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Hart et al.

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(54) **PROTECTING DEVICES FROM IMPACT DAMAGE**

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G06F 1/16 (2006.01)
F16M 3/00 (2006.01)

(52) **U.S. Cl.** **307/650**; 361/679.02; 267/136

(58) **Field of Classification Search** 307/108, 307/650, 652; 361/679.02; 267/136

See application file for complete search history.

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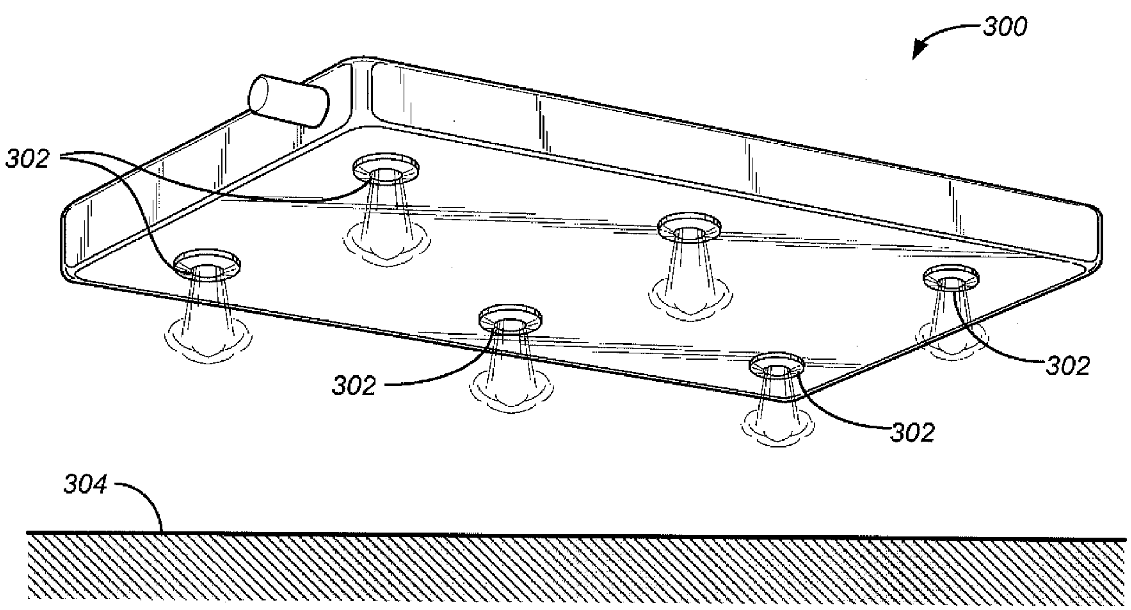
(74) *Attorney, Agent, or Firm* — Novak Druce + Quigg LLP

(57) **ABSTRACT**

A system and method for protecting devices from impact damage is provided. Prior to impact between a surface and a device, a determination of a risk of damage to the device is made. If the risk of damage to the device exceeds a threshold, a protection system is activated to reduce or substantially eliminate damage to the device.

34 Claims, 18 Drawing Sheets



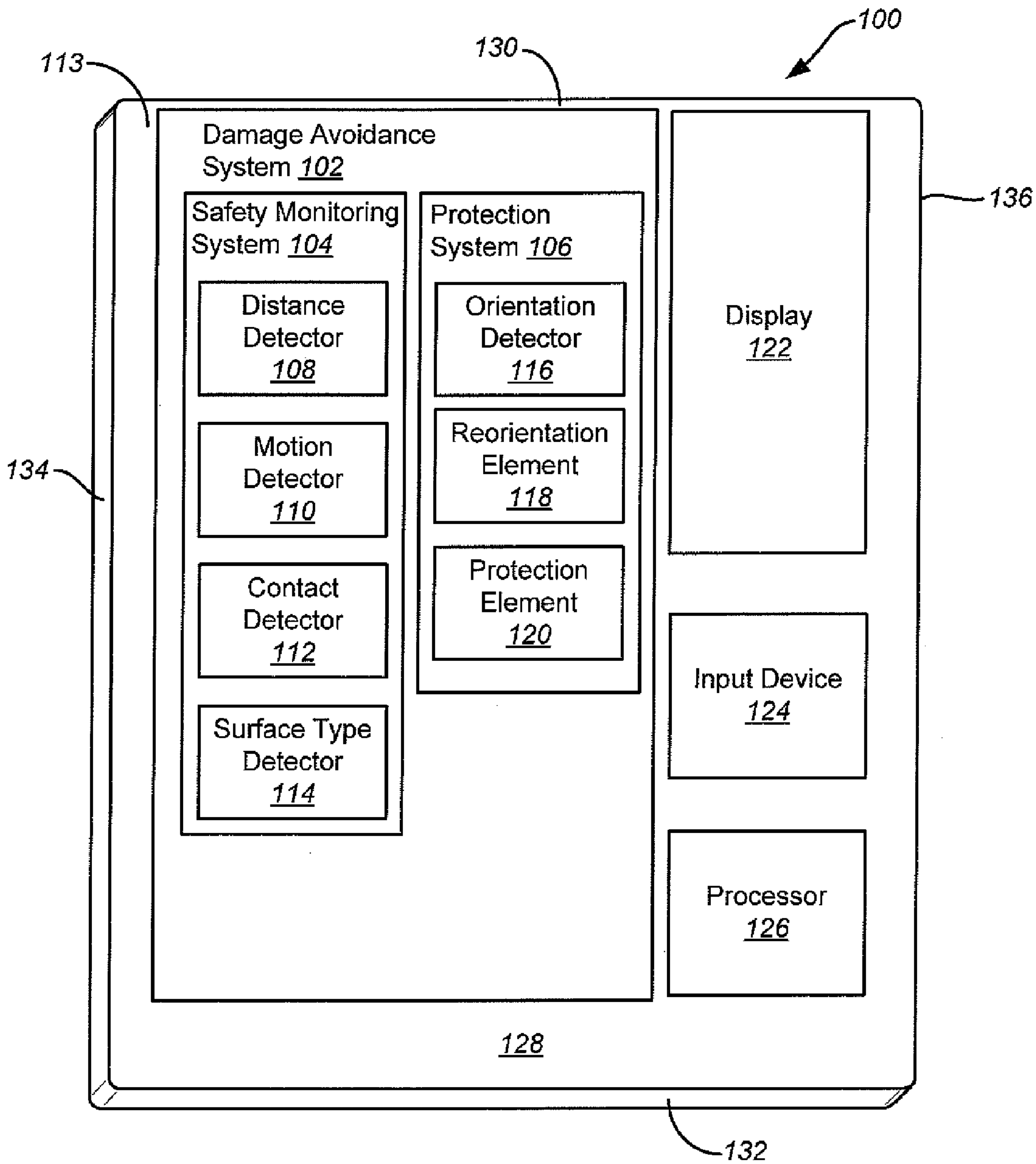

100
113
130
Damage Avoidance System 102
Safety Monitoring System 104
Distance Detector 108
Motion Detector 110
Contact Detector 112
Surface Type Detector 114
Protection System 106
Orientation Detector 116
Reorientation Element 118
Protection Element 120
Display 122
Input Device 124
Processor 126
128
132
134
136

FIG. 1A

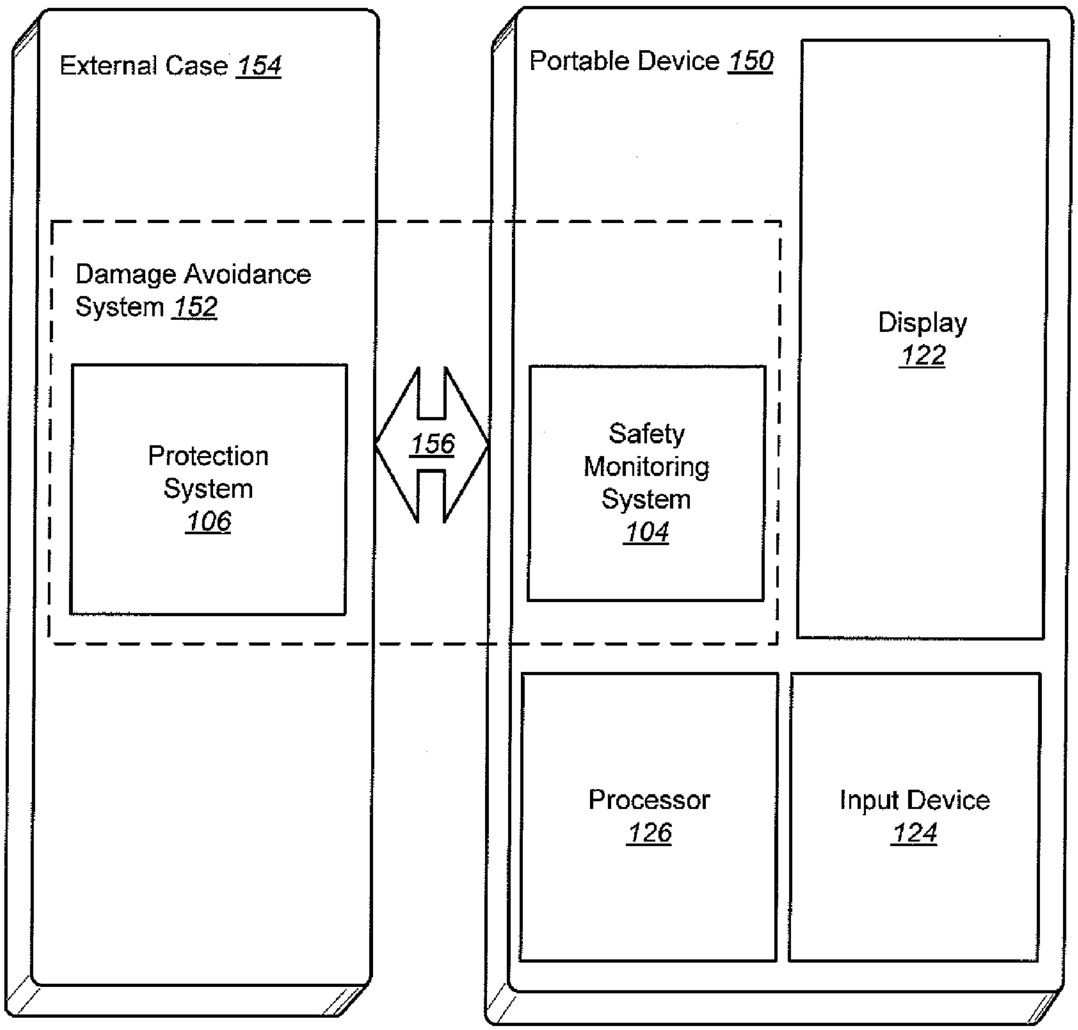

External Case 154
Portable Device 150
Damage Avoidance System 152
Protection System 106
156
Safety Monitoring System 104
Display 122
Processor 126
Input Device 124

FIG. 1B

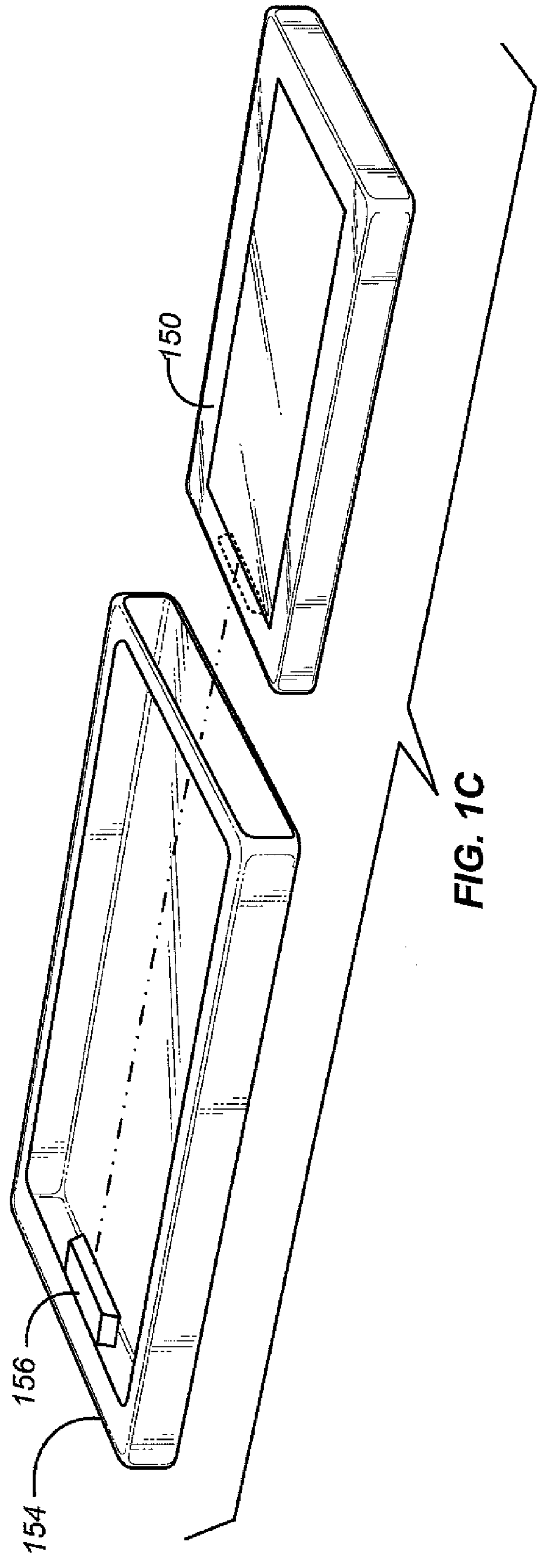


FIG. 1C

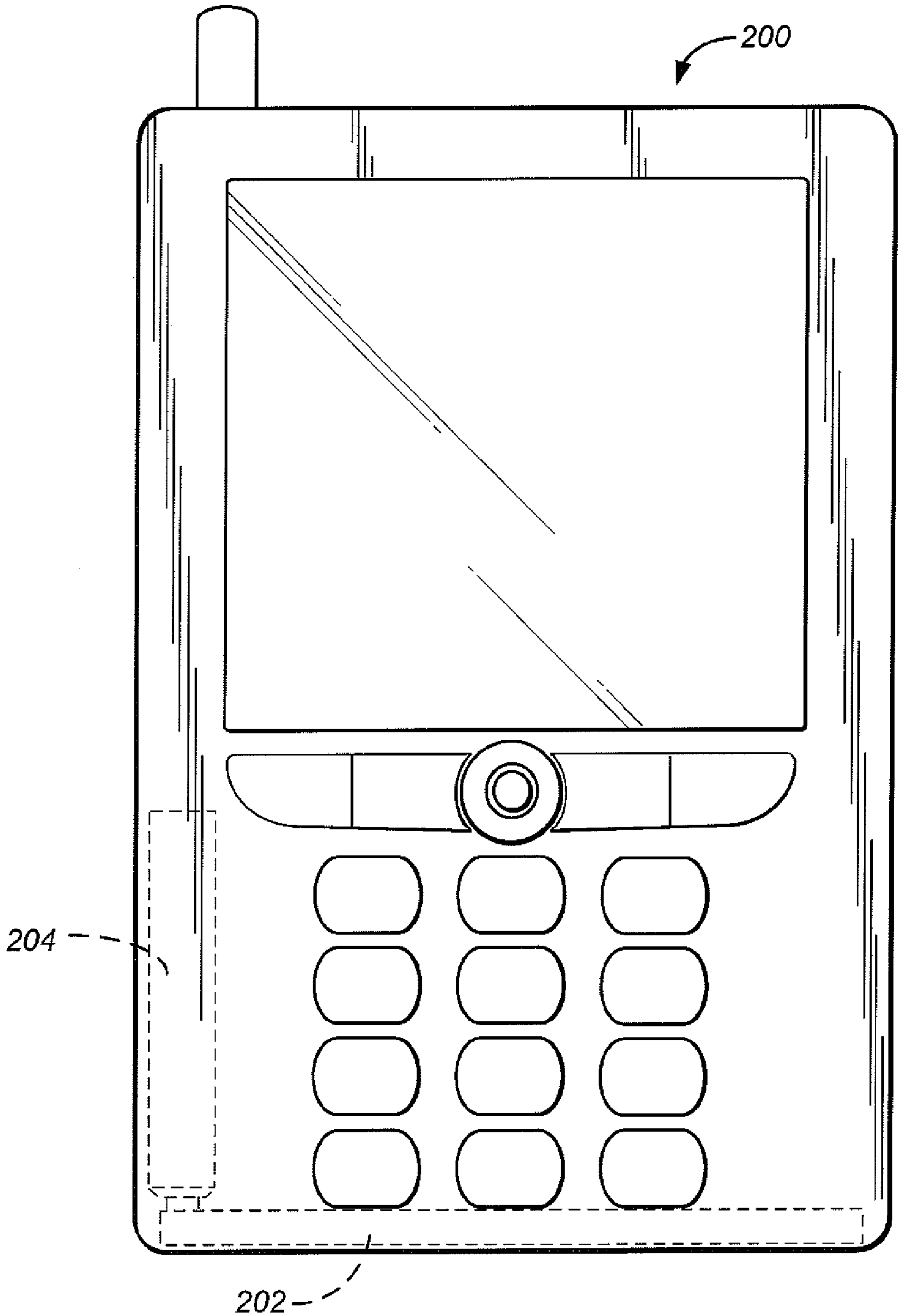


FIG. 2A

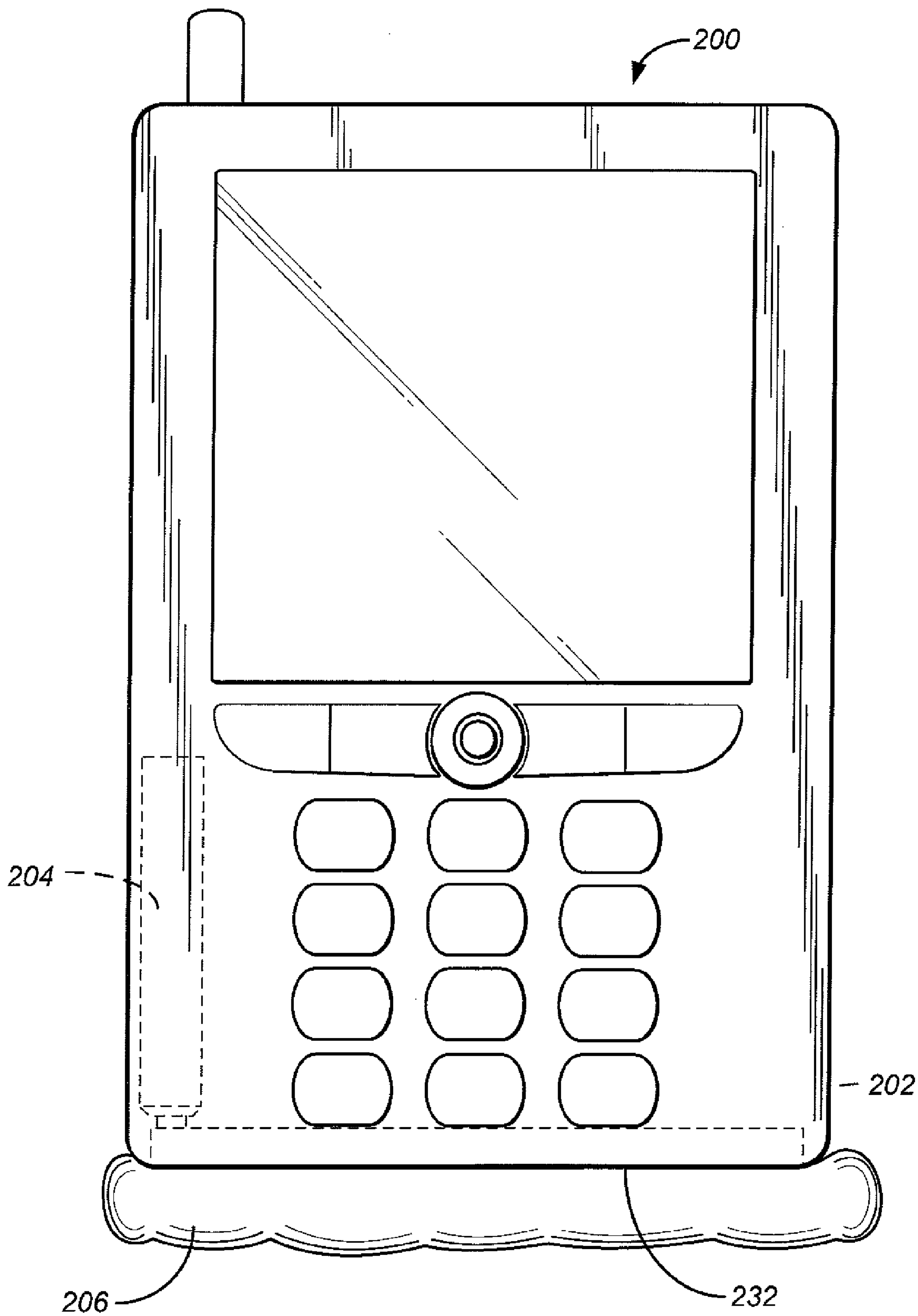


FIG. 2B

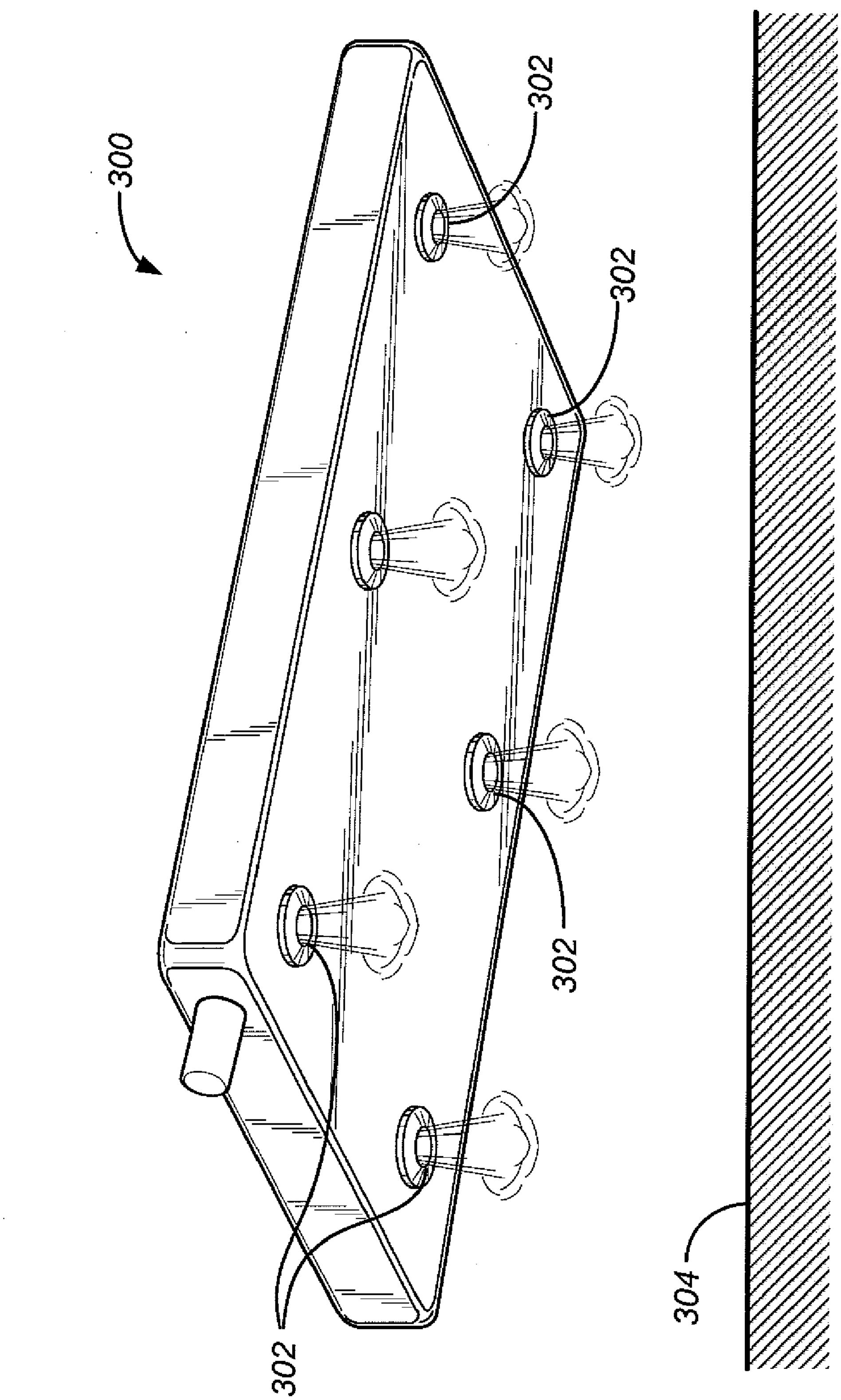


FIG. 3

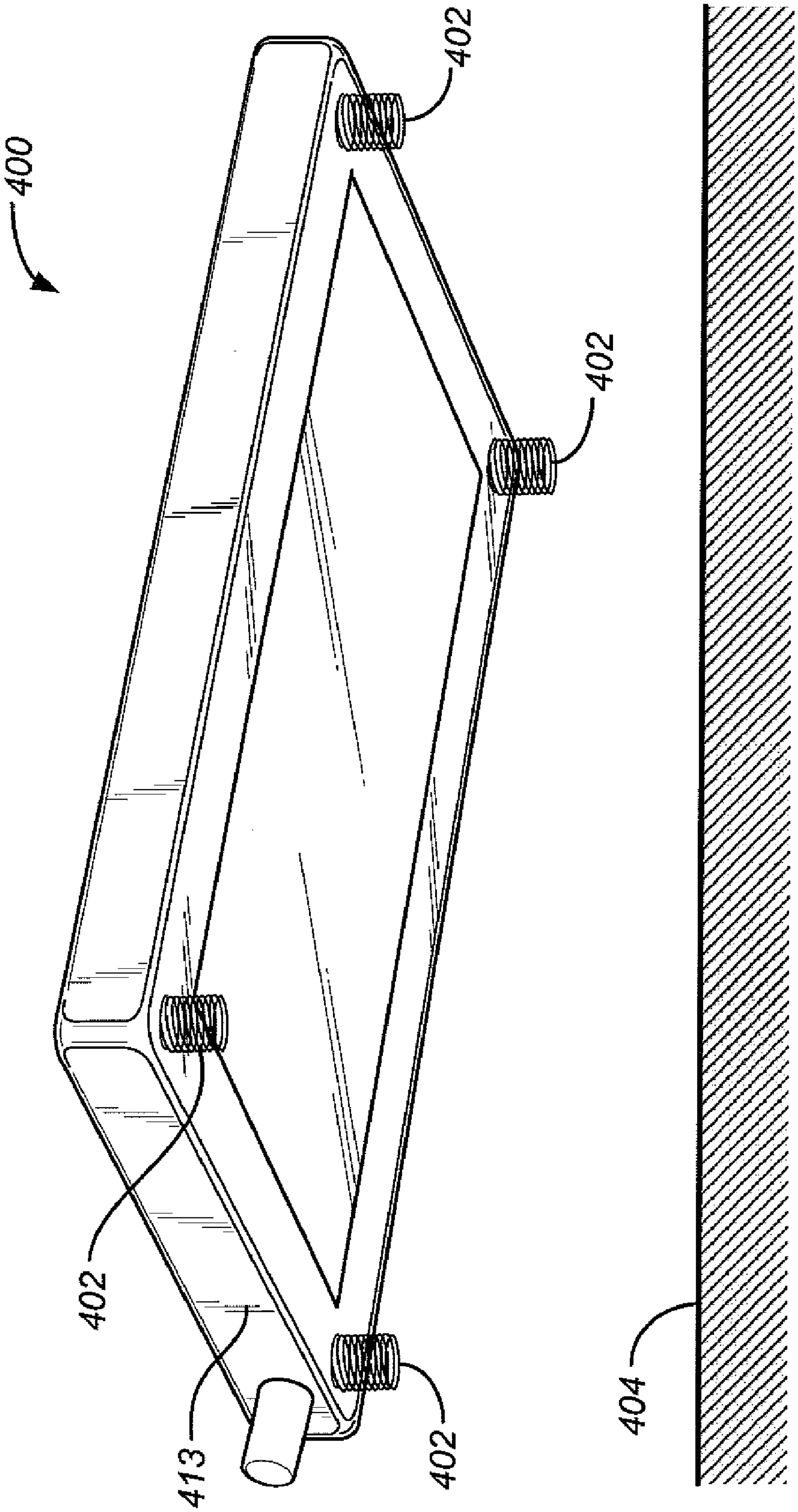


FIG. 4

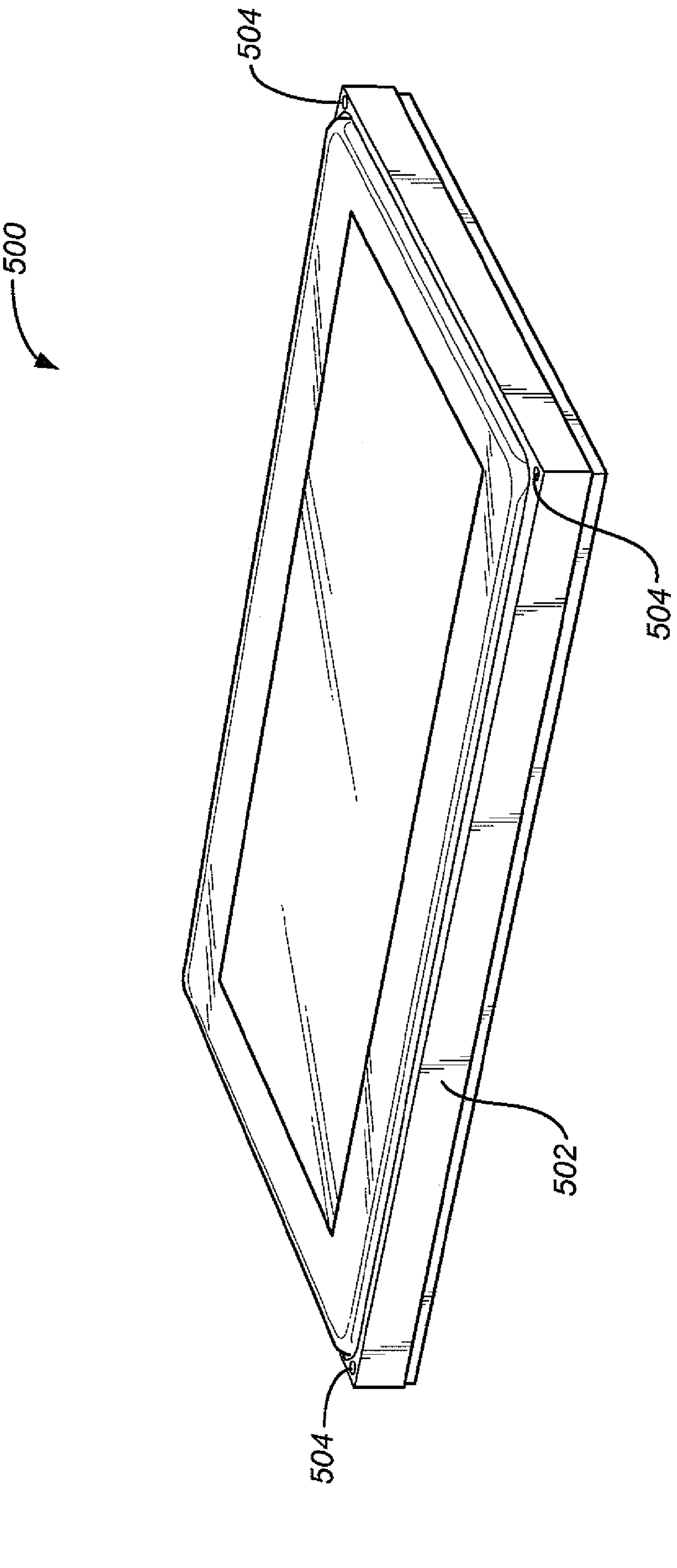


FIG. 5A

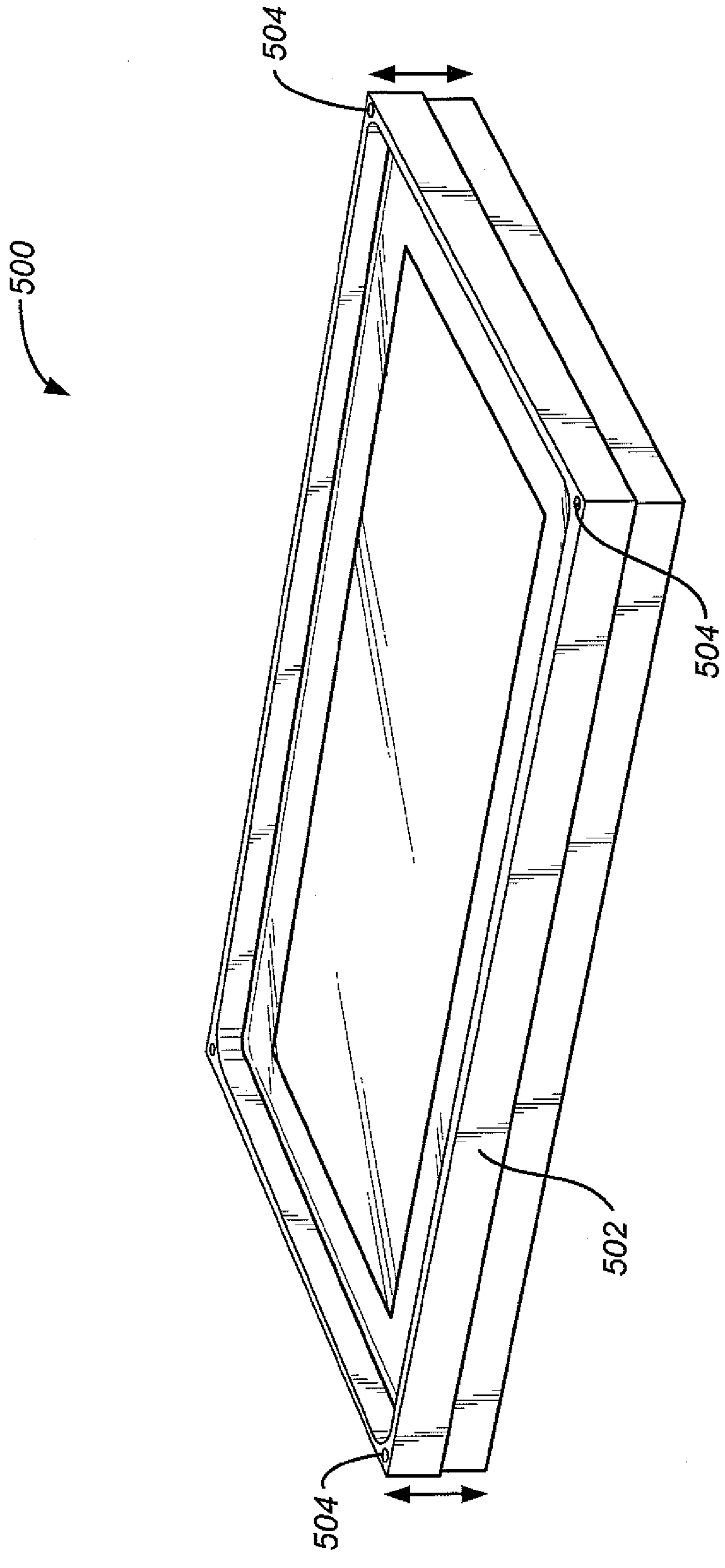


FIG. 5B

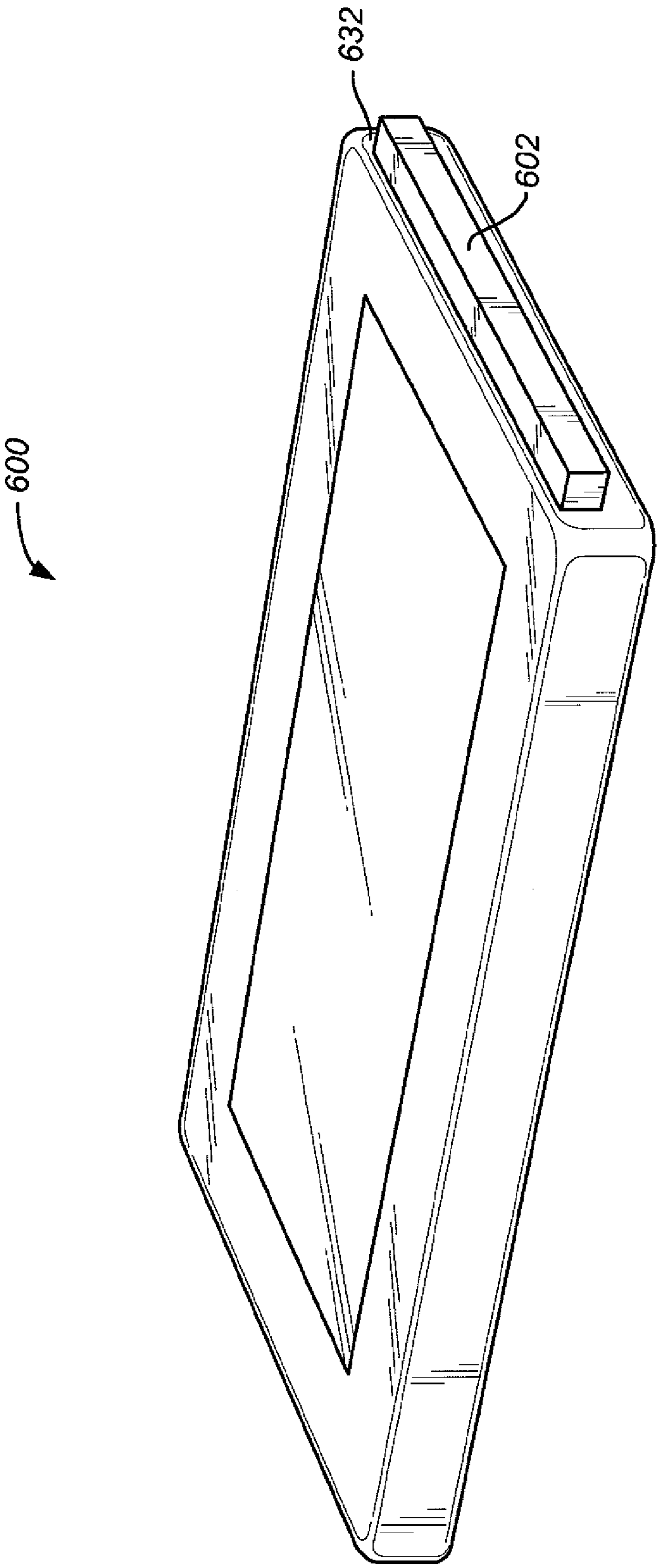


FIG. 6

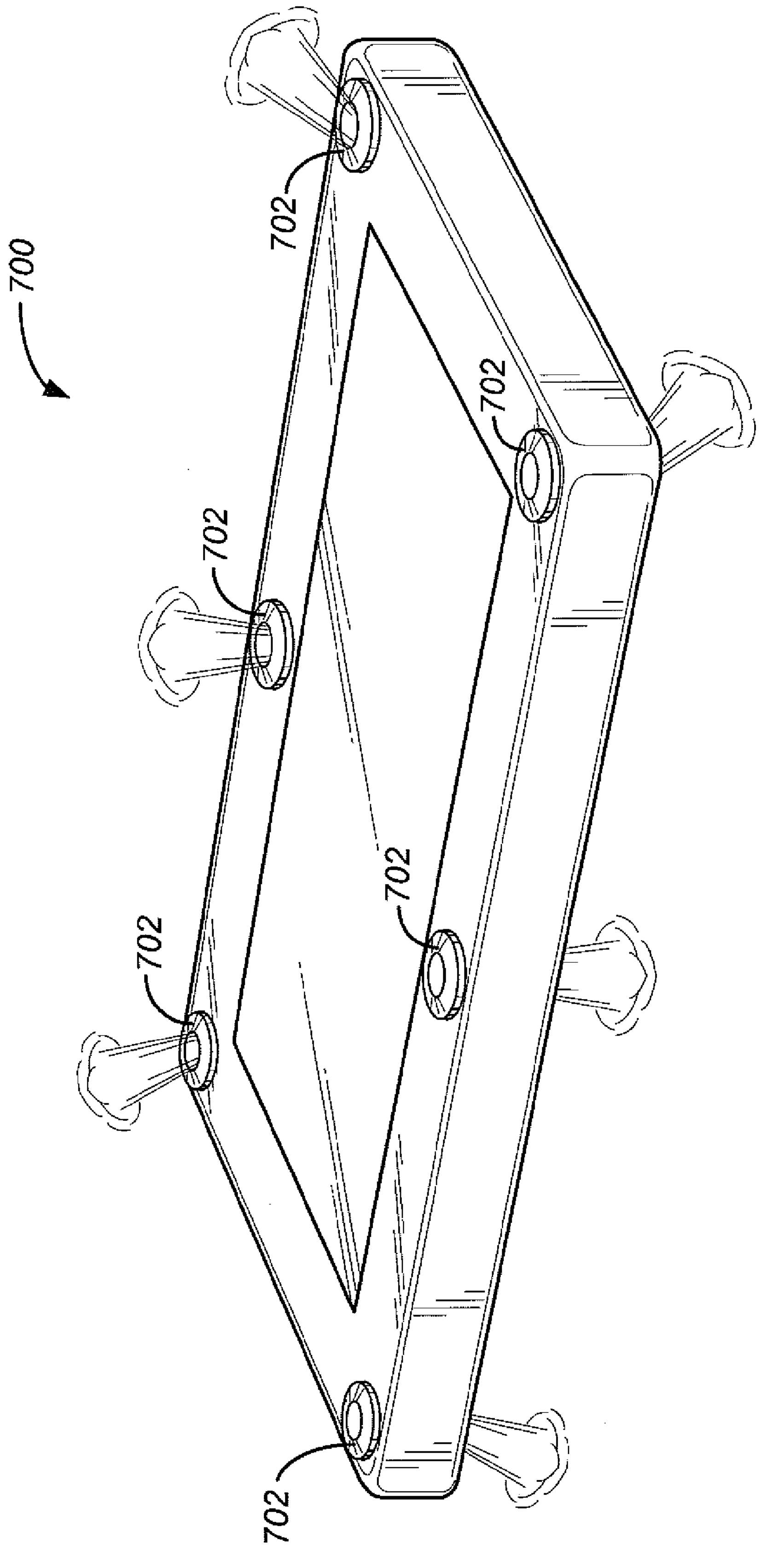


FIG. 7

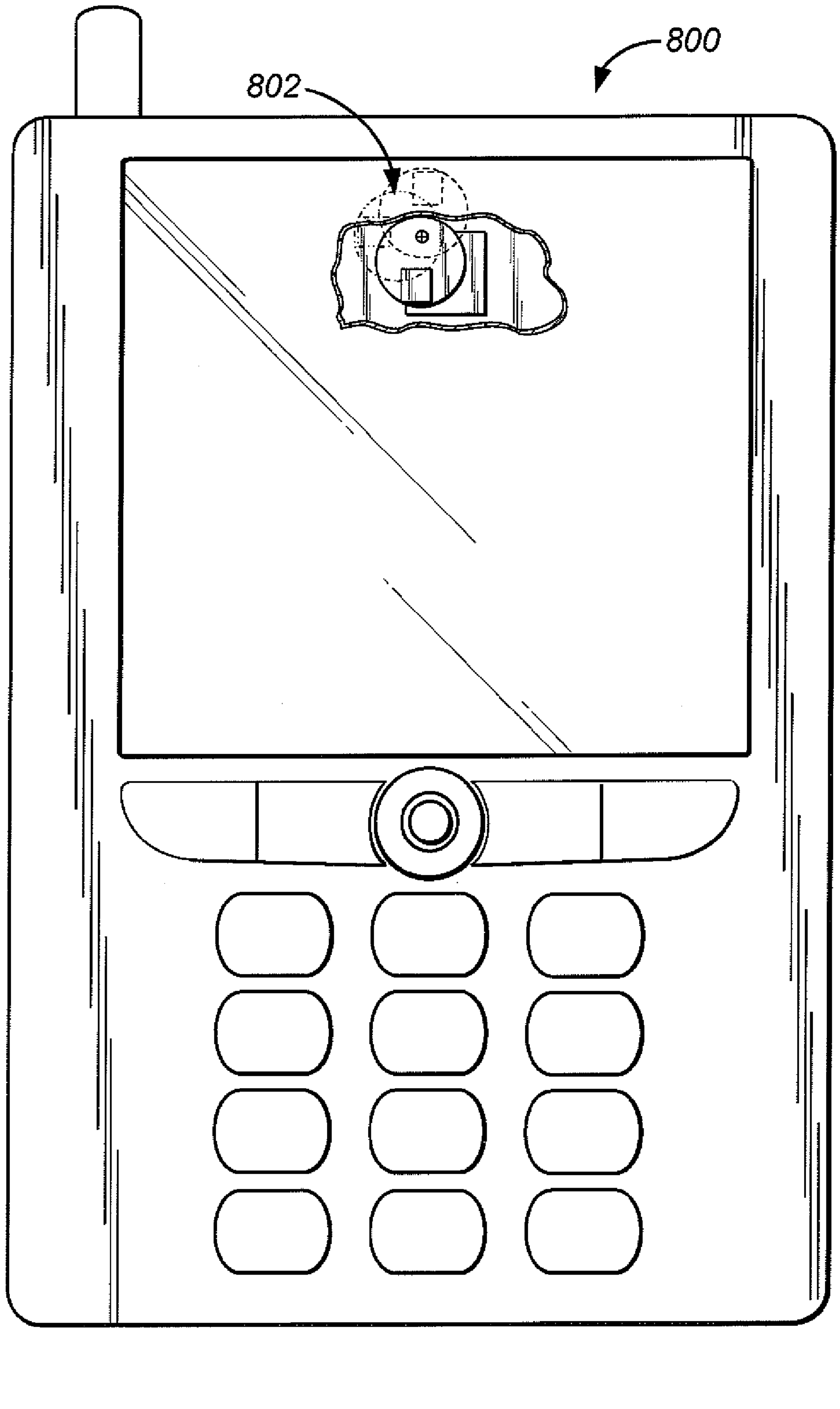


FIG. 8A

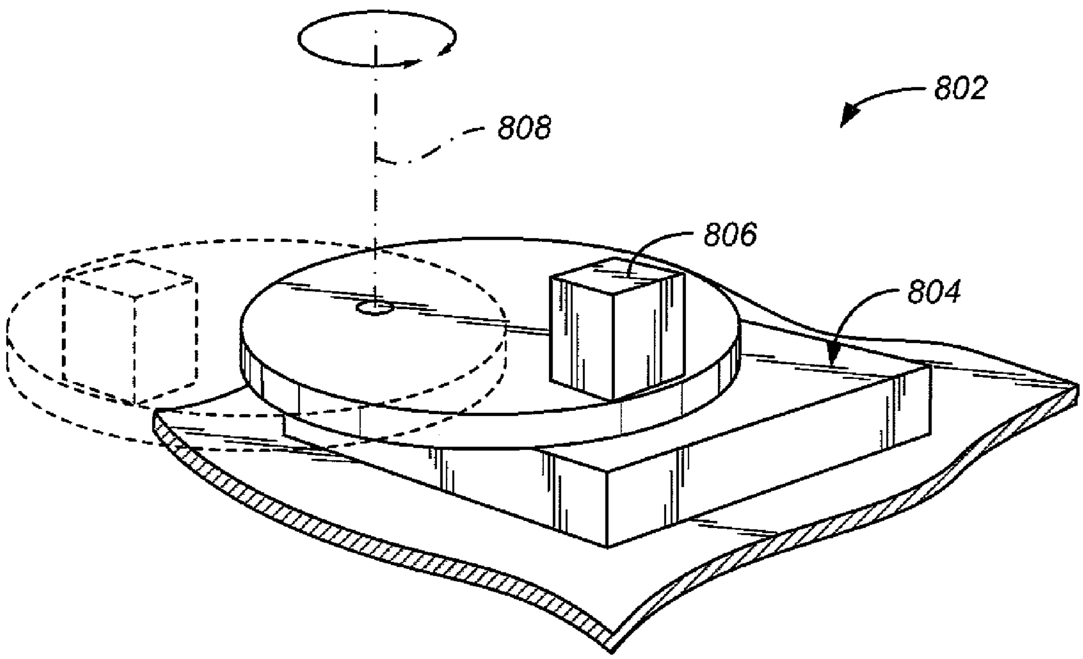


FIG. 8B

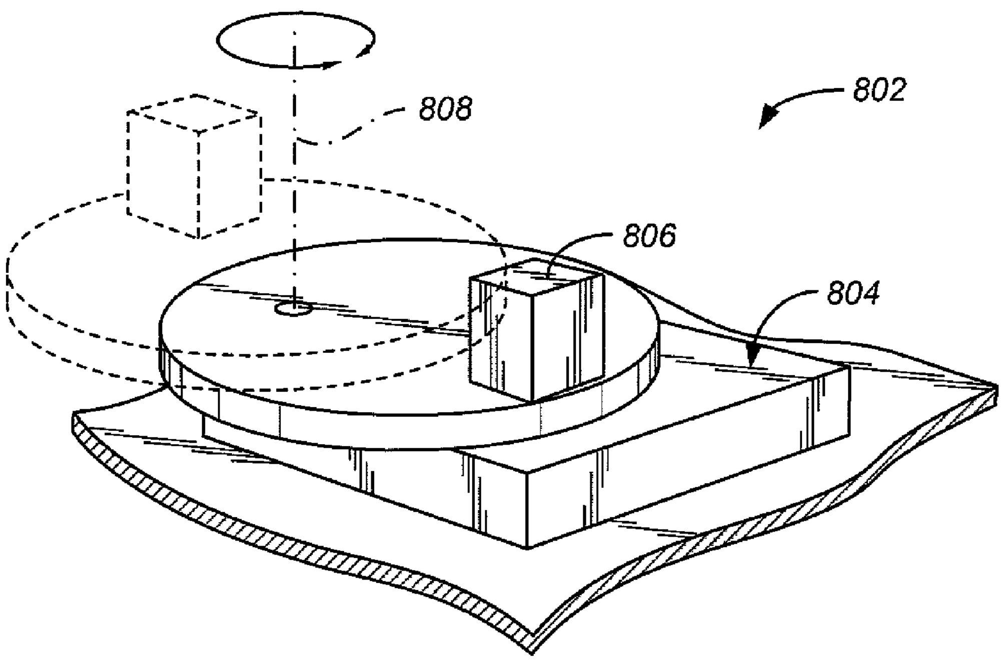


FIG. 8C

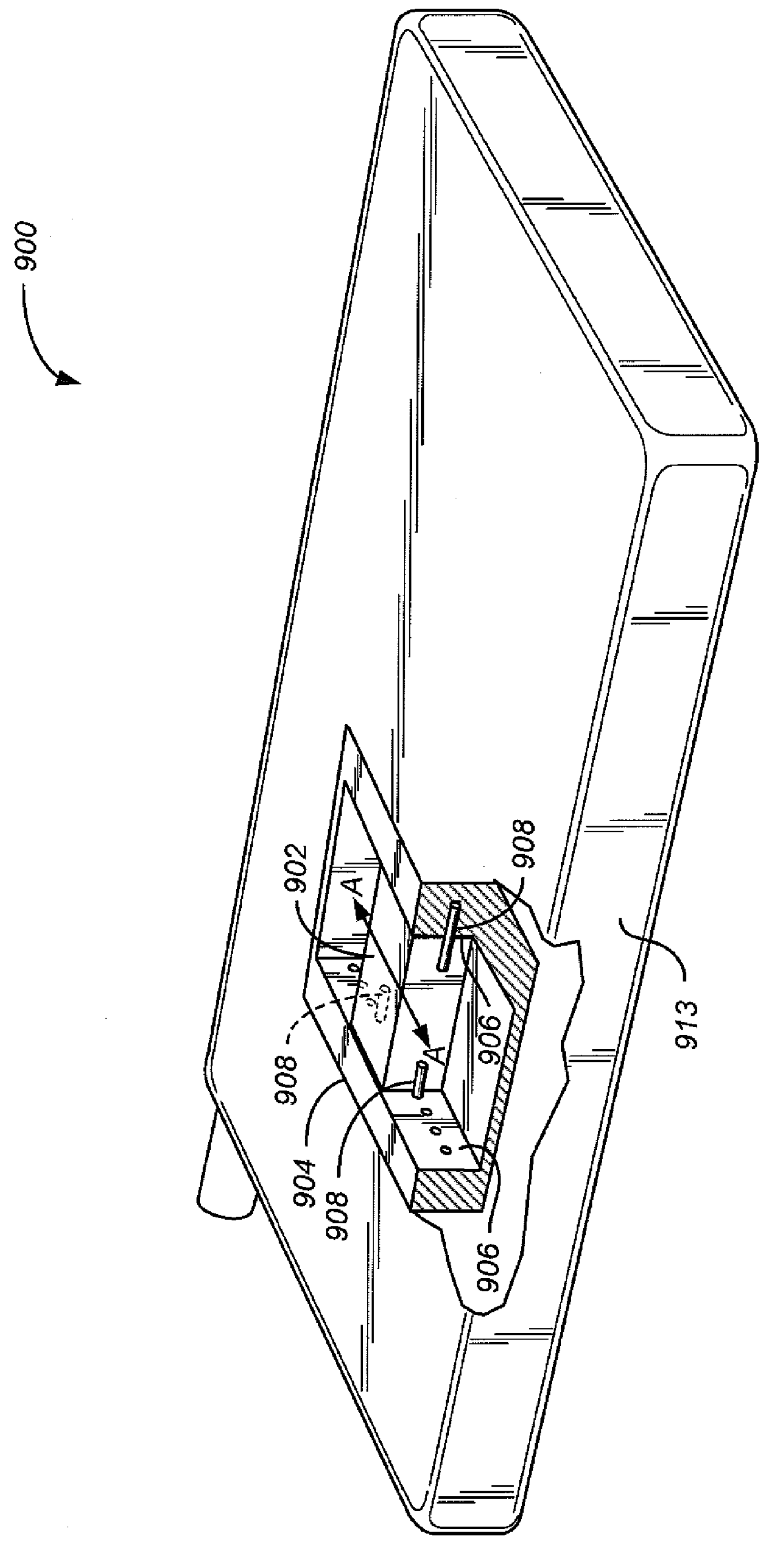


FIG. 9A

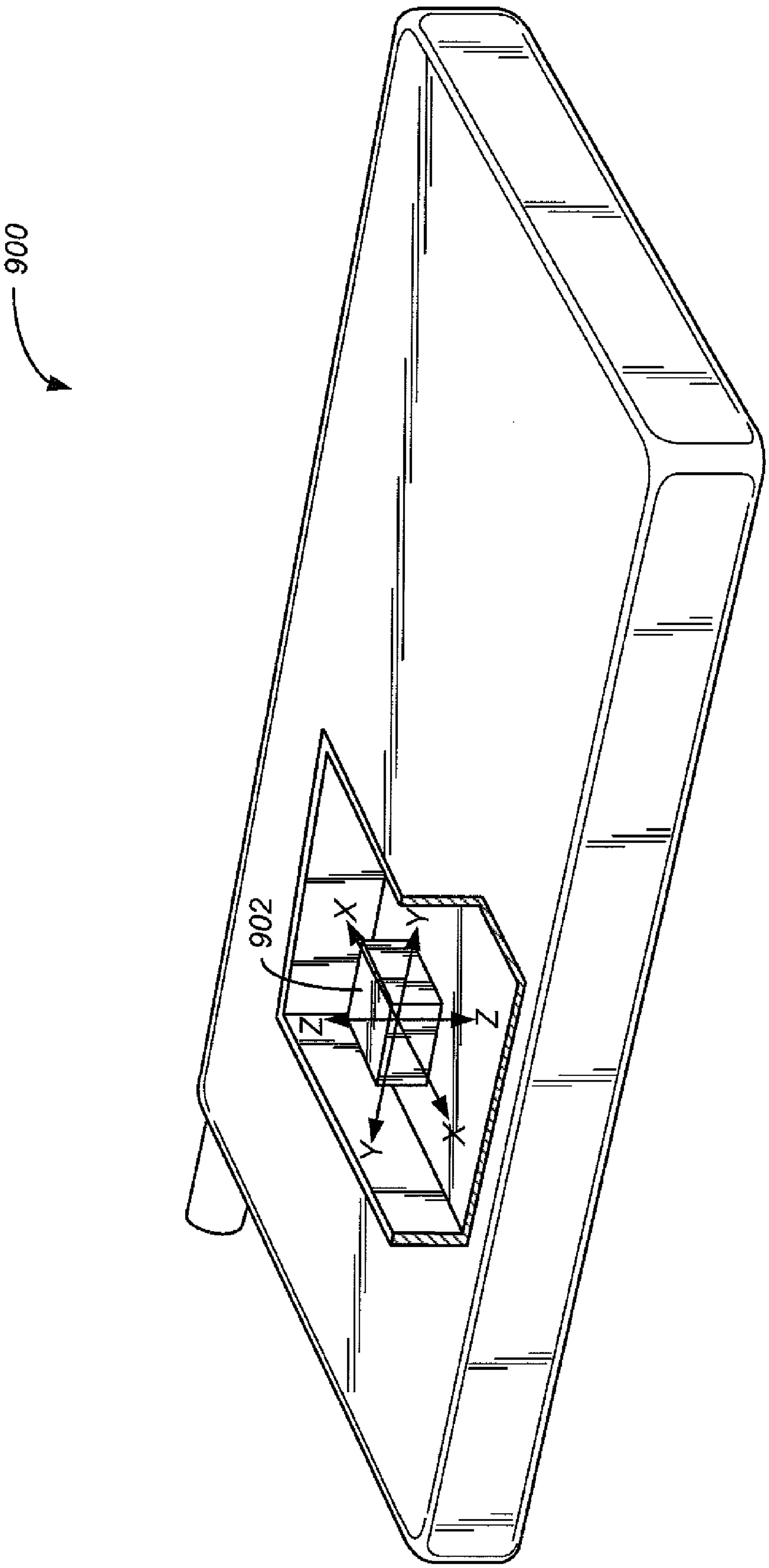


FIG. 9B

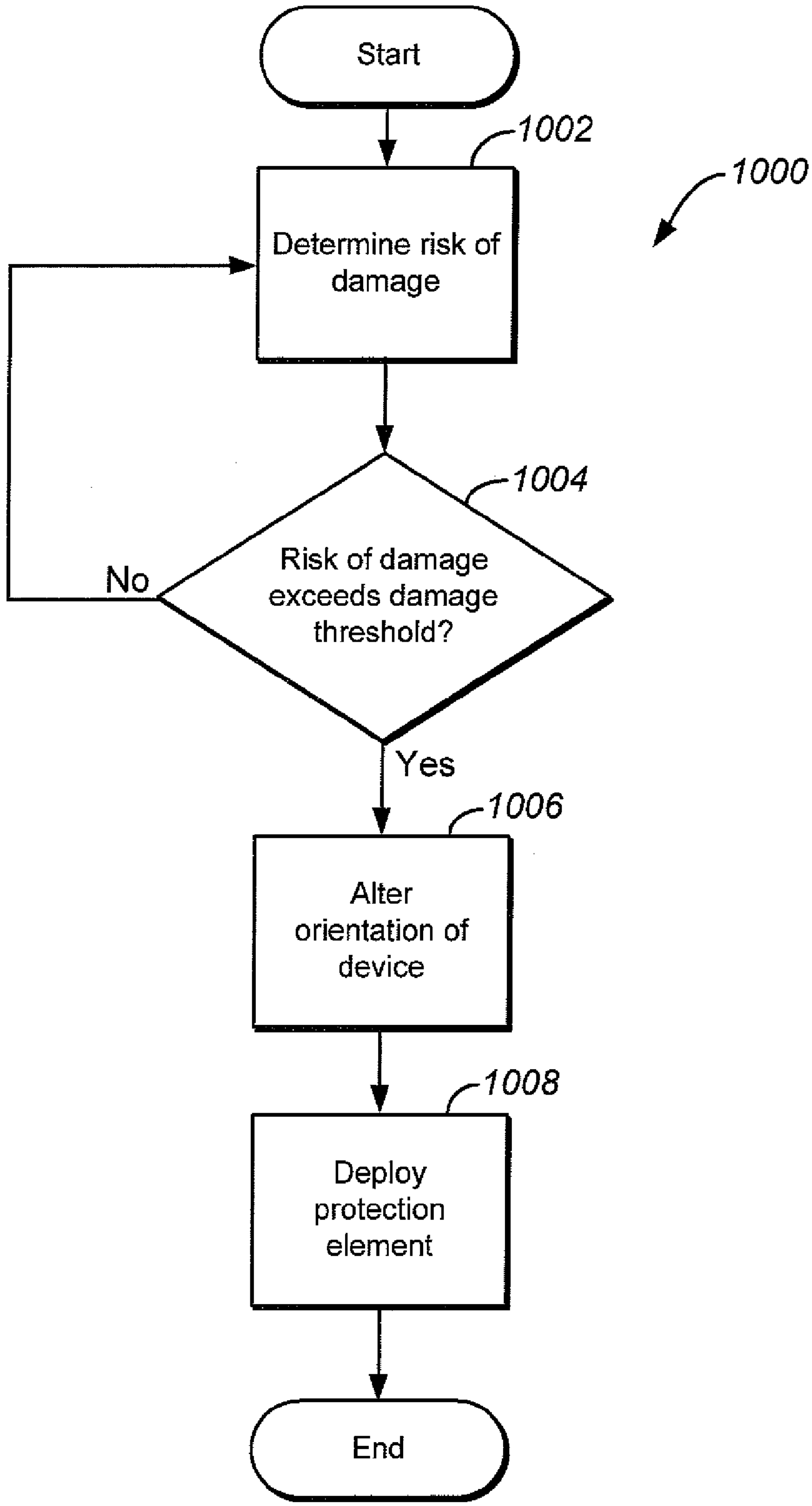

Start
1002
1000
Determine risk of damage
1004
Risk of damage exceeds damage threshold?
No
Yes
1006
Alter orientation of device
1008
Deploy protection element
End

FIG. 10

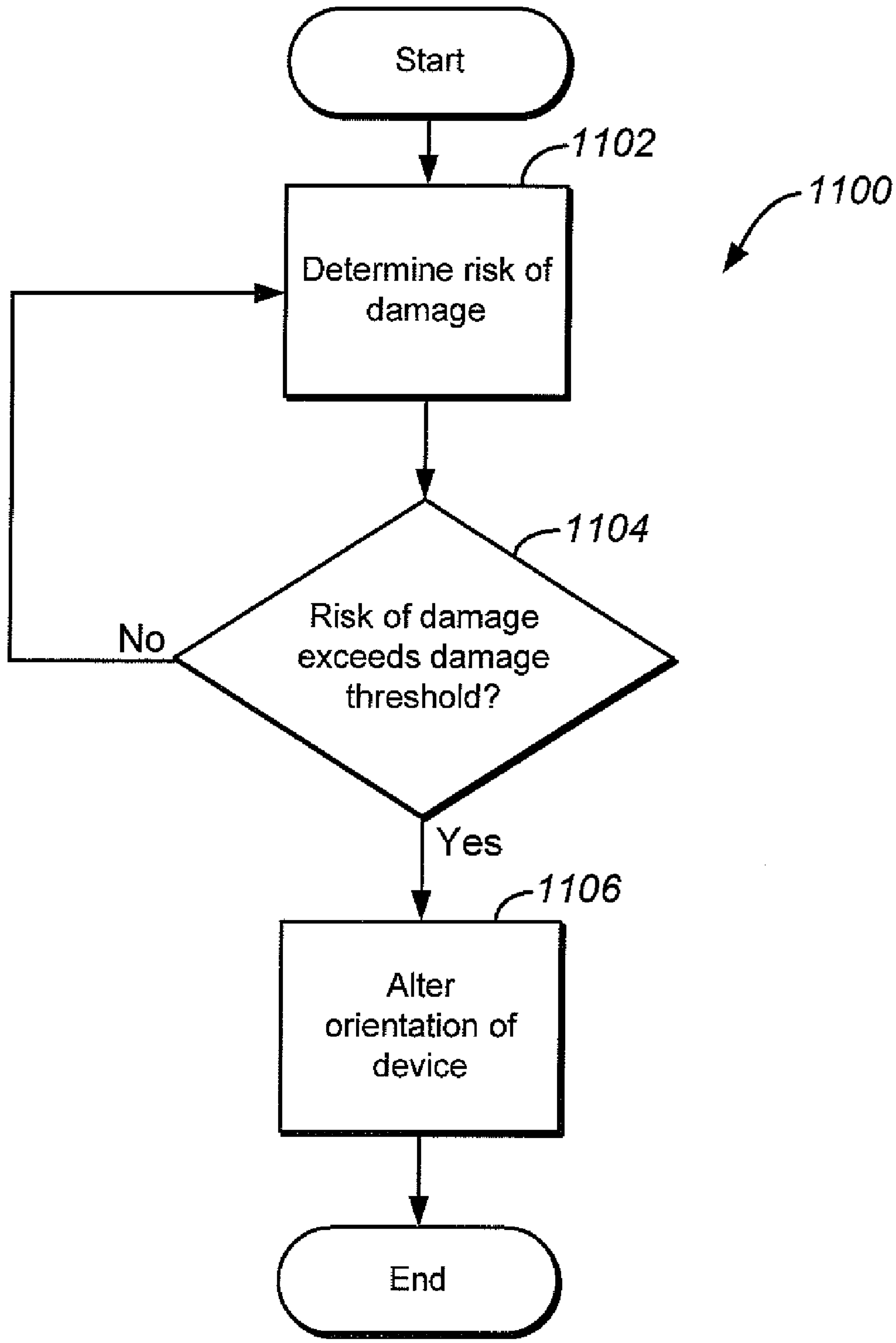

Start
1102
1100
Determine risk of damage
1104
Risk of damage exceeds damage threshold?
No
Yes
1106
Alter orientation of device
End

FIG. 11

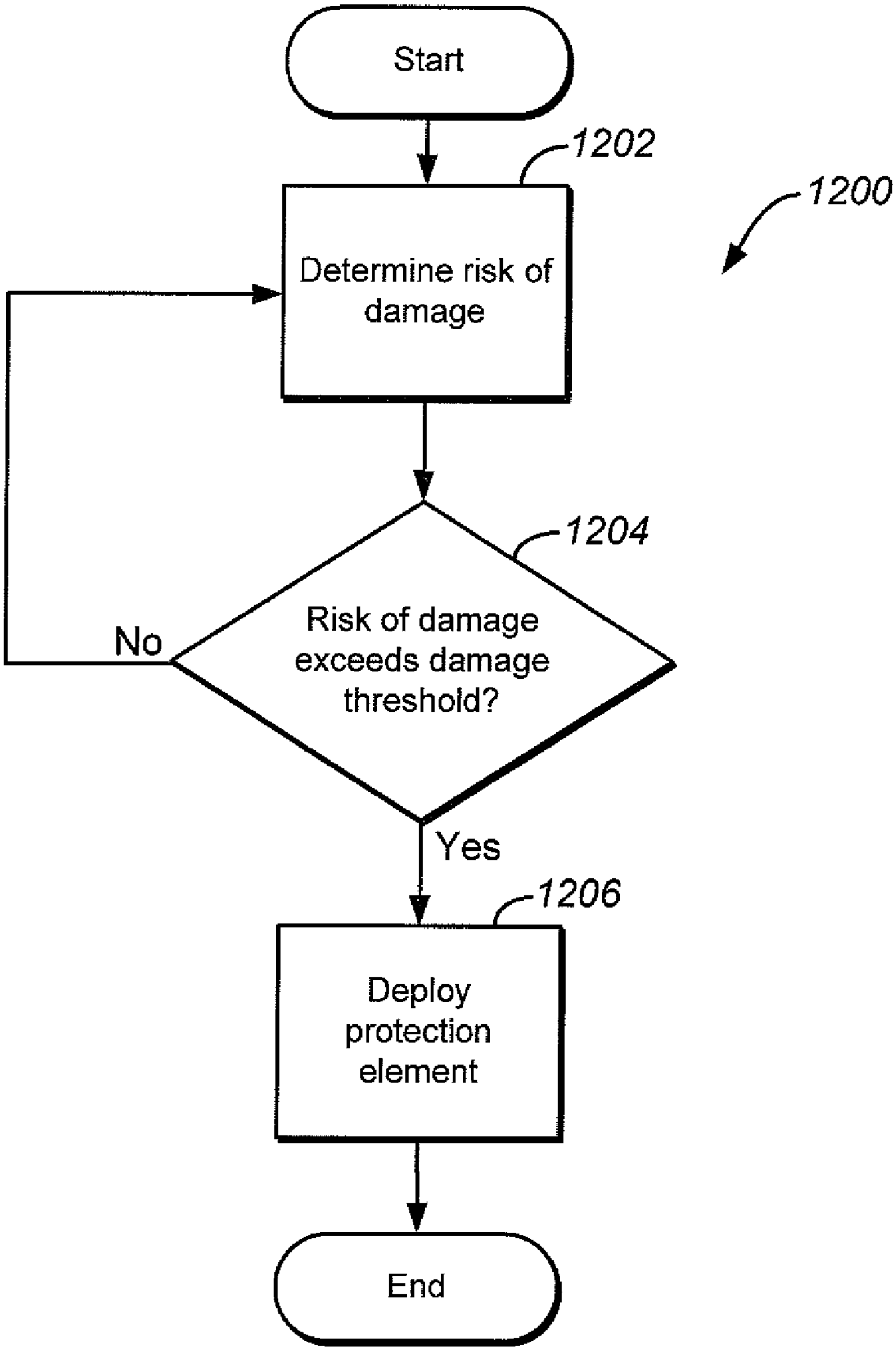

Start
1202
1200
Determine risk of damage
1204
Risk of damage exceeds damage threshold?
No
Yes
1206
Deploy protection element
End

FIG. 12

PROTECTING DEVICES FROM IMPACT DAMAGE

BACKGROUND

In today's world, portable devices have become ubiquitous and often indispensable to our work and personal life. A main convenience is that they are often small and light devices that are easy to hold in a hand, carry in a holster, purse or pocket or otherwise easily transportable. These characteristics of portable devices make them convenient for a user to take wherever they go. Examples of such portable devices include cellular phones, smart phones, personal data assistants, electronic media players, notebook computers, netbook computers, tablet computers, barcode scanners, cameras, video cameras, pagers, portable video game consoles, video game controllers and the like.

People often carry around many types of portable electronic devices. For example, a user may carry a cellular or smart phone, a personal data assistant (PDA) and an audio (e.g. mp3) player. These portable devices are sometimes vitally important to the user as they often contain data that is related to the user's work and personal life. The data may be publicly available to all (e.g., mp3, downloaded images) as well as private data that may be difficult or nearly impossible to replace (e.g., photographs, passwords, private telephone numbers).

While the size and weight of portable devices make them convenient to carry around, these characteristics often make them more susceptible to damage and loss. For example, one type of portable device is a cellular phone. At least one report claims 1 out of 3 cellular phones are damaged or lost in the first year of ownership. Damage may occur when a cellular phone experiences an uncontrolled impact with a hard surface or even become submerged in a liquid. With the number of cellular phones in use exceeding several billion and repairs typically exceeding $25, the costs of damage and loss of cellular phones amounts to billions of dollars per year.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**A is a block diagram of an embodiment of a portable device with a damage avoidance system according to the teachings of this disclosure;

FIG. **1**B is a block diagram of an embodiment of a removably attachable damage avoidance system and a portable device;

FIG. **1**C is a perspective view of an embodiment of a portable device having the removably attachable damage avoidance system of FIG. **1**B;

FIG. **2**A illustrates an embodiment of a portable device having a protection element that includes an airbag;

FIG. **2**B illustrates an embodiment of the portable device of FIG. **2**A where the airbag has been deployed;

FIG. **3** illustrates an embodiment of a portable device having a protection element that includes a propulsion element;

FIG. **4** illustrates an embodiment of a portable device having a protection element that includes one or more springs;

FIG. **5**A illustrates an embodiment of a portable device having a protection element that includes an impact absorbing structure;

FIG. **5**B illustrates an embodiment of the portable device of FIG. **5**A having a protection element that includes an impact absorbing structure that has been deployed;

FIG. **6** illustrates an embodiment of a portable device having a protection element that includes a reinforced edge;

FIG. **7** illustrates an embodiment of a portable device having a reorientation element that includes a propulsion element;

FIG. **8**A illustrates an embodiment of a portable device having a reorientation element that includes a rotational modifier;

FIG. **8**B illustrates an embodiment of a reorientation element that includes the rotational modifier of FIG. **8**A in one possible position;

FIG. **8**C illustrates an embodiment of a reorientation element that includes the rotational modifier of FIG. **8**A in another possible position;

FIG. **9**A illustrates an embodiment of a portable device having a reorientation element that includes a weight;

FIG. **9**B illustrates another embodiment of a portable device having the reorientation element of FIG. **9**A that includes a weight that is movable along the X, Y and Z axes;

FIG. **10** is a flowchart illustrating a method for protecting a portable device;

FIG. **11** is a flowchart illustrating an embodiment of a method for protecting a portable device; and

FIG. **12** is a flowchart illustrating another embodiment of a method for protecting a portable device.

DETAILED DESCRIPTION

The technology described herein is a system and method for protecting a portable device from damage due to an impact with a surface. As described herein, various embodiments utilize a damage avoidance system that detects a risk of damage to the portable device caused by an uncontrolled impact with a surface and takes steps to reduce or eliminate that risk. For example, the damage avoidance system may detect that the portable device is no longer in contact with a user and is uncontrollably moving toward a surface such that, upon impact, there is a risk of damage to the portable device. Upon detecting the risk of damage and prior to impact with the surface, the damage avoidance system activates a protection system having one or more protection elements that work in concert to reduce or prevent damage to the portable device upon impact with the surface.

To illustrate a specific example, a cellular phone (a portable device) may be equipped with a damage avoidance system that includes a safety monitoring system and a protection system. If the user drops the cellular phone, the safety monitoring system, through use of various detection elements described below, determines that the device is no longer in contact with the user, measures a distance from an approaching surface (e.g., ground) and determines a velocity toward that surface. Based on the collected information, the safety monitoring system determines whether the risk of damage to the cellular phone, that will be caused by the impending impact, exceeds an acceptable threshold. If the safety monitoring system determines that the risk of damage exceeds the acceptable threshold, the protection system is activated. The protection system, in this example, causes the device to be reoriented and deploys an airbag prior to contact such that the airbag first contacts the surface at impact. Instead of the cellular phone directly impacting the surface, the airbag absorbs the impact and cushions the cellular phone so that damage is reduced or substantially eliminated.

This brief introduction is provided for the reader's convenience and is not intended to limit the scope of the technology described herein. Several example implementations and contexts are provided hereinafter with reference to the following figures, as described below in more detail. However, the following implementations and contexts are but a few of many.

For instance, and as discussed above, these techniques apply to a variety of portable devices and for a variety of reorientation elements and protection elements.

FIG. **1**A is a block diagram of an embodiment of a portable device **100** according to the teachings of this disclosure. The portable device **100**, as discussed above, may be one of any number of devices. In this illustrated embodiment, the portable device **100** includes a damage avoidance system **102** which is capable of detecting whether there is a risk of damage to the portable device that exceeds an acceptable damage threshold and taking steps to reduce or eliminate that damage.

The damage avoidance system **102** includes a safety monitoring system **104** and a protection system **106**. The safety monitoring system **104** includes one or more monitoring elements that determine/measure various states and/or information related to the portable device **100**. For example, the safety monitoring system **104** may include monitoring elements such as a distance detector **108**, a motion detector **110**, a contact detector **112** and a surface type detector **114**. As will be appreciated, more or fewer monitoring elements may be included in the safety monitoring system **104**.

The distance detector **108** may be any number of components that can measure/determine the distance between the portable device **100** or damage avoidance system **102** and a surface (not shown). For example, the distance detector **108** can use a sound or light generator/source (e.g., radar, sonar, laser, and infra-red) in conjunction with a receptor/receiver to capture the reflection of the generated sound or light wave to determine/calculate the distance between portable device **100** and the surface. In some embodiments, the distance detector **108** periodically measures/determines a distance between the portable device **100** and the surface. In other embodiments, the distance detector **108** continuously measures a distance between the portable device **100** and the surface. The distance detector **108** may be disabled until a triggering event occurs (e.g., orientation detector **116** identifies that the portable device **100** is falling) or always be enabled. In yet other embodiments, the distance detector **108** does not measure distance until the contact detector **112** measures/determines that the portable device **100** is no longer contacting another object.

The motion detector **110** measures/determines movement of the portable device **100**. For example, the motion detector **110** may measure acceleration or motion of the portable device **100**. The motion detector **110** may include, for example, an accelerometer or any type of motion detection device. In some embodiments, the motion detector **110** may receive inputs from components such as an accelerometer and/or the distance detector **108** in order to calculate a velocity of portable device **100**. Alternatively, motion detector **110** can use existing circuit(s) of the portable device **100** or a dedicated element in communication with the motion detector **110** to determine the velocity of the device by identifying the difference in power, intensity or other measurement between radio signals received from cellular phone towers or wireless access points. Motion detector **110** may also include a sound or light generator/source in conjunction with a detector/receiver to capture the reflection of the generated sound or light wave to calculate the velocity of portable device **100**.

The contact detector **112** measures whether the portable device **100** is contacting or substantially proximate to another object (e.g., a user's hand, desk surface, pocket). For example, the portable device **100** may include a force sensing resistive material on the surface of the device housing **113** that detects whether the portable device **100** is in contact with another object. If the contact detector **112** determines that the portable device **100** is in contact with another object (such as a user), it is unlikely that there is a potential risk of damage to the device as it is likely not out of the user's control. Other embodiments of the contact detector **112** include transmitting and receiving a signal to determine whether the portable device **100** is contacting or substantially proximate to another object or specific type of object including use of transducers, temperature detecting circuitry, infra-red, radar and sonar elements.

The surface type detector **114** may determine the type of surface that the portable device **100** is approaching when moving toward a surface. For example, the surface type detector **114** may measure whether the surface is a solid surface (e.g., concrete, wood floor) or a softer surface (e.g., chair, pillow, hand). The surface type detector **114** may also determine a relative value of ability of the surface to absorb or reflect the energy from the impact of the portable device **100** and the surface. The relative value may be measured or identified as a hardness or firmness of the surface. The surface type detector **114** may use a number of technologies, such as infra-red, radar, x-ray or image recognition to perform the determination of the surface type. For example, using image recognition, the portable device **100** may include a camera and image recognition software. The camera can capture images of the surface, and, using image recognition techniques, the type of surface may be determined. As discussed below, the damage avoidance system **102** may use the surface type in determining whether the risk of damage exceeds an acceptable damage threshold (in consideration with data from the other components of the safety monitoring system **104**).

Based on the various data/information provided from the safety monitoring system **104**, the damage avoidance system **102** determines if the risk of damage to the portable device **100** exceeds a damage threshold. The damage threshold may vary according to particular needs and/or devices. In some embodiments, the damage threshold may be exceeded if the distance measured between the portable device **100** and the surface is more than the distance at which the portable device **100** underwent drop tests during design or more than the specified operating conditions for the device. In other embodiments, the damage threshold may be exceeded if the safety monitoring system **104** measures that the device is not in contact with another object and exceeds a predetermined velocity. Any combination of measurements, portable device specifications and/or durability test information may be used by the damage avoidance system **102** to determine whether the damage threshold has been, will be or is predicted to be exceeded.

As an example, if the contact detector **112** measures that the portable device **100** is no longer in contact with a user, an accelerometer (not shown) measures that the device is accelerating at a rate of 9.80665 meters/second^2 and the distance detector **108** measures that the device is 15 meters from a surface, the damage avoidance system **102** may determine that the risk of damage to the portable device **100** upon impact will likely exceed a damage threshold. If the expected risk of damage exceeds the damage threshold, the damage avoidance system **102** activates the protection system **106**, described below, which takes steps to reduce or substantially eliminate the damage to the device that would otherwise be caused at impact with the surface.

In addition to determining whether a risk of damage exceeds a damage threshold, the damage avoidance system **102** may utilize measurements from the safety monitoring system **104** (e.g., distance, velocity, acceleration) to calculate and/or predict a time remaining until impact with the surface. The time remaining until impact may be used by the protection system **106** to determine whether and/or when the reorientation element **118** and/or the protection element **120** should be activated such that the protection element **120** will first impact the surface. For example, if the measured orientation, motion and time until impact are such that the device will impact on a side containing the protection element **120**, the protection system **106** may not activate the reorientation element **118**. However, if the data measurements indicate that the portable device **100** will impact the surface with a side that does not include a protection element **120**, the protection system **106** may activate the reorientation element **118** at a specific time, based on the measurements, so that the portable device **100** is reoriented in a manner that a side with a protection element **120** will first impact the surface. In addition, if the protection element **120** is deployable (e.g., air bag, springs, thrusters), the protection system **106** may use the time remaining until impact to determine when to deploy the protection element **120**.

The protection system **106** may include any number of components that work to reduce or eliminate the detected risk of damage to the portable device **100**. For example, the protection system **106** may include an orientation detector **116**, a reorientation element **118** and a protection element **120**. The orientation detector **116** may be a standalone component or combination of components that are designed to detect the orientation of the portable device **100**. For example, devices such as accelerometers or tilt sensors could be used. As another example, orientation detector **116** may be a camera associated with the portable device **100**. For example, the camera can be located on the back surface of the portable device **100**. Images taken from the camera can be indicative of a ceiling, thus, the orientation of the portable device **100** may be that the front surface of the portable device **100** is facing toward the ground. The orientation of the portable device **100** with respect to other surfaces, for example a wall or a table, may then be extrapolated (determined) from such information. Detecting the orientation of the portable device **100** may provide the protection system **106** with information regarding the orientation of portable device **100** with respect to approaching surface(s). As described below, this information may help the protection system **106** determine what actions to take so that the portable device **100** will be in a desired orientation at impact with the surface.

The reorientation element **118** may be any number of elements that can alter the orientation of the portable device **100**. In general, the reorientation element **118** may produce a force, alter a physical property or otherwise create a change in and/or alter the orientation of the portable device **100** with respect to a surface. As discussed below with respect to FIGS. **7-10**, examples of the reorientation element **118** may be a gas expelled from a compressed gas cartridge, a rotational modifier, a moveable weight or other types of devices that can cause reorientation of the portable device **100**. An example reorientation technique using a moveable weight may be to relocate the position of the battery within portable device **100** to alter or create a rotation of portable device **100**. Yet another technique may be to utilize actuators to cause vibrations in the portable device **100** that cause portable device **100** to rotate in a desired direction. These techniques may be used alone or in conjunction with each other. Other techniques may be readily apparent to a person skilled in the relevant art. In one embodiment, reorientation element **118** and protection element **120** can be combined into a single element. For example, the same propulsion elements can be used to alter the device orientation (See FIG. **7**) as well as cause a gentle or safe landing (See FIG. **3**).

The protection element **120** may be any number of elements that help protect the portable device **100** from damage due to impact with a surface. In general, the protection element **120** acts to absorb the energy that would otherwise transfer to portable device **100** or to components inside the portable device **100** as a result of impact with a surface.

For example, the protection element **120** may be an energy-absorbing material, a material that allows the kinetic energy of portable device **100** to be dissipated over a greater time or area, a material that reduces the kinetic energy of portable device **100** or other appropriate materials. As discussed with respect to FIGS. **2-6**, examples of the protection element **120** may be one or more of an airbag, a propulsion element, a spring, an impact absorbing structure and a reinforced edge, among others.

In addition to the elements described above, the portable device **100** may also contain a display **122**, an input device **124** (e.g., keypad) and a processor **126**. The processor **126** may be any number of devices that are commonly thought of as central processing units (CPUs) or any device that is capable of receiving an input, performing an operation on the input and producing an output. In general, the processor **126** may be the CPU of the portable device **100** or may be additional processing units that are used alone or in conjunction with the CPU in order to provide functionality to the portable device **100** and/or the damage avoidance system **102**.

It should be understood that display **122** and input device **124** are not required, but rather are used herein to help provide a frame of reference when discussing the orientation of portable device **100**. As used herein, the front surface **128** of the portable device **100** is the side that contains the display **122** and the input device **124**. The back surface (not shown) of the portable device **100** is the side opposite the front surface **128**. The top surface **130** is a side of the portable device **100** that perpendicularly extends between the front surface **128** and the back surface that is closer to the display **122** and further away from the input device **124**. The bottom surface **132** is the side opposite the top surface **130**. The left surface **134** is the side perpendicularly extending between the top surface **130** and the bottom surface **132** that is to the left of the display **122** as it faces a user. The right surface **136** is the side opposite the left surface **134**.

Although FIG. **1**A illustrates that the damage avoidance system **102** is integral to the portable device **100**, in other embodiments one or more components of the damage avoidance system **102** may be removably attached to the portable device **100**. FIG. **1**B illustrates a portable device **150** using a removably attachable damage avoidance system **152**. For example, one or more components of the damage avoidance system **152** may be housed in an external case **154** that is removably attachable to the portable device **150**. In this example, the safety monitoring system **104** is included in the portable device **150** and may utilize existing components of the portable device **150** (e.g., accelerometer, camera, contact detector **112**, processor **126**, etc.). The protection system **106** is included in the external case **154** and communicates with the safety monitoring system **104** using any type of wired or wireless data communication path **156**. For example, the external case **154** may connect with and communicate through a universal serial bus on the portable device **150**. As illustrated in the block diagram of FIG. **1**B and the perspective view of FIG. **1**C, the damage avoidance system **152** may be contained in both the portable device **150** and the external case **154** and optionally use existing components of the portable device **150**. In some embodiments, the damage avoidance system **152** may be completely contained in the external case **154**. In still another embodiment, not shown, a majority of the damage avoidance system **152** may be contained in the portable device **150** and a single use element (e.g., air bag) of the protection system **106** may be contained in the external case **154**. In such an example, other portions of the protection system **106**, contained in the portable device **150** may communicate with the single use element via the communication path **156** causing the single use element to activate or deploy prior to impact. After use, the external case **154** can be removed and replaced for future use. Regardless of configuration, the damage avoidance system **152** effectively operates in the same manner to determine whether a risk of damage to the portable device **150** exceeds a damage threshold and takes steps to reduce or eliminate that risk.

FIGS. **2**-**6** illustrate various embodiments of the protection element **120** (FIG. **1**A). FIG. **2**A illustrates an embodiment of portable device **200** having an airbag **202**. A deflated airbag **202** may be embedded into the portable device **200**. The airbag **202** may be coupled to a compressed gas cartridge **204**. Upon detection by the damage avoidance system **102** that the risk of damage exceeds a damage threshold, the protection system **106** may cause the airbag **202** to deploy out of a side and/or from a face of portable device **200** prior to impact. The airbag **202** may be inflated by the compressed gas cartridge **204**. For example, the gas cartridge may be a compressed air or carbon dioxide cartridge. In certain embodiments, the airbag **202** may be deployable from multiple sides and/or face(s) of portable device **200**. Thus, airbag **202** can be deployed from the side of portable device **200** that is expected to impact the surface. Alternatively, there may be multiple airbags **202** that are deployable to cover all or some of the sides of portable device **200**. In general, airbag **202** should deploy at least on a side that will first impact the surface.

FIG. **2**B illustrates an embodiment of portable device **200** in which airbag **202** has been deployed as inflated airbag **206**. FIG. **2**B shows inflated airbag **206** along the bottom surface **232** of portable device **200**. Inflated airbag **206** provides a cushion along the bottom surface **232** of portable device **200** such that upon impact, inflated airbag **206** reduces (or eliminates) the energy transferred to portable device **200** due to impact with the surface. The airbag may, in some embodiments, be deployed from another surface of the portable device **200** (as well as more than one surface). In addition, multiple airbags **202** may be deployed from the side(s)/face(s).

FIG. **3** illustrates an embodiment of portable device **300** having a protection element **120** that includes one or more propulsion elements **302**. Propulsion elements **302** may operate to propel and/or expel a gas from the portable device **300** to reduce the speed of portable device **300** as it travels toward an impact surface **304** substantially in the orientation shown in FIG. **3**. A compressed gas cartridge, as described above, may be used as a source for the gas.

FIG. **4** illustrates an embodiment of portable device **400** having an embodiment of protection element **120** that includes one or more springs **402**. In one instance, one or more springs **402** are deployable from one or more side(s) or face(s) of portable device **400** prior to impact in order to absorb at least a portion of the impact energy to minimize or prevent damage to portable device **400**. In such an embodiment, portable device **400** may be reoriented prior to impact such that deployed springs **402** are substantially perpendicular relative to the impact surface **404**. In some embodiments, one or more springs **402** may be located within the body of portable device **400** such that a portion of housing **413** is physically separated from at least some of the internal components within portable device **400** prior to impact. This way, upon impact, the housing **413** first impacts the surface **404**. As a result, the housing **413**, in combination with the spring(s) **402**, prevent the impact energy from transferring to the internal components.

FIGS. **5**A-**5**B illustrate an embodiment of portable device **500** having an embodiment of protection element **120** that includes a protection structure **502** in a non-deployed position (FIG. **5**A) and in a deployed position (FIG. **5**B). The protection structure **502** can comprise a portion of the portable device **500** such as a bezel, housing panel or other portion of the portable device **500**. Springs **504** are operable to push the protection structure outward from the device when the safety monitoring system **104** determines that a risk of damage exceeds a damage threshold. In this way, protection structure **502** may be deployed from the portable device **500** prior to impact with the surface. In some embodiments, protection structure **502** is a rigid structure once deployed. In other embodiments, protection structure **502** is designed to collapse and absorb energy associated from the impact with the surface. The protection structure **502** may be retracted into portable device **500** during normal use of portable device **500** and may be compressed back into the retracted position, as shown in FIG. **5**A, after deployment for multiple uses. In some embodiments, the protection structure **502** can be made of material that is designed to break or deform upon contact with the impact surface, thus providing additional cushioning to portable device **500**.

FIG. **6** illustrates an embodiment of portable device **600** having an embodiment of protection element **120** that includes one or more reinforced edges **602**. Although reinforced edge **602** is shown in FIG. **6** to extend substantially the entire length of the bottom surface **632** of portable device **600**, in some embodiments, reinforced edge **602** may partially extend along one or more edge(s) or face(s) of portable device **600**. Reinforced edge **602** may include material such as, but not limited to, rubber, foam, neoprene or any other energy-absorbing or compressible material. Reinforced edge **602** may be a retractable element that is located within portable device **600** while operating in "normal" use and deployed when the safety monitoring system **104** determines that a risk of damage exceeds the damage threshold. In some embodiments, reinforced edge **602** can be retracted back into portable device **600** after being deployed.

Although the addition of a protection element **120** to the portable device **100** is described, it should be understood that the addition of a protection element **120** is optional. For example, even though a portable device **100** may not have a protection element **120**, protection system **106** may be configured to reorient the portable device **100** such that a face of the portable device **100** with a large surface area (relative to other faces of the portable device **100**) first impacts the surface. Striking this surface spreads the force of impact across a greater area, thus minimizing damage to a portable device **100**. Additionally, although certain embodiments of protection element **120** have been described above, these embodiments are for illustrative purposes only, and it is not the intent to limit the scope of this disclosure to such embodiments. Other embodiments that are readily apparent to those skilled in the relevant art are within the spirit and scope of this disclosure.

FIG. **7** illustrates an embodiment of a portable device **700** where the reorientation element **118** includes one or more openings **702** in the portable device **700**. The portable device **700** may have more or fewer openings **702** than shown in FIG. **7**. The openings **702** may extend completely through the portable device **700** or extend only partway through the portable device **700**. The openings **702** may also be modifiable (e.g., a valve), fixed or any combination of modifiable and fixed openings.

In some embodiments, the openings **702** may be used to reorient the portable device **700** while it is traveling in the air. The openings **702** may also provide the portable device **700** with the ability to alter its angular momentum to either increase or decrease its rate of rotation. As will be discussed in more detail below, altering the rate of rotation of portable device **700** may allow protection element **120** (FIG. **1**A) to be in a position to protect portable device **700** from damage caused by impact.

As an example of using openings **702** as a reorientation element **118**, openings **702** in portable device **700** may comprise a propulsion element to allow gas to be forced through the openings **702** in order to impart an additional force to alter the orientation of the portable device **700**. In this embodiment, the openings **702** travel partway through portable device **700** so that the gas can be expelled from a side or selectable portion of portable device **700**. For example, the portable device **700** may include one or more compressed gas cartridges (not shown) and valves (not shown) that may be used to control from which openings **702** the gas is expelled and the rate of expulsion from each cartridge. By selectively expelling gas through certain openings **702** and controlling the rate of gas expelled from each opening, the angular momentum of the portable device **700** can be altered. The gas can be used to increase or decrease the rate of rotation of the portable device **700** so that at the point of impact with the surface, the portable device **700** is oriented so that a side with a protection element **120** first impacts the surface. As depicted in FIG. **7**, gas can be forced through one opening **702** on one side (e.g. top) of the portable device **700**, and gas can be forced through another opening **702** on the opposite side (bottom) of the portable device **700**. This allows extra force to increase or decrease the rate of rotation of the portable device **700**. In some embodiments, openings **702** may be adjustable in order to expel the gas in one or more directions.

According to one embodiment, as portable device **700** is travelling toward the impact surface, it may be desired to alter the orientation of the portable device **700** by thirty degrees so that the back surface (not shown) of the portable device **700** first impacts the surface. Utilizing the damage avoidance system **102**, it is determined that additional angular momentum is required in order to achieve the desired orientation before impact with the surface. Accordingly, the damage avoidance system **102** causes the reorientation element **118** to expel gas through one or more openings **702** to provide additional angular momentum to alter the orientation of portable device **700** so that a thirty degree rotation can be achieved prior to impact.

As another embodiment, the openings **702** in the portable device **700** may not use any propulsion element at all. In one embodiment, the openings **702** may extend through the portable device **700** and are modifiable from either side of the portable device **700**. For example, one or more openings **702** can be selectively opened or closed to alter the air resistance on a side of portable device **700**. A control element such as a solenoid and/or motor (not shown) in the portable device **700** may cause a cover to partially or completely block one or more of the openings **702** thereby altering the resistance on a side of the portable device **700**. By increasing or decreasing the air resistance, the orientation of portable device **700** can be altered.

In addition, reorientation element **118**, openings **702** and/or one or more of the propulsion element(s) that operate to alter or modify the orientation of portable device **700** may be used to reduce the force at the time of impact with the surface. For example, in one embodiment, gas is expelled from the openings **702** so that as portable device **700** nears the surface, the velocity of the portable device **700** is reduced.

FIGS. **8**A, **8**B and **8**C illustrate an embodiment of a portable device **800** where the reorientation element **118** includes a rotational modifier **802**. Rotational modifier **802** may be any number of components that can modify the rotation of the portable device **800**. Modifying the rotation of the portable device **800** may allow a desired side of the portable device **800** to first impact the surface.

An illustrative rotational modifier **802** may be an actuator or other type of vibration mechanism, such as a motor **804** attached to an offset weight **906** (as shown in FIGS. **8**B and **8**C). The vibration mechanism can rotate to a selected position and then vibrate on a side of the portable device **800** to provide impulses in a particular direction to increase or decrease rotation of the portable device **800**. In some embodiments, rotational modifier **802** can be a gyroscope. For example, a gyroscope can be designed to increase or decrease the rate of rotation of the portable device **800**. In operation, when the damage avoidance system **102** determines that, based on the current rate of rotation of the portable device **800**, a side of the portable device **800** without a protection element **120** will first impact the surface, the damage avoidance system **102** may cause the protection system **106** to activate a gyroscope (reorientation element **118**) to reorient portable device **800**.

While in some embodiments the rotational modifier **802** is operable to rotate the offset weight **806** such that it creates a substantially continuous vibration in the device, in other embodiments the offset weight **806** can be rotated into one or more alternative positions from its normal position in order to alter the center of mass of portable device **800**. For example, FIG. **8**B illustrates an embodiment of reorientation element **118** that includes the rotational modifier **802** of FIG. **8**A in one possible alternative position. As depicted, the motor **804** is operable to rotate offset weight **806** about axis **808**. The position of the offset weight **806** depicted in solid lines can denote a position in which the offset weight **806** is in a normal position, while the position depicted in hashed lines depicts the offset weight **806** in a first offset position. Similarly, FIG. **8**C illustrates an embodiment of reorientation element **118** that includes the rotational modifier **804** of FIG. **8**A in a second possible alternative position. Here, the position depicted in solid lines again denotes the position in which the offset weight **806** is in a normal position, while the position depicted in hashed lines depicts the offset weight **806** in a second offset position. Accordingly, the center of mass of portable device **800** is altered as needed by moving the offset weight **806** into these example alternative positions.

FIGS. **9**A and **9**B illustrate an embodiment of a portable device **900** where the reorientation element **118** includes a movable weight **902**. FIG. **10**A illustrates a rear view of the portable device **900**, whereby a portion of the housing **1013** has been removed to expose a compartment **904**. A movable weight **902**, when moved, alters the center of gravity of the portable device **900** to cause a change in the rate or direction of rotation of the portable device **900**.

In one embodiment, the movable weight **902** is a relatively heavy component of the portable device **900**, such as a battery. By altering the location of the movable weight **902** within the compartment **904**, the center of gravity of the portable device **900** is altered. Using a battery as movable weight **902** to change the center of gravity of portable device **900**, as well as providing power to portable device **900**, allows the battery to serve multiple purposes and eliminates the need to have a separate movable weight **902** in the portable device **900**.

FIG. **9**A illustrates that, according to some embodiments, the movable weight **902** may be placed on rails **906** within compartment **904** in the portable device **900**. The movable weight **902** may be held in place by various objects, such as retractable pins **908**, which can releasably control an object in place along the rails **906**. When it is desired to relocate the movable weight **902** within compartment **904** in order to change the center of gravity of the portable device **900**, one set of pins **908** may be withdrawn to allow the movable weight **902** to slide along the rails **906** to a new location within the portable device **900**. Alternatively, or in addition to the rails **906**, a motor (not shown) can cause the movable weight **902** to move along the rails **906** to a desired location.

Although FIG. **9**A illustrates that the movable weight **902** has only one degree of freedom along the rails **906** (as shown by arrow A-A), FIG. **9**B illustrates that the movable weight **902** may be able to move in additional degrees of freedom (e.g. along any number of axes, including the X, Y and Z axes) in other embodiments. At some time after recovery of the portable device **900**, the movable weight **902** can be returned to its original position and re-secured on the rails **906**. In yet other embodiments, the moveable weight **902** is example of an ejectable element that can be completely ejected from the portable device **900**. This ejection can serve to change the center of mass of the portable device **900**, cause the portable device **900** to have a lower mass at impact and/or alter the orientation of the portable device **900** from the force of the ejection of the moveable weight **902** (e.g. from springs or other mechanisms operable to eject the moveable weight **902** from the portable device **900**). The ejectable element can include one or more relatively heavy components of the portable device **900**. Similarly, an ejectable element may be ejected but remain within portable device **900**. The ejectable element may be ejected to reduce the possible damage to sensitive components or to reduce a stress or strain on another element (e.g., a connector or circuit board).

FIG. **10** is a flowchart illustrating a method **1000** executed by damage avoidance system **102** for protecting a portable device **100** using safety monitoring system **104** and protection system **106**, as described above. At step **1002**, damage avoidance system **102** determines a risk of damage to the portable device **100**. In some embodiments, damage avoidance system **102** periodically makes this determination. In other embodiments, damage avoidance system **102** continuously (e.g., real-time) makes this determination. For example, damage avoidance system **102** may utilize one or more of distance detector **108**, motion detector **110**, contact detector **112** and/or surface type detector **114** to determine the risk of damage to the portable device **100**. Damage avoidance system **102** may weigh the information provided by each detector in safety monitoring system **104** differently when assessing a risk of damage.

At step **1004**, damage avoidance system **102** determines whether a risk of damage to the portable device **100** exceeds a damage threshold. If the damage avoidance system **102** determines that a risk of damage does not exceed a damage threshold, the method **900** returns to step **1002**. At a time after damage avoidance system **102** determines that a risk of damage to the portable device **100** exceeds a damage threshold, at step **1006** damage avoidance system **102** alters, if necessary, the orientation of the portable device **100**. For example, if orientation detector **116** determines that the portable device **100** is already in a desired orientation (e.g., the protection element **120** will first impact the surface), then the portable device **100** is not reoriented prior to impact. If reorientation of the portable device **100** is required, reorientation element **118** alters the orientation of the portable device **100** one or more times prior to impact until the protection element **120** is positioned to first impact the surface. At step **1008**, the protection element **120** may be deployed. The protection element **120** may be deployed before, during or after the reorientation of the portable device **100**.

FIG. **11** is a flowchart illustrating a method **1100** executed by damage avoidance system **102** for protecting a portable device **100** using safety monitoring system **104** and protection system **106**. Steps **1102** and **1104** operate substantially as described above with respect to steps **1002** and **1004** of method **1000** to determine a risk of damage to the portable device **100** and to determine whether that risk exceeds a threshold. However, according to the embodiment of method **1100**, a protection element **120** is not deployed. Rather, once it is determined that the risk of damage to the portable device **100** exceeds a threshold, at step **1106** the reorientation element **118** of protection system **106** alters the orientation of the portable device **100** to reduce or eliminate the risk of damage. For example, protection system **106** may be configured to reorient the portable device **100** such that a reinforced surface or a surface of the portable device **100** with a large surface area (relative to other surfaces of the portable device **100**) first impacts the surface.

FIG. **12** is a flowchart illustrating a method **1200** executed by damage avoidance system **102** for protecting a portable device **100** using safety monitoring system **104** and protection system **106**. Steps **1202** and **1204** operate substantially as described above with respect to steps **1002** and **1004** of method **1000** to determine a risk of damage to the portable device **100** and to determine whether that risk exceeds a threshold. However, according to the embodiment of method **1200**, the portable device **100** is not reoriented. Rather, once it is determined that the risk of damage to the portable device **100** exceeds a threshold, at step **1206** the protection system **106** deploys a protection element **120** (e.g. airbag, propulsion system, fans, springs, etc.) to reduce or eliminate the risk of damage. In such an embodiment it may be desirable to use a protection element **120** that protects substantially all surfaces of the portable device **100** from first contacting the impact surface. For example, an airbag that covers all or a substantial portion of the surface of the portable device **100** can be deployed. Additionally, in some embodiments, the protection element **120** may be deployed to protect a particular side of the portable device **100** that naturally tends to contact a surface first when dropped. For example, the center of mass of the portable device **100** may cause the device to impact on a particular side of the portable device **100** more often than others. In such a case, the protection element **120** may specifically be designed to deploy such that this particular side is protected.

In addition to helping to protect the portable device **100** from impact damage, damage avoidance system **102** may help locate a portable device **100** if it becomes lost or misplaced. In one embodiment, safety monitoring system **104** monitors at least one of movement and/or contact to determine if the portable device **104** is lost or misplaced. For example, after determining that the portable device (e.g., cell phone) has not moved or changed relative position for a defined period of time, damage avoidance system **104** may cause the portable device **104** to send a message. The message may be voice, text, SMS or other communication that informs the recipient that the portable devices may be lost/misplaced and may include location information, including for example the GPS coordinates from the portable device or a location based upon a triangulated signal. In one embodiment, at least one of motion detector **110** and/or contact detector **112** is used to determine motion and/or that the portable device **104** has been contacted (e.g., touched) the user within a defined or selected period of time. In addition, damage avoidance system **102**, may also monitor the remaining battery operational life so that the portable device sends the communication before the portable device becomes non-operational because of an insufficient charge.

Although the portable devices examples generally typically refer to a cellular phone, the portable device may include smart phones, personal data assistants, electronic media players, electronic book readers, notebook computers, netbook computers, tablet computers, barcode scanners, cameras, video cameras, pagers, portable video game consoles, video game controllers and the like as each are susceptible to damage and/or loss.

All of the processes described herein may be embodied in, and fully automated via, software code modules executed by one or more general purpose or particular computers or processors. The code modules may be stored in any type of computer-readable medium or other computer storage device. Some or all of the methods may alternatively be embodied in specialized computer hardware. In addition, the components referred to herein may be implemented in hardware, software, firmware or a combination thereof.

Conditional language such as, among others, "can," "could," "might" or "may," unless specifically stated otherwise, are otherwise understood within the context as used in general to convey that certain embodiments include, while other embodiments do not include, certain features, elements and/or steps. Thus, such conditional language is not generally intended to imply that features, elements and/or steps are in any way required for one or more embodiments or that one or more embodiments necessarily include logic for deciding, with or without user input or prompting, whether these features, elements and/or steps are included or are to be performed in any particular embodiment. In addition, the terms measures, measuring, ascertain, calculate, determine and determining are generally used interchangeably to convey that the described components, systems or methods operate to determine a particular result or condition.

Any process descriptions, elements or blocks in the flow diagrams described herein and/or depicted in the attached figures should be understood as potentially representing modules, segments or portions of code which include one or more executable instructions for implementing specific logical functions or elements in the process. Alternate implementations are included within the scope of the embodiments described herein in which elements or functions may be deleted, executed out of order from that shown or discussed, including substantially concurrently or in reverse order, depending on the functionality involved as would be understood by those skilled in the relevant art.

It should be emphasized that many variations and modifications may be made to the above-described embodiments, the elements of which are to be understood as being among other acceptable examples. All such modifications and variations are intended to be included herein within the scope of this disclosure and protected by the following claims.

What is claimed is:

1. A method for protecting a portable device that includes an airbag deployable from a side of the portable device, comprising:

detecting that the portable device will impact a surface;

prior to impact with the surface, determining if a risk of damage to the portable device from the impact exceeds a damage threshold;

when the risk of damage to the portable device exceeds the damage threshold:

altering the orientation of the portable device such that the air bag first impacts the surface; and

deploying the airbag prior to impact with the surface.

2. The method of claim **1**, further comprising:

determining a time to impact between the surface and the portable device.

3. The method of claim **1**, wherein altering the orientation is performed by a portable device reorientation element.

4. The method of claim **3**, wherein altering the orientation comprises forcing a gas through a modifiable opening in the portable device.

5. The method of claim **3**, wherein the portable device reorientation element is at least one of: a movable weight, a gyroscope, an actuator and a propulsion element.

6. A system for protecting a portable device, comprising:

a device safety monitoring system configured to detect a risk of damage to the portable device from impacting a surface;

a protection element operable to reduce the risk of damage to the portable device caused by the impact with the surface;

an orientation detector, operable to detect an orientation of the portable device; and

a reorientation element, operable to modify the orientation of the portable device such that the protection element first impacts the surface.

7. The system of claim **6**, wherein at least one of the protection element and the reorientation element includes a propulsion element.

8. The system of claim **6**, wherein the protection element comprises at least one of: an impact absorbing structure, a reinforced side and a spring.

9. The system of claim **8**, wherein the device safety monitoring system is removably attached to the portable device.

10. A system for protecting a portable device, comprising:

a device safety monitoring system configured to detect a risk of damage to the portable device caused by impact with a surface;

a reorientation element operable to modify the orientation of the portable device; and

a deployable protection element, activated upon detection of the risk of damage by the device safety monitoring system exceeding a damage threshold, wherein the deployable protection element is externally deployed from the portable device prior to impact with the surface.

11. The system of claim **10**, wherein the deployable protection element includes at least one of an airbag, a propulsion element and a spring.

12. The system of claim **11**, wherein the propulsion element deploys a gas from the portable device.

13. The system of claim **11**, wherein the deployable protection element is deployable from at least one side of the portable device.

14. The system of claim **10**, wherein the device safety monitoring system comprises at least one of:

a velocity detector;

an accelerometer;

a distance detector; and

a contact detector.

15. The system of claim **10**, further comprising:

an orientation detection element in communication with the reorientation element, operable to detect an orientation of the portable device.

16. The system of claim **10**, wherein the reorientation element modifies a rotation of the portable device.

17. The system of claim **10**, wherein the reorientation element modifies the orientation of the portable device so that a side of the portable device that contains the deployable protection element first impacts the surface.

18. The system of claim **10**, wherein the reorientation element comprises at least one of: a propulsion element, an ejectable element, a movable weight, an actuator, a gyroscope and a modifiable opening.

19. The system of claim **18**, wherein the movable weight is a battery.

20. The system of claim **18**, wherein the propulsion element expels a gas from the portable device.

21. The system of claim **10**, wherein the reorientation element reorients the portable device prior to a deployment of the deployable protection element.

22. A computer-readable storage medium whose contents include instructions that when executed configure one or more computing devices to perform a method comprising:

prior to impact between a surface and a device having a protection element:

determining that the impact may cause damage to the device; and

modifying an orientation of the device with a reorientation element such that the protection element first impacts the surface.

23. The computer-readable medium of claim **22**, wherein the determining that the impact may cause damage to the device comprises at least one of:

determining a velocity of the device;

determining a distance between the device and the surface;

determining an acceleration of the device;

determining a contact with the device;

determining a time to impact of the device and the surface; and

determining an impact surface type.

24. The computer-readable medium of claim **22**, wherein the protection element comprises at least one of: an airbag, a propulsion element and a spring.

25. The computer-readable medium of claim **24**, wherein the spring is operable to deploy from at least one surface of the device.

26. The computer-readable medium of claim **22**, wherein the modifying an orientation of the device further comprises:

activating the reorientation element such that the protection element first impacts the surface.

27. The computer-readable medium of claim **22**, wherein the modifying the orientation of the device reorients the device such that first contact with the surface is at least a portion of the side having the protection element.

28. The computer-readable medium of claim **26**, wherein the reorientation element includes at least one of: a propulsion element, a movable weight, an actuator, a gyroscope and a modifiable opening.

29. The computer-readable medium of claim **28**, wherein the propulsion element expels a gas from the device.

30. The computer-readable medium of claim **28**, wherein the movable weight comprises a battery.

31. The computer-readable medium of claim **22**, further comprising deploying the protection element prior to impact with the surface.

32. The computer-readable medium of claim **22**, wherein the protection element is deployable from a surface of the device.

33. The computer-readable medium of claim **22**, wherein the device comprises at least one additional protection element.

34. The computer-readable medium of claim **33**, wherein the protection element is deployable from a first surface of the device and the at least one additional protection element is deployable from a second surface of the device.

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