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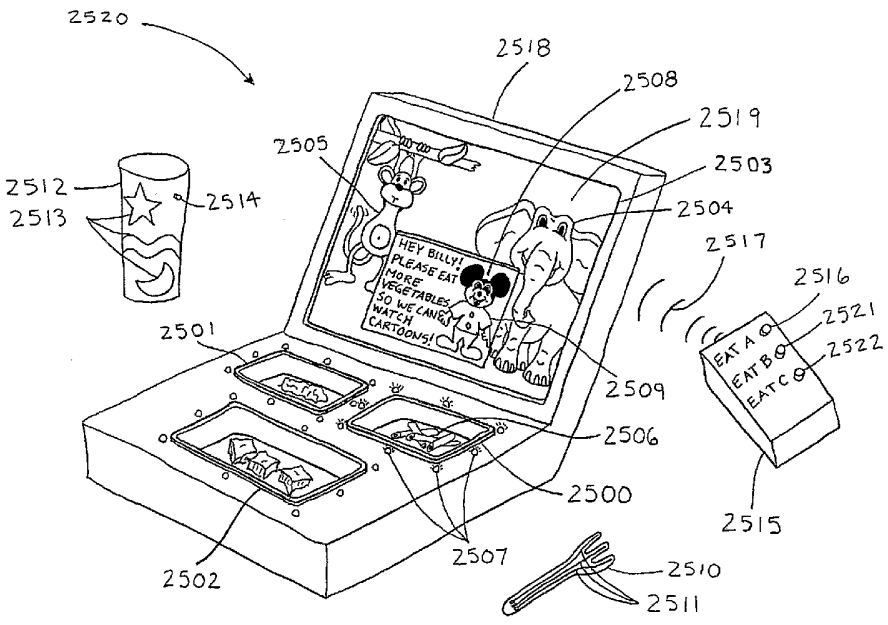
(54) Title: FOODWARE SYSTEM HAVING SENSORY STIMULATING, SENSING AND/OR DATA PROCESSING COMPONENTS



(57) Abstract: Active foodware system comprises at least a dining plate unit that provides visual stimuli by having a power source and a visual sensory stimulating component to provide light emanating from the dining plate. Other devices can provide auditory and haptic stimuli. The dining plate unit can be a single component where the device and circuitry are all contained in the unit and protected from water or can be two components: an upper translucent dining plate and an underplate comprising the devices and circuitry for directing light through the upper translucent dining plate.

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Description

FOODWARE SYSTEM HAVING SENSORY STIMULATING, SENSING AND/OR DATA PROCESSING COMPONENTS

CROSS-REFERENCE TO RELATED APPLICATIONS

[1] This application is a continuation-in-part of application serial no. 10/904,103, filed October 22, 2004, all of which is incorporated by reference.

BACKGROUND OF THE INVENTION

Technical Field

[2] The field of this invention is devices associated with food presentation and/or consumption.

Background

[3] Much of our lives are spent consuming food, including beverages. Ingestion is the primary object. However, there are a number of situations where one wishes to have some additional experience with eating. With a number of people, one can have a conversation associated with the consumption. However, eating alone can be a solitary experience. We have all seen restaurants where the diners are involved in eating and watching television. Children can be recalcitrant when a parent is trying to feed them. To encourage children to eat, various plate designs have been used. Labels on containers are static and limited to having a printed design. Fast food chains have various dishes with graphic designs, such as the latest movie hero. In these situations the diner is involved with stimuli other than the food for different purposes. The other stimuli can involve entertainment, distraction, reward or the like.

[4] For the most part the diner does not have control over what is being presented, as in the case of television, or the presentation is static and quickly loses its attraction, as in dining plate design. In addition, there is an interest in using the period of time in which the diner is eating to present information.

[5] Also, there is an interest in providing dishware, utensils and beverage containers with attractive designs. At dinners, there is an effort to have the china, glassware, and utensils to be properly related to have an attractive table. On many occasions, one is celebrating an event or holiday where the decorations are related to the event or holiday. Having separate sets of china for each event is beyond the ability of most households to afford and store.

[6] Furthermore, one is interested in providing dynamic flexible components, where the programs for the viewer can be readily changed, adapted to particular situations, and expanded, as desired. A personal computer ("PC") provides opportunities to devise programs that can be related to specific situations associated with dining. Even with

the decreasing costs of computers, the computer is still a significant investment to be dedicated to a dining experience. Being able to use available data processing equipment without the investment associated with a dedicated instrument is advantageous. Marrying dishware with data processing equipment already owned by a user provides substantial economic advantages and encourages the combination of food presentation with a programmed data processor.

[7] There are a number of devices that are found in non-analogous art and have found different purposes than providing a dining experience. For example, the game Pong, invented by Nolan Bushnell, was provided as a visual game to allow two players to compete in bouncing a virtual ball against a virtual wall. Such game could be produced in a table form where the players ostensibly could have had food that was supported by the table. However, the potential for food to be present existed, but the food was not associated with the game and the presence of food was incidental to the purpose of device. Other devices have been used to weigh food, such as a food scale. Conceivably, a food scale could have a processor for indicating the weight and allied information, e.g., units of weight, but any visual presentation is limited to weight and not to consumption of food.

[8] An opportunity exists to provide devices associated with food presentation that provide more than support for the food and can be modified in relation to the needs of a particular situation.

Relevant Literature

[9] Garmaise, U.S. Pat. No. 5,678,925, describes a mug for sensing and indicating the temperature of its liquid contents. Tipton, U.S. Pat. No. 5,575,553, describes a container with light encapsulated in the sidewall for illuminating the sidewall. Crapio, U.S. Pat. No. 3,839,793, describes a utensil with exposed LED. Reber, et al., U.S. Pat. No. 5,969,606, describes a food storage container with humidity sensor. de Lange, U.S. Pat. No. 5,023,761, describes a utensil holder with light for illuminating the food at the working end of the utensil. Voskoboinik, et al., U.S. Pat. No. 5,485,355, describes cable-like electroluminescent light sources. Albert, U.S. Pat. No. 5,075,970, describes a sound-emitting utensil. Carson, U.S. Pat. No. 6,254,247 B1, describes a liquid container and method for producing a holographic image on the container.

SUMMARY OF THE INVENTION

[10] The subject invention relates to foodware systems with single media or multimedia capabilities and optionally communication capabilities. Active foodware systems are provided producing sensory signals, particularly in recognizable formats, where the signals are initiated by an independent action, generally related to the food being presented. Such active foodware systems may also be associated with user input, such

as verbal or contact, and can also be programmable. Typical active foodware system feedback will usually include at least one of visual, auditory and haptic feedback, employing optical sources, such as point light sources, images, and information; oral sources, such as microphones, speakers and voice synthesizers, allowing for verbal interaction and communication capability; and the like. The active foodware system may directly or indirectly provide the signals, where the active foodware system, particularly translucent plates or dishes, can be seated on an underplate having the indicated capabilities. Components of the devices include processors, memory, computer programs in the memory, power sources, feedback devices, speakers, fiber optic components, light sources, ports, and the like. In many instances when a light source is referred to as a light emitting diode (LED) the light source may be a laser diode. The active foodware system can have independent data processing and a monitor or be fitted to a laptop PC where the laptop monitor provides the visual presentation and data processing, analysis of signals obtained from the active foodware system and the opportunity to vary the visual presentation. The active foodware system of the subject invention has a multitude of uses, including but not limited to informing or entertaining the user/diner, and may display television signals, radio signals, music player signals, computer signals and the like.

BRIEF DESCRIPTION OF THE DRAWINGS

[11] FIG. 1 is a perspective view of a child using an active foodware system, such as a plate, fork and cup.

[12] FIG. 2A is a plan view of a translucent square eating plate serving as a dining surface, a transmissive element and a support element, which eating plate is over a square underplate with LCD panel on its top. FIG. 2B is an end view of the translucent square plate over the square underplate. FIG. 2C is an end view of the square underplate with LCD panel on top.

[13] FIG. 3A is a plan view of a round eating plate with light guides, such as light fibers, and associated circuitry inside the body of the plate. FIG. 3B is an end view of a light fiber inside the body of the plate.

[14] FIGs. 4A-4D are examples of simple designs which may be made by embedding light guides into a plate with translucent top surface. Each line shown inside the periphery of the round plate represents a portion of a light guide.

[15] FIG. 5A is a cross-sectional view of a light channel in the plate of FIG. 6A. FIG. 5B is a cross-sectional view of a light fiber in a channel in the plate of FIG. 6B.

[16] FIG. 6A is a top view of a plate with a light channel. FIG. 6B is a top view of a plate with a light fiber in a channel.

[17] FIGs. 7A-7C are cross-sectional views of light fibers. FIG. 7A is a cross-sectional view of an unclad light fiber. FIG. 7B is a cross-sectional view of a light fiber with a

portion of its cladding removed. FIG. 7C is a cross-sectional view of a light fiber with a portion of its wall etched or roughened.

[18] FIG. 8A is a side view of a light guide, such as a light fiber, with light emitting diode (LED). FIG. 8B is an electrical schematic of a circuit for driving the LED. FIG. 8C is an electrical schematic of a circuit for driving one or a multiplicity of LEDs with an LED driver integrated circuit.

[19] FIGs. 9A-9D are plan views of plates with various active foodware system designs produced by one or more visual display technologies, such as light guides, light fibers, electroluminescent wire elements, LEDs, LCD panels, and the like.

[20] FIGs. 10A-10C are three frontal views of an active foodware system container with a programmable moving image. FIG. 10D is a plan view of the container with image panel and circuitry components.

[21] FIG. 11 is a cross-sectional side view of a plate with one or more active components, including, but not limited to a light guide, an LED, an LCD panel, an on/off button, a digital processor and a battery. The interconnections are not shown for clarity.

[22] FIG. 12A is a cross-sectional side view of a dining plate positioned in functional relation to a dining plate base (also referred to as an underplate) where the dining plate has one or more sensors, and where the dining plate and dining plate base can communicate information between each other. FIG. 12B is a simplified cross-sectional view of the dining plate of FIG. 12A where only the connector is shown. FIG. 12C is a side view of the dining plate base of FIG. 12A.

[23] FIG. 13 is an electrical block diagram of a processor communicating with a variety of sensing and stimulation components, including display devices, of an active foodware system item of the subject invention.

[24] FIG. 14 is a plan view of an eating utensil (fork) with one or more active components, in this case, three light guides, an on/off switch, a battery and an electrical circuit.

[25] FIGs. 15A-15C are plan views of various active foodware system utensils with one or more active components. FIG. 15D is a side view of a cup with one or more active components. No circuitry is shown for clarity.

[26] FIG. 16A is a side view of a cup with one or more active components. In this case, the active component is oil suspended in a non-oil-based liquid. Shown is an optional illuminating component in the base of the cup. FIG. 16B is a side view of a utensil (knife) with one or more active components, such as oil in a non-oil-based liquid. Shown is an optional illuminating component in the base of the handle. FIG. 16C is a plan view of the cup of FIG. 16A.

[27] FIG. 17A is a side view of a container with a label with one or more active

components. In this case, one active component is a light fiber. Also shown are an LED, on/off switch and circuit. FIG. 17B is a cross-sectional view of the container of FIG. 17A with a label with one or more active components. FIG. 17C is a cross-sectional view of a container with one or more active components inside the wall of the container. FIG. 17D is a cross-sectional view of a container with one or more active components inside the container. In this case, one active component is a light fiber. FIG. 17E is a cross-sectional side view of the container of FIG. 17D with one or more active components inside the container. A light fiber is shown.

[28] FIGs. 18A and 18B are side views of containers with labels with one or more active components. FIG. 18A shows a 7-segment display. FIG. 18B shows a more complicated label including an LCD panel and speaker. FIG. 18C is a block diagram circuit associated with FIGs. 18A and 18B. The circuitry is not shown on FIGs. 18A and 18B for clarity.

[29] FIG. 19A is a side cross-sectional view of an active foodware system comprising a dining plate with a rotating component inside. FIG. 19B is a plan view of the rotating component of FIG. 19A. Additionally, the rotating component may comprise one or more active components. Among other things, the non-rotating portion of the eating plate may comprise one or more light guiding, light transmitting, light modifying or light distorting components.

[30] FIG. 20A is a side cross-sectional view of an active foodware system comprising a dining plate with rotating component inside, where the dinging plate is in functional relation to a dining plate base (also referred to as an underplate) with a powered rotating device magnetically coupled to the rotating component. FIG. 20B is a plan view of one example of magnetically coupled rotating device.

[31] FIGs. 21A-21D are plan views of an active foodware system comprising a dining plate with a multi-pixel LCD display capable of displaying static images or images which appear to move.

[32] FIG. 22 is a plan view of an active eating plate where information is displayed and updated around the perimeter of the dining surface.

[33] FIG. 23A is a plan view of an active foodware system comprising a dining plate with multiple compartments and one or more active components. In this case, the compartments include LCD panels where a small figure may be displayed to encourage the user/diner. FIG. 23B is a plan view of a control pad for communicating information to the plate of FIG. 23A.

[34] FIG. 24A is a perspective view of an active foodware system comprising a dining plate with a visual sensory stimulating component positioned in functional relation. FIG. 24B is a perspective view of a food container with visual sensory stimulating component positioned in functional relation.

[35] FIG. 25 is a perspective view of an active foodware system comprising a dining plate with three food dishes, a paused primary video behind a secondary video, a remote control for controlling the active foodware system, including at least one of the active foodware dining plate, an active foodware cup and an active foodware utensil.

[36] FIG. 26 is a perspective view of an active foodware dining surface computer cover and a laptop computer that the active foodware dining surface computer cover fits over.

[37] FIG. 27A is a perspective view of the underside of an active foodware dining surface computer cover where the computer monitor food shield articulates with the computer keyboard food shield. FIG. 27B is a perspective view of the active foodware dining surface computer cover where the computer monitor food shield is folded back to mate with the computer keyboard food shield.

[38] FIG. 28 is a perspective view of a portion of an active foodware dining surface with a food-sensing platform and food dish.

[39] FIG. 29A is a cross section of a food-sensing platform portion of an active foodware dining surface. FIG. 29B is a cross section of a second type of food-sensing platform portion of an active foodware dining surface. FIG. 29C is a cross section of a third type of food-sensing platform portion of an active foodware dining surface. FIG. 29D is a cross section of a third type of food-sensing platform portion of an active foodware dining surface.

[40] FIG. 30 is a circuit block diagram of a processor receiving weight information from a food-sensing platform of an active foodware dining plate.

[41] FIG. 31 is a block diagram of a computer processor receiving encoder information from a food-sensing platform of an active foodware dining plate and outputting a signal to illuminate one or more lights on the active foodware dining plate.

[42] FIG. 32 is a flowchart describing a portion of an exemplary computer program controlling an active foodware dining plate.

[43] FIG. 33 is a perspective view of a tablet computer and computer cover comprising three dining compartments, each exemplifying different feedback lighting.

[44] FIG. 34 is an active foodware system in the form of a laptop computer with four dining surfaces: one to the side of the monitor, one capable of being swiveled in front of the monitor and two covering a portion of the laptop and to the side of the keyboard.

[45] FIG. 35 is a gamepad with foodware cover.

[46] FIG. 36 is a portable music player with active foodware docking dish.

[47] FIG. 37A is a cross section of an active foodware system with a dining plate inductively receiving electrical energy from an underplate. FIG. 37B is a plan view of the dining plate of FIG. 37A. FIG. 37C is a plan view of the underplate of FIG. 37A. FIG. 37D is an exemplary circuit employed by the plate and underplate of FIG. 37A.

[48] FIG. 38 is a perspective view of an active foodware system transmitting a signal to an external display.

[49] FIG. 39 is a cross section of an active foodware system where a passive translucent plate with a dining surface receives light from a visual display underplate through an optical coupler.

[50] FIG. 40A is a plan view of another active foodware system where a passive plate receives light from a visual display through an optical coupler. FIG. 40B is a cross section view of the passive plate of FIG. 40A.

[51] FIG. 41A is a perspective view of an active foodware system comprising a portable computer and adjustable structure for positioning food and beverages in convenient proximity to the computer. FIG. 41B is a perspective view of the adjustable structure of FIG. 41A. FIG. 41C is a perspective view of the adjustable structure of FIG. 41A where the extension of the frame and surface are capable of being adjusted.

[52] FIG. 42 is a perspective view of an active foodware system comprising an active foodware plate, at least one dining surface, and display devices to be received by, or for attachment to, the active foodware plate.

[53] FIG. 43 is a computer monitor showing a graphical user interface for a computer program for communicating with an active foodware system.

[54] FIG. 44 is a computer monitor showing another graphical user interface for a computer program for communicating with an active foodware system.

[55] FIG. 45 is a cross section view of an active foodware system with a dining surface and an optical sensor for detecting food.

[56] FIG. 46 is a plan view of an active foodware system with a dining surface and an optical sensor for detecting food.

[57] FIG. 47A is a cross section view of an assembled active foodware system including a passive plate with a dining surface and one or more light guides, and a removable active underplate with one or more light sources for emitting light into the one or more light guides of the passive plate. FIG. 47B is a cross section view of the unassembled passive plate and active underplate of FIG. 47A. FIG. 47C is a cross section view of an assembled active foodware system including a passive plate with a dining surface and one or more light guides, and a removable active underplate with one or more light sources for emitting light into the one or more light guides of the passive plate. FIG. 47C also shows an optional motor and rotating translucent film for affecting the emitted light before it reaches the one or more light guides.

[58] FIGs. 48A-48I are cross section views of typical active foodware plate forms.

DETAILED DESCRIPTION OF THE INVENTION

[59] An active foodware system is provided that can afford single media or multimedia presentation. The active foodware system comprises devices that provide at least one

of visual, auditory and haptic stimuli, usually at least visual, where the stimuli can be related to the food being presented. The active foodware system may comprise a power source, a device or devices for producing signals and may also include a device or devices for sensing and/or receiving signals and a processor for processing signals and/or data. The active foodware system may include all of the sensing and stimuli producing devices. The active foodware system may also include the circuitry to control the devices and perform the various activities provided by the active foodware system.

[60] The active foodware system comprises as a central element a dining surface. The dining surface is equivalent to an eating surface and is the exposed surface of an eating or dining plate. The dining surface will be recessed as compared to a region surrounding the dining surface. The recessed surface serves to receive food and the surrounding region prevents spillage. In combination with the dining surface will be a mechanical structure supporting the dining surface.

[61] Also as part of the system will be at least one of a sensing component, a stimulating component or a processor component; or the mechanical structure will have a form to separably receive a processor module. Typically, when the mechanical structure has a stimulating component as other than a software controlled graphical display below the dining surface, then light emanates from the dining surface or the mechanical structure is integral with the dining surface. When the sensing component senses weight, typically the stimulating component will include information other than information provided by a scale.

[62] Typically one of the sensing, stimulating or processor components will be in functional relationship with a mechanical structure. These components may be attached, integral, molded or sealed into, encased, in contact with, connected to or otherwise directly involved with the mechanical structure. Alternatively, the mechanical structure may have a "space," where space includes a cavity, slot, opening, etc., for receiving a processor component, usually with the mechanical structure able to cover at least a portion of the processor component, particularly during dining.

[63] The mechanical structure is intended to be supported by furniture, such as a dining table, desk, high chair, and the like, types of furniture that find use for dining, although not necessarily limited to dining. The furniture raises the mechanical structure to a level where dining is convenient with the mechanical structure, but may raise the dining surface to a level somewhat higher than the level at which one normally dines. The height to which the mechanical structure is raised will generally be about 2.5 feet or greater and less than about 3.5 feet, where the mechanical structure will generally raise the dining surface to less than about 1 foot above the support. In the case of a plate, the dining surface may be raised about an inch or less.

[64] The active foodware system typically has a dining plate having an exposed dining surface for receiving and presenting food. Referring to a "dining plate" or "dining dish," the dining plate or dining dish typically includes any recessed relatively flat dining surface, deeper dining dish, dining bowl, and the like, where one typically uses a utensil or one's fingers to remove the food. It may also include a controller, such as a switch, control circuit, processor, etc. for controlling sensory stimulation or sensing components. Thus the active foodware system can appeal to various organoleptic characteristics. The stimulating and sensing components can be related to the food being presented, either directly or indirectly, such as presence of the food, consumption of the food, temperature, food menu, selection, etc., or providing attention-attracting stimuli, such as entertainment, information, educational presentation, promotional advertisements, etc., which can keep the diner interested and close to the food. The plate may be a unitary object that includes the dining surface, a light transmissive entity and a support member, where the latter may be the same structural element. Usually, the plate will be associated with a light generator that may be separate or be part of the same structural element. There can be one or more dining surfaces that are contiguous or separated. Each dining surface will usually be in close proximity or juxtaposition to one or more stimulating, e.g., transmissive, entities. Generally, the area under the dining surface will be light transmissive when the light generator is below the dining surface. Typically, the sensing component will be part of the mechanical structure.

[65] Active foodware system components can include or be adapted to include a data processor and visual feedback display unit in an active foodware system. By designing an active foodware system component to fit the unit to form an integral structure, the resulting active foodware system has the flexibility of the unit in providing stimuli while at the same time presenting food to the viewer. Also, signals from the active foodware system component can be processed by the data processor and be used in providing the stimuli. The data processor and visual feedback display unit may be provided by a personal computer, such as a laptop computer with a monitor, or a game console. When the data processor and monitor are integral to other components of the active foodware system, other than a separable dining surface, the combined unit will be referred to as the "sensory unit." When the data processor and monitor are separable from the other components of the active foodware system, other than a separable dining surface, such other components will be referred to as the "separable sensory unit."

[66] A subassembly of the subject invention employs a dining plate with an exposed dining surface and a connector to an external processor for controlling the stimuli. In this way, the subassembly can be sold as an individual entity separate from the processor, where the user may connect the subassembly to the external processor. By

having appropriate components integrated with the plate in the subassembly, these can be controlled by the external processor when the subassembly is connected to the external processor.

[67] For the purposes of this invention the "active foodware system" includes all of the components that serve as elements to present, store, utilize or consume food and provide sensory stimulation, sensing and controlling. The active foodware system includes foodware, such as dishware, utensils, containers, flatware, stemware, and ancillary devices used with such entities, such as cup holders. The active foodware system may comprise components or subsystems comprising individual components. A distinction will be made between physically separable and inseparable components and subsystems of the active foodware system. In the system there will be at least a dining surface, such as a dining plate, dining bowl or dining dish, from which food is consumed. The dining surface may be supported by one member of a place setting when in use. There is at least one active component that provides sensory stimulation. There may be one or more passive components. In describing the invention, those components generating or using electrical power will be referred to as "active" components and active subsystems comprise at least one active component. Each of the active components is active in employing electrical power to provide feedback to a user/diner and/or sensing user/diner input. Those components or subsystems that do not generate or use electrical power will be referred to as "passive" components or subsystems, respectively.

[68] In referring to a processor, the processor may be programmable or non-programmable, e.g., hard wired, and there may be one or more processors. Programming may be accomplished with hardware or software. A programmable processor may be a central processing unit (CPU), microcontroller, microprocessor, digital signal processor (DSP), and the like, which is typically connected to ROM and RAM and has a software program in the ROM and/or RAM controlling the programmable processor's operation. The processor may also be a Programmable Logic Array (PLA), Field-Programmable Logic Array (FPLA), Programmable Array Logic (PAL), and the like. The processor will provide for receiving signals from sensors and outputting stimuli of the active foodware system. The processor can be part of an existing system, particularly a commercially available system, having in addition to the processor a graphic display and optionally one or more ports for connection to electronics of the mechanical structure. Such existing systems include generically laptops, where "Laptops" refers to the family of laptop computers, tablet computers, handheld computers, intelligent mobile terminals, and the like. The existing systems also include generically gamepads, where "Gamepads" refers to gamepads, game consoles, and the like. As exemplary are the Sony PSP®, Sony Playstation® Game

Console, Microsoft Xbox®, etc.

[69] The active foodware system may also include sensing capability. Sensing may involve sensing components, including but not limited to contact sensors, touchscreens, motion sensors, proximity sensors, temperature sensors, moisture sensors, pressure sensors, light sensors, sound sensors and the like. The sensing capability may be associated with food characteristics, such as weight, position, center of mass, temperature, movement, color, reflectivity, opacity, size, density, volume, etc.

[70] Stimulation directed to the diner can provide encouragement to eat, rewards for eating, minatory messages, educational messages, information, directions concerning food selection, etc. A portion of the dining surface may have access reversibly blocked. For example, access to dessert may be blocked until the active foodware system senses that the other foods have been eaten.

[71] Other forms of stimulation may include heating of the plate and food, e.g. a heating element in the plate, color patterns, pictures, photographs, etc. For visual stimulation, a light generator is employed. The light generator may take various forms, such as an LCD, LED, electroluminescent wire, fluorescent light, plasma display, neon light, incandescent light, optical fiber, light channel or tube, CRT, etc. When referring to a light generator as a component of a system, the associated video processing, interface and circuitry is inherently included if not explicitly included. When referring to a light generator as a component of a system, the light generator may also include a touch screen, even if not explicitly shown.

[72] The active foodware system can include utensils and vessels with the dining plate. The different components of a place setting may each provide stimulation and sensing and may communicate with each other and a user of the active foodware system. For example, one can provide that the proximity or contact of a utensil to the dining plate can result in encouragement to bring the utensil to the food on the dining surface and recognize when the utensil is moved away from the dining surface.

[73] In distinguishing the subject invention devices from a food scale, the scale is limited to provide solely information about the weight of the food, such as the weight, the units, e.g., grams, in which the weight is presented, cost, and the like.

[74] The active foodware system may be used in a restaurant and provide a food menu, which may be hierarchical. Such an active foodware system may display an image of various food options on the dining surface as the food would actually look if ordered. The active foodware system may allow diner input, ordering and payment, for example, by sensing contact with the plate or voice input. A diner's order on the active foodware system may be automatically directed to the kitchen.

[75] Of particular interest are dining plates, which can be used for presenting food, particularly with conventional or active utensils and drinking receptacles, for

demonstration of various designs, for providing information or entertainment, etc. The dining plate will usually be the center of the active foodware system involving most, if not all, of the stimuli to the user/diner.

[76] The dining plates may be active systems or subsystems and have all or some of the circuitry and stimuli producing devices contained in the dining plate. For example, by molding an upper or lower layer of a dining plate having compartments and channels for housing the devices and connecting the devices, the various devices may readily be placed in their appropriate positions and relationships and connected accordingly. One may then seal all of the devices with potting compound, epoxy, fiberglass, and the like, to protect the devices and connectors from moisture. A complementary layer, e.g., undercover, can be attached while the sealant is curing, so as to be bonded to the sealant and provide for an attractive dining plate, e.g., an attractive underlayer. Alternatively, one may provide for a channel proximal to the edge of the dining plate with an underlayer having a ridge fitting into the channel. By having a sealant in the channel or on the ridge, fitting the ridge into the channel will hermetically seal the upper and lower layers to form the dining plate. The design will allow for chambers, leads or the like at the periphery of the dining plate for connection to other components, such as batteries, antennae, etc. A compartment can be provided at the periphery for receiving a battery that would be in operative connection with the internal devices through leads, pads, etc., that can be made of corrosion resistant materials, to allow for washing of the dining plate after removing the battery.

[77] The manner in which the upper and lower layers of the plate are sealed is to provide for a water resistant seal. In this way the dining plate can be washed and the devices and circuitry between the layers are protected from corrosion. By having an external power source or providing for a sealed compartment for receiving a power source, one can provide an integral plate that only lacks the power source, but can be connected with the power source when in use.

[78] The dining plate unit may have an upper dining plate, of which at least a portion is translucent, and an underplate having the various devices for the stimuli or sensing. Such translucent plate would include the dining surface, a transmissive entity and further serve as a support structure for the dining surface. The translucent plate can be glass or various plastics, such as polycarbonate, PVC, Plexiglas, polyethylene, polypropylene, poly-4-methylpentene-1, delrin, etc. The translucent plate may be read ily molded and typically will be relatively thin to allow for efficient transmission of light from the underplate. Thicknesses in the range of about 1 to 10mm may be employed. In addition, various designs may be incorporated into the translucent dining plate to cooperate with the stimuli emanating from the underplate.

[79] The foodware system may be capable of communicating data, such as sending data

or receiving downloaded data, such as video files, movies, pictures, designs, audio files, computer programs, etc. The data communication may be done offline or streamed in real time. The data communication may be via a wired or wireless link. The data communication may be from or to a website. The data communication may be from or to a server computer. Data communication may be from or to a peer-to-peer network. Data communication may be via any convenient protocol, including http, https, ftp, and the like. The active foodware system may accept external hardware media such as DVDs, CDs, memory sticks, floppy disks, hard drives and the like, where the content may be seen and/or heard on the active foodware system. By having ports, connectors, transmitters or receivers for receiving external signals that can then be presented as stimuli, the active foodware system provides great flexibility. Thus, the active foodware system can be self-contained or rely on external devices to provide signals which are then presented to the user/diner.

[80] The data received by the active foodware system can be utilized in different ways depending upon the type of received data. Typically, if the data is a picture file format, the active foodware system will display a digital image; if the data is a movie or video format, then the active foodware system will display movie or video; if the data is a haptic feedback file format, the active foodware system will provide haptic feedback; if the data is an audio file format, the active foodware system will play sound; and if the data is a computer program, the active foodware system will run the program. However, one type of data may be converted into a different stimulation; for example, an audio format may be converted into a haptic format and/or visual format or may be used to augment a visual image.

[81] By "image" is intended a representation formed by light emission at different sites, usually of other than a simple geometric form. For the most part, the image will be formed by a plurality of light-emitting sites. Light-emitting sites may be obtained with one or more electroluminescent elements, a plurality of LEDs, an LCD display, a fluorescent display, a plasma display, a plurality of incandescent lights, and the like. Simple geometric forms include circles and various regular polygons of from 3-4 sides, such as triangles, squares, and rectangles.

[82] The active foodware system may comprise a mechanical structure having a dining surface and comprising any one of a stimulating component, a sensing component and a processor component, with the component being in proximity to the dining surface, with the dining surface being recessed in relation to a region surrounding the dining surface, with the dining surface being recessed for receiving food and preventing spillage from said dining surface, and in the event that the stimulating component is a visual stimulating component, (a) the visual stimulating component has a plurality of sites that emit light that produces other than a single simple geometric form, or (b) the

visual stimulating component is sealed in the mechanical structure.

[83] The active foodware system may also comprise: a dining surface, where the dining surface is recessed in relation to a region surrounding the dining surface, where the dining surface is recessed for receiving food and preventing spillage from the dining surface, and in combination with the dining surface, further comprising a mechanical structure for supporting the dining surface, and (1) in functional relationship to the mechanical structure, any one of the following functioning while dining: a sensing component, a stimulating component and a processor component, with the proviso that (a) when the mechanical structure has a visual stimulating component and the stimulating component is other than a software controlled graphical display, either (i) light emanates from the dining surface from a plurality of sites that emit light that produces other than a single simple geometric form, or (ii) the visual stimulating component is sealed in the mechanical structure or (b) when the sensing component senses weight, the stimulating component includes information other than information provided by a scale; or (2) the mechanical structure has an adjustable support structure, a horizontal dining platform for supporting food in a raised position, while a keyboard is positioned at least partially under the dining platform, at least a portion of the dining platform being translucent to permit viewing at least a portion of the keyboard during dining.

[84] Typical active foodware system visual displays include light guides (such as optical fibers, electroluminescent light sources, light channels in the active foodware system material, light tubes, and the like), liquid crystal displays, light emitting diodes, laser diodes, plasma displays, fluorescent lights, fluorescing fluids, incandescent lights, and the like. The active foodware system may include haptic feedback, including but not limited to vibrotactile feedback, tactile feedback, electrocutaneous feedback, and force feedback, so the user/diner may feel desired vibrations, jolts, impacts or movements of the active foodware system. A useful vibrotactile feedback element is a rotating motor with eccentric mass, such as is found in vibrating cell phones. Typical auditory feedback displays include voice-coil speakers, piezoelectric speakers, and the like, including speakers and sound-generating elements used in cell phones.

[85] The active foodware system may accept wired or wireless input that affects the visual, auditory or haptic display of the active foodware system, such as signals from a data processor. For example, the active foodware system may accept voice input, wired or wireless mouse input, wired or wireless peripheral device input. Games may be played using the active foodware system where the active foodware system dining plate comprises a visual feedback display. The active foodware system may have built-in controls for controlling the displayed content, providing game control input, communicating with other active foodware systems, and the like.

[86] Embodiments of particular interest include having a passive or active component or subsystem comprising the dining surface that interacts with a separable active component or subsystem. For example, one may have an underplate as an active subsystem under a dining plate having a dining surface. Such underplate may rest on a table, be part of a table or be affixed to a table. In one embodiment, at least a portion of the dining plate is translucent while the underplate transmits visual sensory stimulation through the translucent portion of the dining plate. Another example, is the use of a data processor, e.g., laptop computer, and visual feedback display, e.g., monitor, that fits with a subsystem comprising a dining surface. The subsystem optionally includes a sensor for sensing changes in the amount of food present and provides feedback. One can also provide for recognition by the data processor of a unit of food related to an average amount per intake and have the sensor recognize when the change in the amount is unrelated to an average intake, e.g., where the food is discarded.

[87] One may be interested in sensing the position of food on the dining surface. Various technologies that may be employed as the sensing component include infrared emitters/detectors, cameras, including CCD cameras, touch screens, pressure and weight sensors, ultrasonics, radar, temperature, sensors, lasers, proximity sensors, and the like. Depending upon the technology, the different entities would be positioned in different known ways in relation to the dining surface. A signal from the sensing component may be transmitted to a stimulating component to modulate the stimulation. The sensed information can be used in a variety of ways by the active foodware system. For instance, if it is detected that while a child is eating, food is being moved about the dish rather than being consumed, the parent may be notified or the stimulation to the child may be altered. The parent may be notified by phone, email, pager, auditory signal, etc. In another embodiment, designs, both colors and patterns, displayed at the dining surface may be varied. Attractively, one could have simulated electrostatic patterns related to the position of the food.

[88] One item of an active foodware system may communicate information with another item of an active foodware system. An active foodware system fork may communicate its movement to an active foodware system dining plate of the same user/diner or the active foodware system dining plate of a different user/diner. A computer which typically is not in physical contact with the active foodware system may communicate with the active foodware system in real time or offline.

[89] Active foodware systems may include corded telephone technology, cordless telephone technology, walkie talkie technology, mobile/cellular telephone technology, internet access, web searching technology, and the like.

[90] Advertisers may combine promotions with active foodware systems. For example, a fast-food store may provide active foodware system cups, dining plates and/or utensils

with moving and/or talking movie characters or interactive games on them.

[91] The subject active foodware system serves to provide an enhanced dining experience. One can present to a diner a visual, aural, haptic or other sensory stimulation to enhance the dining experience. A dining surface is maintained in proximity to a stimulating component. Of particular interest is to have a processor to communicate with the stimulating component to provide the desired stimulation. The method comprises presenting food to a diner on such dining surface; running a computer program on a computer with instructions for selecting at least one active foodware system; transferring data from the computer memory to the processor; and depending upon the type of the data, displaying, playing or operating the data, in conjunction with a member of the active foodware system, such as a dining plate or underplate. The selected member will have a receiver for receiving and storing the data. One may also select data from a data source to be included in the data transferred to the active foodware system member. In this way, stimulation may be provided during the consumption of the food. The stimulation can be related to the food and its consumption, providing information about the food, its preparation, its characteristics, etc.

[92] Of particular interest is sensing the weight of the food on a dining surface. Visual or auditory stimuli in relation to the weight of food sensed can be provided. Auditory signals may be provided that relate to the consumption of the food and provide rewards, instructions, etc., in relation to such consumption.

[93] The subject invention is further described in detail hereunder referring to the embodiments provided in the drawings.

[94] FIG. 1 shows a user/diner **100** seated at a table **101** using a variety of active foodware system items, including an active dining plate **102**, an active fork **103** and an active cup **104**. Only these three active component examples are shown in the figure; however, many different items used to eat, drink, contain, serve, support, pour, store, prepare, hold, and mix food, when comprising active or passive components, may be considered as active foodware systems according to the subject invention. For clarity, the active dining plate **102** does not have any food on it. Such active component may comprise one or a multiplicity of a variety of active sensory stimulating and sensing components. Visual sensory stimulating components include but are not limited to light emitting diodes (LEDs), optical fibers, optical tubes, electroluminescent light sources, optical channels, liquid crystal display (LCD) panels, incandescent lights, fluorescent lights, fluorescing fluids, and the like. Such active foodware system may comprise one or a multiplicity of auditory sensory stimulating components, including but not limited to voice-coil speakers, piezo-electric speakers, and other sound generating components. Such active foodware system may comprise one or a multiplicity of

sensing components, including but not limited to contact sensors, touchscreens, motion sensors, proximity sensors, temperature sensors, moisture sensors, pressure sensors, light sensors, sound sensors and the like. Such active foodware system may also comprise one or a multiplicity of haptic feedback components, including but not limited to tactile, vibrotactile and force feedback components to provide tactile and force feedback to the user/diner. Such active foodware system may provide a multimedia dining experience to the user/diner.

[95] FIGs. 2A-2C provide one embodiment of the subject active foodware system invention where an LCD screen is positioned in functional relation to an dining plate surface, in this case under the dining plate. This embodiment provides a rectangular active foodware system **213** comprising an active underplate or active underplate subsystem **201** with LCD visual display **202** and a passive eating plate **200** with at least a portion of the top surface **212** being translucent to allow viewing of at least a portion of the information provided by the visual display **202**. The passive dining plate **200** may be attached to the active underplate **201** or left unattached. FIG. 2A is a plan view of the passive dining plate placed over the active underplate. FIG. 2B is a side view of the passive dining plate **200** above the active underplate **201**. FIG. 2C is a side view of the active underplate. The passive dining plate **200** may contact the table via supports **210** where the active underplate is accessible via openings **211** between the supports **210**. Alternately, the passive dining plate may be supported by the active underplate and not contact the table surface directly.

[96] The active underplate **201** of FIGs. 2A-2C comprises a processor **203** which generates a display control signal that is used by the display amplification circuitry **214** to drive the visual display **202**. The interconnections are not shown here in FIGs. 2A-2C, but a general functional block diagram is provided later in FIG. 13. The electrical details are known to those skilled in the art. The active underplate **201** further comprises battery **204**, electrical adapter/battery charger connector **208**, speaker **207**, on/off switch **206**, external media slot **205** and data adaptor **209**. The external media slot **205** may accept any of a variety of past, present or future media, including but not limited to CDs, DVDs, floppies, tape, memory sticks, and the like. The data adaptor **209** represents one or a multiplicity of port connectors for a variety of wireless and wireline data, and may be a USB connector, Firewire connector, serial connector, parallel connector, infrared connector, electromagnetic connector, and the like. In FIGs. 2A-2C, data adaptor **209** and electrical adaptor/battery charger connector **208** are optionally obstructed by supports **210** for safety reasons to prevent wired connection during dining to any device that might present an electrical hazard if a liquid were spilled on the wire or connection during dining.

[97] FIG. 3A is a plan view of one embodiment of the subject invention where a visual

display is made up of light guides, such as light fibers, electroluminescent light sources, light tubes, light channels and the like being placed in functional relation to a dining plate. In this embodiment, representations for two eyes and a smile are illuminated by light guides. The left eye comprises light guide **301** and associated LED **302**; the right eye comprises light guide **303** and associated LED **304;** and the smile comprises light guide **305** and associated LED **306**. FIG. 3A also shows a power source **307**, on/off switch **308** (such as a single pole, single throw switch), electrical resistors **309**, **310**, and **311**, along with the interconnections. The embodiment as shown provides a very simple circuit where pressing the on/off switch illuminates the LEDs and their associated light guides. In a more complicated embodiment, a processor may be used to provide more sophisticated lighting effects. Electrical circuits to provide a wide variety of lighting effects are well known by those skilled in the art.

[98] The power source **307** may be a battery, and may be rechargeable and may be replaceable. The battery may also be manufactured into the plate such that is cannot be user replaced. If rechargeable, the battery may be removed and recharged. Alternatively, the battery may be left in the plate and recharged via a connector (not shown) on the plate. If it is desired to not have any openings or connectors to the plate, the battery may also be associated with a transformer (not shown) in the dining plate so it can be inductively charged via an external electromagnetic field, such as provided in FIGs. 37A-37D. The battery may also be associated with a photovoltaic cell (not shown) in the dining plate which charges the battery using light.

[99] The lighting power source, circuitry and/or one or more lighting components may be removable. The lighting components and circuitry may be located inside the material of the dining plate or positioned below the dining surface. In such cases, enough of the material between the dining surface of the dining plate and the lighting component(s) should be translucent to permit at least a portion of the light escaping from the lighting component(s) to be viewed by the user/diner. The dining plate may be manufactured from typical dining plate materials, such as China, glass, ceramic, plastic, porcelain and the like. Translucent portions of the dining plate are made from any hard non-toxic translucent material, such as glass, plastic and the like. Translucent liquids may also be encapsulated between the light source and surface of the dining plate.

[100] FIG. 3B is a side view of the dining plate of FIG. 3A where only the light guide **305** and associated LED **306** producing the smile are shown for clarity, and which in this case are located inside the material of the dining plate.

[101] FIGs. 4A-4B are various dining plate designs that can be easily produced using the light guide embodiment of FIGs. 3A and 3B. Multiple light guides may co-exist in a single dining plate and be selectively activated to provide the illusion that the face is

changing expression. In FIGs. 4A-4B, the lines making up the eyes and mouth may be produced using one or a multiplicity of light guides per facial line.

[102] FIG. 5A is a cross-sectional view at section 5A-5A of the dining plate **500** of FIG. 6A. There is a channel **501** in the dining plate for directing and diffusing light from light source **502** on its way to the reflective surface **507**. Light may be reflected internally or the light may refract. The refracted light that escapes the surface of the dining plate may be viewed by the user/diner. The diameter of the channel may be selected so that a desired amount of light escapes the channel for viewing by the user/diner. The surface roughness and optional coatings may also be selected to determine the amount of light that escapes the channel. Such augmentation of the channel may be graded to provide a desired intensity of glow along the channel by the user/diner. For example, it might be desired to have the ends of the channel emit more light, i.e., glow more, than the middle, or vice versa, or it might be desired to have a uniform glow along the length of the channel.

[103] In a related embodiment, the channel may be filled with a fluorescing gas, material, liquid or other fluid, and where the light source **502** is an energy source that causes the gas, material or fluid to fluoresce.

[104] FIG. 5B is a cross-sectional view at section 6B-6B of the dining plate **503**. There is a channel **505** into which a light guide **504**, such as an optical fiber, electroluminescent light source, or light tube, resides. The light guide has a light source **506** at one end and may have an optional reflective surface **508** at the other. The index of refraction of the light guide and of the dining plate channel, as well as any gap between the guide and channel wall, may be selected to produce the desired amount of refraction and perceived glow of the channel by the user/diner. Such optical technology is known by those skilled in the art.

[105] FIG. 7A is a cross section of a light guide **700**. Such a guide may be an optical fiber, electroluminescent light source, optical tube, or any other appropriate light guiding element. FIG. 7B is a light guide **701** with cladding **702** to help prevent light from escaping. In FIG. 7B, a portion **703** of the cladding has been removed to allow a desired amount of light to escape from a desire section of the guide. FIG. 7C is a cross section of a light guide **704** where a portion **705** of the light guide has been modified to allow light to escape. A light guide may be modified using a variety of techniques, such as by etching, scoring, and the like.

[106] FIG. 8A is a side view of a light guide **800**. There is a light source **801** at one end and an optional reflective surface **802** at the other end. The light guide may be an optical fiber, electroluminescent light source, light tube or any other suitable light guiding element where light can be allowed to escape and pass through a translucent material for the user/diner to see. When the light guide is an optical fiber, theoretically,

light **803** that does not exceed a critical angle of incidence with the surface will be internally reflected, whereas light **804** that does exceed the critical angle of incidence will be refracted according to Snell's Law. Refracted light that passes through a translucent material may be viewed by the user/diner. The light guide may also be a light tube with openings permitting the light to escape in desired locations and amounts.

[107] Light sources are commonly light emitting diodes (LEDs) and/or laser diodes, but can be any of a variety of light producing devices, including incandescent lights, electroluminescent elements, fluorescent lights, glowing coils, and the like.

[108] FIG. 8B is a simple electrical circuit schematic for driving an LED. When the switch **805** is closed, electrical current **806** from the power source **807** passes through the wires **808**, through the resistor **809** and through the LED **810**, causing it to give off light.

[109] FIG. 8C shows an integrated circuit block **811** with a digital processor and memory and powered by a power source **812**. When the processor detects that the switch **813** is closed, it runs a program in its memory that determines which of the light sources **814** to energize and when. The technology for creating such a circuit is known to those skilled in the art and actual circuit implementations may vary considerably. The invention is not limited to an embodiment using the simple exemplary circuits provided here.

[110] FIGs. 9A-9D are active foodware system dining plates with varying visual display designs and technologies. Auditory output may be combined with any of these visual displays. FIGs. 9A and 9B are dining plates **900** and **901**, respectively, using light guides to create desired patterns and designs. Each of the lines **902** and **903** may be illuminated using optical guides, including but not limited to "lossy" optical fibers (i.e., which allow some light to escape to be viewed by the user/diner), electroluminescent light sources, light channels, light tubes and the like.

[111] FIG. 9C is a dining plate **904** comprising one or a multiplicity of LEDs **905** which may be illuminated in a desired sequence or in response to user/diner or food activity. The LEDs may be any of a variety of technologies and desirable colors, including but not limited to, red, yellow, blue, green, and the like. A matrix of colored LEDs may be used in combination to produce a composite image where one or more LEDs represent a single picture element (pixel).

[112] FIG. 9D is an active foodware system dining plate **906** comprising an active LCD screen capable of displaying a large number of different images. The LCD screen may have a uniform matrix of pixels where any arbitrary image or alphanumeric character may be displayed. Alternatively, to reduce cost and complexity, the LCD screen may include only portions of a limited number of images or alphanumeric characters. By

sequencing the LCD through a pattern of pixels or preset image portions, the user/diner may perceive an object or alphanumeric character to move. Moving or non-moving objects visually displayed by the active foodware system may be associated with aural stimulation from the active foodware system to provide a multimedia experience.

[113] The user/diner may load pictures or movies onto the active foodware system dining plate for display, such as wedding pictures, baby pictures, pictures or movies from a trip and the like. Entertaining and/or other desired images, artwork, videos, graphics, sounds, haptic sensations, "screen savers" and the like, may be downloaded from websites for display on a member of an active foodware system, such as a dining plate. Digital images of the tablecloth or other desirable colors or patterns may be loaded and displayed on the dining plate so the dining plate matches the tablecloth or a dinner party theme. Slideshows may be displayed on the active foodware system plate. Movies may be displayed on the active foodware system dining plate. The dining plate may be associated with a television tuner, TV cable, satellite dish, and the like, such that the user/diner may watch television on their dining plate. The active foodware system dining plate may serve as a computer monitor. Sounds may be recorded and played back through a speaker or vibrating portion associated with the dining plate. For example, the dining plate could display stationary or moving text saying, "Happy Birthday, Jill!" while simultaneously audibly displaying the "Happy Birthday" song through the speaker. At the end of the song, an image or movie of Jill as a baby may be displayed on the dining plate.

[114] FIGs. 10A-10C are three frontal views of an active foodware system liquid container, in this case an active foodware cup **1000** comprising a visual display **1001**, auditory display **1002**, user/diner interaction controls **1003**, processor **1004** and power source **1005**. The three views show an image perceived by the user/diner to move from the right to left by successively changing the displayed position of the image. The visual display uses any technology capable of displaying an image, including but not limited to LCD technology, LED technology, plasma screen technology, electroluminescent technology, and the like. The cup may have user controls for turning on the visual display, interacting with the image, playing a game, communicating with others, or otherwise controlling the operation of the cup. The cup may provide auditory feedback to the user/diner via the auditory display **1002**. The auditory feedback may be sounds associated with the image and the sounds need not be associated with the image. The auditory feedback may contain speech, music, beeps and other noises and sounds. The auditory feedback may provide advertisements and entertainment. The cup may accept auditory input from the user/diner via a microphone (not shown). FIG. 10D is a plan view of the active foodware system cup **1000** of FIGs. 10A-10C.

[115] FIG. 11 is a side cross-sectional view of an active foodware system dining plate

1100 comprising a variety of visual displays, including an LCD screen **1101**, a light guide **1102** with associated light-guide-illuminating LED **1103** and a separate LED **1104**. Although one of each of three visual display components is shown in FIG. 11, an active foodware system may comprise only one of these visual display components, or it may comprise more than one of such visual displays, and/or an active foodware system may comprise other visual displays not shown in this figure, such as a plasma display, a fluorescent display, and the like. The active foodware system dining plate of FIG. 11 also comprises a switch **1105**, which may be used to turn on/off the visual display(s), a power source **1106** and a processor **1107**. An active foodware system may comprise multiple switches and controls to control a variety of modes and functions of the active foodware system dining plate. The power source may comprise a battery, rechargeable battery, A/C to D/C power supply, transformer and the like. The processor may be a central processing unit (CPU), microcontroller, microprocessor, digital signal processor (DSP), and the like, and may have associated with it computer memory, such as RAM and ROM, and have a computer program in the memory. The processor may also be a Programmable Logic Array (PLA) or Programmable Array Logic (PAL). The processor has connections to the visual displays, switch and power source, where the processor is able to cause the visual displays to be illuminated in a desired manner and/or display a desired image. Interconnections between the components of FIG. 11 and the specific electrical circuitry are known by those skilled in the art, and so they have been omitted from the figure for clarity.

[116] FIGs. 12A-12C are side cross-sectional views of an active foodware system comprising an dining plate **1200** in functional relation to a non-dining underplate **1201**, where the dining plate and non-dining underplate are not permanently affixed to each other. Such a configuration of the dining plate **1200** and non-dining underplate **1201** finds use when it is desired to submerge the dining plate in water or place it in a dishwasher, which, depending on design choices, might not be advisable for the non-dining underplate. For instance, the non-dining underplate might have a cord and wall plug **1202** for 110V or other high voltage alternating current electrical power. The non-dining plate might also have a speaker **1203** (such as a voice-coil speaker), microphone **1204**, a switch **1205**, a processor **1206** and other components and compartments **1207** that might not fair well if submerged in water.

[117] The dining plate of FIGs. 12A and 12B has at least one sensory element capable of providing feedback or sensing a state. Such a sensory element includes, but is not limited to an LED **1213**, and LCD screen **1214**, a light guide **1215**, an electroluminescent element, a plasma screen, a fluorescent light, an illuminating fluid, a haptic feedback actuator **1216** (such as a vibrotactile feedback actuator (e.g., an eccentric mass actuator), a tactile feedback actuator, a force-feedback actuator, and the like), a

pressure sensor **1208**, a temperature sensor **1209**, a tilt sensor, a proximity sensor, a speaker **1203**, a microphone **1204**, an electromagnetic sensor, a motion sensor a position sensor, a velocity sensor, an acceleration sensor, a heart rate sensor, a blood pressure sensor, a calorimeter, and the like.

[118] As depicted in FIG. 12A, a pressure sensor **1208** may comprise a strain gage placed under the surface of the dining plate and electrically connected to a Wheatstone bridge electrical circuit (not shown, but known to those skilled in the art). A temperature sensor **1209** may comprise a thermistor (electrical circuit not shown, but known to those skilled in the art). A proximity sensor may comprise an infrared emitter-detector pair of LEDs **1210** (electrical circuit not shown, but known to those skilled in the art). These sensors communicate their signals to the processor (memory and inter-connections not shown, but known to those skilled in the art) via the connector **1211** on the dining plate mating with connector **1212** on the non-dining underplate. In conjunction with or independent of the temperature sensor **1209** one may have a heating element **1217** that serves to heat the food and, if desired, maintain the food at a desired temperature, where the temperature sensor **1209** may be used to control the heating element **1217**.

[119] The dining plate of FIG. 12B may communicate information with the non-dining underplate of FIG. 12C via a wired or wireless connection. Wired connections include, but are not limited to comprising metal contacts which touch mating metal contacts. Wireless connections include, but are not limited to electromagnetic communication, light-based communication, acoustic communication, and the like. Electromagnetic communication may be used to communicate data as well as power (typically via a transformer). Light-based communication may include optoisolators.

[120] FIG. 13 is a block diagram of a processor **1300**, such as a microprocessor, micro-controller, digital signal processor (DSP), and the like. The processor may have associated with it computer memory, such as RAM and ROM, and have a computer program in the memory. The processor may also be a Programmable Logic Array (PLA) or Programmable Array Logic (PAL). The processor is communicating with one or more sensing and display devices. Such devices include, but are not limited to visual indicators including LEDs **1301**, which may have associated control hardware and software **1302**, LCDs **1303**, which may have associated control hardware and software **1304**, plasma displays, electroluminescent light sources and fluorescent displays, CRTs, speakers **1305**, including voice-coil and piezo-electric speakers, which may have associated control hardware and software **1306**, microphones **1307**, motors **1308** which may have associated control hardware and software **1309**, force- and tactile-feedback displays, motion sensors, temperature sensors **1310**, pressure sensors **1311**, contact sensors, moisture sensors, humidity sensors, tilt sensors, wireless ports, USB

communication ports **1312**, serial ports, parallel ports, Fire-wire ports, CD drives **1313**, memory card ports, on/off and other control switches **1314**, antennae **1315**, power sources **1316**, and the like. Any of the sensing and display devices may have their own dedicated control hardware and software even though not explicitly shown in the figure.

[121] Not all possible sensing and stimulating components or devices according to the subject invention are shown in FIG. 13. Only a few exemplary sensing and display devices are depicted, and the details of the interconnections and interface hardware and software are known to those skilled in the art. There is a multitude of sensing and display technologies capable of providing the desired results, and not all such specific technologies are listed. For example, when a motor **1308** is listed, it may be an electrical motor, pneumatic motor, piezo-electric motor, hydraulic motor, or any other technology for producing a linear or angular displacement based on a control signal. When a temperature sensor is listed, it may be a thermistor, thermocouple, and the like, or any other device for detecting temperature and converting it into a usable signal. When a power source is listed, it may be a battery, A/C adapter, transformer, or any other device for storing, converting or generating electrical power.

[122] FIG. 14 is a plan view of a dining utensil **1400** which includes active sensing and feedback. More specifically, the dining utensil is a fork, where light guides **1401** extend into the tines **1402** from LEDs **1403** positioned in the handle **1404**. There is also an on/off switch **1405**, power source **1406** and circuitry **1407** positioned in the handle **1404**. The LEDs **1403** are connected to the circuitry **1407** via interconnections **1408**, the switch **1405** is connected to the circuitry **1407** via interconnections **1409** and the power source **1406** is connected to the circuitry **1407** via interconnections **1410**. The details of the circuitry **1407** are known to those skilled in the art. The switch **1405** may be any contact or proximity sensor, and the power source **1406** may be any device for supplying power, including but not limited to a battery.

[123] FIGs. 15A-15C are plan views of three different examples of active dining utensils. In FIG. 15A, a fork **1500** has light guides **1501** emanating from light sources **1502** and where the light guides direct light emission for illuminating desired portions of the fork, such as each of three tines **1503**. A power source, on/off switch, control electronics and interconnections are not shown for clarity and are known to those skilled in the art. Similarly, FIG. 15B is a spoon **1504** with light guides **1505** emanating from light sources **1506** and where the light guides direct light emission for illuminating desired portions of the spoon, such as a pattern in the end of the spoon **1507**. Again, electrical details are omitted for clarity and are known to those skilled in the art. FIG. 15C is a knife **1508** with light guide **1509** emanating from a light source **1510** and where the light guide directs light emission for illuminating desired portions

of the knife such as the blade **1511** of the knife. Again, electrical details are omitted for clarity and are known to those skilled in the art.

[124] FIG. 15D is a drinking container **1512** with multiple active components. In this embodiment, four different light guide examples are shown, including a star **1513**, a crescent moon **1514**, a double wavy line **1515** and a spiral **1516**. In this figure, the spiral **1516** is shown on an optional straw associated with the drinking container. Each light guide is associated with a light source and each light guide directs light emission for illuminating desired portions of the container. The drinking container as shown also comprises a light source **1517** without light guide. The light source may be an LED. Again, electrical details are omitted for clarity and are known to those skilled in the art. In each of the FIGs. 15A-15D, the light sources may be energized in a desired spatial or temporal pattern and may be energized based on a signal from any of a variety of sensors (not shown) and including but not limited to a contact sensor, tilt sensor, moisture sensor, temperature sensor, auditory sensor, radio frequency sensor, electromagnetic sensor, optical sensor, and the like.

[125] FIGs. 16A and 16C are a side view and plan view, respectively, of a drinking container **1600** with active components. In this embodiment, the container wall **1601** is filled with two liquids such as water with oil, where the specific gravity of the oil is greater than that of the water. In the base **1602** of the container are a lighting source **1603** and a heating source. In this embodiment, the lighting source is an incandescent light and also serves as the heating source. There may also be an on/off switch **1604**, power source **1605**, electrical control circuitry **1606** and interconnections **1607**. In this embodiment, the electrical control circuitry is an electrical resistor and the power source is a battery. Such electronics may also be distributed throughout the container wall and need not be concentrated only in the base. The details of such electrical circuitry are known to those skilled in the art. Since oil and water don't mix, the oil will exist in amorphous shapes **1608** throughout the water **1609**. Additionally, since the oil is heavier than water the oil shapes will sink to the bottom of the water near the base of the container. There the heating source will heat the oil, and surrounding water, causing the oil to rise to nearer the top of the container wall while the cooler oil shapes and the water nearer the top sink toward the bottom. Over time, some oil shapes will separate into multiple pieces, while other oil shapes will recombine. Additionally, due to the varying optical properties of the oil and water, the light source in the base will create interesting and entertaining optical patterns as the oil shapes move.

[126] The specific type of oil and/or the particular properties of the water may be selected to provide desired physical and optical properties. For instance, different oils may exhibit desirable fluorescing properties; they may have different separating and recombining properties and may sink and rise at different rates.

[127] FIG. 16B is an dining utensil comprising similar oil-water technology. In this embodiment, a knife handle **1610** has oil **1611** and water **1612** in it, and also comprises a lighting and heating source, along with the associated electronics, which are not shown in this embodiment and are known to those skilled in the art.

[128] FIGs. 16A-16C are simple examples of components of an active foodware system, such as a drinking container and an dining utensil, which possess active components. The particular exemplifications shown in these figures are illustrative of these types of components and is not intended to be limiting.

[129] Active foodware systems may also comprise electrostatic technology. For example, a component of an active foodware system may be partially hollow and filled with a gas containing ions and an energized electrode such that where the user/diner contacts the external surface of the component of the active foodware system an electrical arc will occur, looking like a miniature lightening bolt from the electrode to the point of user/diner contact. Such technology is known to those skilled in the art and the details are not presented explicitly but are incorporated herein by reference.

[130] An active foodware system is desirable in many applications, including entertainment and promotion at home and in a restaurant. For example, fast food chains may provide an active foodware system as a promotional item. Active foodware systems with lighting sources will make it fun to eat in an otherwise dark environment. Lighting sources may include black lights, and oils may include associated fluorescence matched to the black lights.

[131] FIG. 17A is a frontal view of a liquid container **1700** with an active component. In this particular embodiment a beer bottle has a label **1701** with light guide **1702**, light source **1703**, function control switch **1704** and electrical circuitry **1705** which contains an electrical power source. As is the case with other light guides, the light guide guides light from the light source to one or more locations where the light is emitted for the user/diner to see. The light may be emitted over the entire length of the light guide, over a portion of the light guide and/or at one or more discrete points. In the embodiment of FIG. 17A an indicia of label **1701**, such as the name of a beer, is illuminated, producing a similar visual effect to a miniature neon street sign. Light sources producing different colors may be used.

[132] FIG. 17B is a cutaway top view of FIG. 17A showing the light guide **1702** and associated components affixed to the label **1701** which is affixed to the front of the liquid container.

[133] FIG. 17C is a cutaway view similar to FIG. 17B, but where the lighting source **1706** and light guide **1707** are positioned inside the wall **1708** of the liquid container. The light from the lighting source may be guided in a variety of manners, including via a light fiber, electroluminescent light source, a light tube, a light channel which may

contain air, gas, or another fluid, which may fluoresce, and the like. The associated electronics are not shown but are known to those skilled in the art.

[134] FIG. 17D is a cutaway view of FIG. 17E where at least a portion of the light guide **1709** is located inside the liquid **1710** of the liquid container **1711**. The light from the lighting source **1712** may be guided in a variety of manners, including via a light fiber, a light tube, and the like. With such a location, the light guide **1709** can illuminate the liquid **1710** being contained. The light source **1712** may be located in a variety of convenient places, including inside the wall of the container, in the liquid inside the container, or in any location where light from the light source can enter the light guide. The associated electronics are not shown but are known to those skilled in the art.

[135] FIG. 17E is a side cross-section view of the liquid container **1711** of FIG. 17D, where at least a portion of the light guide **1709** is positioned inside the liquid **1710** in the liquid container. The associated electronics are not shown but are known to those skilled in the art.

[136] FIG. 18A is a frontal view of a liquid container **1800** with an active label. The label **1801** may include a variety of display elements such as pictures or the segments of a 7-segment display **1802**. The active elements of the label may include LCD or LED technology. The label may have a function switch **1803** which may be used to turn on/off the display and select the desired images to display. The associated electronics, including the power source, are not shown for clarity but are known to those skilled in the art.

[137] FIG. 18B is a frontal view of a liquid container **1804** with a label with a matrix of individually controllable picture elements (pixels) capable of producing a large number of desirable images. The label **1805** may be a separate component associated with the liquid container or the label may be a region of the container itself comprising one or more active components. Similar to a television screen, the pixels may produce text **1806** or other images **1807** which may appear to move given appropriate pixel sequencing. The label of this specific embodiment also comprises an auditory output device **1808**. Such an auditory output device may be a piezo-electric speaker, voice-coil speaker, or any other suitable device for producing sound. The label as shown also comprises a function control switch **1809**; although, multiple function control switches may be used. The function control switch may turn on/off the visual display, may turn on/off the auditory output and may select from one or more visual or auditory displays.

[138] FIG. 18C is an electrical block diagram comprising a processor **1810**, function control switch **1811**, power source **1812**, audio amplifier **1813**, audio output device **1814** and visual display with driver **1815**. The electrical block diagram also includes one or more optional sensors **1816** and optional wireless communication capabilities **1817**. The label may also include a microphone (not shown) to detect spoken user/

diner input. Sensors include, but are not limited to, contact sensors, motion sensors, temperature sensors, positions sensors, humidity sensors, light sensors, auditory sensors, liquid level sensors, sensors to detect whether the container is open, and the like. Details of the electrical block diagram and how to physically implement it are known to those skilled in the art.

[139] With the embodiment of FIG. 18B a user/diner may see and/or hear moving advertisements on the label. Advertisements may be associated with signals from one or more sensors. A vendor can send updated advertisements that may be associated with signals from one or more sensors. For example, if a sensor is a global positioning system (GPS), a liquid container vendor may send an advertisement specific to the user/diner's city or restaurant. A restaurant may send an advertisement to a user/diner inside their restaurant, and the user/diner may respond by activating a function control switch on the liquid container or by speaking into the microphone. Using sensors, information may be collected about the user/diner.

[140] Many of the embodiments depicted thus far have included a liquid container but are meant to exemplify how active components may be associated with a broad class of active foodware systems and not limited to liquid containers.

[141] FIG. 19A is a side cross-sectional view of an active dining plate **1900** comprising a stationary dining surface **1901** and a movable inner portion **1902**. In this embodiment, the movable inner portion is a rotating disk being rotated by a flat "pancake" motor **1903**. A plan view of the rotating disk is shown in FIG. 19B. The stationary dining surface may comprise one or more active elements, including but not limited to LEDs **1904** and light guides. The stationary dining surface may also comprise a portion **1905** which is translucent such that light coming from the movable inner portion can be seen by the user/diner. The dining surface may have one or more elements for diffusing, modifying or transmitting light coming from the movable inner portion. Such elements may include light guides **1906**, components **1907** with different shapes and indices of refraction, translucent films, and the like. The movable inner portion **1902** may comprise one or more active components, including but not limited to light sources such as LEDs **1908**, light guides with associated light sources **1909**, LED or LCD panels **1910**, reflective surfaces **1911**, electroluminescent elements, and the like. Text and images may be displayed and may provide advertisements. Kaleidoscopic images may be produced. Details of the electrical circuitry have been omitted for clarity but are known to those skilled in the art. As with other embodiments, the active technologies shown in the embodiment here with a dining plate may also be applied to other active foodware system components, including cups, utensils and the like.

[142] FIG. 20A is a side cross-section view of a stationary dining surface **2000** with a first movable inner portion **2001**. Although the active sensing and feedback features are not

redrawn in FIG. 20A for clarity, the stationary dining surface **2000** and first movable inner portion **2001** of the embodiment of FIG. 20A may have similar active sensing and feedback features to the stationary dining surface **1901** and movable inner portion **1902**, respectively, of FIGs. 19A and 19B; however, rather than the first movable inner portion **2001** being directly moved by a motor, the first movable inner portion **2001** of the embodiment of FIG. 20A is magnetically coupled via magnets to a second movable portion **2002** which is moved by a motor **2003** and which may be positioned below the first movable portion **2001**. There are various ways to magnetically couple the first movable portion with the second movable portion such that movement of the second movable portion causes the first movable portion to move. For example, the second movable portion may have magnets **2004**, which may be permanent magnets or electromagnets, which are positioned in functional relation to iron-based objects **2005** in the first movable portion, such that the magnetic fields **2006** provided by the magnets of the second movable portion pass through the stationary dining surface **2000** and provide a magnetic attraction to the iron-based objects **2005** in the first movable portion **2001**. Accordingly, as the first movable portion moves, the second movable portion similarly moves. Alternatively, the first movable portion may comprise magnets, either permanent magnets or electromagnets, which magnetically couple to iron-based objects in the motorized second movable portion.

[143] FIGs. 21A-21D are plan views of an embodiment of an active dining plate **2100** where a refreshable moving image, depicted as a spider **2101**, may be viewed by the user/diner. The image may be generated by a variety of technologies including an LCD screen in functional relation to the dining plate. For instance, the LCD screen may be affixed to the dining plate, or it may be positioned beneath the top surface and viewed through optics in the dining plate. The dining plate may comprise optics, including but not limited to optics which enlarge the image, decrease the size of the image, distort the image, redirect all or a portion of the light from the image or allow the image to be viewed unaltered. FIGs. 21A-21D show images of a moving spider at different times. In FIG. 21A, the spider **2101** is at the top of the active dining plate **2100**; in FIG. 21B, the spider **2101** has crawled counterclockwise around the perimeter of the active dining plate **2100**; in FIG. 21C, the spider **2101** has crawled even further counterclockwise; and in FIG 21D, the spider **2101** has descended down a web **2102**.

[144] FIG. 22 is a plan view of an active dining plate **2200** where information is displayed. In this embodiment, the information is displayed around the periphery of the dining plate; although, it could be displayed at any convenient location on the dining plate. The information may include, but is not limited to, text, graphics, images, advertisements **2201**, news flashes, stock quotes **2202**, time **2203**, temperature, weather, sports scores, song information which may be accompanied by music coming from a

speaker associated with the plate, appointment notification, a phone number, a greeting, and the like. The information that is displayed on the active foodware system dining plate may be pre-programmed into memory associated with the dining plate, it may be received in real time and/or it may be provided to the dining plate via wired or wireless technology, external media, and the like.

[145] FIG. 23A is a plan view of an active foodware system dining plate **2300**. This embodiment has a movable character **2301** for communicating with the user/diner. The plate also comprises optional boundaries **2302** and partition labels **2303** associated with the contents **2304** of the partitions. The boundaries may be physical or visually displayed boarders. The character may communicate with the user/diner, for example a child, where the character entertains, encourages and/or coaches, and the like, the user/diner while eating. The character may be a computer generated animation, recorded video, and the like. Visual, auditory and haptic feedback may be associated with the character. In one scenario, the character may use auditory feedback to tell a young user/diner how good beans taste and that all his friends finish their beans, so the young user/diner is encouraged to eat a food he might otherwise not.

[146] FIG. 23B is a plan view of a computing device **2305** which is able to communicate with the active foodware system dining plate **2300**, or in general, with any active foodware system component. In this embodiment, the computing device is handheld and has a touch screen **2306**, including a graphical display, with optional stylus **2307** and keyboard **2308**. The computing device may communicate with the active foodware system dining plate wirelessly or via wires. The details of such wired and/or wireless communication is known by those skilled in the art. One application is that a parent may use the computing device to communicate with a child user/diner via their active foodware system dining plate. For example, using an optional stylus **2307**, the parent may touch a part of a touch screen **2306** on the computing device corresponding to a particular location or food on the child's active foodware system dining plate and which may invoke a desired response from the moveable character **2301** or may invoke some other feedback to the child. For example, the parent may touch a partition **2309** on their touch screen labeled "BEANS," causing the character animated on the dining plate to appear to jump over the partition on the dining plate from the "MEAT" to the "BEANS," and using auditory or visual feedback ask the child if he would please eat some beans. The dining plate may have contact or proximity sensing (not shown, but known to those skilled in the art) capable of detecting that the child is using a utensil in proximity to the beans such that the character then gives positively reinforcing feedback to the child. There may be a wide variety of commands the parent can invoke from the computing device that produce desired feedback to the child user/diner via his active foodware system.

[147] FIG. 24A is a perspective view of a dining plate **2400** with food **2401** on it and with a visual display **2402**, such as an LCD or plasma display in close functional relationship to the dining plate. In this embodiment, the visual display **2402** is attached to the dining plate **2400** such that there is at least a portion of the visual display **2402** which is not intended to be covered by food **2401**. The visual display **2402** may be attached to the dining plate **2400** by a hinge **2403** such that the angle of the visual display may be changed by the user/diner. Such optional hinge includes, but is not limited to two-piece hinges with a mating pin, living hinges, flexible joints, and the like. The visual display **2402** may be able to be tilted all the way back so it lies in the same plane as the dining plate **2400**. The visual display **2402** may also be able to be tilted all the way forward so it covers the dining plate **2400**. The control and communication circuitry of the visual display is known to those of ordinary skill in the art and may be located at any convenient location, including behind the visual display screen or under the dining plate. The circuitry is not shown here for clarity. One advantage of this embodiment is that information **2404** of the visual display **2402** will not be obscured by food **2401**, yet the visual display **2402** is still closely associated with the dining plate **2400**. Auditory sensory stimulating components, sensing components and/or haptic components may also be associated with the dining plate of this embodiment.

[148] FIG. 24B is a perspective view of a food container **2405** with food **2406** in it and with a visual display **2407**, such as an LCD, electroluminescent display, LED display or plasma display in close functional relationship to the container. A typical use for this embodiment is found with fast food restaurants, such as where children's meals, chicken pieces and the like are distributed. In this embodiment, the visual display **2407** is associated with the lid **2410** of the food container such that there is at least a portion of the visual display **2407** which is not intended to be covered by the food **2406**. The visual display **2407** may be affixed to the lid **2410** of the food container, which may be flexibly attached to the bottom portion **2411** of the food container by a hinge **2408** such that the angle of the visual display may be changed by the user/diner. Such optional hinge **2408** includes, but is not limited to two-piece hinges with a mating pin, living hinges, flexible joints, and the like. The food container lid with associated visual display may be able to be tilted all the way back so the visual display lies in the same plane as the bottom surface of the bottom portion of the food container. The food container lid with associated visual display may also be able to be tilted all the way forward so the lid covers the bottom portion of the food container. The control and communication circuitry of the visual display is known to those of ordinary skill in the art and may be located at any convenient location on or about the food container, including in the lid behind the associated visual display screen or under the bottom

portion of the food container. The circuitry is not shown here for clarity. One advantage of this embodiment is that information **2409** of the visual display **2407** will not be obscured by food **2406**, yet the visual display **2407** is still closely associated with the food container **2405**. Auditory sensory stimulating components, sensing components and/or haptic components may also be associated with the food container of this embodiment.

[149] FIG. 25 is a perspective view of one embodiment of an active foodware system **2520** comprising a structure **2518**. In this embodiment there are three food dishes **2500** , **2501** and **2502**, respectively, each dish being on a food-sensing platform (not shown). A first video **2519** of a cartoon comprising a monkey **2505** and elephant **2504** is being displayed on the screen 2503. The example is demonstrating the case where the food **2506** from at least one food dish **2500** is not being eaten fast enough such that lights **2507** associated with the food dish **2500** are illuminated, the first video **2519** is paused and a second video **2508** predominates where a character **2509** of the second video **2508** encourages the diner (in this case, "Billy") to please eat more of the food **2506** in a particular food dish **2500**.

[150] Other active foodware components of the active foodware system include a fork **2510** with lighted tines **2511** and a drinking cup **2512** with lighted designs **2513** and an LED **2514**. For further description of these and other foodware components refer to FIGs. 14-16. Operation of the active foodware system **2520** may be controlled by other devices. Controller **2515**, as depicted, allows a person to direct commands to the diner to eat from a specified dish by pressing any of the buttons **2516**, **2521** and **2522**. The controller **2515** sends a wireless signal to controlling circuitry (not shown) in the structure **2518**. The wireless signal causes the first video **2519** to pause and launches the second video **2508**, where the second video **2508** instructs the diner to eat more of the food **2506** in the dish **2500**. The signal also causes lights **2507** to be illuminated. The signal may be transmitted to the circuitry using infrared or RF technology, and the like. Alternately, the signal may be sent using a wired connection.

[151] FIG. 26 is a perspective view of an active foodware system **2607**. In a first useful embodiment, the structure **2600** includes an integral processor (not visible) and a display **2602**; in a second useful embodiment, the structure **2600** is capable of receiving a processor and display, such as may be provided by a laptop computer **2601** with display **2603** and keyboard **2605**. In the second embodiment typically at least a portion **2604** of the structure **2600** covers at least a portion **2608** of the laptop computer **2601**, and protects the laptop computer **2601** and its keyboard **2605** from food. Also in the second embodiment, the screen **2602** of the structure **2600** is translucent and protects the laptop display **2603** from food. In both the first and second embodiments, the structure **2600** includes at least one food dish where at least one

characteristic or attribute of food (not shown) put on the dining surface of the dish is sensed. Typical food characteristics that are sensed include weight and center of mass. In the figure, three dishes **2606** are depicted. Regardless of whether the structure **2600** includes an integral display or receives a display, the structure **2600** may include stimulating components, such as visual, auditory or haptic stimulating components, none of which are shown in FIG. 26. Typical visual stimulating components include LEDs and electroluminescent wire. The sensing circuitry is not shown and typically is connected either by wire or wirelessly to the circuitry associated with the processor. A computer program controlling the processor may cause an action in response to the characteristic of the food that is sensed. For example, a video or music file being displayed by a stimulating component may be paused if the food is not being consumed at a desired rate as determined by a sensor sensing the weight of the food over time.

[152] FIGs. 27A and 27B are perspective views of a portion of an active foodware system structure **2700**. The structure **2700** is capable of receiving a processor and display, such as provided by the laptop computer **2601** of FIG. 26. The structure **2700** may include any of a variety of useful stimulation and sensing components, none of which are shown in FIGs. 27A and 27B. Rather, FIGs. 27A and 27B are simplified here to exemplify key concepts of a useful hinge structure, such as may be employed by the second embodiment of FIG. 26. When the hinge structure of FIGs. 27A and 27B is employed by the second embodiment of FIG. 26, the view of FIGs. 27A and 27B is looking up from the lower right of the structure **2600** of FIG. 26. The hinge structure permits the structure **2700** to open into a first configuration (FIG. 27A), where it may cover all or a portion of a laptop computer **2601** to protect it from food. The hinge structure also permits the structure **2700** to close in a second configuration (FIG. 27B), where it becomes more compact for storage and also serves to protect sensing and circuitry components.

[153] In FIGs. 27A and 27B the active foodware structure **2700** has a display structure **2701** for supporting a translucent surface **2703** in proximity to the display **2603** of the laptop **2601** to protect the display **2603** from food. The display structure **2701** may rest on, contact or register to the frame surrounding the display **2603**. The display structure **2701** includes links **2705** and **2708** and, via hinge pins **2707** and **2710**, respectively, is positioned relative to a structure surface **2704** which includes mating links **2706** and **2709**, respectively. The edge **2702** between the structure surface **2704** and mating link **2709** is identified to help clarify the relation between the configurations of FIGs. 27A and 27B.

[154] FIG. 28 is a close-up perspective view of a portion of an active foodware system **2800** including a structure with a surface **2801**, a food-sensing surface **2802** and a

dining dish **2803**. Sometimes, the food-sensing surface **2802** with its electrical circuitry is referred to as an active component; whereas, the dining dish **2803** when it contains no electronics is referred to as a passive component. The food-sensing surface **2802** may lie below, lie at the same level or lie above the structure surface **2801**. The dining dish **2803**, which may be microwavable, refrigerator safe, freezer safe, oven safe, etc., is typically filled with food and then placed on the food-sensing surface. The circuitry for the food-sensing surface is not shown. The portion of an active foodware system **2800** may include any of a variety of useful and desirable stimulation and sensing components, and may represent the front portion of the active foodware systems of FIGs. 25-27. The cross-section A-A through the portion of the active foodware system **2800** of FIG. 28 that includes the food-sensing surface **2802** is further described in FIGs. 29A-29D. Each embodiment of FIGs. 29A-29D is sometimes referred to as a type of active subsystem.

[155] FIG. 29A is a first embodiment of cross section A-A through the portion of the active foodware system **2800** of FIG. 28 that includes the food-sensing surface **2802**. The food-sensing surface **2907** and the surface **2903** of FIG. 29A correspond to the food-sensing surface **2802** and the surface **2801**, respectively, of FIG. 28. In FIG. 29A a load cell **2900** is used to measure the "combined weight" of the food-sensing surface **2907**, a food dish **2803** resting on the food-sensing surface **2918**, and any food put on the dining surface of the food dish. In this first embodiment, the active foodware system **2800** employing the load cell **2900** senses in real time changes in the weight of food present on the dining surface of the food dish and infers how quickly food is being eaten, and the active foodware system **2800** causes a corresponding stimulation to be presented to the diner and/or inform another person.

[156] In FIG. 29A, the end **2901** of the load cell **2900** is spaced away from the surface **2903** by a spacer **2902** and affixed to the surface **2903** by a fastener **2904**. The end **2905** of the load cell **2900** is affixed to the food-sensing surface **2907** by a fastener **2908** and spaced away from the food-sensing surface **2907** by a spacer **2906**. Food spilled from the food dish **2803** is prevented from reaching the load cell **2900** and its associated electrical circuitry (not shown) by a seal **2909**. The seal **2909** is typically a flexible material, such as rubber or plastic, that can be cleaned and sanitized and can provide a water-tight seal between the food-sensing surface **2907** and the surface **2903**.

[157] The load cell **2900** has a flexible section **2910** that helps direct bending in a known manner. The flexible section **2910** of the load cell **2900** may be created by removing material from the load cell, such as by drilling, sanding, machining, milling, etc. The flexible section **2910** may also be created by an appropriate mold in the case where the load cell is molded or cast. The flexible section **2910** of the load cell **2900** causes a "double bending" of the load cell **2900** when a load is applied to the end **2905** relative

to the end **2901**, resulting in a deflection of the end **2905** relative to the end **2901**. The load cell **2900** has four strain gages **2911**, **2912**, **2913** and **2914** mounted near the flexible section **2910** to measure the amount of double bending when the end **2905** deflects relative to the end **2901** due to the combined weight. Wires from the strain gages are omitted from the drawing for clarity. As food is added to the dining surface of the dish **2803** resting on the food-sensing surface **2907**, the end **2905** deflects further relative to the end **2901**, and the strain gages **2911** and **2914** increase their strain while the strain gages **2912** and **2913** decrease their strain. Similarly, as food is removed from the dining surface of the dish **2803** resting on the food-sensing surface **2907**, the deflection of the end **2905** relative to the end **2901** decreases, and the strain gages **2911** and **2914** decrease their strain while the strain gages **2912** and **2913** increase their strain. An electrical circuit which converts signals from the strain gages into an electrical signal related to the combined weight is provided in FIG. 30.

[158] One useful embodiment of the load cell **2900** is made from an aluminum alloy, where the depth dimension (into the page) and height dimension typically range from ¼" to 1", and the length dimension typically ranges from 1" to 6". Transducer Techniques® of Temecula, CA manufactures such load cells, including their EBB Series. Another type of load cell which may be employed to sense weight of food on the food-sensing surface is a "thin beam" load cell, which may be made from a material such as 301 SS berryllium copper with a thinner height dimension that typically ranges from 0.002" to 0.1". Again, Transducer Techniques manufactures such thin beam load cells, including their TBS series.

[159] FIG. 29B is a second embodiment of cross section A-A through the portion of the active foodware system **2800** of FIG. 28 that includes the food-sensing surface **2802**. The food-sensing surface **2918** and the surface **2920** of FIG. 29B correspond to the food-sensing surface **2802** and the surface **2801**, respectively, of FIG. 28. In FIG. 29B a compression load cell **2915** is used to measure the "combined weight" of the food-sensing surface **2918**, a food dish **2803** resting on the food-sensing surface **2918**, and any food put on the dining surface of the food dish. In this second embodiment, the active foodware system **2800** employing the compression load cell **2915** senses in real time changes in the weight of food present on the dining surface of the food dish and infers how quickly food is being eaten, and the active foodware system **2800** causes a corresponding stimulation to be presented to the diner and/or inform another person.

[160] In FIG. 29B, the food-sensing surface **2918** rests on the load button **2917** of the compression load cell **2915** which rests on the recessed section **2916** of the surface **2920**. Food spilled from the food dish **2803** is prevented from reaching the compression load cell **2915** and its associated electrical circuitry (not shown) by a seal **2919**. The seal **2919** is typically a flexible material, such as rubber or plastic, that can

be cleaned and sanitized and can provide a water-tight seal between the food-sensing surface **2918** and the surface **2920**.

[161] As food is added to the dining surface of dish **2803** resting on the food-sensing surface **2918**, the load button **2917** applies pressure to the body of the compression load cell **2915**. The applied pressure is typically sensed by strain gages inside the body of the compression load cell **2915**. Electrical wires from the compression load cell **2915** are omitted from the figure for clarity. Using an electrical circuit consistent with the configuration of strain gages employed, the combined weight and changes in the amount of food present on the dining surface can be measured. A typical electrical circuit is similar to the circuit of FIG. 30. When three or more compression load cells **2915** are used, the center of mass of the food on the dining surface can also be measured.

[162] One useful embodiment of the compression load cell **2915** is made from heat treated 17-4ph stainless steel, with body diameter ranging from ¼" to 3" and height ranging from 1/8" to 2". Transducer Techniques manufactures such compression load cells, including their SLB series.

[163] FIG. 29C is a third embodiment of cross section A-A through the portion of the active foodware system **2800** of FIG. 28 that includes the food-sensing surface **2802**. The food-sensing surface **2921** and the surface **2932** of FIG. 29C correspond to the food-sensing surface **2802** and the surface **2801**, respectively, of FIG. 28. In FIG. 29C a displacement sensor **2946** is used to measure the displacement of the food-sensing surface **2921** resulting from the "combined weight" of the food-sensing surface **2921**, a food dish **2803** resting on the food-sensing surface **2921**, and any food put on the dining surface of the food dish. The displacement sensor **2946** has a movable element **2931** attached to the food-sensing surface **2921** and a stationary element **2930** attached to spring-retention member **2928**. The displacement sensor **2946** may be any convenient displacement sensor, including but not limited to (1) a linear encoder, where a movable element **2931** has encoder slots, and a stationary element **2930** contains optical sensors for sensing the encoder slots; (2) an LVDT (linear variable displacement transducer) where a movable element **2931** is the LVDT movable core, and a stationary element **2930** contains the sensing coil; (3) an optical displacement sensor and the like. In this third embodiment, the active foodware system **2800** employing the displacement sensor **2946** senses in real time changes in displacement corresponding to changes in the weight of food present on the dining surface of the food dish and infers how quickly food is being eaten, and the active foodware system **2800** causes a corresponding stimulation to be presented to the diner and/or inform another person.

[164] In FIG. 29C, the food-sensing surface **2921** rests on the compression springs **2926**

and **2927** which are attached to the surface **2920** by guide members **2922** and **2923**, respectively. The guide members **2922** and **2923** pass through guide openings **2924** and **2925**, respectively, of the food-sensing surface **2921**. The guide members **2922** and **2923** are affixed at one end to a surface **2932** and have spring-retention members **2928** and **2929** at the other end. Accordingly, springs **2926** and **2927** apply a force between the spring-retention members **2928** and **2929** and the food-sensing surface **2921**. There is at least one compression spring with associate guide member, and typically there are more than two compression springs with associated guide members. Food spilled from the food dish **2803** is prevented from reaching the compression springs **2926** and **2927**, guide members **2922** and **2923**, displacement sensor **2946** and its associated electrical circuitry (not shown) by a seal **2933** which follows the perimeter of the opening in the surface **2932** and is attached to the surface **2932** and to the food-sensing surface **2921**. The seal **2933** is typically a flexible material, such as rubber or plastic, that can be cleaned and sanitized and can provide a water-tight seal between the food-sensing surface **2921** and the surface **2932**.

[165] As food is added to the dining surface of dish **2803** resting on the food-sensing surface **2921**, the food-sensing surface **2921** compresses compression springs **2926** and **2927** against spring-retention members **2928** and **2929**, respectively, while a displacement sensor **2946** measures the displacement of food-sensing surface **2921** relative to a spring-retention member **2929**. Electrical wires from the displacement sensor **2946** are omitted from the figure for clarity. Using an electrical circuit consistent with the type of displacement sensor employed, the combined weight and changes in the amount of food present on the dining surface can be measured. A block diagram of an electrical circuit which converts signals from a linear encoder into an electrical signal related to the combined weight is provided in FIG. 31. Multiple displacement sensors may be used, and when three or more displacement sensors are used, the center of mass of the food on the dining surface can also be measured.

[166] FIG. 29D is a fourth embodiment of cross section A-A through the portion of the active foodware system **2800** of FIG. 28 that includes the food-sensing surface **2802**. The food-sensing surface **2934** and the surface **2947** of FIG. 29D correspond to the food-sensing surface **2802** and the surface **2801**, respectively, of FIG. 28. In FIG. 29D at least one displacement sensor is used to measure the displacement of the food-sensing surface **2934** resulting from the "combined weight" of the food-sensing surface **2934**, a food dish **2945** resting on the food-sensing surface **2934**, and any food put on the dining surface of the food dish. The displacement sensor employed may be any convenient displacement sensor, including but not limited to (1) a linear encoder, (2) an LVDT (linear variable displacement transducer), (3) an optical displacement sensor, and the like. The left portion of FIG. 29D shows the use of an optical displacement

sensor **2948**, while the right portion of FIG. 29D shows the use of a linear encoder **2949**. Typically, a single displacement sensor technology is employed; however, two different displacement sensor technologies are exemplified in FIG. 29D. The displacement sensor **2948** includes an infrared emitter-detector pair **2940** which senses the amount of infrared light that is reflected from the reflective surface **2941**, which is rigidly attached to the food-sensing surface **2934**. As the food-sensing surface moves up and down, the reflective surface **2941** moves closer to, and further from, respectively, the infrared emitter-detector pair **2940**, and so the signal from the infrared emitter-detector pair **2940** increases and decreases, respectively. The displacement sensor **2949** includes and infrared emitter-detector pair**2937** which reflects light off of a stationary encoder element **2939** which is attached to a surface **2947**. The stationary encoder element **2939** has a series of light reflective and non-reflective lines **2938** such that when the infrared emitter-detector pair **2937** moves relative to the stationary encoder element **2939** and passes by the series of light reflective and non-reflective lines **2938** the electrical signal from the infrared emitter-detector pair **2937** increases and decreases, respectively. The peaks of the electrical signal may be counted to determine the location of the infrared emitter-detector pair **2937** relative to the stationary encoder element **2939**. In this fourth embodiment, the active foodware system **2800** employing at least one displacement sensor senses in real time changes in displacement corresponding to changes in the weight of food present on the dining surface of the food dish and infers how quickly food is being eaten, and the active foodware system **2800** causes a corresponding stimulation to be presented to the diner and/or inform another person.

[167] For a given combined weight, the amount of displacement of the food-sensing surface **2934** relative to the surface **2947** is determined by the tension in the tension springs **2942** and **2943** which are attached at one end to food-sensing surface portions **2935** and **2936**, respectively, and at the other end to the surface **2947**. There is at least one tension spring, and typically there are more than two tension springs. Food spilled from the food dish **2945** is prevented from reaching the tension springs **2942** and **2943**, displacement sensors **2949** and **2948** and their associated electrical circuits (not shown) by a seal **2944** which follows the perimeter of the opening in the surface **2947** and is attached to the surface **2947** and to the food-sensing surface **2934**. The seal **2944** is typically a flexible material, such as rubber or plastic, that can be cleaned and sanitized and can provide a water-tight seal between the food-sensing surface **2934** and the surface **2947**.

[168] As food is added to the dining surface of the dish **2945** resting on the food-sensing surface **2934**, the food-sensing surface **2934** extends the tension springs **2942** and **2943** while the displacement sensors **2949** and/or **2948** measure the displacement of food-

sensing surface **2934** relative to the surface **2947**. Electrical wires from the displacement sensors **2949** and **2948** are omitted from the figure for clarity. Using an electrical circuit consistent with the type of displacement sensor employed, the combined weight and changes in the amount of food present on the dining surface can be measured. Multiple displacement sensors may be used, and when three or more displacement sensors are used, the center of mass of the food on the dining surface can also be measured.

[169] FIG. 30 is an electrical circuit which converts signals from strain gages of a load cell into an electrical signal related to the deflection of the load cell. Such an electrical circuit may be employed to determine the deflection of the load cell of FIG. 29A or FIG. 29B. Relating to FIG. 29A, the strain gages **2911**, **2912**, **2913** and **2914** correspond to FIG. 30 as the strain gages **3000**, **3002**, **3003** and **3001** which are wired in a Wheatstone Bridge configuration. As the load cell **2900** deflects under the load of food, the strain gages **3000** and **3001** experience tension (positive strain) and the strain gages **3002** and **3003** experience compression (negative strain). These four strain gages form two separate voltage dividers of the excitation voltage **3004**. The voltage divider consisting of the strain gages **3001** and **3002** produces a voltage **3005**, and the voltage divider consisting of the strain gages **3003** and **3000** produces a voltage **3006**. The difference in these two voltages **3005** and **3006** is determined by the instrumentation amplifier **3007**. An instrumentation amplifier typically has a high-impedance input stage, which often includes amplification and filtering, followed by a differential amplification stage. An instrumentation amplifier may be realized by a single integrated circuit or may be realized using multiple integrated circuits and discrete components, such as operational amplifiers, resistors, capacitors and the like. The output voltage **3008** of the instrumentation amplifier **3007** may be filtered by a filter **3009**. Such a filter may be any convenient filter, including a second order Butterworth filter realized by a Sallen-Key operational amplifier topology. The filtered analog voltage **3010** is input to an analog-to-digital converter (ADC) **3011** which may use the excitation voltage **3004** as the conversion reference inputs **3012** and **3013**. The ADC **3011** may be any convenient converter and may be a single integrated circuit or be realized using multiple integrated circuits and discrete components. The ADC **3011** may be any desired resolution. The digital data **3014** from the ADC **3011** is inputted to a processor **3015** for processing.

[170] FIG. 31 is a block diagram of an electrical circuit which converts signals from a linear encoder into an electrical signal related to the combined weight and which outputs a light stimulus. Such a circuit may be employed by the displacement sensors of FIGs. 29C and 29D. The linear encoder **3100** may be any convenient linear encoder, including an optical linear encoder. An optical linear encoder typically has a movable

element which is movable relative to a housing, where the movable element is opaque with slots or translucent bands. The housing typically has an infrared emitter for transmitting light and an infrared detector for receiving light that passes through the slots or translucent bands of the movable element. The linear encoder may be used to measure the displacement between the moveable element and the housing. An infrared emitter-detector that was used in an exemplary embodiment is a Fairchild H21LTB Optologic® Optical Interrupter Switch.

[171] The linear encoder **3100** outputs an encoder signal **3101** comprising two pulse trains one quarter period out of phase. The quadrature detector **3102** converts the encoder signal **3101** into a single pulse train and a direction signal, collectively referred to as the quadrature output signal **3103**. The quadrature detector **3102** may be a specialized single integrated circuit or realized using a 74LS74 flip flop or equivalent. The counter **3104** receives the quadrature signal **3103** and determines a total count signal **3105** corresponding to the absolute position of the linear encoder. A counter that was used in an exemplary embodiment is a Fairchild 74F579A1 integrated circuit. The processor **3106** receives the total count signal **3105** and processes it. Based on the value of the total count signal **3105**, the processor **3106** may output a light command **3107** to a latch **3108** which stores the command as the stored light command **3109**. The latch **3108** that was used in an exemplary embodiment is a 74LS373. The stored light command **3109** is input to the optical driver **3110** which generates the necessary signal **3111** to turn on the light **3112**. In an exemplary embodiment the optical driver **3110** is a 7406 integrated circuit and the light **3112** is an LED.

[172] FIG. 32 is a block diagram of an exemplary algorithm and logic of a computer program for controlling an embodiment of the subject invention. The logic is for an embodiment where a child is to be encouraged to eat one or more foods at least at a minimum rate. The form of encouragement provided by this embodiment is his being allowed to watch a video of his choice while eating, as long as he eats each of the foods in front of him fast enough until each is sufficiently gone. Any of a variety of single- or multimedia forms of entertainment or information may provide the encouragement. In this embodiment, if the child does not eat each of the foods at least at a specified minimum rate, his desired video is paused and a warning video is run which specifically asks the child to eat the food he isn't eating fast enough so his desired video may continue playing.

[173] In particular, the program starts with block **3200**. At this point, the child's video may be started if it is not already playing. After performing typical programming initialization, such as memory allocation, the weights of each food compartment are queried in block **3201** by the program. Querying the weight may include reading the digital output of the analog-to-digital converter **3011** in FIG. 30. Various functions of

the weights are then determined by the program. For example, the rate of change of weight in each food compartment is typically calculated. The absolute weights of the foods in each compartment, as well as, the rate of decrease of weight, are compared to desired values in block **3202**. Until the weight in each compartment is below a specified level, then as long as the rate of decrease of weight of each food compartment (which is assumed to correlate with the rate of consumption of the food in the respective compartments) is beyond a required level, the video (i.e., the type of encouragement in this case) is allowed to continue.

[174] If the rate of decrease of food in a particular compartment is not fast enough, then a warning signal is provided to the diner as denoted by block **3203**. A typical warning signal includes the flashing of one or more lights, typically LEDs, and may include LEDs of different color, and the flashing may be in a variety of sequences. The weights of the food compartments are queried again as depicted by block **3204** and the necessary conditions are again tested.

[175] If a warning signal was provided following the previous test and still the rate of food consumption is not fast enough in one or more food compartments as determined in block **3205** then the video is paused and one or more severe warnings are issued to the diner, such as shown by block **3206**. Such severe warnings may include LEDs that are consistently on and a graphical character that comes on a video monitor and specifically informs the diner that the video will not continue until more of a particular food is eaten. The parent may also be alerted by any of a variety of methods, including paging, calling on the phone, email, an auditory signal, text message, and the like. The graphical character associated with a severe warning may be selected by a parent to be a cartoon that the child diner specifically likes, respects or identifies with. The character and its attributes (such as synthesized voice parameters and movement information) may be selected in variety of ways, including selection from a library of characters in memory on the active foodware system, or the character and its attributes may be downloaded from a website. The request the character makes may be entered into a file by the parent and spoken by the active foodware system in a synthesized voice corresponding to the cartoon character. An exemplary character might be a mouse, and an exemplary request is the following: "Hey Billy. We're having a lot of fun watching the video together, but we won't be able to keep watching it unless you eat more vegetables." The character may then point to the particular dish that isn't being eaten from quickly enough.

[176] The weight of the food compartments are monitored again as shown by block **3207**. If sufficient food is still not being consumed, as determined by block **3208**, control of the program returns to block **3206**. The parent may enter multiple requests to be spok en by the character, where each time block **3206** is run, a different request may be

spoken. Such requests may be selected to be spoken by the character at random or in a particular sequence, such as may be desired when successively more severe warnings are to be issued.

[177] When the weight of each food container falls below predetermined levels the program terminates. Prior to program termination the parent may be alerted that the child has finished eating by any of a variety of methods, including paging, calling on the phone, email, auditory signal, text message, and the like. Also prior to program termination, the character may issue a congratulatory stored message, such as: "Good boy, Billy! Thank you for eating all your food. I look forward to watching another video with you again later."

[178] FIG. 33 is an active foodware system comprising a computer **3301** and an active foodware computer cover **3300**. In the figure, the computer **3301** is a portable tablet computer. The active foodware computer cover **3300** shows a few exemplary features that an active foodware cover may comprise; however, the active foodware computer cover **3300** embodiment as shown is not intended to limit the scope of features or structure that active foodware computer covers may comprise. In general, an active foodware computer cover comprises typically at least one food compartment, at least one sensory stimulating or sensing component, and cleanable material (typically plastic) for covering and protecting from spilled food at least a portion of a computer, such as the visual display screen **3309** and keyboard **3310** of a computer **3301**.

[179] In FIG. 33 the active foodware computer cover **3300** illustrates three different food compartments; however, typically, when an active foodware computer cover has multiple food compartments each compartment will be of the same general design. The food compartment **3302** includes electroluminescent visual stimulation **3305** outlining at least a portion of the food compartment **3302**. The food compartment **3303** includes LED visual stimulation **3306** positioned on the food compartment. The food compartment **3304** includes LED visual stimulation **3307** positioned near the food compartment. As shown, the active foodware computer cover **3300** has a transparent screen **3308** for covering the visual feedback display screen **3309** of the computer **3301**.

[180] The visual stimulation of a food compartment (**3302**, **3303** or **3304**) may be activated in association with a computer program running on the computer **3301**. The active foodware computer cover **3300** typically communicates information with the computer **3301** via wired or wireless technology. The computer **3301** may also provide electrical power to the active foodware computer cover **3300** via wired or wireless technology. When electrical power is provided wirelessly, it is typically provided via inductively coupling the active foodware computer cover **3300** with the computer **3301**.

[181] The food compartments may include food sensors, such as weight sensors or optical sensors, for detecting food and/or monitoring consumption of the food in the food compartments. The food compartments may also be used with dishes that may be removed for cleaning and/or microwaving.

[182] FIG. 34 is an active foodware system **3400** illustrating how and where food compartments may be positioned relative to a keyboard and monitor. The active foodware system **3400** may comprise an active foodware computer cover and computer, or it may be an integrated unit. The following description is for the case where the active foodware system **3400** is an integrated unit, i.e., the food compartments and any associated stimulation or sensing are integrated into a computer structure comprising a processor, memory, keyboard, visual display, and other components typically associated with a laptop computer.

[183] The active foodware system **3400** comprises a transparent cover **3402** over an LCD monitor, where the transparent cover **3402** forms a water tight seal with the monitor housing **3401**. A food compartment **3405** is attached to the monitor housing **3401** and to the side of the monitor screen and transparent cover **3402**. A food compartment **3406** is attached to the monitor housing **3401** via a swivel mounting. The swivel mounting comprises a first link **3407** with a first end extending from the food compartment **3406** and a second end attached to the first end of a second link **3408** by a hinge pin **3409**. The second end (i.e., non-pinned end) of the second link **3408** is attached to the monitor housing **3401**. Accordingly, the food compartment **3406** may be rotated to a variety of desired positions, such as in front of the monitor or the side.

[184] Food compartments **3410** and **3411** are mounted to the keyboard housing **3412** and typically mounted to the side of the keyboard **3404**; although, either food compartment **3410** or **3411** may also cover a portion or all of the keyboard **3404**. As shown, the keyboard **3404** is covered by a cleanable material **3403** which is typically a transparent, flexible plastic. Although not explicitly shown, as with other embodiments, the food compartments may comprise stimulating and/or sensing components, and such component may communicate with a processor.

[185] FIG. 35 is an active foodware system comprising a hand-held computer **3505** and an active foodware computer cover **3500** which fits over the hand-held computer **3505**. The hand-held computer **3505** may be most any portable device comprising a visual display **3508**, processor, memory and a computer program. Types of portable devices include a game pad, personal digital assistant (PDA), portable PC, mobile telephone, and the like. Examples of such portable devices include the Playstation Portable® (PSP) by Sony, the GameBoy® Micro by Nintendo, the Tungsten® hand-held computer by Palm, Treo® cell phone by Palm and the Blackberry® by Research In Motion. In the figure, the hand-held computer **3505** has user inputs **3506** and **3507**. The active

foodware computer cover **3500** has a structure **3501** and food compartments **3502** and **3503**; although, only one food compartment is necessary. The active foodware computer cover **3500** also has a transparent material, such as plastic, attached to the structure **3501** which allows the user to see important information on the visual display **3508**, such as a video or gaming feedback, but prevents food from damaging the hand-held computer **3505** and associated components.

[186] As was discussed relative to other embodiments of the subject invention, the food compartments may include stimulating and/or sensing components. Such components include LEDs, electroluminescent elements, food sensing devices such as load cells, and the like. The active foodware computer cover **3500** may communicate one or more signals with the hand-held computer **3505**, where such communication may be via wire or wireless connection. The active foodware computer cover **3500** may operate in association with a computer program running on the hand-held computer **3505**. For example, the hand-held computer **3505** may run a video that is paused by a computer program running on the hand-held computer **3505** if the user isn't eating food in the food compartments **3502** and **3503** at a desire rate as sensed by load cells associated with the food compartments **3502** and **3503**. If the video is the output display of a videogame, in addition to pausing the game, the game could deduct points from the user if the user weren't eating at a desired rate. The controls **3506** and **3507** of the hand-held computer **3505** may be fully covered, partially covered or not covered at all by the active foodware computer cover **3500** depending on the desired level of control accessibility.

[187] FIG. 36 is an active foodware system **3600** capable of accepting a portable device **3604** such as a music player (e.g., an iPod® by Apple Computer), video player, mobile telephone, hand-held gamepad, hand-held computer, and the like. The active foodware system **3600** has a food compartment **3601**, a docking location **3602** which may comprise a cavity and/or connector, and may comprise a speaker. The speaker may be of any convenient speaker design including voice coil or piezoelectric. If it is desired to make the active plate **3700** water tight so it is dishwasher safe a piezoelectric speaker may be preferred. The portable device **3604** typically includes a visual feedback screen **3607**, a user input control **3606** and a docking connector **3605**. A useful embodiment is where the portable device **3604** is an Apple iPod® playing a music video, where the music video is viewable while eating the food in the food compartment **3601** and the music is heard through the speaker **3603**. As with other embodiments, the food compartment **3601** may have associated stimulation and sensing technology (not shown). The sensing technology may comprise a food sensor, such as a load cell, for sensing the amount of food present. The active foodware system **3600** may contain an integral processor (not shown) or may use a processor associated with

the portable device **3604** to acquire data from the food sensor and affect the operation of the portable device **3604**, such as pause its operation until food is consumed as desired.

[188] FIG. 37A is a cross-sectional view of an active foodware system comprising an active dining plate **3700** that receives electrical power wirelessly from an underplate **3711** using a transformer. The cross-section of the active dining plate **3700** of FIG. 37A is through section B-B of FIG. 37B; whereas, the cross-section of the underplate **3711** of FIG. 37A is through section C-C of FIG. 37C. FIG. 37B is a plan view of the active dining plate **3700**; FIG. 37C is a plan view of the underplate **3711** and FIG. 37D is a schematic diagram of an electrical circuit for inductively transforming electrical power between the active dining plate **3700** and underplate **3711**. The numberings in FIGs. 37A-37C are consistent.

[189] External electrical power, such as from a wall socket, power supply, battery and the like, enters the underplate **3711**. In the embodiment of FIGs. 37A-37C the external power comes from a wall socket via the connector **3716**. The connector **3716** is connected via a wire **3715** to the underplate electronics module **3714** which may comprise a processor. The underplate electronics module **3714** comprises any circuitry for driving the leads **3722** and **3723** of the transformer primary coil **3713**. If the underplate **3711** comprises an underplate communications module **3717** the underplate electronics module **3714** may also communicates information with the underplate communications module **3717**. The underplate communications module **3717** may communicate information with an external processor via a wire **3718** and connector **3719**. The underplate communications module **3717** may also communicate information with an active dining plate communications module **3710** in the active dining plate **3700** via wireless technology including infrared (IR) light and radio frequency (RF) electromagnetic waves. When IR light is used to communicate information between the active dining plate communications module **3710** and the underplate communications module **3717** at least a portion of the active dining plate **3700** and the underplate **3711** between the active dining plate communications module **3710** and the underplate communications module **3717** is translucent.

[190] The leads **3722** and **3723** are coiled around the core **3712** (which is typically made of iron) creating the primary coil **3713** of a transformer. When the active plate **3700** is placed on top of the underplate **3711** the core **3712** fits into the cavity **3702**. Ideally there is very little gap between the core **3712** and the wall of the cavity **3702**. Leads **3720** and **3721** from the active plate electronics module **3703** encircle the cavity creating the secondary coil **3701** of the transformer. When an alternating (A/C) voltage signal is placed across the leads **3722** and **3723** of the primary coil **3713** an electromagnetic field is set up in the core **3712** and alternating voltage exists across the

leads **3720** and **3721** of the secondary coil **3701**. Ignoring parasitic and other non-ideal voltage losses, the magnitude of the alternating voltage appearing across the leads **3720** and **3721** of the secondary coil **3701** is equal to the alternating voltage appearing across the leads **3722** and **3723** of the primary coil **3713** times the ratio of windings of the secondary coil **3701** to windings of the primary coil **3713**.

[191] The power conditioning module **3703** comprises the voltage rectification, regulation and conditioning circuitry associated with the transformer secondary coil **3701**. A block diagram including such circuitry is found in FIG. 37D. The power conditioning module **3703** is connected to the active plate electronics module **3704** which typically comprises a processor for controlling the functionality of the active dining plate **3700**. If the active dining plate **3700** comprises an active plate communications module **3710** the active dining plate electronics module **3704** may also communicate information with the active dining plate communications module **3710**.

[192] The embodiment of FIGs. 37A-37C comprises an LCD display **3705** with a protective transparent screen **3706** in the active dining plate **3700**. The embodiment also includes a speaker **3707** recessed in a cavity **3708** on a sloping surface on the underneath portion of the active dining plate **3700**. The cavity **3708** has a lip **3709** such that any drips of liquid or food over the edge of the active dining plate will collect on and drip from the lip **3709** of the active plate **3700** and not drip onto the speaker. The active dining plate electronics module **3704** contains the controller for controlling the LCD display **3705** and speaker **3707**.

[193] FIG. 37D is a schematic diagram of the typical components of an electrical circuit for transmitting power from a wall socket through the underplate **3711** and wirelessly to the active dining plate **3700** using an inductive transformer. The electrical power from the wall socket is represented by $V_{AC\ IN}$ **3728**. This electrical power is provided to the underplate **3711** and drives the primary coil **3713** of the transformer with a core **3712**, where both the primary coil **3713** and transformer core **3712** reside in the underplate **3711**. The secondary coil **3701** of the transformer resides in the active dining plate **3700**. The output of the secondary coil **3701** is alternating current (A/C) so it is first rectified by the bridge rectifier comprising four power rectifying diodes **3724**. A part which suffices for such use is a 1N4001 rectifying diode. The output of the bridge rectifier is then low-pass filtered. There are many circuits suitable for low-pass filtering. The low-pass filter used in FIG. 37D is a simple passive low-pass filter comprising resistor R **3725** and capacitor C_1 **3726**. To further smooth out ripple and provide the desired output voltage $V_{DC\ OUT}$ for other electrical circuitry a voltage regulator **3727** is used followed by a capacitor **3729**. Using the transformer to inductively transmit electrical power from a wall socket to the active dining plate **3700** the active dining plate **3700** doesn't need any power connectors or battery com-

partments and thus can be made to be water tight and dishwasher safe.

[194] FIG. 38 is an active foodware system where the active foodware dining plate **3800** communicates wirelessly with a monitor **3801** having a screen **3810** via a wireless transceiver **3802** on the active foodware dining plate **3800** and a wireless transceiver **3803** on the monitor **3801**. Each wireless transceiver may send or receive a wireless signal. The monitor **3801** may be a television or any other convenient video output device. The communication between the active foodware dining plate **3800** and monitor **3801** may also be via wired technology. The wireless technology can be any convenient and effective technology such as infrared (IR), radio frequency electromagnetic waves (RF) and the like. The active foodware dining plate **3800** may also communicate with a unit **3807** which then communicates by a wired or wireless connection **3808** with the monitor **3801**. The unit **3807** is a device which communicates with a monitor, including but not limited to a digital video recorder (DVR), TiVo®, set-top box, DVD player, VCR, game console, and the like. The active foodware dining plate **3800** may communicate with the unit **3807** via wired or wireless link, but in FIG. 38 the unit **3807** is shown to have a wireless transceiver **3809** to communicate a wireless signal with the active foodware dining plate's **3802** wireless transceiver **3802**.

[195] The active foodware dining plate **3800** in the embodiment of FIG. 38 has multiple food compartments **3804** and a speaker **3805**. This particular embodiment also shows the wireless transceiver **3802** extending from the main housing of the active foodware dining plate **3800** by a cable **3806**; however, the wireless transceiver **3802** may be a part of the main housing or internal to the main housing. Eating activity in the food compartments **3804** may be sensed by sensing technology (not shown) and used to control the monitor **3801** and/or unit **3807**. For example, if the active foodware dining plate **3800** senses that food in food compartments **3804** is not being eaten at a desired rate, a video being displayed on the monitor screen **3810** may be paused until the desired rate is achieved.

[196] FIG. 39 is a cross-sectional view of an active foodware system with a passive dining plate **3900** on top of an optical coupler **3901** which guides light from the screen **3902** of a visual display **3903** on a supporting surface **3904**. At least a portion **3905** of the optical coupler **3901** contacts the passive dining plate **3900** and at least a portion **3906** of the optical coupler **3901** contacts the screen **3902**. At least a portion of the passive dining plate **3900** is translucent near where the passive dining plate **3900** contacts the portion **3905** of the optical coupler. The index of refraction and other physical and optical properties of the portions **3905** and **3906** of the optical coupler are selected to provide desired transfer of light from the screen **3902** of the visual display **3903** to the passive dining plate **3900**, which light then passes through the translucent

passive dining plate **3900** and is observed by an observer.

[197] FIGs. 40A and 40B provide another embodiment of an active foodware system where light from a visual display screen is transmitted through an optional optical coupler and then through a passive dining plate for the diner to see. FIG. 40A is a plan view of the active foodware system and FIG. 40B is a cross section of FIG. 40A through section D-D. The passive dining plate **4000** has a dining portion **4001** intended for dining and a information portion comprising regions **4005**, **4006**, **4007**, **4008**, **4009**, **4010**, **4011**, **4012**, **4013**, **4014**, **4015** and **4016** intended to display information to the diner, where such regions are collectively referred to as the information portion **4017**.

[198] The passive dining plate **4000** which has at least a portion which is translucent is placed in confronting relation to a visual display **4002** which has screen **4003**. An optional optical coupling structure **4004** provides optical coupling between the screen **4003** and the passive dining plate **4000**. For instance, by selection of the index of refraction of the optical coupling structure **4004** the bending of light from the time it leaves the screen **4003** until it enters the passive dining plate **4000** can be controlled. In the exemplary embodiment of FIGs. 40A and 40B the dining portion **4001** of the passive dining plate **4000** rests against the screen **4003**, and the information portion **4017** of the passive plate **4000** rests against the optical coupling structure **4004**.

[199] In one exemplary application of the embodiment of FIGs. 40A and 40B, thirteen (13) different digital images and/or videos are shown, one in the dining portion **4001** and one in each of the twelve portions of the information portion **4017**. In FIG. 40A the boundaries shown between each of the twelve portions of the information portion **4017** are purely graphical, such that the boundaries are displayed on the screen **4003** and observed through the passive dining plate **4000**. For instance, at a wedding anniversary party, a guest may see ten images from the wedding in portions of the information portion **4017**, two videos in the remaining two portions of the information portion **4017** and see an image of the wedding invitation in the dining portion **4001**. The passive dining plate **4000** may be easily washed in the dishwasher or placed in a microwave oven.

[200] The visual display **4002** may comprise an auditory output, such as a speaker or speaker jack. The visual display **4002** may also comprise wired or wireless technology for transferring information to or from the visual display **4002**. The visual display **4002** may also comprise sensors and/or stimulators and/or a programmable processor for performing other desired functions.

[201] FIG. 41A is an active foodware system comprising a computer **4110** and a structure **4100** for holding food in a convenient location relative to the computer **4110** such that the diner may easily access the computer **4110** while eating and drinking without concern for spilling the food and drink on the computer **4110**, its keyboard **4111**,

computer monitor **4112** or screen **4113**.

[202] In the exemplary embodiment of FIGs. 41A and 41B the structure **4100** has a base **4107** on which the computer **4110** typically rests. An elevating structure for elevating food containers is attached by a section **4105** to the base **4107**. The section **4105** of the elevating structure is rotatably attached to a section **4103**, where the sections **4105** and **4103** are capable of rotating relative to each other around a separating region **4115**. In the exemplary embodiment of FIG. 41B the elevation of a section **4102** of the elevating structure relative to the section **4103** may be adjusted using a tightening band **4104**. For instance, when the tightening band **4104** is turned one way the elevation of the section **4102** relative to the section **4103** may be freely adjusted until the tightening band **4104** is turned the other way until tight.

[203] A liquid container holder **4108** with a cavity **4109** is attached to the section **4102**. A drinking vessel **4114** may be placed in the cavity **4109**. A food tray comprising a frame **4106** and a surface **4101** is also attached to the section **4102**. Accordingly, both the liquid container holder **4108** and the food tray comprising the frame **4106** and the surface **4101** may be adjusted in both elevation and position relative to the computer **4110** via the elevating structure. Typically the surface **4101** is translucent to make it possible to see portions of the computer that would otherwise have an obstructed view. Likewise, the frame **4106** may also be translucent. The exemplary embodiment of FIGs. 41A and 41B is configured for a diner who uses his right hand to access other items, such as a computer mouse, writing instrument, napkin and the like. Accordingly, the structure **4100** is shown with elevating structure on the left side and leaving an un-obstructed gap on the right side between the computer **4110** and the frame **4106** with the surface **4101**. If desired, the frame **4106** with the surface **4101** may be rotated such that none, or only a portion, of the frame **4106** and surface **4101** cover the computer **4110**.

[204] Similar to FIG. 41B, FIG. 41C provides another useful embodiment that comprises a base **4121**, an adjustable support structure extending from the base, a horizontal dining platform (also referred to as a food tray and a surface **4116**) for supporting food, while a keyboard is positioned at least partially under the dining platform, and supported by the support structure in a raised position from the base **4121**, where typically at least a portion of the dining platform is translucent to permit viewing at least a portion of the keyboard during dining.

[205] The embodiment of FIG. 41C is similar to FIG. 41B, but additionally, the food tray comprising a frame **4115** and a surface **4116** (where typically at least a portion of the surface **4116** is translucent) is capable of being extended or retracted, in addition to being rotated and adjusted up and down. In FIG. 41C, the frame **4115** comprises a fixed frame member **4117** to which the fixed surface **4119** is attached, and a sliding

frame member **4118** to which a sliding surface **4120** is attached. The sliding frame member **4118** with the sliding surface **4120** is able to be extended or retracted by the user relative to the fixed frame member **4117** with the fixed surface **4119**. Also exemplified in FIG. 41C is a base **4121** that is U-shaped comprising a first base leg **4122** and a second base leg **4123**. Depending on the desired spacing between the two legs, **4122** and **4123**, the two legs **4122** and **4123** may either be placed in front and/or behind, respectively, a laptop computer, such as a laptop computer **4110**, or may be placed underneath it.

[206] FIG. 42 is an active foodware system comprising a dining plate unit **4200** which may further comprise one or more food compartments **4201**. The dining plate unit **4200** comprises a connector **4202** for connecting to a device. The connector **4202** may also support the connected device in a desired orientation. In the exemplary embodiment of FIG. 42, the connector **4202** includes a cavity into which the device is inserted. In the exemplary embodiment of FIG. 42, three exemplary devices are shown, but the subject invention is not limited to such three exemplary devices. The exemplary devices include a portable gaming unit **4208** (such as a Sony Playstation Portable®), a computer monitor **4203** and a portable computer **4205**. The computer monitor **4203** may be part of a tablet computer, and the portable computer **4205** may be part of a mobile phone. The device may be connected to the dining plate unit **4200** via a wired or wireless connector, and such connection may be part of the connector **4202** or may be achieved by an external connection comprising a connector **4214** for connecting to the dining plate unit **4200** and a connector **4215** for connecting to the device, and where the connectors **4214** and **4215** are connected by a wire **4213**. The connectors **4214** and **4215** may be USB connectors, serial connectors, parallel connectors, or any other convenient wired or wireless connectors.

[207] In FIG. 42 the portable gaming unit **4208** has user input controls **4210** and **4212**, and has a visual display **4209**. The gaming unit also has auditory outputs, including a speaker **4217** and an audio output jack **4218**. The computer monitor **4203** has a screen **4204**, a speaker **4219** and an audio output jack **4220**. The portable computer **4205** has a visual display **4206**, user input buttons **4207**, a speaker **4221** and an audio output jack **4222**. When connected to the dining plate unit **4200**, auditory information from a dev ice may be output from a speaker **4216** on the dining plate unit **4200**. Auditory information may also be input to the dining plate unit **4200** via an audio input jack **4223**.

[208] FIG. 43 is a computer program with a graphical user interface (GUI) displayed on a computer monitor **4300** with screen **4301**, where the GUI allows for easy visual selecting of content to be displayed on an active foodware system. In general, the computer program with GUI makes it easier and more intuitive for a hostess to "author" active foodware content. In one example of the computer program a hostess

sets a physical table with four active foodware dining plates, where the dining plates each have a visual display. On her computer the hostess defines a graphical table icon **4302** with four graphical plate icons **4303**, **4304**, **4305** and **4306**. Alternately, the hostess may select a table icon with dining plates from a predefined list. Then the hos tess may open a folder **4307** on her computer containing one or more graphical images **4308**, **4309**, **4310**, **4311**, **4312** and **4313**. Using her computer mouse **4314** and the well-known "drag and drop" computer mouse paradigm the hostess may "drag" the thumbnail icon of a desired image **4313** from the folder **4307** to a second location **4315** and then "drop" the thumbnail icon of the desired image over the graphical icon of a desired plate **4306**. The computer software interprets the action of dragging and dropping the thumbnail icon as a command to display a thumbnail of the image on the corresponding graphical icon of the desired plate and also to send the necessary image data to the physical active foodware dining plate corresponding to the graphical plate icon either via wireless or wired technology.

[209] Properties of the image may also be configured using the computer program, such as where a slideshow may be exhibited on the dining plate. Such properties include the display of multiple images where the time of display for an image may be set by the hostess. The hostess may also select how one image wipes or fades into the next. The hostess may also select text or sound to be displayed with the image, such that a multimedia performance may be scripted for each physical dining plate. In general, selectable properties include properties commonly available by slideshow software, such as Microsoft PowerPoint®.

[210] In the preceding example, the icon that is dragged and dropped from the folder **4307** represented an image. However, in general, the icon may represent an executable application, a video, a multimedia presentation, object linking and embedding (OLE), a communication link, a computer program, function, command, and the like that affects the operation of the active foodware system.

[211] FIG. 44 is a computer program with a graphical user interface (GUI) displayed on a computer monitor **4400** with screen **4401**, where the GUI allows for easy visual selecting of content to be displayed on an active foodware system. In general, the computer program with GUI makes it easier and more intuitive for a hostess to "author" active foodware content. In one example of the computer program a hostess sets a physical table with the active foodware dining plate **4000** of FIGs. 40A and 40B. On her computer the hostess selects a graphical plate icon **4402**, corresponding to active foodware dining plate **4000**, with twelve graphical region icons **4403** through **4414**. Then the hostess may open a folder **4415** on her computer containing one or more graphical images **4416** through **4421**. Using her computer mouse **4422** and the well-known "drag and drop" computer mouse paradigm the hostess may "drag" the

thumbnail icon of a desired image **4421** from the folder **4415** to a second location **4423** and then "drop" the thumbnail icon of the desired image over the graphical icon of a desired region icon **4412**. The computer software interprets the action of dragging and dropping the thumbnail icon as a command to display a thumbnail of the image in the corresponding graphical region icon and also to send the necessary image data either via wireless or wired technology to the physical active foodware dining plate **4000** and display it in the corresponding region **4011**.

[212] Properties of the image may also be configured using the computer program, such as where a slideshow may be exhibited on the dining plate. Such properties include the display of multiple images where the time of display for an image may be set by the hostess. The hostess may also select how one image wipes or fades into the next. The hostess may also select text or sound to be displayed with the image, such that a multimedia performance may be scripted for each physical dining plate. In general, selectable properties include properties commonly available by slideshow software, such as Microsoft PowerPoint®.

[213] In the preceding example, the icon that is dragged and dropped from the folder **4415** represented an image. However, in general, the icon may represent an executable application, a video, a multimedia presentation, object linking and embedding (OLE), a communication link, a computer program, function, command, and the like that affects the operation of the active foodware system.

[214] FIG. 45 is a cross section of an active foodware system where food **4501** on a dining plate **4500** is detected by an optical sensor **4502**. Any convenient optical sensor may be used. The particular optical sensor **4502** in the embodiment of FIG. 45 is an infrared emitter-detector sensor, where infrared (IR) light is emitted from the emitter **4503**, passes through a translucent portion **4505** of the dining plate **4500**, reflects off the surface of the food **4501** and is detected by the IR detector **4504**. Typically, the IR emitter **4503** is an LED or laser diode, and the IR detector **4504** is a photodiode, photo transistor, photo Darlington, photo cell, and the like. The driving and processing electrical circuitry for such sensors is known to those skilled in the art and so it is omitted from FIG. 45 for clarity. If no food is present a very limited amount the emitted IR light will reflect and so the signal sensed by the IR detector **4504** will be small. In contrast, if food is present over the emitter **4503** a large portion of the emitted IR light will be reflected and so the signal sensed by the IR detector **4504** will be relatively large. In general, the signal returned by the IR detector **4504** is related to the amount of food present. Typically, more than one IR emitter-detector sensor is used. A large array of IR emitter-detector sensors may be used to provide the desired resolution for determining the amount of food present on the dining plate **4500**.

[215] FIG. 46 is a plan view of an active foodware system comprising a dining plate **4600**

where a light source **4607** emits light from a portion of the dining plate towards a light detector **4605** located at another portion of the dining plate **4600** where food **4610** may lie between the light source **4607** and the light detector **4605**. In the exemplary embodiment of FIG. 46, the light source **4607** is a laser diode that rotates about an axis **4608**. The laser diode may also be converted into a sheet of light by a lens or other means to eliminate the need to rotate the laser diode. The light from the laser diode **4607** passes through a translucent food barrier **4616** and is detected by a light detector **4605** unless it is blocked by the food **4610**. Using the light detector, the existence, amount and position of food **4610** may be determined. In FIG. 46 the dining plate **4600** is partitioned into three sections containing the food **4610** and the light detector **4605** in a first section, food **4611** and **4612** and a light detector **4604** in a second section and food **4613** and a light detector **4606** in a third section. The light detector may be any convenient light detector, including but not limited to a charge coupled device (CCD) array, a linear CCD array, a camera, a CCD camera, a lateral-effect photodiode, an array of photodiodes, an array of phototransistors, an array of photocells, and the like. The driving and processing electrical circuitry for such emitters and detectors is known to those skilled in the art and is omitted from FIG. 46 for clarity.

[216] FIGs. 47A and 47B are cross sections of an active foodware system comprising a passive dining plate **4700** and an active underplate **4706**. The passive dining plate **4700** comprises a dining surface **4701**, one or more light guides **4702** and a bottom surface **4703**. The passive dining plate **4700** may also comprise optical wave guides. Typical light guides include fiber optic wires, channels, tubes, and the like. The active underplate **4706** comprises one or more light sources **4711**. In the figure, each light source **4711** is a light emitting diode (LED) with a light emitting portion **4712**. The LEDs may be laser diodes and/or may emit light in any of a variety of desirable wavelengths. The light sources **4711** may be any desirable light source, including LEDs, laser diodes, electroluminescent light sources, liquid crystal display light sources (LCDs), fluorescent lights, plasma lights, incandescent lights, and the like. The active foodware system may comprise one or more light sources **4711**, and when a plurality of light sources **4711** are used, the light sources **4711** may all be the same type of light source or may be different types of light sources.

[217] The light directed by the light guides **4702** may individually, or together, form an image enhancing the dining experience. Such an image may include, but is not limited to a face, a smiley face, such as provided by FIGs. 4A-4D, a cartoon figure, a sun, a moon, a star, a pattern, a design, or any other desirable image. The image may be alterable by selectively energizing the light sources, by affecting the light after it has been energized, by affecting the light guide, or any other reasonable technique. By dynamically altering the image, the image may be made to appear to move. For instance,

an action figure may appear to walk, crawl, fly, and the like; a face may appear to smile, wink, talk, frown, and the like; a pattern may appear to morph over time or to the beat of music, which music may also emanate from the active foodware system.

[218] In the exemplary embodiment of FIGs. 47A and 47B, the active underplate **4706** also serves as a base for the passive dining plate **4700**. In the embodiment the active underplate **4706** has a protuberance **4709** which supports the light sources **4711**. The protuberance **4709** fits into a cavity **4710** in the passive plate **4700** and positions the light sources **4711** in functional relationship with the light guides **4702**. Typically, the light sources **4711** are positioned in confronting relationship to the light guides **4702**. Light emitted from the light sources **4711** is guided through the light guides **4702** and is allowed to disperse from the light guides **4702** at desired sites or regions providing a desired lighting effect to be viewed by a diner. There are various ways known to those skilled in the art to disperse light from a light guide, including but not limited to introducing discontinuities in the guide, altering the index of refraction, altering the translucency of the guide or its surroundings, abrading or etching the surface, changing the dimension of the light guide such that the angle of incidence of light is able to exceed the critical angle for total internal reflection, applying coatings, terminating the light guide, and the like.

[219] In FIG. 47B the active underplate **4706** is shown to comprise a power source **4727**, a control switch **4725**, an optional processor **4726** and an optional speaker **4728**. The power source **4727** can comprise any convenient power source, including but not limited to a battery, a power adapter connector, an inductive transformer, such as shown in FIGs. 37A-37D, and the like. The control switch **4725** may control any of a variety of functions, including but not limited to turning the lights on/off, selecting one of a variety of lighting effects, such as flashing or strobing, and may be used to select a mode of operation of the processor **4726**, and the like. The processor **4726** may be employed to control a variety of complex stimulations, including but not limited to outputting music to the speaker **4728** and synchronizing lighting effects to the associated musical beat. The processor **4726** may also receive data from, or transmit data to, either wired or wirelessly, other entities. Such data may comprise operational commands, desired stimulation, such as a desired lighting effect, desired music, and the like. The details of the electrical circuitry and interconnects are known to those skilled in the art and are omitted from the figure for clarity.

[220] In the exemplary embodiment of FIGs. 47A and 47B the active underplate **4706** is shown to comprise support structures **4708**. The active underplate **4706** is also shown to comprise underplate fasteners **4705** which fasten the active underplate **4706** to the passive dining plate **4700** dining plate fasteners **4704**. The underplate fasteners **4705** may be any convenient fastener, including but not limited to one or more simple pro-

tuberances that fit into the dining plate fasteners **4704** and hold the active underplate **4706** to the passive dining plate **4700** by friction. There are a multitude of other fastening techniques known to those skilled in the art that may be used, including hooks, clips, snaps, slide locks, tongue-in-groove locks, Velcro®, screws, and the like.

[221] FIG. 47C is a cross section of an active foodware system comprising a passive dining plate **4707** and an active underplate **4718**. The passive dining plate **4707** comprises a dining surface **4713**, one or more light guides **4714** and a bottom surface **4715**. The passive dining plate **4707** may also comprise optical wave guides. Typical light guides include fiber optic wires, channels, tubes, and the like. The active underplate **4718** comprises one or more light sources. In the figure, one light source **4720** is shown and which is an incandescent light. The light source **4720** may alternatively be an LED. The LED may be a laser diode and/or may emit light in any of a variety of desirable wavelengths. In general, the light source **4720** may be any desirable light source, including an LED, laser diode, electroluminescent light source, LCD, fluorescent light, plasma light, incandescent light, and the like. The active foodware system may comprise one or more light sources, and when a plurality of light sources are used, the light sources may all be the same type of light source or may be different types of light sources.

[222] The light directed by the light guides **4714** may individually, or together, form an image which may enhance the dining experience. Such an image may include, but is not limited to a face, a smiley face, such as provided by FIGs. 4A-4D, a cartoon figure, a sun, a moon, a star, a pattern, a design, or any other desirable image. The image may be alterable by selectively energizing the light sources, by affecting the light after it has been energized, by affecting the light guide, or any other reasonable technique. By dynamically altering the image, the image may be made to appear to move. For instance, an action figure may appear to walk, crawl, fly, and the like; a face may appear to smile, wink, talk, frown, and the like; a pattern may appear to morph over time or to the beat of music, which music may also emanate from the active foodware system.

[223] Light emitted from the light source **4720** is altered by having it pass through a light modifier. In the exemplary embodiment of FIG. 47C, light modification is achieved with a moving translucent film **4724**. Movement of the translucent film **4724** may be predetermined or may be alterably controlled. The translucent film **4724** is moved by an actuator **4721**, such as a rotary electrical motor. There are a variety of other suitable actuators which may alternatively be employed which are known to those skilled in the art for moving a low-mass translucent film **4724**. As light emitted from the light source **4720** passes through the translucent film **4724** it takes on the color and pattern imparted by the translucent film **4724** before it enters the light guides **4714**. Ac-

cordingly, depending on the pattern on the translucent film **4724**, as the motor moves the translucent film **4724,** the light passing into and through the light guides, and ultimately dispersed for a diner to see, is varied.

[224] In the exemplary embodiment of FIG. 47C, the active underplate **4718** also serves as a base for the passive dining plate **4707**. The light source **4720** is positioned in functional relationship to the light guides **4714**, and typically the light source **4720** is positioned in confronting relationship to the light guides **4714**. Light emitted from the light source **4720** is guided through the light guides **4714** and is allowed to disperse from the light guides **4714** at desired sites or regions providing a desired lighting effect to be viewed by a diner. There are various ways known to those skilled in the art to disperse light from a light guide, including but not limited to introducing discontinuities in the guide, altering the index of refraction, altering the translucency of the guide or its surroundings, abrading or etching the surface, changing the dimension of the light guide such that the angle of incidence of light is able to exceed the critical angle for total internal reflection, applying coatings, terminating the light guide, and the like.

[225] In FIG. 47C the active underplate **4718** is shown to comprise a power source **4730**, a control switch **4729**, an optional processor **4731** and an optional speaker **4732**. The power source **4730** can comprise any convenient power source, including but not limited to a battery, a power adapter connector, an inductive transformer, such as shown in FIGs. 37A-37D, and the like. The control switch **4729** may control any of a variety of functions, including but not limited to turning the lights on/off, selecting one of a variety of lighting effects, such as flashing or strobing, may control the rate, direction and position of shaft of the motor, and may be used to select a mode of operation of the processor **4731**, and the like. The processor **4731** may be employed to control a variety of complex stimulations, including but not limited to outputting music to the speaker **4732** and synchronizing lighting effects to the associated musical beat. The processor **4731** may also receive data from, or transmit data to, either wired or wirelessly, other entities. Such data may comprise operational commands, desired stimulation, such as a desired lighting effect, desired music and the like. The details of the electrical circuitry and interconnects are known to those skilled in the art and are omitted from the figure for clarity.

[226] In the exemplary embodiment of FIG. 47C the active underplate **4718** is shown to comprise support structures **4719**. The active underplate **4718** is also shown to comprise underplate fasteners **4717** which fasten the active underplate **4718** to the passive dining plate **4707** dining plate fasteners **4716**. The underplate fasteners **4717** may be any convenient fastener, including but not limited to one or more simple protuberances that fit into the dining plate fasteners **4716** and hold the active underplate

4706 to the passive dining plate **4700** by friction. There are a multitude of other fastening techniques known to those skilled in the art that may be used, including hooks, clips, snaps, slide locks, tongue-in-groove locks, Velcro(R), screws, and the like.

[227] FIGs. 48A-48I are cross section views of typical dining plates forms which may be used in an active foodware system. Other dining plate forms may be alternately used in an active foodware system. FIG. 48A is a cross section view of a form of a dining plate **4800** comprising a dining surface **4801** and upwardly curved surrounding surface **4802** . Typically, the surrounding surface is intended to direct food from the outer portion of the plate back toward the more central portion of the plate where the dining surface is, to reduce spillage, and to provide a convenient surface for grasping the plate.

[228] FIG. 48B is a cross section view of a form of a dining plate **4804** comprising a dining surface **4803** and downwardly curved surrounding surface **4805**.

[229] FIG. 48C is a cross section view of a form of a dining plate **4806** comprising a dining surface **4807** and relatively flat (in cross section) sloping surrounding surface **4808**.

[230] FIG. 48D is a cross section view of a form of a dining plate **4809** comprising a dining surface **4810**, a first flat (in cross section) sloping surrounding surface **4811** and a second flat (in cross section) surrounding surface **4812** sloping less than the first sloping surrounding surface **4811**.

[231] FIG. 48E is a cross section view of a form of a dining plate **4813** comprising a dining surface **4814**, a first upwardly curved surrounding surface **4815**, a second flat (in cross section) sloping surrounding surface **4816** and supports **4817**.

[232] FIG. 48F is a cross section view of a form of a dining plate **4818** comprising a dining surface **4819**, a first vertical surrounding surface **4820** and a second flat (in cross section) sloping surrounding surface **4821**.

[233] FIG. 48G is a cross section view of a form of a dining plate **4822** comprising a dining surface **4823**, a first vertical surrounding surface **4824** and a second horizontal surrounding surface **4825**.

[234] FIG. 48H is a cross section view of a form of a dining plate **4826** comprising a dining surface **4827**, a first upwardly curving surrounding surface **4828**, a second horizontal surrounding surface **4829** and a downwardly curved outer edge **4830**.

[235] FIG. 48I is a cross section view of a form of a dining plate **4831** comprising a dining surface **4832** and vertical surrounding surface **4833**.

[236] It is evident from the above description that a new way of using foodware in an active foodware system, particularly dinnerware, is provided. Instead of static dinnerware that while being attractive is passive, the subject dinnerware is active providing for numerous stimuli for a variety of purposes. The active foodware system

dinnerware can be used to encourage young users or diners to eat their food, learn while eating, be responsive to requests and commands, be entertained, be monitored, listen to music, watch TV, communicate by means of the dinnerware, and the like. Adults may use the dinnerware to communicate with others, watch events, review activities, read email, search the internet, and the like. The subject active foodware system provides an entirely new paradigm in the use of common foodware and makes the active foodware system highly versatile in its applications.

[237] All publications and patent applications cited in this specification are herein incorporated by reference as if each individual publication or patent application were specifically and individually indicated to be incorporated by reference.

[238] Although the foregoing invention has been described in some detail by way of illustration and example for purposes of clarity of understanding, it will be readily apparent to those of ordinary skill in the art in light of the teachings of this invention that certain changes and modifications may be made thereto without departing from the spirit or scope of the appended claims.

Claims

[1] A mechanical structure having a dining surface and comprising any one of a stimulating component, a sensing component and a processor component, with said component being in proximity to said dining surface, said dining surface being recessed in relation to a region surrounding the dining surface, said dining surface recessed for receiving food and preventing spillage from said dining surface, in the event that said stimulating component is a visual stimulating component, (a) said visual stimulating component has a plurality of sites that emit light that produces other than a single simple geometric form, or (b) said visual stimulating component is sealed in said mechanical structure.

[2] A mechanical structure according to claim 1, wherein said stimulating component comprises a plurality of sites emitting light producing an image other than a single simple geometric form.

[3] A mechanical structure according to claim 1, wherein said stimulating component comprises a visual stimulating component comprising a liquid crystal display.

[4] A mechanical structure according to claim 1, wherein said mechanical structure comprises at least one of a processor component or a sensing component.

[5] An active foodware system comprising: a dining surface, said dining surface being recessed in relation to a region surrounding the dining surface, said dining surface recessed for receiving food and preventing spillage from said dining surface, in combination with said dining surface, a mechanical structure for supporting said dining surface, and (1) in functional relationship to said mechanical structure, any one of the following functioning while dining: a sensing component, a stimulating component and a processor component, with the proviso that (a) when said mechanical structure has a visual stimulating component and said stimulating component is other than a software controlled graphical display, either (i) light emanates from said dining surface from a plurality of sites that emit light that produces other than a single simple geometric form, or (ii) said visual stimulating component is sealed in said mechanical structure or (b) when said sensing component senses weight, said stimulating component includes information other than information provided by a scale; or (2) said mechanical structure has an adjustable support structure, a horizontal dining platform for supporting food in a raised position, while a keyboard is positioned at least partially under said dining platform, at least a portion of said dining platform being translucent to permit viewing at least a portion of the keyboard during dining.

[6] An active foodware system according to claim 5, wherein said active foodware system comprises:
a dining surface, said dining surface being recessed in relation to a region surrounding the dining surface, said dining surface recessed for receiving food and preventing spillage from said dining surface, in combination with said dining surface, a mechanical structure for supporting said dining surface, and (1) in functional relationship to said mechanical structure, any one of the following functioning while dining: a sensing component, a stimulating component or a processor component, with the proviso that (a) when said mechanical structure has a visual stimulating component and said stimulating component is other than a software controlled graphical display, either (i) light emanates from said dining surface from a plurality of sites that emit light that produces other than a single simple geometric form, or (ii) said visual stimulating component is sealed in said mechanical structure or (b) when said sensing component senses weight, said stimulating component includes information other than information provided by a scale.

[7] An active foodware system according to claim 6, wherein said system comprises a sensing component.

[8] An active foodware system according to claim 7, wherein said sensing component senses a characteristic of food on said dining surface.

[9] An active foodware system according to claim 8, wherein said characteristic is position or weight and said system comprises a stimulating component responsive to said sensing component.

[10] An active foodware system according to claim 6, wherein said system comprises a stimulating component.

[11] An active foodware system according to claim 6, wherein said system comprises a first processor.

[12] An active foodware system according to claim 11, wherein said first processor communicates with a second processor.

[13] An active foodware system according to claim 5, wherein said mechanical structure has a space underneath said dining surface for separably receiving a processor module.

[14] An active foodware system comprising: a dining surface, in combination with said dining surface, a mechanical structure for supporting said dining surface, in functional relationship with said mechanical structure, a visual stimulating component functioning during dining, wherein said visual stimulating component comprises a plurality of light-emitting sites forming an image.

[15] An active foodware system according to claim 14, wherein said visual

stimulating component is controlled by a processor.

[16] An active foodware system according to claim 15, including a processor readable program.

[17] An active foodware system according to claim 15, including a sensing component electronically sensing weight on said dining surface.

[18] An active foodware system according to claim 14, including a processor readable program for interacting with a diner and a sensing component electronically sensing weight on said dining surface, wherein said processor readable program modifies said visual stimulating component in response to said sensing component.

[19] An active foodware system according to claim 14, wherein said visual stimulating component comprises an LCD beneath said dining surface.

[20] An active foodware system comprising: at least one dining surface, in combination with said dining surface, a mechanical structure for supporting said dining surface and a sensing component, wherein when said sensing component senses weight, said active foodware system further comprises a stimulating component that provides information other than information provided by a scale.

[21] An active foodware system according to claim 20, comprising a plurality of dining surfaces, and further comprising a visual stimulating component, wherein said visual stimulating component is controlled by a processor, a processor readable program for interacting with a diner and said sensing component electronically sensing weight on said dining surface, wherein said processor readable program modifies said visual stimulating component in response to said sensing component.

[22] An active foodware system according to claim 20, wherein said stimulating component is a visual stimulating component.

[23] An active foodware system comprising a housing for receiving a laptop, said housing in communication with said laptop, a dining plate support for a dining plate capable of sensing an attribute of food in said dining plate.

[24] An active foodware system according to claim 23, wherein said processor module comprises a display and said structure has a transparent shield over said display.

[25] An active foodware system according to claim 24, wherein said display displays video.

[26] A method employing an active foodware system according to claim 1 employing computer memory external to said active foodware system, said method comprising:
transferring data from said computer memory to said processor; and

depending upon the type of said data, displaying, playing or operating said data.

[27] Method for enhancing a dining experience employing active foodware comprising a dining surface in close proximity to a stimulating component, said method comprising:
presenting food on said dining surface to a diner; and
activating said stimulating component to provide stimulation during consumption of said food.

[28] A method according to claim 27, wherein said stimulating component is at least one of visual or aural.

[29] A method according to claim 27, wherein said stimulating component is a visual display related to food consumption by said diner.

[30] A method for presenting food to a diner, said method comprising:
presenting food to a diner on said dining surface of an active foodware system according to claim 1;
sensing the weight of said food on said dining surface; and
presenting visual or auditory stimuli in relation to the weight of food sensed.

[31] A base, an adjustable support structure extending from said base, a horizontal dining platform for supporting food, while a keyboard is positioned at least partially under said dining platform, and supported by said support structure in a raised position from said base, at least a portion of said dining platform being translucent to permit viewing at least a portion of the keyboard during dining.

[32] Method for offering a dining experience, said method comprising:
running a computer program with instructions for selecting at least one active foodware system;
transmitting data to said active foodware system having a receiver for receiving and storing said data; and
operating on said data by said active foodware system.

[33] A method according to claim 32, the additional step of:
selecting said data from a data source.

[34] A method according to claim 32, the additional step of:
selecting a member of said active foodware system for receiving and storing said data.

[35] A dining plate unit comprising:
a dining plate;
a power source;
a visual sensory stimulating component received in or attached to one of said dining plate or an underplate, and including at least one light source selected from the group consisting of light emitting diodes (LEDs), optical wave guides,

electroluminescent light sources, liquid crystal display (LCD) panels, fluorescent displays, plasma displays, incandescent lights, fluorescent lights and fluorescent materials;
a visual sensory stimulating component controller for selectively energizing said at least one light source for enhancing a dining experience;
light from said at least one light source forming an image, wherein a light guide is employed with said LEDs and incandescent lights.

[36] An active foodware system comprising:
a dining plate comprising at least one light guide;
an underplate;
at least one visual sensory stimulating component attached to said underplate;
a power source for energizing said at least one visual sensory stimulating component and generating light, wherein when said plate is in functional relationship to said underplate, said light is directed to said at least one light guide.

[37] An active foodware system according to claim 36, wherein said underplate further comprises (1) a translucent film between said at least one visual sensory stimulating component and said at least one light guide and (2) an actuator for moving said translucent film and modifying said light.

[38] An active foodware system according to claim 36, wherein said underplate further comprises at least one of the group consisting of a controller, a processor, a speaker, a light modifier and an actuator.

[39] An active foodware system according to claim 36, wherein said dining plate comprises a cavity, said at least one light guide extending from said cavity, said underplate comprising a protuberance for inserting into said cavity and supporting said at least one visual sensory stimulating component in functional relationship to said at least one light guide.

[40] An active foodware system comprising: a dining surface, in combination with said dining surface, a mechanical structure for supporting said dining surface, said mechanical structure comprising a housing for a laptop or gamepad, said housing occupied by said laptop or gamepad.

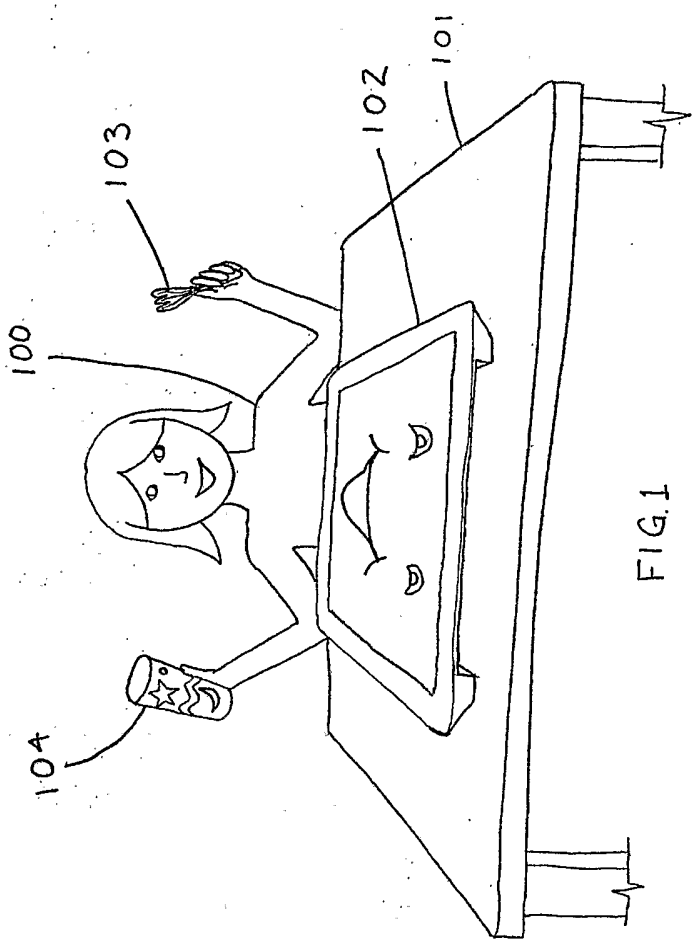

FIG.1

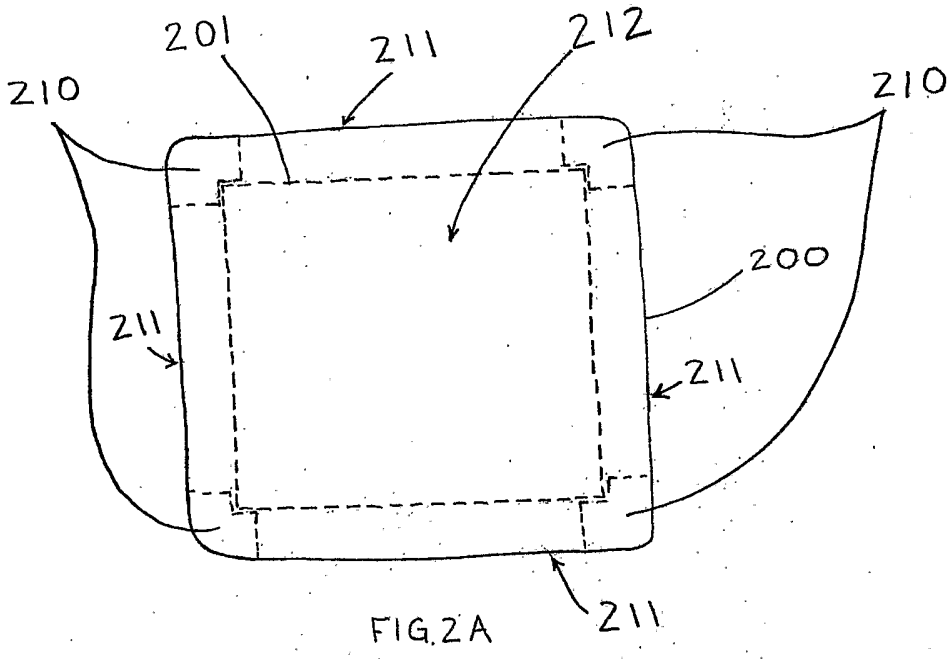

FIG. 2A

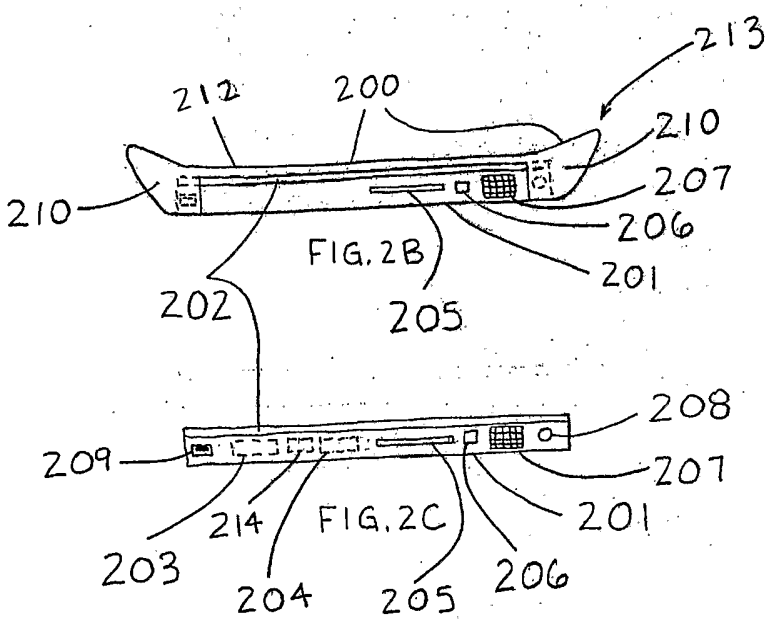

FIG. 2B

FIG. 2C

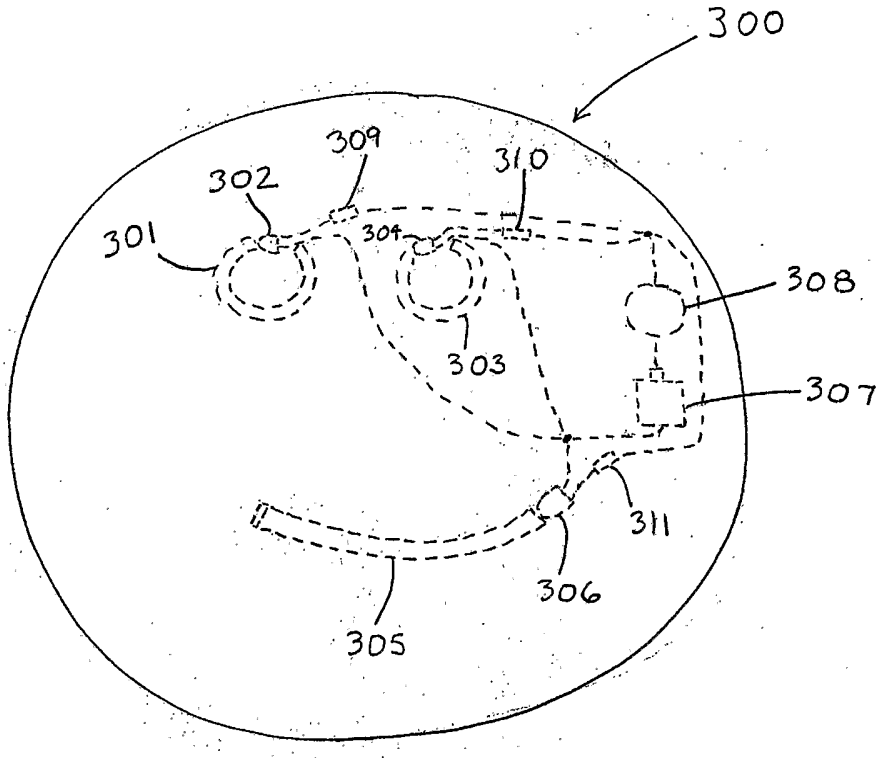

FIG. 3A

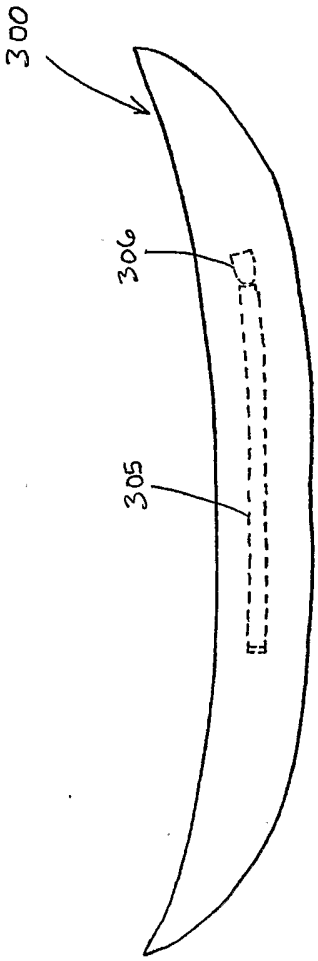

FIG. 3B

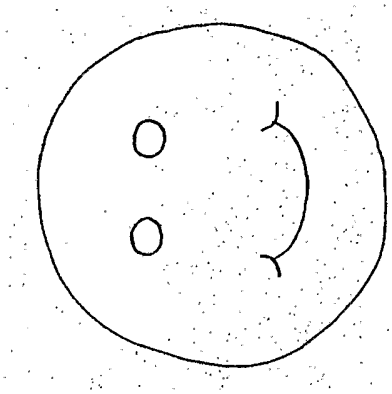

FIG. 4B

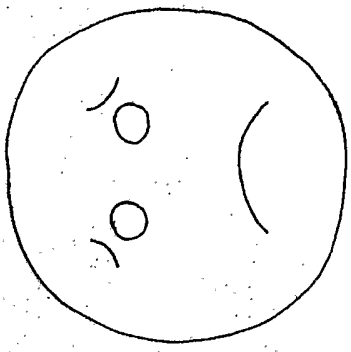

FIG. 4D

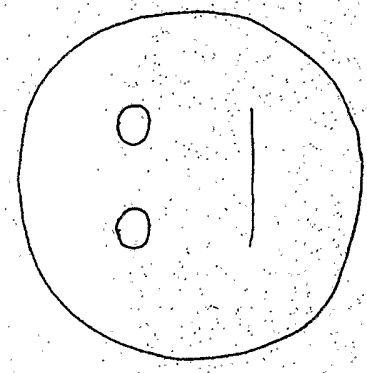

FIG. 4A

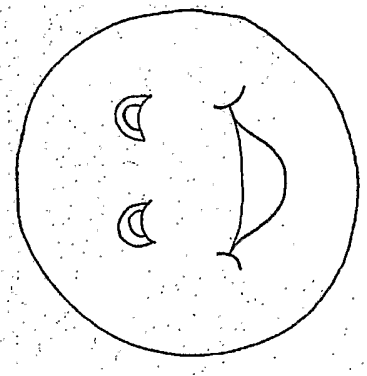

FIG. 4C

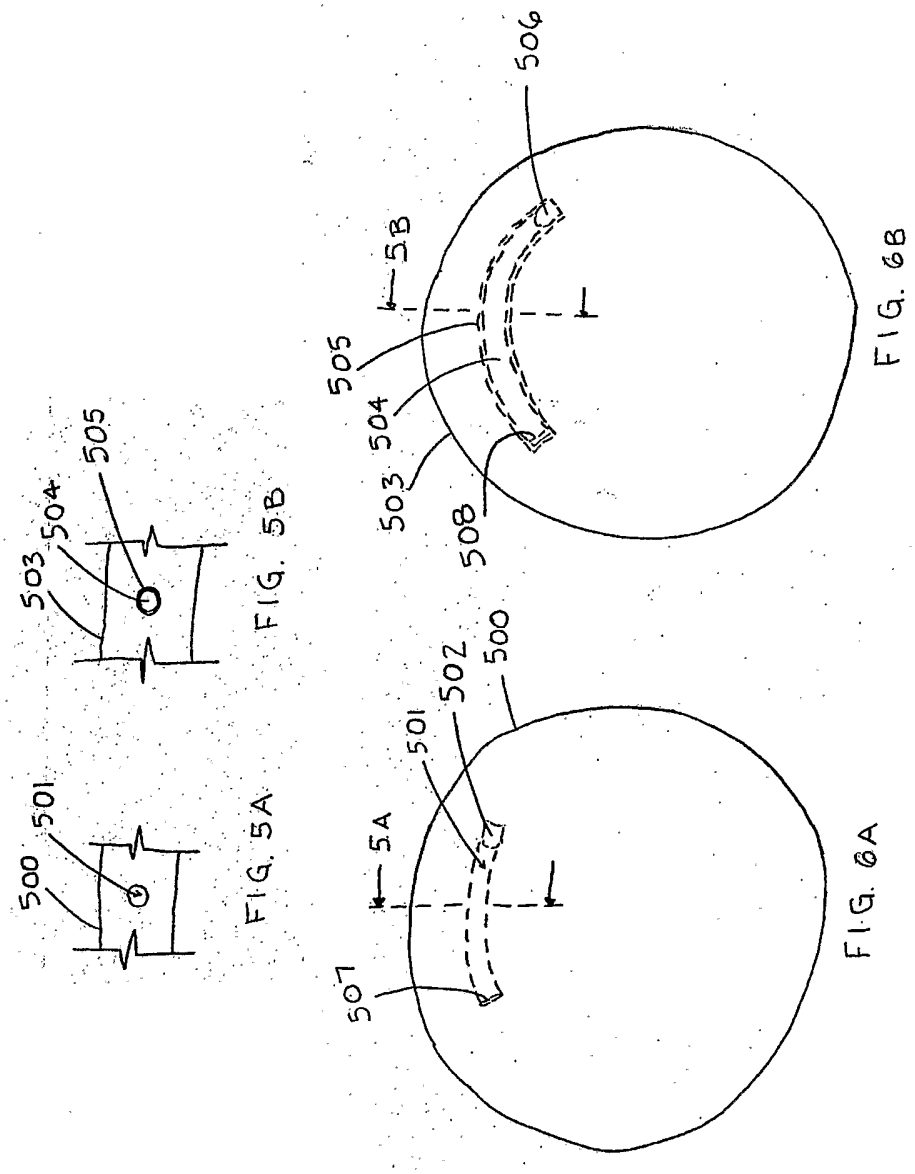
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FIG. 6A
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FIG. 6B
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FIG. 5A
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FIG. 5B

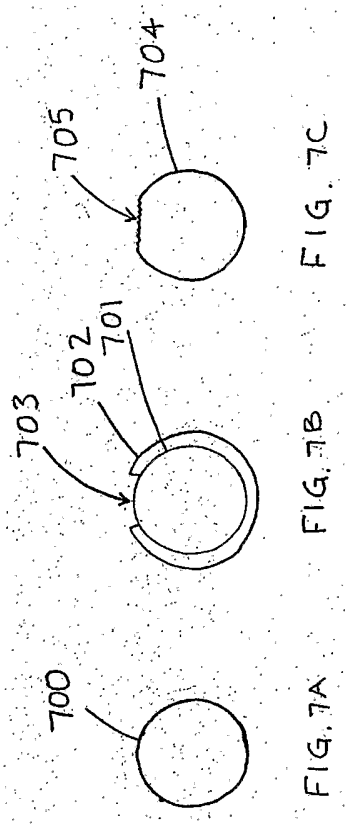

FIG. 7A FIG. 7B FIG. 7C

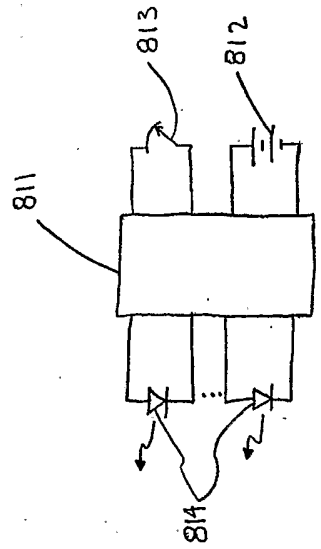

FIG. 8C

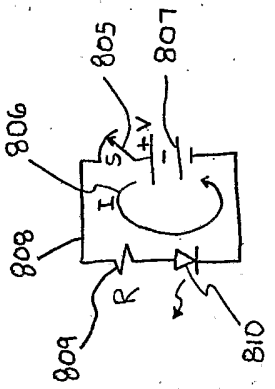

FIG. 8B

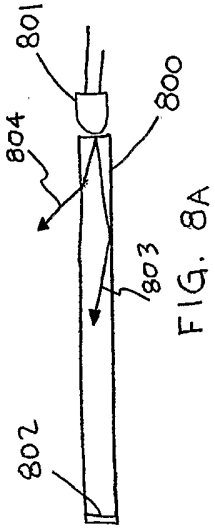

FIG. 8A

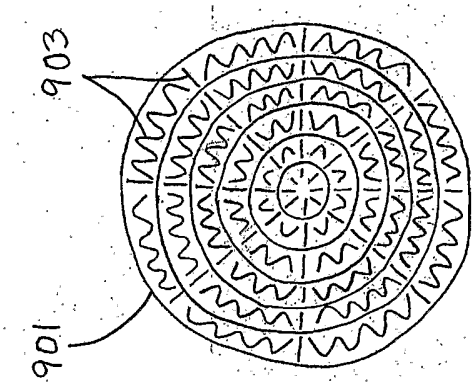

FIG. 9B

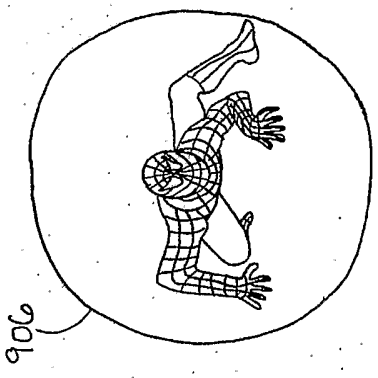

FIG. 9D

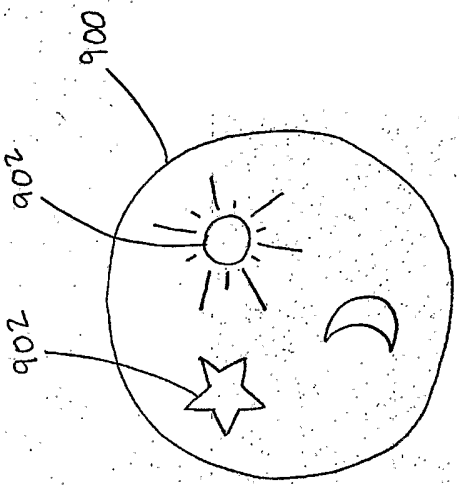

FIG. 9A

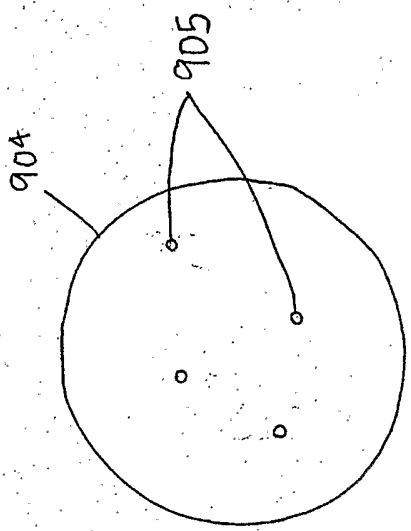

FIG. 9C

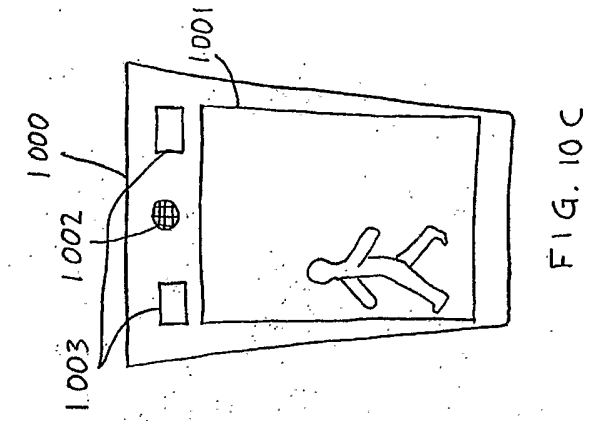

FIG. 10 C

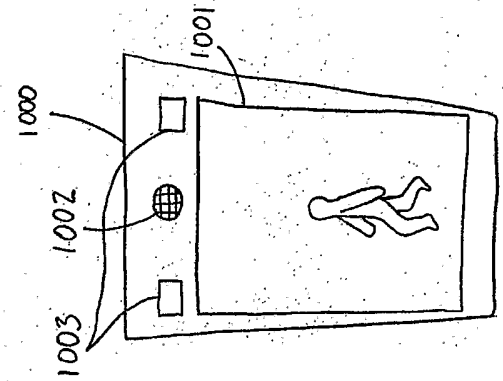

FIG. 10 B

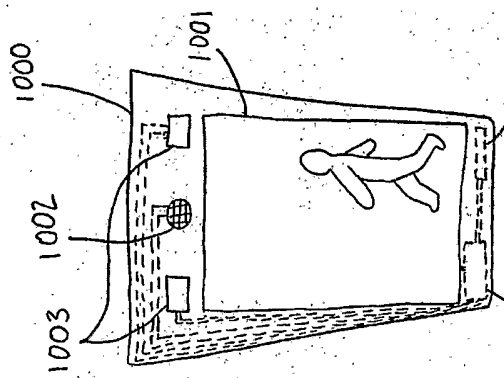

FIG. 10 A

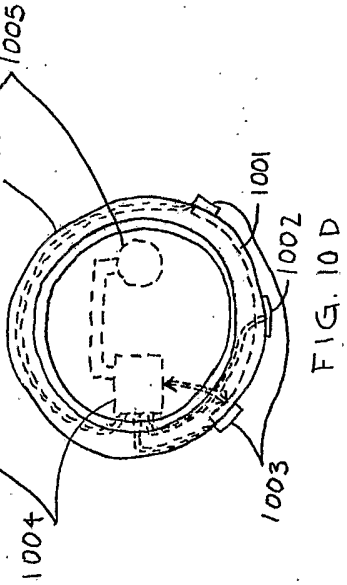

FIG. 10 D

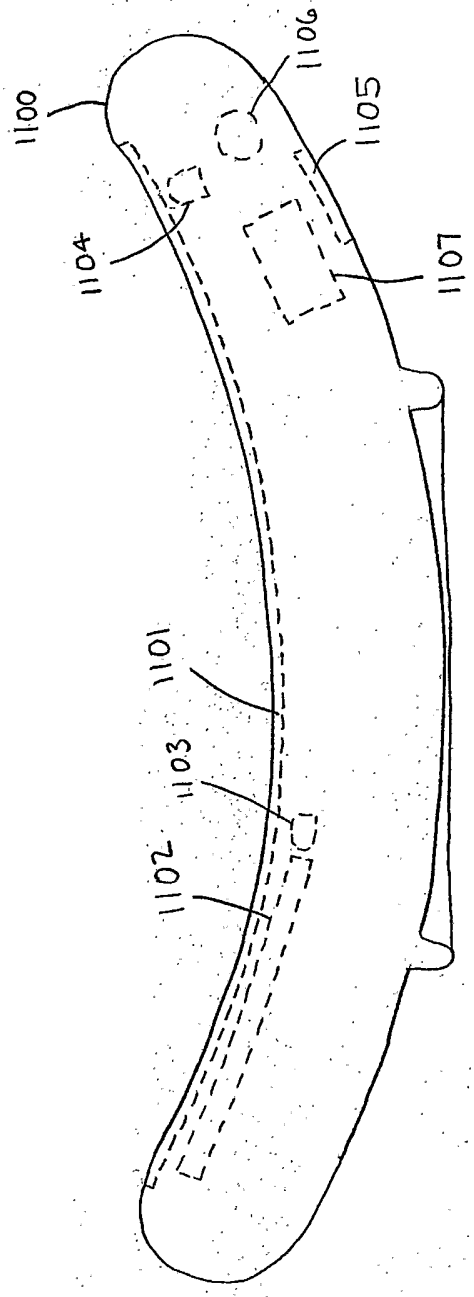

FIG. 11

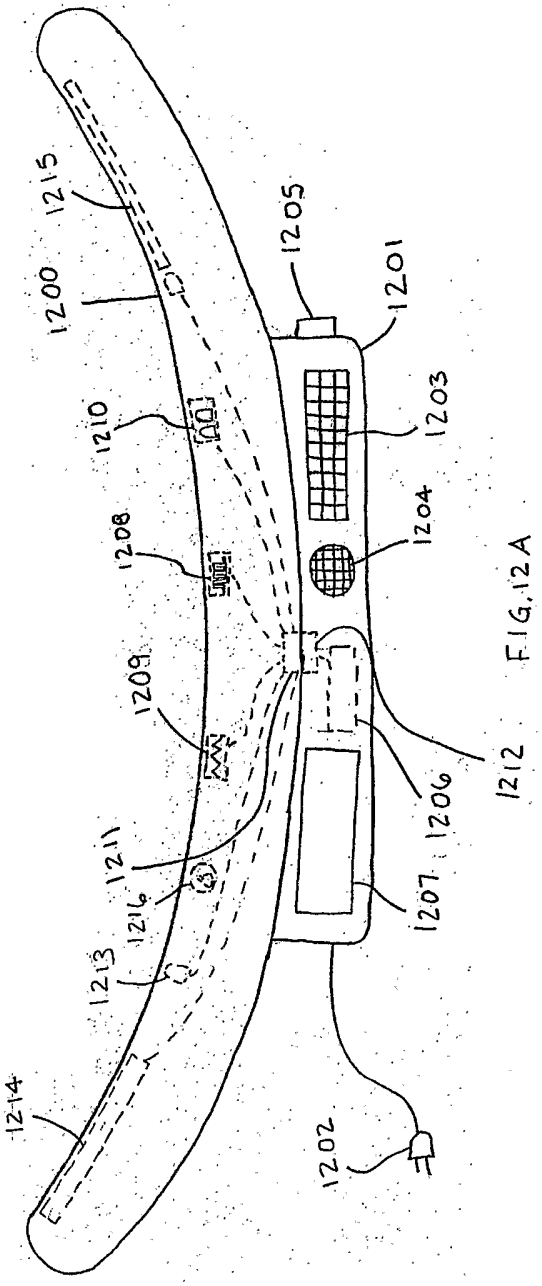
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FIG.12A

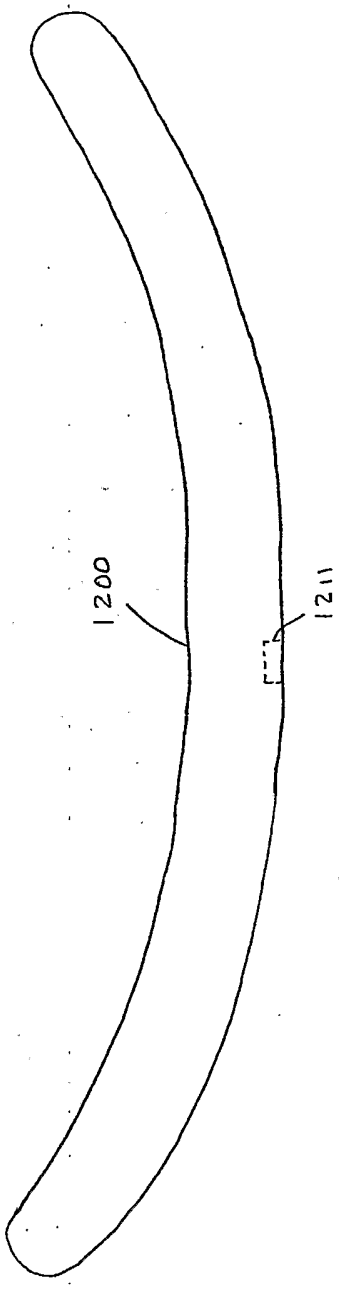

FIG. 12B

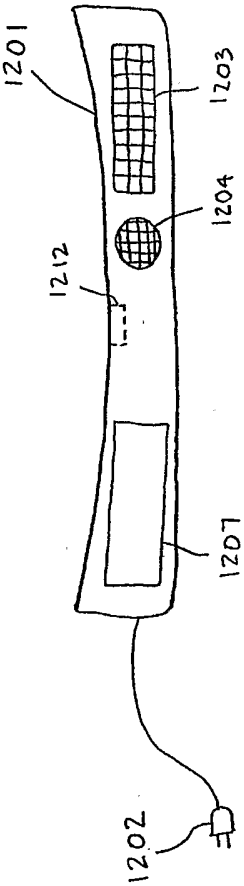

FIG. 12C

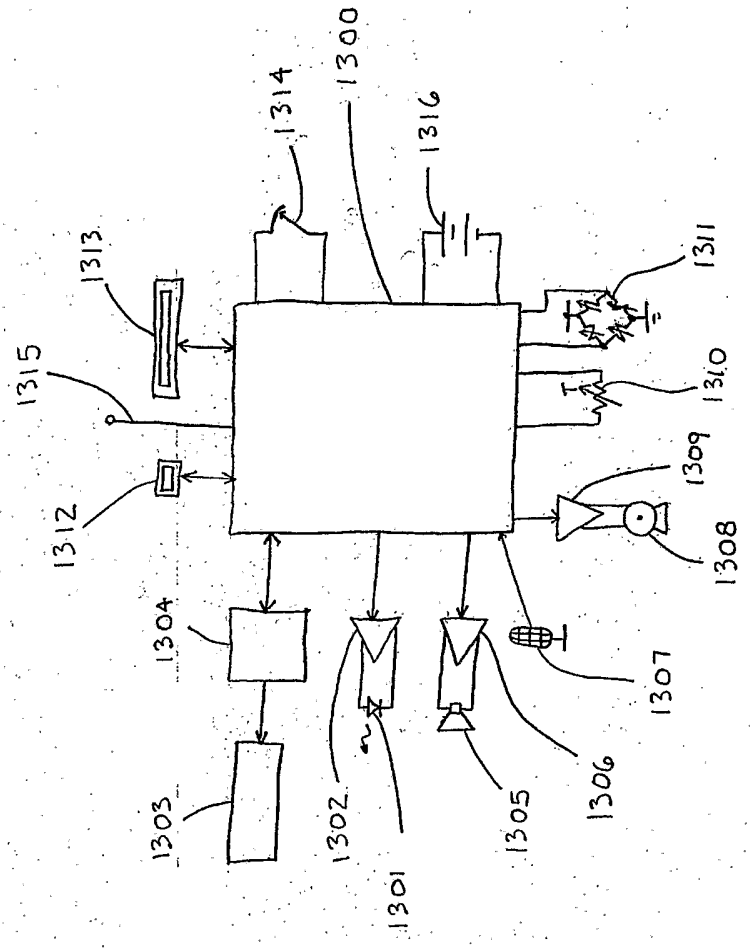
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FIG. 13

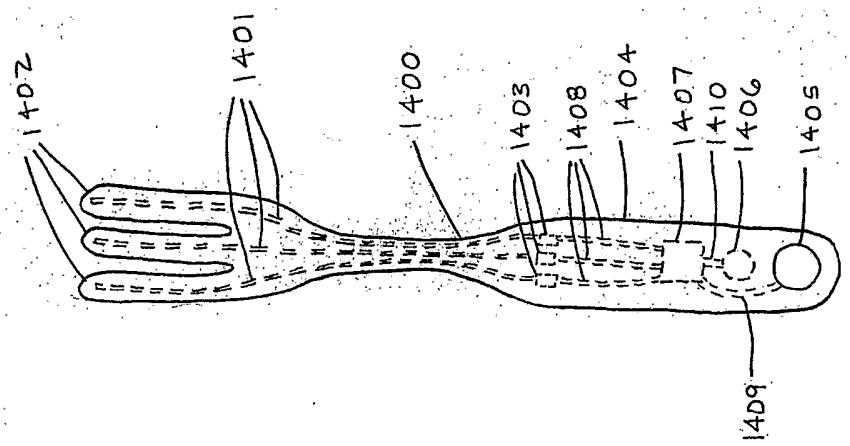


FIG. 14

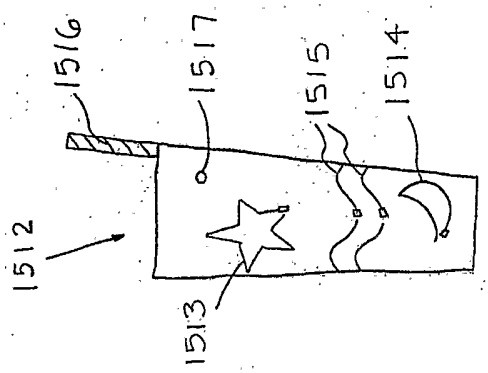


FIG. 15D

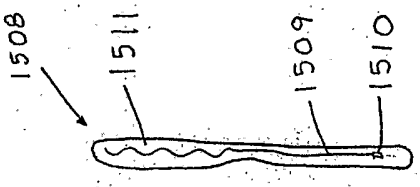


FIG. 15C

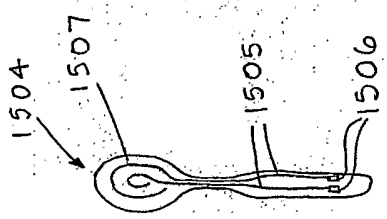


FIG. 15B

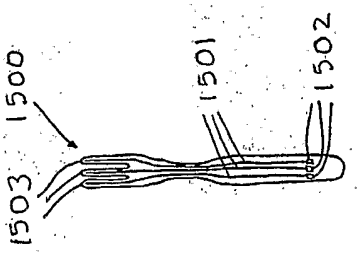


FIG. 15A

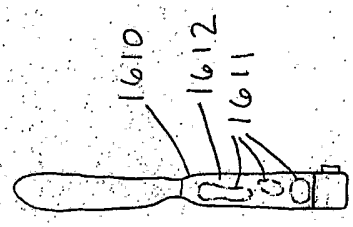


FIG. 16B

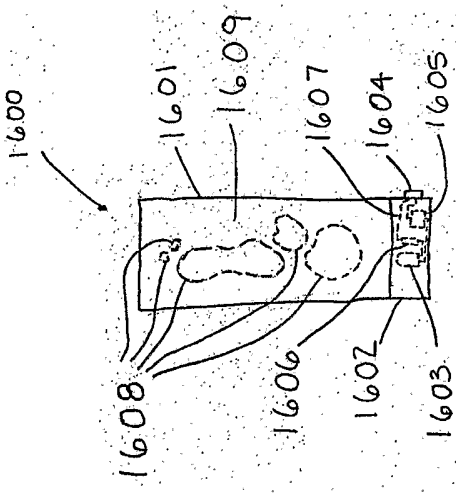


FIG. 16A

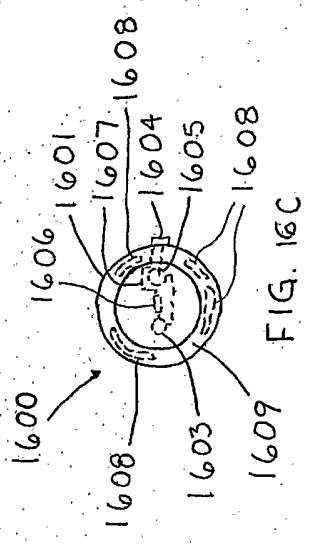


FIG. 16C

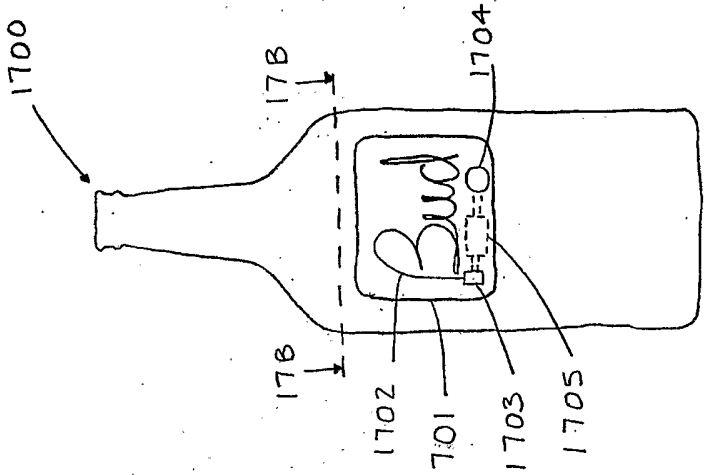


FIG. 17A

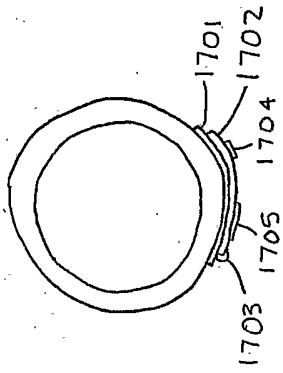


FIG. 17B

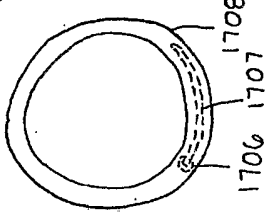


FIG. 17C

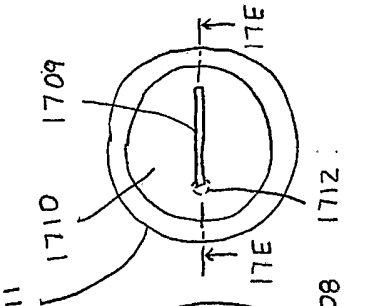


FIG. 17D

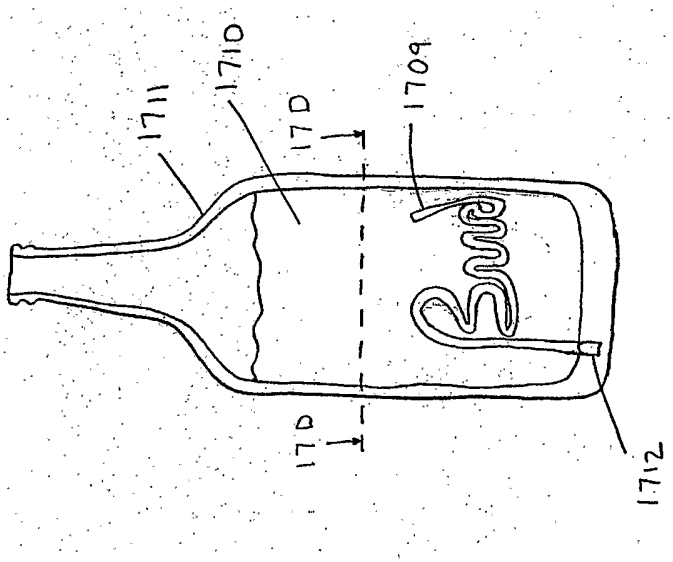


FIG. 17E

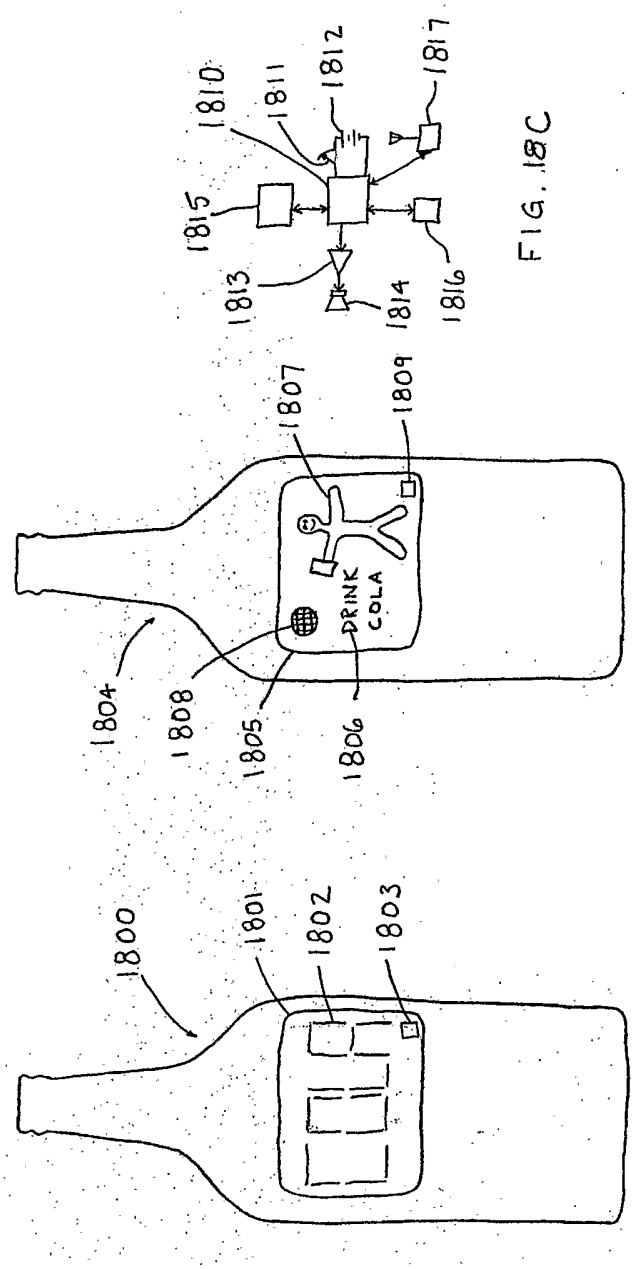


FIG. 18C

FIG. 18B

FIG. 18A

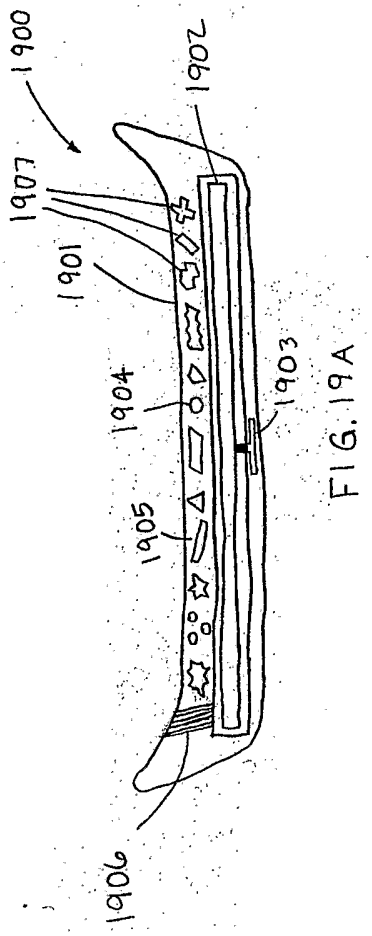


FIG. 19A

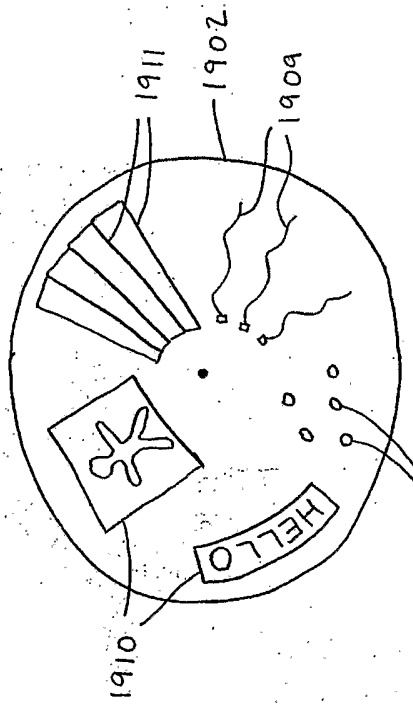


FIG. 19B

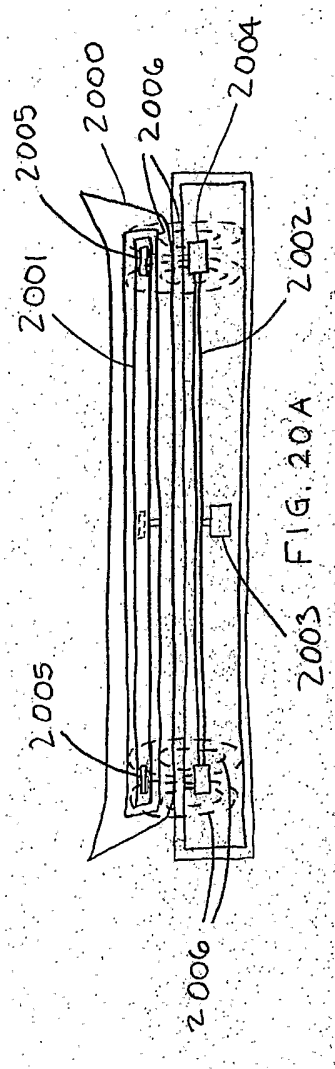


FIG. 20A

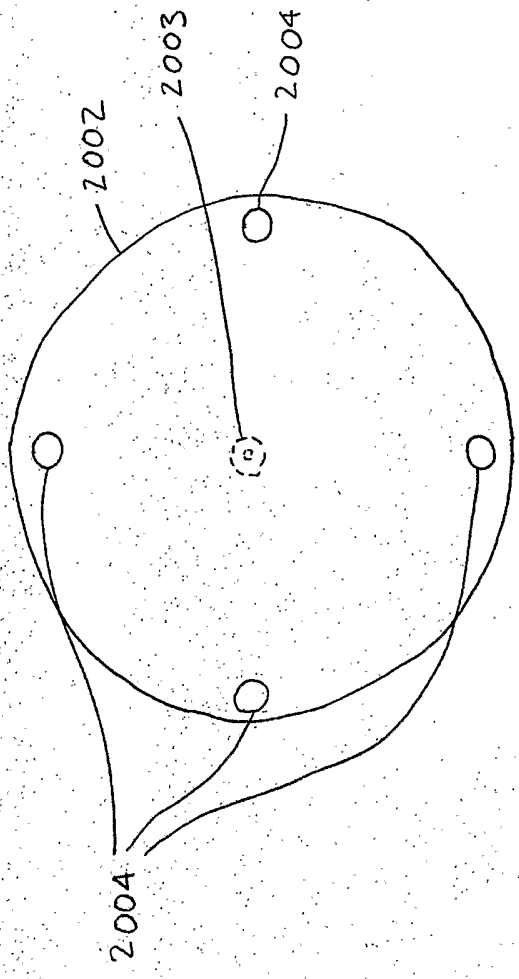


FIG. 20B

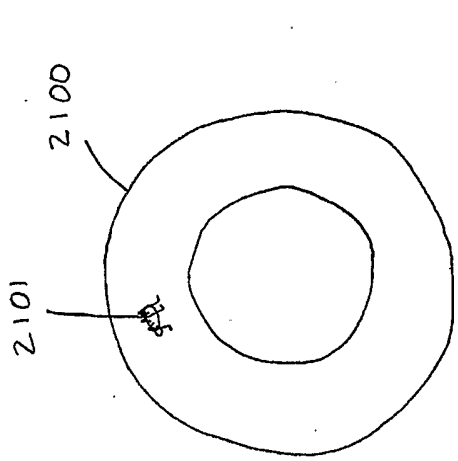


FIG.21B

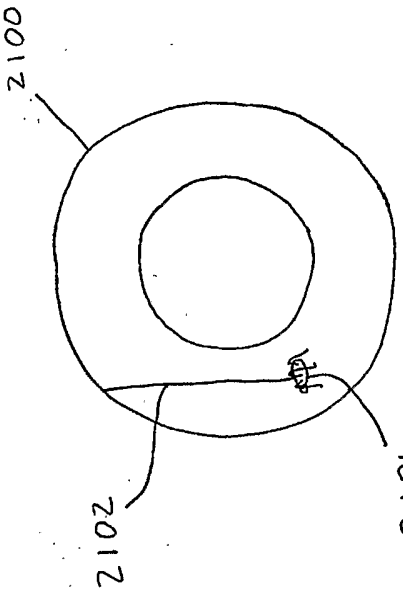


FIG.21D

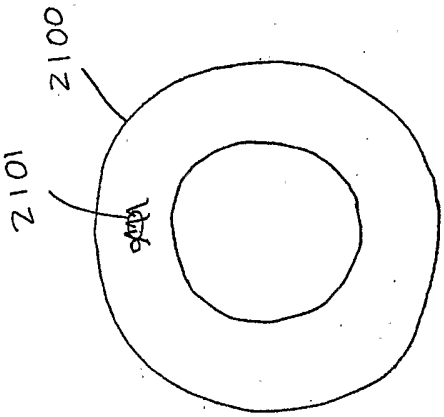


FIG.21A

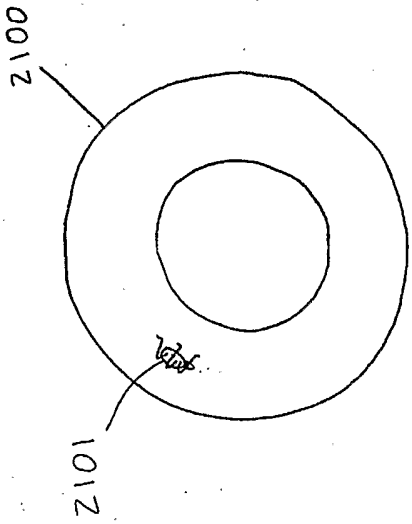


FIG.21C

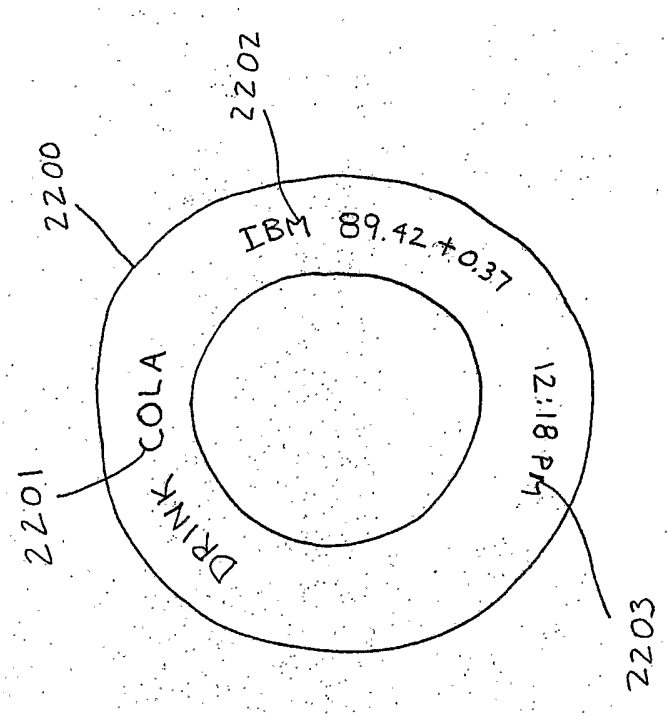


FIG. 22

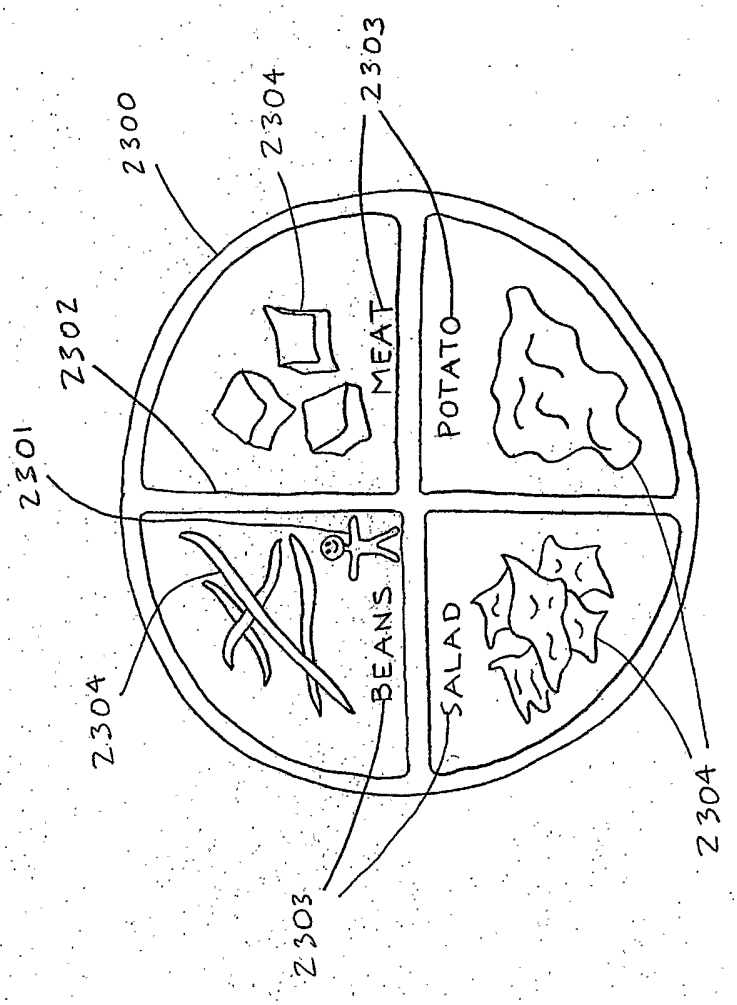

2300
2304
2303
2302
2301
MEAT
POTATO
BEANS
SALAD
2304
2303
2304

FIG. 23 A

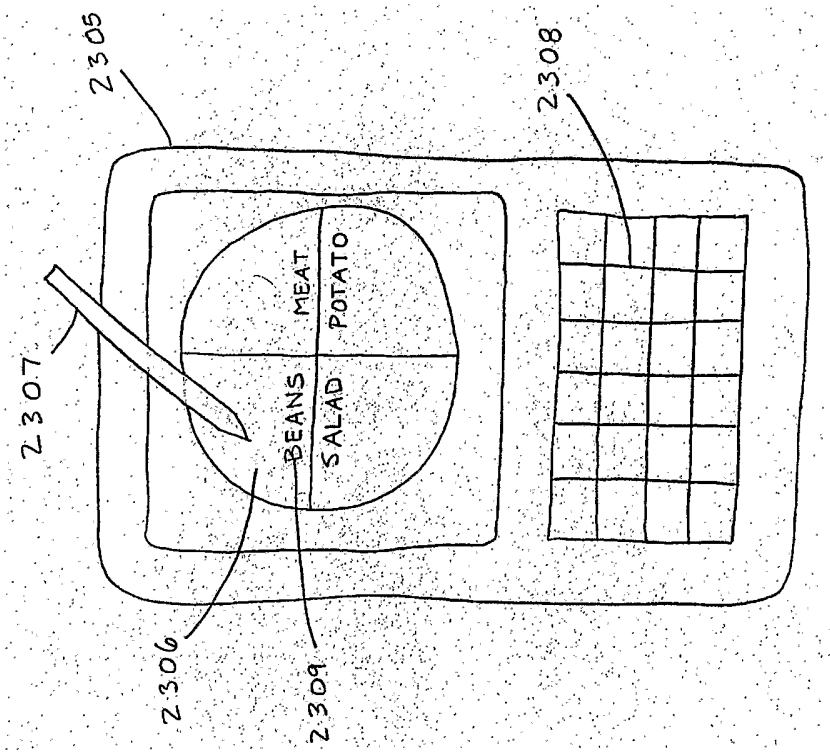


FIG. 23B

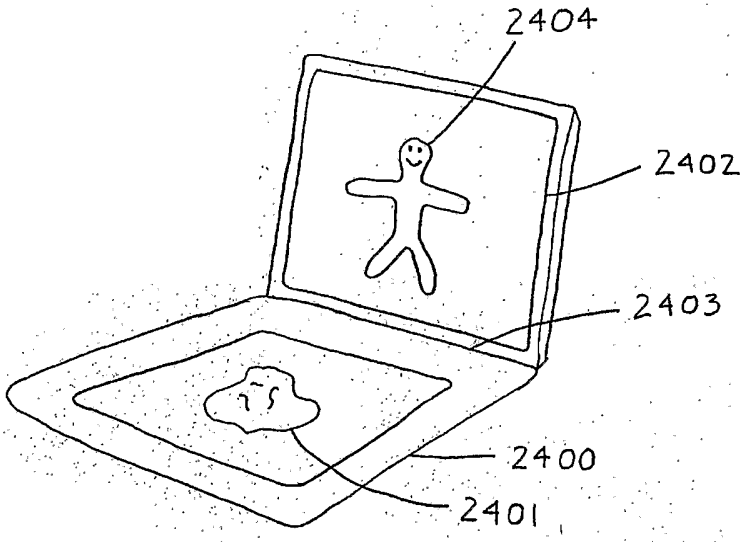


FIG. 24 A

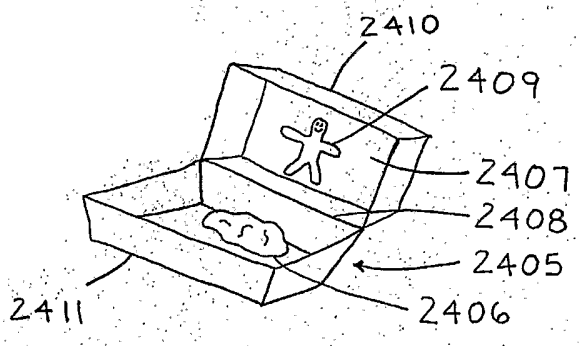


FIG. 24 B

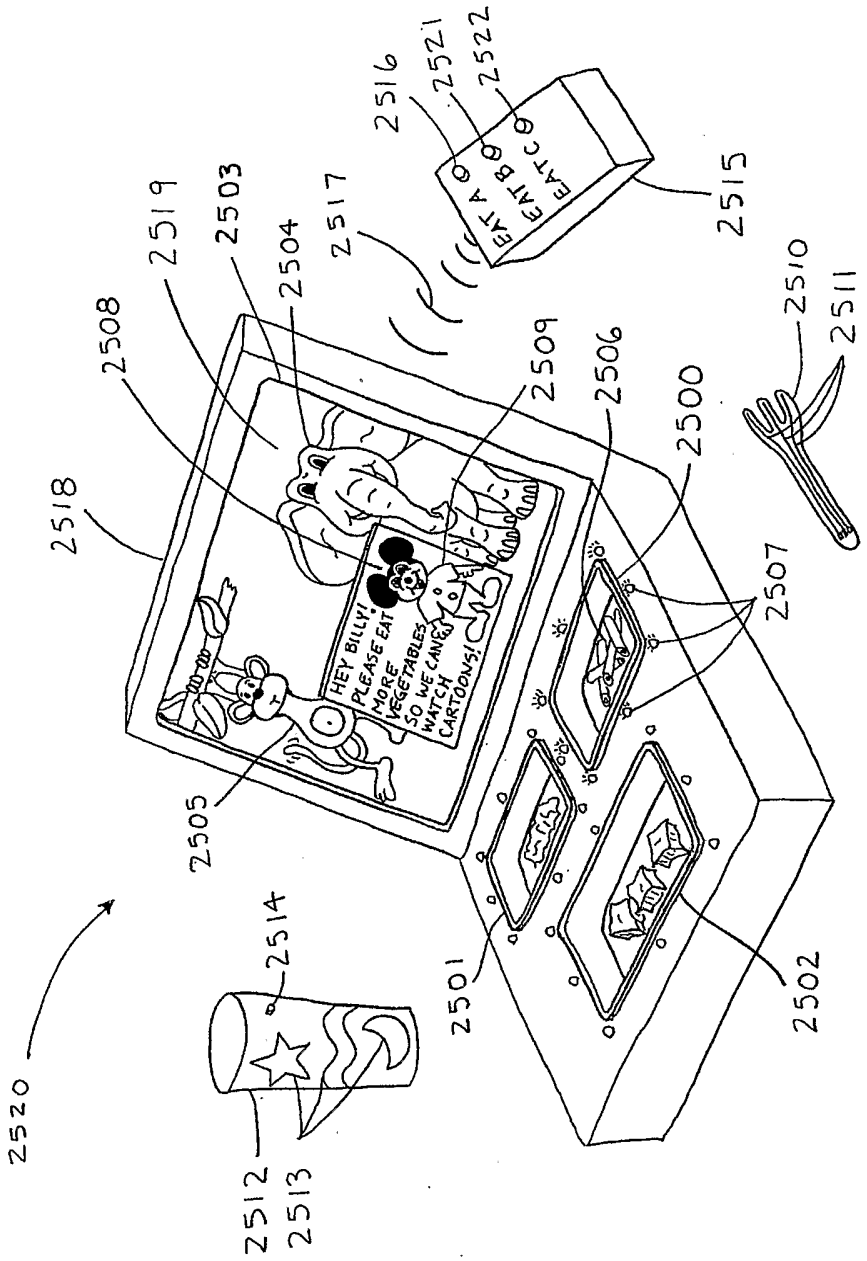

2516
2521
2522
2515
2519
2503
2517
2504
2508
2509
2506
2500
2510
2511
2518
2507
2505
2501
2502
2514
2520
2512
2513
HEY BILLY! PLEASE EAT MORE VEGETABLES SO WE CAN WATCH CARTOONS!

FIG. 25

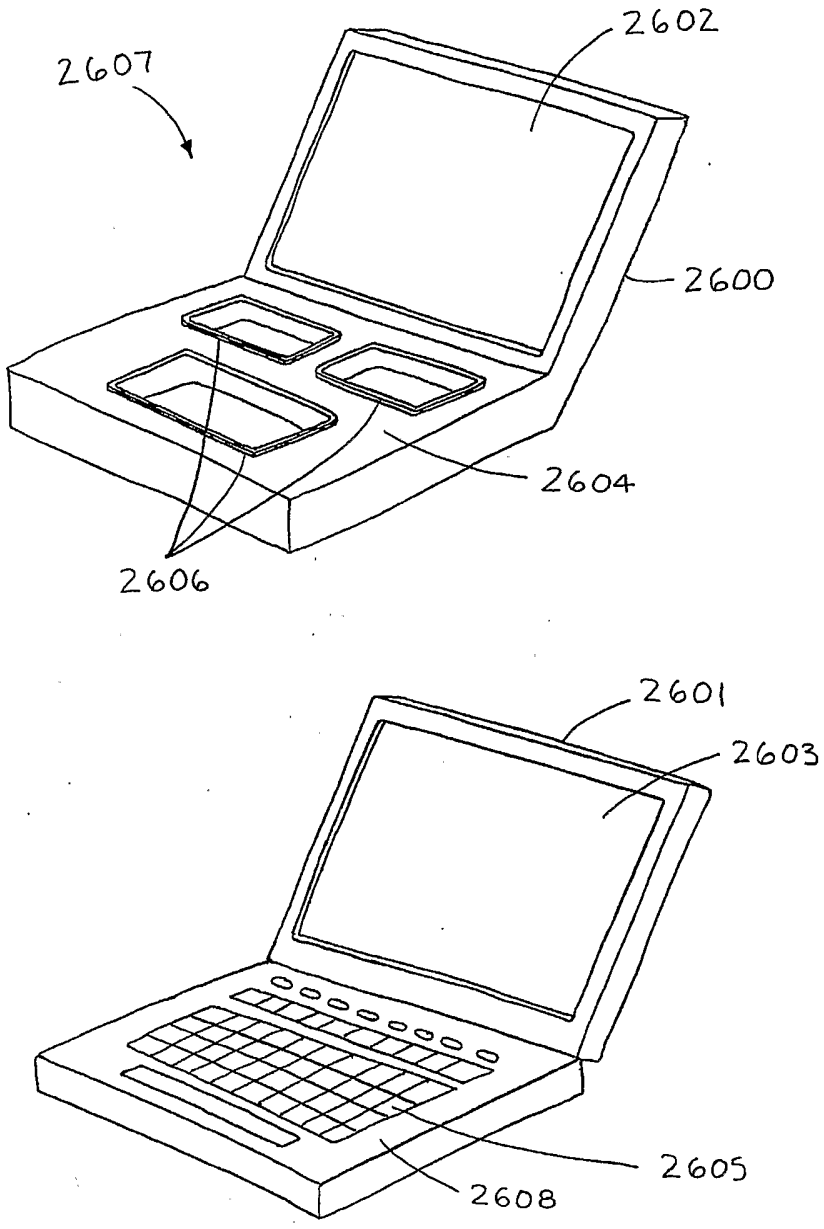


FIG. 26

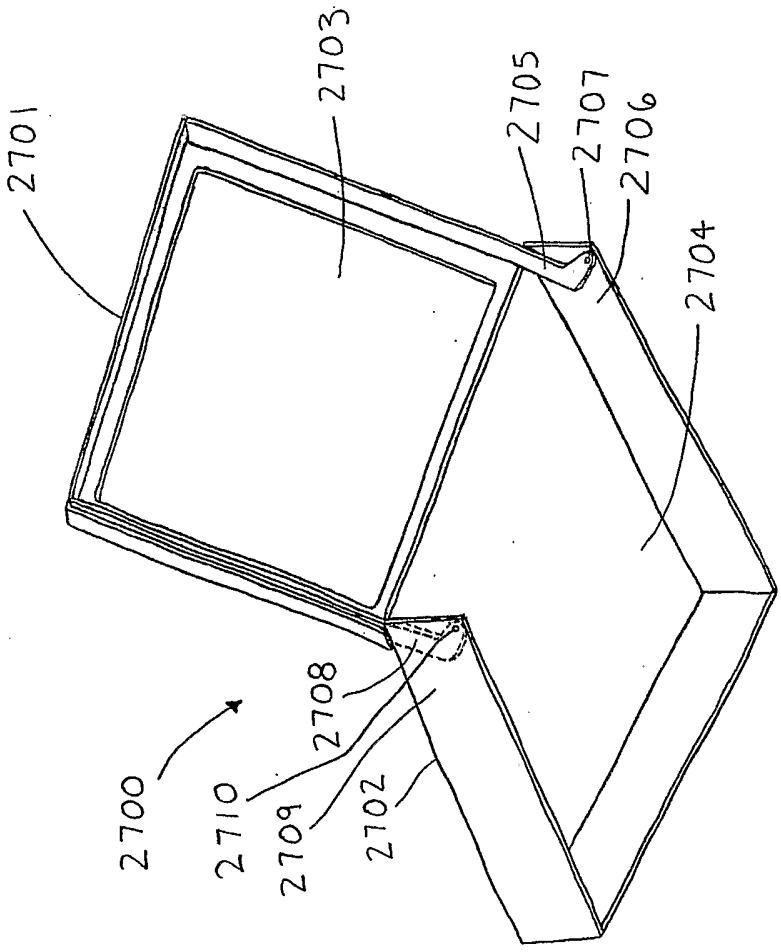


FIG. 27A

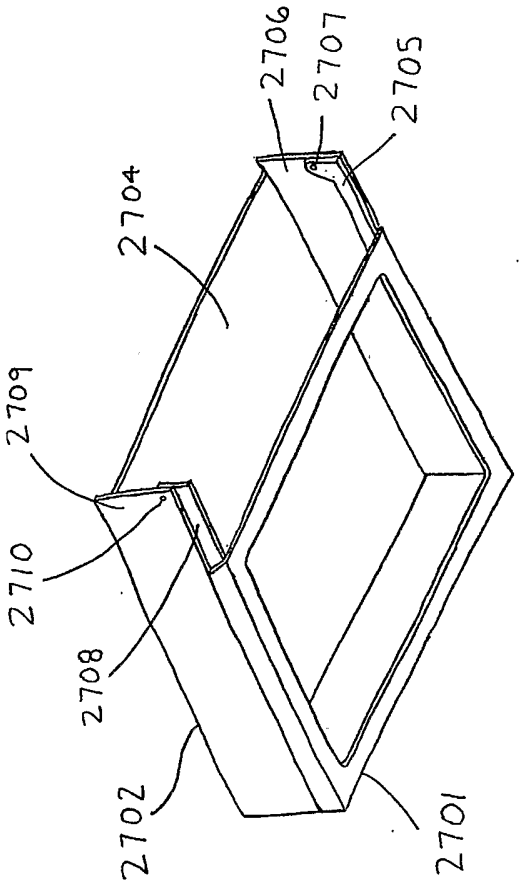


FIG. 27B

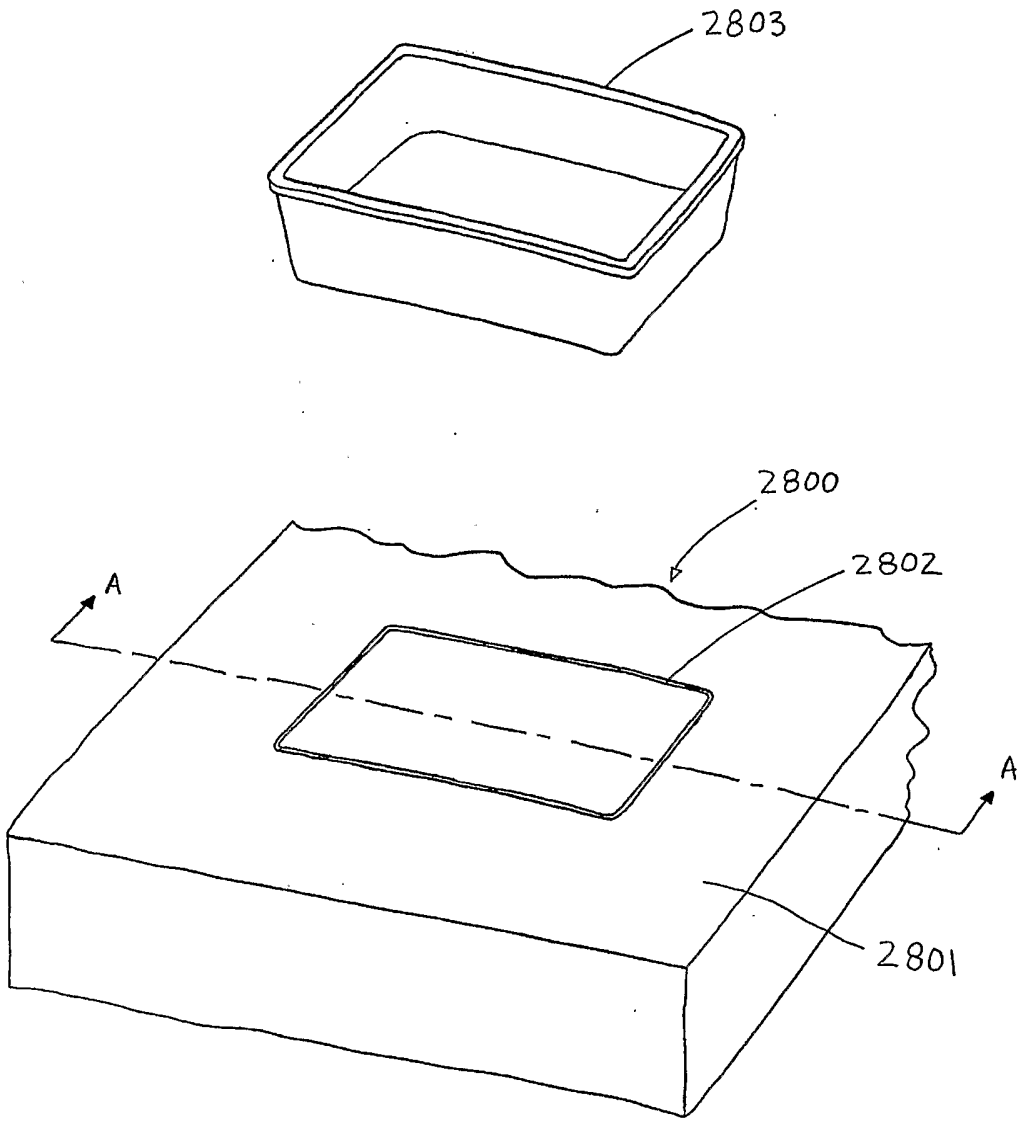


FIG. 28

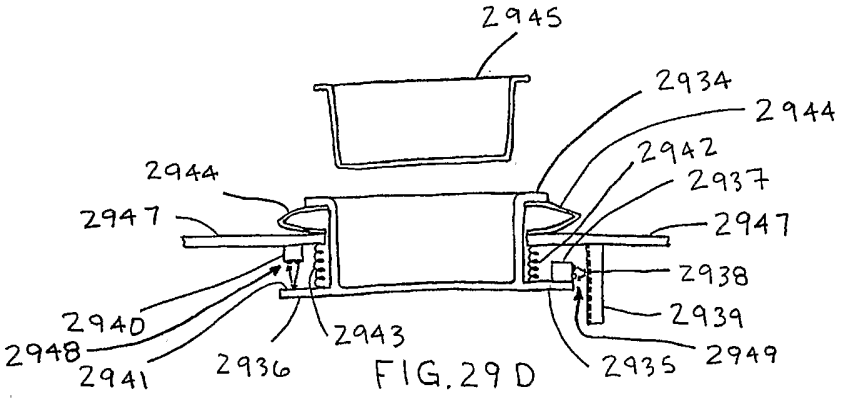


FIG. 29 D

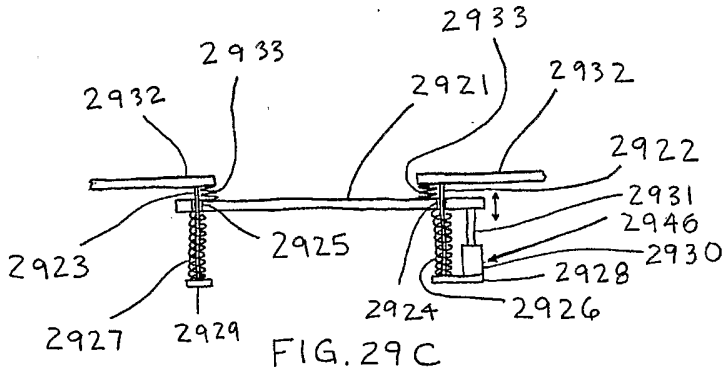


FIG. 29 C

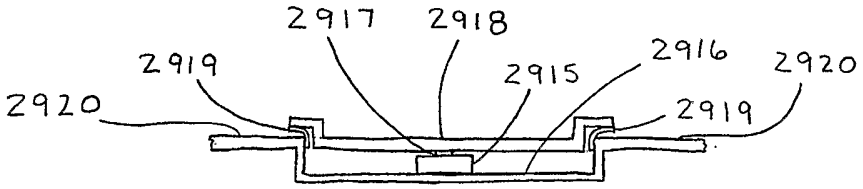


FIG. 29 B

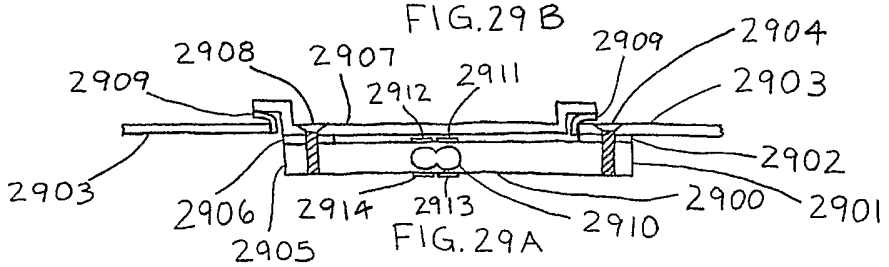


FIG. 29 A

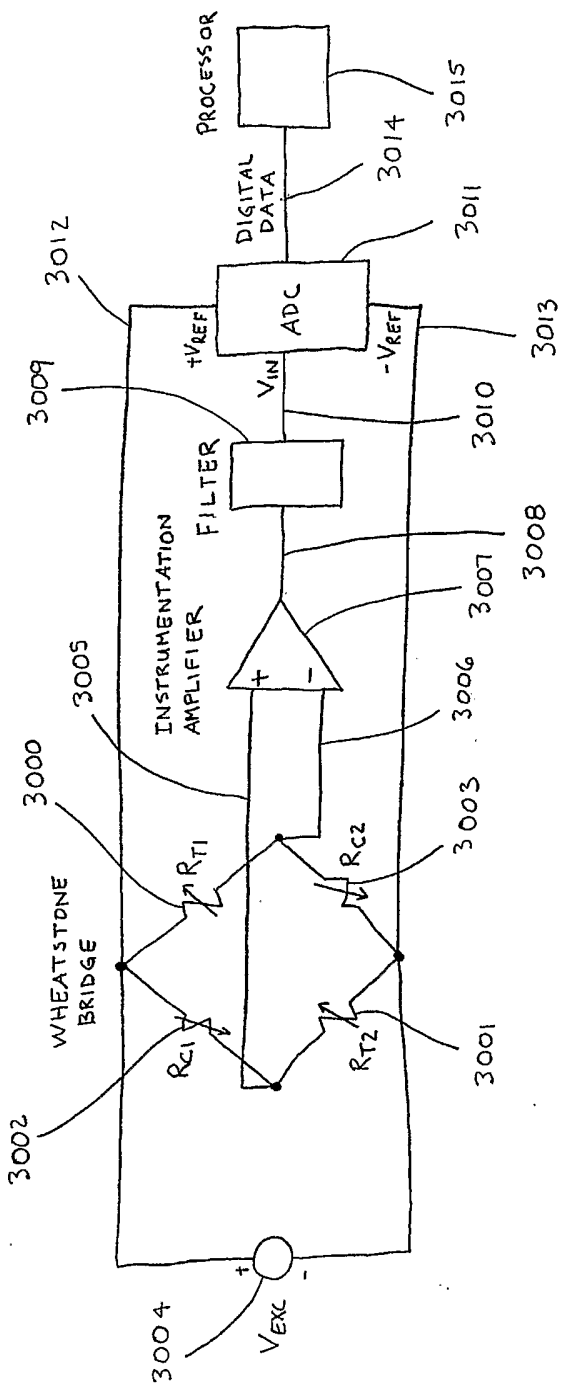

PROCESSOR
3015
DIGITAL DATA
3014
3011
3012
ADC
+VREF
-VREF
3013
VIN
3009
3010
FILTER
INSTRUMENTATION AMPLIFIER
3008
3007
3005
3006
3000
3003
RT1
RC2
WHEATSTONE BRIDGE
RC1
RT2
3001
3002
3004
VEXC

FIG. 30

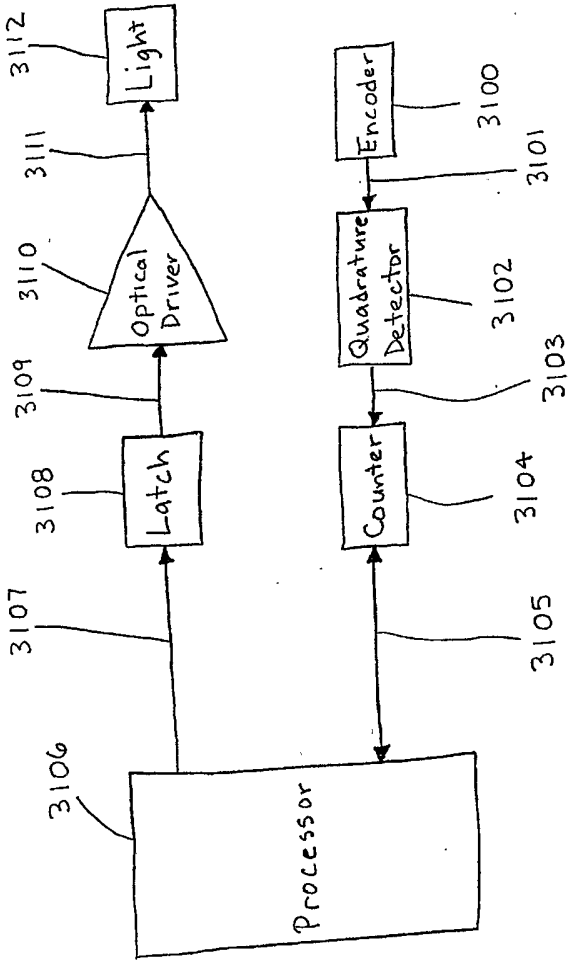

Light
3112
3111
Optical Driver
3110
3109
Latch
3108
3107
3106
Processor
Encoder
3100
3101
Quadrature Detector
3102
3103
Counter
3104
3105

FIG. 31

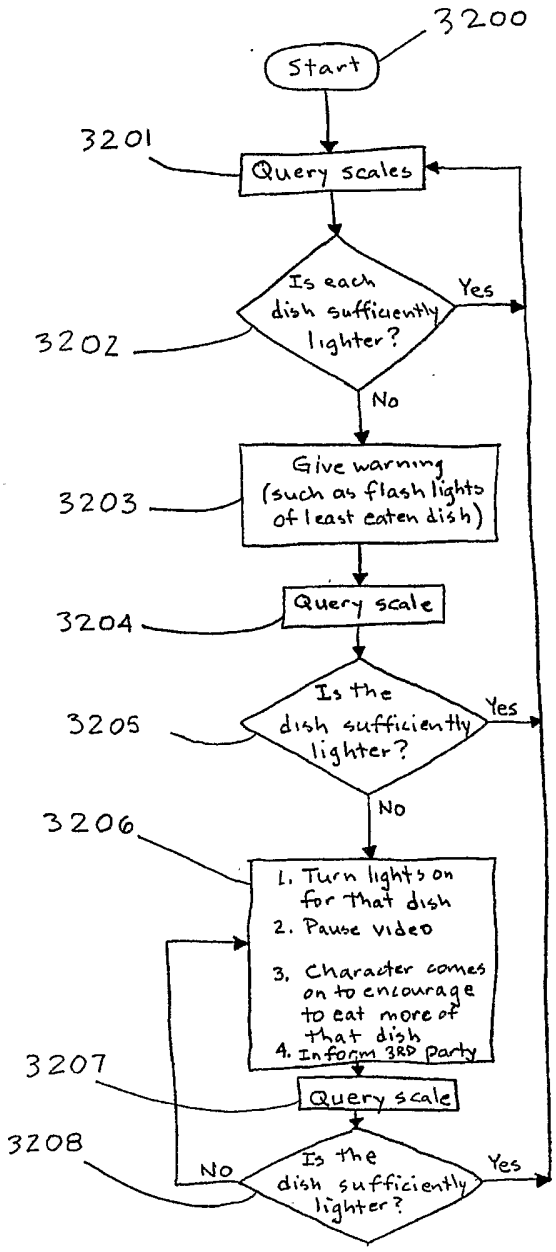

3200
Start
3201
Query scales
Is each dish sufficiently lighter?
Yes
3202
No
Give warning (such as flash lights of least eaten dish)
3203
Query scale
3204
Is the dish sufficiently lighter?
Yes
3205
No
3206
1. Turn lights on for that dish
2. Pause video
3. Character comes on to encourage to eat more of that dish
4. Inform 3RD party
3207
Query scale
3208
Is the dish sufficiently lighter?
No
Yes

FIG. 32

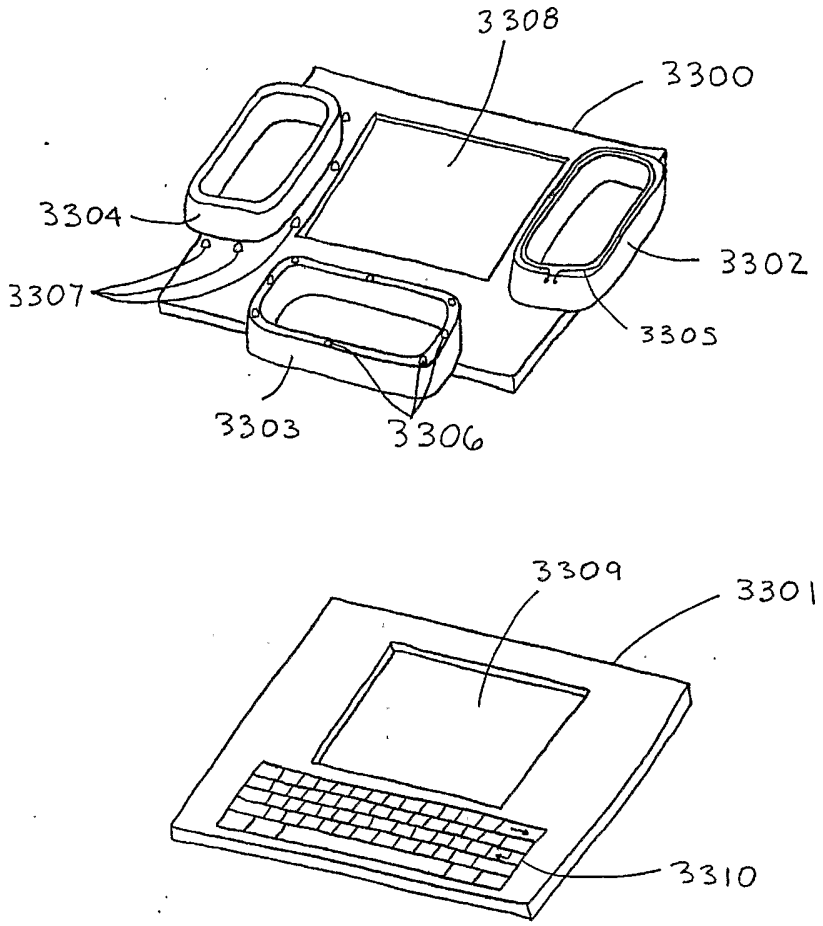


FIG. 33

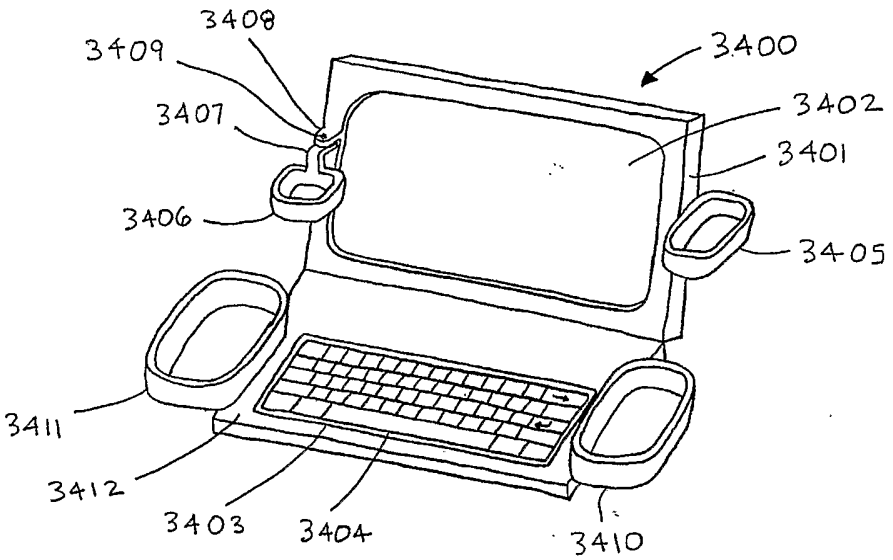


FIG. 34

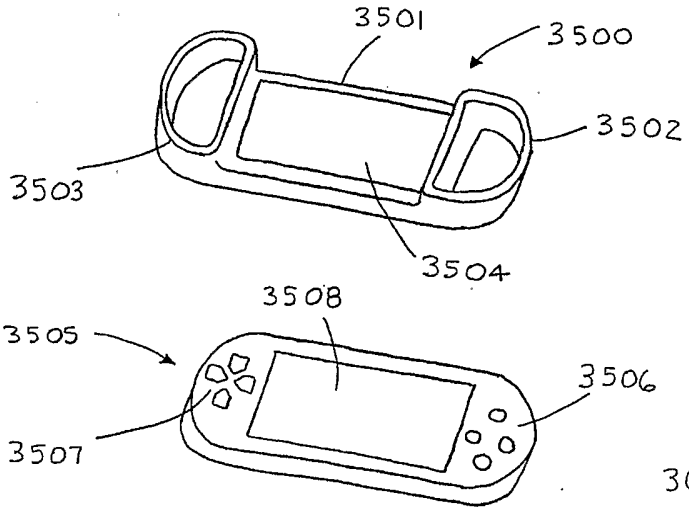


FIG. 35

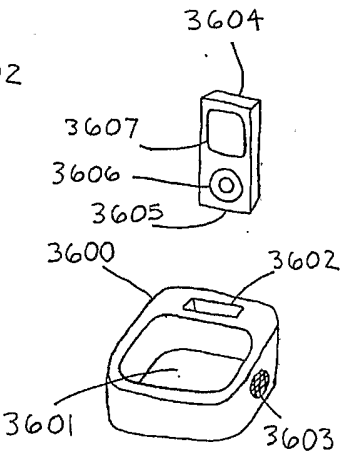


FIG. 36

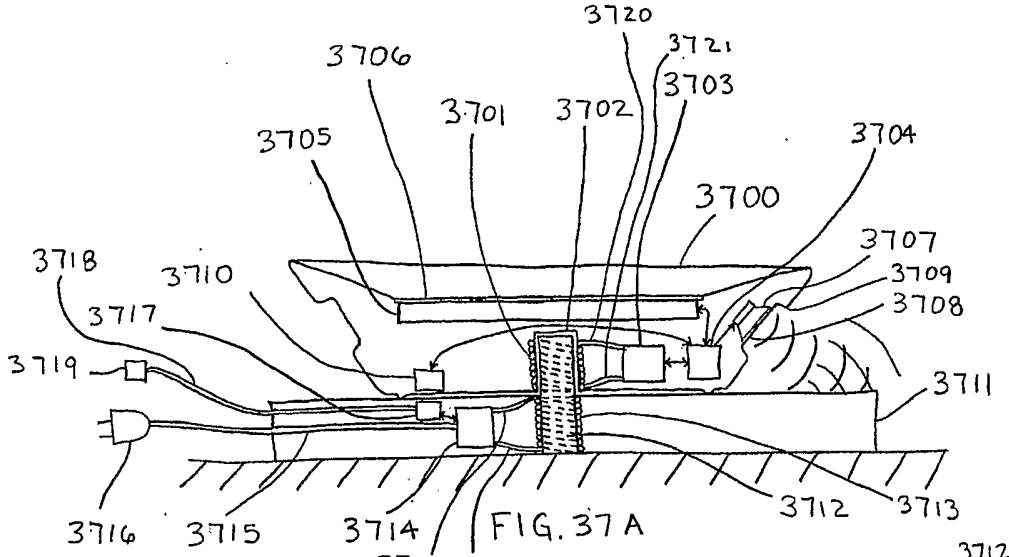


FIG. 37A

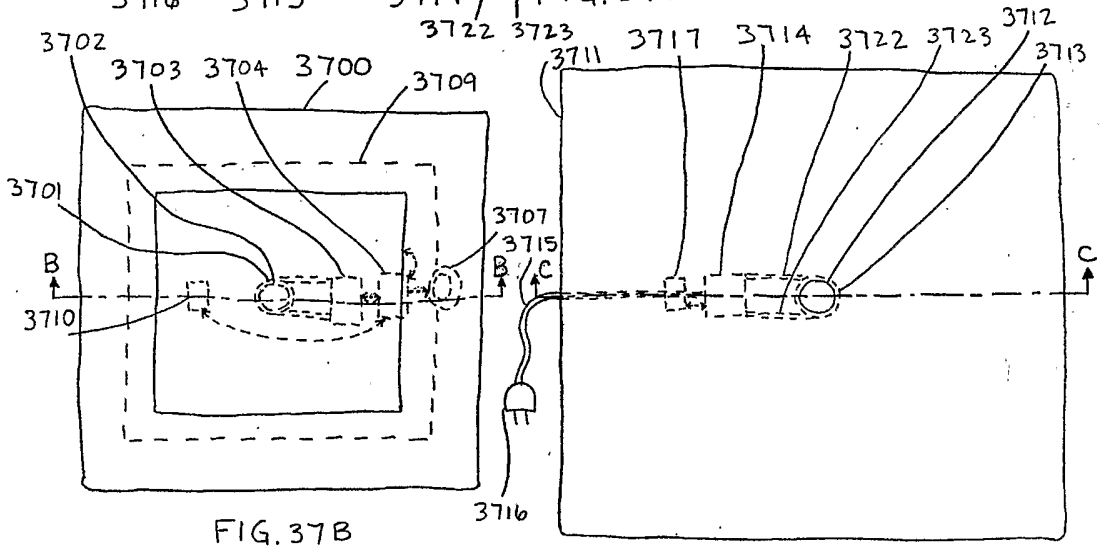


FIG. 37B

FIG. 37C

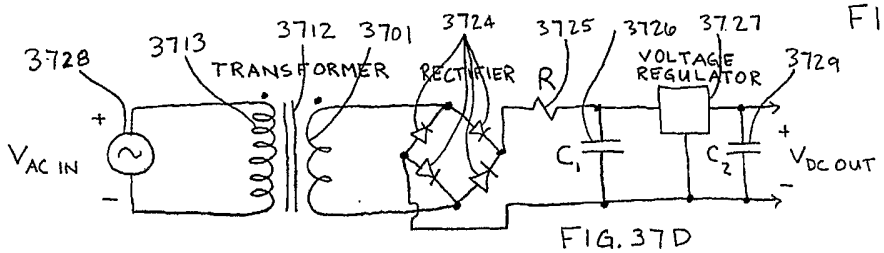


FIG. 37D

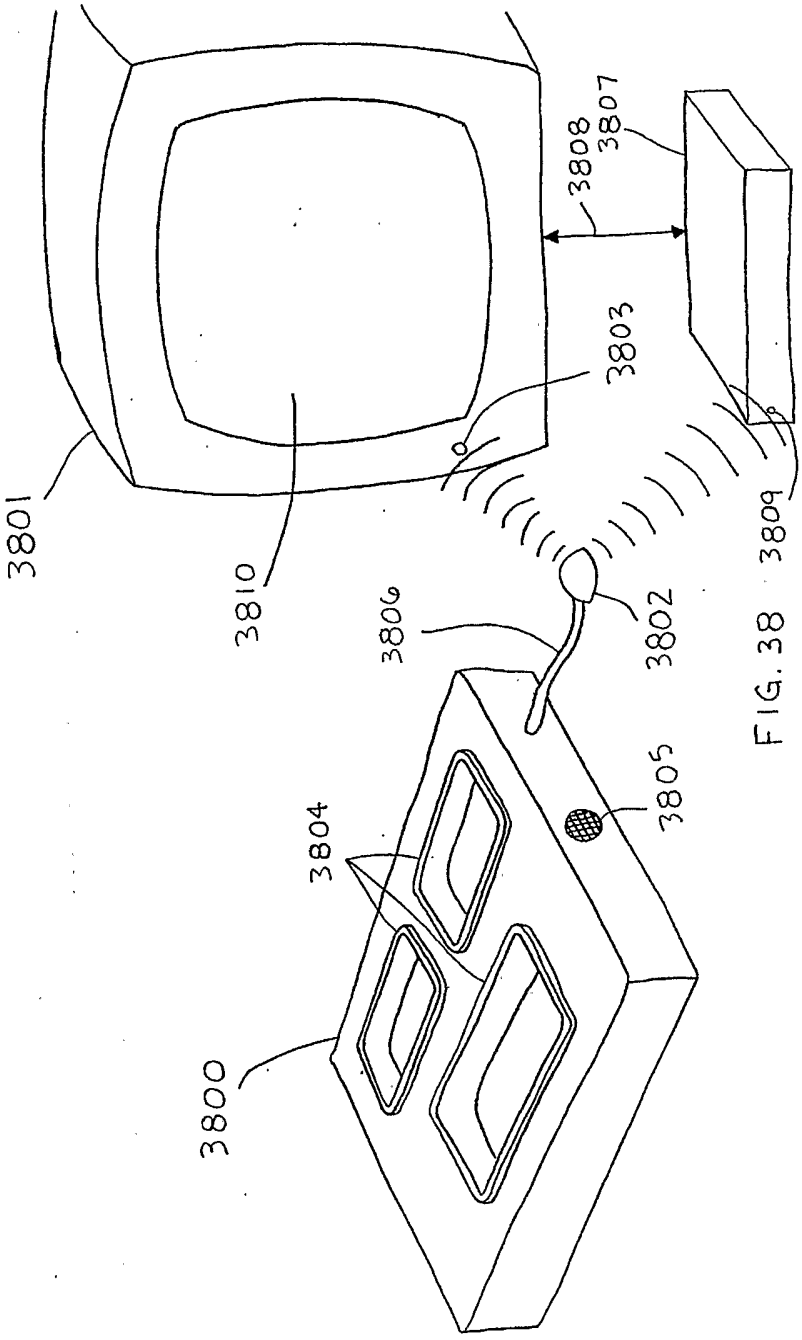


FIG. 38

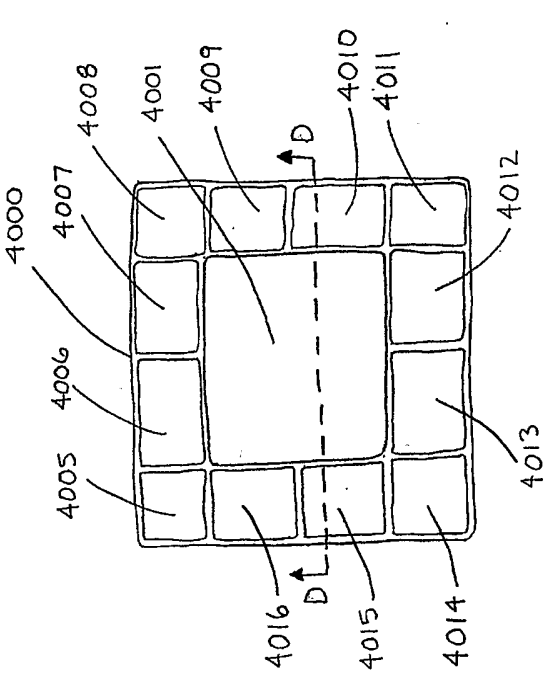


FIG. 40A

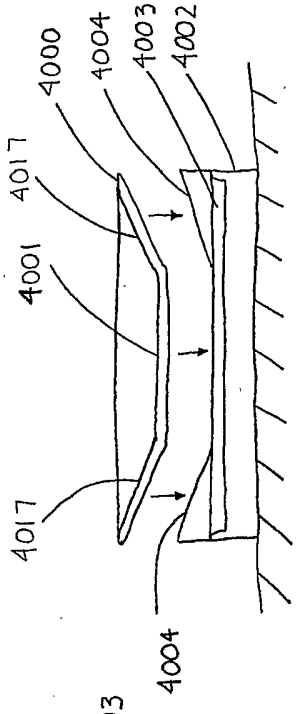


FIG. 40B

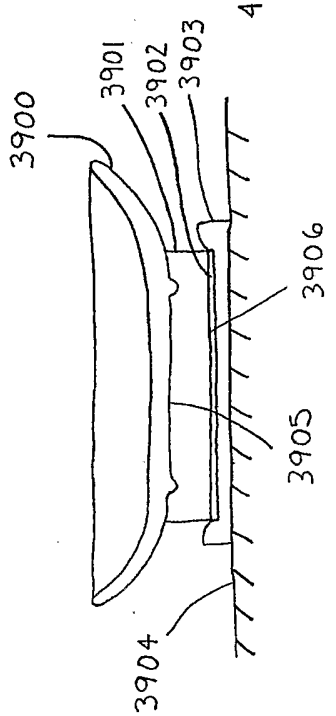


FIG. 39

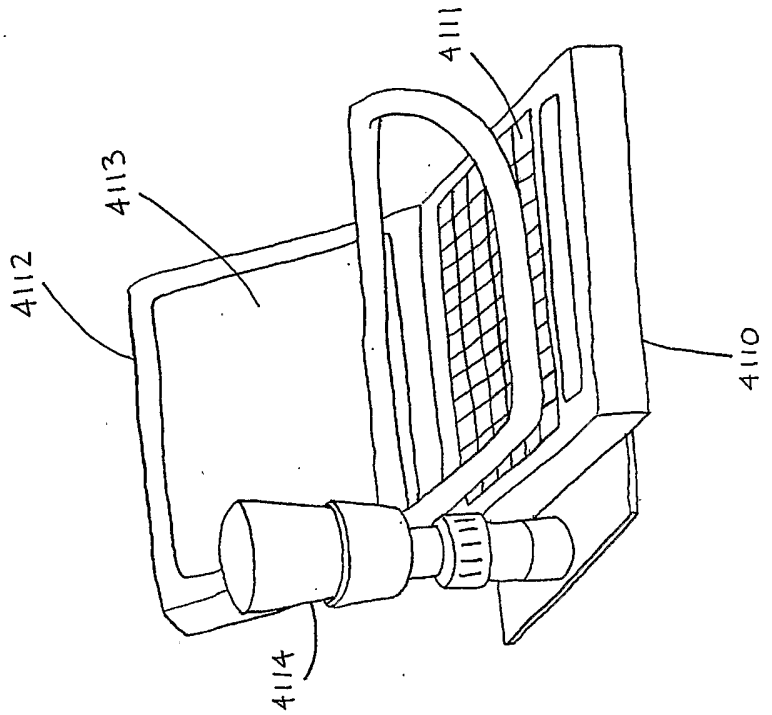


FIG. 41A

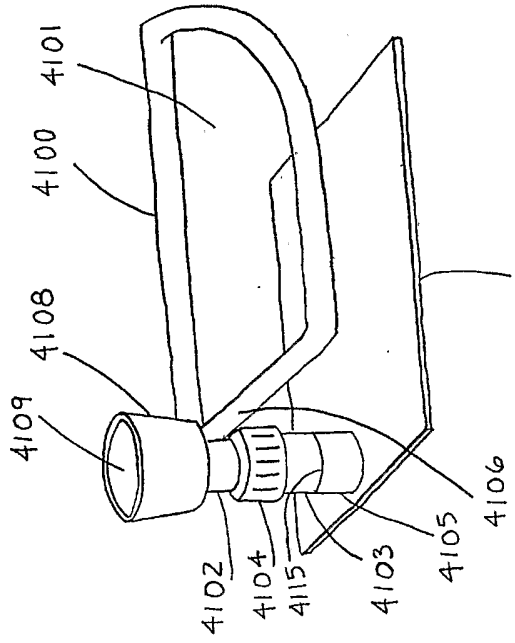


FIG. 41B

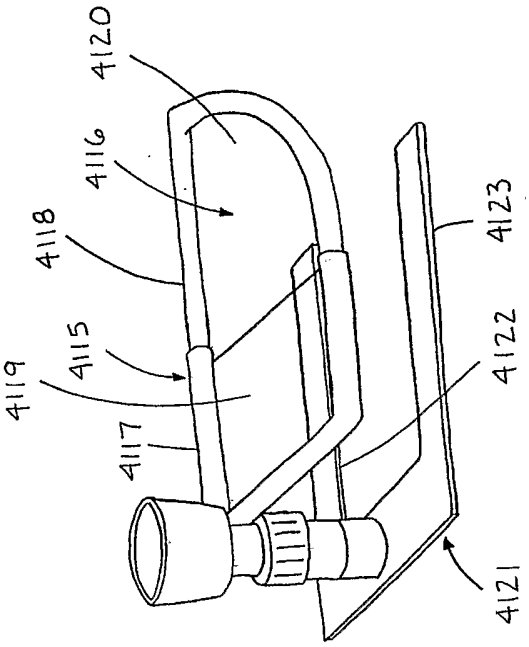
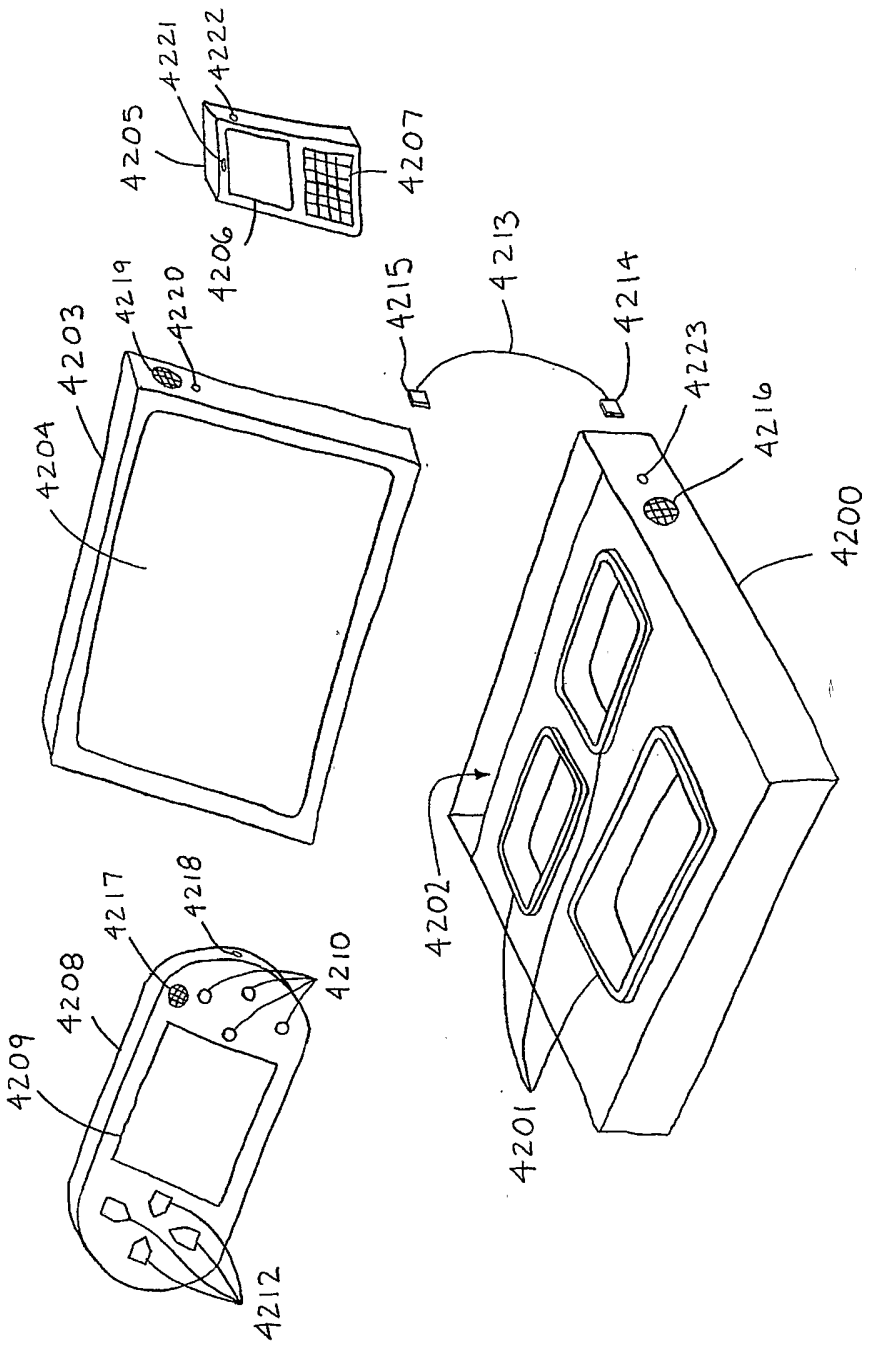


FIG. 41C


4221
4222
4205
4207
4206
4219
4220
4203
4215
4213
4214
4223
4216
4204
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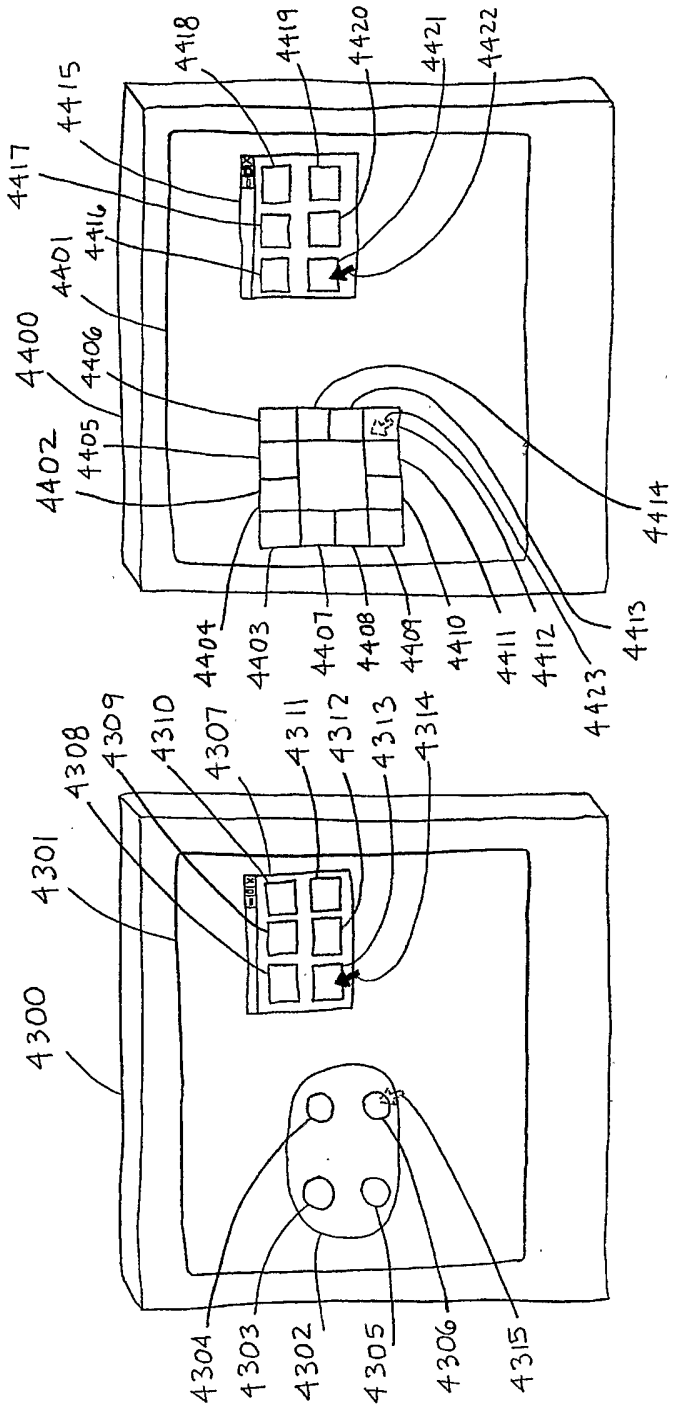
4202
4217
4218
4208
4210
4209
4201
4212

FIG.42


4418
4419
4420
4421
4422
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4417
4416
4401
4400
4406
4405
4402
4414
4404
4403
4407
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4314
4301
4300
4304
4303
4302
4305
4306
4315

FIG. 44

FIG. 43

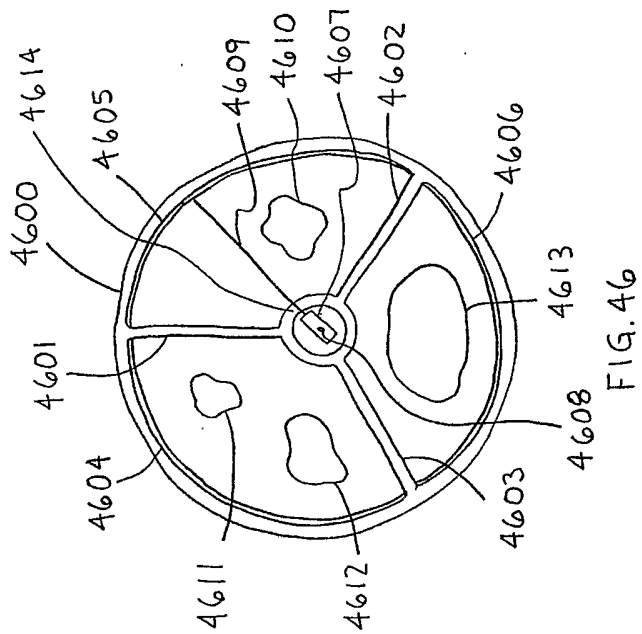
4614
4605
4609
4610
4607
4602
4606
4600
4613
4601
4608
4604
4603
4611
4612

FIG. 46

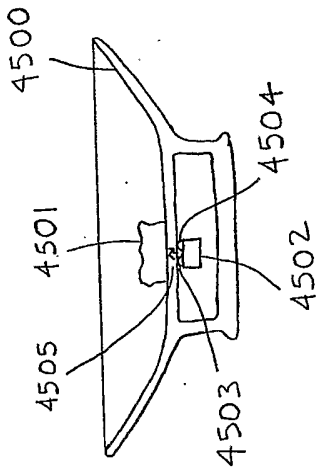
4500
4504
4501
4502
4505
4503

FIG. 45

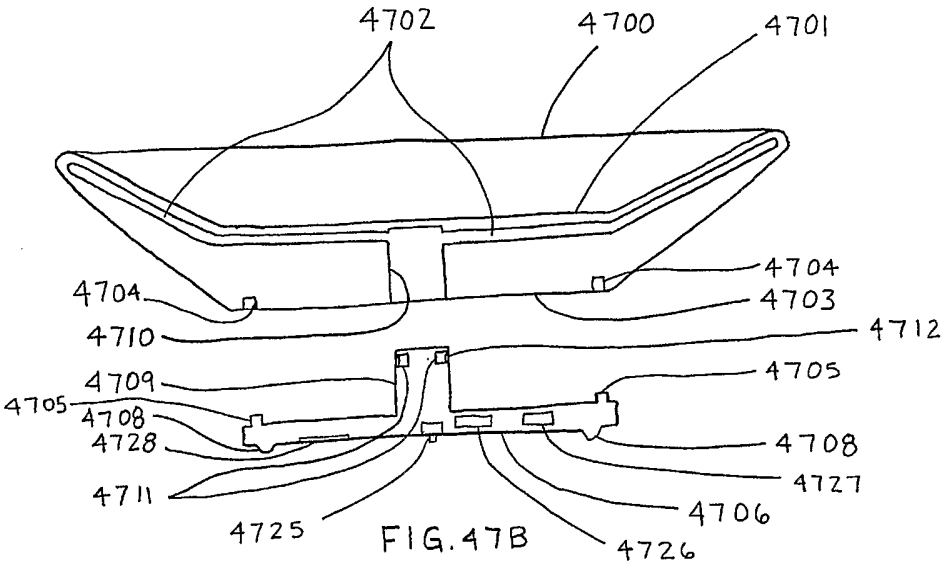

FIG.47B

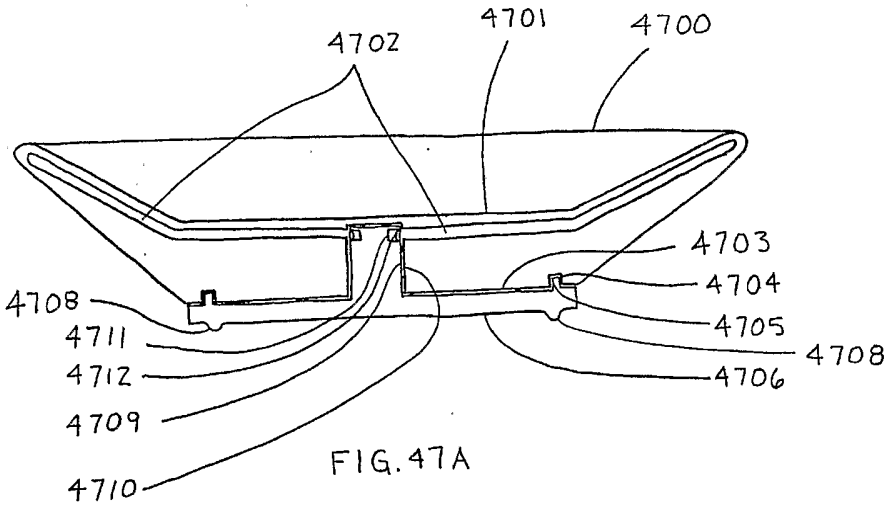

FIG.47A

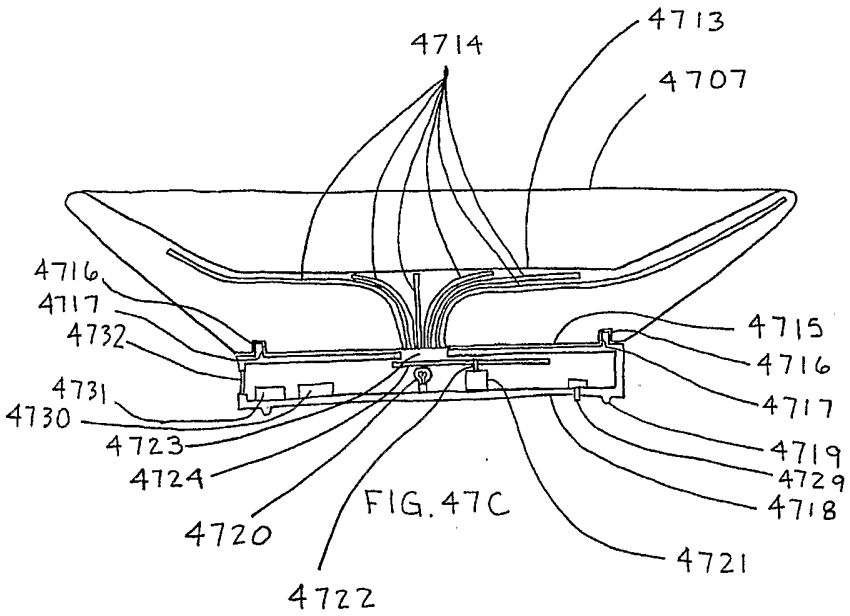
4714
4713
4707
4716
4717
4732
4731
4730
4723
4724
4720
4722
4715
4716
4717
4719
4729
4718
4721

FIG. 47C

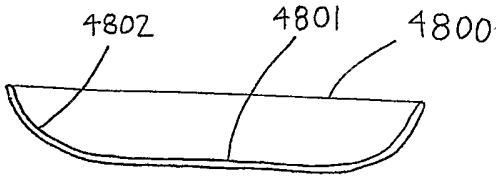

FIG.48A

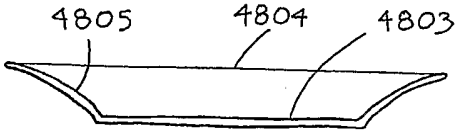

FIG.48B

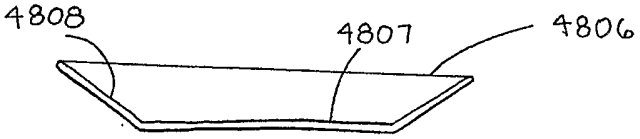

FIG.48C

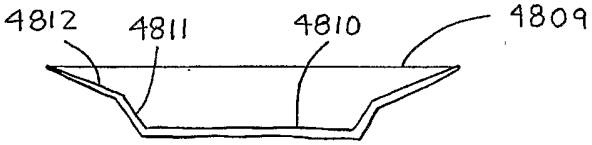

FIG.48D

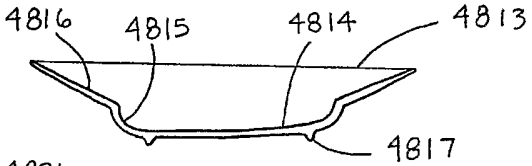

FIG.48E

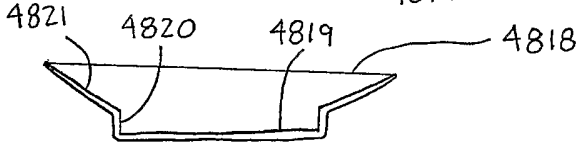

FIG.48F

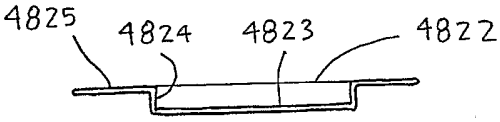

FIG.48G

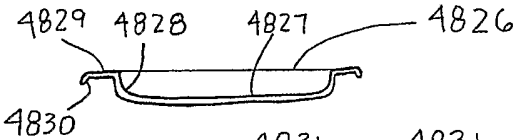

FIG.48H

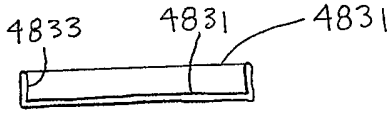

FIG.48I