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(54) **VIDEO GAME SYSTEM WITH WIRELESS MODULAR HANDHELD CONTROLLER**

(71) Applicant: **Nintendo Co., Ltd.**, Kyoto (JP)

(72) Inventors: **Akio Ikeda**, Kyoto (JP); **Kuniaki Ito**, Kyoto (JP); **Ryoji Kuroda**, Kyoto (JP); **Genyo Takeda**, Kyoto (JP); **Masahiro Urata**, Kyoto (JP)

(73) Assignee: **Nintendo Co., Ltd.**, Kyoto (JP)

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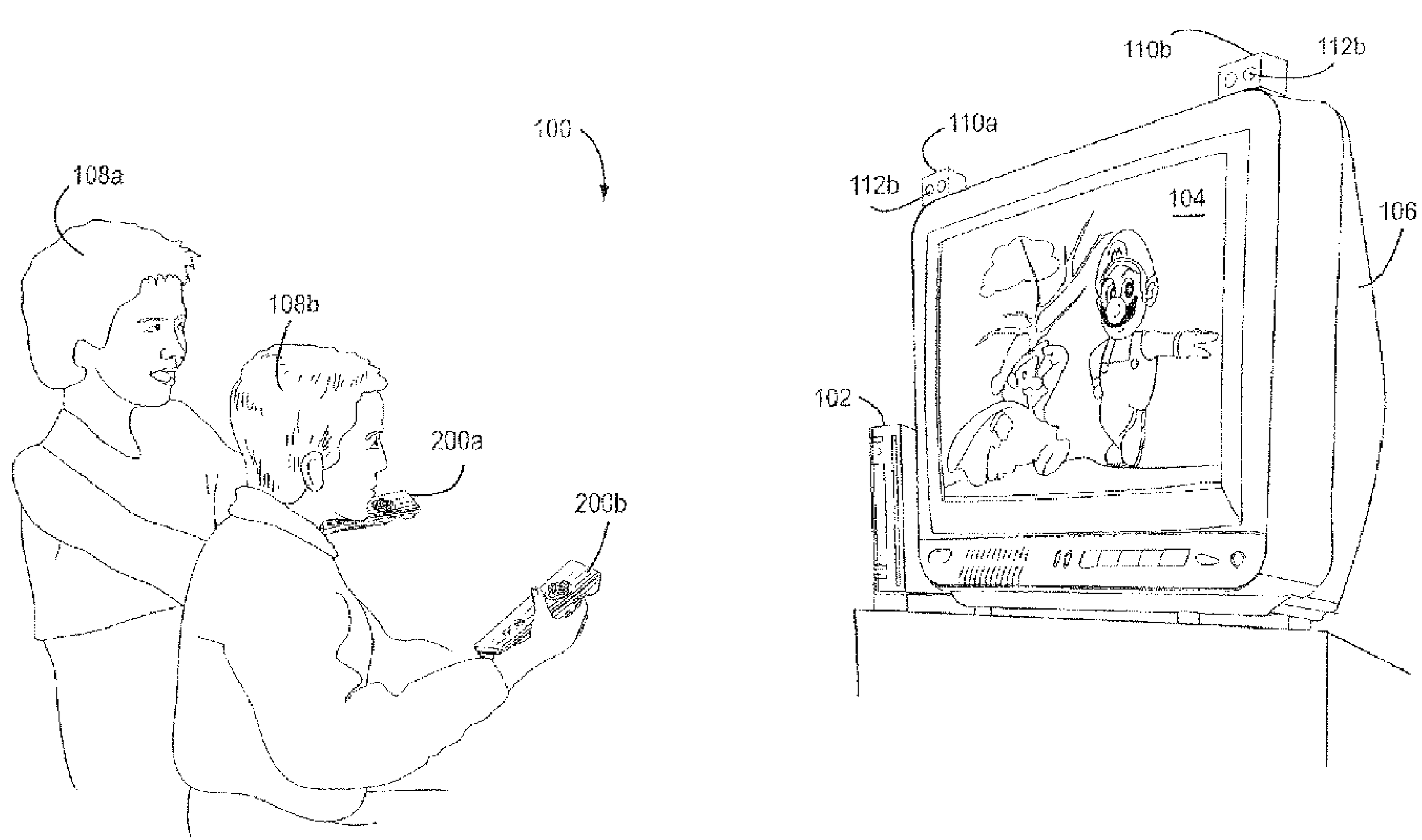
Primary Examiner — James S McCellan

(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye P.C.

(57) **ABSTRACT**

A home entertainment system for video games and other applications includes a main unit and handheld controllers. The handheld controllers sense their own motion by detecting illumination emitted by emitters positioned at either side of a display. The controllers can be plugged into expansion units that customize the overall control interface for particular applications including but not limited to legacy video games.

42 Claims, 27 Drawing Sheets



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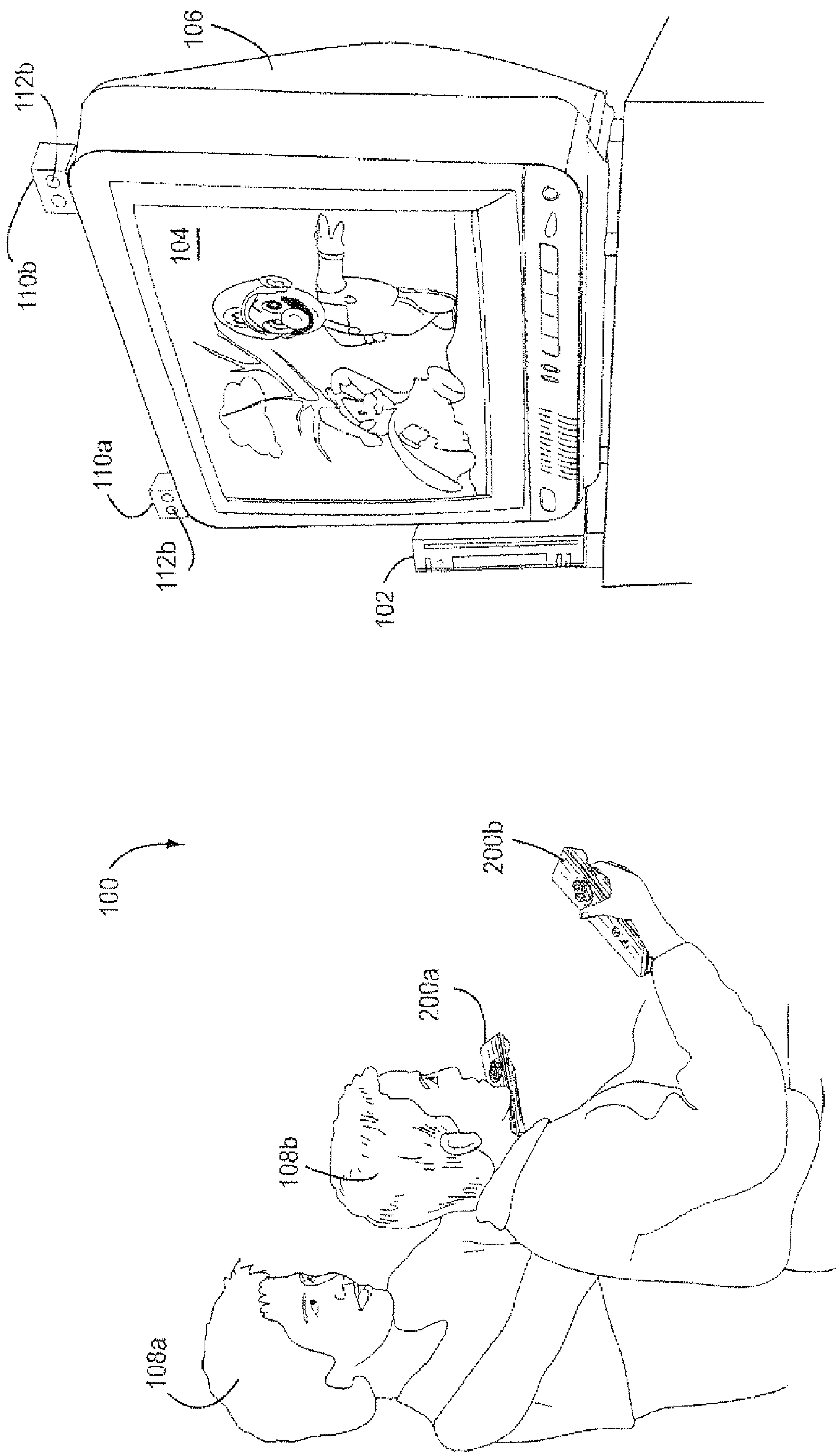

Fig. 1

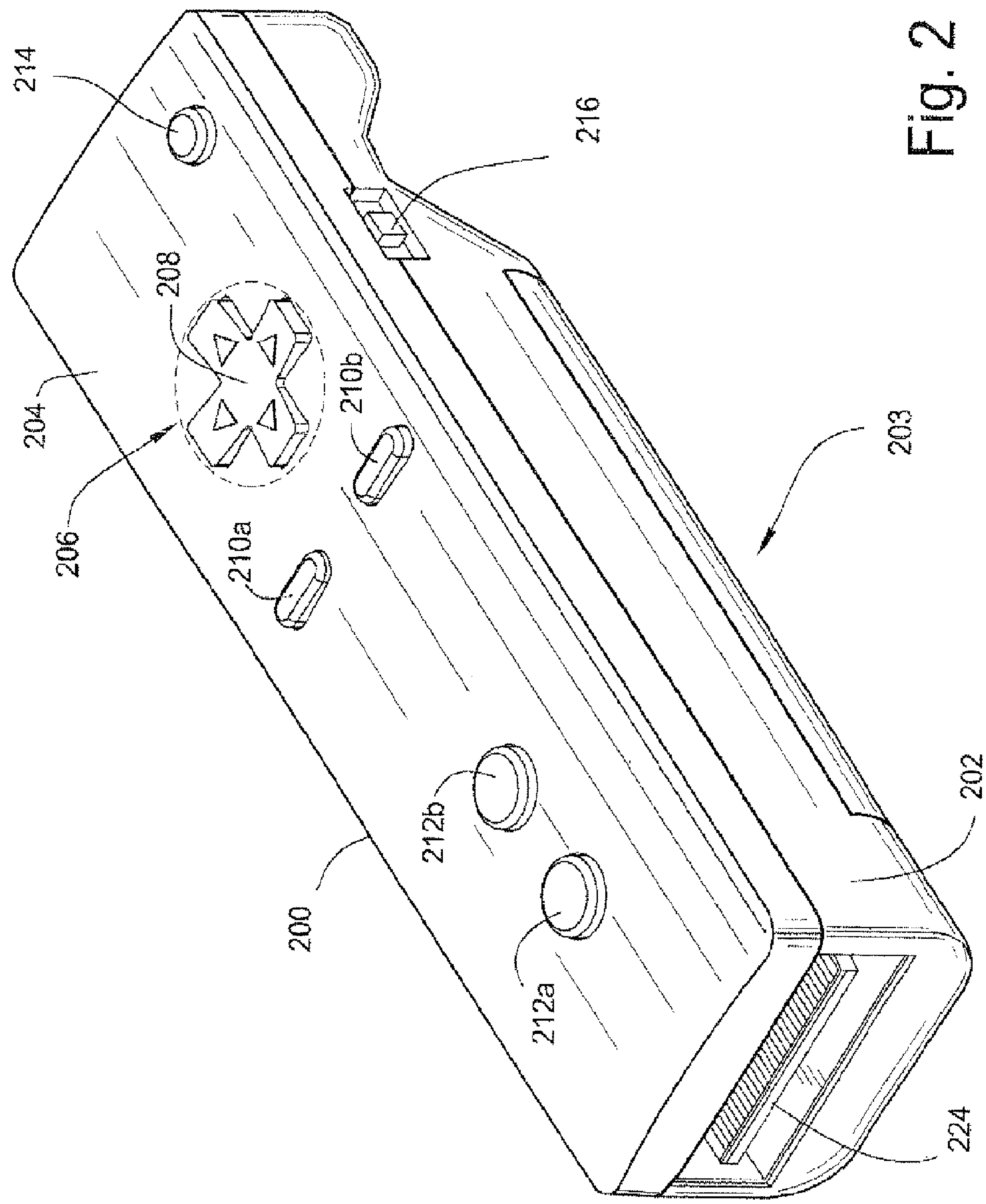

Fig. 2

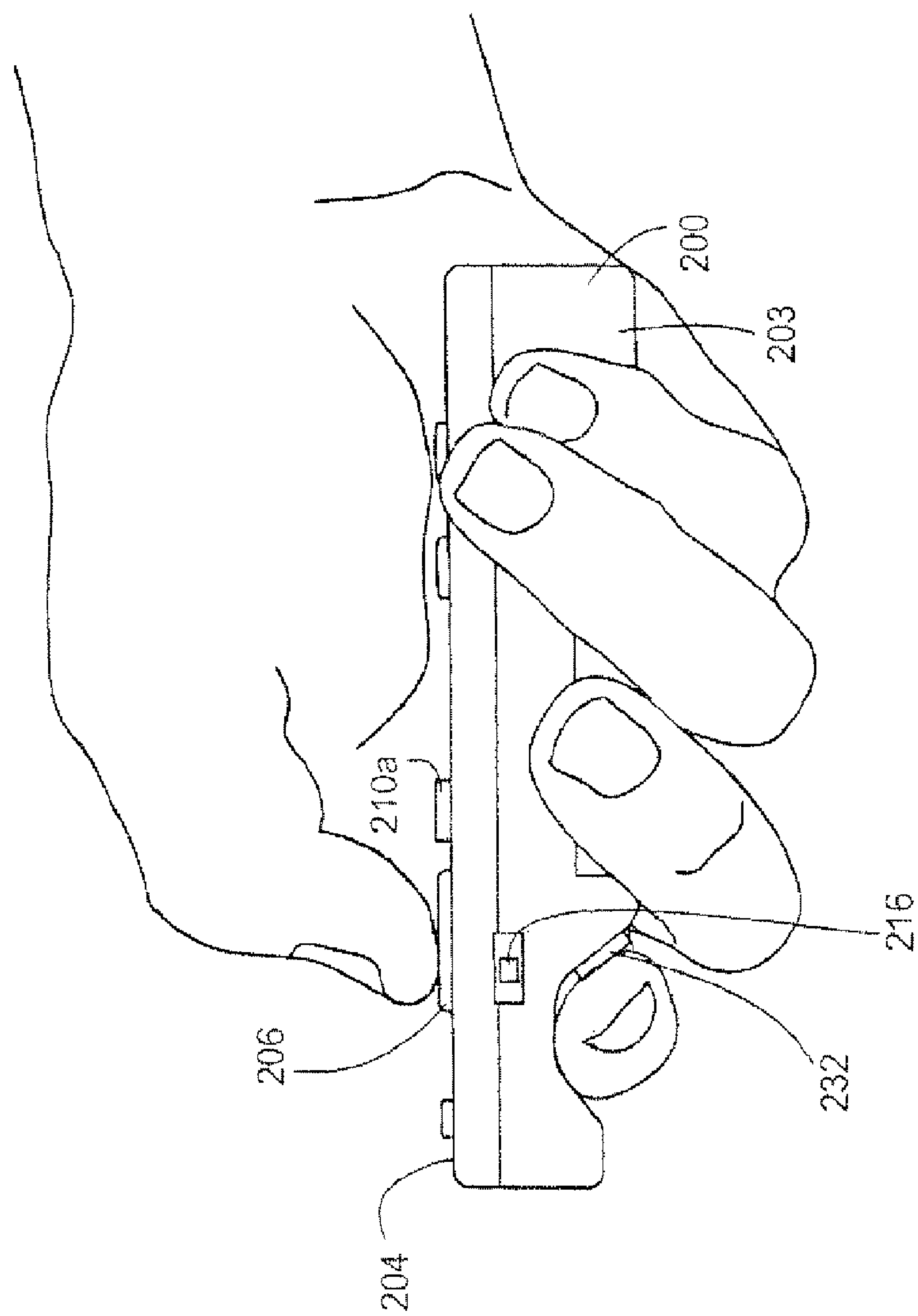

Fig. 2A

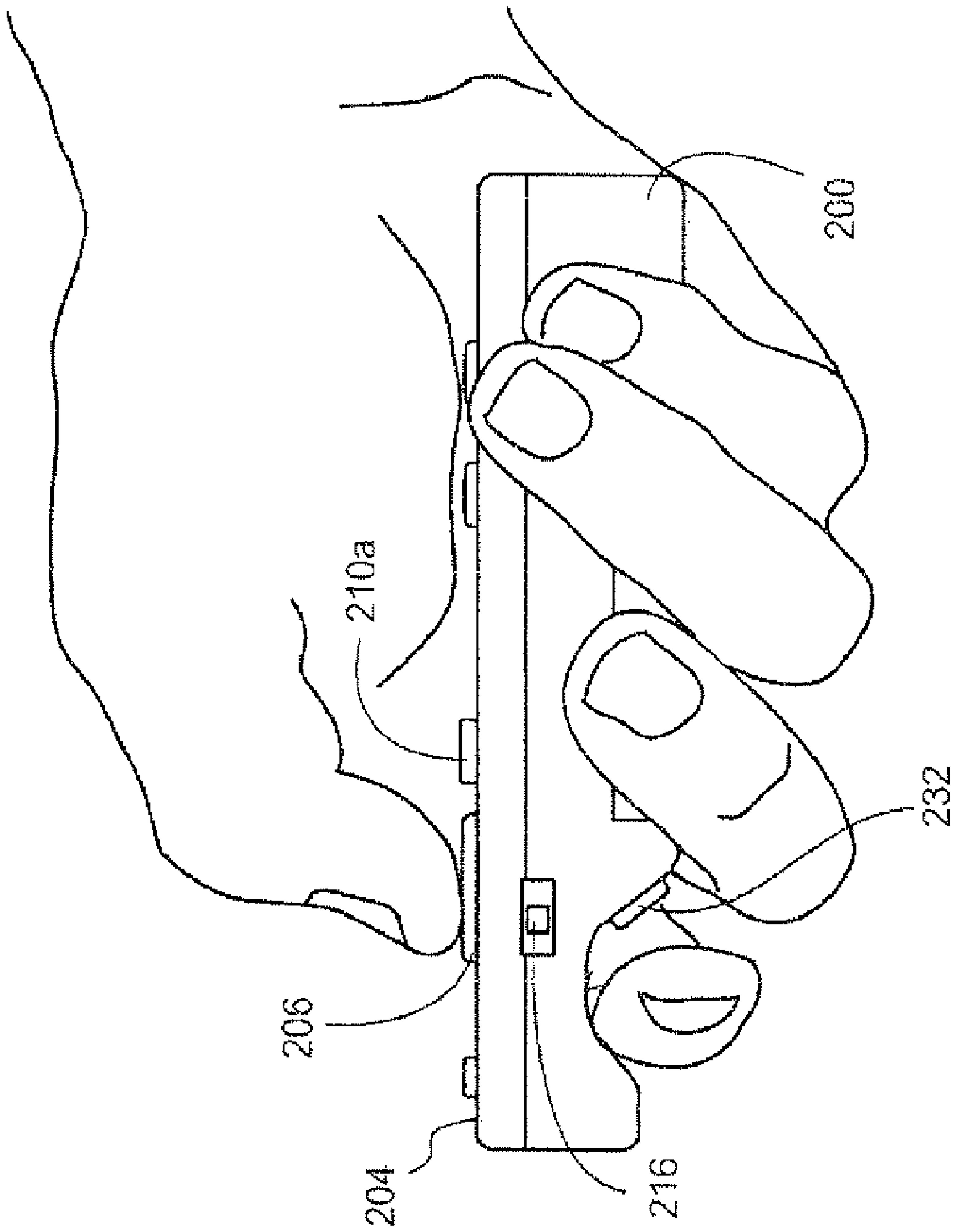

Fig. 2C

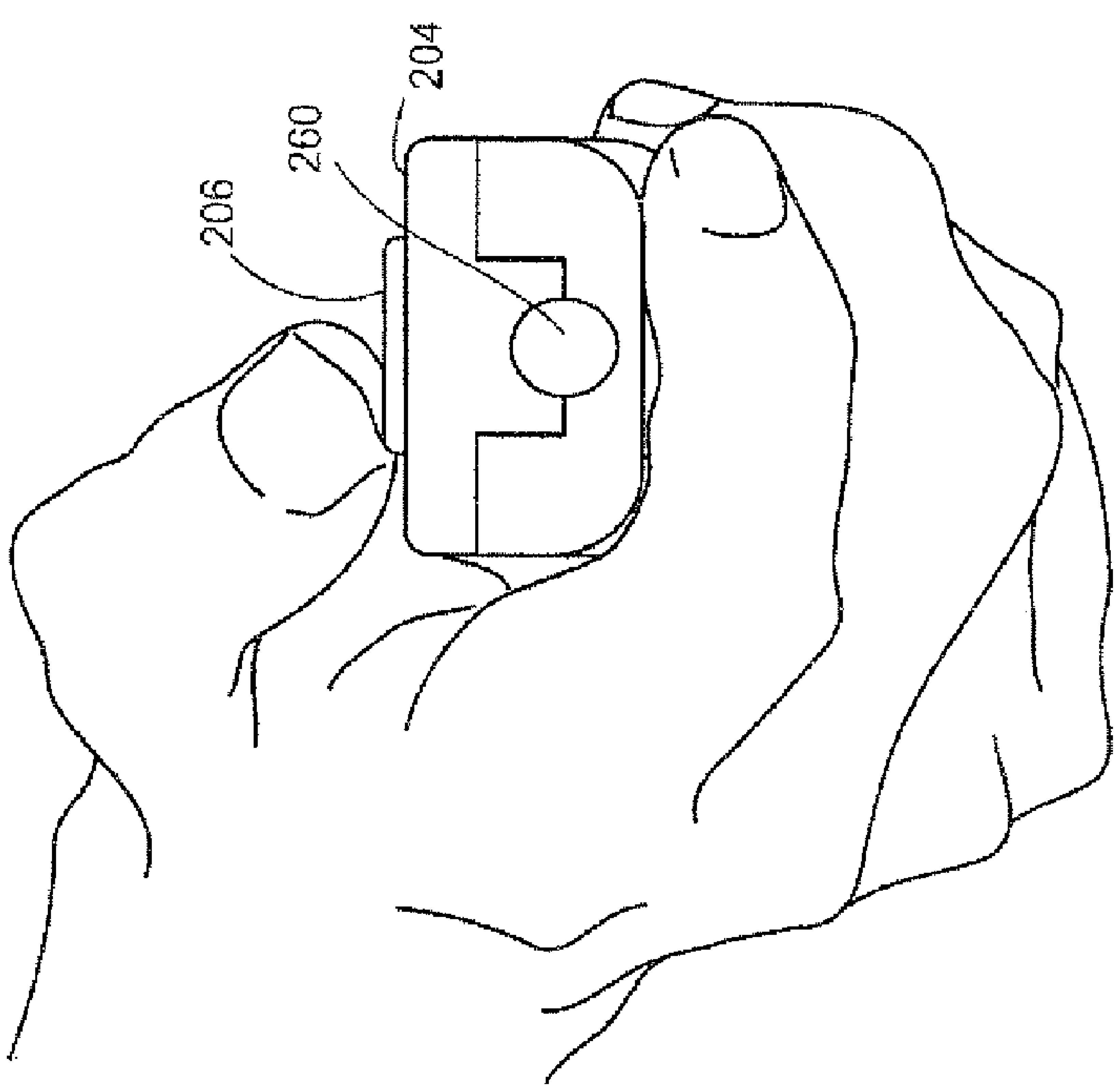

Fig. 2B

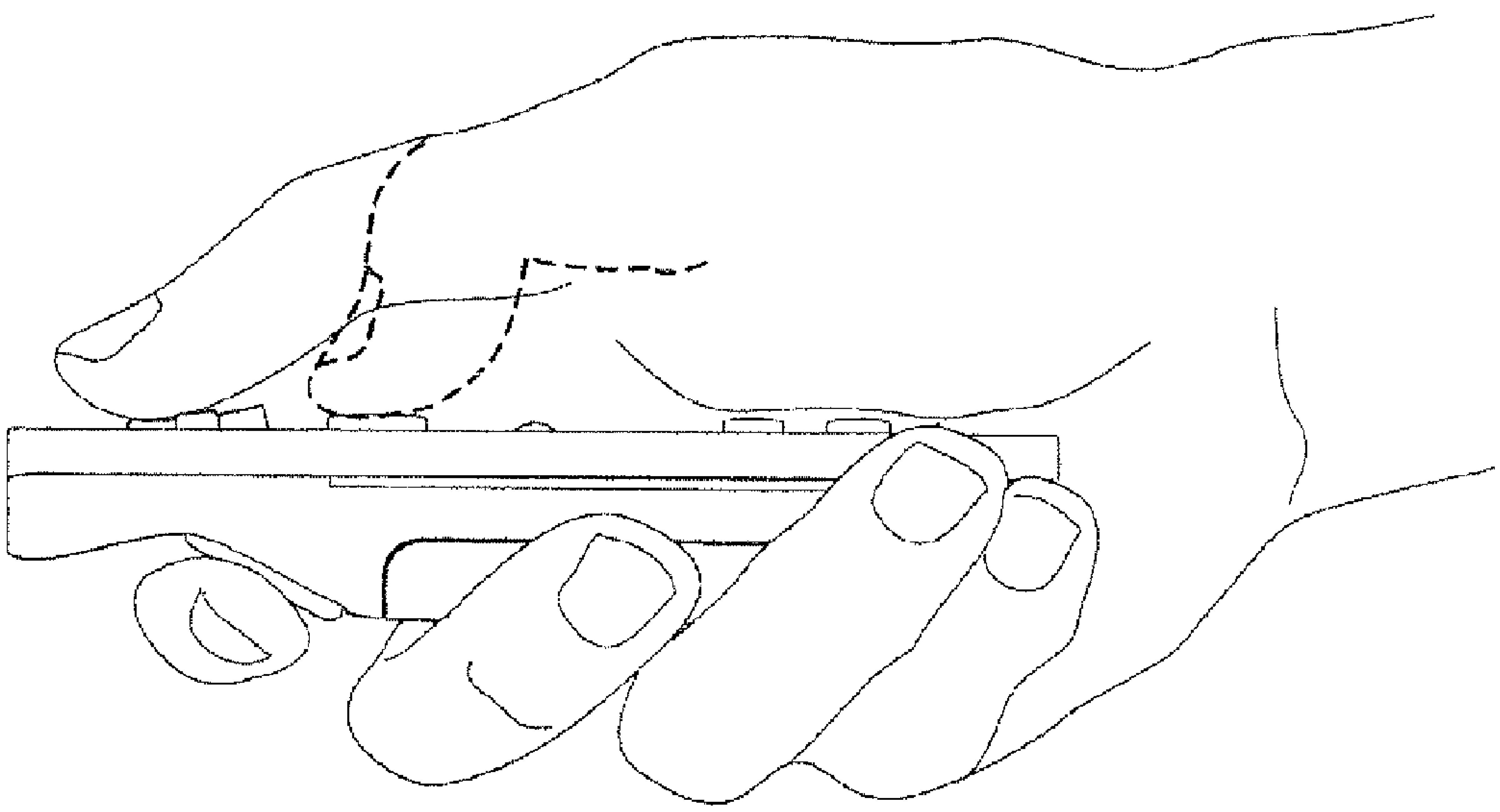

Fig. 2D

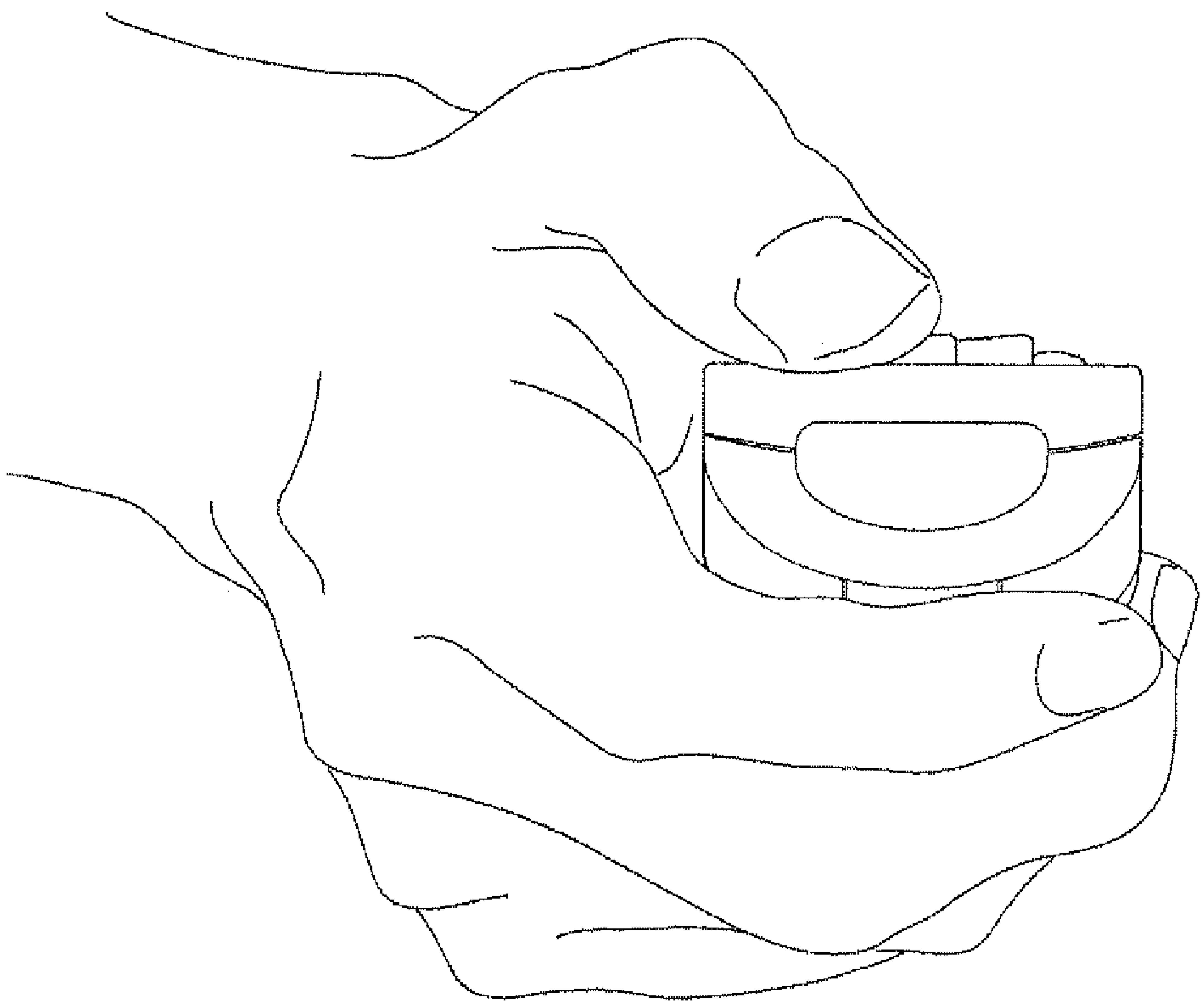

Fig. 2E

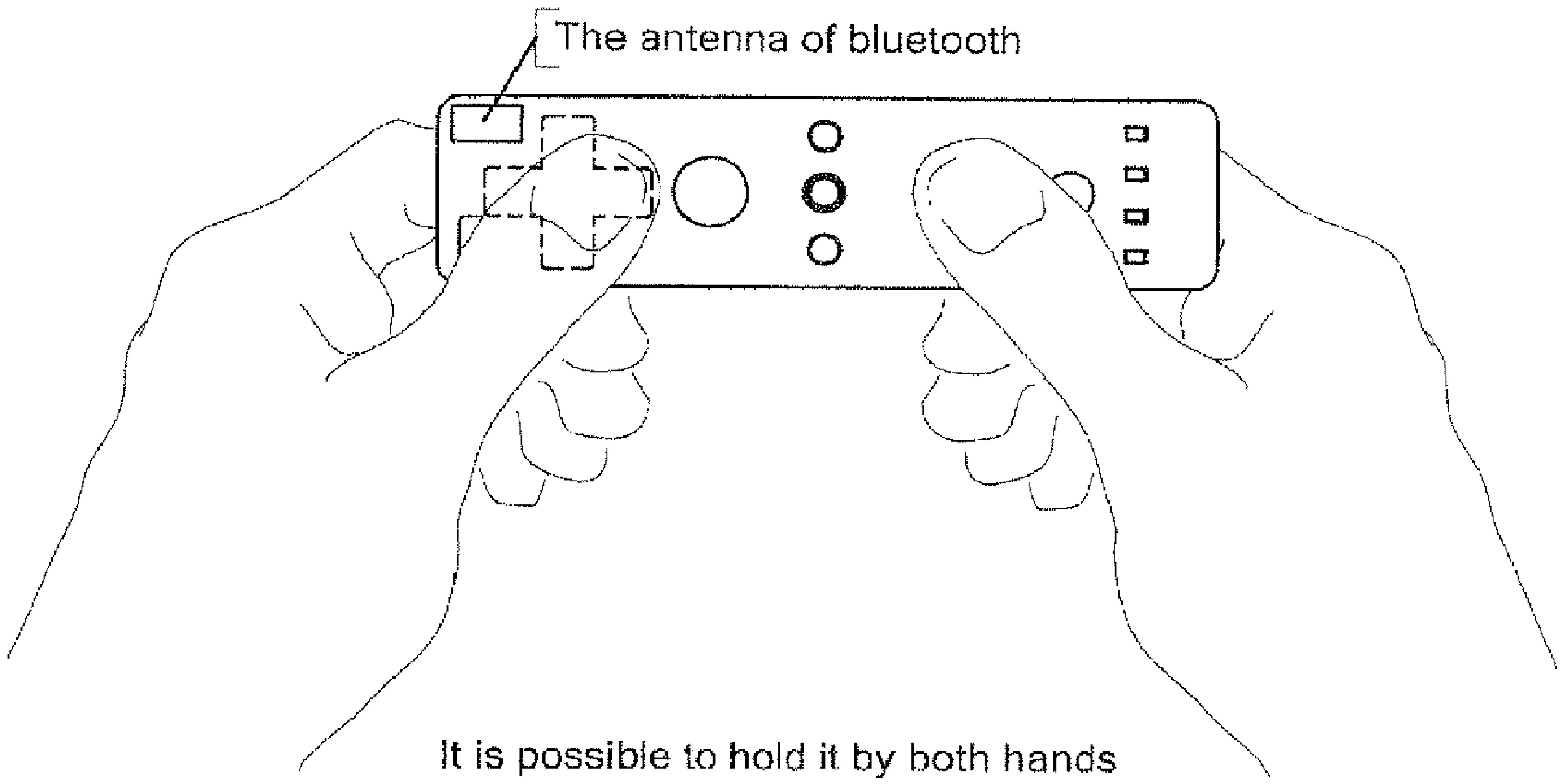
The antenna of bluetooth
It is possible to hold it by both hands

Fig. 2F

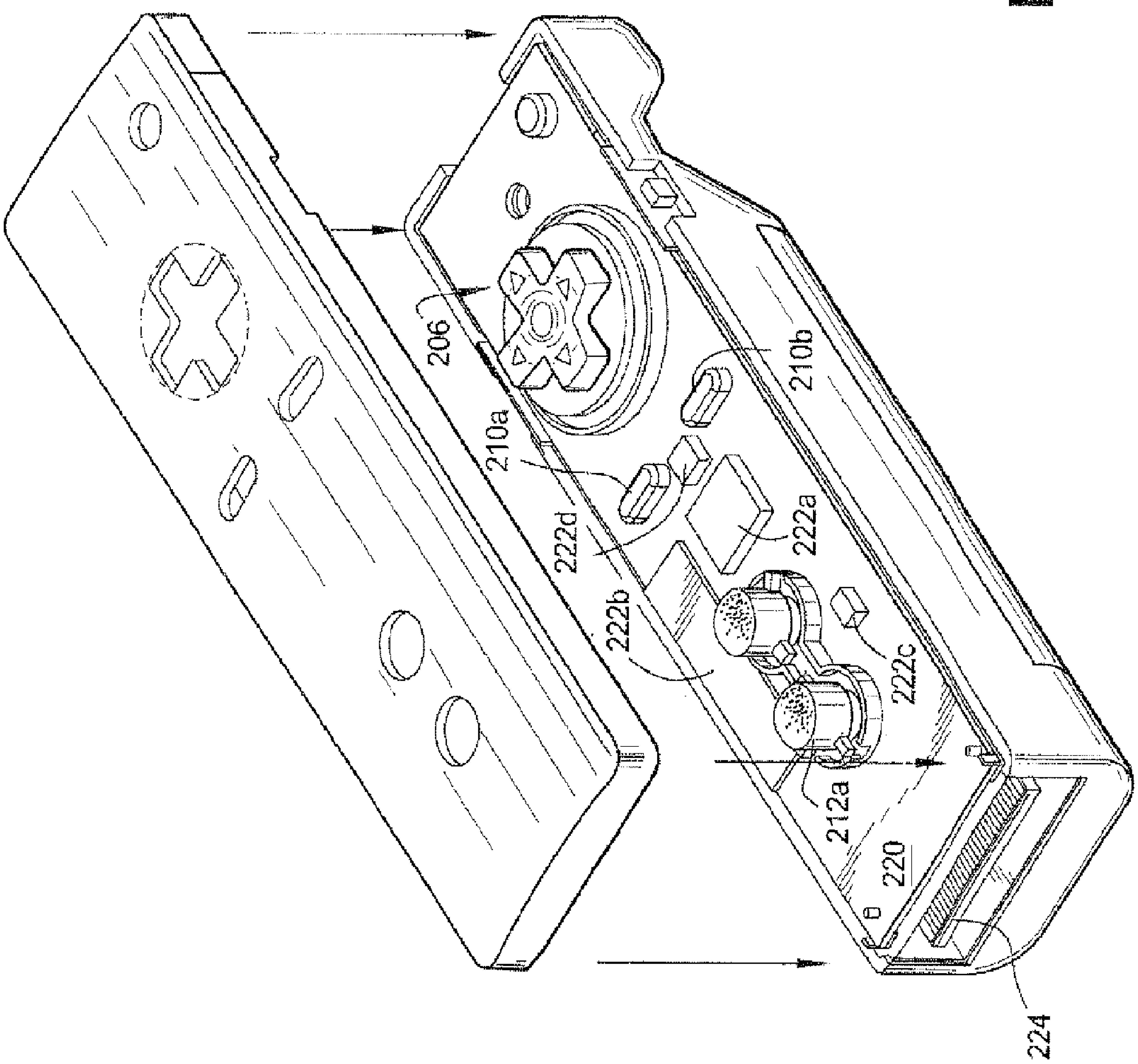

Fig. 3

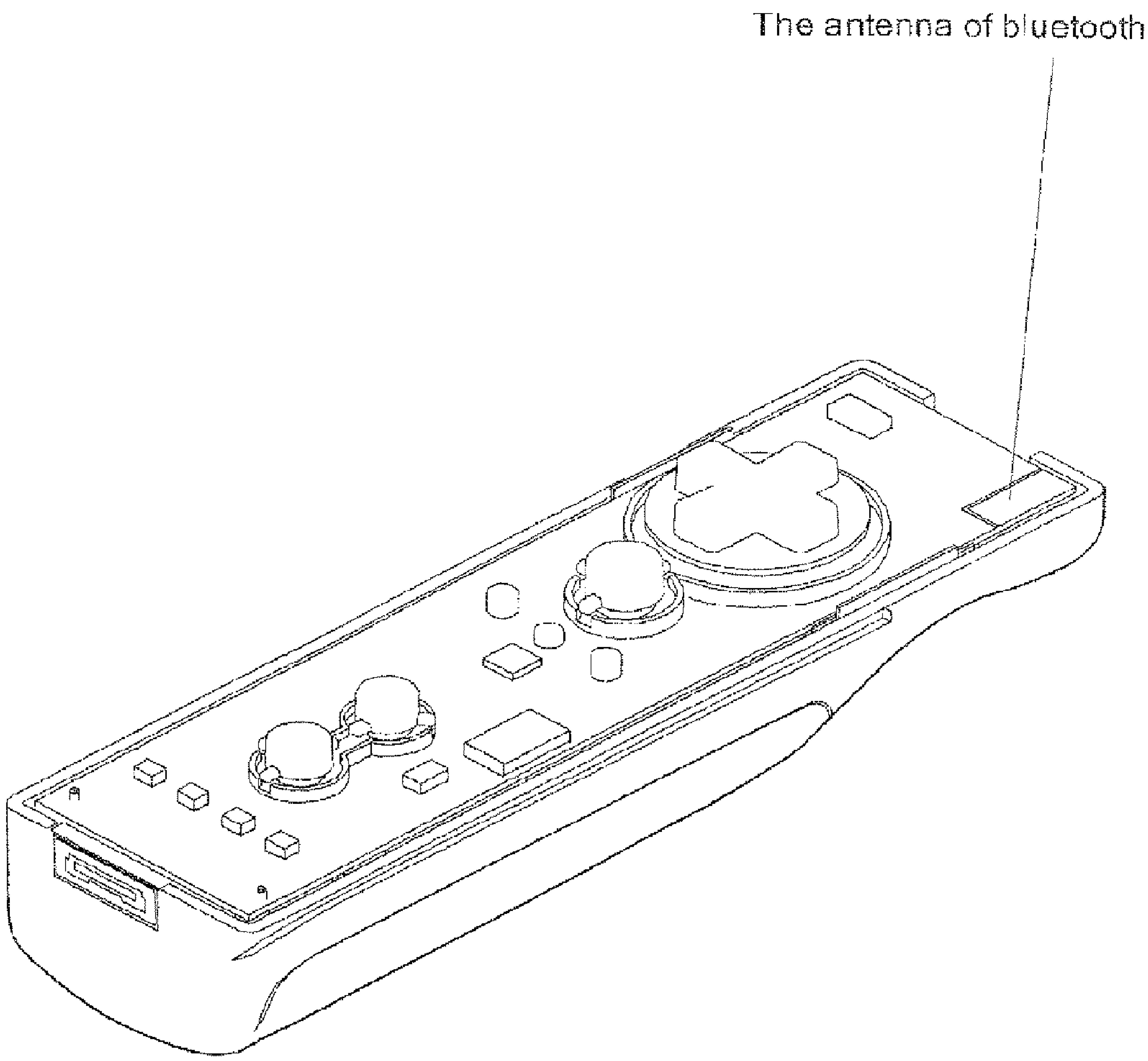

Fig. 3A

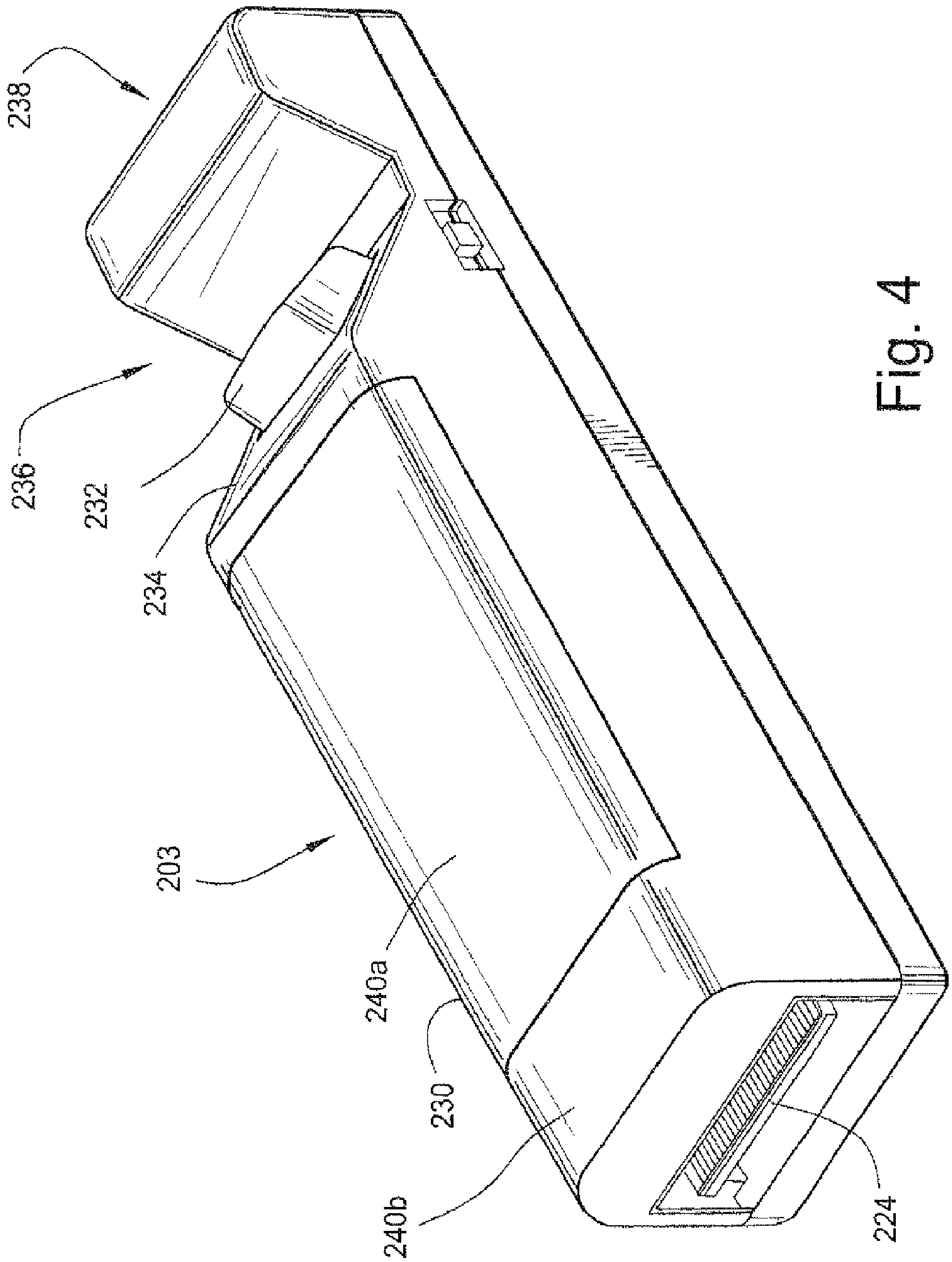

Fig. 4

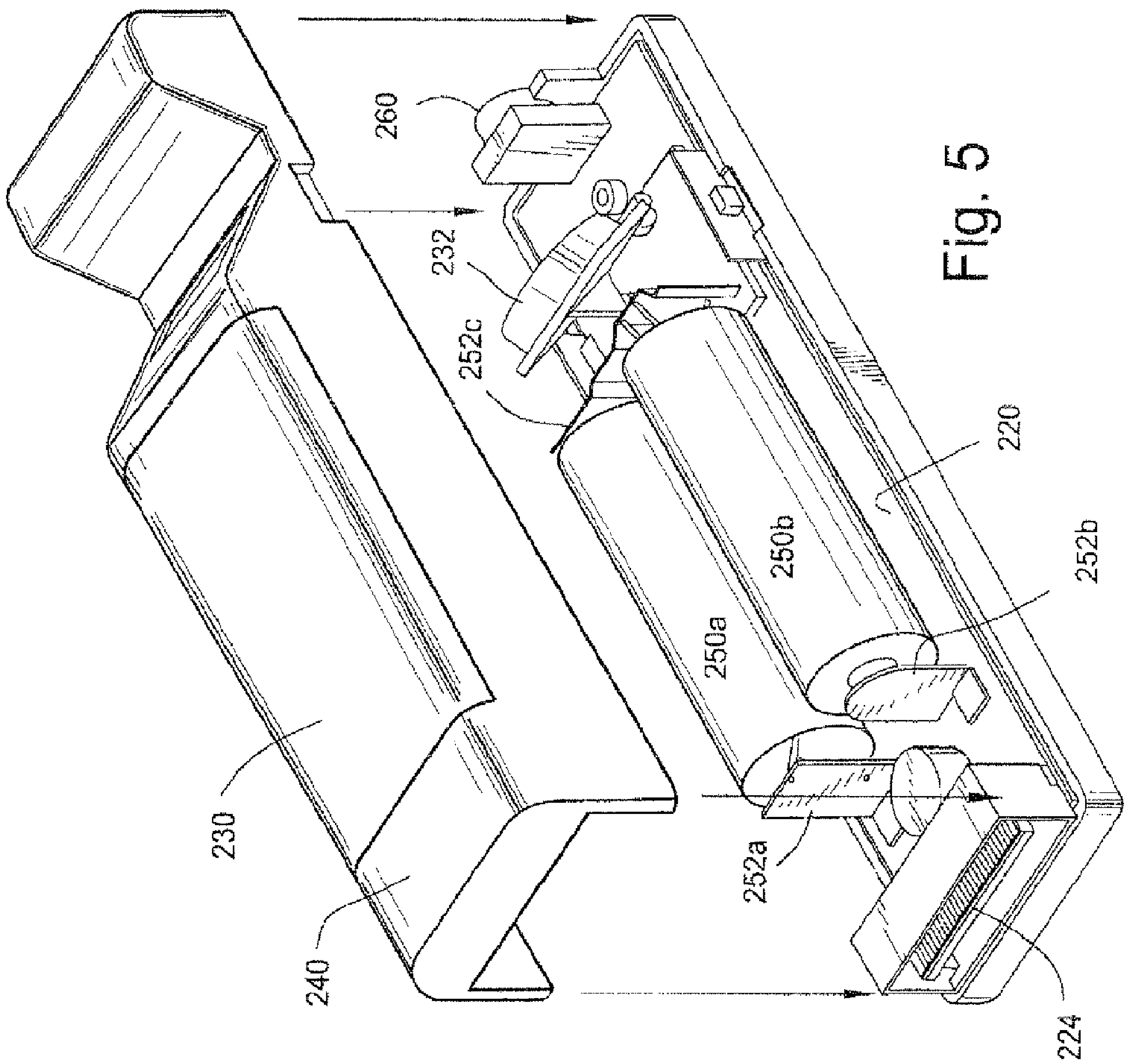

Fig. 5

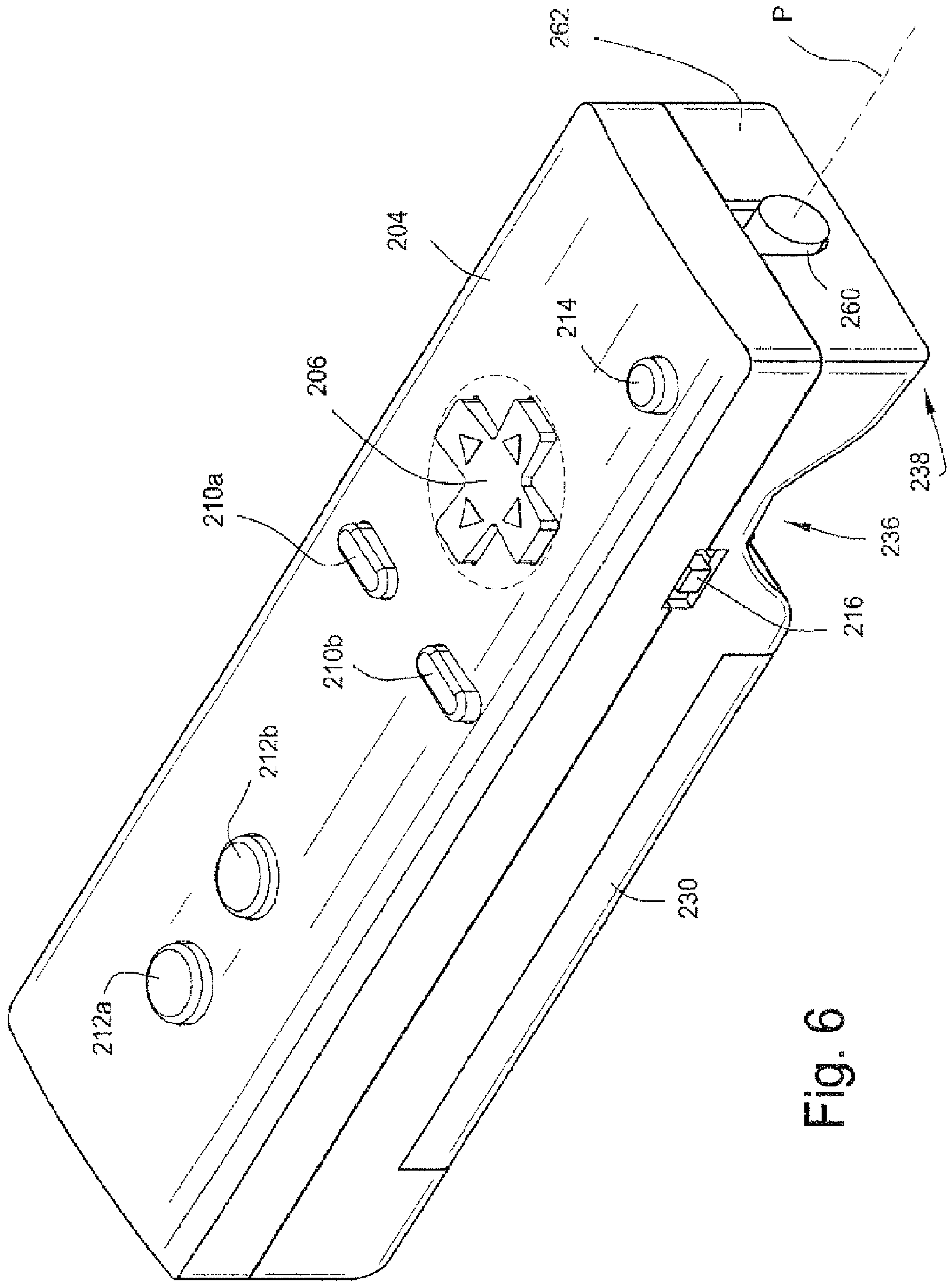

Fig. 6

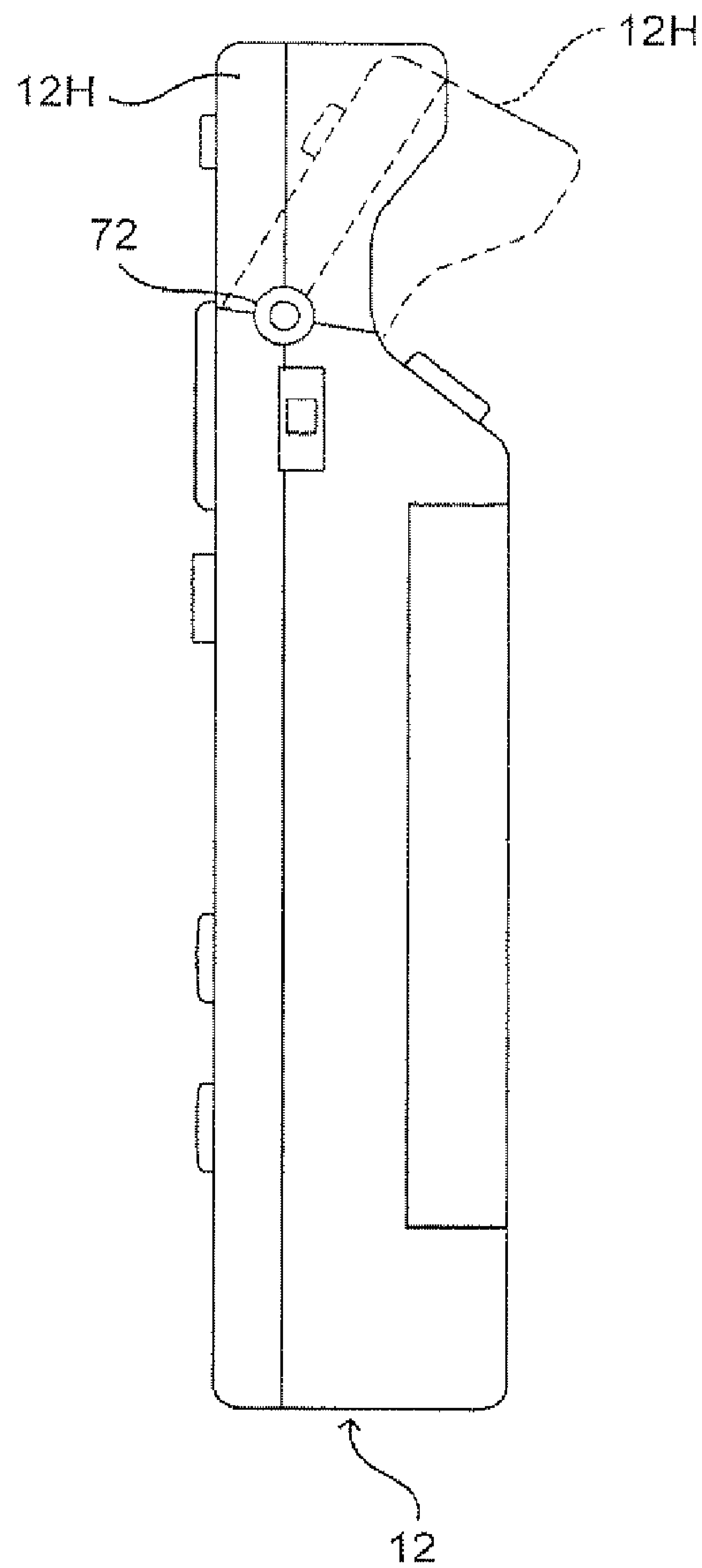

Fig. 6A

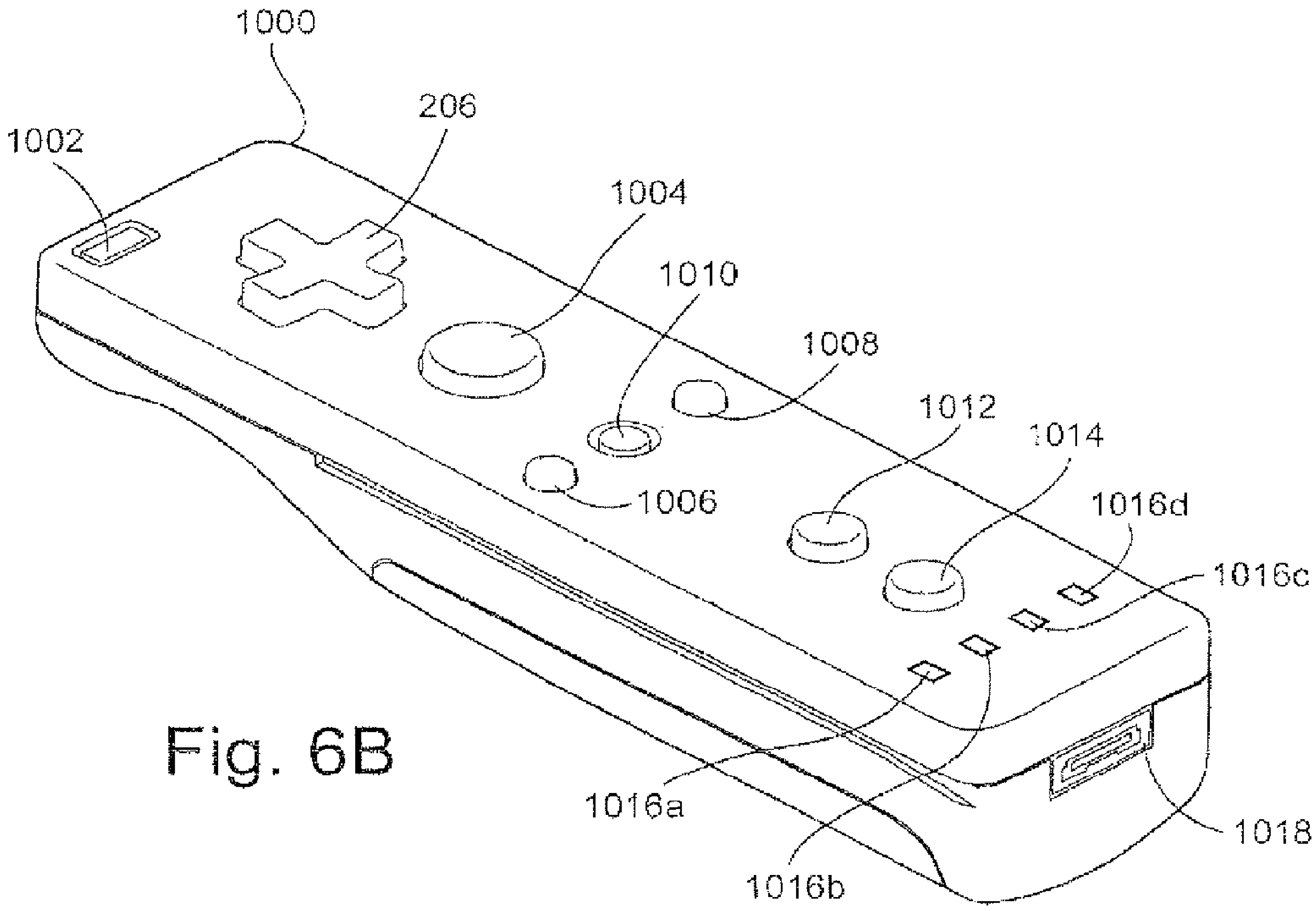
1000
1002
206
1004
1010
1008
1012
1014
1006
1016d
1016c
1016a
1016b
1018

Fig. 6B

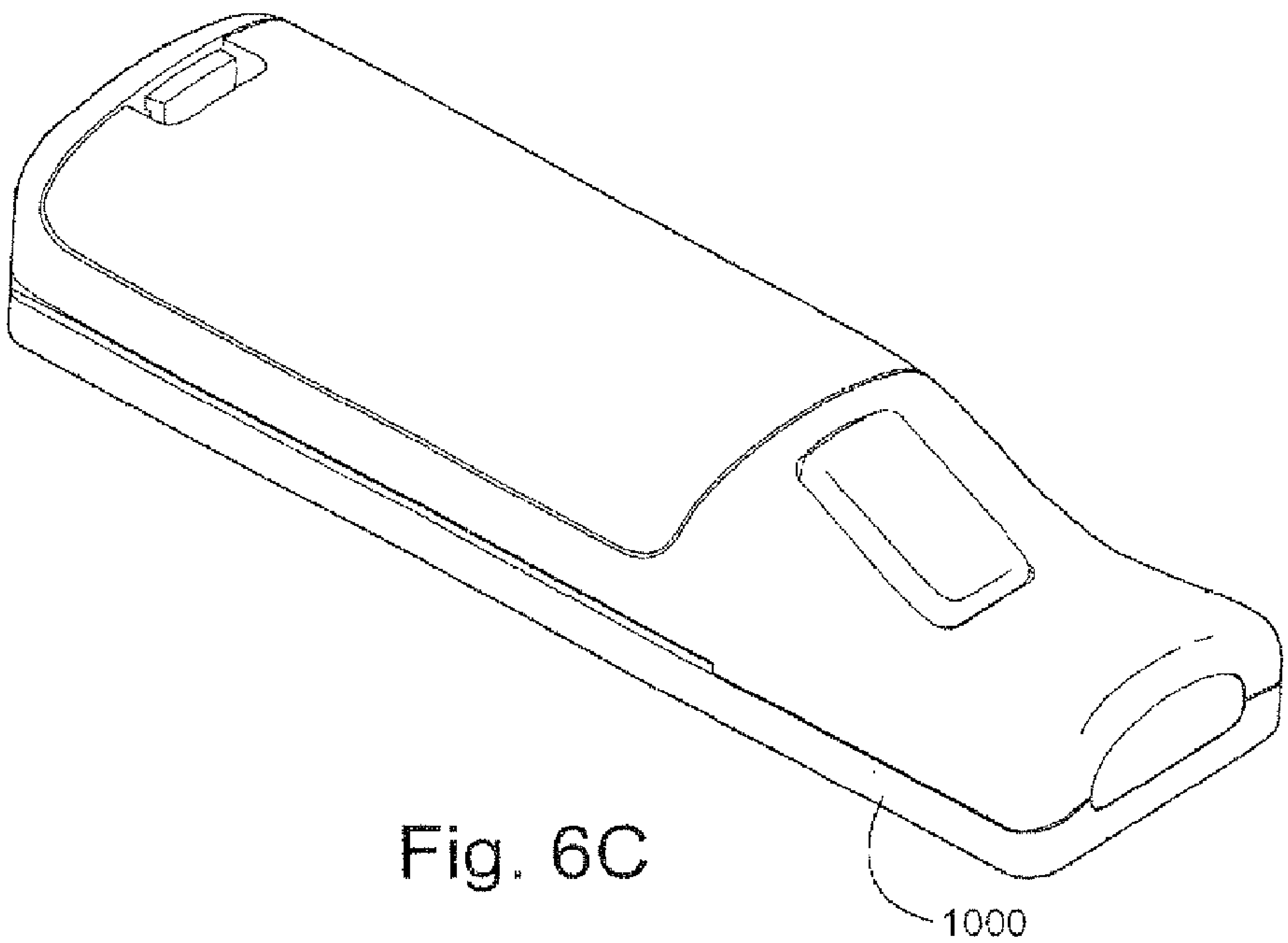
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Fig. 6C

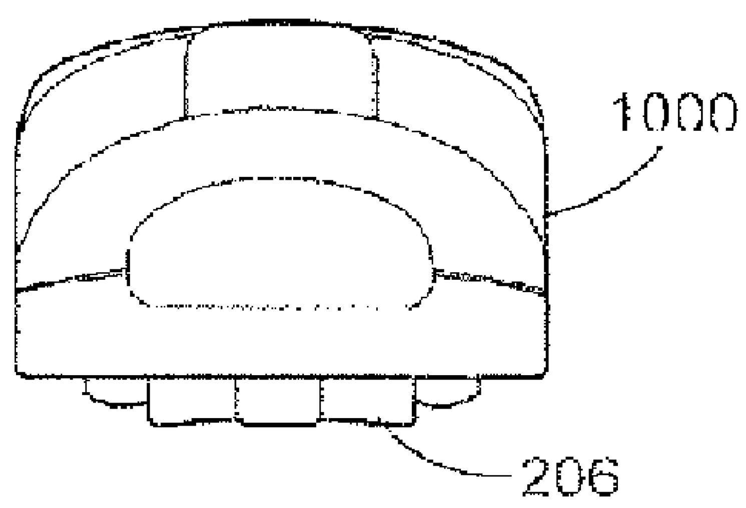


Fig. 6G

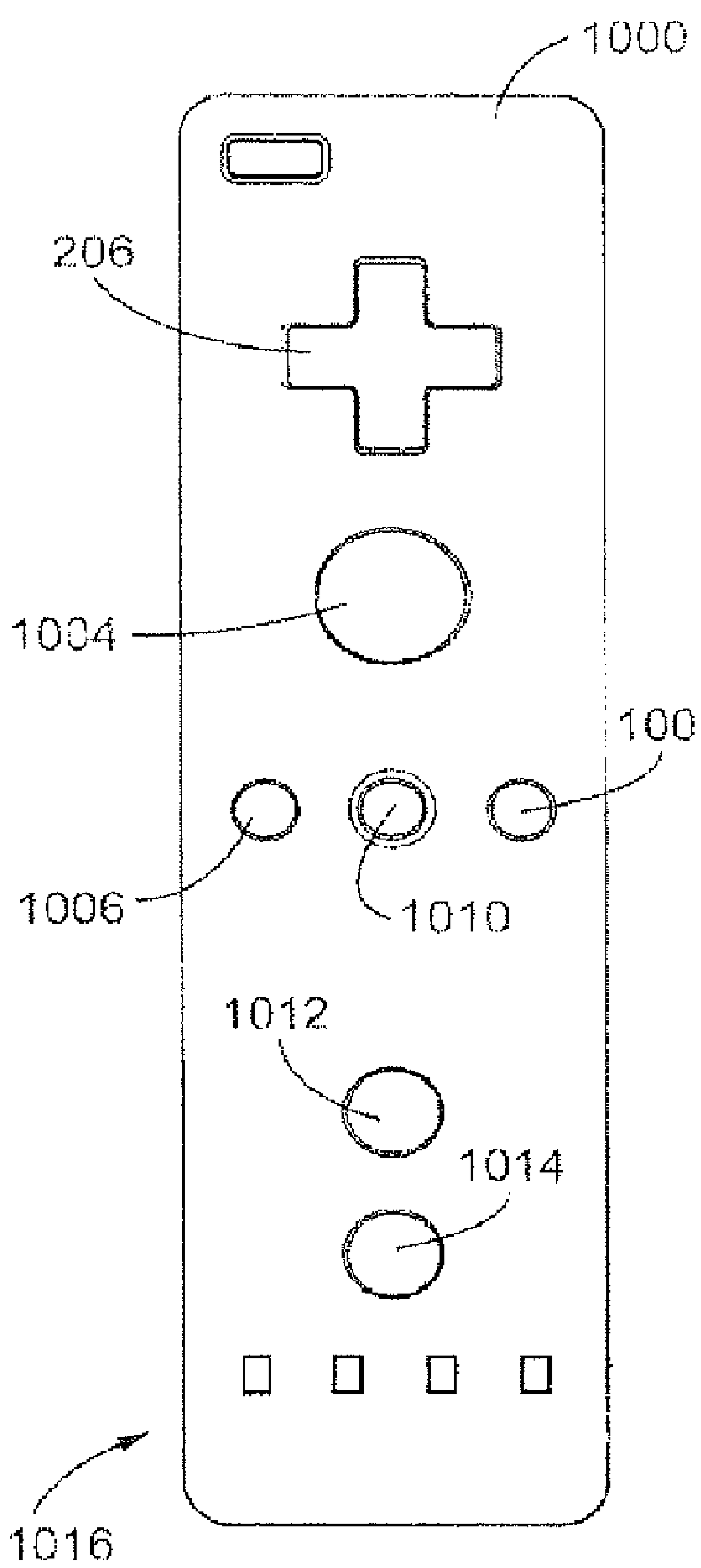
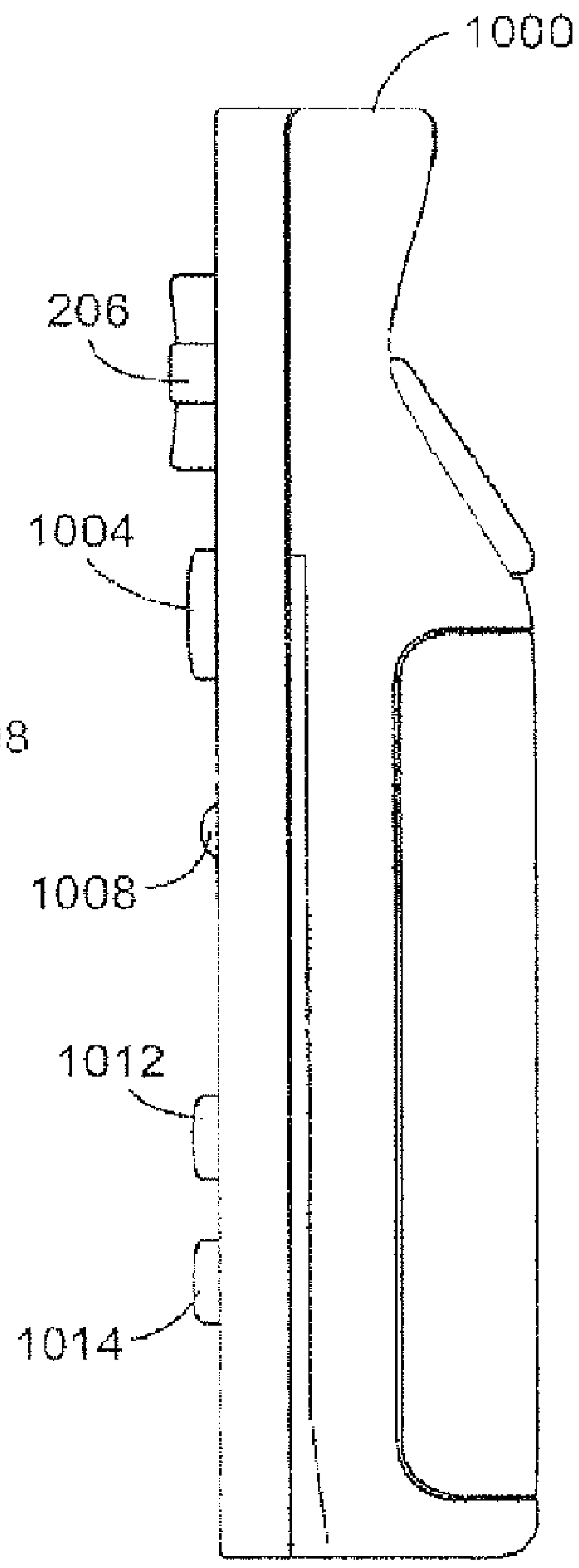


Fig. 6D



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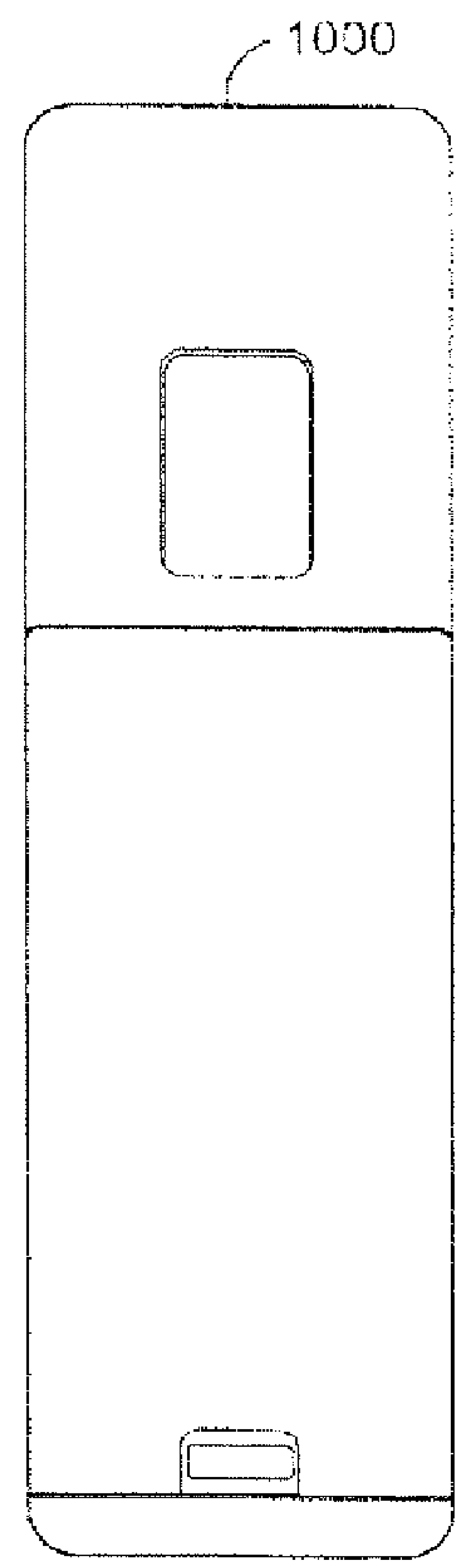

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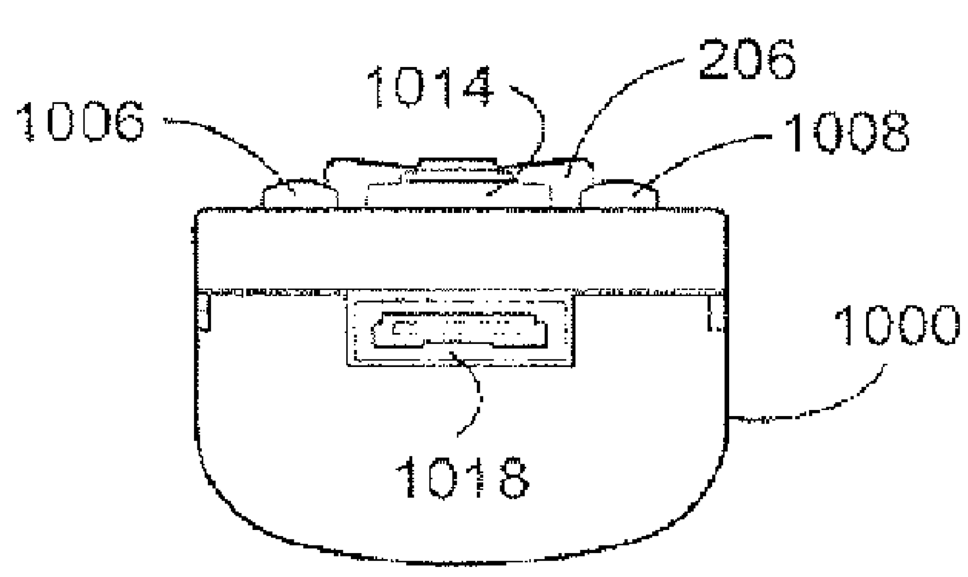


Fig. 6H

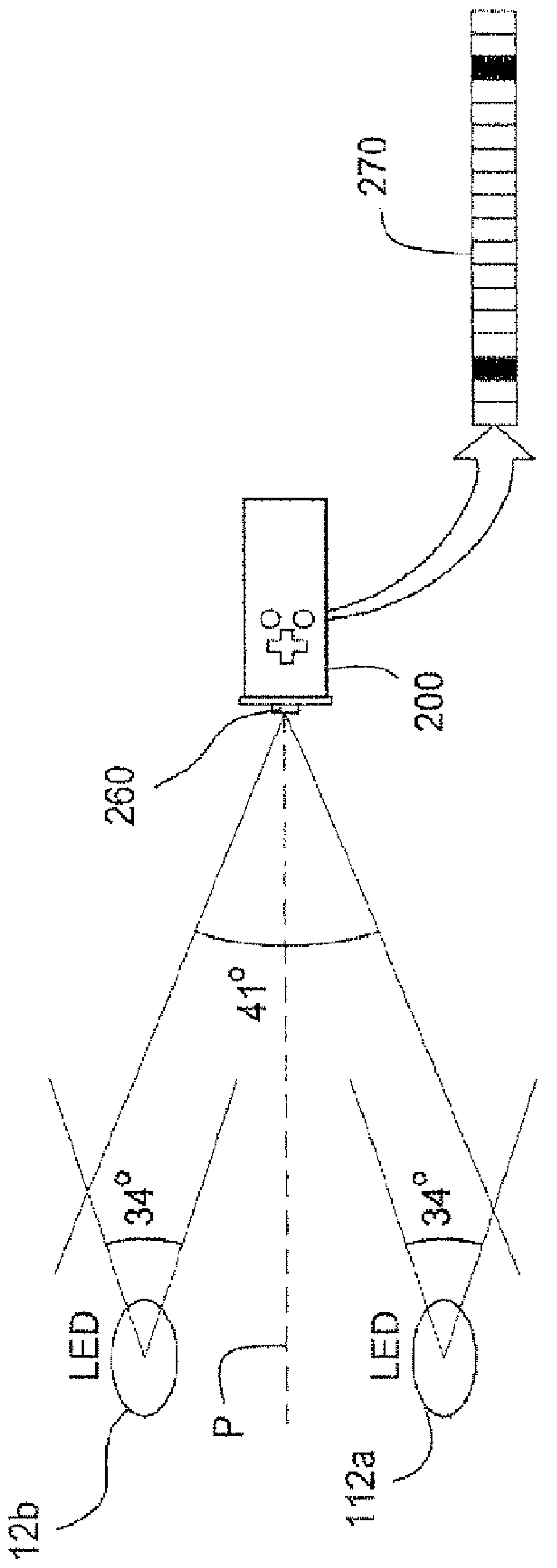
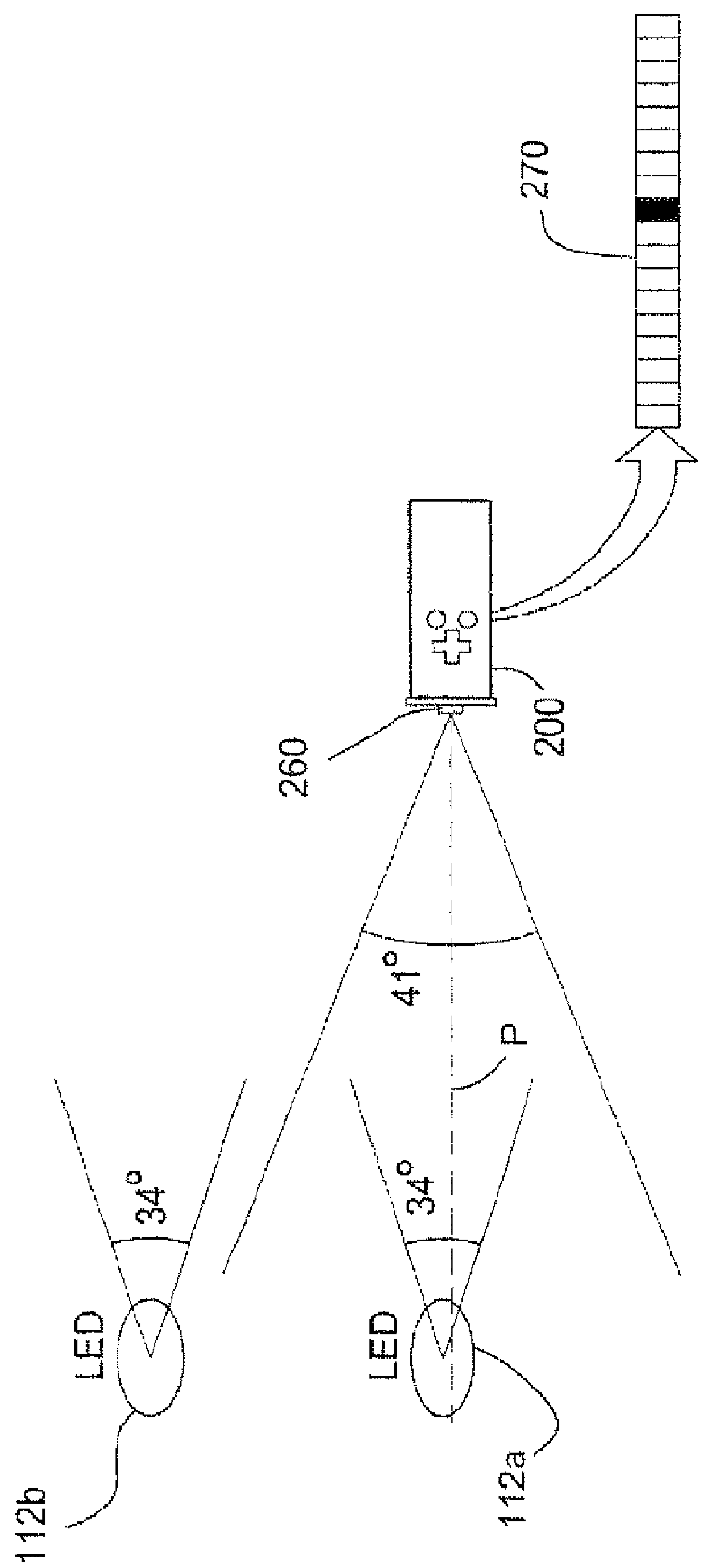

270
200
260
41°
34°
34°
LED
LED
P
112b
112a

Fig. 7A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200
260
41°
P
34°
34°
LED
LED
112b
112a

Fig. 7B

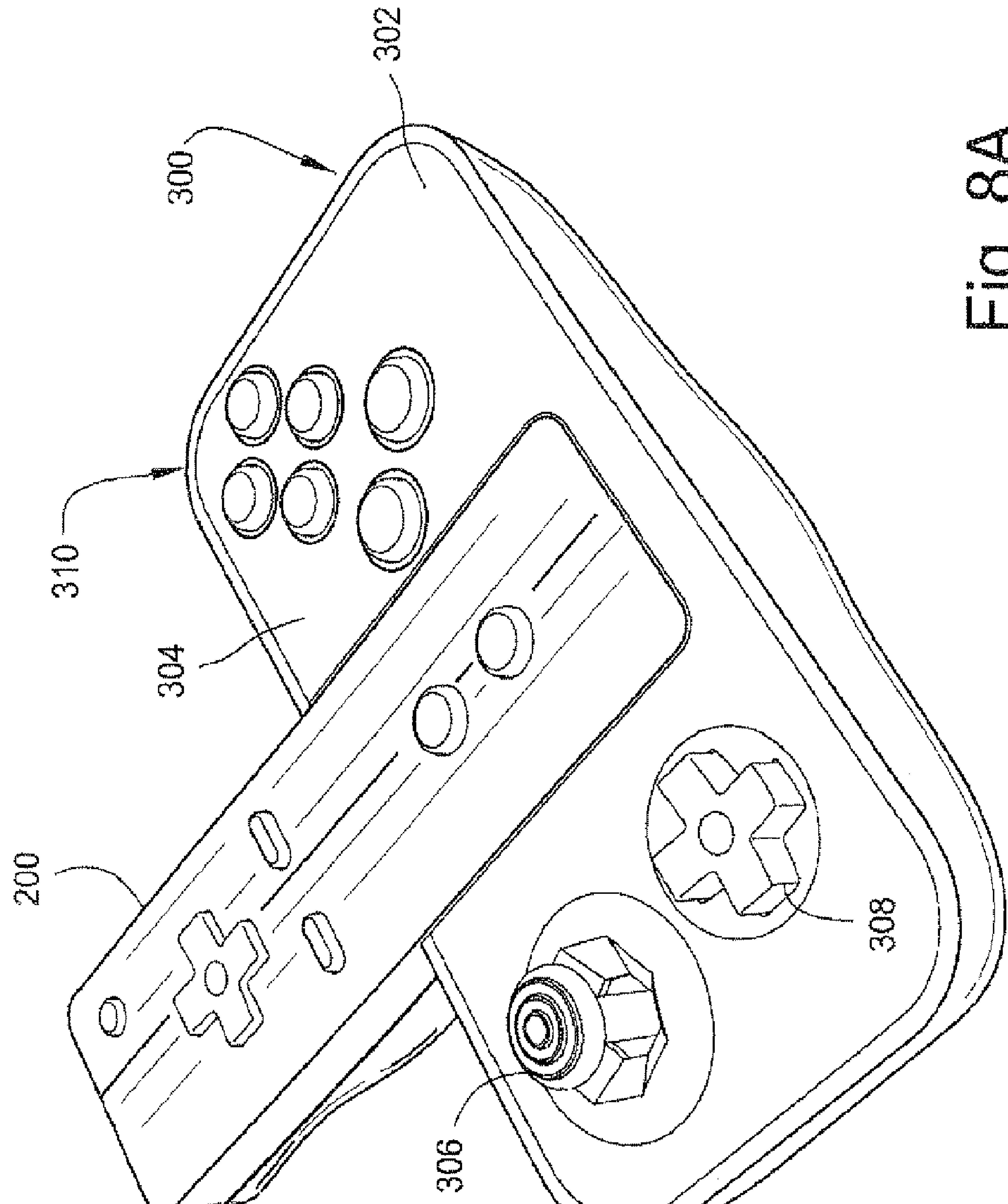

Fig. 8A

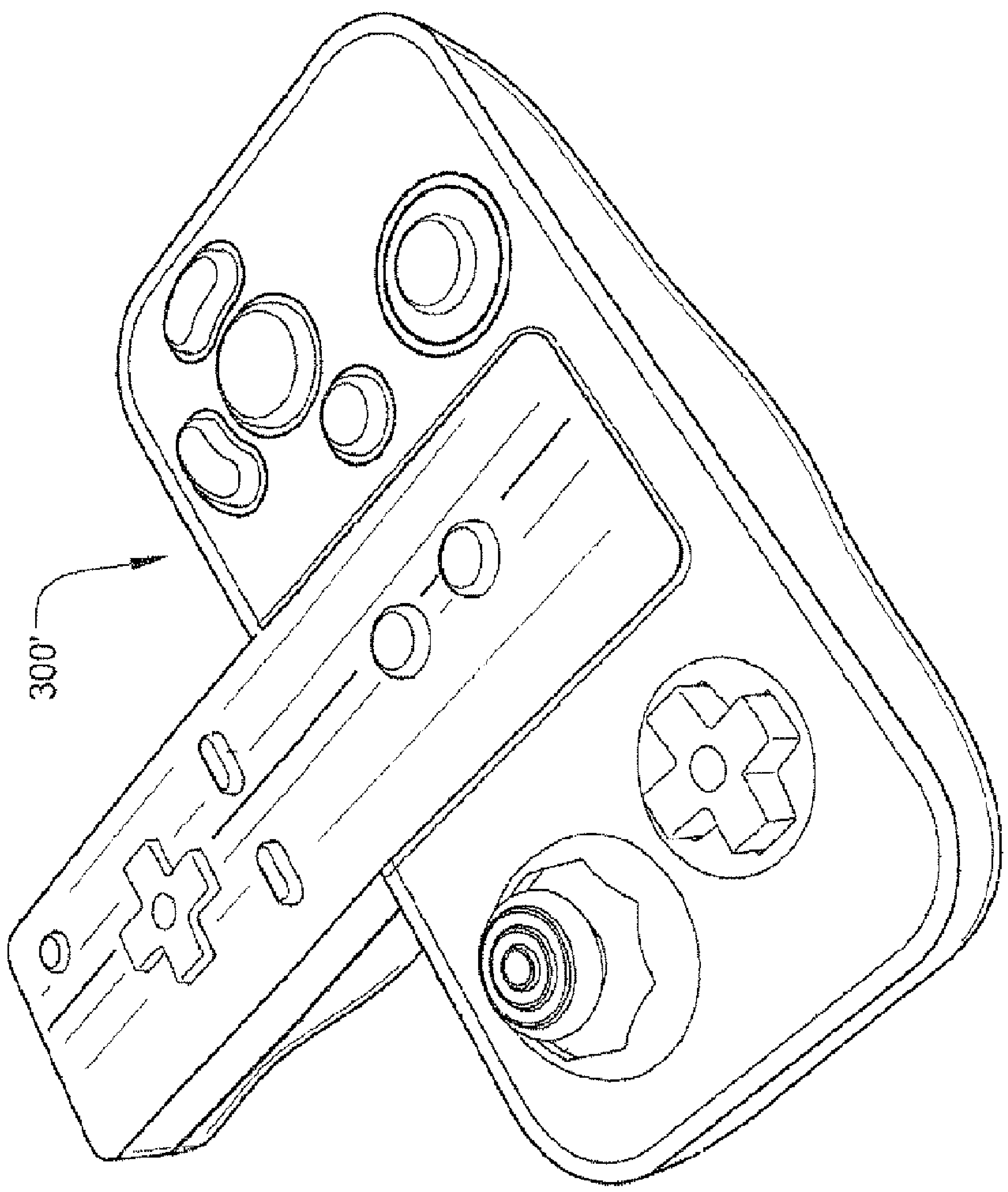

Fig. 8B

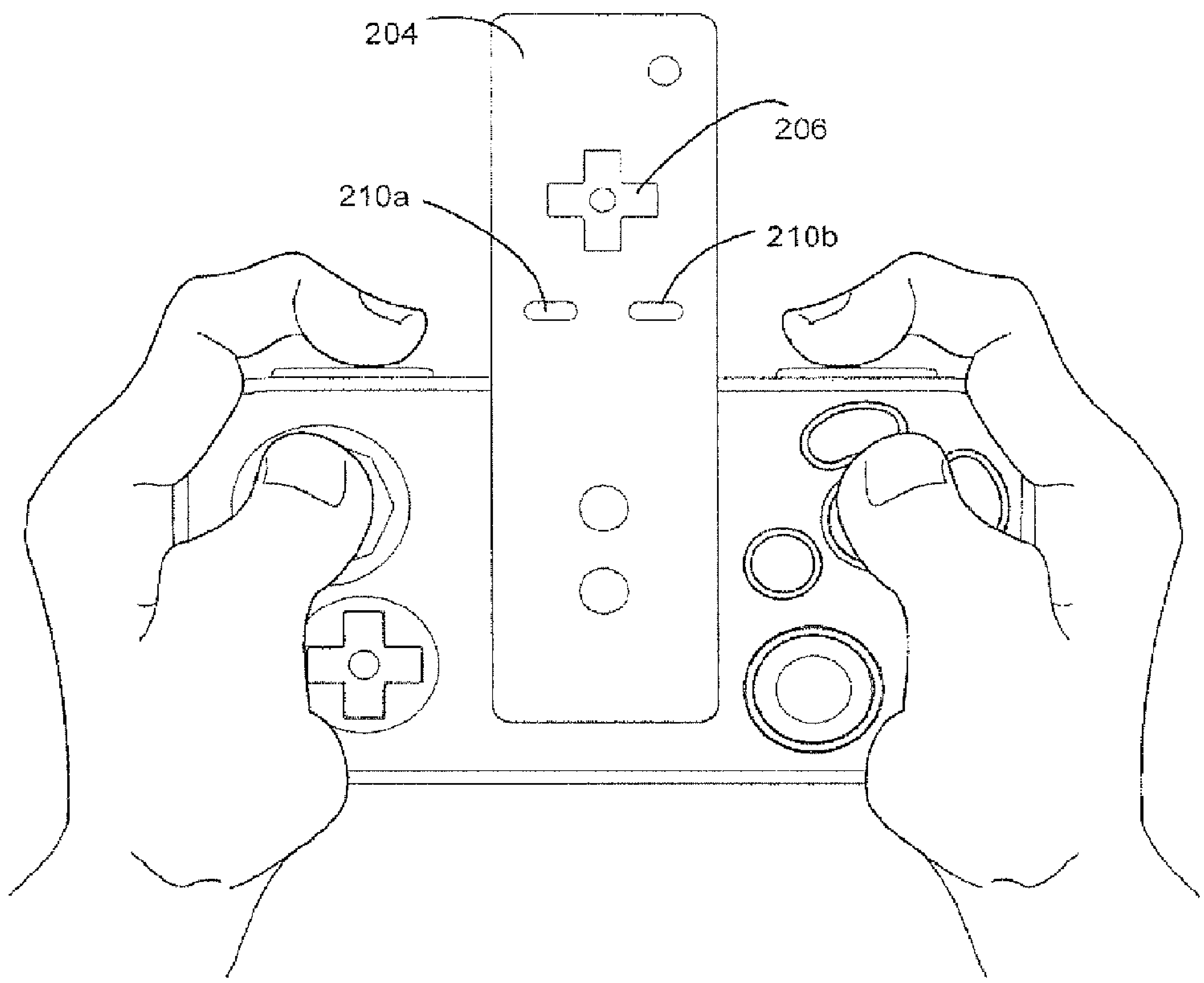

Fig. 8B-1

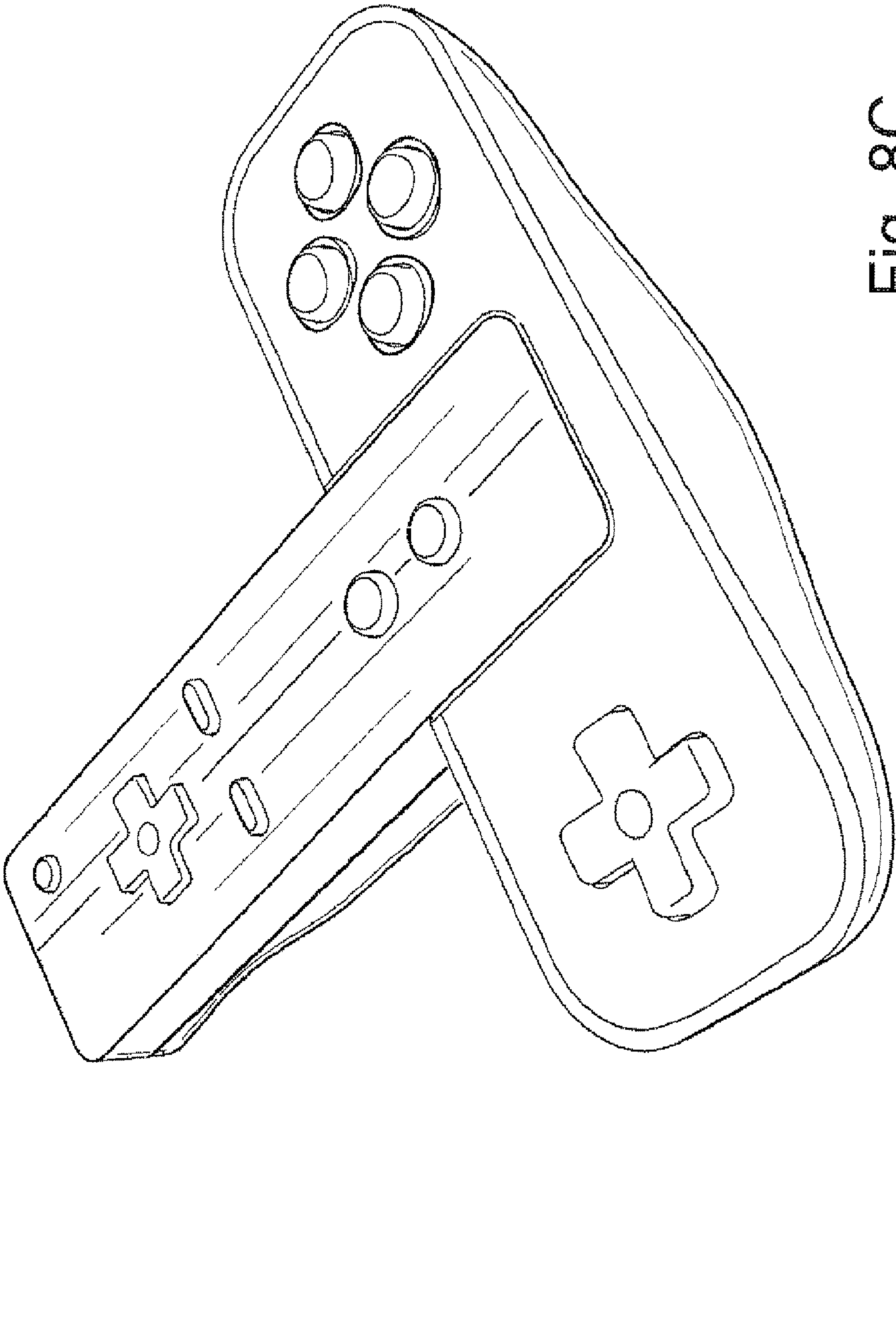

Fig. 8C

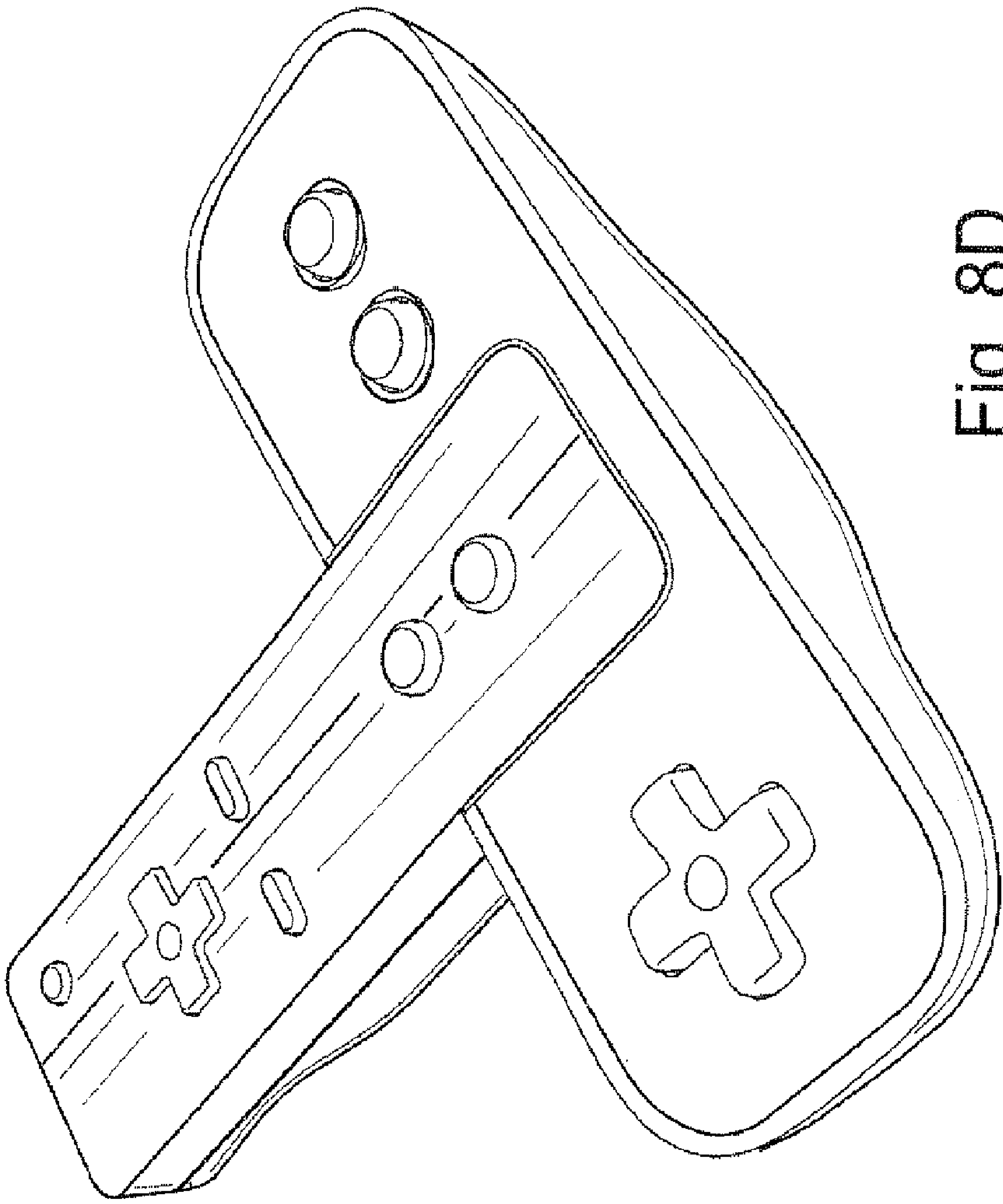

Fig. 8D

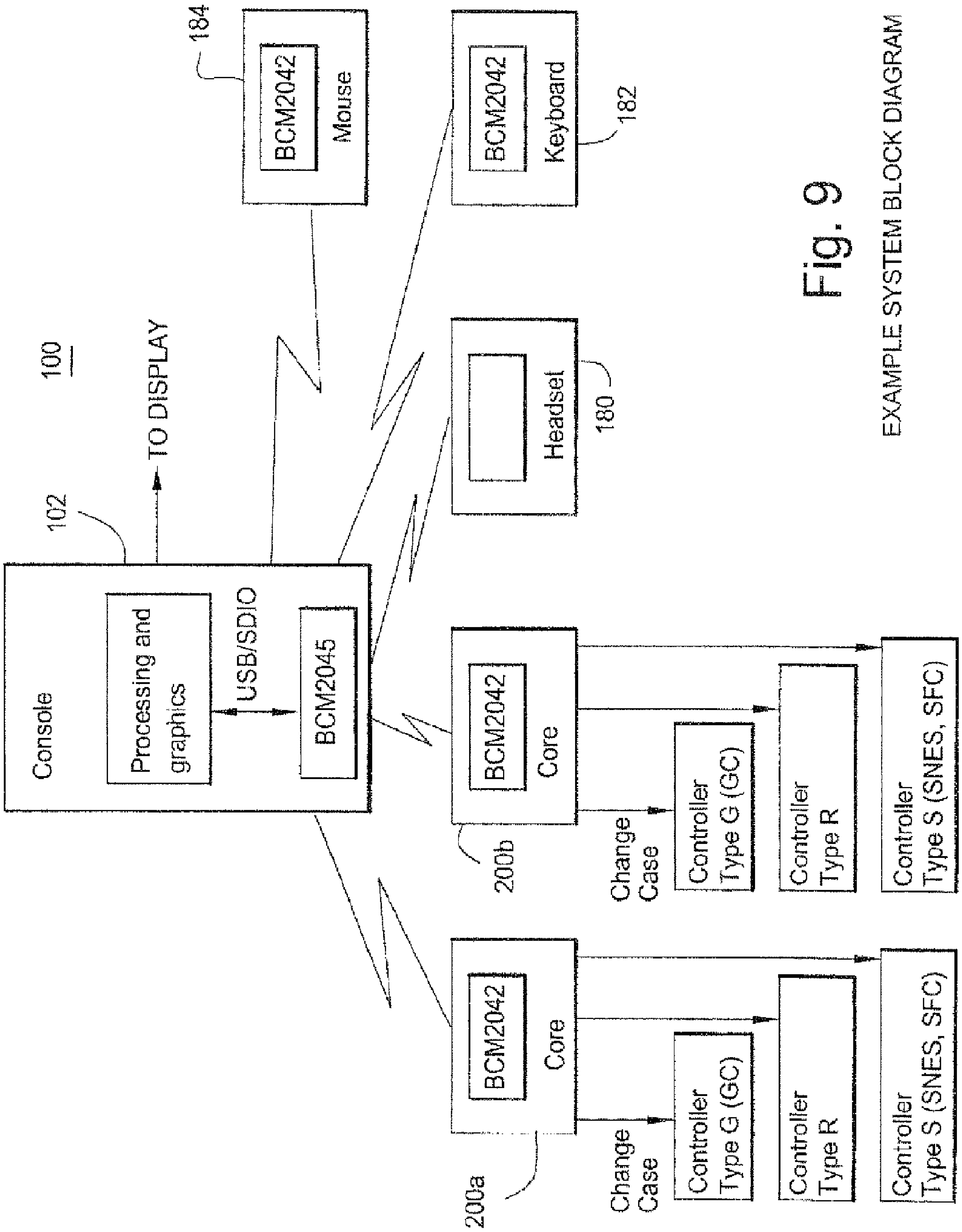

Fig. 9
EXAMPLE SYSTEM BLOCK DIAGRAM

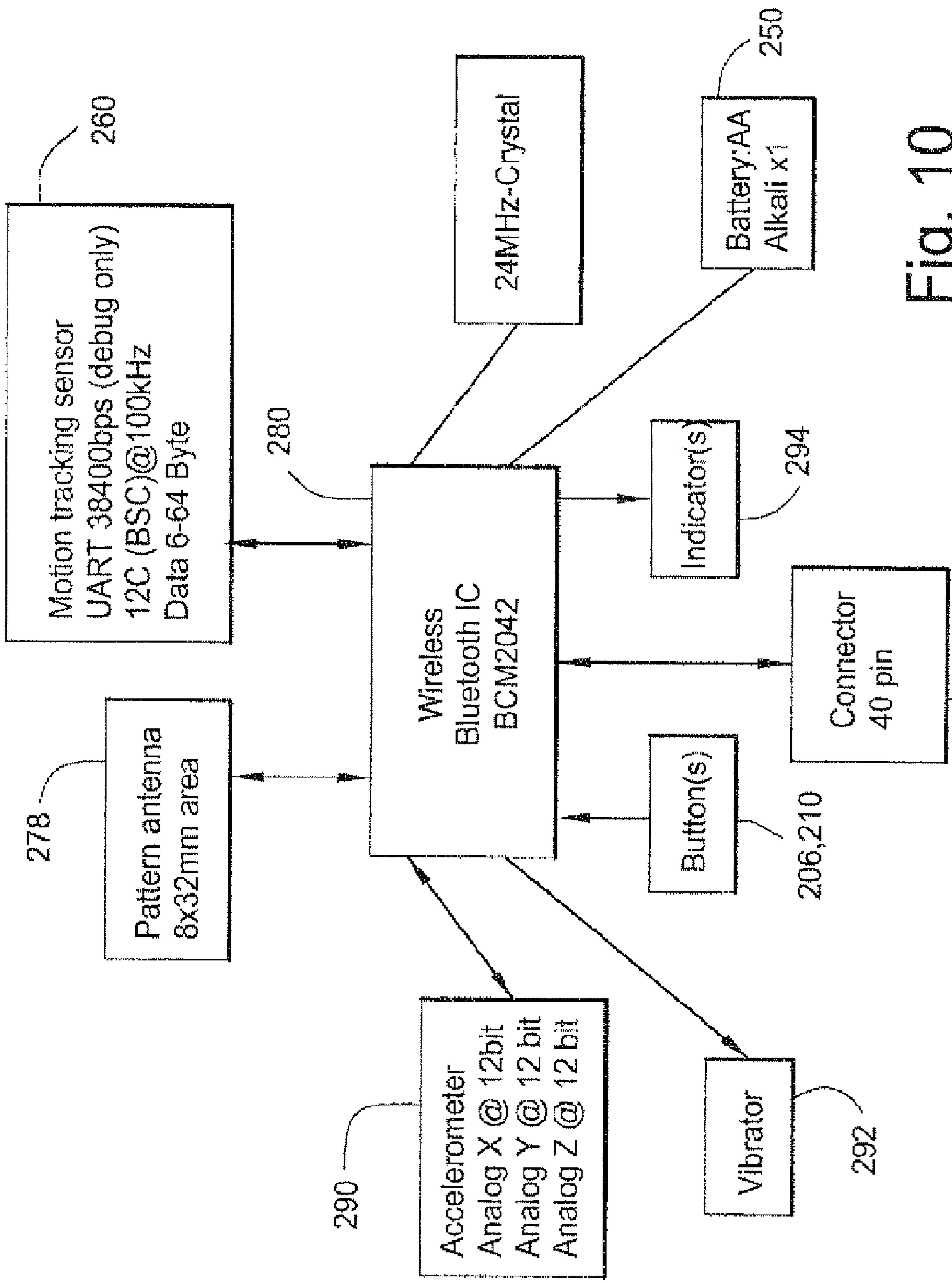

Fig. 10

EXAMPLE CONTROLLER BLOCK DIAGRAM

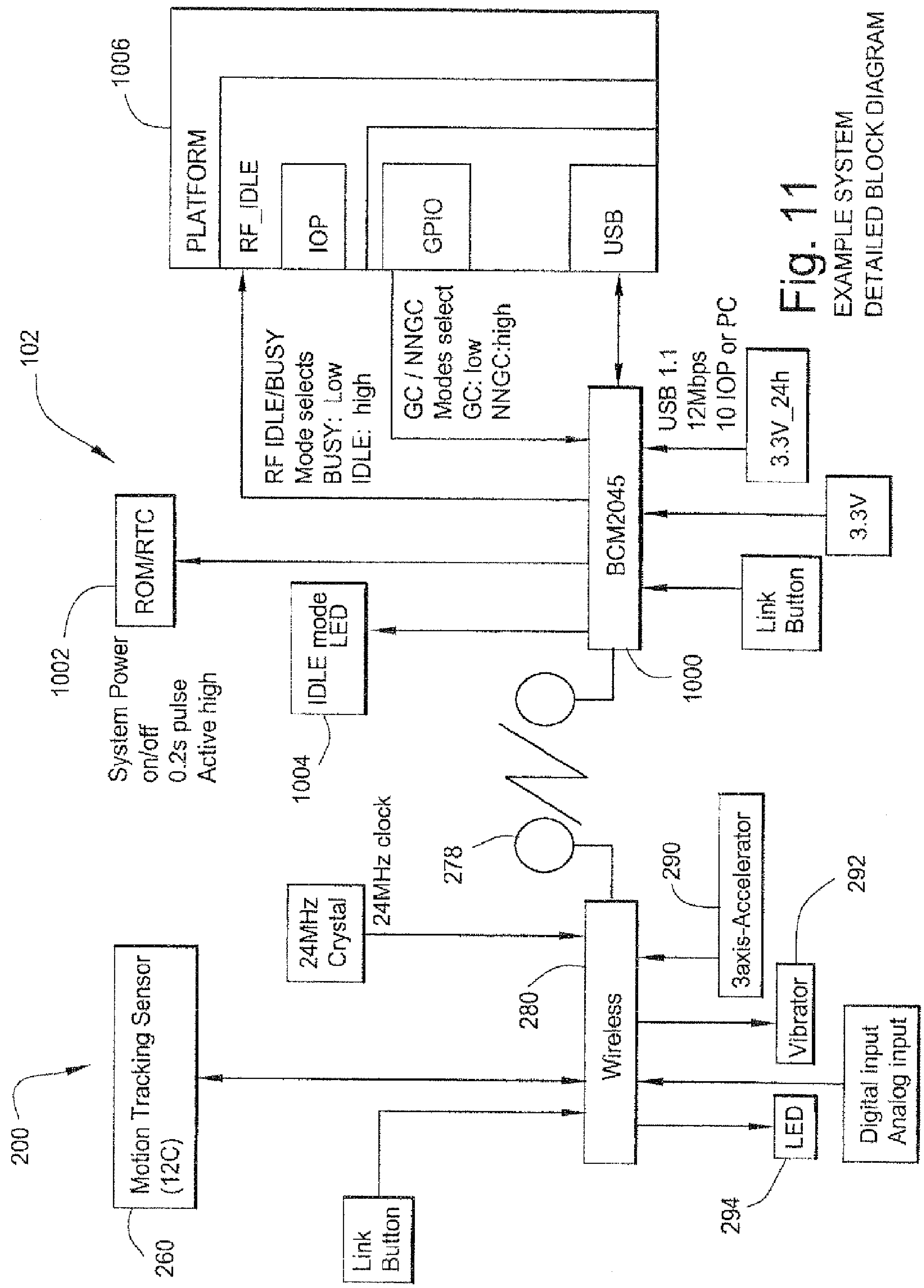

Fig. 11
EXAMPLE SYSTEM
DETAILED BLOCK DIAGRAM

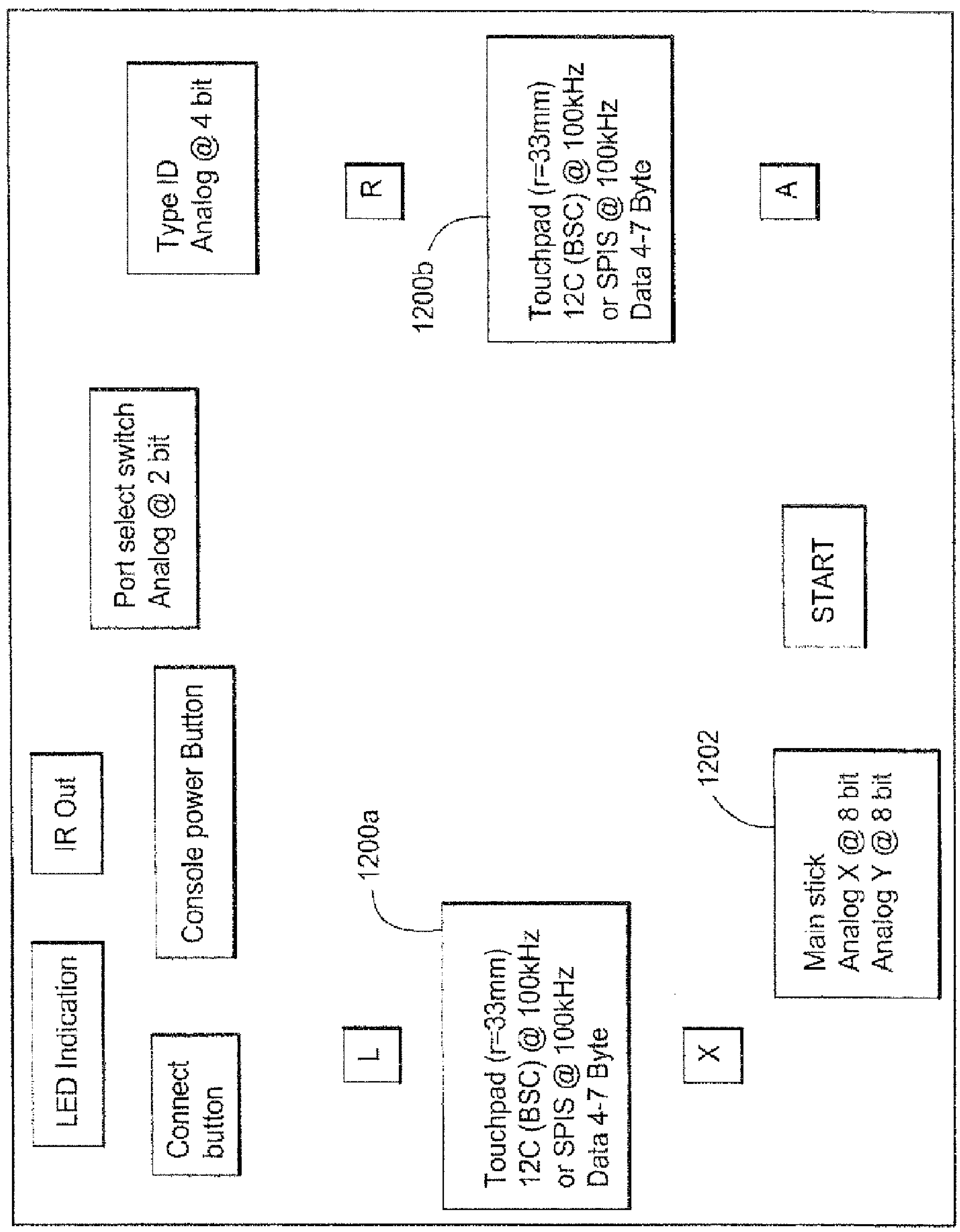

Fig. 12A EXAMPLE EXPANSION UNIT

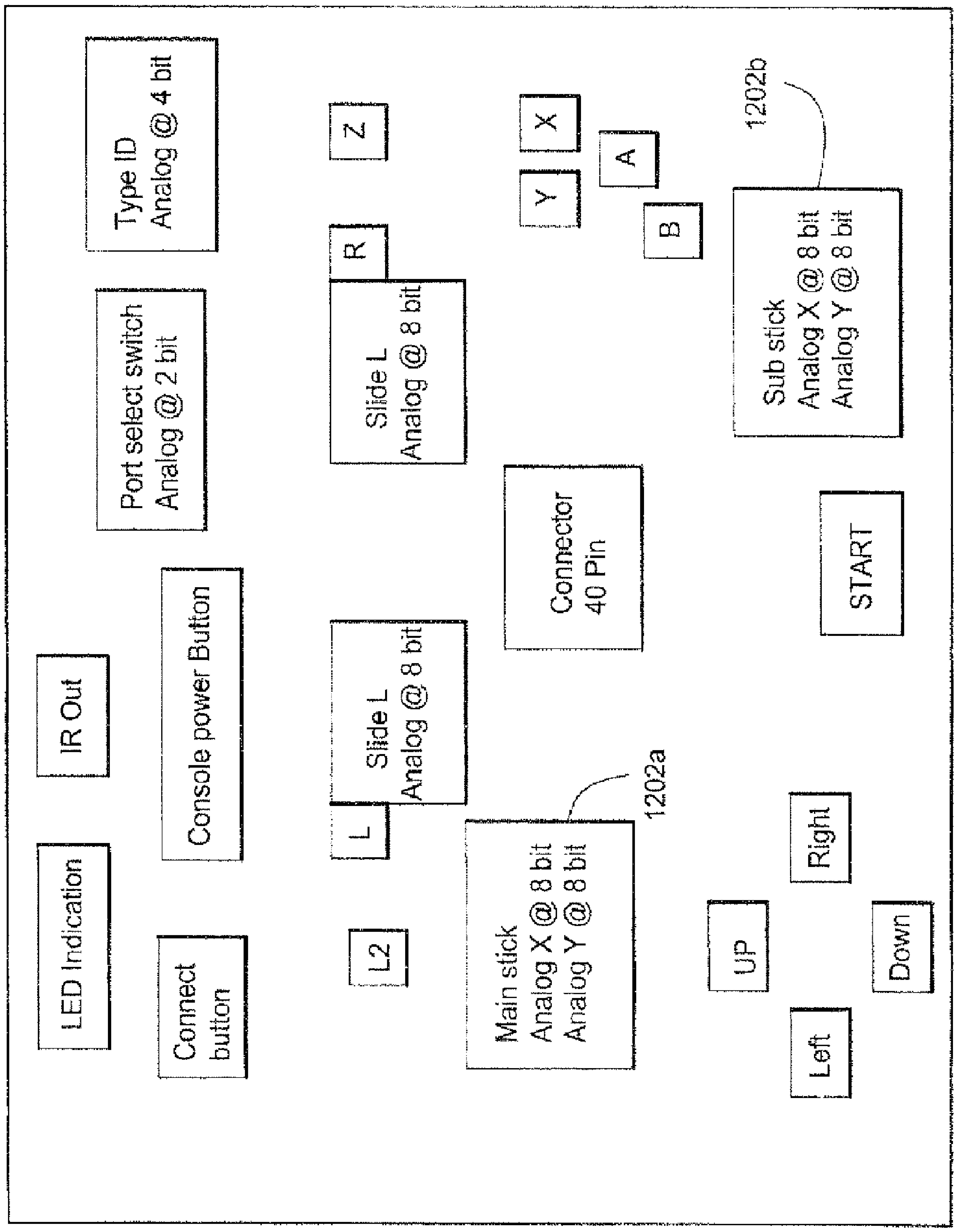

Fig. 12B EXAMPLE EXPANSION UNIT

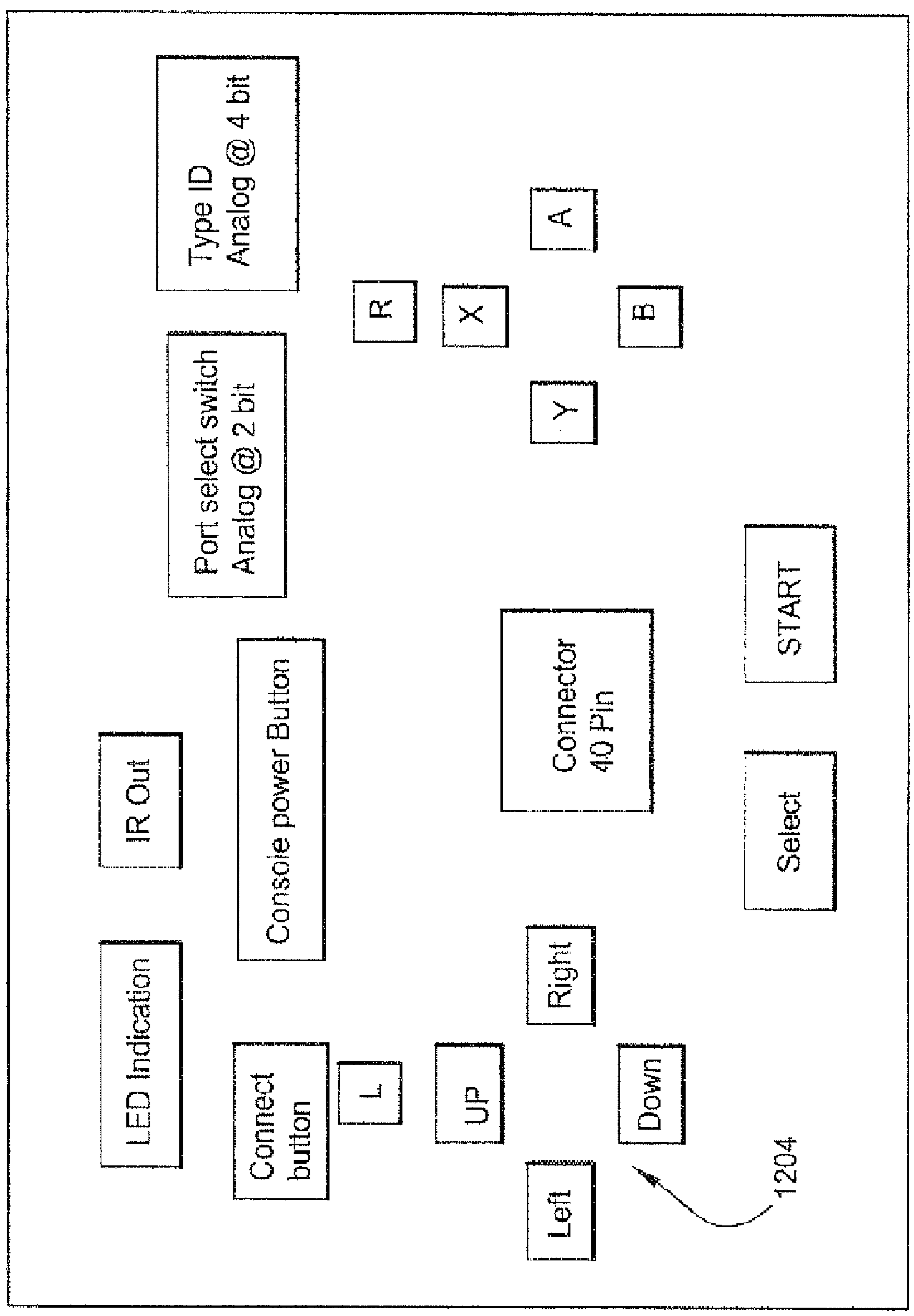

Fig. 12C
EXAMPLE EXPANSION UNIT

VIDEO GAME SYSTEM WITH WIRELESS MODULAR HANDHELD CONTROLLER

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

This application is a reissue of U.S. Pat. No. 8,430,753, for which more than one reissue application has been filed, namely application Ser. No. 14/694,783 filed on Apr. 23, 2015 which is also a reissue of U.S. Pat. No. 8,430,753.

CROSS-REFERENCES TO RELATED APPLICATIONS

This application *is a reissue of U.S. application Ser. No. 13/071,088 (now U.S. Pat. No. 8,430,753), filed Mar. 24, 2011, which* is a continuation of U.S. application Ser. No. 11/532,328, filed Sep. 15, 2006, which claims priority from provisional application No. 60/716,937, filed on Sep. 15, 2005. This application is also related to U.S. application Ser. No. 11/446,187, filed on Jun. 5, 2006; and U.S. application Ser. No. 11/446,188, filed on Jun. 5, 2006, the disclosures of which are incorporated herein by reference.

FIELD

The technology herein relates to consumer electronics, and more particularly to video game and entertainment systems. In still more detail, the technology herein relates to a home video game system including a modular remote wireless handheld control device with capabilities including position sensing.

BACKGROUND AND SUMMARY

Computer graphics technology has come a long way since video games were first developed. Relatively inexpensive 3D graphics engines now provide nearly photo-realistic interactive game play on home video game and personal computer hardware platforms costing only a few hundred dollars.

Most game players demand great graphics, but the core of video game play is the man-machine interface—the interaction between the (human) game player and the gaming platform. Video games are fun and exciting to play because the game player can interact with the game and affect or control the gaming events and outcome. Since the essence of an enjoyable video game play experience relates to the way the user interacts with the game and the game playing system, user input details tend to be important to the success and marketability of home video game play systems.

One aspect of the video game user interface relates to how the user controls the position of one or more objects on the display. Much work has been done on this user interface aspect in the past. For example, the first Magnavox Odyssey home video game systems provided detachable handheld controllers with knobs that allowed the game player to control the horizontal and vertical positioning of objects on the screen. Pong®, another early home video game system, had a very simple user interface providing controls the players manipulated to control the positioning of paddles on the screen. Nintendo's Game and Watch® early handheld video

game systems used a "cross-switch" as described in Nintendo's U.S. Pat. No. 4,687,200 to control the position of objects on the screen. These were relatively simple yet effective user interfaces.

In recent years, video game system handheld controllers have tended to become increasingly more complicated and more capable. Video game platforms offered by Nintendo and others have provided joysticks, cross-switches or other user-manipulable controls as a means for allowing the user to control game play in a variety of simple and sophisticated ways. Many handheld controllers provide multiple joysticks as well an array of trigger buttons, additional control buttons, memory ports, and other features. Rumble or vibration effects are now common, as are wireless capabilities. Home video game manufacturers supply a variety of user input devices, and game accessory manufacturers often provide an even wider array of input device options. For example, some in the past have also tried to develop a video game handheld controller that senses the orientation of the handheld controller itself to control object position on the display. See U.S. Pat. No. 5,059,958 assigned to the present assignee.

One challenge that some have confronted in the past relates to cross-platform video game play. Generally, most video game system manufacturers differentiate new gaming systems from other or previous ones by providing unique user interface features including for example handheld controller configurations. Video games for play on different home video game platforms may therefore use different handheld controller configurations. While it may be possible in some cases to "remap" the user controls from one interface configuration to another so a game for one platform can be controlled using a different input control interface, such remapping may be less than optimal and/or change the game play experience in significant ways. For example, playing a game using a four-active-position cross-switch to control the movement of the main character on the screen may be quite a different experience for the user as compared with using an analog or digital joystick offering many different directional positions.

Furthermore, most video game platforms in the past have provided a single basic user interface that is used for all games playable on the platform. Even though different video games may provide quite different game play, video game developers have become skilled at using the common set of user input controls provided by the platform to control various different games. For example, most games developed to run on the Nintendo GameCube home video game system make use of the same handheld controller inputs comprising two joysticks, trigger switches and additional miscellaneous controls. Some games allocate different controls to different functions. For example, in one game, the left-hand joystick might navigate a 2D map view of a battlefield whereas in another game that same control might be used to allow the user to adjust virtual camera position or direction within a three-dimensional world.

The technology herein advances home video game user interfaces in ways not previously envisioned, to provide a more flexible and satisfying user experience across an ever increasing and divergent range of video games and other applications.

One illustrative non-limiting exemplary aspect of the technology herein provides for positioning video game objects on the screen in response to the position of a handheld controller relative to the display. Rather than moving a joystick or cross-switch, the user simply moves the entire handheld controller. The motion of the controller is sensed and used to control the position of objects or other parameters in connection with video game play.

Another exemplary non-limiting illustrative aspect of the technology herein provides a handheld controller with a modular design. The basic controller functionality including wireless connectivity, vibration generation, position sensing, orientation sensing and other features are provided within a core or basic handheld controller unit. This core unit can control many or most videogame input functions and play most games. However, for enhanced input functionality, the core unit can be plugged into an expansion controller assembly providing additional controls, inputs and other functionality. As one example, the core unit can be plugged into a first accessory expansion unit providing touch pads when it is desired to play videogames requiring touch pad input. The same core unit can be plugged into a different expansion unit providing joysticks and other input devices to play videogames designed for joystick inputs. The same core controller can be plugged into a still additional expansion unit when the player wishes to interact with a videogame system using a simpler control interface providing a cross-switch and additional input buttons. In one exemplary illustrative non-limiting implementation, some of the accessory units are designed to mimic earlier or different videogame platforms to allow the videogame system to match user interactivity experiences provided by such other systems.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features and advantages will be better and more completely understood by referring to the following detailed description of exemplary illustrative non-limiting implementations in conjunction with the drawings, of which:

FIG. **1** shows an exemplary illustrative videogame system being operated in a typical home game playing environment;

FIG. **2** shows an exemplary illustrative non-limiting implementation of a handheld videogame controller;

FIGS. **2**A-**2**E show different views of the FIG. **2** implementation being grasped by the hand;

FIG. **2**F shows exemplary two-handed operation;

FIGS. **3** and **3**A show exemplary illustrative variations of the FIG. **2** controller with a top plate removed;

FIG. **4** shows a bottom view of the FIG. **2** controller;

FIG. **5** shows a bottom view of the FIG. **2** controller with bottom cover removed;

FIG. **6** shows a side and front perspective view of the exemplary FIG. **2** controller;

FIG. **6**A shows an additional exemplary view of the FIG. **2** controller including a head pivot or tilt feature;

FIGS. **6**B-**6**H show different views of an alternative exemplary illustrative non-limiting handheld controller implementation;

FIGS. **7**A and **7**B show different views of the FIG. **2** controller when used to detect position relative to light emitters;

FIGS. **8**A, **8**B, **8**B-**1**, **8**C and **8**D show exemplary illustrative non-limiting expansion controller units into which the FIG. **2** core unit may be removably disposed and interconnected;

FIG. **9** shows an exemplary illustrative non-limiting block diagram implementation of the FIG. **1** system;

FIG. **10** shows an overall block diagram of the FIG. **2** controller;

FIG. **11** is an exemplary illustrative non-limiting block diagram of an overall system; and

FIGS. **12**A-**12**C show exemplary illustrative non-limiting block diagrams of different expansion unit controller configurations.

DETAILED DESCRIPTION

Example Overall Exemplary Illustrative Non-Limiting System

FIG. **1** shows an illustrative, exemplary non-limiting implementation of a video game system **100**. System **100** includes a main unit **102** sometimes also called a "console." Main unit **102** executes applications including video game software, and generates images for display on the display **104** of a conventional home color television set or other display device **106**. Main unit **102** also generates sound for reproduction by TV set **106**. People **108** can interact with the video game play to control or affect the images and the progression of the game or other application.

Main unit **102** in the exemplary illustrative non-limiting implementation can be used to play a variety of different games including driving games, adventure games, flying games, fighting games, and almost any other type of game one might think of. The video game software that main unit **102** executes may be delivered on bulk storage devices such as optical disks, semiconductor memory devices or the like, it may be down loaded into the main unit over a network, or it may be provided to the main unit in any other desired manner. Main unit **102** may also be capable of performing applications in addition to video games (e.g., movie playback, email, web browsing, or any other application one can imagine). A security system built into main unit **102** may ensure that only authorized or authentic applications are executed.

FIG. **1** shows people ("video game players") **108**a, **108**b interacting with main unit **102** to play a video game. While two players **108** are shown, any number of players may interact with the main unit **102** at any given time. In the exemplary illustrative non-limiting implementation shown, each video game player **108** holds and operates a wireless handheld control unit ("controller") **200**. The players **108** operate these controllers **200** to generate input signals. The controllers **200** communicate their input signals wirelessly to main unit **102**. Such wireless communications can be by any convenient wireless method such as radio transmission, infrared, ultraviolet, ultrasonic or any other desired technique. Wireless peripherals could include Bluetooth, 802.11 (WiFi), HiperLAN/1, HiperLAN/2, HomeRF, VWB, WiMax or other. In other implementations, cords or cables could be used to connect controllers **200** to main unit **102**.

In the exemplary illustrative non-limiting implementation of system **100** shown, players **108** operate handheld controllers **200** in various ways to provide input signals to main unit **102**. For example, players **108** may depress buttons or otherwise manipulate other controls on controllers **200** to generate certain input signals. The effect of such control manipulations in the exemplary illustrative non-limiting implementation depends, at least in part, on the particular software that main unit **102** is executing. For example, depressing a certain button may provide a "start game" or "pause game" in some contexts, and may provide different functions (e.g., "jump character") in other contexts.

In the illustrative exemplary non-limiting implementation shown, controllers **200** have internal capabilities for detecting position and/or orientation. In the exemplary illustrative non-limiting implementation, players may change the orientation or position of controllers **200** to generate input signals. Controllers **200** may sense position and/or orientation and report that information to main unit **102**. Main unit **102** may use that information to control or affect video game play or other functionality.

In one exemplary illustrative non-limiting implementation, each handhold controller **200** may include an internal position, attitude or orientation sensor that can sense the position, attitude and/or orientation of the controller relative to the earth's gravitational force. Such a sensor may for example comprise a 3-axis accelerometer that can sense orientation (or changes in orientation) of the controller **200** relative to the direction of earth's gravitational pull. The output of such a sensor may be reported to main unit **102** and used for example to control motion of a character displayed on display **104**.

In addition, the exemplary illustrative non-limiting implementation of system **100** shown in FIG. **1** includes wireless emitters **110**a, **110**b. These wireless emitters **110** may be placed on each side of display **104** in alignment with the edges of the screen. The wireless emitters **110** may for example each comprise one or more light emitting diodes or other devices **112** that emit infrared or other electromagnetic or other radiation.

In one exemplary illustrative non-limiting implementation, the energy that emitters **110** emit has a wavelength or other characteristic that allows the radiation to be readily distinguished from ambient radiation. In the exemplary illustrative non-limiting implementation, handheld controllers **200** each detect the radiation emitted by emitters **110** and generate signals indicative of the controller's relative position and/or movement. Multiple controllers **200** can sense the same emitted radiation and generate different signals depending on the position or movement of that particular controller. Controllers **200** report the relative position and/or movement signal to main unit **102**. Main unit **102** may take any appropriate action in response to such signals such as, for example, moving, rotating or otherwise changing a game character or other object or background on the display **104**, scrolling a screen, selecting a different game function, or taking other actions.

In the exemplary illustrative implementation shown, the emitters **110** are added or retro-fitted onto a conventional color television set **106** by for example using an adhesive to attach the emitters onto the top housing of the television set on the extreme left and right of the housing in alignment with the edges of display **104**. In this exemplary illustrative non-limiting implementation, emitters **110** can be connected to main unit **102** by cables or wires run behind the television set **106**. In other implementations, emitters **110** could be built-in to television set **106** or mounted separately (e.g., on a set top box or otherwise). In still other implementations, emitters **110** could possibly be replaced with small reflective surfaces attached by adhesive to corners of display **104**, and controllers **200** could emit electromagnetic radiation and receive reflections from the reflective surfaces (e.g., whose angle of incidence is equal to angle of reflectance). In still other implementations, controllers **200** could emit electromagnetic radiations and units **110** could include sensors that sense the emitted radiation. Other implementations are possible.

Example Illustrative Non-Limiting Handheld Controller Design

FIG. **2** shows a perspective view of an exemplary illustrative non-limiting implementation of controller **200**. Controller **200** provides a housing **202** that is graspable by one hand (see FIGS. **2**A, **2**B, **2**C). Controller **200** in the exemplary illustrative non-limiting implementation is compact and has a solid rugged feel to it. It can be dropped onto a hard surface without breaking. Portions of its housing **202** are curved to fit comfortably into the hand (see FIGS. **2**A, **2**B, **2**C).

As shown in FIG. **2**A, the thumb can be positioned to operate controls on a top control surface **204** while the fingers are comfortably wrapped around the controller's bottom surface **203**. The digits of the hand (including the thumb) can operate the different controls arrayed on a top control surface **204** and elsewhere on the controller without fatigue and without wasted or undue motion. The controller **200** is small and lightweight enough to be comfortably held and supported for long periods of time without fatigue. Controller **200** is dimensioned to exactly and comfortably fit the average hand—not too small, not too big. The controls are arranged such that the controller **200** can be operated equally easily by the right hand or the left hand.

The controller housing **202** provides a top control surface **204** providing an array of controls depressible with the digits (fingers and/or thumbs) of the user's hand. In one illustrative non-limiting implementation, the user may operate a direction switch **206** with a thumb or forefinger to indicate a direction in two dimensions. In the illustrative non-limiting exemplary implementation shown, the directional switch **206** may comprise a switch surface **208** that can be rocked in different directions to provide different direction signals. The simplest form of such a directional switch **206** may comprise a so-called "cross switch" (a switch in the shape of a cross) that can be rocked in four different directions to provide four different, mutually exclusive direction signals (i.e., up, down, left, right). A somewhat more flexible form of a directional switch **208** may comprise a circular switch surface **208** that can be rocked in any of a number of different directions to provide corresponding different control signals indicating for example twelve, sixteen or more different directions. Other directional switch configurations could be used to provide a much higher number of directional inputs approaching, equaling or exceeding the number of signals from an analog or digital joystick. A touch or "joy" pad, a pointing stick, a trackball, or other input device could be used instead of or in addition to a switch. If a joypad were used, it could likely be operated in a direction-indicating mode as opposed to a "drag displacement" mode. Other arrangements could include touch sensitive display(s) or other types of displays.

Top control surface **204** in the exemplary illustrative non-limiting implementation also provides a pair of thumb-operated control switches **210**a, **210**b. These control switches **210**a, **210**b can be oriented as shown, or they could each be rotated say 45 degrees so as to be angularly displayed from one another in order to expose more surface area to a thumb positioned to operate either control switches **210** or directional switch **206**. Control switches **210**a, **210**b could be used to actuate a variety of game or other functions including for example "start" and "select" functions.

Top control surface **204** may also provide an additional push button **214** operated by the thumb for other functionality selection. A slide switch **216** on the side of housing **202** may be operated to provide on/off or other functionality. Depending on requirements, a slide switch **216** could be located on either or both side surfaces of the exemplary controller **200**.

Top control surface **204** in the exemplary illustrative non-limiting implementation further provides two additional controls **212**a, **212**b that may comprise indicator lamps or lights. Alternatively, such controls **212** could comprise additional operable controls such as push button switches, so-called "pointing stick" type input devices, or other input devices. These controls **212** may be relatively dormant or little used (while not being subject to accidental operation) when the controller **200** is operated in the hand positions shown in FIGS. **2**A, **2**B, **2**C, **2**D, **2**E, **2**F. However, another way of using controller **200** is to hold the controller in one hand (or place it on a flat surface such a table) and operate its controls with the forefinger and other fingers of the other hand. In such an alternate operating mode, the forefinger could be used to operate controls **212**a, **212**b if they are activatable input devices as opposed to indicators. FIG. **2**D for example shows that in one exemplary illustrative implementation, the user may move his or her thumb forward or backward to access different controls. FIG. 2D shows the ability to move the thumb side to side to provide different control actuations. FIG. 2F shows an exemplary illustrative non-limiting implementation whereby the user can hold the handheld controller in both hands and operate it with both left thumb and right thumb simultaneously.

FIG. 3 shows an exploded view of controller 200 with a top plate 204 removed to reveal a printed circuit board 220. Metallic pathways (not shown) and associated solder or other electrical interconnections may be used to electrically interconnect components via PC board 220. Various components including integrated circuit chips 222 (e.g., a wireless RF "Bluetooth" or other communications device, an accelerometer and other components) may be mounted to the printed circuit board 220. The printed circuit board 220 may also serve as a mounting surface for the directional switch 206, controls 210, 212, etc. The printed circuit board 220 in one exemplary illustrative non-limiting implementation provides a rugged fiberglass structure used to both mount and electrically interconnect components of controller 200. The same or different printed circuit board 220 may provide an edge or other connector 224 for use in electrically connecting controller 200 to other devices (to be described below). FIG. 3A shows a different exemplary illustrative non-limiting implementation with a different exemplary non-limiting control layout. Further configurations are also possible.

FIG. 4 shows a bottom view of an exemplary illustrative non-limiting implementation of controller 200. The bottom view reveals an access plate 230 for installing one or more small conventional removable/replaceable battery cells (see FIG. 5). FIG. 4 also shows an additional "trigger" type switch 232 operable by the forefinger when the controller is held in the hand (see FIG. 2A, 2C). "Trigger" switch 232 may for example sense pressure to provide a variable input signal that depends on how much pressure the user's forefinger is exerting on the switch. Such a variable-pressure "trigger" switch 232 can be used in a video game to fire weapons, control the speed of a vehicle in a driving or space game, or provide other functionality.

In the exemplary illustrative non-limiting exemplary implementation shown, the trigger switch 232 is disposed on an angular surface 234 of the bottom surface 240 of controller 200 within a V-shaped depression 236 located near the front distal end 238. This V-shaped depression 236 is dimensioned to comfortably provide a resting and grasping slot for the forefinger (see FIG. 2C) which may be slightly rotated and pulled toward the user between a resting position (see FIG. 2C) and an actuation position (see FIG. 2A). With the middle, ring and pinkie fingers wrapped around and grasping the curved center 240c and rear 240r portions of the controller's bottom surface 203 and the forefinger comfortably engaged within the v-shaped depression 236, the user feels quite comfortable holding and operating controller 200 with one hand and positioning and aiming it precisely in desired directions.

FIG. 5 shows an exploded view of controller 200 with the lower housing portion 240 removed to expose internal components such as removably replaceable batteries 250 and associated holders/contacts 252, and trigger switch 232. While two batteries 250 are shown in FIG. 5, any number of batteries (e.g., one, three, etc.) can be used depending on weight, power and other requirements. Note that to replace batteries 250, the user would not usually remove the lower housing 240 but rather would simply remove the access plate 230. In other configurations, the controller 200 might be rechargeable and batteries 250 could be of the nickel-cadmium or other type that do not require routine replacement. In such exemplary configuration, the controller 200 could be placed into a charging station to recharge the batteries 250 instead of expecting the user to replace the batteries. While FIG. 5 shows a separate edge connector 224, it is possible that the edge connector could be formed by a distal edge of the printed circuit board 220.

FIGS. 6B-6H show an additional exemplary non-limiting illustrative implementation of a handheld controller with a different control configuration. A power button 1002 may be used to activate power on the main unit 102. A control pad 206 provides directional input. An A button 1004 can be operated by the thumb instead of the control pad 206 to provide a momentary on-off control (e.g., to make a character jump, etc.). Select and start buttons 1006, 1008 may be provided for example to start game play, select menu options, etc. A menu button 1010 (which may be recessed to avoid accidental depression) may be provided to display or select menu/home functions. X and Y buttons may be used to provide additional directional or other control. Light emitting diodes or other indicators 1016a-d may be used to indicate various states of operation (e.g., for example to designate which controller number in a multi-controller environment the current controller is assigned). A connector 1018 is provided to connect the controller to external devices. FIG. 6C shows an underneath side perspective view, FIG. 6D shows a top plan view, FIG. 6E shows a side plan view, FIG. 6F shows a bottom plan view, FIG. 6G shows a front plan view, and FIG. 6H shows a rear plan view.

Example Illustrative Non-Limiting Optical Pointing Device Motion Detection

FIG. 6 shows a front perspective view of controller 200 illustrating an additional sensing component 260 also shown in FIG. 5. Sensor 260 in the exemplary illustrative non-limiting implementation is disposed on the "nose" or front surface 262 of controller 200 so that it points forward, looking down a pointing axis P. The direction of pointing axis P changes as the user changes the orientation of controller 200. It is possible to provide a pivot mechanism (see FIG. 6A) to allow the user to pivot the nose portion up and down to provide better ergonomics (e.g., the user could be sitting on the floor below the level of the emitters 112 and still be able to point directly forward, with the sensor 260 axis P being aimed upwardly).

Sensing component 260 in the exemplary illustrative non-limiting implementation comprises an infrared-sensitive CCD type image sensor. Sensor 260 may comprise a one-dimensional line sensor or it could comprise a 2D sensor such as for example a low resolution monochrome CCD or other camera. Motion tracking sensor 260 may include a lens and a closely coupled digital signal processor to process incoming images and reduce the amount of information that needs to be conveyed to main unit 102. In one exemplary non-limiting implementation, motion tracking sensor 260 may include a 128 pixel by 96 pixel relatively low resolution monochrome camera, a digital signal processor and a focusing lens. More than one such sensor could be used if desired.

In the exemplary illustrative non-limiting implementation, sensor 260 gives controller 200 optical pointing capabilities. For example, movement of the controller 200 can be detected (e.g., by the controller itself) and used to control what is being displayed on display 104. Such control could include for example scrolling of the screen, rotation or other reorientation of display objects in response to rotation/reorientation of controller 200, and other responsive interactive displays. Such control may provide a better moment arm as compared to a joystick.

In the exemplary illustrative non-limiting implementation, sensor **260** is designed and configured to sense the emitters **110** shown in FIG. **1**. FIGS. **7**A, **7**B show that sensor **260** has a certain well defined field of view (FOV) symmetrical with the sensor pointing axis P. For example, the sensor **260** may have a field of view of about 20.5 degrees on each or every side of pointing axis P (this particular field of view angle is a design choice; other choices are possible in other configurations). Such well defined field of view provides an acute triangularly shaped (or cone-shaped for 2D sensor configurations) viewing area that sensor **260** can "see"—with the base of the triangle increasing in length as distance from the controller **200** increases. Sensor **260** also has a well defined sensitivity such that it can only "see" IR emissions above a certain range of intensity. Emitters **112** are designed in the exemplary illustrative non-limiting to provide sufficient output power and beam spreading consistent with the sensitivity of sensor **260** such that sensor can "see" the emitters at ranges consistent with how video game players arrange themselves in a room relative to a television set **106** (taking into account that a player may sometimes sit close to the television when playing by himself, that players may be sitting on the floor, standing, sitting on chairs or couches or other furniture, etc.).

In more detail, FIG. **7**A shows that in the exemplary illustrative non-limiting implementation, the overall field of view of sensor **260** is wider than the typical separation of emitters **112** and is also wider than beam width of each emitter **112**. In one exemplary illustrative non-limiting implementation, the ratio of the beam spreading angle (e.g., 34 degrees) of the beams emitted by emitters **112** to the field of view (e.g., 41 degrees) of sensor **260** may be approximately 0.82 (other ratios are possible). Plural emitters **112** can be used at each emission point to provide a wider beam (horizontal field of view) than might otherwise be available from only a single emitter, or a lens or other optics can be used to achieve desired beam width.

At an average distance from controller **200** to television set **106** and associated emitters **112** and assuming a maximum television screen size (and thus a maximum physical separation between the emitters), such a ratio may maximize the displacement of two radiation "dots" or points appearing on the CCD sensor array **270** that sensor **260** comprises. Referring to FIG. **7**A for example, when the central axis of sensor **260** is directed centrally between displaced emitters **112** (note that in one exemplary illustrative non-limiting implementation, the emitters are disposed on either side of the television display and are therefore relatively far apart relative to the resolution of the image being generated), the CCD array **270** that sensor **260** defines will register maximal illumination at two points near the ends of the sensor array. This provides a higher degree of resolution when the sensor **260**'s central axis P is displaced relative to the center of separation of the emitters **112** (see FIG. **7**B) even when using a relatively low resolution CCD imaging array (e.g., a 128-cell long sensor array). Note that while a linear array **270** is illustrated in FIGS. **7**A, **7**B for sake of convenience, a rectangular array could be used instead.

In the illustrative, exemplary non-limiting implementation shown, it is unnecessary to modulate or synchronize emitters **112** in the exemplary illustrative non-limiting implementation, although it may be desirable to power down the emitters when not in use to conserve power usage. In other arrangements, however, synchronous detection, modulation and other techniques could be used.

The exemplary illustrative non-limiting implementation of controller **200** and/or main unit **102** includes software or hardware functionality to determine the position of controller **200** relative to emitters **112**, in response to the illumination maxima sensed by sensor **260**. In one example illustrative non-limiting implementation, controller **200** includes an onboard processor coupled to the sensor **260** that interprets the currently detected illumination pattern, correlates it with previous sensed illumination patterns, and derives a current position. In another example illustrative non-limiting implementation, controller **200** may simply report the sensed pattern to main unit **102** which then performs the needed processing to detect motion of controller **200**. The sensor could be affixed to the human operating the system to provide additional control.

Since it may not be desirable to require end users of system **100** to measure and program in the precise distance between the emitters **112** and since television sets vary in dimension from small screens to very large screens, controller **200** does not attempt to calculate or derive exact positional or distance information. Rather, controller **200** may determine movement changes in relative position or distance by analyzing changes in the illumination pattern "seen" by CCD array **270**.

It may be possible to ask the user to initially point the controller **200** at the center of the television screen **104** and press a button, so as to establish a calibration point (e.g., see FIG. **7**A)—or the game player may be encouraged to point to the center of the screen by displaying an object at the center of the screen and asking the user to "aim" at the object and depress the trigger switch. Alternatively, to maximize user friendliness, the system can be self-calibrating or require no calibration at all.

Differences in the illumination pattern that CCD array **270** observes relative to previously sensed patterns (see e.g., FIG. **7**B) can be used to determine or estimate movement (change in position) relative to previous position in three dimensions. Even though the CCD array **270** illumination shown in the FIG. **7**B scenario is ambiguous (it could be obtained by aiming directly at emitter **112**a or at emitter **112**b), recording and analyzing illumination patterns on a relatively frequent periodic or other basis (e.g., 200 times per second) allows the controller to continually keep track of where it is relative to the emitters **112** and previous controller positions. The distance between the illumination points of emitters **112** and CCD array **270** can be used to estimate relative distance from the emitters. Generally, game players can be assumed to be standing directly in front of the television set and perpendicular to the plane of display **106**. However, scenarios in which controller **200** is aimed "off axis" such that its central axis P intersects the plane of emitters **112** at an angle other than perpendicular can also be detected by determining the decreased separation of the two maximum illumination points on the CCD array **270** relative to an earlier detected separation. Care must be taken however since changes in separation can be attributed to changed distance from the emitters **112** as opposed to off-axis. Simpler mathematics can be used for the motion and relative position detection if one assumes that the player is aiming the sensor axis P directly at the display **104** so the axis perpendicularly intersects the plane of the display.

Software algorithms of conventional design can ascertain position of controller **200** relative to emitters **112** and to each logical or actual edge of the display screen **104**. If desired, controller **200** may further include an internal conventional 3-axis accelerometer that detects the earth's gravitational forces in three dimensions and may thus be used as an inclinometer. Such inclination (orientation) information in three axis can be used to provide further inputs to the relative position-detecting algorithm, to provide rough (x, y, z) position information in three dimensions. Such relative position information (or signals from which it can be derived) can be wirelessly communicated to main unit **102** and used to control the position of displayed objects on the screen.

Example Modular Control Interface Controller Expansion

FIGS. **8**A-**8**D illustrate an additional feature of the exemplary illustrative non-limiting implementation of controller **200**. In accordance with this additional feature, the controller **200** may be used as the "core" of a modular, larger handheld controller unit by connecting the controller **200** to an additional expansion unit **300**. Core controller **200** may "ride piggyback" on an expansion unit **300** to easily and flexibly provide additional control interface functionality that can be changed by simply unplugging the controller from one expansion unit an plugging it in to another expansion unit.

FIG. **8**A shows one exemplary illustrative non-limiting such additional expansion unit **300** including a housing **302** having a control surface **304** providing an array of additional controls including for example a joystick **306**, a cross-switch **308** and various push-button controls **310**. Expansion unit **300** includes a depression such that when the rear portion of controller **200** is inserted into the depression, the resulting combined unit provides an overall planar T-shaped control surface that combines the expansion unit **300** control surface with the controller **200** control surface in a flush and continuous manner. In such case, the user may grasp the expansion unit **300** with two hands and may operate the controls of controller **200** (see FIG. **8**B-**1**) or controls on the expansion unit **300**. Expansion unit **300** thus effectively converts the controller **200** designed to be held in a single hand into a two-handed controller while also supplying additional controls.

FIG. **8**B shows a further expansion unit **300'** having a somewhat different control configuration. FIGS. **8**C and **8**D show additional non-limiting illustrative example expansion units.

As shown in FIG. **8**B-**1**, expansion units **300** may provide all of the controls that the user would operate to control a video game when controller **200** is plugged into the additional unit. This provides a high degree of flexibility, since any number of additional units **300** of any desired configuration can be provided. Such additional units **300** can be manufactured relatively inexpensively since they can rely on controller **200** for power, processing, wireless communications and all other core functions. In the exemplary illustrative non-limiting implementation, controller edge connector **224** exposes sufficient connections and a sufficiently flexible interface such that an expansion unit **300** of virtually any desirable description can be compatibly used.

One possible motivation for manufacturing expansion units **300** is to provide control interface compatibility with other video game platforms including for example legacy platforms such as the Nintendo Entertainment System, the Super Nintendo Entertainment System, the Nintendo 64, the Nintendo GameCube System, and the Nintendo Game Boy, Game Boy Advance and Nintendo DS systems. An expansion unit **300** providing a control interface similar or identical to for the example the Super Nintendo Entertainment System could be made available for playing Super Nintendo Entertainment System games on system **100**. This would eliminate the desire to reprogram or rework Super Nintendo Entertainment System games for use with the newer or different interface provided by controller **200**.

Another possible, more general motivation for additional expansion units **300** is to provide customized control interfaces for particular games or other applications. For example, it would be possible to develop a unit **300** with a steering wheel for driving games, a unit with a keyboard for text entry applications, a unit with one or multiple touch pads for touch screen style games, etc. Any desired control configuration is possible and can be flexibly accommodated.

Still another possible application would be to use expansion units **300** to give different players of a multi-player game different capabilities. For example, one game player might use controller **200** "as is" without any expansion, another game player might use the expansion configuration shown in FIG. **12**A, yet another game player might use the expansion configuration shown in FIG. **12**B, etc. One could imagine a military battle game for example in which game players playing the role of tank drivers use an expansion unit that resembles the controls of a tank, game players playing the role of artillerymen use an expansion unit that resembles controls of heavy artillery, and a game player playing the role of a commanding general uses an expansion unit that provides more general controls to locate infantry, artillery and tanks on the field.

Example Illustrative Non-Limiting Block Diagrams

FIG. **9** shows a block diagram of an exemplary illustrative implementation of system **100**. As described above, system **100** includes a main unit **102** and one or several controllers **200**a, **200**b, **200**c, etc. Each controller **200** may be connected to any of additional expansion units **300** or may be used by itself, depending on the application. Additional wireless peripherals to system **100** may include a headset unit **180** for voice chat and other applications, a keyboard unit **182**, a mouse or other pointing device **184**, and other peripheral input and/or output units.

FIG. **10** is a block diagram of an exemplary illustrative non-limiting implementation of controller **200**. In the example shown, controller **200** may comprise a wireless connectivity chip **280** that communicates bidirectionally with main unit **102** via a pattern antenna **278**. Wireless communications chip **280** may be based on the Bluetooth standard but customized to provide low latency. In the example shown here, most or all processing is performed by the main unit **102**, and controller **200** acts more like a telemetry device to relay sensed information back to the main unit **102**. Such sensed inputs may include a motion tracking sensor **260**, an accelerometer **290**, and various buttons **206**, **210**, etc. as described above. Output devices included with or within controller **200** may include a vibrational transducer **292** and various indicators **294**.

FIG. **11** shows an overall exemplary illustrative non-limiting system block diagram showing a portion of main unit **102** that communicates with controller **200**. Such exemplary illustrative non-limiting main unit **102** portion may include for example a wireless controller **1000**, a ROM/Real Time Clock **1002**, an idle mode indicator **1004**, a processor **1006** and various power supplies. Link buttons may be provided on each side of the communications link to provide manual input for synchronization/training/searching.

FIGS. **12**A, **12**B and **12**C show different exemplary block diagram configurations for different expansion units **300**. The FIG. **12**A example includes dual touch pads **1200** and a joystick **1202** for touch screen compatible gaming; the FIG. **12**B example includes two joysticks **1202** and other controls for games requiring two different joysticks (e.g., Nintendo GameCube legacy games); and the FIG. **12**C example includes a cross-switch **1204** and other controls for more limited user interface type games (e.g., Nintendo Entertainment System legacy games).

Each expansion unit may be programmed with a 4-bit or other length "type" ID to permit controller **200** to detect which type of expansion unit is being used. Main unit **102** can adapt user interactivity based at least in part on the "type" ID.

While the technology herein has been described in connection with exemplary illustrative non-limiting implementations, the invention is not to be limited by the disclosure. The invention is intended to be defined by the claims and to cover all corresponding and equivalent arrangements whether or not specifically disclosed herein.

We claim:

1. A wireless handheld remote controller configured to be held in one hand, comprising:

a housing including an upper surface and a lower surface;

at least one digit operable detector disposed on the upper surface;

at least one depressible trigger disposed on said lower surface;

an inertial sensor mounted in the housing;

a two dimensional radiation detector;

a processor that processes an output of the radiation detector and determines an illumination pattern;

a wireless transceiver that transmits information based on signals generated by the inertial sensor and the processor; and

an output device operatively coupled to the transceiver.

2. The controller of claim **1** wherein the radiation detector is disposed, at least in part, at a front portion of the housing.

3. The controller of claim **1**, wherein the radiation detector comprises a two dimensional camera.

4. The controller of claim **1**, wherein the radiation detector comprises:

a two dimensional radiation sensor array; and

an infrared filter that is mounted on the housing in front of the two dimensional radiation sensor array such that only infrared light passing through the filter is received by the radiation sensor array.

5. The controller of claim **1**, wherein the radiation detector generates frames of two dimensional image data, and wherein the processor determines an illumination pattern for each frame of image data.

6. The controller of claim **5**, wherein each illumination pattern comprises X and Y coordinates for illuminated objects appearing within a frame of image data.

7. The controller of claim **5**, wherein each illumination pattern comprises X and Y coordinates for illuminated objects appearing within a frame of image data that have an intensity that rises above a predetermined threshold value.

8. The controller of claim **5**, wherein each illumination pattern comprises X and Y coordinates for illuminated objects appearing within a frame of image data that emit infrared radiation having an intensity that rises above a predetermined threshold value.

9. The controller of claim **5**, wherein the wireless transceiver transmits information regarding the illumination patterns for frames of image data.

10. The controller of claim **9**, wherein the inertial sensor comprises an accelerometer.

11. The controller of claim **10**, wherein the accelerometer is a three axis accelerometer that senses linear acceleration in each of three mutually perpendicular axes, and wherein the inertial sensor outputs three linear acceleration values corresponding to the three mutually perpendicular axes multiple times every second.

12. The controller of claim **11**, wherein the wireless transceiver also transmits a set of the three acceleration values multiple times every second.

13. The controller of claim **1**, wherein the inertial sensor comprises an accelerometer.

14. The controller of claim **13**, wherein the accelerometer is a three axis accelerometer that senses linear acceleration in each of three mutually perpendicular axes, and wherein the inertial sensor outputs three linear acceleration values corresponding to the three mutually perpendicular axes multiple times every second.

15. The controller of claim **14**, wherein the wireless transceiver transmits a set of the three acceleration values multiple times every second.

[16. The controller of claim **1**, wherein the output device comprises a speaker, and wherein the speaker outputs sounds based on a signal received by the wireless transceiver.**]**

17. The controller of claim **1**, wherein the output device comprises a vibration module that causes the housing to vibrate based on a signal received by the wireless transceiver.

18. The controller of claim **1**, wherein the output device comprises at least one indicator light that is selectively illuminated based on a signal received by the wireless transceiver.

19. The controller of claim **1**, wherein the output device comprises an array of indicator lights that are selectively illuminated based on a signal received by the wireless transceiver.

20. The controller of claim **1**, wherein the at least one digit operable detector comprises at least one depressible button disposed on the upper surface of the housing.

21. A handheld electronic device, comprising:

a housing configured to be held by both hands of a user for providing input to a processor, wherein the housing includes a top surface, a bottom surface, and a further surface extending between the top surface and the bottom surface;

a touch-sensitive input panel arranged at a surface of the housing and configured to receive touch input; and

a first input device and a second input device arranged at the top surface on a first side from the lateral center of the top surface, the first and second input devices being operable with a thumb of the user to provide directional inputs to the processor,

wherein one of the first input device or the second input device includes a directional switch input device and the other includes an inclinable stick input device, and

wherein the top surface comprises a proximal portion closer to the body of the user when the user holds the housing in two hands, the first input device is arranged between the second input device and the proximal portion.

22. The handheld electronic device according to claim 21, further comprising a third input device arranged at the top surface on a second side that is opposite the first side from the lateral center of the top surface.

23. The handheld electronic device according to claim 22, wherein the third input device includes at least four control buttons in a cross-shaped arrangement.

24. The handheld electronic device according to claim 22, wherein the third input device includes an inclinable stick input device.

25. The handheld electronic device according to claim 24, wherein the first input device includes a directional switch input device, and wherein the first input device and the third input device are positioned symmetrically on opposite sides of the lateral center of the top surface.

26. The handheld electronic device according to claim 22, further comprising a fourth input device arranged at the left side of the further surface and a fifth input device arranged at the right side of the further surface, wherein the fourth input device is operable with a finger of the user's left hand and the fifth input device is operable with a finger of the user's right *hand when the user holds the housing with both hands to provide input to the processor.*

27. The handheld electronic device according to claim 22, further comprising at least one fourth input device on a surface of the housing other than the top surface, the at least one fourth input device configured to generate an analog signal based upon a level of user input.

28. The handheld electronic device according to claim 27, wherein the at least one fourth input device is further configured to vary the analog signal based upon how much pressure is exerted on the at least one fourth input device by a finger of the user.

29. The handheld electronic device according to claim 22, further comprising a fourth input device arranged at a lateral center of the top surface, the fourth input device being a button switch.

30. The handheld electronic device according to claim 29, wherein the button switch is recessed in relation to the top surface.

31. The handheld electronic device according to claim 30, wherein the fourth input device is configured to generate an input signal to cause a MENU or HOME operation.

32. The handheld electronic device according to claim 22, wherein a recessed button switch is arranged at a lateral center of the top surface, and wherein one of the first input device or the second input device and a second inclinable stick input device are arranged symmetrically on opposite sides of the lateral center of the top surface.

33. The handheld electronic device according to claim 21, further comprising at least one wireless antenna, wherein the handheld electronic device is configured to communicate with a console device using a wireless protocol over the wireless antenna.

34. The handheld electronic device according to claim 33, wherein the wireless protocol is based upon the Bluetooth protocol standard.

35. The handheld electronic device according to claim 21, further comprising a vibration generator configured to vibrate the housing in response to a signal received via a wireless communication interface.

36. The handheld electronic device according to claim 21, further comprising at least one image sensor.

37. The handheld electronic device according to claim 36, further comprising a focusing lens associated with the image sensor.

38. The handheld electronic device according to claim 21, further comprising at least one inertial sensor.

39. A handheld electronic device, comprising:

a housing configured to be held by both hands of a user for providing input to a processor, wherein the housing includes a top surface, a bottom surface, and a further surface extending between the top surface and the bottom surface;

a touch-sensitive input panel arranged at a surface of the housing and configured to receive touch input; and

a first input device and a second input device arranged at the top surface on a first side from the lateral center of the top surface, the first and second input devices being operable with a thumb of the user to provide directional inputs to the processor,

the handheld electronic device further comprising at least one light indication devices arranged on the housing and configured to indicate an identification of the handheld electronic device, wherein the identification uniquely identifies the handheld electronic device among a plurality of controllers communicating with a particular console device.

40. A handheld electronic device, comprising:

a housing configured to be held by both hands of a user for providing input to a processor, wherein the housing includes a top surface, a bottom surface, and a further surface extending between the top surface and the bottom surface;

a touch-sensitive input panel arranged at a surface of the housing and configured to receive touch input; and

a first input device and a second input device arranged at the top surface on a first side from the lateral center of the top surface, the first and second input devices being operable with a thumb of the user to provide directional inputs to the processor,

the handheld electronic device further comprising additional input devices arranged at locations of the top surface, wherein the additional input devices are configured, respectively, to cause a start operation, to cause a select operation, and to cause processing to return to a predetermined configuration.

41. A handheld electronic device, comprising:

a housing configured to be held by both hands of a user for providing input to a processor, wherein the housing includes a top surface, a bottom surface, and a further surface extending between the top surface and the bottom surface;

a touch-sensitive input panel arranged at a surface of the housing and configured to receive touch input; and

a first input device and a second input device arranged at the top surface on a first side from the lateral center of the top surface, the first and second input devices being operable with a thumb of the user to provide directional inputs to the processor,

wherein the touch-sensitive input panel includes a touch screen, and wherein

the handheld electronic device further comprises another touch-sensitive input panel.

42. A handheld electronic device, comprising:

a housing configured to be held by both hands of a user for providing input to a processor, wherein the housing includes a top surface, a bottom surface, and a further surface extending between the top surface and the bottom surface;

a touch-sensitive input panel arranged at a surface of the housing and configured to receive touch input; and

a first input device and a second input device arranged at the top surface on a first side from the lateral center of the top surface, the first and second input devices being operable with a thumb of the user to provide directional inputs to the processor,

wherein one of the first input device or the second input device includes a directional switch input device and the other includes an analog directional input device, and

wherein the top surface comprises a proximal portion closer to the body of the user when the user holds the housing in two hands, the first input device is arranged between the second input device and the proximal portion.

43. A handheld electronic device, comprising:

a housing configured to be held by both hands of a user for providing input to a processor, wherein the housing includes a top surface, a bottom surface, and a further surface extending between the top surface and the bottom surface;

a touch-sensitive input panel arranged at a surface of the housing and configured to receive touch input; and

a first input device and a second input device arranged at the top surface on a first side from the lateral center of *the top surface, the first and second input devices being operable with a thumb of the user to provide directional inputs to the processor,*

wherein one of the first input device or the second input device includes a directional switch input device and the other includes an analog directional input device, and

wherein the first input device is disposed at a first position on the housing top surface and the second input device is disposed next to the first input device at a second position on the housing top surface, the second position being closer to the body of the user than the first position when the housing is held by both hands of the user.

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