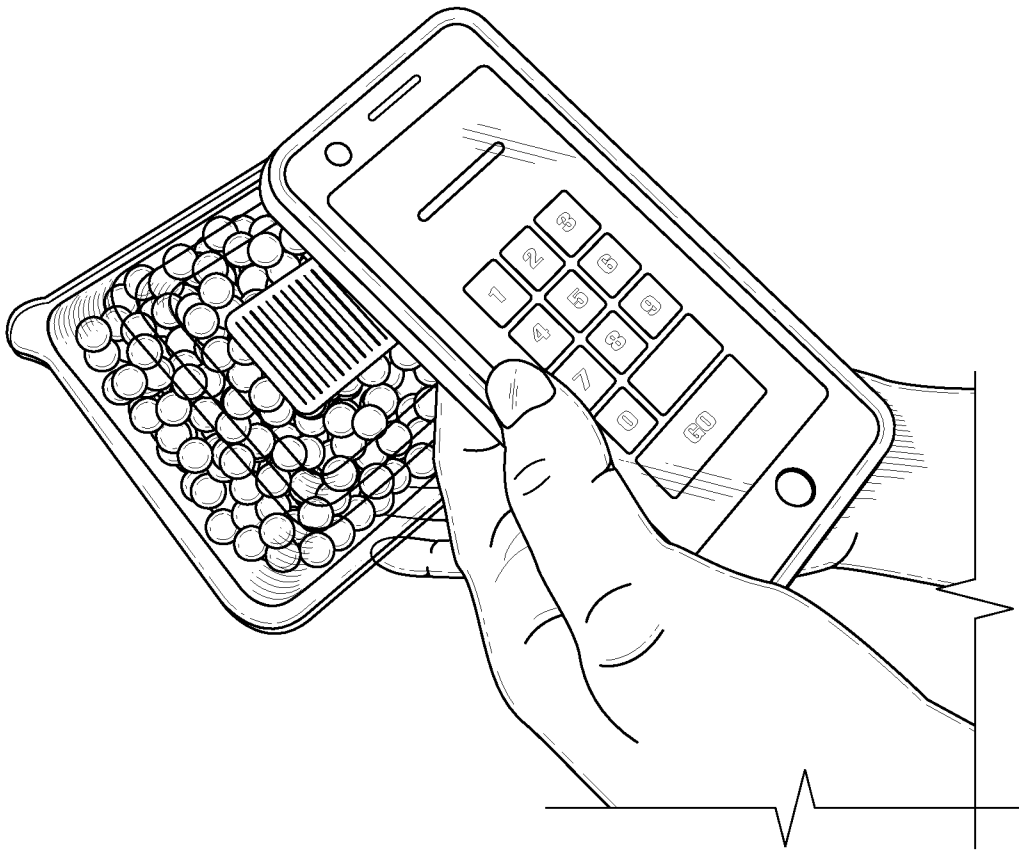


FIG. 49

36/58

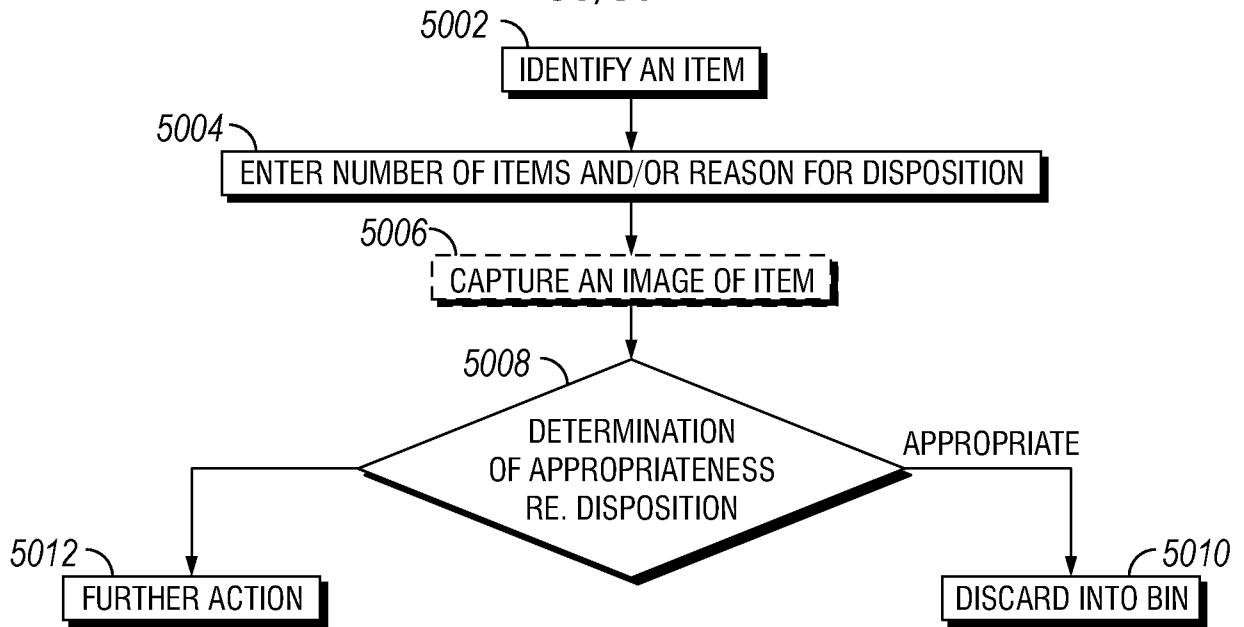


FIG. 50

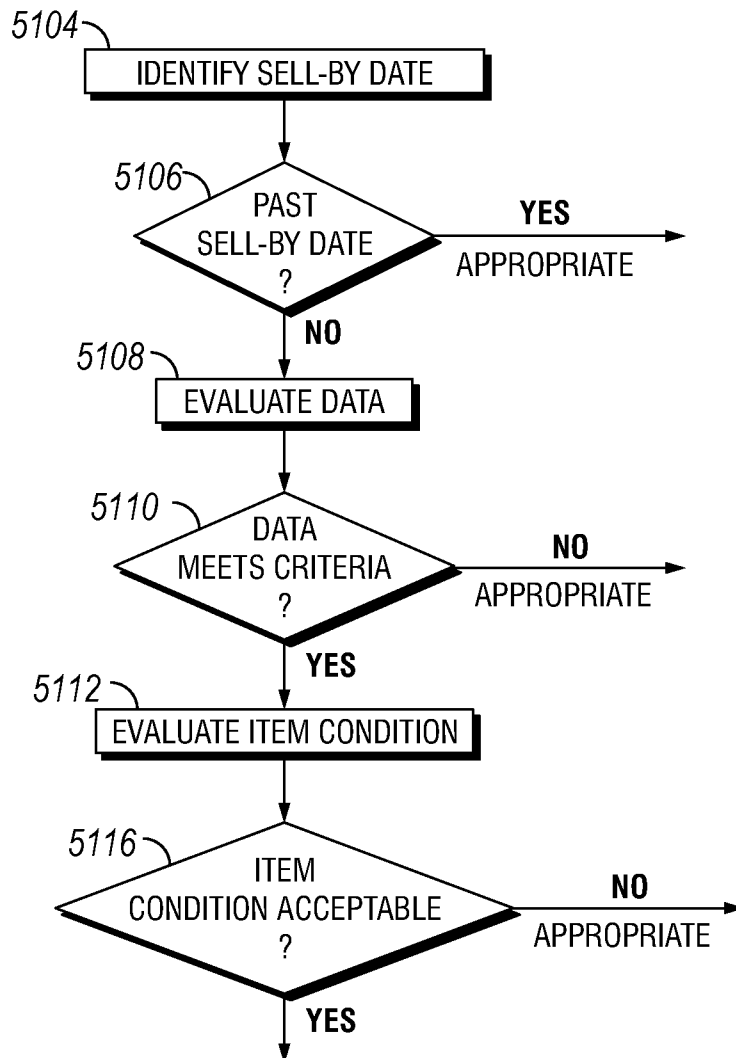


FIG. 51

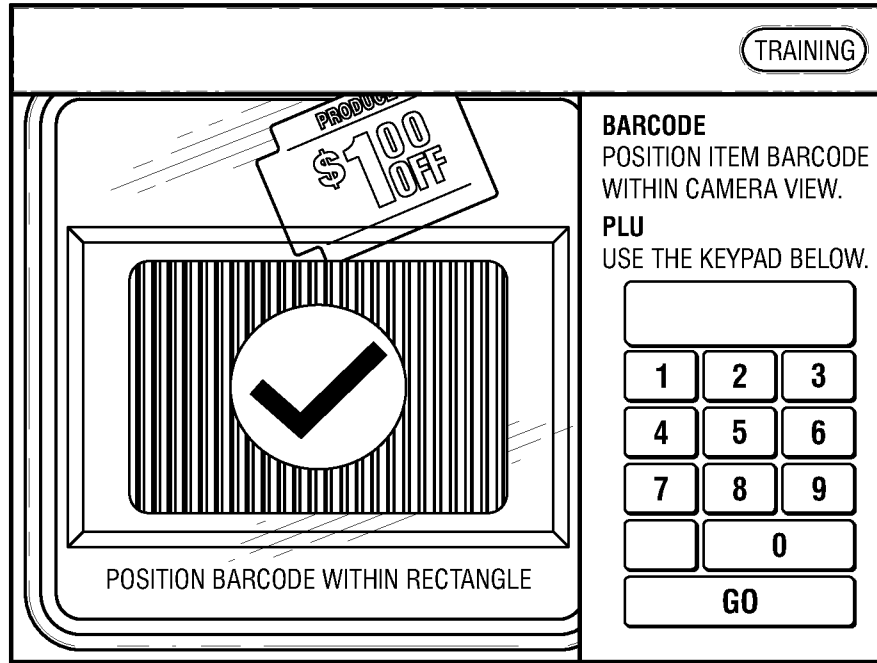


FIG. 52

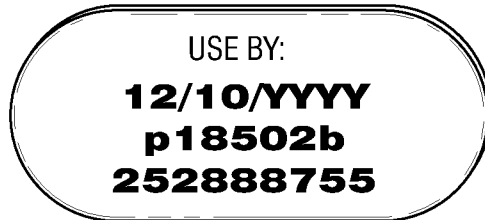


FIG. 53



FIG. 54

38/58

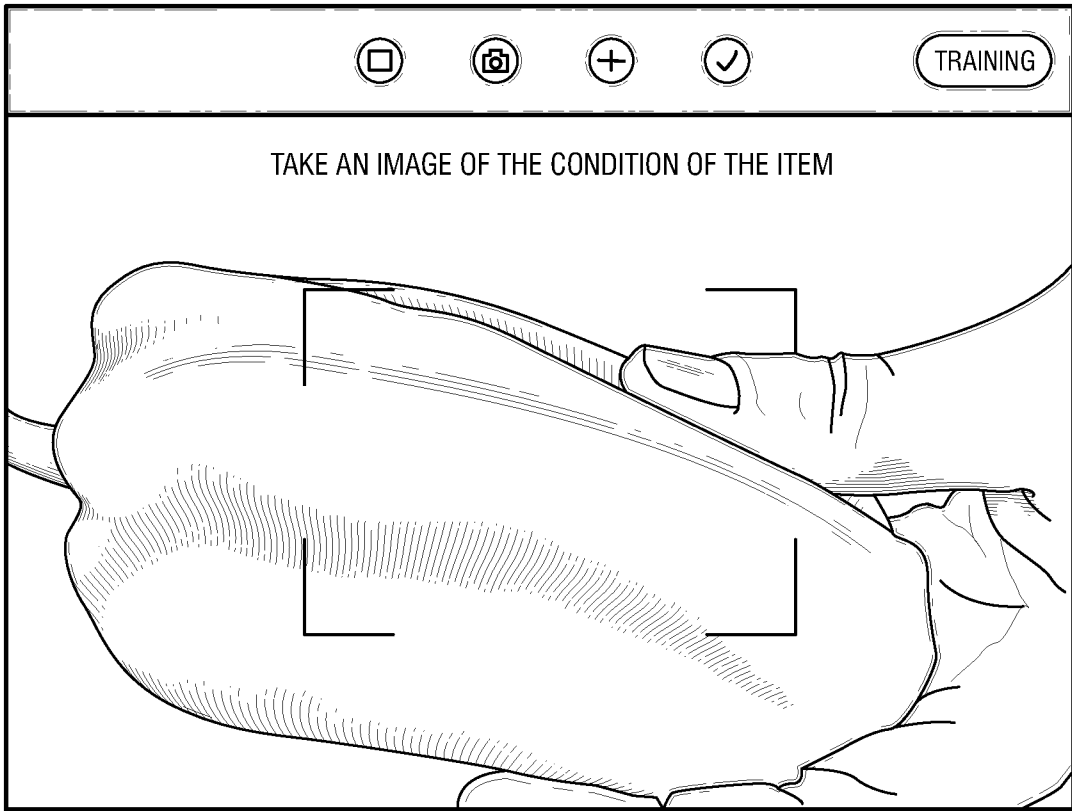


FIG. 55

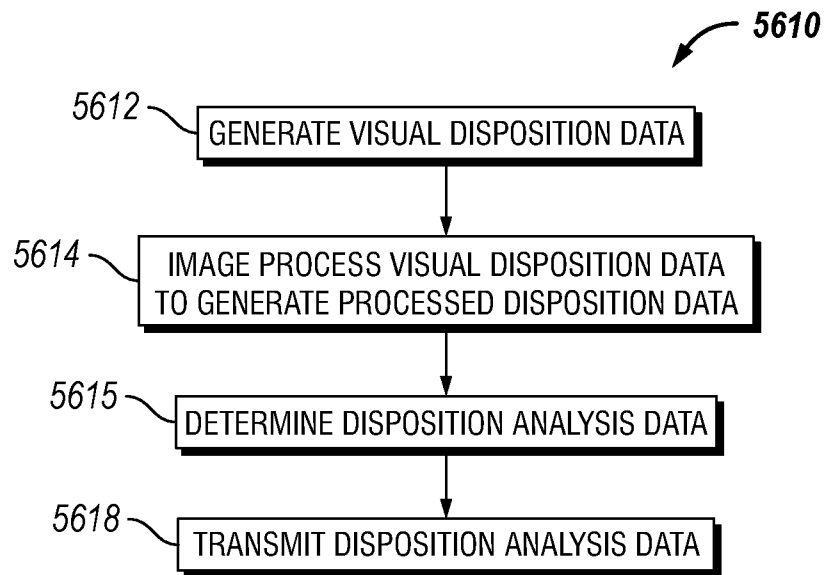


FIG. 56

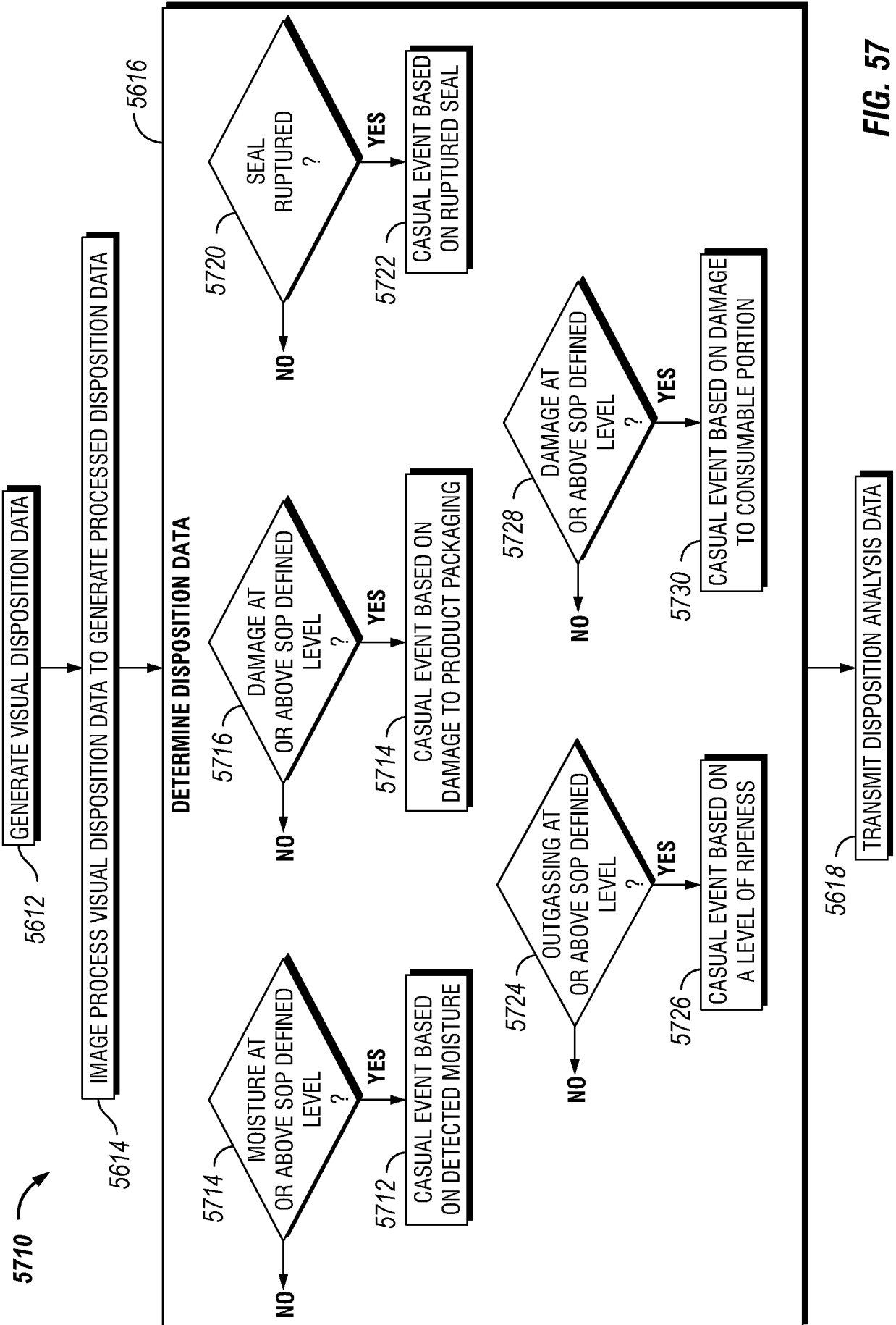


FIG. 57

40/58

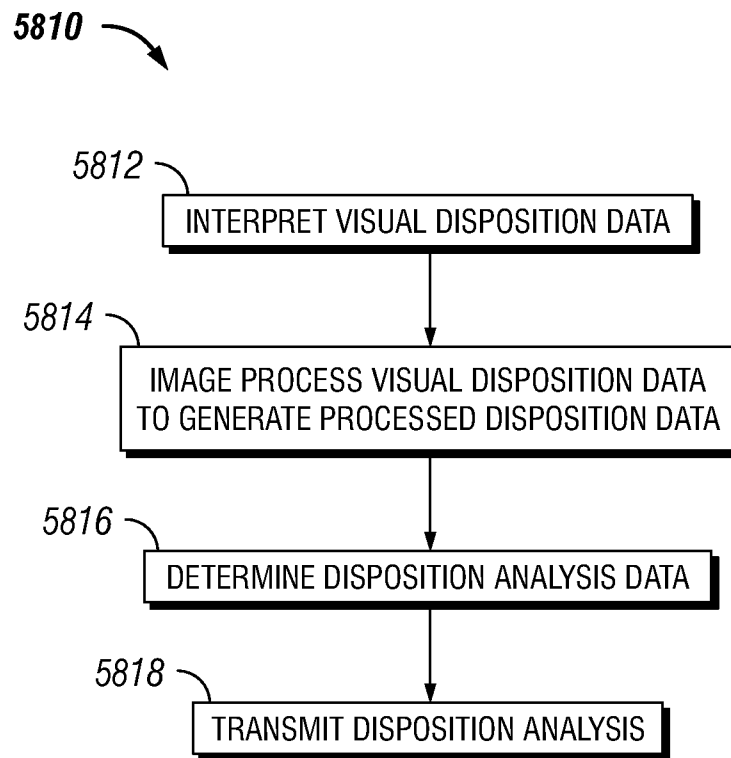


FIG. 58

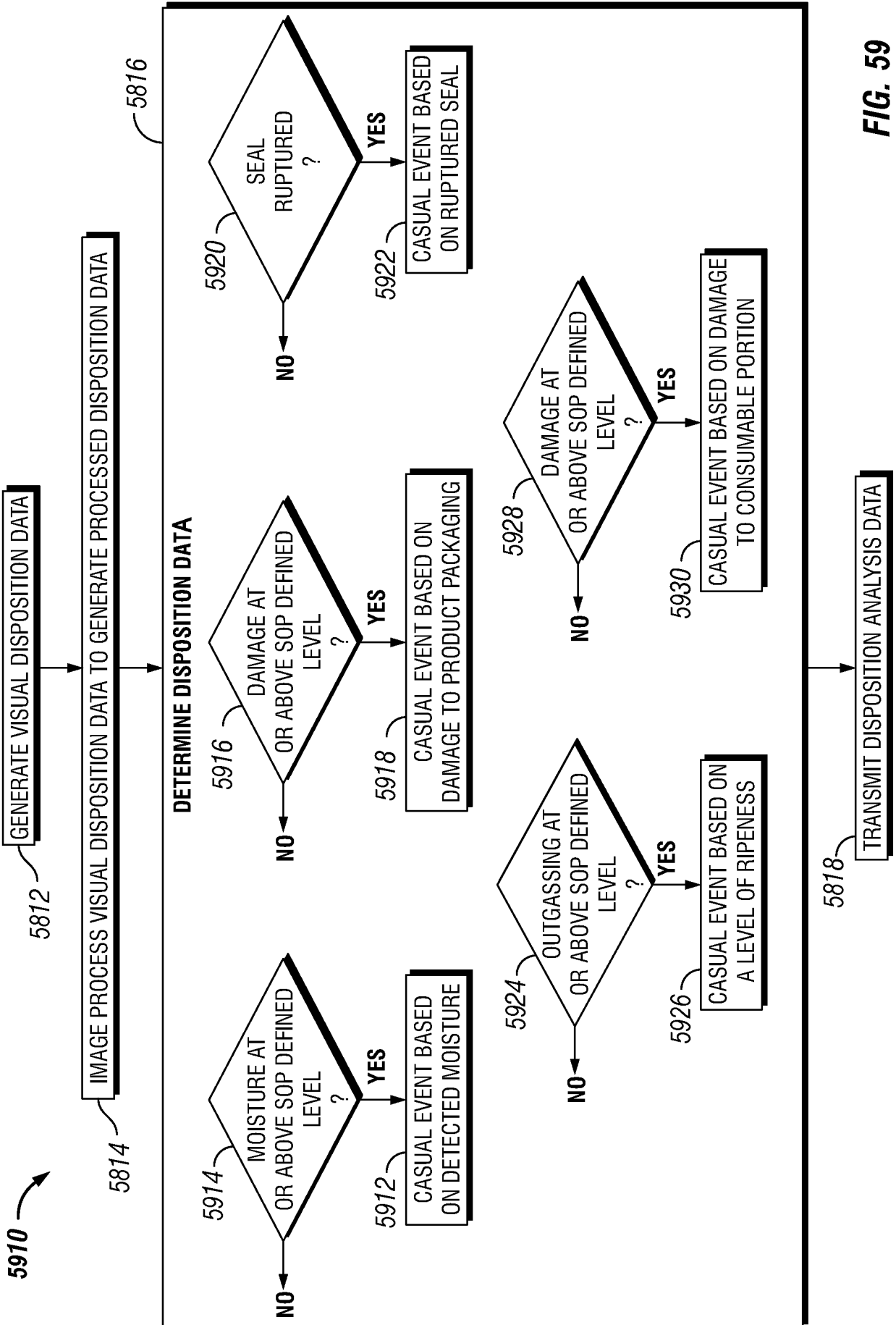


FIG. 59

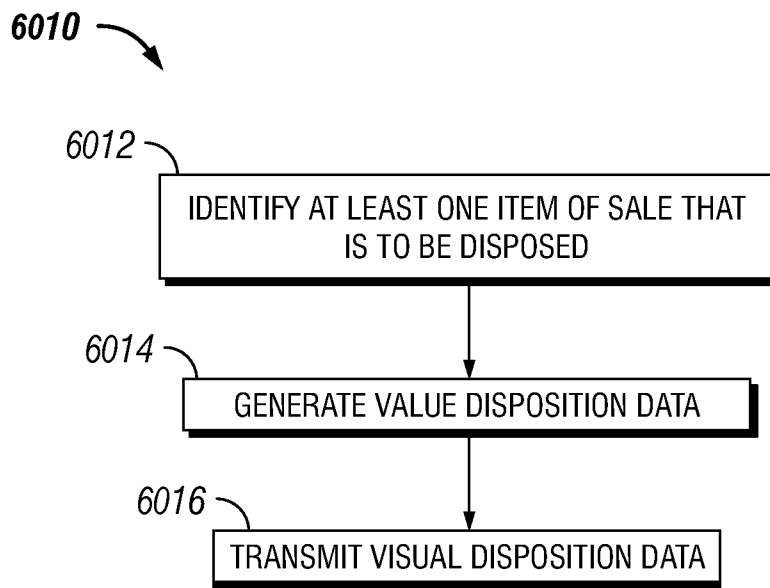


FIG. 60

43/58

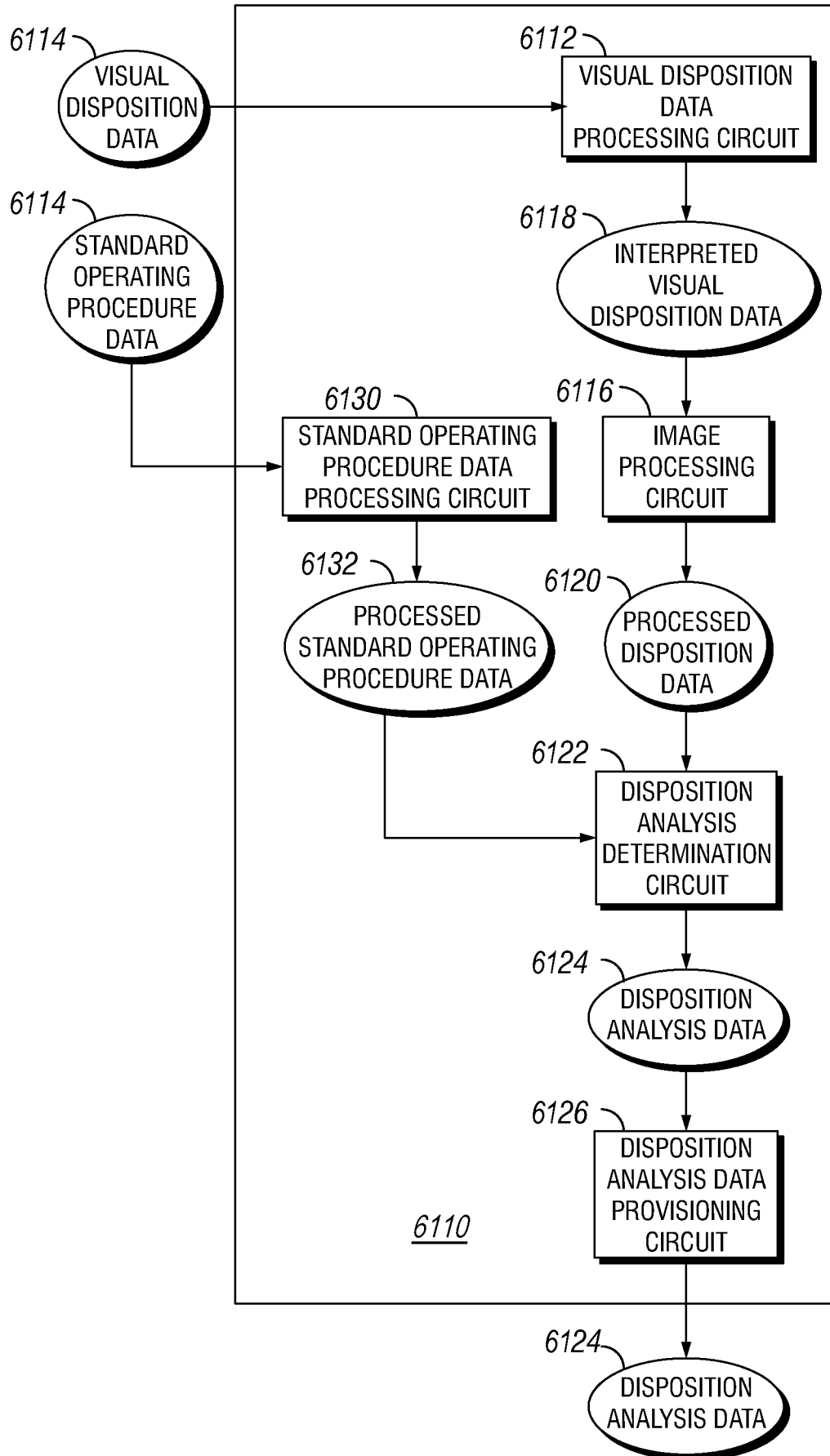


FIG. 61

44/58

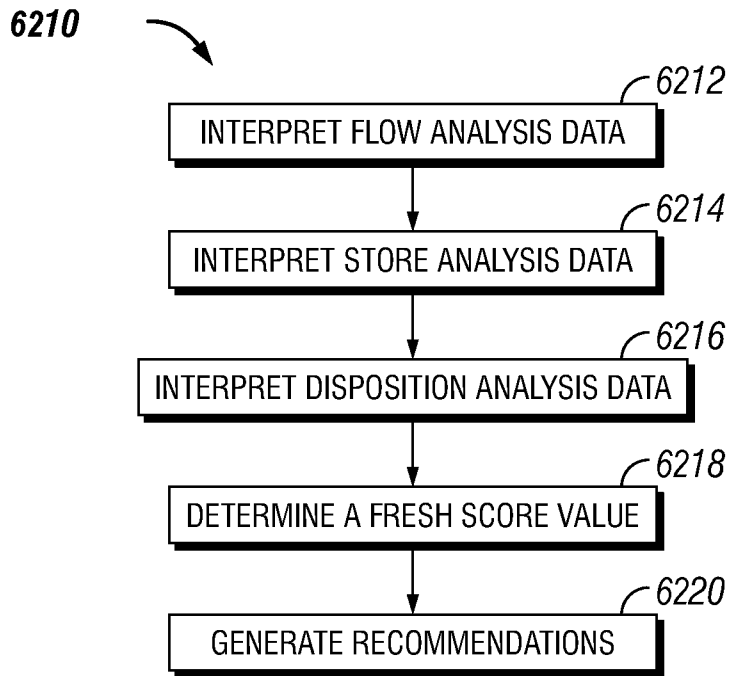


FIG. 62

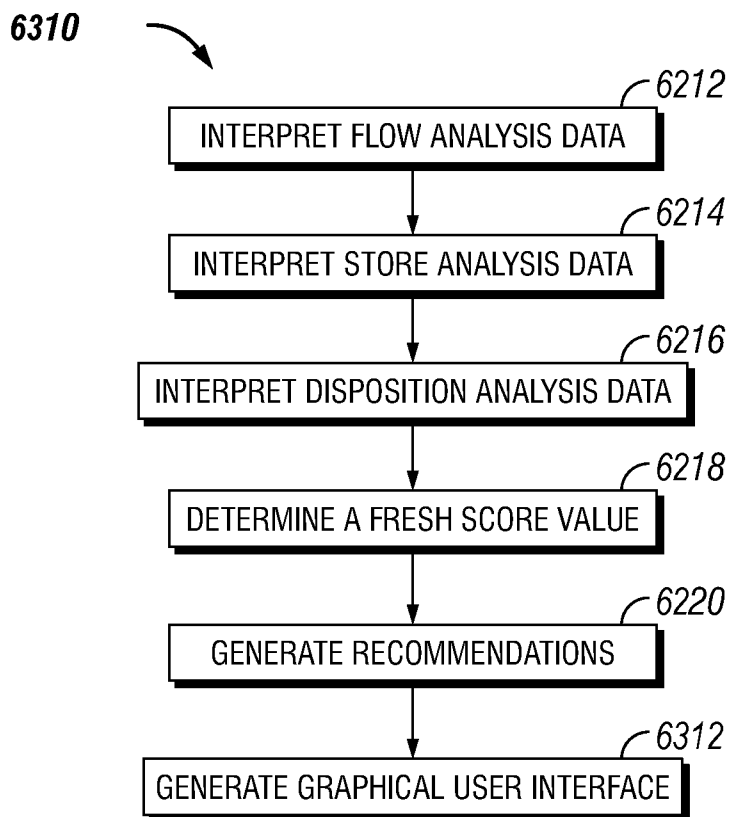


FIG. 63

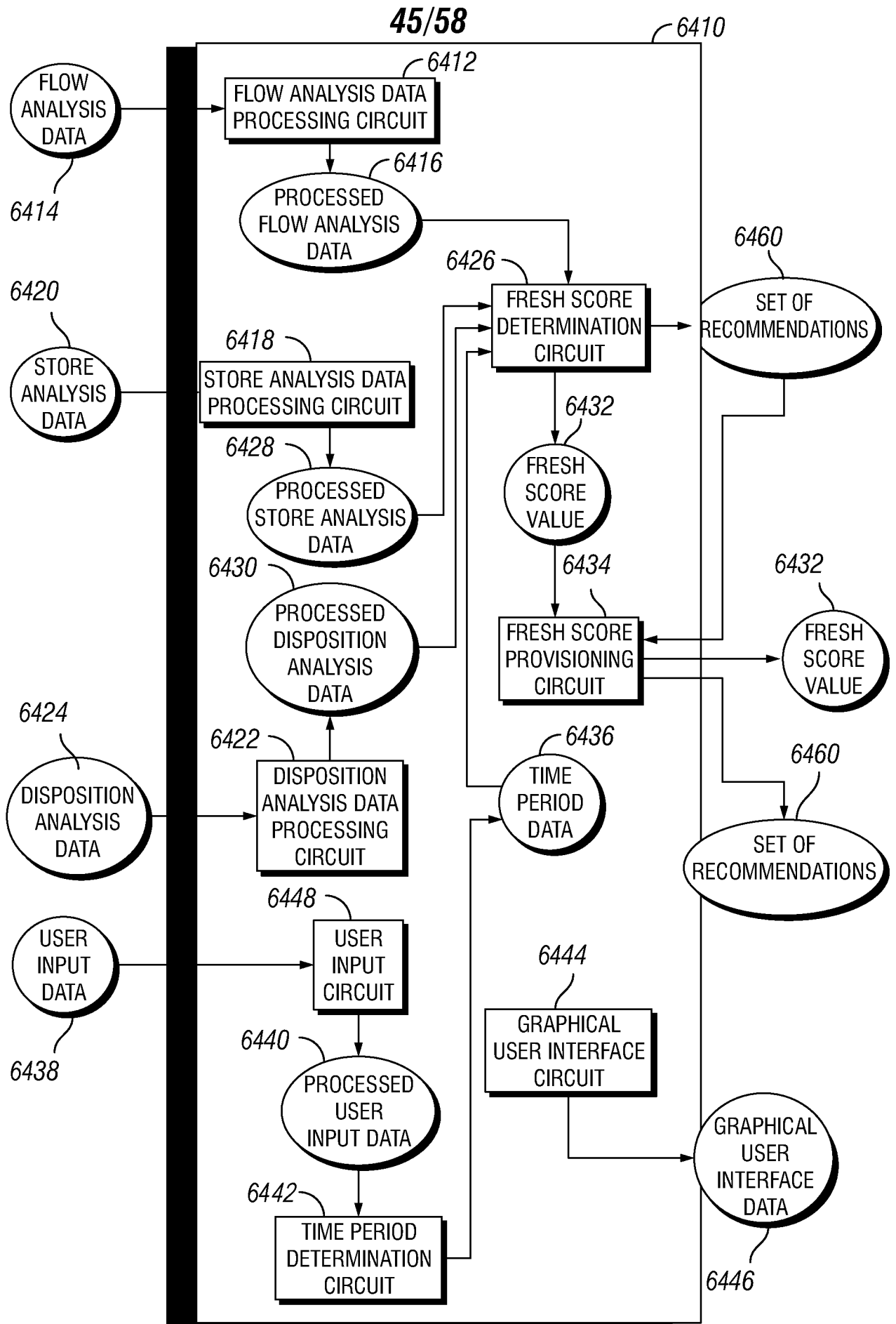


FIG. 64

46/58

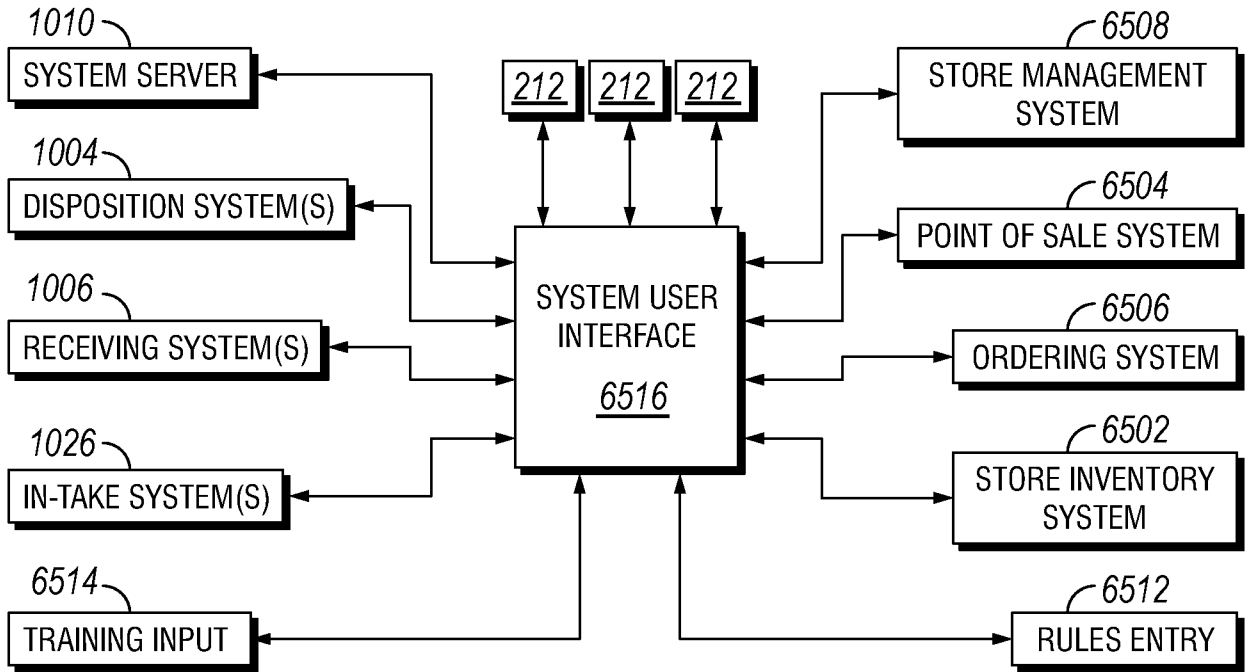


FIG. 65

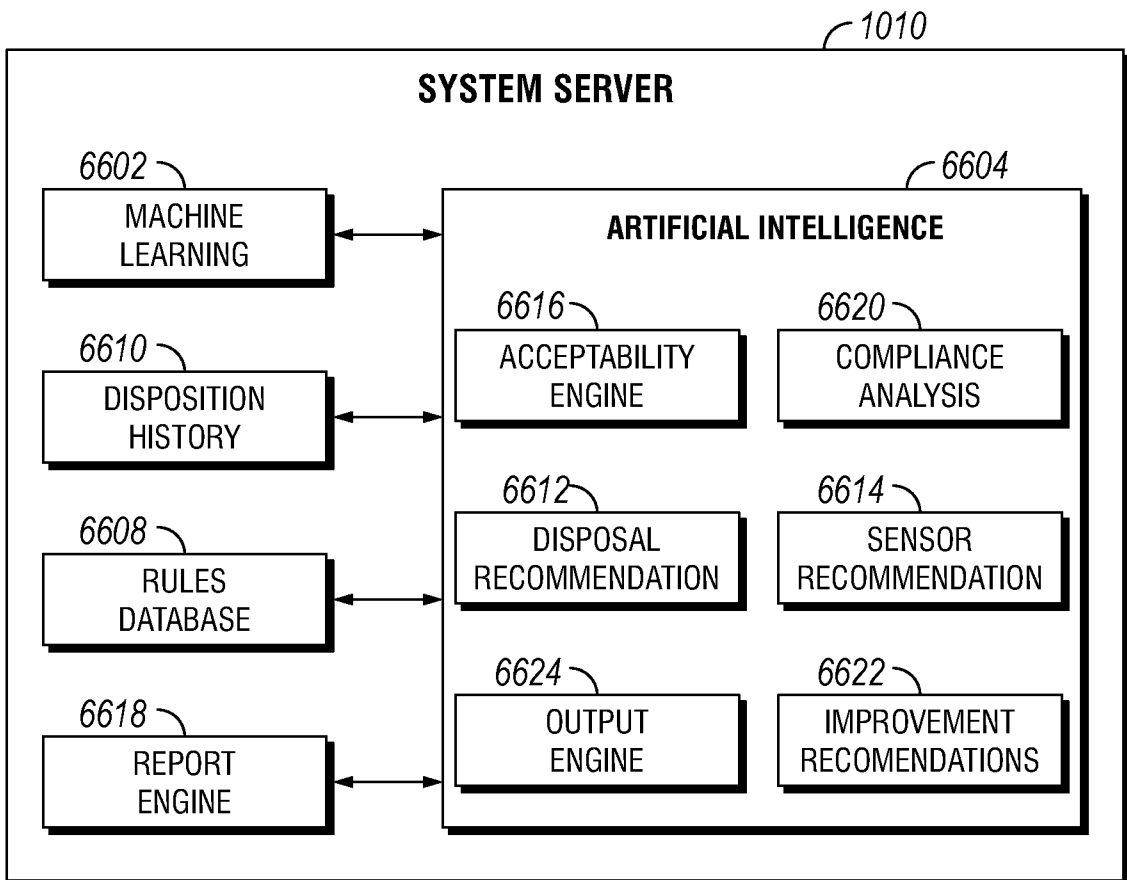


FIG. 66

47/58

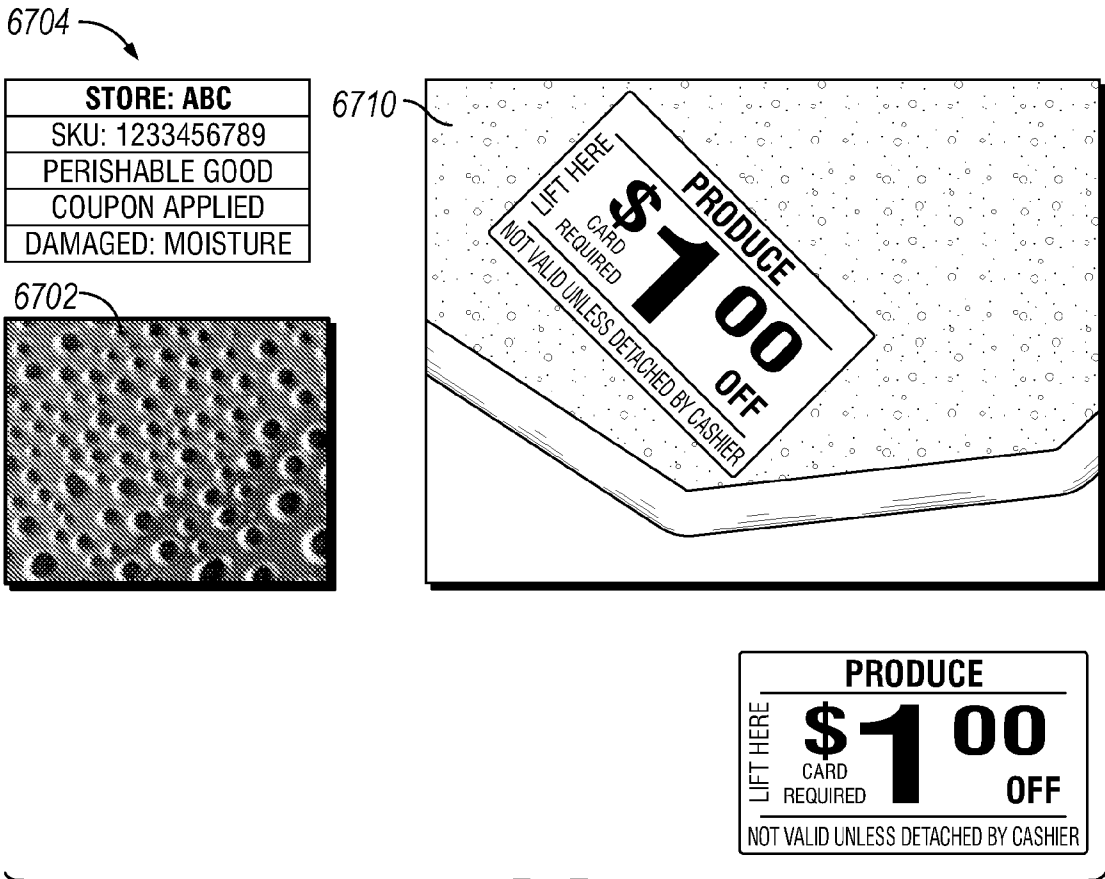


FIG. 67

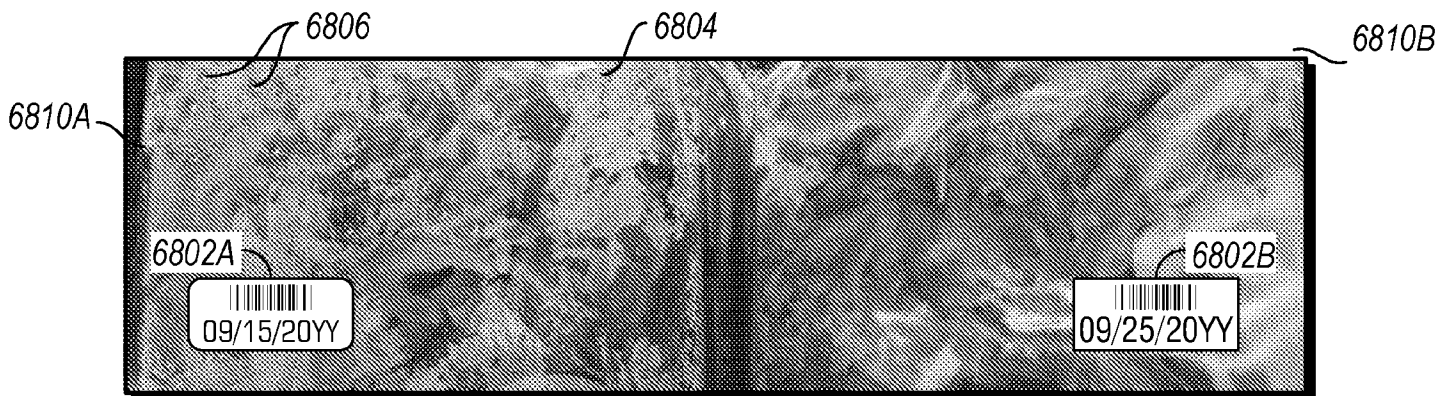


FIG. 68

48/58

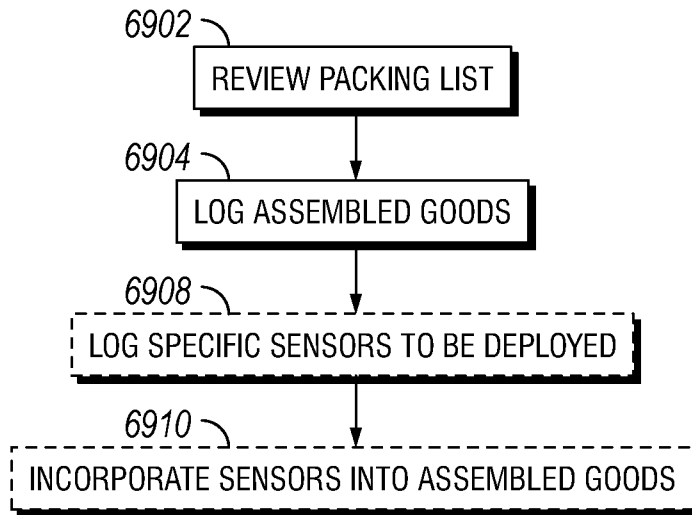


FIG. 69

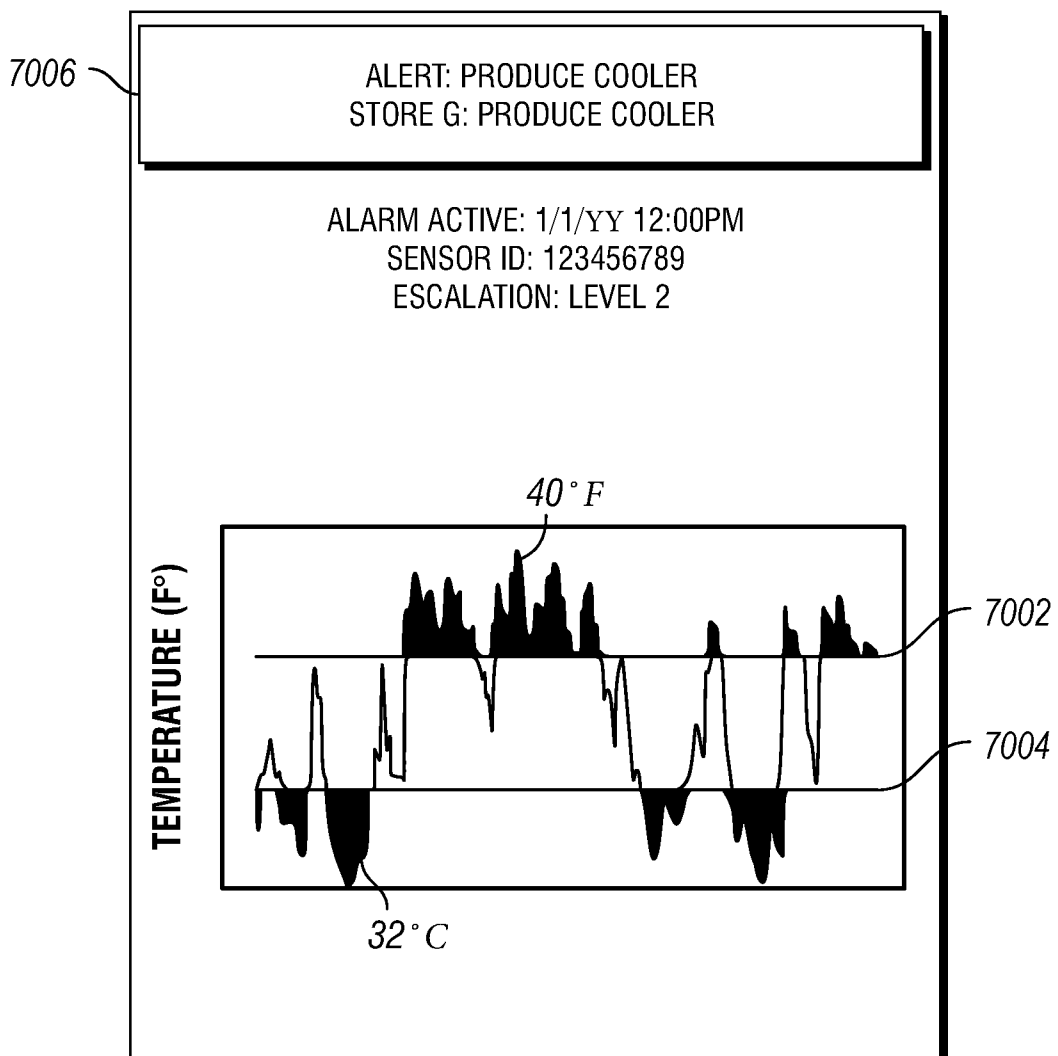


FIG. 70

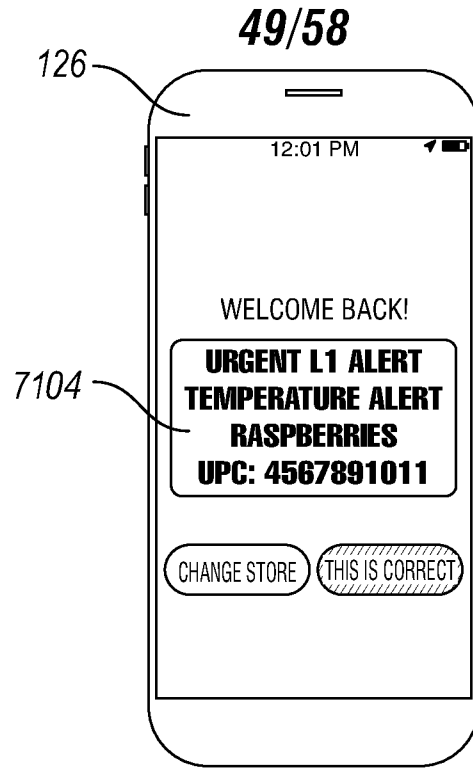


FIG. 71

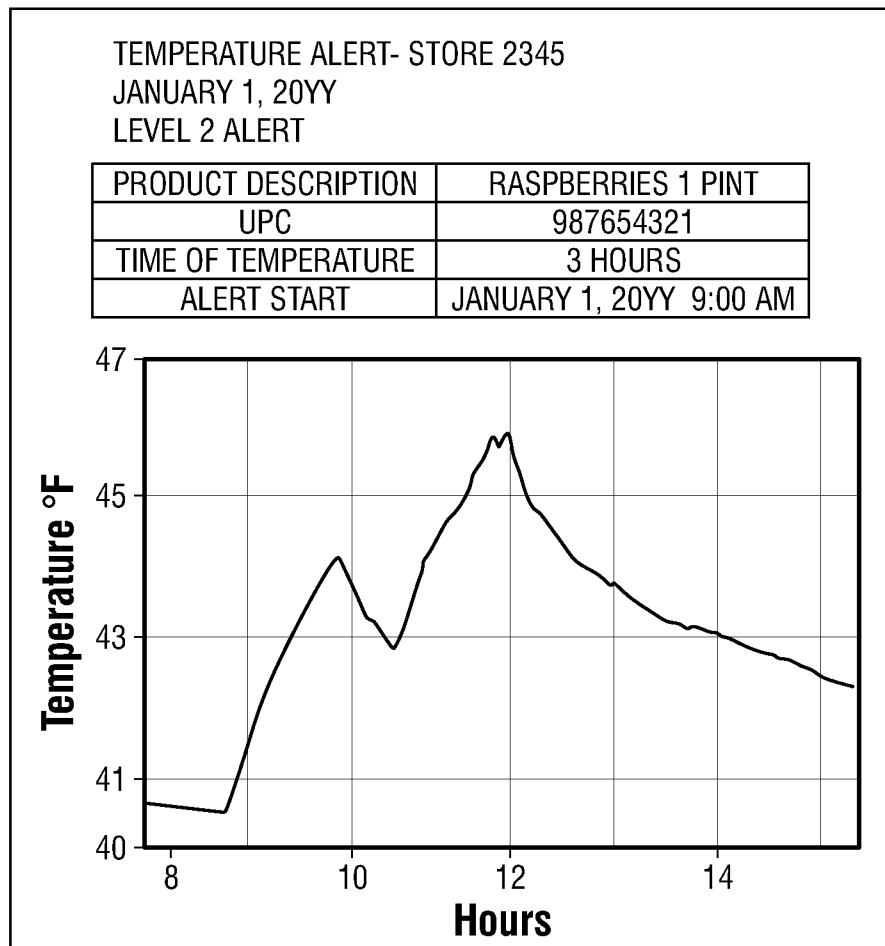


FIG. 72

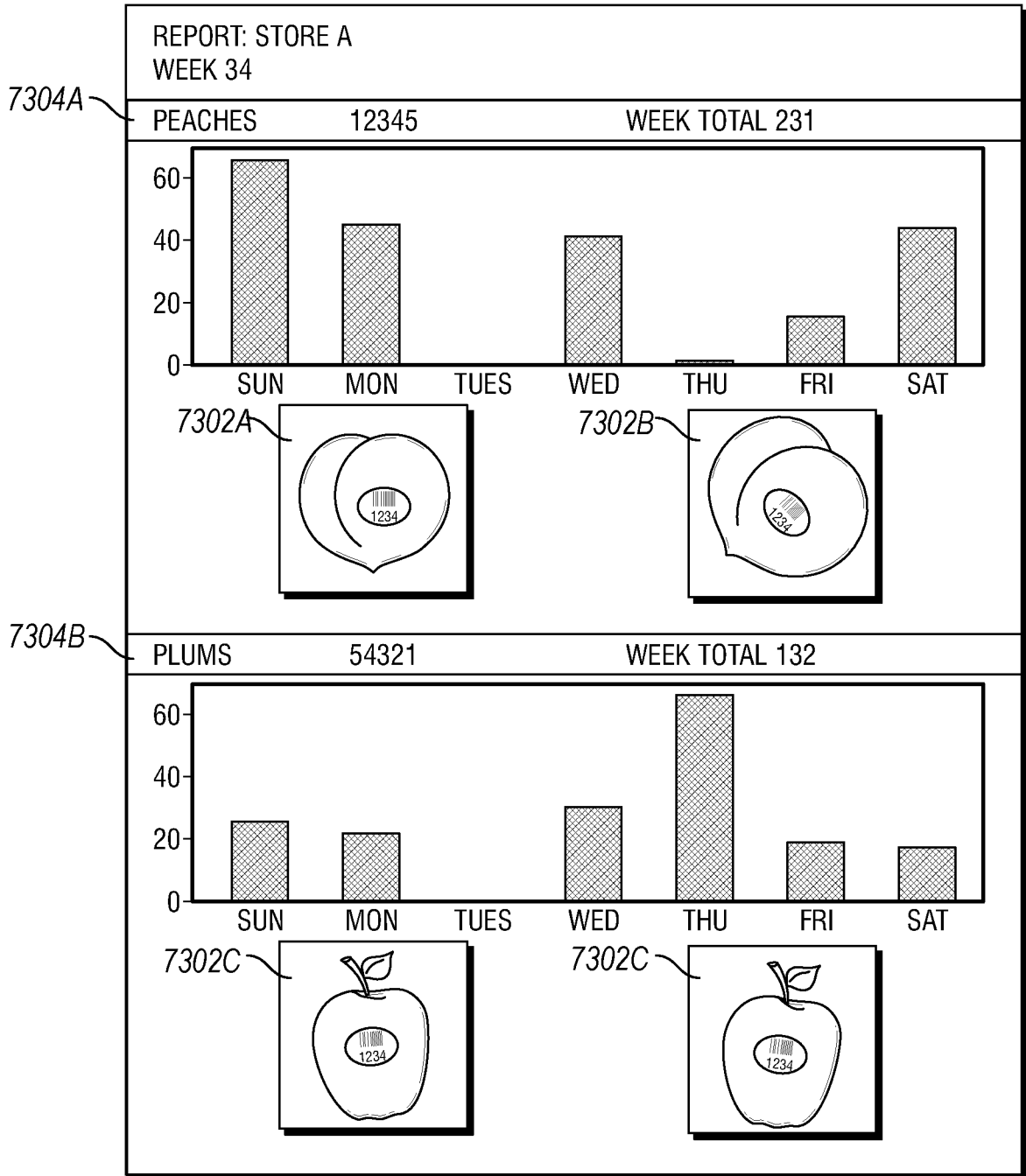


FIG. 73

7304C

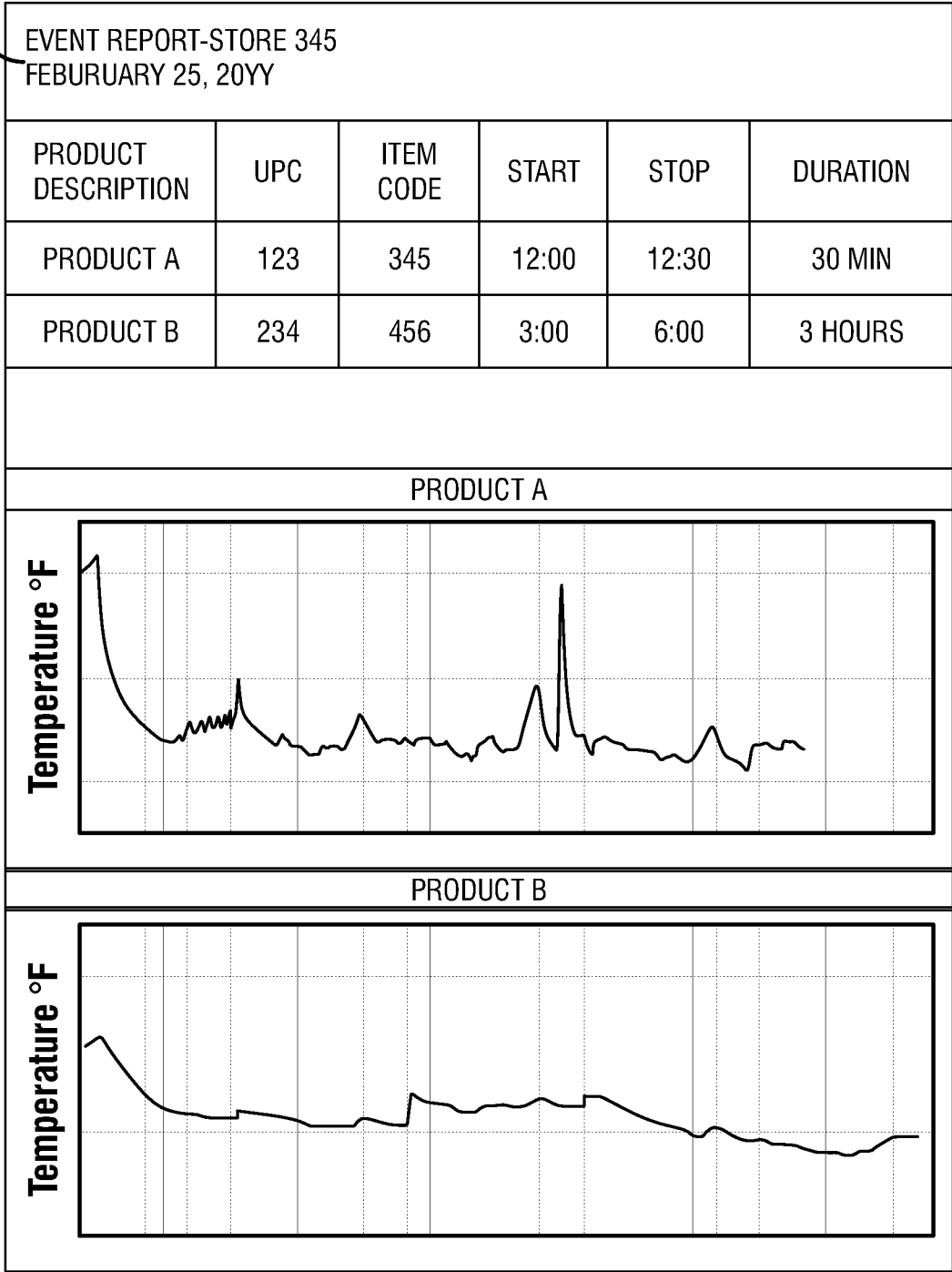


FIG. 74

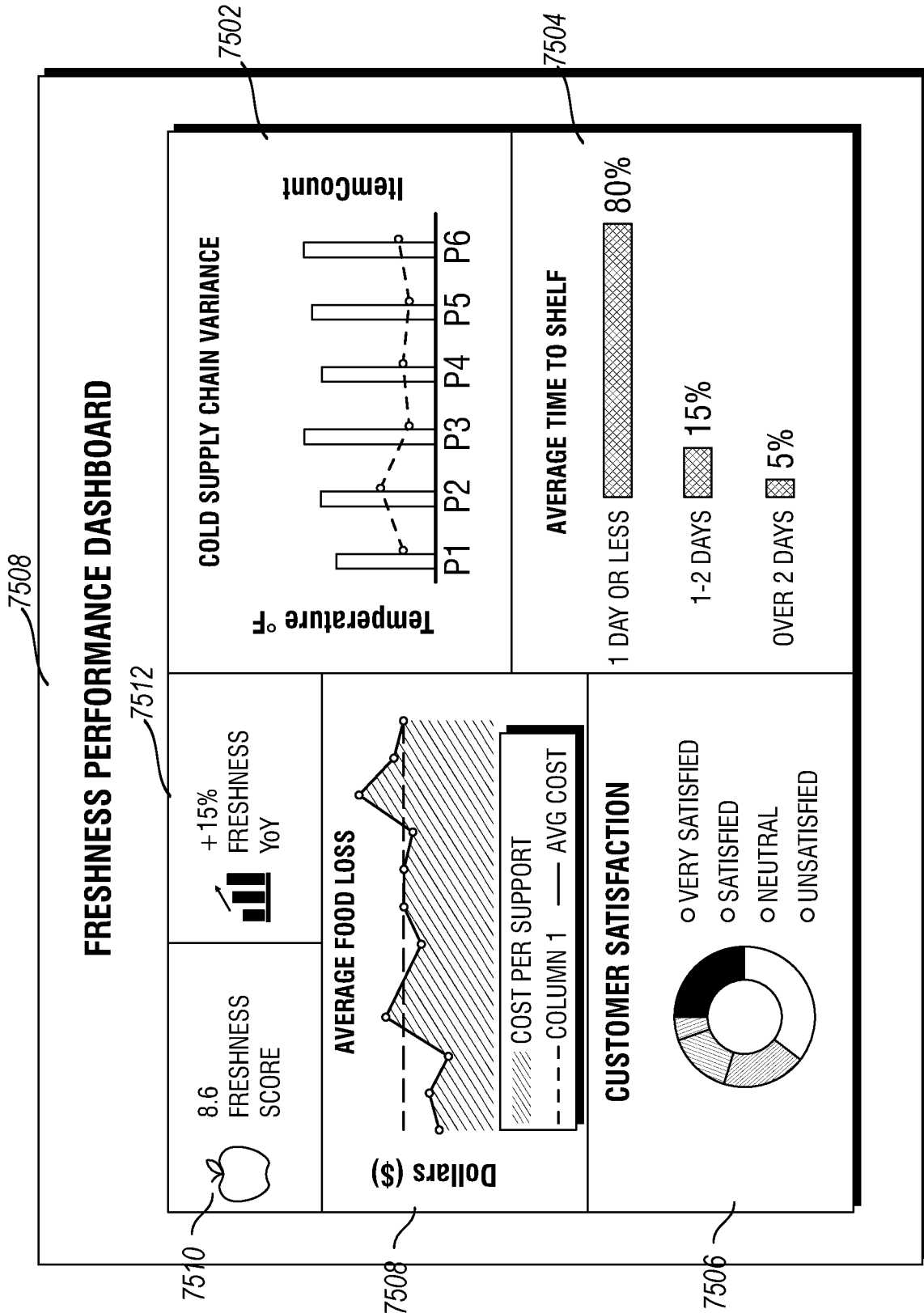


FIG. 75

53/58

PRODUCT TEMPERATURE DATA

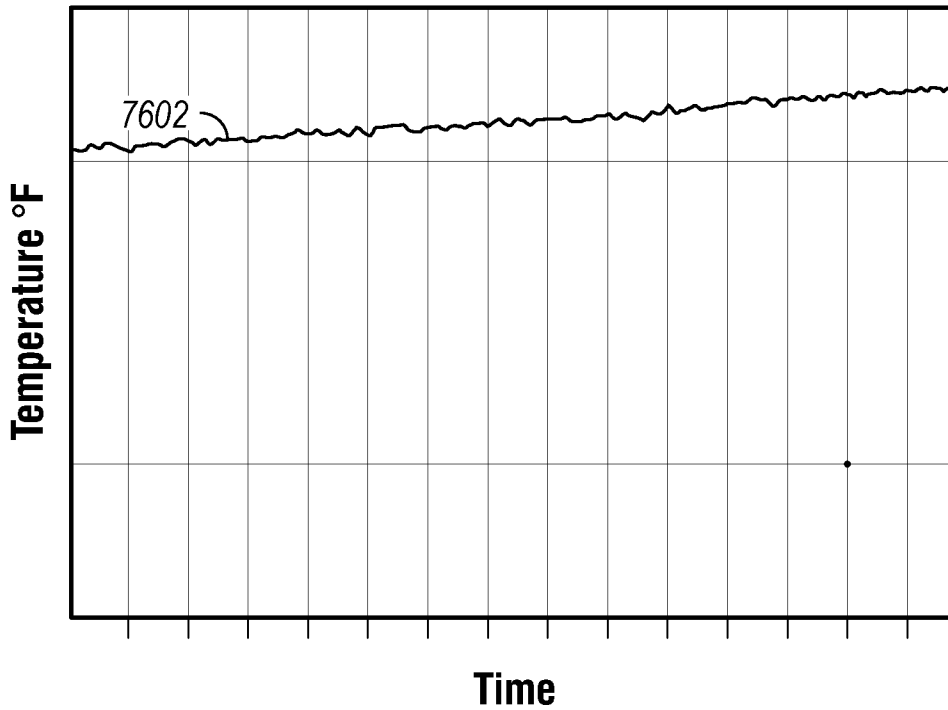


FIG. 76

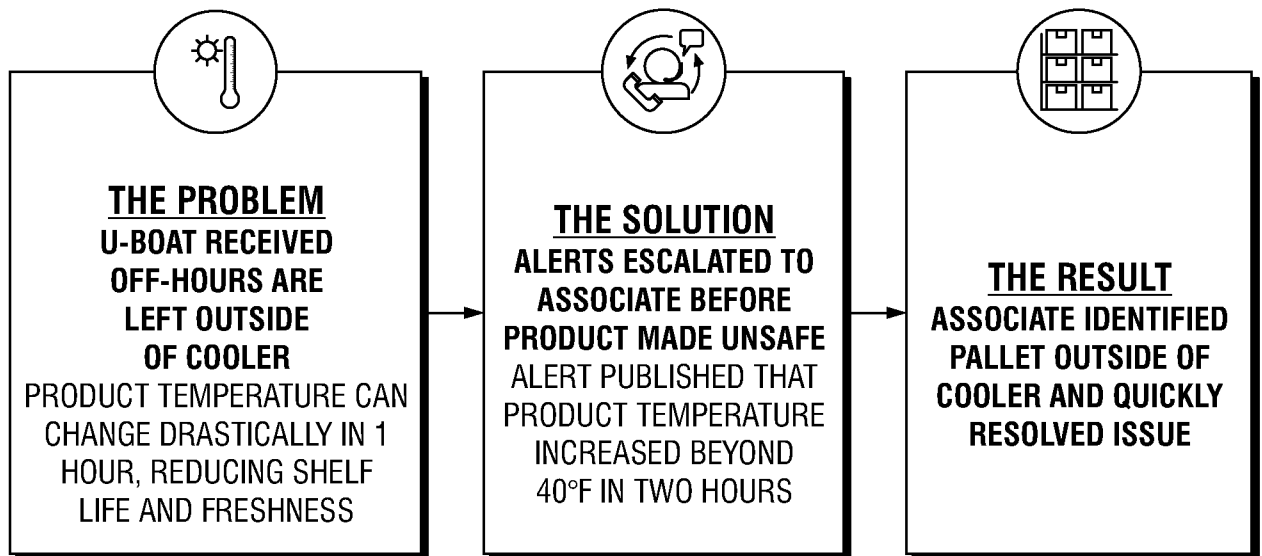


FIG. 77

54/58

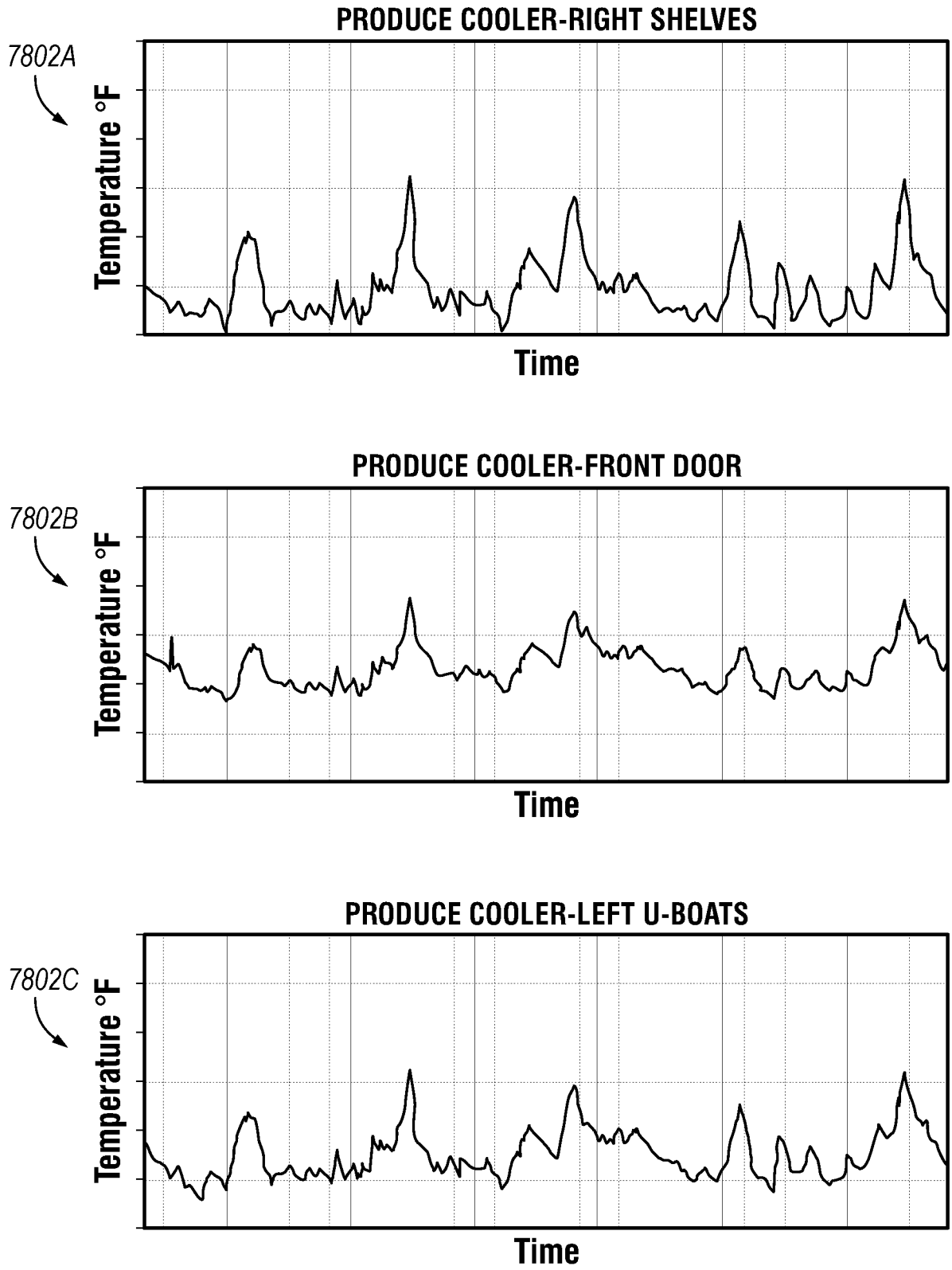


FIG. 78

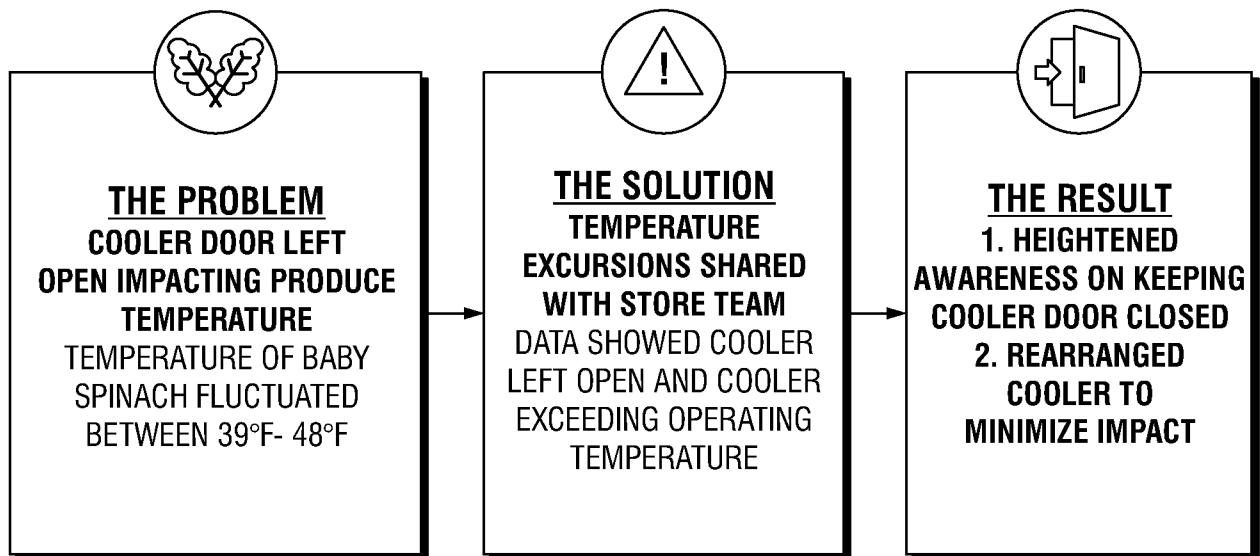


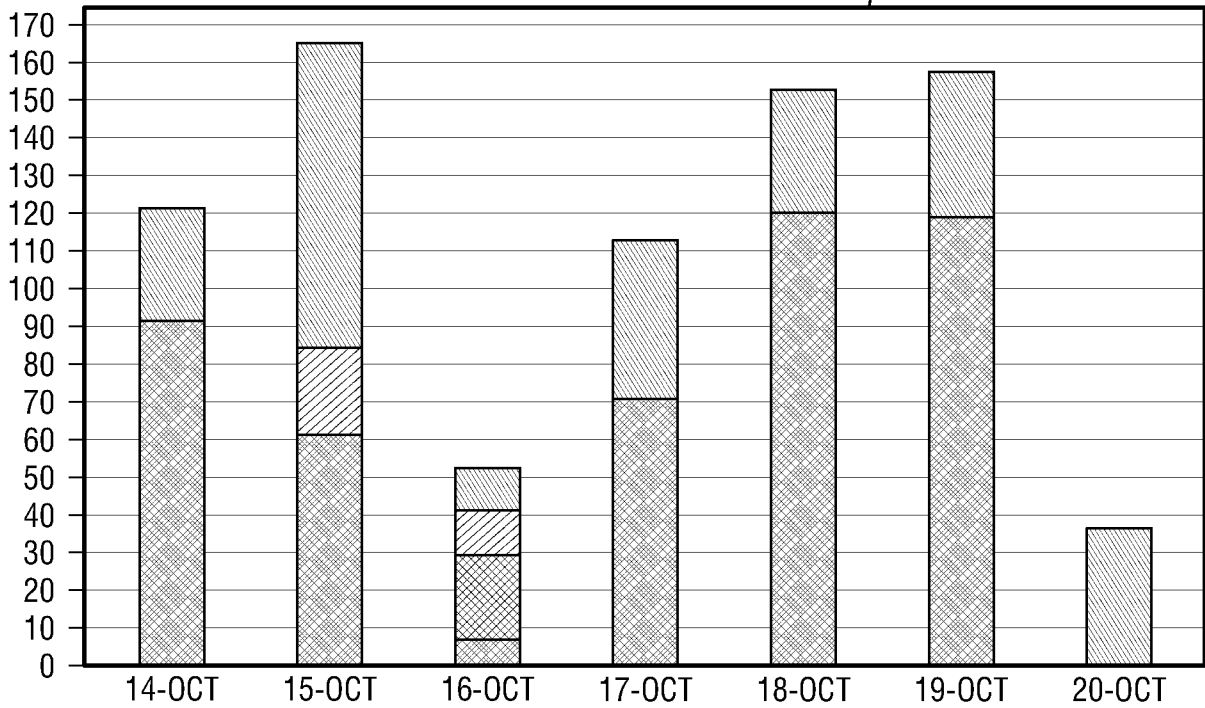
FIG. 79

8010

Fresh Vision Report - Store XXX

14-OCT-oct 20

8012



8016 8018 8022 8020 8026 8028

8014

DATE	ALL ITEMS	DONATED	VISIBLY SPOILED	OUT OF DATE	STORE DAMAGE	FRIDGE FAILURE	RECEIVED POOR
10-20	37	0	0	37	0	0	0
10-19	158	0	119	39	0	0	0
10-18	153	0	121	32	0	0	0
10-17	114	0	72	42	0	0	0
10-16	53	0	8	0	22	0	12
10-15	166	0	62	81	0	0	23
10-14	122	0	92	30	0	0	0

FIG. 80

57/58

Fresh Vision Report - Store XXX

14 OCT - OCT 20

8110

8114 DESCRIPTION	8116 ITEM CODE	8118 CATEGORY	8120 TOTAL DISPOSITIONED
PEACHES	YYYY	STONE FRUITS	70
STRAWBERRY 1LB	YYYY	BERRIES	61
PLUMBS	YYYY	STONE FRUITS	60
RED RASPBERRIES 6OZ	YYYY	BERRIES	32
GUAVAS	YYYY	TROPICAL EXOTIC FRUIT	17
ORG RUSSET POT 6Z	YYYY	POTATOES	15
BARTLETT PEARS	YYYY	PEARS	15
RED GRAPES	YYYY	GRAPES	14
2LB STRAWBERRY	YYYY	BERRIES	11
FRUIT TRAY	YYYY	VALUE ADDED FRUIT	10

FIG. 81

VELOCITY ALERT

AUG 29

LEVEL 1 ALERT

8210

PRODUCT DESCRIPTION	+BLUEBERRY PINT 1EA
UPC	123456789
ALERT SYSTEM	AUG 27 18:40:17
TIME SINCE DEPLOYED	2 DAYS

8212

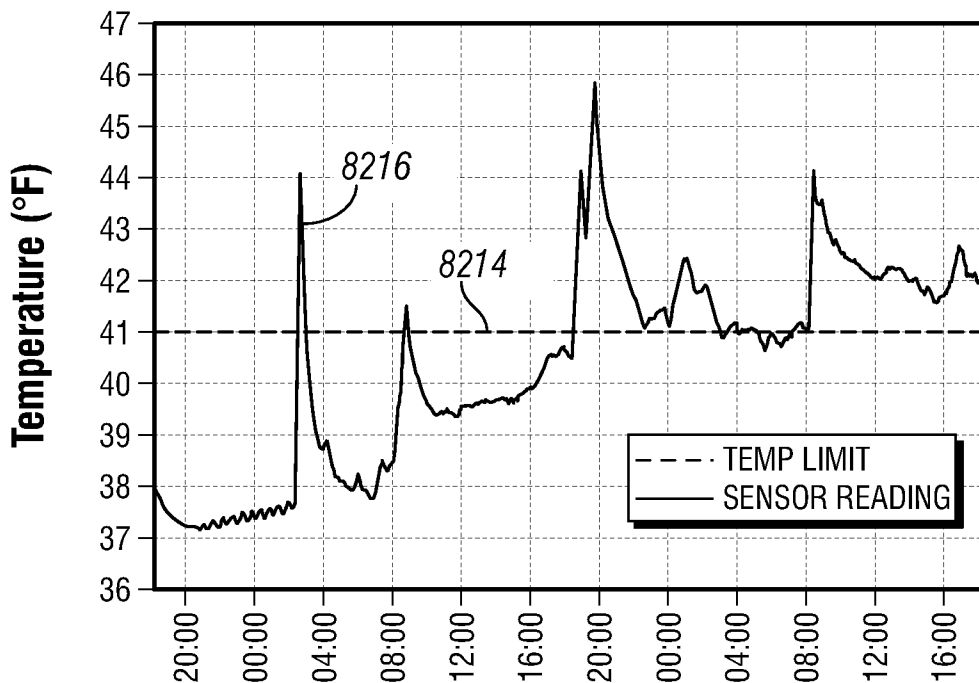


FIG. 82

58/58

8310

Fresh Flow Event Report - Store XXX

AUG 22

8312

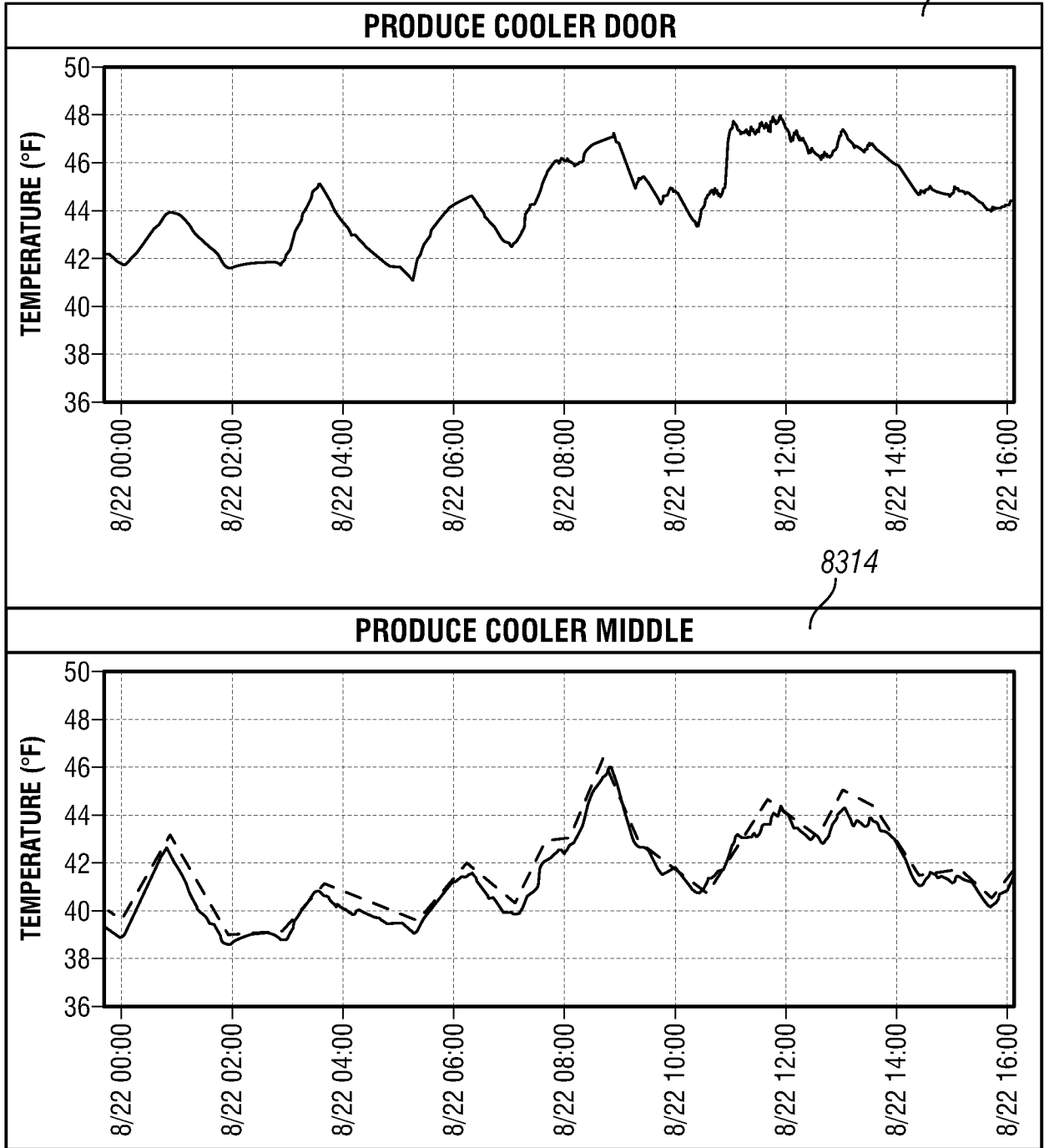


FIG. 83

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2020/051585

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G01N 33/02; G06F 17/50; G06Q 10/00; G06Q 10/08; H04Q 9/00 (2020.01)

CPC - G06Q 10/0875; G01N 33/02; G06Q 10/06; G06Q 10/0832; G06Q 10/087; G06Q 30/0601; G06Q 30/0613 (2020.08)

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

see Search History document

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	HEISING. "Intelligent packaging for monitoring food quality: a case study on fresh fish." In: Wageningen University. 16 April 2014 (16.04.2014) Retrieved on 27 December 2020	1-3, 5, 6, 8-16
Y	(27.12.2020) from <https://library.wur.nl/WebQuery/wurpubs/fulltext/298571#page=21> pg. 9-15, 23, 24, 28-32, 36, 37, 45, 47, 82, 116, 117, 138, 139, 151, 154	4, 7, 17-116, 281-291
Y	US 2015/0066570 A1 (INTERSTATE BATTERIES, INC.) 05 March 2015 (05.03.2015) entire document	4, 33, 63, 92
Y	SGS. "IMPROVING THE MEAT SUPPLY CHAIN, FROM FARM TO RETAILER." 31 March 2014 (31.03.2014) Retrieved on 27 December 2020 (27.12.2020) from <https://www.sgs.com/en/news/2014/03/improving-the-meat-supply-chain-from-farm-to-retailer> entire document	7, 37, 45, 67, 81, 88-90, 96, 100, 103
Y	US 2007/0185751 A1 (DEMPERS) 09 August 2007 (09.08.2007) entire document	17-61, 64-78, 88-90, 109-116, 283, 284
Y	US 2007/0210923 A1 (BUTLER et al) 13 September 2007 (13.09.2007) entire document	21, 23, 54, 71, 111
Y	US 6,439,345 B1 (RECKTENWALD et al) 27 August 2002 (27.08.2002) entire document	41
Y	NASSAR et al. "Compliant plant wearables for localized microclimate and plant growth monitoring." In: npj Flexible Electronics. 10 September 2018 (10.09.2018) Retrieved on 28 December 2020 (28.12.2020) from <https://www.nature.com/articles/s41528-018-0039-8.pdf> entire document	62-90

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"D" document cited by the applicant in the international application

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

29 December 2020

Date of mailing of the international search report

03 FEB 2021

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

Telephone No. PCT Helpdesk: 571-272-4300

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2020/051585

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2017/0224552 A1 (THE PROCTER & GAMBLE COMPANY) 10 August 2017 (10.08.2017) entire document	91-116
Y	US 2002/0038267 A1 (CAN et al) 28 March 2002 (28.03.2002) entire document	98-104
Y	US 2017/0344935 A1 (WAL-MART STORES, INC.) 30 November 2017 (30.11.2017) entire document	281-291
A	US 2007/0055586 A1 (LUCAS) 08 March 2007 (08.03.2007) entire document	1-116, 281-291
A	US 2014/0180953 A1 (PURFRESH, INC.) 26 June 2014 (26.06.2014) entire document	1-116, 281-291
A	US 2018/0007453 A1 (WAL-MART STORES, INC.) 04 January 2018 (04.01.2018) entire document	1-116, 281-291

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2020/051585

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.:
1-116, 281-291

- 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.

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 1-31, 32-61, 62-90, 91-116 and 281-291, are drawn to a method for monitoring and reporting on a condition of a plurality of individual items of sale throughout a supply chain.

Group II, claims 117-139, are drawn to a repository device for decommissioning a plurality of micro-climate sensors.

Group III, claims 32-61 and 140-154, are drawn to a method comprising: interpreting product flow data generated via a plurality of micro-climate sensors each corresponding to one of a plurality of items of sale flowing through a supply chain; identifying a deviation from a standard operating procedure (SOP) for the supply chain.

Group IV, claims 155-201 and 281-291, are drawn to a method comprising: generating, via a plurality of micro-climate sensors disposed on a floor of a store, store floor data corresponding to a plurality of items of sale disposed on the floor.

Group V, claims 202-280 and 281-291, are drawn to a method comprising: generating visual disposition data from a plurality of items of sale in a store.

The inventions listed as Groups I, II, III, IV, or V 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: associating at least one micro-climate sensor with a corresponding individual item of sale in the plurality; generating, via the plurality of micro-climate sensors, product flow data for each corresponding item of sale; determining flow analysis data from the product flow data; and transmitting the flow analysis data as claimed therein is not present in the invention of Groups II, III, IV, or V. The special technical feature of the Group II invention: the repository device comprising: an opening for receiving at least one micro-climate sensor of the plurality; at least one space for storing the at least micro-climate sensor; a plurality of sensors operative to detect a presence of the at least one micro-climate sensor; and a sensor decommission circuit structured to generate a decommission command value in response to detection of the at least one micro-climate sensor via the plurality of sensors as claimed therein is not present in the invention of Groups I, III, IV, or V. The special technical feature of the Group III invention: identifying a deviation from a standard operating procedure (SOP) for the supply chain; generating a deviation message corresponding to the deviation; and transmitting the deviation message; wherein the deviation is with respect to at least one of: a manual process defined by the SOP; or an automated process defined by the SOP as claimed therein is not present in the invention of Groups I, II, IV, or V. The special technical feature of the Group IV invention: generating, via a plurality of micro-climate sensors disposed on a floor of a store, store floor data corresponding to a plurality of items of sale disposed on the floor; determining, based at least in part on standard operating procedure (SOP) data corresponding to a SOP of the store, store analysis data from the store floor data; and transmitting the store analysis data; wherein the store analysis data indicates a measure of the store's compliance with the SOP as claimed therein is not present in the invention of Groups I, II, III, or V. The special technical feature of the Group V invention: generating visual disposition data from a plurality of items of sale in a store; image processing the visual disposition data to generate processed disposition data; determining disposition analysis data from the processed disposition data; and transmitting the disposition analysis data; wherein the disposition analysis data comprises an indication of a causal event for a disposal for at least one of the plurality of items of sale as claimed therein is not present in the invention of Groups I, II, III, or IV.

Groups I, II, III, IV, and V lack unity of invention because even though the inventions of these groups require the technical feature of generating product flow data for each corresponding item of sale, this technical feature is not a special technical feature as it does not make a contribution over the prior art.

Specifically, US 2018/0007453 to Wal-Mart Stores, Inc. teaches generating product flow data for each corresponding item of sale (Paras. [0015-0016]).

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