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DESCRIPTION

Description

FIELD OF THE DISCLOSURE

[0001] The present invention relates in general to gypsum panels and, in particular, to a method for detecting and measuring drywall joints

BACKGROUND

[0002] Conventional joints between drywall or wall board panels include an intersection between panels. A joint also may include any materials applied at or adjacent to the intersection to increase its mechanical stability and to reduce the appearance of the intersection.

[0003] Interior residential and commercial drywall joints typically are completed at one of three different levels of quality or finish. For example, a "Level 3" finish, as is known to those of ordinary skill in the art, includes tape embedded in joint compound at all joints and interior angles, which are immediately wiped with a joint knife leaving a thin coating of joint compound over all joints and interior angles. One separate coat of joint compound is applied over all joints and interior angles. Fastener heads and accessories are covered with two separate coats of joint compound. The surface shall be smooth and free of tool marks and ridges. A "Level 4" finish includes everything in a Level 3 finish, however an additional separate coat of joint compound is applied over all flat joints and one separate coat of joint compound is applied over Interior angles. Fastener heads and accessories are covered with three separate coats of joint compound. At the highest level of quality, a "Level 5" finish includes everything in a Level 4 finish. In addition, a thin skim coat of joint compound or a material manufactured especially for this purpose, is applied to the entire surface. US 2016/221174 A1 relates to a multi-tool assembly including a handle which extends in a first direction between opposite ends and which presents an interior with a pocket.

[0004] Accordingly, conventional drywall levels of finish are merely prescriptive in nature. They substantially require only a list of steps to be completed, rather than being qualitatively or quantitatively defined. Although prescriptive definitions of drywall finishes are workable, more precise and accurate tools and methods of defining different levels of drywall finishes continue to be of interest.

SUMMARY

[0005] The present invention is defined in the claims. A method of preparing a surface is described in claim 1.

[0006] The foregoing and other objects and advantages will be apparent to those of ordinary skill in the art in view of the following detailed description, taken in conjunction with the appended claims and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] So that the manner in which the features and advantages of the embodiments are attained and can be understood in more detail, a more particular description may be had by reference to the embodiments thereof that are illustrated in the appended drawings. However, the drawings illustrate only some embodiments and therefore are not to be considered limiting in scope as there may be other equally effective embodiments.

FIG. 1 is a schematic front view of an embodiment of a laser system.

FIG. 2 is a schematic side view of the laser system of FIG. 1.

FIG. 3 is a side view of another embodiment of a laser system.

FIG. 4 is an enlarged, schematic side view of still another embodiment of a laser system.

FIG. 5 is a schematic side view of the laser system of FIG. 4.

FIG. 6 is a schematic front view of the laser system of FIG. 5.

FIG. 7 is a schematic side view of another embodiment of a laser system.

FIG. 8 is a schematic front view of the laser system of FIG. 7.

FIG. 9 is a schematic side view of another embodiment of a laser system.

FIG. 10 is a schematic front view of the laser system of FIG. 9.

FIGS. 11A, 11B and 11C are schematic side, top and isometric views, respectively, of another embodiment of a laser system.

FIG. 12 illustrates an exemplary portable device executing a plurality of exemplary applications.

[0008] The use of the same reference symbols in different drawings indicates similar or

identical items.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0009] Embodiments of a system, method and apparatus for drywall joint detection and measurement are disclosed. As will be described herein, the claimed invention can enable user visualization of something (e.g., a joint) that is difficult to see or not readily visible to become readily visible and, if desired, qualitatively and/or quantitatively evaluated.

[0010] A system for visually enhancing a geometry of a joint 103 (FIGS. 1 and 2) between panels 105 that form at least a portion of a wall 107 is disclosed. In an example, the system may include an assembly 101 configured to be positioned on a surface 109. The surface 109 may comprise a surface other than the wall 107 itself. The assembly 101 may be configured to project a laser line 111 across at least a portion of the wall 107 and the joint 103. Although a vertical wall is shown in the drawings, the wall 107 could be a horizontal wall, a ceiling, or an angled wall, such as a gabled wall or gabled ceiling. Accordingly, the laser line 111 can be horizontal and the system may be configured to visually enhance the geometry of a vertical joint. Alternatively, the laser line can be vertical and the system may be configured to visually enhance the geometry of a horizontal joint. In other versions, the joint may not be horizontal and nor vertical, and the laser line can still be perpendicular to the joint regardless of an orientation of the joint. The laser line 111 may be a continuous line or a discontinuous line, such as a dashed or dotted line.

[0011] While the assembly 101 is shown resting on a floor in FIGS. 1 and 2, the assembly 101 may be affixed to a tripod or other stand. Moreover, the assembly 101 may be mounted on, or otherwise hung from, a ceiling. In such an aspect, the assembly 101 may be mounted upside down and may project the laser line 111 in a downward direction away from the assembly 101. In another aspect, the assembly 101 can be mounted on a wheeled stand that a user, or finisher, can easily move as he or she moves along the wall to apply wall compound. Moreover, the assembly 101 can be mounted on a bracket, or clamp, that can be affixed to scaffolding, a ladder, a lift, or other similar device. The bracket, or clamp, can be magnetic or mechanical. In yet another aspect, the assembly 101 can be sufficiently small in size that it can be mounted to the finisher, e.g., to the belt of the finisher or on a helmet worn by the finisher.

[0012] Further, the laser line 111 may include multiple horizontal lines or multiple vertical lines. In the alternative, the laser line 111 may include a grid of horizontal lines and vertical lines. The grid lines may be spaced apart a predetermined distance - vertically and horizontally. For example, the grid lines may have a grid spacing that is greater than or equal to 15.24 cm (0.5 feet). In another aspect, the grid spacing may be greater than or equal to 30.48 cm (1.0 feet), such as greater than or equal to 45.72 cm (1.5 feet), greater than or equal to 60.96 cm (2.0 feet), greater than or equal to 76.2 cm (2.5 feet), greater than or equal to 91.44 (3.0 feet). In another aspect, the grid spacing may be less than or equal to 243.84 (8.0 feet). Further, the grid spacing may be less than or equal to 228.6 cm (7.5 feet), such as less than or equal to 213.36

cm (7.0 feet), less than or equal to 198.12 cm (6.5 feet), less than or equal to 182.88 cm (6.0 feet), less than or equal to 167.64 cm (5.5 feet), less than or equal to 152.4 cm (5.0 feet), less than or equal to 137.16 cm (4.5 feet), less than or equal to 121.92 cm (4.0 feet), or less than or equal to 106.68 cm (3.5 feet). It is to be understood that the grid spacing can be with a range between, and including, any of the minimum or maximum values for the grid spacing described herein.

[0013] In another aspect, the laser line 111 can include a single line that scans up and down or side to side. Further, the laser line 111 can include a plurality of lines that are concentrated at eye level to the user.

[0014] Although the system is illustrated with a single joint 103, the laser system also may be configured to simultaneously visually enhance geometries of a plurality of joints 103. Moreover, the system may be configured to simultaneously visually enhance a wall geometry of an entirety of the wall 107. Depending on the application, the assembly 101 may be configured to be positioned against the wall 107 or away from the wall 107. For example, the assembly 101 may be positioned at a distance away from the wall 107 in a range of, e.g., about 0 inches to about 1.2 m (48 inches).

[0015] Embodiments of the laser line 111 may include a length L, such as a prescribed length. For example, the length of the laser line 111 can be at least about 0.1 meters, such as at least about 0.25 meters, or even at least about 0.5 meters. In other versions, the length of laser line 111 can be not greater than about 10 meters, such as not greater than about 9 meters, not greater than about 8 meters, not greater than about 7 meters, not greater than about 6 meters, not greater than about 5 meters, not greater than about 4 meters, or even not greater than about 3 meters. Other versions of the length of laser line 111 can be in a range between any of these values.

[0016] In some versions, the assembly 101 may emit the laser line 111 at a fan angle 112 (FIG. 1). For example, the fan angle 112 can be at least about 10 degrees, such as at least about 20 degrees, or even at least about 30 degrees. In other versions, the fan angle 112 can be not greater than about 160 degrees, such as not greater than about 150 degrees, or even not greater than about 140 degrees. Other versions of the fan angle 112 can be in a range between any of these values.

[0017] In some versions, the laser line 111 may be projected at an angle of incidence 113 (FIG. 2) relative to a plane defined by the wall 107. Embodiments of the angle of incidence 113 can be at least about 1 degree. In other versions, the angle of incidence 113 can be at least about 2 degrees, such as at least about 3 degrees, at least about 4 degrees, at least about 5 degrees, at least about 10 degrees, at least about 15 degrees, or even at least about 20 degrees. In other embodiments, the angle of incidence 113 can be not greater than about 60 degrees. In other examples, the angle of incidence 113 can be not greater than about 55 degrees, such as not greater than about 50 degrees, not greater than about 45 degrees, or even not greater than about 40 degrees. In still other embodiments, the angle of incidence 113

can be in a range between any of these values.

[0018] In some versions, the laser line 111 can be substantially perpendicular to the joint 103. Embodiments of the laser line 111 may enable enhanced, qualitative user visualization of the joint 103, and non-planar distortion in the joint 103 relative to the plane defined by a nominal surface of the wall 107. Versions of the laser line 111 may enable visualization of distortion as a slope of the joint 103. For example, the slope may be defined as a maximum dimension D (shown exaggerated in FIG. 3; e.g., a protrusion or a recession) of the joint 103 that is perpendicular to the plane defined by the wall 107, divided by half of a maximum width W (FIG. 1) of the joint 103 that is parallel to the plane and perpendicular to an intersection between the panels 105. In one example, the slope can be not less than about 0.00001. In another example, that distortion (e.g., the maximum dimension D) can be as small as 0.1 mm from the plane defined by the wall 107.

[0019] In some versions, the assembly 101 also may include leveling means 115 (FIG. 3). The leveling means 115 may be configured to enable a user to manual level (e.g., with respect to gravity or vertical) the assembly 101. For example, the leveling means 115 comprises elevation screws. In other versions, the assembly 101 may be configured to be self-leveling. In some examples, a laser 117 (FIG. 4) of the assembly 101 may be mounted to a pendulum 119. The pendulum 119 may include one, two or three degrees of freedom. Versions of the pendulum 119 may include magnetic braking. An example of magnetic braking is depicted at: <http://video.mit.edu/watch/mit-physics-demo-pendulum-and-magnet-3078/>.

[0020] Embodiments of the assembly 101 may include a mirror 120 (FIG. 3). For example, mirror 120 may be configured to redirect the laser line 111 at the wall 107. In some versions, the mirror 120 may be oriented at an angle with respect to a mean plane of the wall 107. In some versions, the angle of the mirror 120 can be in a range of about 45 degrees to about 60 degrees.

[0021] As shown in FIGS. 11A-11C, embodiments of the assembly 101 also may include a wall alignment feature 121. The wall alignment feature 121 may be configured to set at least one of distance of the assembly 101 from the wall 107 and orientation of the assembly 101 relative to the wall 107. For example, the wall alignment feature 121 may include extensions configured to engage the wall 107. In some versions, the extensions may be configured to engage the wall 107 and set orientation by perpendicularly aligning the assembly 101 relative to the wall 107. In one embodiment, the extensions may comprise retractable rods.

[0022] As shown in FIG. 2, the system also may include a camera 131 and a computer 133 coupled to the camera 131. In some versions, the camera 131 and computer 133 may be combined in a single device, such as a smart phone.

[0023] In FIG. 12, an embodiment of a portable device 102 may include a wearable smart phone communications device (e.g., computer 133) that executes multiple applications. For example, portable device 133 executes a wireless communications application (e.g., telephony

application 104), a content delivery application 106 (e.g., camera 131), and other applications 108. Computer 133 may include a battery system 408, and a processor 410 configured to execute instructions stored in memory system 412. Portable device 102 may include subscriber identity module 414 and connectivity system 406 to facilitate wireless or wired communications consistent with one or more protocols for wide area networks. Such networks may include a satellite or terrestrial wide area network using, e.g., Long-Term Evolution (LTE), second-Generation (2G), third-Generation (3G), fourth-generation (4G), LTE-Advanced, LTE in unlicensed spectrum (LTE-U), Global System for Mobile Communications (GSM), Enhanced Data rates for GSM Evolution (EDGE), High Speed Packet Access (HSPA), Universal Mobile Telecommunications System (UMTS), and Worldwide Interoperability for Microwave Access (WiMax) wireless communications, or other wireless communications protocols, which use one or more of Code Division Multiple access (CDMA), Time Division Multiple Access (TDMA), Frequency Division Multiple Access (FDMA), Wideband CDMA (WCDMA), Orthogonal Frequency Division Multiple Access (OFDMA), or other suitable communications techniques), local area networks (e.g., Institute of Electrical and Electronics Engineers (IEEE) 802.11 standard-compliant networks), or other network protocols. Sensors 402 and display system 404 may be configured to communicate with a user, although other input and output devices (e.g., keyboard) may be included.

[0024] Examples of the computer 133 may be configured to quantify the geometry of the joint 103 based on a digital image from the camera 131. In some versions, the geometry may be quantified by expressing the non-planar distortion of the joint 103 along the laser line 111, and defining a width W (FIG. 1) of the joint 103 and a slope of edges of the joint 103.

[0025] Embodiments of the system may further comprise a reference guide. For example, the reference guide may be configured to be located on the wall 107 adjacent to the laser line 111. Alternatively, the reference guide may be a virtual reference guide that is simulated by the computer 131. Versions of the reference guide may include one or more of the following: an object configured to be physically mounted to the wall (e.g., ruler); a pre-defined image projected on the wall (e.g., fiducial marker); and a laser image projected on the wall. In one example, the laser image may be configured to be analyzed by a computer using a Hough transform to retrieve perspective information and/or line location.

[0026] The computer 133 may be configured to be coupled to the camera 131 and quantify the geometry of the wall 107 based on the digital images, parameters of the laser line 111, the reference guide and a distance between the camera 131 and the wall 107, such that a quality of the joint 103 is measured. Examples of the parameters of the laser line 111 may include length, non-linear distortion, etc. See, e.g., <https://www.picotronic.de/picopage/en/product/detail/code/70115369> for an example. The angle of camera 131 may be orthogonal to a mean plane of the wall 107.

[0027] As shown in FIGS. 4-6, the assembly 101 may include a plurality of lasers 117. Thus, in some examples, the laser image of the reference guide may include a plurality of laser images, such as at least 3 laser images. In the illustrated embodiment, the laser image comprises

additional laser lines 135. Some versions of the additional laser lines 135 may be parallel to each other. Optionally, the additional laser lines 135 may be configured to be substantially perpendicular to the joint 103. Alternatively, the assembly 101 may consist of only one laser 117.

[0028] As shown in FIGS. 7 and 8, the additional laser lines 135 may be at different angles with respect to the assembly 101. In an example, each of the additional laser lines 135 may be at an angle of separation relative to an adjacent laser line 135, and the angles of separation can be identical, as shown. In contrast, the additional laser lines 135 can be at a same angle with respect to the assembly 101, as shown in FIGS. 4 and 5.

[0029] FIGS. 9 and 10 depict an embodiment of the system wherein the laser image comprises a grid 141 of laser dots. In an example, the grid 141 of laser dots may comprise a wavelength of light that differs from that of the laser line 111. In some versions, horizontal and vertical distances between the laser dots may be configured to be calculated by the computer 133 (FIG. 2) based on the digital image from the camera 131.

[0030] In some embodiments of the system, the assembly 101 may be configured to not rotate about an axis perpendicular to the surface 109 on which the assembly 101 is positioned.

[0031] Embodiments of a method of assessing a geometry of a joint 103 between drywall panels 105 on a wall 107 also is disclosed. For example, the method may include projecting a laser image across the joint 103; positioning a reference guide (e.g., such as those described herein) on the wall 107 adjacent to the laser image; digitally imaging the laser image and the reference guide; and processing the digital images and quantifying the geometry of the joint 103 based on the digital images, parameters of the laser image and the reference guide, such that a quality of the joint 103 is determined.

[0032] In some versions, the projecting step may include projecting a plurality of laser images across the joint 103. Embodiments of the positioning step may include at least one of: physically mounting an object to the wall; projecting a pre-defined image projected on the wall; and projecting a laser image on the wall. In an example, the digitally imaging step may comprise using a camera 131, and the final step may include quantifying the geometry of the joint 103 further based on a distance between the camera 131 and the wall 107. Alternatively, a geometry of a plurality of joints, or a geometry of an entirety of the wall also may be quantified.

[0033] In another embodiment, a method of preparing a surface is disclosed. For example, the method may include constructing a wall 107 having panels 105 that engage at intersections; detecting a planarity and non-planarity of the intersections, and adjusting non-planar intersections into planar intersections (e.g., by moving the panels); applying material to the planar intersections to conceal the planar intersections and form joints; and then detecting a planarity and non-planarity of the joints, and adjusting non-planar joints into planar joints.

[0034] In some versions, the constructing step may include fastening the panels 105 to a frame to form the wall 107. The detecting steps may include visually enhancing a geometry of the intersections or joints by projecting a laser line 111 across the intersections or joints, the laser line is substantially perpendicular to the intersections or joints, and the laser line enables enhanced, qualitative user visualization of the intersections or joints and non-planar distortion in the intersections or joints relative to a plane defined by the wall 107. Versions of the applying material step and adjusting step may include at least one of taping, applying plaster or joint compound, wiping, washing, and wet or dry sanding the planar intersections.

[0035] It can be appreciated that the system for visually enhancing a geometry of a joint as described herein can be calibrated to various finishing tools, e.g., a drywall flat box or other drywall finishing box. The system can provide recommendations to the finishing tool if a problem is detected. For example, if a particular joint is underfilled, the system can instruct a finisher to set the finishing tool to "4" and re-coat the joint. In another example, if one side of a particular joint is low, the system can instruct the finisher to add compound to the low side of the joint. By inputting the type of finishing box being used, a type of joint compound being used, or a combination thereof, the system will be able to provide instructions to a particular finishing tool based on the type of finishing tool being used and based on the type of joint compound being used.

[0036] It can be appreciated that the system described herein can also be used to check the flatness of other objects. For example, the system can be used to check the forward alignment of the front faces of adjacent studs. Further, the system can be used to check the flatness of drywall prior to coating the drywall with compound. In another aspect, the system can be used to check the level of insulation fill, i.e., whether sprayed or blown-in insulation completely fills the volume between adjacent studs up to the faces of the studs. In still another aspect, the system can be used to check the flatness or straightness of two surfaces that meet at a corner and check that the corner has a consistent angle along the length of the corner. For any of the uses described herein, the system can provide a visual check and quantify whether the visual check passes or fails a predetermined threshold selected by a user.

REFERENCES CITED IN THE DESCRIPTION

Cited references

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Patent documents cited in the description

- US2016221174A1 [0003]

PATENTKRAV

1. Fremgangsmåde til fremstilling af en overflade, hvilken fremgangsmåde omfatter:

(a) konstruktion af en væg med paneler, der går i indgreb med hinanden i skæringspunkter;

(b) påføring af materiale på de plane skæringspunkter med henblik på at skjule de plane skæringspunkter og danne fuger; og derefter

(c) detektering af en planhed og ikke-planhed af fugerne og tilpasning af ikke-plane fuger til plane fuger,

10 hvor trin (c) omfatter visuel forstærkning af en geometri af fugerne ved projicering af en laserlinje over fugerne, hvilket derved muliggør forstærket, kvalitativ brugervisualisering af fugerne og ikke-plan forvridning i fugerne i forhold til et plan, der defineres af væggen.

2. Fremgangsmåde ifølge krav 1, hvor trin (a) omfatter fastgørelse af panelerne til en ramme til dannelse af væggen.

3. Fremgangsmåde ifølge krav 1, hvor trin (b) omfatter:

visuel forstærkning af en geometri af skæringspunkterne ved projicering af en laserlinje over skæringspunkterne.

4. Fremgangsmåde ifølge krav 3, hvor laserlinjen i det væsentlige er vinkelret på skæringspunkterne.

5. Fremgangsmåde ifølge krav 4, hvor laserlinjen muliggør forstærket, kvalitativ brugervisualisering af skæringspunkterne og ikke-plan forvridning i skæringspunkterne i forhold til et plan, der defineres af væggen.

6. Fremgangsmåde ifølge krav 1, hvor tilpasning af ikke-plane skæringspunkter til plane skæringspunkter i trin (b) omfatter bevægelse af panelerne.

7. Fremgangsmåde ifølge krav 1, hvor trin (b) omfatter:

- (1) projicering af et laserbillede over skæringspunkterne;
 - (2) positionering eller simulering af et referencestyreelement på væggen, der støder op til laserbilledet;
 - (3) digital billeddannelse af laserbilledet og referencestyreelementet; og
 - 5 (4) behandling af de digitale billeder og kvantificering af skæringspunkternes geometri baseret på de digitale billeder, parametre for laserbilledet og referencestyreelementet, således at en kvalitet af skæringspunkterne bestemmes.
8. Fremgangsmåde ifølge krav 1, hvor panelerne er tørvægspaneler.
9. Fremgangsmåde ifølge krav 8, hvor trin (b) omfatter mindst én af
- 10 tilklæbning, påføring af puds eller spartelmasse, aftørring, afvaskning og våd- eller tørslibning af de plane skæringspunkter.
10. Fremgangsmåde ifølge krav 1, hvor laserlinjen i det væsentlige er vinkelret på fugerne.
11. Fremgangsmåde ifølge krav 1, hvor trin (c) omfatter:
- 15 (1) projicering af et laserbillede over fugerne;
- (2) positionering eller simulering af et referencestyreelement på væggen, der støder op til laserbilledet; og
- (3) digital billeddannelse af laserbilledet og referencestyreelementet.
12. Fremgangsmåde ifølge krav 10, hvor trin (c) yderligere omfatter
- 20 behandling af de digitale billeder og kvantificering af fugernes geometri baseret på de digitale billeder, parametre for laserbilledet og referencestyreelementet, således at en kvalitet af fugerne bestemmes.

DRAWINGS

Drawing

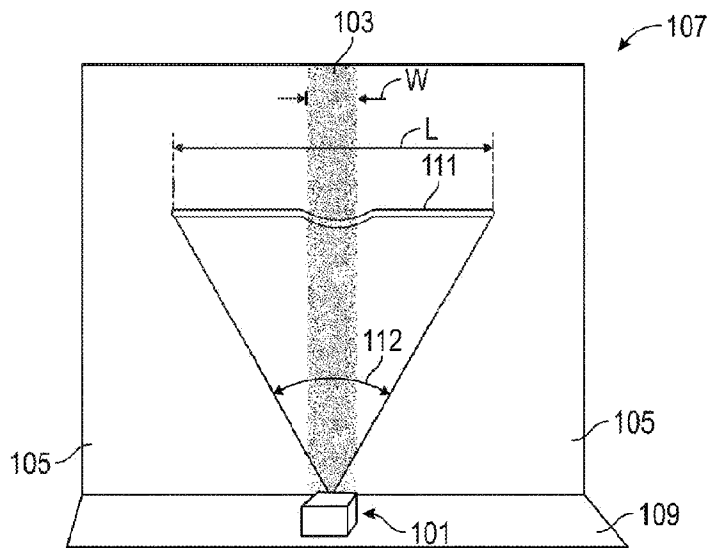


FIG. 1

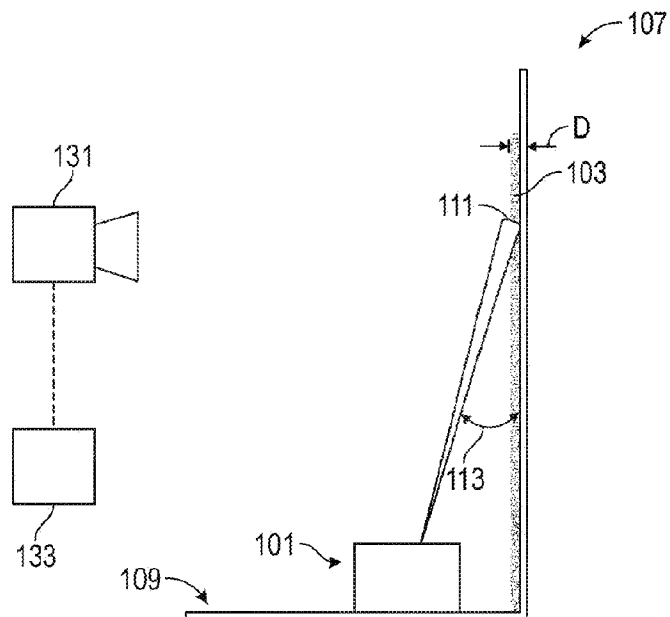


FIG. 2

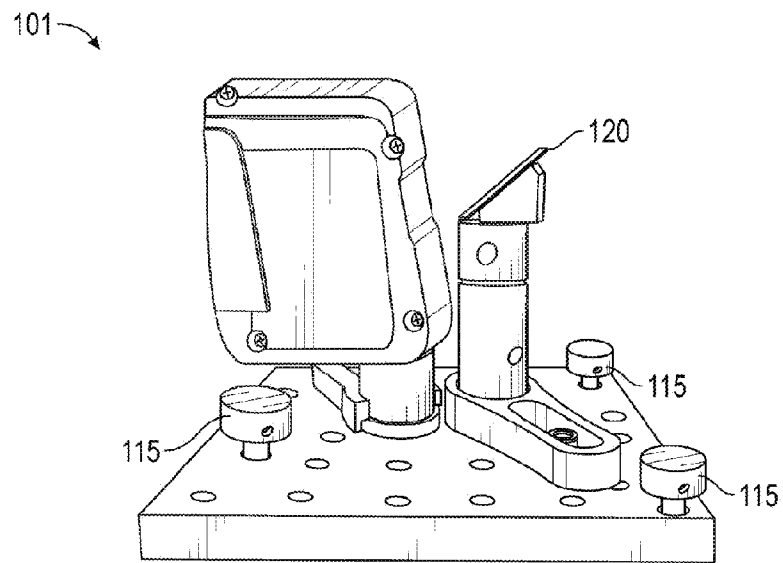


FIG. 3

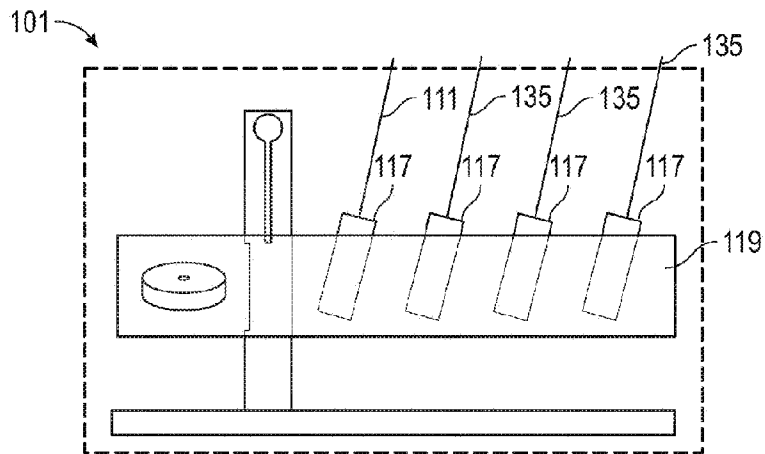


FIG. 4

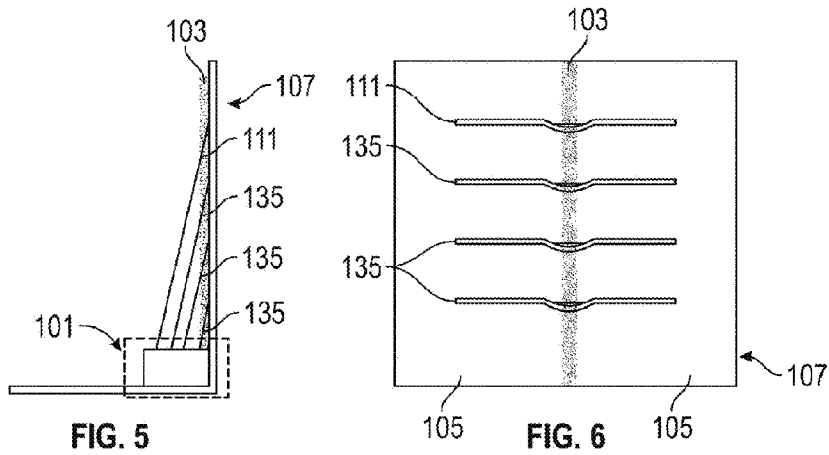


FIG. 5

FIG. 6

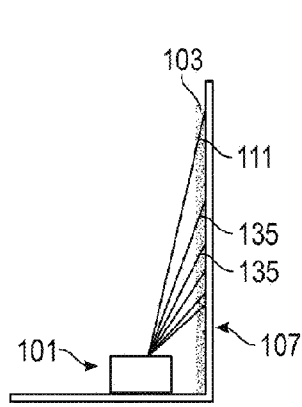


FIG. 7

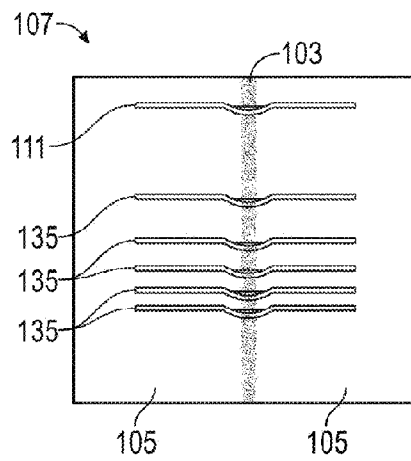


FIG. 8

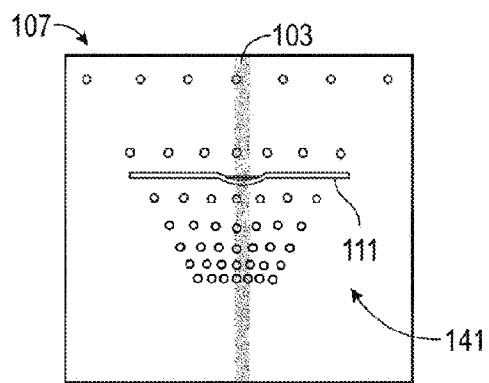


FIG. 9

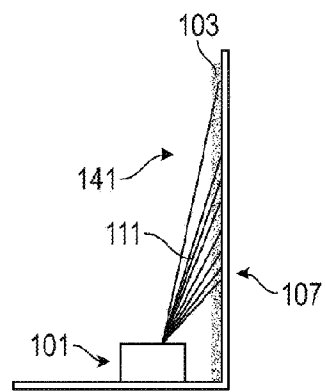


FIG. 10

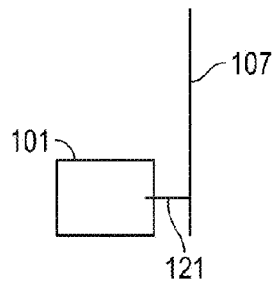


FIG. 11A

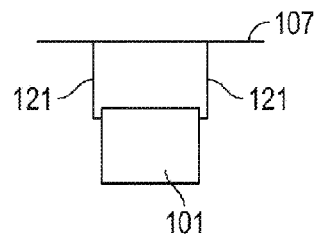


FIG. 11B

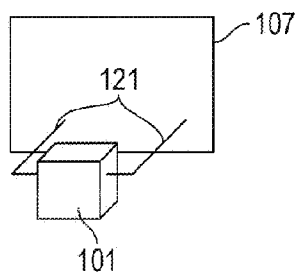


FIG. 11C

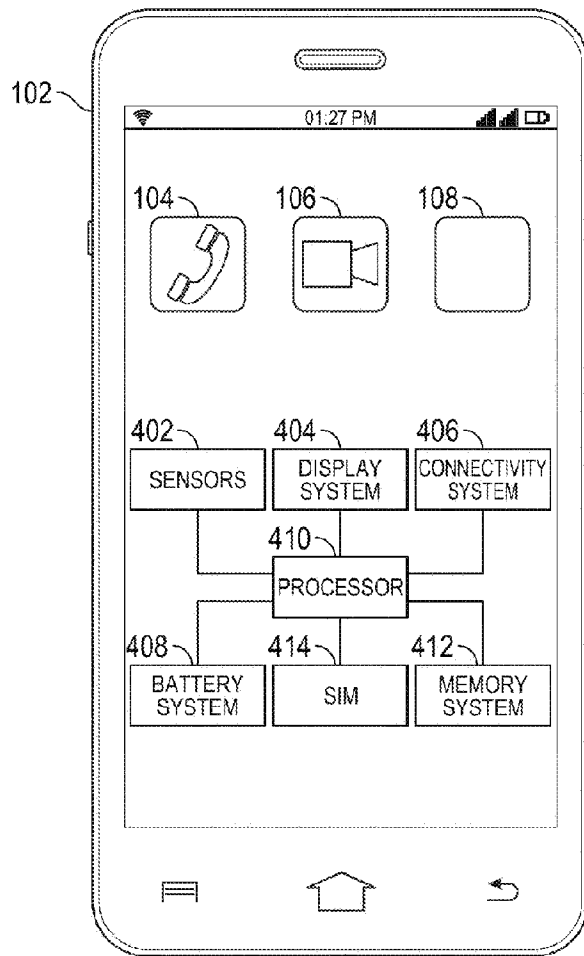


FIG. 12