(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
8 May 2008 (08.05.2008)

PCT

(10) International Publication Number
WO 2008/054479 A2

(51) International Patent Classification:
G08B 13/00 (2006.01)

(21) International Application Number:
PCT/US2007/006884

(22) International Filing Date: 19 March 2007 (19.03.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/785,570 24 March 2006 (24.03.2006) US
11/388,764 24 March 2006 (24.03.2006) US

(71) Applicant *(for all designated States except US)*: **RSIALARM, INC.** [US/US]; 202 East Golden Lake Circle, Circle Pines, MN 55014 (US).

(72) Inventors: **REIBEL, Jean-Michel**; 6 Rue De Rungis, F-67200 Strasbourg (FR). **JENTOFT, Keith**; 202 East Golden Lake Circle, Circle Pines, MN 55014 (US).

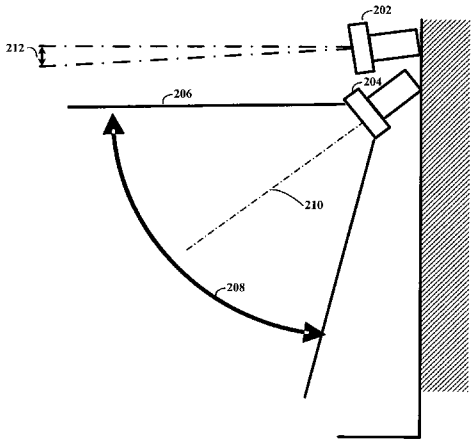
(74) Agent: **CRAWFORD, Robert, J.**; Crawford Maunu PLLC, 1270 Northland Drive, Suite 390, St. Paul, MN 55120 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

(54) **Title:** INTEGRATED MOTION-IMAGE MONITORING METHOD AND DEVICE



(57) **Abstract:** Security systems and methods are implemented using a variety of devices and methods. According to one such implementation, a security system uses a controller 102 to communicate with security-monitoring devices 104-110 and has an integrated image- capture device comprising a circuit board structure having an angle-setting support article, a circuit board 310 with a nonadjustable surface, and data-communicating electrical conductors. A camera 314 is secured to the nonadjustable surface and is directed at a first angle relative to the nonadjustable surface. A motion detector 312 is secured to the nonadjustable surface and is directed at a second angle relative to the nonadjustable surface of the circuit board. The support article sets the first angle relative to the second angle for capturing both images and motion in a target area. A data-communication circuit communicates data from the camera and the motion detector via the data-communicating electrical conductors and wirelessly communicates the data to the controller.

WO 2008/054479 A2

INTEGRATED MOTION-IMAGE MONITORING METHOD AND DEVICE

RELATED PATENT DOCUMENTS

This patent document claims benefit under 35 U.S.C. § 119(e) to the following U.S. patent documents: Provisional Application No. 60/785,570, entitled "Motion-Image Monitoring Method and Device," filed on March 24, 2006; and Application Serial No. 11/388,764 (RSIA.006PA), entitled "Security Monitoring Arrangement And Method Using A Common Field Of View," filed on March 24, 2006, which in turn claims benefit under 35 U.S.C. § 119(e) to U.S. Provisional Patent Application No. 60/719,369, entitled "Security Monitoring Arrangement and Method with Privacy Control," filed on September 22, 2005. Priority is claimed for common subject matter to each of these underlying patent documents.

Applicant respectfully makes reference to co-filed U.S. Patent Application Serial No. 11/687,991 filed on March 19, 2007 and entitled: "Integrated Motion-Image Monitoring Method and Device," for the purpose of calculating the PCT Search Fees under 35 U.S.C. § 111(a).

FIELD OF THE INVENTION

The present invention is directed to a method and device for monitoring the inside of a facility or residence and, more specifically, to a method and device using an integrated motion detector and camera.

BACKGROUND

A variety of applications benefit from protection of residents, employees, personal property, and the like, by using security monitoring systems within facilities, *e.g.*, to monitor and/or sense certain conditions such as a facility-operations problem or the presence of an unwanted intruder. Many such security systems are connected to a central control unit and monitored by an operator who can alert the appropriate emergency services in the event of an unwanted intruder. Often, a home monitoring security system includes a combination of sensing devices and alarm devices and some also include cameras. To achieve the maximum monitoring coverage, these devices are distributed throughout the interior of the facility.

Security systems that employ cameras are advantageous in that they are able to record any and all activity associated with a suspected breach of the facility. In some instances, however, the cameras record the regular activities of the facilities' residents

and/or employees. The cameras also record activities that are falsely perceived to be security breaches such as pet behaviors and authorized users that have been accidentally locked out.

In specific situations, such as those having the potential to violate the privacy of authorized residents and/or employees of the facility, such comprehensive recordation by the security cameras may be undesirable. Since unwanted intruders could breach the security of a facility while the inhabitants are present, it is necessary for the security monitoring system to be functioning at all times. However, having cameras constantly being triggered to record inhabitants' daily living and working routines is a dramatic invasion of the inhabitants' privacy, especially considering false triggers. Further, the monitoring and recording of guests' activities can be just as invasive.

While numerous cameras and motion detectors are generally necessary to provide proper security coverage of a residence or facility, the size and frequent placement of the devices are burdensome to install and maintain and are aesthetically unpleasant. Each room or area in a facility typically requires both a motion detector and a camera, and large areas may require more combinations. The sizes of these devices render their presence in a facility obvious. Moreover a full-facility security system typically requires installation of several system components including wiring for communications and power between cooperative units within the system.

Implementing small detectors and cameras presents a host of problems. For security reasons, ease of installation and flexibility of a system, it is a disadvantage to require the detectors and cameras to be electrically connected to other components. More specifically, detectors and cameras that operate using an external power source, such as an electrical outlet, can be circumvented by removing the power source. This presents a number of security weaknesses in the overall system. Moreover, reliance on an external power source often complicates the installation process because the installation requires a connection to the external power source. This may require routing of wires carrying power to the detectors and cameras. Small devices have the additional problem of not having space to include large independent power sources, such as batteries. Accordingly, the functionality and time between charging of the devices is often sacrificed for size. For example, many wireless communications protocols drain batteries and other power sources rapidly. Other power hungry portions of cameras and detectors include the camera, the detector, image processing and illumination devices. These and other problems have

hampered the implementation of small, portable cameras and detectors used in security applications.

The above-discussed issues have presented challenges to developing a home and/or facility security monitoring system that provides maximum coverage while minimizing one or more of the above-identified issues.

SUMMARY

The present invention is directed to the above and related types of integrated security devices. These and other aspects of the present invention are exemplified in a number of illustrated implementations and applications, some of which are shown in the figures and characterized in the claims section that follows.

Various aspects of the present invention are applicable to a security device that uses both motion detection and image-capture to detect a security breach.

According to one embodiment of the present invention, a security system uses a controller to communicate with security-monitoring devices and has an integrated image-capture device comprising a circuit board structure having an angle-setting support article, a circuit board with a nonadjustable surface, and data-communicating electrical conductors. A camera is secured to the nonadjustable surface and is directed at a first angle relative to the nonadjustable surface. A motion detector is secured to the nonadjustable surface and is directed at a second angle relative to the nonadjustable surface of the circuit board. The support article sets the first angle relative to the second angle for capturing both images and motion in a target area. A data-communication circuit communicates data from the camera and the motion detector via the data-communicating electrical conductors and wirelessly communicates the data to the controller.

Consistent with another embodiment of the present invention, a security system uses a controller to communicate with security-monitoring devices. An integrated image-capture device has a circuit board structure with an angle-setting support article, a circuit board with a nonadjustable surface and electrical conductors. An integrated arrangement includes a camera secured to the nonadjustable surface and directed at a first angle relative to the nonadjustable surface. The arrangement also includes a motion detector secured to the nonadjustable surface and differently directed at a second angle relative to the nonadjustable surface of the circuit board. The support article sets the first angle relative to the second angle for capturing both images and motion in a target area. The camera and the motion detector are electrically connected to respective ones of the electrical

conductors. A control circuit provides wireless communication between the controller and the integrated arrangement.

According to another embodiment of the present invention, a security system uses a controller to with communicate security-monitoring devices. Within the security system an integrated image-capture device is used that has a battery circuit. The battery circuit is connected to a circuit for receiving wireless control signals. The receiving circuit is connected to a power-control circuit that is responsive to reception of the wireless control signals and that controls use of the battery circuit. The device also includes a camera, a motion detector and a circuit board structure to electrically integrate the camera and the motion detector. The circuit board structure sets a first angle at which the camera is to capture images and a second angle, different from the first angle, at which the motion detector is to detect motion. Logic synchronizes transmission of data between the circuit for receiving wireless control signals and the controller.

According to another embodiment of the present invention, a security system uses a controller to communicate with security-monitoring devices. An image-capture device having a circuit board with a nonadjustable surface includes a circuit for wirelessly interfacing with the controller. The image-capture device has a camera secured to the nonadjustable surface of the circuit board and directed at a first angle substantially perpendicular to the surface of the circuit board. A motion detector integrates with the nonadjustable surface of the circuit board using one or more through-hole connections. A support directs the motion detector at a second angle different from said first angle during soldering of the through-hole connections.

The above summary of the present invention is not intended to describe each illustrated embodiment or every implementation of the present invention. The figures and detailed description that follow more particularly exemplify these embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention may be more completely understood in consideration of the detailed description of various embodiments of the invention in connection with the accompanying drawings, in which:

FIG. 1 shows a building-security system, according to an example embodiment of the present invention;

FIG. 2 illustrates a security device mounted to a wall, according to an example embodiment of the present invention;

FIG. 3 is a side view of a motion-image security device, according to an example embodiment of the present invention;

FIG. 4A illustrates orientations of LEDs, according to an example embodiment of the present invention;

FIG. 4B is a bottom view of a motion-image security device showing LED orientation, according to an example embodiment of the present invention;

FIG. 5 is a perspective view of an internal support piece of a motion-image security device, according to an example embodiment of the present invention; and

FIG. 6 is a graph of filter responses, according to an example embodiment of the present invention.

While the invention is amenable to various modifications and alternative forms, specifics thereof have been shown by way of example in the drawings and will be described in detail. It should be understood, however, that the intention is not necessarily to limit the invention to the particular embodiments described. On the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION

The present invention is believed to be applicable to a variety of different approaches for, and arrangements used in, monitoring a target area. The invention has been found to be particularly advantageous for addressing security-monitoring applications in a residence or office-facility environment where one or more peripheral devices communicate with another device and are used to monitor one or more respective target areas. While the present invention is not necessarily so limited, such a security-monitoring application is used in the following discussion to exemplify certain embodiments of the present invention.

Consistent with such an application, FIG. 1 depicts a security system according to an example embodiment of the present invention, as might be useful for monitoring a building (such as a home or workplace). FIG. 1 includes building 100, control panel 102, and peripheral devices 104-110. The security system is implemented in such a manner so as to reduce the power consumption of one or more of the control panel 102 and the peripheral devices 104-110 as related to the wireless communications between the devices. When implementing the wireless communications, the devices use multiple frequencies (channels) as well as communication intervals. The devices are able to reduce the power consumption by utilizing information regarding a specific frequency from the multiple

frequencies used and the communication interval. For example, if the transmitting devices modify their transmissions based upon the information, a receiving device may reduce the power consumption by decreasing the time the receiving device is listening for a transmission from another device. By reducing the power consumption, the system lends itself to implementing bi-directional communications between the devices, which typically require more power consumption than unidirectional communications.

The jagged lines and ellipses found between the control panel 104 and the peripheral devices 104-110 represent wireless communications between the control panel and the peripheral devices. The wireless communications may be implemented using suitable frequencies. For instance, wireless communications frequencies in industrial, scientific and medical (ISM) radio bands (900Mhz, 2.4Ghz and 5.8Ghz) have been found to be suitable for security systems; however, alternate frequencies may be implemented in accordance with the particulars of the system or its intended implementation. For example implementations related to communicative coupling and data transfer among the above-discussed devices in accordance with appropriate protocols, reference may be made to U.S. application serial no. 11/389,673 filed on March 24, 2006, entitled "Spread Spectrum Communications for Building-Security" (Attorney Docket No. RSIA.010PA), and to European Patent Application Publication No. EP 1 363 260 filed on May 6, 2003, entitled "Procédé De Communication Radiofréquence Entre Plusieurs Dispositifs Et Système De Surveillance Mettant En Ouvre Un Tel Procédé," which are herein fully incorporated by reference.

The various elements of the peripheral devices 104-110 and the control panel 102 are implemented using one or more of electric circuit arrangements, processors, memory elements, software code, programmable logic devices, input/output interfaces or combinations thereof. In alternative (more specific) embodiments, the embodiments disclosed herein are implemented in combination with the embodiments described in the above-referenced patent document No. 11/388,764, entitled "Security Monitoring Arrangement And Method Using A Common Field Of View" (fully incorporated herein by reference).

Building 100 represents a facility for which the building security system is implemented. Common implementations of building 100 include, but are not limited to, residential homes, retail stores, office buildings, government buildings, museums and other facilities. Typically, the security system will monitor several locations of building 100. Accordingly, FIG. 1 depicts various peripheral devices throughout the building.

Peripheral communications devices 104-110 may take the form of various different devices, a few of which are depicted in FIG. 1. For instance, device 104 depicts a window sensor that may, among other things, detect when the window has been opened or otherwise compromised; device 106 depicts a camera for video capture; device 108 depicts an alarm; and device 110 depicts a mobile peripheral, such as a key fob for interfacing with the control panel 102 or another peripheral. These peripheral devices 104-110 communicate with control panel 102 using wireless communications.

Block 112 depicts several elements that may be implemented in the peripheral devices 104-110, including a transceiver block, a message protocol block, a synchronization block and a transmit (Tx) anticipation block. Various embodiments of the present invention use one or more of these blocks. In one such embodiment, a peripheral device wirelessly transmits a signal using the transceiver block. The peripheral device uses information regarding a transmission period and the listening channel of the control panel in the transmission process.

In one embodiment, the peripheral devices 104-110 transmit building security information to the control panel 102. For instance, device 106 might transmit video images or device-status information to the control panel 102, while device 104 might transmit information relating to the window sensor.

FIG. 1 depicts control panel 102 as including a transceiver block, a message protocol block, a synchronization block and a transmit (Tx) anticipation block. Various embodiments of the present invention use one or more of these blocks. In one such embodiment, the transceiver block is used for receiving signals from one of the peripheral devices 104-110 as a function of the communication intervals and the frequency the control panel 102 uses to listen for transmissions. The listening frequency is one of several potential frequencies available for communication between the peripheral devices and the control panel. For instance, the system may use a number of contiguous frequency slots (channels) within a suitable frequency band. One example of such a use includes 25 or more channels within the ISM frequency band from 902-928 MHz. Numerous other combinations of channels and frequency bands are possible using the present invention.

Typically, the control panel and peripherals are implemented using a similar set of elements as depicted by blocks 102 and 112; however, various components may be implemented differently. For instance, the synchronization block can be implemented differently in the control panel versus the peripheral devices where the control panel provides synchronization information to each of the peripherals and the peripherals must

use the synchronization information to maintain synchronization using a local clock. In such an instance, the peripherals would compare the synchronization information with the local clock in order to compensate for any difference between the peripherals' time frames and the control panel's time frame.

The control panel 102 and the peripheral blocks 104-110 are depicted as having a transceiver; however, the system may be implemented using variations of receivers and transmitters. In some instances, the control panel may be implemented with only a receiver and the peripherals with only a transmitter. In other instances, the control panel may be implemented with only a transmitter, while the peripherals are implemented with only a receiver. Other implementations allow for one or more of the control panels and peripherals to have both a transmitter and receiver (transceiver). Thus, transceiver is used herein to describe a receiver, transmitter or both a receiver and transmitter.

FIG. 2 illustrates a security device mounted to a wall, according to an example embodiment of the present invention. An example embodiment of the present invention involves a monitoring device that includes an integrated motion detector and an image-capture device. In certain implementations, the motion detector is designed with a passive infrared (PIR) detector 202. While other motion detectors may be used, the remaining discussion of the motion detector will refer to a PIR-type detector. The security device points the PIR detector at an angle 212. In a preferred implementation, the PIR detector 202 is positioned at an angle 212 of about five degrees to a horizontal axis (*e.g.*, parallel to the ground). The monitoring device also includes an image sensor 204. For certain implementations, the lens of the image sensor is a wide angle lens (*e.g.*, a Fresnel lens). In one instance, the security device directs the image sensor 204 in a direction 210. The image sensor 204 may be oriented such that the upper bound 206 of the viewing area 208 is at or near horizontal, one example being parallel to the ground. While maintaining this common upper bound 206, the two components (*i.e.*, the PIR detector 202 and the image sensor 204) can be angled at different angles so as to form a common field of view. This can be useful for increasing the effective coverage of the components. For example, the devices can be easily installed because the installer knows the coverage (shown by field of view 208) will extend horizontally from the height the components are placed on the wall. Thus, the installation height is easily established by determining the highest point for which coverage is desired (*e.g.*, head level). Moreover, such an alignment between components can be beneficial because the components can have a common field of view. More

specifically, an indication of motion by a PIR sensor will directly correspond to the image captured by a camera.

FIG. 3 is a side view of a motion-image security device, according to an example embodiment of the present invention. In one implementation consistent with the example illustration shown in FIG. 3, the monitoring device includes a housing 302 that contains a single circuit board 310 for both components (motion sensor 312 and image-capture device 314). In a particular embodiment, circuit board 310 is one of a variety of commonly used solid printed-circuit-boards (PCB). For example, circuit board 310 may be implemented using a common 2 (or more) layer FR4 circuit board that has a rectangular shape as shown by FIG. 3. Many standard circuit components (*e.g.*, image detectors and PIR devices) are designed to mount flush with a circuit board. Accordingly, standard circuit components mounted on a common circuit board results in the circuit components having a common alignment (*e.g.*, perpendicular to the circuit board), as shown by angle 306. Certain aspects of the present invention provide for the use of such a solid circuit board and standard components having different alignments. For instance, an angled support 502 (shown in FIG. 5) is used in connection with the single circuit board 310 to provide the PIR sensor angle depicted at 316. Wired legs 320 and 322 of the sensor 312 pass through and are used with "through holes" to package the PIR sensor 312 with the circuit board 310. The angle difference between the wired legs 320 and 322 and circuit board 310 can be accommodated using any number of techniques. A few example techniques include, without limitation, bending the wired legs 320 and 322, using holes in circuit board 310 sufficiently large to allow for angled entrance of wired legs 320 and 322, using angled holes in circuit board 310 and fastening the wired legs to one side of the circuit board using solder, screws or similar fastening techniques. Either side of the circuit board 310 includes areas 328 and 330 for mounting circuitry such as PIR signal-manipulation circuitry and radio frequency (RF) transceiver circuits (discrete and/or integrated components) and the antenna 331. Similarly, the circuit board 310 includes areas for mounting an image-capture related-device (*e.g.*, lens) 332 and a video processor 334 programmed to process (manipulate) captured images.

In a more particular application, the RF and related circuits mounted on the board can be designed and programmed to implement the communication and related operations in a manner consistent with one or more embodiments disclosed in the above-referenced U.S. patent document, filed on March 24, 2006, and entitled "Spread Spectrum Communications for Building-Security" (Attorney Docket No. RSIA.010PA).

FIGS. 4A-4B and FIG. 5 illustrate various views of one embodiment of the monitoring device shown in FIG. 3. FIG. 4A illustrates IR-type LEDs (infrared emitting diodes or IREDs) 410 and 412 that emit light as used by the monitoring device for night-vision image capture. FIG. 4B is a bottom view of such a device that orients the LEDs 410 and 412 for motion-image security purposes. A sensor, such as image-capture 314 and PIR detector 312 captures the reflected IR. FIG. 4A shows two possible illumination patterns 420 and 430 for IREDs 410 and 412. 420 shows a first illumination pattern where the bases of the IREDs are parallel to each other. Such a pattern would result from standard mounting on a common PCB. 430 shows a second illumination pattern that has less overlap of illumination and provides a broader illumination angle. This is accomplished by angling the IREDs away from one another. Such an angled illumination pattern can be accomplished using techniques similar to those discussed in relation to PIR sensor 312 and as further discussed herein.

FIG. 5 is a perspective view of an internal support piece of a motion-image security device, according to an example embodiment of the present invention;

The PIR sensor support of FIG. 5 is connected with the body of the main plastic (structural) part 516 using strippable ribs 512. These ribs 512 may be cut to gain access to the circuit board 310, for example, to make repairs, without interfering with the PIR sensor 312. The ribs 512 allow for access to the circuitry without need to unsolder the PIR sensor or potentially disturb the PIR sensor's angle as depicted at 316 of FIG. 3. The image-capture device may be of surface-mounted device (SMD) type and soldered using a reflow process. The circuit board (310 of FIG. 3) is attached, *e.g.*, clipped, to the main plastic part 516 and the board-support combination is inserted into the housing 302 of the motion-image security device with each of the sensing components angled so as to provide a common field of view. The housing 302 is generally shown in FIG. 3, and for a more particular view of such a housing, reference may be made to U.S. Design Application No. 29/256,856, filed on March 24, 2006 (Docket No. RSIA.002DE), entitled "Mountable Security Detector."

In one embodiment of the present invention, parasitic reflection of light can be reduced using a thin wall 510. In a preferred embodiment, this wall 510 has a cone shape that minimizes adverse effects to the view pattern of the PIR sensor.

Consistent with another embodiment of the present invention, keying of the various sensors and illumination devices can be incorporated into housing 302. More specifically, IRED supports 506 can include keying portions 504 and PIR support 502 can include

keying portion 508. Various keying solutions can be implemented depending upon the component being used and the housing design.

Certain embodiments include a compact housing which involves miniaturization of the circuitry and components of the motion-image security device. To obtain a compact overall device, the electronic components are assembled on both sides of the circuit board. In certain implementations, the placement includes the image sensor located on a top side with the video processor located on the opposite side. Thus the length of the connections between the image sensor and the processor can be reduced so as to avoid signal noise. Moreover, to reduce electromagnetic interference (EMI), the "noisy" components (*e.g.*, video components, image sensor, video processor, memory) are located near one portion of the board such as the bottom, while the RF and the PIR conditioning circuits are located near another portion such as the upper end.

The image sensor is used in connection with two infrared emitting diodes (IREDs) to provide night vision and image-capture in light-deficient environments. In certain implementations, they are located near the image sensor, in a symmetrical fashion, to evenly distribute the infrared energy. In certain other implementations the IREDs are not positioned horizontally but instead have angled bases or supports to provide an infrared distribution that reduces the overlap between the two IREDs in the central axis and increases the angle of illumination. The IREDs also draw a high level of current, which limits the use of small SMD types, which cannot dissipate high power. Instead, the through hole-type is used. This is also advantageous for allowing flexibility in the angles of illumination provided by the IREDs.

Common through-hole footprints create difficulties in placing the video processor near (but on an opposite side of) the image sensor. In certain implementations, a plastic support piece is used to overcome these difficulties. For example, the IREDs are positioned by adapting IRED supports on the plastic support to orient the desired angles of the IREDs, and thereby avoiding the soldering of the thru hole IRED during the initial placement. The IRED (through-hole) legs can be bent and using a screw 404 to create pressure on the legs of each of the IREDs thereby forming an electrical contact with the circuit board. In one implementation, these two screws also serve to fastening the image sensor lens holder 514 tightly to the circuit board to reduce parasitic light due to gaps between the circuit board and the lens holder.

The above-discussed screws can be used for both tightening the support holder to the circuit board, to position the optical chamber between the image sensor and the lens,

and for pressing the IRED legs to the circuit board to obtain a good contact. Soldering is then optionally avoided for the IRED attachment and the metalized holes usually required for a through hole footprint are also not needed. This frees space on the opposite side of the circuit board for positioning the video processor (*e.g.*, a DSP).

According to another embodiment of the presenting invention, the various components can be integrated independently from a single, non-adjustable circuit board. For instance, a flex board can be used to provide different angles for the IREDs, camera and motion detector. Another such implementation may incorporate flexible/angled interconnects, such as ribbon cable or angled connecters, to integrate the components and circuit board(s) upon which the components reside. These and other embodiments include the use of a power control circuit that is used in conjunction with a battery circuit. The power control circuit responds to various control signals by reducing the power consumption of the device. This is particularly useful for implementing a self-powered device that operates for extended periods of time without replacing, recharging or otherwise supplementing power to the device.

In one instance, the power control circuit receives control signals from the central controller. In response to the control signals the power control circuit can implement any one of a number of different power saving techniques. One such technique involves placing the device in reduced power state by disabling or otherwise reducing power consumption by one or more of the motion detector, camera and IREDs. Thus, the power control circuit can maintain the reduced power state until a control signal is received that prompts the device to leave the reduced power state. Such a control signal can be from the central controller or from other sources, such as a keyfob or an intrusion sensor. Additional logic can further control the various power states. For instance, the motion detector can be activated in response to a control signal, while keeping the camera disabled until motion is detected. This can also reduce the intrusiveness of the security system by minimizing the time during which images are captured. In another power reduction state, the image captures can be reduced in frequency. For example, instead of capturing an image every second, the device could be configured to capture and/or transmit an image every minute. This can significantly reduce the average power consumption over a period of time.

In another instance, the power control circuit controls the transmission of images from the camera to the central controller. Wireless transmission circuitry can require a significant amount of power to operate. Thus, the transmission of large amounts of data

may require extensive periods of transmission activity and corresponding power draw. One technique employed by the device is performed by compression logic that reduces the size of the image data to be transferred. Another technique involves logic to limit the transmitted data to necessary images. For instance, the device may be enabled to capture images when a door or window sensor is triggered; however, the captured images need not be sent if a correct authorization code is provided by the person triggering the sensor. Various other logic implementations can be used to reduce unnecessary transmissions of captured images. Yet another technique involves the use of efficient handshake protocols between the devices. Many communication protocols require one or more of the devices to have extended periods of listening or sending in order to synchronize communications between devices. An efficient handshaking protocol can be used to reduce the synchronization times leading to significant power savings. For further details of one such protocol, reference can be made to U.S. application serial no. 11/389,673 filed on March 24, 2006, entitled "Spread Spectrum Communications for Building-Security" (Attorney Docket No. RSIA.010PA), which is fully incorporated herein by reference.

In other embodiments, the motion-image security device may be used to capture images both in daylight and using night vision technology. In environments with sufficient light, the image sensor may capture images in color. In addition, the image-capture device includes a camera that can also obtain black and white pictures in low-light environments such as at night using an infrared illuminator. This can be achieved with a black and white image sensor since color image sensors integrate a filter, which rejects the IR wavelength in order to keep the color fidelity. In certain implementations, a color image sensor is used with specific color filters. FIG. 6 shows a graph of filter responses (illustrated by lines representing green 604, red 602 and blue 606 colors), according to an example embodiment of the present invention. The illustrated filters' responses show that in the IR wavelength, the sensitivity of each color is balanced, and is close to the sensitivity in the visible spectrum. This allows night vision with the IRED illuminators where the color signal is ignored, and only the luminescence signal is used to obtain black and white pictures.

Another embodiment allows for multiple image-capture possibilities in daylight environments. If the level of IR light is low (*e.g.*, indoor light with fluorescent bulbs), the color fidelity will be good because the response to each color will not be overly effected by IR light and the camera can capture color images. If the level of IR is high (*e.g.*, incandescent bulbs or direct sun exposure), the color fidelity of the image sensor may be adversely effected by the IR light, and the camera can deliver black and white images. In

still other embodiments, all image acquisition operates using the color signals while a remote monitoring station (*e.g.*, PC) determines if the black and white or color images will be displayed.

In certain implementations, the image-capture device is initialized with multiple operating modes. For example, in an auto mode, once the image-capture device is armed, the device will begin video image acquisition as soon as the motion detector detects motion. In another example, in a control panel mode the motion-image security device sends an intrusion notification to the control panel and waits for a video acquisition command from the panel. The video acquisition and video transfer to the control panel are two independent actions. This allows the image-capture device to obtain video images within a delayed zone, before the system is disarmed. If the disarming is done before the end of a delay, the video will be erased; otherwise the control panel will request the video data and send the video data to a remote monitoring station.

In certain instances, a video transfer requires several times more power than video acquisition. The image-capture device is able to transfer video data at a request of the control panel through a radio channel. The control panel can also request video erasing in memory. Since video data transfer can take more than two minutes, during the transfer time, a destruction of the image-capture device will result in the loss of the remaining video stored in RAM memory. A non volatile memory (*e.g.*, Flash type) may be used to duplicate the video data immediately after the acquisition or during it. The small size of the Flash chip (*e.g.*, SO8) makes it difficult to break, and thus, increases the likelihood of the video data being recovered in case of the device being damaged by an intruder.

The various circuits and logic describe herein can be implemented using a variety of devices including, but not limited to, discrete logic components, analog components, general purpose processors configured to execute software instructions, programmable logic devices and combinations thereof.

While certain aspects of the present invention have been described with reference to several particular example embodiments, those skilled in the art will recognize that many changes may be made thereto without departing from the spirit and scope of the present invention. Aspects of the invention are set forth in the following claims.

What is claimed is:

1. For use in a security system that uses a controller to communicate with security-monitoring devices, an integrated image-capture device comprising:

a circuit board structure having

an angle-setting support article,

a circuit board with a nonadjustable surface, and

electrical conductors;

an integrated arrangement including a camera secured to the nonadjustable surface and directed at a first angle relative to the nonadjustable surface, and including a motion detector secured to the nonadjustable surface and differently directed at a second angle relative to the nonadjustable surface of the circuit board, the support article setting the first angle relative to the second angle for capturing both images and motion in a target area, and the camera and the motion detector electrically connected to respective ones of the electrical conductors; and

a control circuit for wireless communication between the controller and the integrated arrangement.

2. The device of claim 1, further including a battery circuit and a power-control circuit, responsive to the controller, for limiting consumption of power from the battery circuit.

3. The device of claim 1, wherein the device includes a housing that secures the circuit board and an independent power source, and that is adapted to direct the motion detector at an angle along a substantially horizontal plane and to direct the camera in a downwardly direction to cover an area beneath the substantially horizontal plane.

4. The device of claim 1, further comprising:

two infrared emitters integrated with the surface of the circuit board using one or more wired connections; and

two supports that direct one of the infrared emitters at an angle different from an angle of the other infrared emitter.

5. The device of claim 4, wherein the infrared emitters are directed away from one another, thereby increasing an angle of illumination from both emitters, relative to an angle of illumination for both emitters directed parallel to each other and wherein the infrared emitters are electrically connected to the circuit board using a screw that also physically connects a video processor to the circuit board.

6. The device of claim 4, wherein the infrared emitters are directed away from one another, thereby increasing an angle of illumination from both emitters, relative to an angle of illumination for both emitters directed parallel to each other and wherein the infrared emitters are connected to the circuit board using a screw

7. The device of claim 1, wherein the support that directs the motion detector includes strippable ribs for removal of the support.

8. The device of claim 1, wherein the circuit board includes an image processor and wherein the image processor and at least part of a communication circuit are located on a side of the circuit board opposite a side of the circuit board from which the motion detector and the image capture device are directed.

9. The device of claim 1, wherein the device includes a housing that holds the circuit board and that includes a cone shaped portion to reduce parasitic light from reaching the motion detector.

10. The device of claim 1, wherein the motion detector is a passive infrared detector.

11. The device of claim 1, wherein the device is arranged to capture pictures in a black-and-white mode and a color mode.

12. The device of claim 9, wherein during low light conditions, the device operates in the black-and-white mode using light provided by infrared emitters located on the circuit board and wherein, during high light conditions, the device is selectable to operate in either the black-and-white mode or the color mode.

13. For use in a security system that uses a controller to with communicate security-monitoring devices, an image-capture device having a circuit board with a nonadjustable surface, the device comprising:

a circuit for wirelessly interfacing with the controller;

a camera secured to the nonadjustable surface of the circuit board and directed at a first angle substantially perpendicular to the surface of the circuit board;

a motion detector integrated with the nonadjustable surface of the circuit board using one or more through-hole connections; and

a support that directs the motion detector at a second angle different from said first angle during soldering of the through-hole connections.

14. For use in a security system that uses a controller to with communicate security-monitoring devices, an integrated image-capture device comprising:

a battery circuit;

a circuit for receiving wireless control signals;

a power-control circuit, responsive to reception of the wireless control signals, to control use of the battery circuit;

a camera;

a motion detector;

a circuit board structure to electrically integrate the camera and the motion detector, to set a first angle at which the camera is to capture images and to set a second angle, different from the first angle, at which the motion detector is to detect motion; and

logic for synchronizing transmission of data between the circuit for receiving wireless control signals and the controller.

15. The device of claim 14, wherein the device operates in a first power mode and a second power mode under the control of the power-control circuit and wherein the first power mode reduces power consumption of one or more of the camera, the motion detector and the circuit for receiving wireless control signals with respect to power consumption of said one or more of the camera, the motion detector and the circuit for receiving wireless control signals operating in the second power mode.

16. The device of claim 14, further including logic to compress image data captured by the camera.

17. The device of claim 14, further including a temporary memory for storing captured images and logic to select a portion of the stored captured images to be transmitted to the controller and a second portion of the stored captured images that is not transmitted to the controller.

18. The device of claim 14, wherein the synchronization logic identifies periodic times during which communication occurs between the image-capture device and the controller and wherein the power-control circuit disables the circuit for receiving wireless control signals during time not identified as the periodic times.

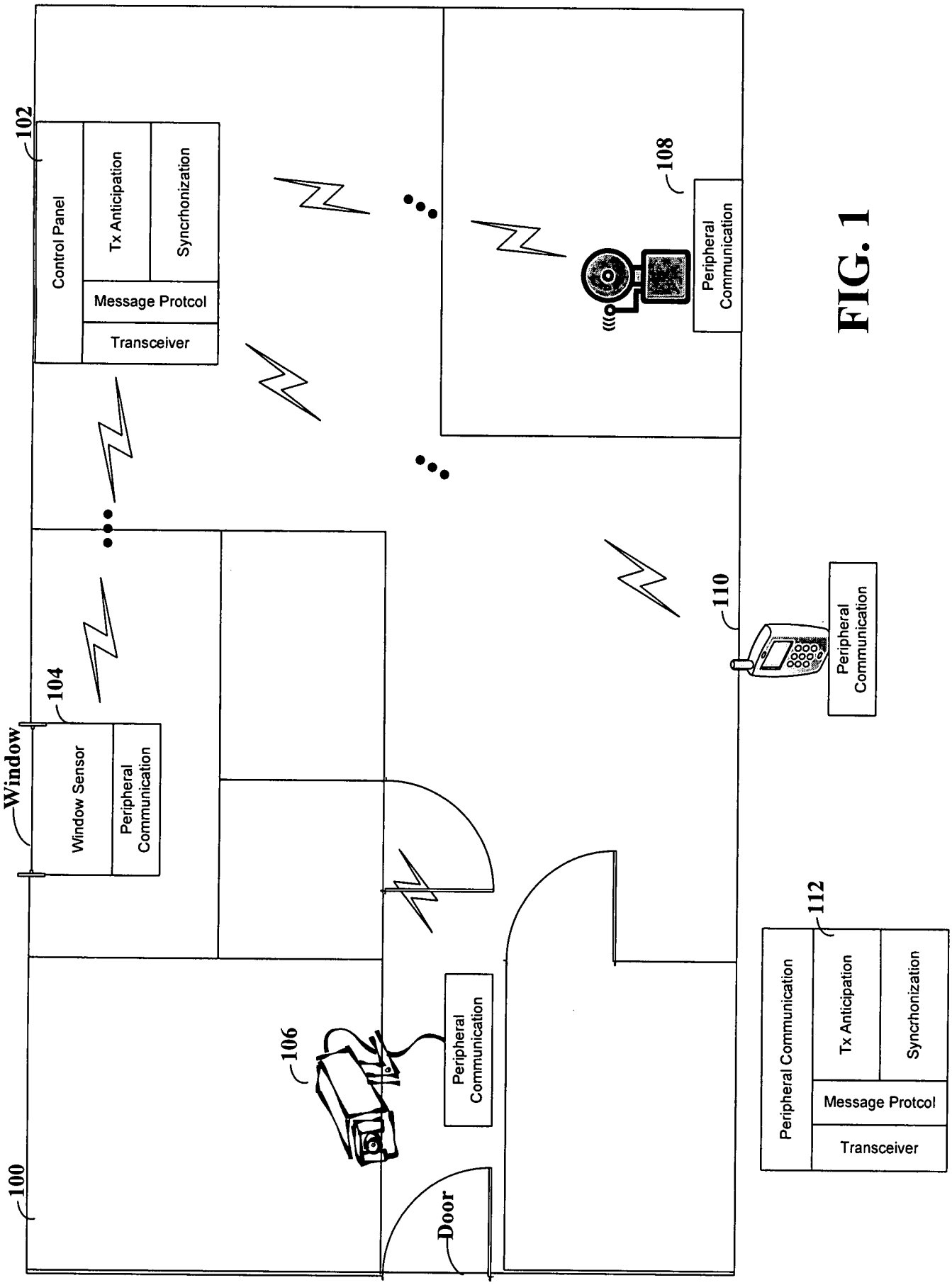

102
Control Panel
Tx Anticipation
Syncrhonization
Message Protcol
Transceiver
108
Peripheral Communication
Window
104
Window Sensor
Peripheral Communication
110
Peripheral Communication
112
Peripheral Communication
Tx Anticipation
Syncrhonization
Message Protcol
Transceiver
106
Peripheral Communication
100
Door

FIG. 1

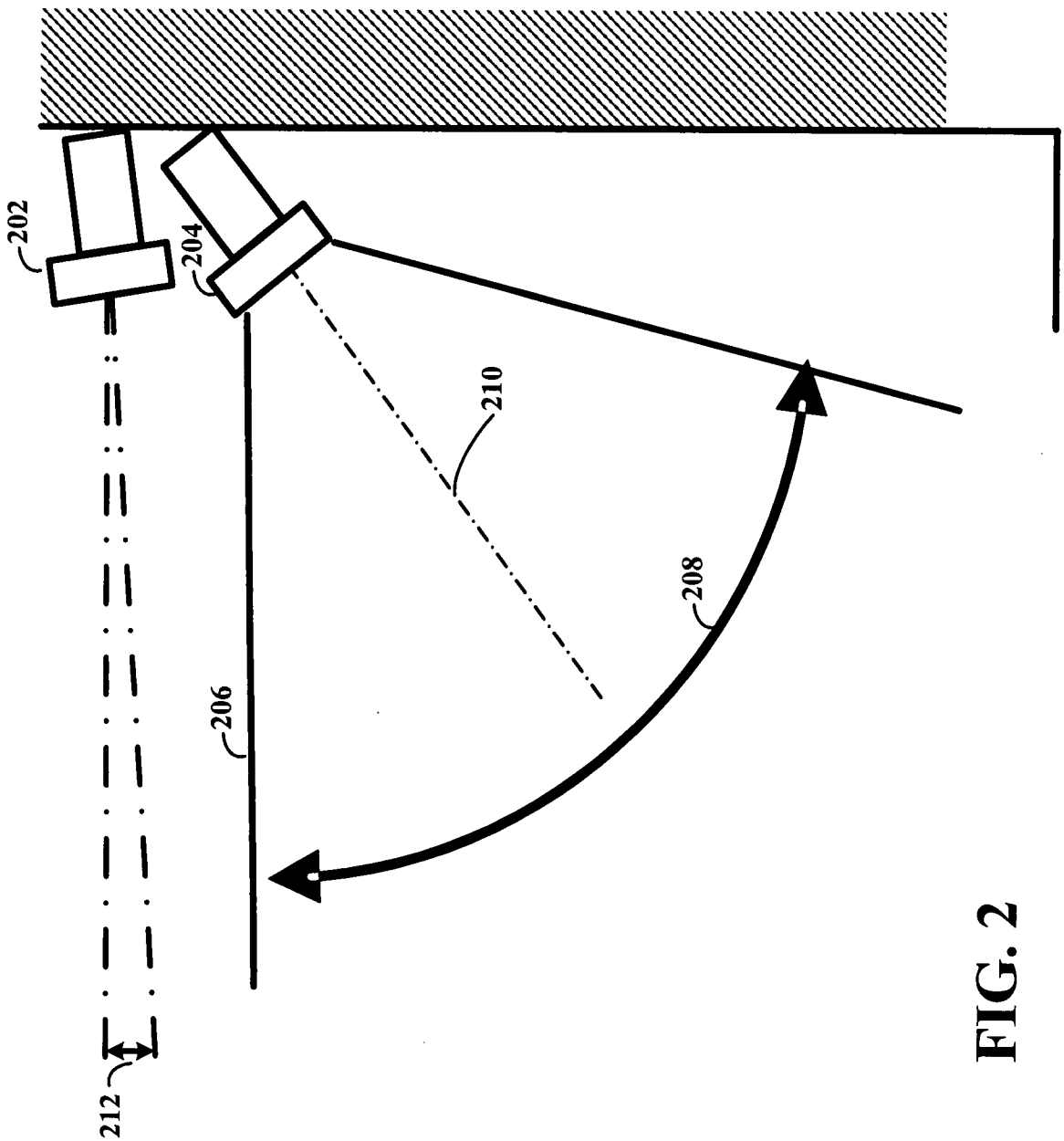


FIG. 2

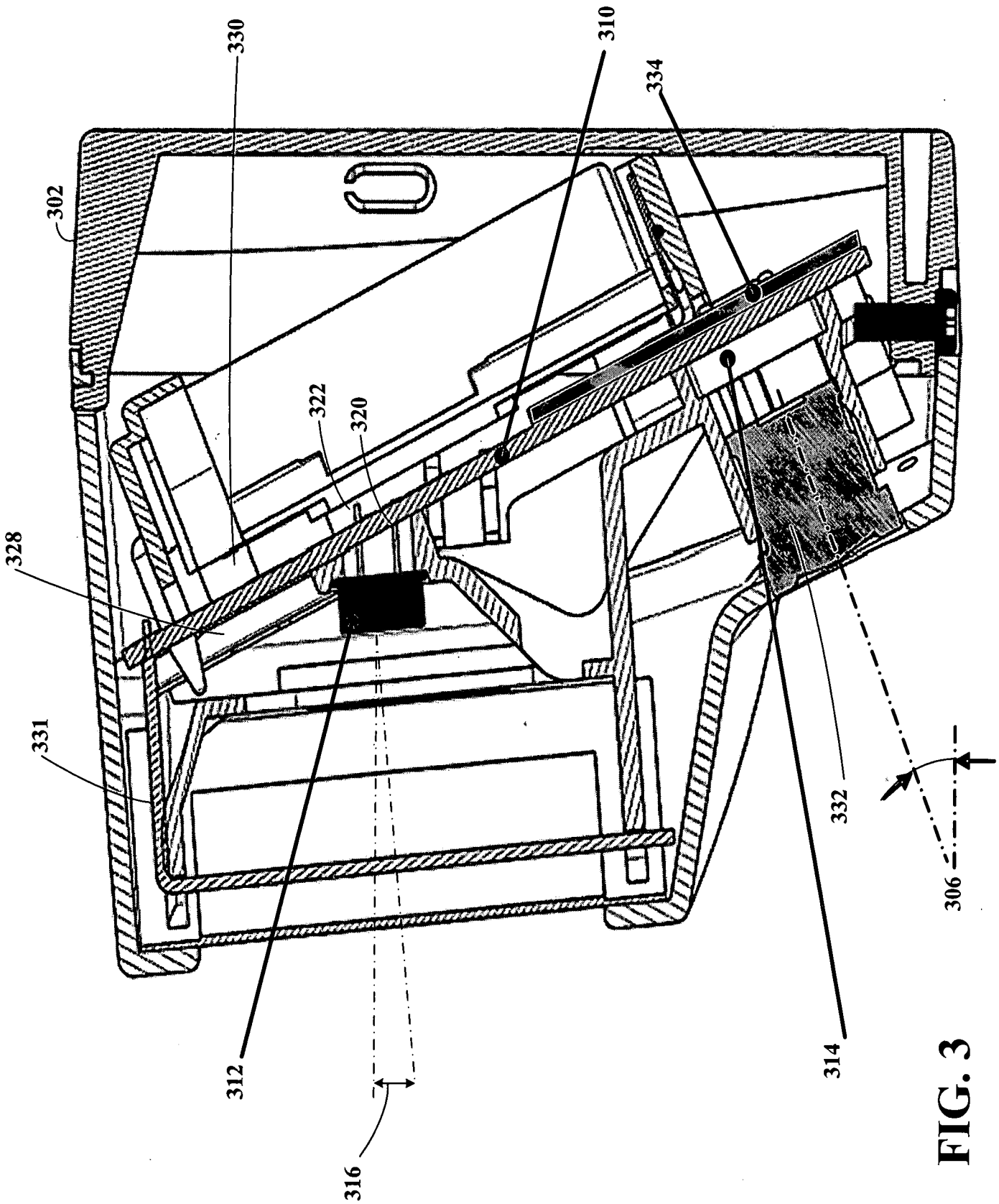


FIG. 3

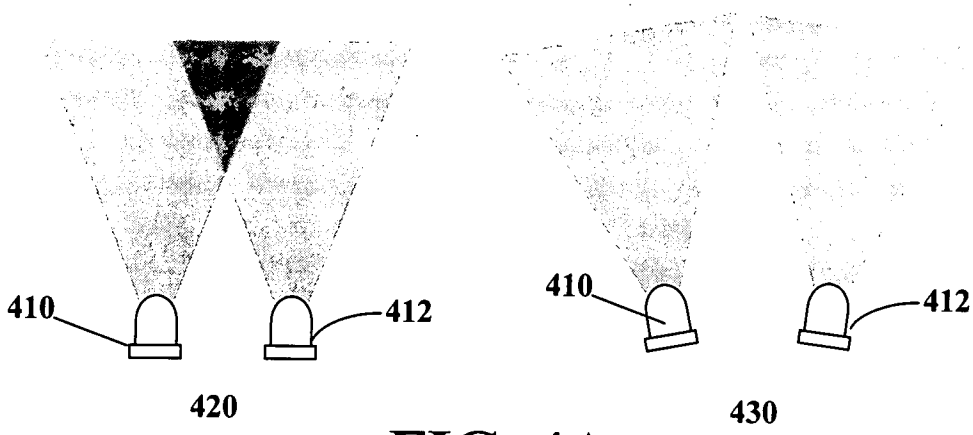


FIG. 4A

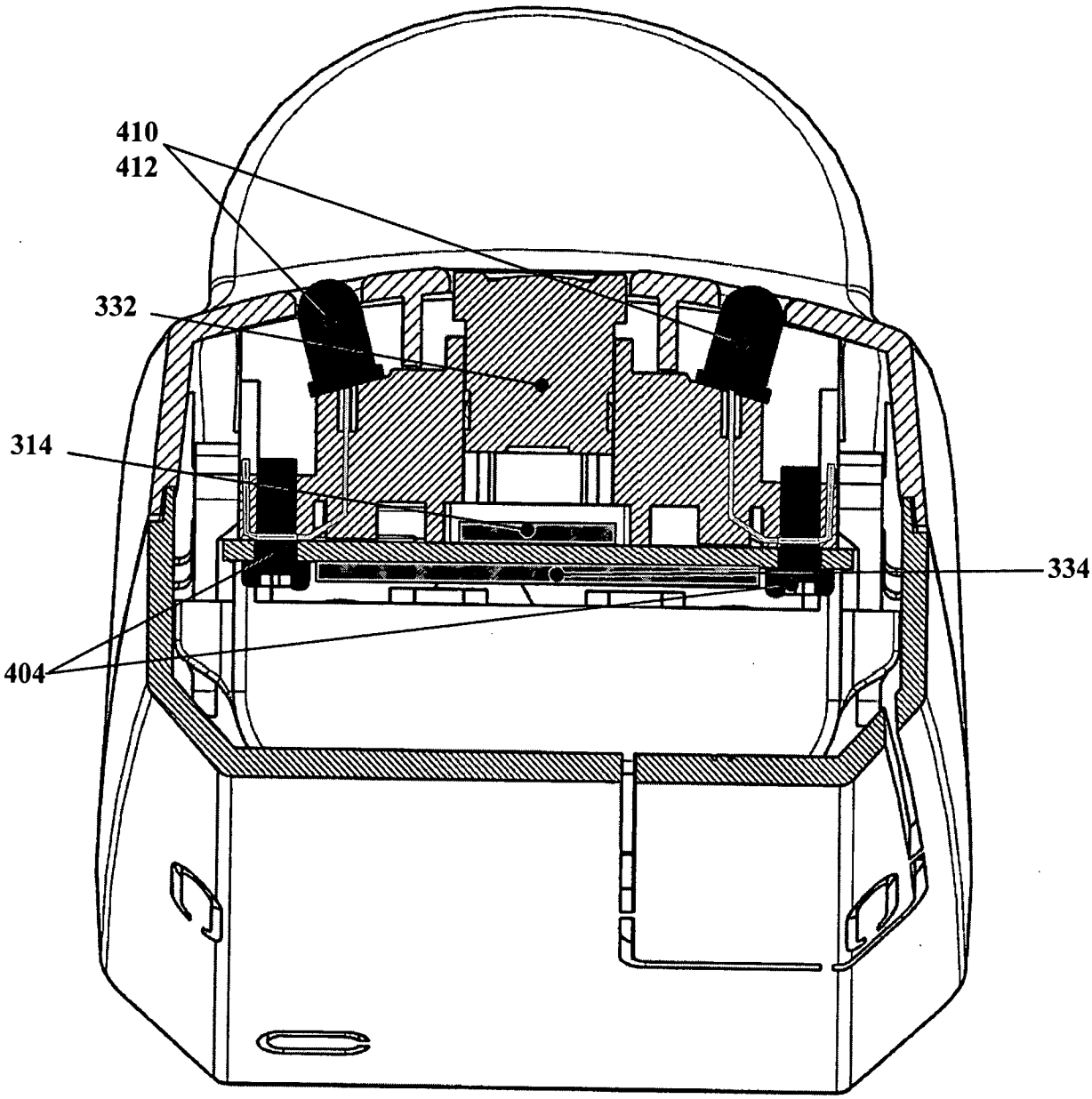


FIG. 4B

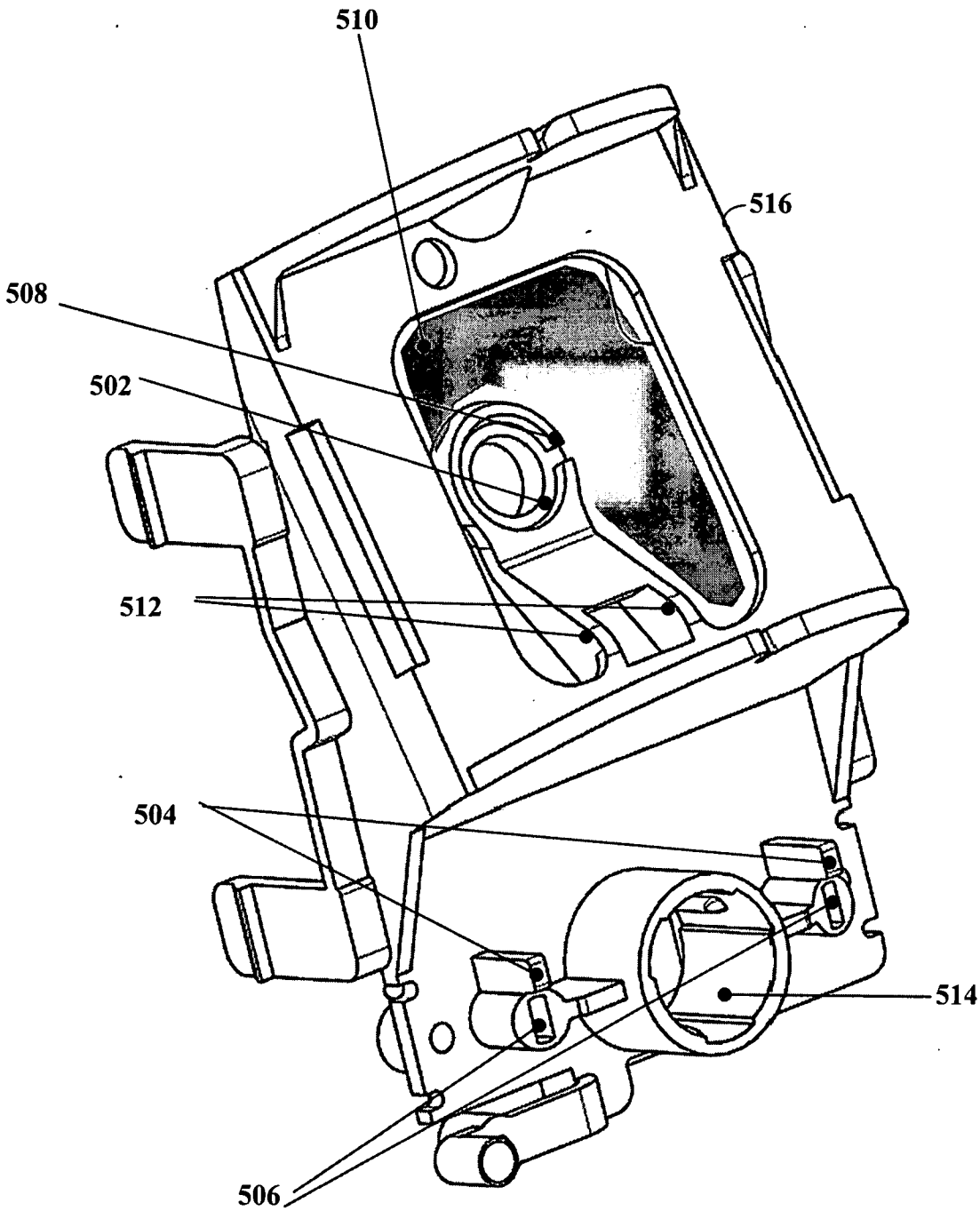


FIG. 5

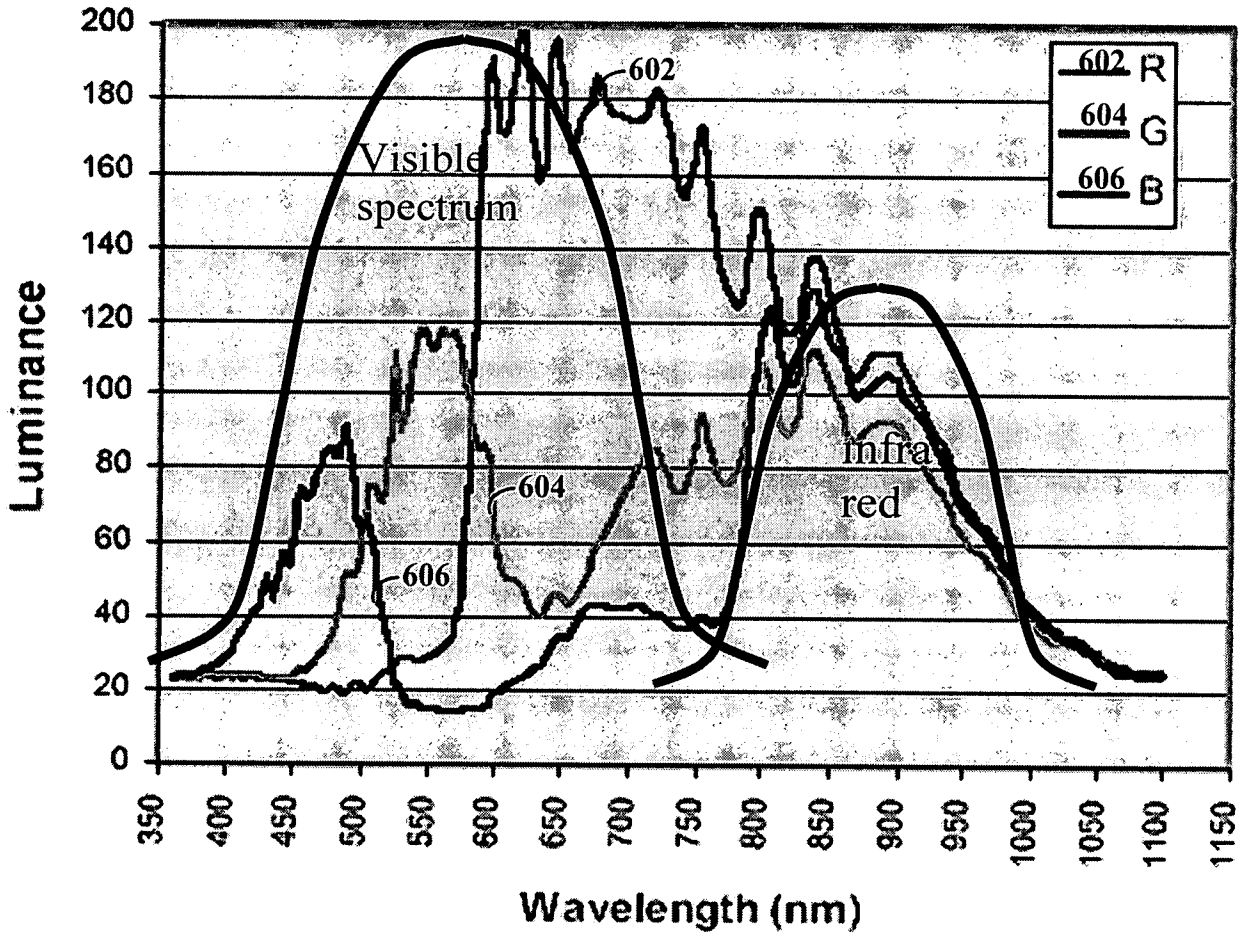

Luminance
200
180
160
140
120
100
80
60
40
20
0
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
1050
1100
1150
Wavelength (nm)
602
604
606
Visible spectrum
infra red
602 R
604 G
606 B

FIG. 6