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(71) Applicant *(for all designated States except US)*: **BLACK AND DECKER** [US/US]; 1207 DRUMMOND PLAZA, Newark, DE 19711 (US).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **MILLIGAN, Michael, A.** [CA/CA]; 125 Thousand Islands Parkway, RR#2, Gananoque, Ontario K7G 2V4 (CA). **KIMBALL, Ted, Andrew** [CA/CA]; 3070 Porter Road, Oxford Station, Ontario K0G 1T0 (CA). **SLOBODIAN, Mark** [CA/CA]; 82 Homestead Street, Ottawa, Ontario K2E 7N6 (CA). **SERGYEYENKO, Oleksiy, P.** [CA/CA]; 376 Brock Street, Brockville, Ontario K6G 6K6 (CA). **HOBDEN, Robert, J., B.** [CA/CA]; 346 1/2 Princess Street, Apt #5, Kingston, Ontario K7L 1B6 (CA).

(74) Agents: **RICHMAN, Howard, R.** et al.; Edell, Shapiro & Finnan, LLC, 1901 Research Blvd., Suite 400, Rockville, MD 20850 (US).

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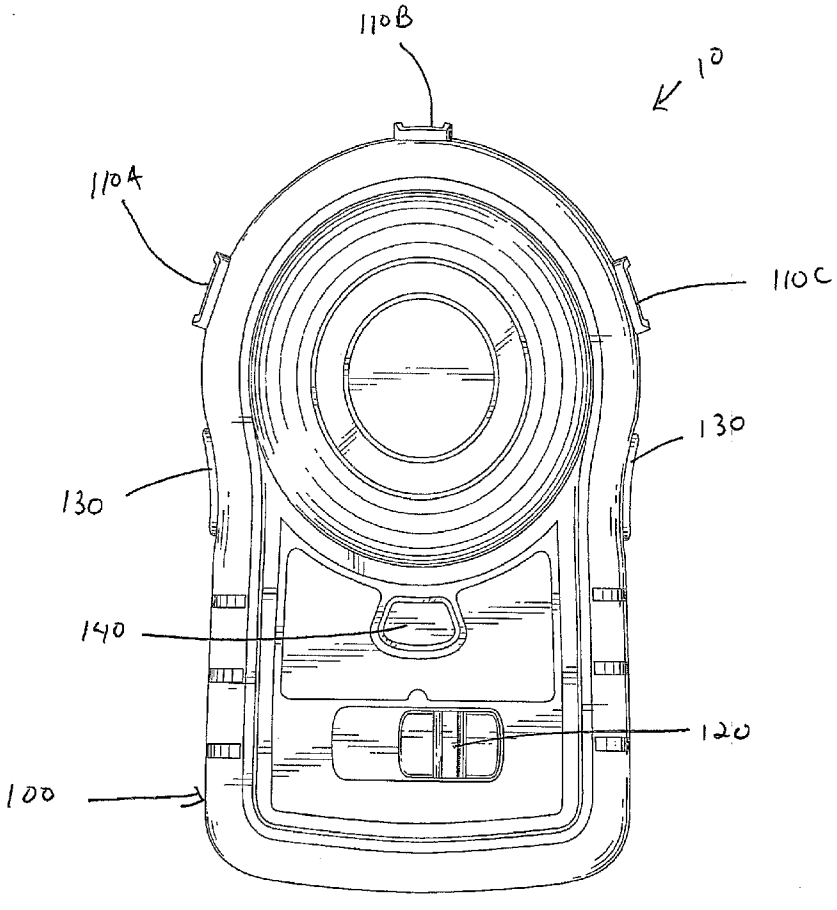
(54) Title: LIGHT LINE GENERATING DEVICE



(57) Abstract: A device that generates a light line on a work surface such as a wall is disclosed. The device includes a housing containing a self-leveling pendulum assembly and a light source that directs a light beam along a pathway. A redirection assembly, also contained in the housing, is capable of altering the pathway of the light beam prior to exiting the housing. The device may further include a measuring tool responsive to rotation of the housing on the work surface. In use, the device selectively generates a light line on the work surface in a desired direction.

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LIGHT LINE GENERATING DEVICE

CROSS REFERENCE TO RELATED APPLICATIONS

[001] This application is a continuation-in-part of co-pending U.S. Application No. 11/140,476, filed on 27 May 2005 and entitled "LASER LEVEL", which is a continuation of U.S. Patent Application No. 10/277,474, filed 22 October 2002 and entitled "LASER LEVEL", now U.S. Patent No. 6,914,930. This application also claims the benefit of a provisional Patent Application No. 60/736,818, filed on 15 November 2005 and entitled "LASER LEVEL". The disclosures of the aforementioned application and patent documents are incorporated herein by reference in their entireties.

FIELD OF THE INVENTION

[002] The present invention relates to a light line generating device and, in particular, to a self-leveling laser level including a redirection assembly operable to selectively direct a single source laser beam in a plurality of directions.

BACKGROUND OF THE INVENTION

[003] Alignment of surfaces is a common problem in a variety of fields, ranging from construction to interior decorating. Proper spatial alignment is necessary to ensure that walls are perpendicular to a floor, or otherwise plumb. Laser level devices are often used in construction to produce a plane of light that serves as a reference for various projects. Laser level devices save considerable time and effort during the initial layout of a construction project as compared to other tools such as beam levels, chalk lines, or torpedo levels. Some examples of projects where laser level devices are useful include laying tile, hanging drywall, mounting cabinets, installing counter tops, and building outdoor decks.

SUMMARY OF THE INVENTION

[004] A light line generating device in accordance with the present invention is disclosed herein. The light line generating device of the present invention may include a pendulum assembly and a light beam redirection assembly. The pendulum assembly may include a self-

leveling pendulum and a light source coupled to the pendulum. The pendulum assembly and light source may be configured to emit a light beam along a generally vertical pathway. The light beam redirection assembly may be capable of altering the travel path of a light beam emitted by the light source. Specifically, the redirection assembly may be selectively positioned to alter the travel path of the light beam to a desired direction (e.g., to a generally horizontal direction). The light line generating device may further include an internal protractor capable of automatically measuring the angular position of the device with respect to a normal or reference position/orientation.

BRIEF DESCRIPTION OF THE DRAWINGS

[005] FIG. 1A illustrates a front view a light line generating device according to an embodiment of the present invention.

[006] FIG. 1B illustrates a perspective view of the light line generating device of FIG. 1A.

[007] FIG. 2A illustrates an exploded view of the light line generating device of FIG. 1A, with the front housing portion removed for clarity.

[008] FIG. 2B illustrates a front perspective view of the light line generating device of FIG. 1A, with the front housing portion removed for clarity.

[009] FIGS. 3A – 3C illustrate internal views of the light line generating device of FIG. 1A, showing the operation of the pendulum lock mechanism.

[0010] FIG. 4A illustrates an exploded view of the light line generating device of FIG. 1A, with the rear housing portion removed for clarity.

[0011] FIG. 4B illustrates a rear perspective view of the light line generating device of FIG. 1A, with the rear housing portion removed for clarity.

[0012] FIGS. 5A – 5C illustrate internal views of the light line generating device of FIG. 1A, showing the operation of the light beam redirection assembly.

[0013] FIG. 6 illustrates a rear perspective view of the light line generating device of FIG. 1, showing the connection ring for a surface mount device.

[0014] FIG. 7 illustrates an isolated perspective view of a surface mounting device according to an embodiment of the present invention.

[0015] FIG. 8 illustrates the surface mounting device of FIG. 7 connected to the light line generating device of FIG. 6.

[0016] FIG. 9 is a side perspective view of a hand tool incorporating the light line generating device of FIG. 1A.

[0017] FIG. 10 is a close-up view of the light line generating device of FIG. 9.

[0018] Like reference numerals have been used to identify like elements throughout this disclosure.

DETAILED DESCRIPTION OF THE INVENTION

[0019] FIGS. 1A and 1B are front and perspective views, respectively, of a light line generating device according to an embodiment of the present invention. As shown, the light line generating device **10** may include a housing or shell **100** including one or more windows **110A-C** operable to permit the transmission of a light beam from the housing **100**. The term window not only includes an opening with a transparent or translucent covering, but also to uncovered apertures through which a beam of light may pass. The number, shape, and/or dimensions of a window **110A-C** are not particularly limited to that which is illustrated herein. When a plurality of windows **110A-C** is present, the windows may be angularly spaced about the housing **100** at any angle suitable for their described purpose. By way of specific example, as shown in FIG. 1A, the top portion of the housing **100** may include a first window **110A**, a second window **110B**, and a third window **110C** angularly spaced from each other. The angle between the windows may include, but is not limited to, approximately 45° - 90°. By way of example, the second window **110B** may be generally aligned with an axis extending vertically through the housing **100**, while the first window **110A** and/or the third window **110C** may be generally aligned with an axis extending horizontally through the housing.

[0020] The housing **100** may further include a first actuator **120**, a second actuator **130**, and viewing pane **140** (each discussed in greater detail below). The housing **100** may be formed as a unitary structure or may be formed from a front portion **150** and a rear portion **160** (best seen in FIG. 1B). The housing **100** may be formed from a hard, impact-resistant, preferably moldable material such as a hard thermoplastic material such as ABS or polystyrene. The housing **100** may also include a grip portion formed from soft or low durometer thermoplastic

elastomer adhered or overmolded to the housing **100**. Alternatively or additionally, the grip portion may be formed from "soft-touch" elastomer materials such as SANTOPRENE, KRATON, and MONOPRENE.

[0021] The light line generating device **10** may further contain a pendulum assembly. FIGS. 2A and 2B are front perspective views of the light line generating device **10** of FIGS. 1A and 1B, with the front housing portion **150** removed for clarity. As shown in the exploded view of FIG. **2A**, the pendulum assembly **200** may include a pendulum **205**, a light line generating unit or light source **210**, a damping mechanism **215**, a calibration mechanism **220**, and/or a bearing cap **225**. The pendulum **205** may be coupled to the rear housing portion **160** such that it freely pivots within the housing **100** (i.e., it may be pendulously suspended). By way of example, the pendulum **205** may pivotally couple to a post **230** extending from the interior surface of the rear housing portion **160**. A guide member **235** may be positioned above the post **230** to direct and/or limit the degree and/or direction of pivot in the pendulum **205**. By way of example, the pendulum **205** may swing about 12° (±6° from its normal (0°) position). One or more bearings (not shown) may optionally be provided between the pendulum **205** and the post **230** to allow for a more fluid and consistent motion. In addition, a bearing cap **225** may be secured to the guide member **235**, capturing the pendulum **205** to the rear housing portion **160** (best seen in FIG 2B).

[0022] In operation, the pendulum **205** is capable of swinging within the housing **100** about a pivot axis which is generally transverse to the light beam generated by the light source **210**, creating a self-leveling pendulum assembly **200** operable to create a substantially vertical (plumb) light line when the light line generating device **10** is placed against a generally vertical work surface such as a wall. The pendulum **205** may self-level even if the work surface is uneven, or even if the device **10** is placed against the work surface in a slightly tilted orientation.

[0023] The light source **210** may include a device operable to generate a light beam **LB** (see FIGS. 5A – 5C) such as a light plane or line. The light source **210** may be fixed to the pendulum **205**, proximate its upper end (i.e., closer to the redirection assembly **400** – described below). By way of example, the light source **210** may include, but is not limited to, a laser assembly including a barrel that houses a laser diode, a collimating lens, and a line lens (none illustrated). The collimating lens forms a laser beam exiting the laser diode into a beam having a generally oval cross-section. The line lens then converts the laser beam into

multiple, super-imposed planar beams (i.e., laser planes having different focal distances). Additional information regarding the configuration of the light source **210**, and in particular, an exemplary laser assembly, is disclosed in U.S. Published Patent Application No. 2006/0013278 (Raskin et al.), the disclosure of which is incorporated herein by reference in its entirety. A power source (not illustrated), connected to the light source **210**, may be controlled via a switch **265** in communication with the first actuator **120**.

[0024] In operation, the light source **210** generates the light beam **LB**, directing it along a pathway. In particular, the light beam **LB** may be directed along a generally vertical pathway, toward the redirection assembly **400** (i.e., the light source **210** is oriented to direct the light beam upward, along the longitudinal axis of the pendulum **205**, as discussed in greater detail below. The light beam **LB** travels out of the housing **100** (through a window **110A**, **110B**, **110C**) generating a light line onto a work surface such as a wall.

[0025] The damping mechanism **215** is capable of decreasing the amplitude of the pendulum **205**. The damping mechanism **215** may be any mechanism suitable for its described purpose (i.e., damping the motion of pendulum **205**). By way of example, the damping mechanism **215** may include curved bar **217** with a metal (e.g., copper) plate on its underside. The interior surface of the rear housing portion **160** (not illustrated) may include magnets configured to align with the metal plate on the curved bar **217**. The metal plate may be formed and positioned such that a precise gap is maintained at a predetermined width when the pendulum **205** is motion (i.e., as the pendulum swings about the post **230**). The interaction between the eddy currents in copper plate with the magnetic field of the magnets causes damping of swaying motion of pendulum **205**. Further information regarding the damping mechanism **215** may be found in U.S. Patent No. 5,144,487, the disclosure of which is incorporated herein by reference in its entirety.

[0026] The calibration mechanism **220** of the pendulum assembly **200** operates to calibrate the orientation of the pendulum **205**. By way of example, the calibration mechanism **220** may include a balance screw disposed proximate the base of the pendulum **205**. The calibration mechanism **220** may be utilized to adjust the pathway of the laser beam **LB** and, in particular, to allow the light source **210** to be angularly adjusted along a vertical plane relative to the housing **100**.

[0027] The light line generating device **10** of the present invention may further include a lock mechanism **240** configured to stabilize the pendulum **205**, preventing its pivotal motion. The

lock mechanism **240** may include a bar **245** with a tab **250** configured to engage a depression **255** formed in the bottom surface of the pendulum **205**. The bar **245**, pivotally coupled to a post **260**, may be spring biased upward such that, in its normal position, the tab **250** engages the depression **255** in the pendulum **205**, preventing its pivotal motion. The first actuator **120** may be engaged to selectively drive the bar **245** downward, disengaging the tab **250** from the depression **255** in the pendulum **205**. Once disengaged, the pendulum **205** is free to pivot/swing about the post **230**.

[0028] The operation of the pendulum assembly **200** and associated lock mechanism **240** is explained with reference to FIGS. 3A, 3B, and 3C, which illustrate front, internal views of the light line generating device **10** of FIG. 1A. Referring to FIG. 3A, the first actuator **120** (e.g., a slide actuator) begins in a first position, in which the bar **245** of the lock mechanism **240** positions the tab **250** within the depression **255** of the pendulum **205**. In this position, the pendulum **205** is secured, preventing its pivotal movement. This, in turn, generally immobilizes the light source **210**.

[0029] Engaging the first actuator **120** by applying a force (as indicated by arrow **F** in FIG. 3B) moves the first actuator **120** from its first position to a second position. In the second position (of FIG. 3B), the first actuator **120**, in communication with the switch **265**, activates the light source **210**, generating a light beam **LB**. In this position, the lock mechanism **240** is still engaged and the pendulum is immobilized.

[0030] Continuing to apply the force **F** moves the first actuator from the second position to a third position (FIG. 3C). In this third position, the first actuator **120** drives the bar **245** of the lock mechanism **240** downward, removing the tab **250** from the depression **255** of the pendulum **205**. As a result, the pendulum **205** is free to pivot about the post **230** within the housing **100** (indicated by arrow **S**), engaging the self leveling feature, where the light source **210** directs the light beam **LB** in a substantially vertical direction. Thus, the pendulum **205** may be unlocked with the light source **210** activated (shown in FIG. 3C) to get self-leveling (or self-adjusting) horizontal or vertical lines (as described below).

[0031] In this manner, a user may selectively activate the light source **210** and/or self-leveling feature of the light line generating device **10**. Selectively preventing the movement of the pendulum **205** relative to the housing **100** not only prevents damage to the pendulum **205** during storage and/or transport, but also enables a user to stabilize the light line generated on the work surface (i.e., it prevents the light line from self-leveling). As a result,

the housing **100** may be rotated manually to project a light line onto the work surface at an angle other than substantially horizontal and/or substantially vertical.

[0032] In another embodiment, the switch **265** may further be operatively connected to a light-emitting diode (LED) configured to illuminate the portion of the measuring tool **405** (FIG. 4A) viewable through the viewing pane **140** of the housing **100**. Specifically, the LED may be engaged while the first actuator **120** is in its second position (FIG. 3B), but not engaged when the first actuator **120** is in its first (FIG. 3A) and/or third (FIG. 3C) positions. With this configuration, the light line generating device **10** indicates when the measuring tool **405** may be properly utilized. Specifically, it may illuminate the measuring tool **405** when the pendulum **205** is locked and the light beam is stabilized (e.g., when the first actuator **120** is in the second position), but not illuminate the measuring tool when the pendulum **205** is unlocked and the light beam is self-leveling (e.g., when the first actuator **120** is in the third position).

[0033] In another embodiment of the present invention, the light line generating device **10** may include a shutter (not illustrated) disposed in front of the measuring tool **405** and behind the viewing pane **140**. The shield may be configured to open when the first actuator **120** is in its second position (FIG. 3B), indicating the pendulum **205** is locked and the measuring tool **405** may be utilized. The shutter, moreover, may be adapted to close, blocking the view of the measuring tool **405** through the viewing pane **140** when the actuator **120** is in its third position (FIG. 3C), preventing the user from utilizing the measuring tool **405** when the pendulum **205** is unlocked.

[0034] FIGS. 4A and 4B are rear perspective views of the light line generating device **10** of FIG. 1A, with the rear housing portion **160** removed for clarity. Referring to FIG. 4A, showing an exploded view, the light line generating device **10** may further include a redirection assembly **400** and a measuring tool **405**. The redirection assembly **400** includes a structure operable to selectively redirect the light beam **LB** generated by the light source **210** in a plurality of directions. For example, the redirection assembly **400** may be configured to direct the light beam **LB** from the light source **210** (having, e.g., a substantially vertical pathway) through the first window **110A**, the second window **110B**, or the third window **110C** of the housing **100**.

[0035] In the embodiment illustrated in FIGS. 4A and 4B, the redirection assembly **400** is a mirror assembly including a base or platform **415** with a first mirror **420** and a second mirror

425. The positioning of the mirrors **420**, **425** is not particularly limited to that illustrated herein, so long as the mirrors **420**, **425** are capable of redirecting the light beam **LB** by the desired angle (e.g., altering the path of the light beam (by 90° in the illustrated example)). The first mirror **420**, for example, may be spaced approximately 45° from the second mirror **425**, creating a gap **427** between the first mirror **420** and the second mirror **425**. In other words, each mirror **420**, **425** may be about 22.5° from a generally vertical line intersecting the gap **427** between the mirrors. This positions the mirrors **420**, **425** such that the light beam **LB** traveling from the light source **210** (e.g., along a substantially vertical pathway) may either reflect off the mirror pair **420**, **425** or pass through the gap **427** (discussed in greater detail below).

[0036] One or both mirrors **420**, **425** may further be associated with a calibration tool **430** (e.g., a spring biased screw) configured to angularly adjust the position of a mirror **420**, **425** on the platform **415** and/or the position of one mirror **420**, **425** with respect to the other mirror **420**, **425**. In the embodiment illustrated in FIGS. 4A and 4B, the second mirror **425** is fixed to the platform **415**, while the first mirror **420** is adjustable.

[0037] The redirection assembly **400** may be moveably coupled to the housing front portion **150**. Specifically, the redirection assembly **400** may be rotatably mounted on a post **P** extending from the interior surface of the housing front portion **150**. The redirection assembly **400** may be rotated about the post **P** to selectively orient the redirection assembly and, in turn, the relationship of the mirrors with respect to the light source **210**/light beam **LB**. The second actuator **130** may be utilized to drive the rotation of the redirection assembly **400** about the post **P** and, in turn, to selectively alter the travel path of the light beam **LB** generated by the light source **210** as it travels through the housing **100**. Specifically, the second actuator **130** may include a channel **435** that captures a post **440** extending from the platform **415** of the redirection assembly **400**. The second actuator **130** may be configured to slide transversely through the housing **100** (indicated by arrow A in FIG. 4B) such that, as it slides, it rotates the platform **415**, repositioning the mirrors **420**, **425**. Detents may be provided to indicate the desired rotational stopping points for the platform **415**.

[0038] Operation of the redirection assembly **400** of the light line generating device **10** in accordance with the present invention is explained with reference to FIGS. 5A, 5B, and 5C, which show front, internal views of the device **10** of FIG. 1A. As explained above, the light source **210** may be mounted on the pendulum **205** such that the light beam **LB** generated by

the light source **210** is directed toward the redirection assembly **400** (e.g., along a generally vertical travel path). Referring to FIG. 5A, the redirection assembly **400** may be oriented in a first position, in which the light beam **LB** may be redirected about -90° such that it is directed out of the first window **110A**. Specifically, the first mirror **420** is positioned within the travel path of the vertical light beam **LB**; consequently, the light beam reflects off the first mirror **420**, then off the second mirror **425**. This redirects the substantially vertical light beam **LB** to have a substantially horizontal travel path, exiting the housing **100** through the first window **110A**.

[0039] As explained above, engaging the second actuator **130** repositions the mirror assembly **400** with respect to the light source **210**. Referring to FIG. 5B, applying a force (indicated by arrow **F**) causes the second actuator **130** to slide to the right and to rotate the redirection assembly **400** (indicated by arrow **R**), moving it from the first position to a second position. The degree of rotation may include, but is not limited to, approximately 45°. In this second position, neither the first mirror **420** nor the second mirror **425** is positioned in the travel path of the light beam **LB**. As a result, the light beam **LB** may be permitted to maintain its generally vertical travel path, passing through the redirection assembly **400** (through the gap **427** between the mirrors **420**, **425**) and out through the second window **110B**.

[0040] Referring to FIG. 5C, continuing to apply the force **F** to the second actuator **130** continues the rotation (indicate by arrow **R**) of the redirection assembly **400** within the housing **100** (e.g., further rotating the redirection assembly approximately 45°) to orient the redirection assembly **400** in a third position. In this third position, the light beam **LB** may be redirected about 90° such that it is directed out of the third window **110C**. Specifically, the second mirror **425** is now positioned in the travel path of the vertical light beam **LB**; consequently, the light beam reflects off the second mirror **425**, then off the first mirror **420**. This redirects the substantially vertical light beam **LB** to have a substantially horizontal travel path, exiting the housing **100** through the third window **110C**. In order to return the redirection assembly **400** back to the first or second positions, an opposite force (not illustrated) may be applied to slide the second actuator **130**, rotating the redirection assembly in an opposite direction.

[0041] In this manner, a user may selectively orient the redirection assembly **400** to selectively control/direct the travel path of the light beam **LB** generated by the light source

210. This configuration permits a single light source **210** to generate a light line on a work surface in a plurality of different directions (e.g., horizontal left, vertical, horizontal right). Each light line generated on the work surface may be self-leveling due to the pendulum assembly **200**. Alternatively, the light line may be fixed with respect to the housing, enabling the user to adjust manually the light line by repositioning the housing **100**. This configuration enables a user to user to direct a light line in a desired direction, depending on the alignment needs of the work surface.

[0042] The measuring tool **405** (see FIGS. 4A and 4B) may be configured to respond to the rotation of the housing **100** on a work surface (e.g., a generally vertical work surface such as a wall). Specifically, the measuring tool **405** may be configured to measure the angle at which the light line generating device **10** has been rotated and/or offset from its normal (e.g., upright/plumb) position. For example, the measuring tool **405** may include a protractor and, particularly, a gravity responsive protractor. The gravity response protractor may be a 360° protractor adapted to freely rotate around a center axis **450**. The protractor may include a weighted area **410** including one or more weights positioned proximate the normal position of the protractor (and thus, of the light source **10**). The weighted area **410**, due to gravity, maintains a constant protractor position with respect to a plumb line (or the plumb direction) while the light line generating device **10** is rotated. For example, when the light line generating device **10** is rotated from its normal, upright/plumb orientation, the weighted area **410** is drawn back to normal, rotating the protractor around the axis **450**. Indicia (e.g., angle measurement marks) on the protractor may be viewed through the viewing pane **140** on the front housing portion. In this manner, the light line generating device **10** may automatically measure the angle of tilt of the device **10** (regardless of how far the housing **100** is rotated) and, as such, the angle from a projected reference line (light beam **LB**).

[0043] By way of further example, when the reference line (the light beam **LB**) is projected out of the second (vertical) window **110B**, a user may lock the pendulum **205** to stabilize the projected reference line (light beam **LB**). Rotating the light line generating device **10** automatically activates the protractor **405**, which allows a user to measure the angle between the projected light beam **LB** and the vertical plumb line (or the horizon). This measurement is then displayed through the viewing pane **140** of the housing **100**.

[0044] The light line generating device **10** of the present invention may further be adapted to mount onto a supporting or work surface, e.g., a generally vertical work surface such as a

wall. FIGS. 6 – 8 illustrate a work surface attachment mechanism in accordance with an embodiment of the present invention. In particular, FIG. 6 is a rear view of the light line generating device **10**, showing the rear housing portion **160**. FIG. 7 is an isolated, top perspective view of a surface mounting device **700** according to an embodiment of the invention. As illustrated, the rear housing portion **160** may include magnet **600** operable to slidably engage a connection ring **710** (e.g., a metal ring) located on the surface mounting device **700**. The surface mounting device **700** may include, but is not limited to, a generally circular disk. The surface mounting device **700** may include a fastener mount **720** configured to receive a fastener such as a screw. The fastener mount **720** may include an aperture **730** adapted to receive a fastener and a conical recess **740** designed to receive the head and shank of the fastener. With this configuration, any type of screw head that fits through the aperture **730** will "self center" on the conical recess **740** when tightened. In operation, once the surface mounting device **700** is placed in a desired position, a fastener is inserted into the aperture **730** and engages the work surface. The screw head is positioned within the conical recess **740**, supporting the surface mounting device **700** on the work surface. Alternatively or in addition to, the surface mounting device **700** may include a hole (not illustrated) operable to receive a pointed fastener (e.g., a pushpin, nail, tack, etc.) which would extend through hole to engage the work surface and secure the surface mounting device thereto.

[0045] In operation, the surface mounting device **700** may be mounted onto a work surface utilizing a fastener as explained above. The surface mounting device **700** may then be oriented such that the connection ring **710** faces outward, away from the work surface. The magnet **600** located in the rear housing portion **160** may then be aligned with the connection ring **710**, coupling the light line generating device **10** to the surface mounting device **700**. While coupled together, the light line generating device **10** may be rotated with respect to the surface mounting device **700**, as indicated by arrow **R** (if desired). That is, once connected, the light line generating device **10** may be selectively rotated about the connector **700** to any desired angular position including, but not limited to, 360° of rotation. Thus, the interaction between the magnet **600** and the connection ring **710** stabilizes the light line generating device **10**, holding it in place, while still allowing its rotation with respect to the work surface.

[0046] In addition to being a stand-alone device, the light line generating device **10** of the present invention may be integrated with hand tools such as a power drill. FIGS. 9 – 10

illustrate a light line generating device **10** in accordance with another embodiment of the invention. FIG. 9 is perspective view of a hand tool **900** including a light line generating device **910** in accordance with an embodiment of the present invention incorporated therein. As illustrated, the hand tool **900** may include a tool portion **905** (e.g., a drill), a light line generating device **910**, and a handle portion **920**. FIG. 10 illustrates a close-up view of the hand tool **900** of FIG. 9, showing the light line generating device **910** integrated into the hand tool **900** at the base **925** of the handle portion **920**. The light line generating device **910** may include a structure similar to that described above, including windows **110A**, **110B**, **110C**, a pendulum assembly **200** (with a light source **210**), and a redirection assembly **400**.

[0047] The light line generating device **910** may further include a first actuator **120** operable to supply power to the tool portion **905** and/or the light line generating device **910**. Power to the tool portion **905** and the light line generating device **910** may be provided via a power source (e.g., a battery) also stored in the base **925** of the handle portion **920**. The tool portion **905** and the light line generating device **910** may be powered via the same power source, or may have individual power sources. The light line generating device **910** may also include a second actuator **130** similar to that described above. Specifically, the second actuator **130** may be configured to selectively orient the redirection assembly **400** to direct a light beam **LB** through a desired window **110A**, **110B**, **110C**.

[0048] In operation, the light line generating device **910** is placed against a supporting or work surface such as a wall. Specifically, the bottom surface **930** of the base **925** may be placed against a generally vertical work surface. The light source **210** may be activated to product a light beam **LB**, generating a light line on the work surface. The pendulum assembly **200** provides the self-leveling feature as described above, while the redirection assembly **400** enables a user to selectively direction the light beam **LB** out of a desired window **110A**, **110B**, **110C** as described above. The light line generated on the work surface may be used to create reference marks using, e.g., a pencil. A user may then utilize the hand tool **900** to act upon (e.g., drill into) the work surface, using the reference marks as a guide.

[0049] While the present invention has been described in detail and with reference to specific embodiments thereof, it will be apparent to one skilled in the art that various changes and modifications can be made therein without departing from the spirit and scope thereof. For example, the housing **100** of the light generating device **10** may possess any suitable dimensions, and may be any shape suitable for its described purpose. The housing **100** may

be shaped to prevent its placement on a horizontal surface such as a floor. The light source **210** may be any source capable of producing a light beam and directing it toward the redirection assembly **400**. Though shown as fixed to the pendulum **205**, the light source **210** may slide along to pendulum to adjust the distance between the light source and the redirection assembly **400**. The pendulum lock mechanism may be configured such that the bar **245** is spring biased out of engagement with the pendulum **205**, wherein the first actuator **240** forces the bar **245** into engagement with the pendulum **205**.

[0050] The windows **110A, 110B, 110C** may be of any shape and include any desired dimensions. The windows **110A, 110B, 110C**, moreover, may be sized to prevent the light beam **LB** from projecting out of housing **100** when the pendulum assembly **200** contacts another component disposed within housing **100**. Additionally, the windows **110A, 110B, 110C** may further prevent the light beams **LB** from exiting the housing **100** when the pendulum assembly **200** approaches the limits of its angular range. In other words, assuming an angular range being between about –6° to about +6° from normal (i.e., a vertical centerline to where the pendulum assembly **200** self-levels), and where pendulum assembly **200** may travel at any angle beyond this range, the size and/or shape of the windows **110A, 110B, 110C** may be configured to block the light beams when the pendulum **205** travels beyond about -5° and/or about +5° from normal. This configuration prevents a user from relying on the emitted beam (as substantially horizontal or vertical) when the pendulum has nearly reached or surpassed its range of motion – as the beam may no longer actually represent true plumb or horizon.

[0051] The redirection assembly **400** may include any structure configured to selectively redirect the light beam **LB** generated by the light source **210**. By way of specific example, instead of a mirror pair **420, 425**, the redirection assembly **400** may include a prism to alter the pathway of the light beam **LB**. By way of further example, a pentaprism may be positioned on the platform **415**. The five-sided reflecting prism may be selectively positioned (e.g., rotated) into the travel path of the light beam **LB**, redirecting the light beam by 90°. The redirection assembly **400**, moreover, may be selectively rotated in clockwise and/or counterclockwise directions.

[0052] In addition, the second actuator **130**, operable to rotate redirection assembly **400**, may include any suitable switch and be disposed at any suitable location. By way of specific example, the second actuator may include knob or lever located on top of, on the rear portion

160 of, or on the front portion **150** of the hosing **100**. Similarly, the surface mounting device **700** may possess any suitable dimensions and be any shape suitable for its described purpose.

[0053] The hand tool **900** may include any hand tool suitable for acting on a work surface. Though a cordless drill is illustrated, the hand tool **900** may include other corded and cordless tools such as a saw, a screwdriver, a nail gun, a staple gun, etc. The hand tool **900** may further include the measuring tool **405** as described above.

[0054] A light line generating device **10** in accordance with the present invention may further include a stud sensor circuit. Information relating to the stud sensor circuitry may be found in U.S. Patent Nos. 4,099,118 and 4,464,622, the disclosures of which are herein incorporated by reference in their entireties.

[0055] Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents. It is to be understood that terms such as "top", "bottom", "front", "rear", "side", "height", "length", "width", "upper", "lower", "interior", "exterior", and the like as may be used herein, merely describe points of reference and do not limit the present invention to any particular orientation or configuration.

I/We claim:

1. A self-leveling, light beam generating device comprising:

a housing;

a pendulum assembly including:

a pendulum, and

a light source fixed to the pendulum, wherein the light source is operable to generate a beam of light along a pathway; and

a light beam redirection assembly capable of moving from a first position to a second position to selectively redirect the beam of light.

2. The light beam generating device of Claim 1, wherein:

the light source directs the light beam in a substantially vertical direction; and

light beam redirection assembly is capable of redirecting the light beam from the substantially vertical direction to a substantially horizontal direction.

3. The light beam generating device of Claim 1, wherein the pendulum is pendulously suspended within the housing via a first attachment point and the redirection assembly is rotatably connected to the housing via a second attachment point.

4. The light beam generating device of Claim 1, wherein the light beam redirection assembly comprises a first mirror angularly spaced from a second mirror.

5. The light beam generating device of Claim 4, wherein:

in the first redirection assembly position, first mirror is oriented in the pathway of the light beam;

in the second redirection assembly position, the second mirror is oriented in the pathway of the light beam.

6. The light beam generating device of Claim 1, wherein the housing comprises at least one window configured to permit the transmission of the light beam through the housing such that a light line is generated on a work surface.

7. The light beam generating device of Claim 6, wherein movement of the redirection assembly from the first position to the second position alters the position of the light line generated on the work surface.

8. The light beam generating device of Claim 1, further comprising a measuring tool responsive to rotation of the housing on the work surface.

9. The light beam generating device of Claim 8, wherein the measuring tool comprises a protractor.

10. The light beam generating device of Claim 1, wherein the light source comprises a laser assembly including a laser diode, a collimating lens, and a line lens.

11. The light line generating device of Claim 1, wherein the pendulum assembly is pendulously suspended to pivot along a plane generally transverse to the light beam pathway.

12. The light line generating device of Claim 11, wherein the pendulum assembly further comprises a damping mechanism.

13. The light line generating device of Claim 11 further comprising a lock mechanism operable secure the pendulum assembly and prevent its pivotal motion.

14. The light line generating device of Claim 13, wherein a first actuator selectively engages and disengages the lock mechanism, as well as selectively activates and deactivates the light source.

15. A light line generating device comprising:

a housing including a first window and a second window;

a self-leveling pendulum assembly disposed within the housing including:

a pendulum, and

a light source operable to create a light line on a work surface, wherein the light source emits a light beam traveling in a first direction; and

a redirection assembly disposed within the housing,

wherein the redirection assembly is movable from a first position, in which the assembly permits the light beam to continue traveling in the first direction, to a second position, in which the assembly redirects the light beam from the first direction to a second direction.

16. The light line generating device of Claim 15, wherein:

in the first direction, the light beam is directed out of the first window; and

in the second direction, the light beam is directed out of the second window.

17. The light line generating device of Claim 16, wherein:

the housing further includes a third window;

the redirection assembly is movable to a third position, in which the assembly redirects the light beam from the first direction to a third direction; and

in the third direction, the light beam is directed through the third window.

18. The light line generating device of Claim 15, wherein the redirection assembly is further movable to a third position, in which the redirection assembly redirects the light beam from the first direction to a third direction.

19. The light line generating device of Claim 15, wherein redirection assembly comprises a mirror assembly including a first mirror and a second mirror.

20. The light line generating assembly of Claim 15, wherein the light source comprises a laser assembly including a laser diode, a collimating lens, and a line lens.

21. The light line generating assembly of Claim 15, wherein the redirection assembly is rotatable between the first position and the second position, and vice versa.

22. The light line generating assembly of Claim 15, wherein the pendulum assembly is capable of pivoting within a plane that is generally transverse to the light beam first direction.

23. The light line generating device of Claim 22 further comprising a lock mechanism operable secure the pendulum assembly, selectively preventing the pivotal motion of the pendulum assembly.

24. The light line generating assembly of Claim 15, wherein the pendulum assembly further comprises a damping mechanism.

25. The light beam generating device of Claim 15 further comprising a measuring tool responsive to rotation of the housing with respect to a supporting surface.

26. The light beam generating device of Claim 25, wherein the measuring tool comprises a protractor.

27. A method of generating a light line on a work surface comprising the steps:

(a) providing a light beam generating device including:

a pendulum assembly including a light source configured to generate a beam of light, and

a light beam redirection assembly;

(b) directing the light beam toward the redirection assembly;

(c) positioning the redirection assembly in a first orientation to cause the light beam to generate a light line on the work surface in a first direction; and

(d) positioning the redirection assembly in a second orientation to cause the light beam to generate a light line on the work surface in a second direction.

28. The method of claim 27, wherein:

the work surface comprises a generally vertical work surface;

the light beam generating device further comprises a measuring tool responsive to rotation of the housing on the work surface; and

the method further comprises (e) placing the light beam generating device on the work surface in a normal position and (f) rotating the light beam generating device from the normal position to a position offset from normal.

29. A light line generating device comprising:

a housing adapted to contact a generally vertical work surface;

a light source operable to create a light line on the work surface;

a measuring tool responsive to rotation of the housing on the work surface.

30. The light line generating device of claim 29, wherein the measuring tool is adapted to measure the angle at which the housing is offset from a normal position.

31. The light line generating device of claim 30, wherein the normal position of the housing is disposed along a line generally plumb to the work surface.

32. The light line generating device of claim 30, wherein the measuring tool comprises a protractor.

33. The light line generating device of claim 29, wherein the measuring tool comprises a 360° protractor rotatably coupled to the housing.

34. The light line generating device of claim 33, wherein the protractor comprises at least one weighted area.

35. The light line device of claim 34, wherein the weighted area maintains a substantially constant position with respect to a normal position of the housing as the housing is rotated from the normal position to a position offset from the normal.

36. The light line device of claim 29, wherein the measuring tool comprises a gravity responsive protractor.

37. The light line generating device of Claim 29 further comprising a mounting device operable to rotatably couple the housing to the generally vertical work surface such that the housing may be reoriented from the normal position to the position offset from normal, moving the light line from a first position to a second position on the work surface.

38. The light line generating device of Claim 37, wherein the measuring tool measures the angle between the first light line position to the second light line position.

39. A self-leveling, light beam generating device comprising:

a housing;

a pendulum assembly including:

a pendulum pendulously suspended within the housing via a first attachment point, and

a light source fixed to the pendulum, wherein the light source is operable to generate a beam of light along a pathway; and

a light beam redirection assembly connected to the housing via a second attachment point,

wherein the redirection assembly is capable of moving from a first position to a second position to selectively redirect the beam of light out of the housing.

40. The light beam generating device of Claim 39, wherein:

the light beam generates a light line on a work surface; and

movement of the redirection assembly from the first position to the second position alters the position of the light line on the work surface.

41. The light beam generating device of Claim 39 further comprising a measuring tool responsive to rotation of the housing with respect to a supporting surface.

42. The light beam generating device of Claim 39, wherein the measuring tool comprises a protractor including a weighted area that maintains a substantially constant position with respect to the plumb line of the supporting surface as the housing is rotated.

43. A method of measuring the angle between light lines on a generally vertical work surface comprising the steps:

(a) providing a light line generating device comprising:

a pendulum assembly including a light source configured to generate a beam of light,

a housing including at least one window operable to permit the transmission of the light beam from the housing to generate a light line on the work surface, and

a measuring tool responsive to rotation of the housing with respect to the work surface;

(b) mounting the light line generating device to the work surface;

(c) activating the light source to generate a light line on the work surface; and

(d) rotating the housing to move the light line from a first position to a second position,

wherein the measuring tool measures a rotation angle between the first light line position to the second light line position.

44. The method of claim 43, wherein:

the measuring tool comprises a protractor adapted to rotate about an axis; and

rotating the housing causes a corresponding opposite rotation of the protractor about the axis.

45. The method of claim 43, wherein:

the light line generating device further includes a mounting device rotatably coupled to the housing;

step (b) comprises (b.1) connecting the surface mounting device to the work surface; and

step (d) comprises (d.1) rotating the housing on the surface mounting device.

46. A hand tool comprising:

a tool portion;

a handle portion; and

a light line generating device comprising:

a self-leveling pendulum assembly including:

a pendulum, and

a light source fixed to the pendulum, wherein the light source is operable to generate a beam of light along a pathway; and

a light beam redirection assembly capable of moving from a first position to a second position to selectively redirect the beam of light.

47. The hand tool of Claim 46, wherein the pendulum is pendulously suspended within the housing via a first attachment point and the redirection assembly is rotatably connected to the housing via a second attachment point.

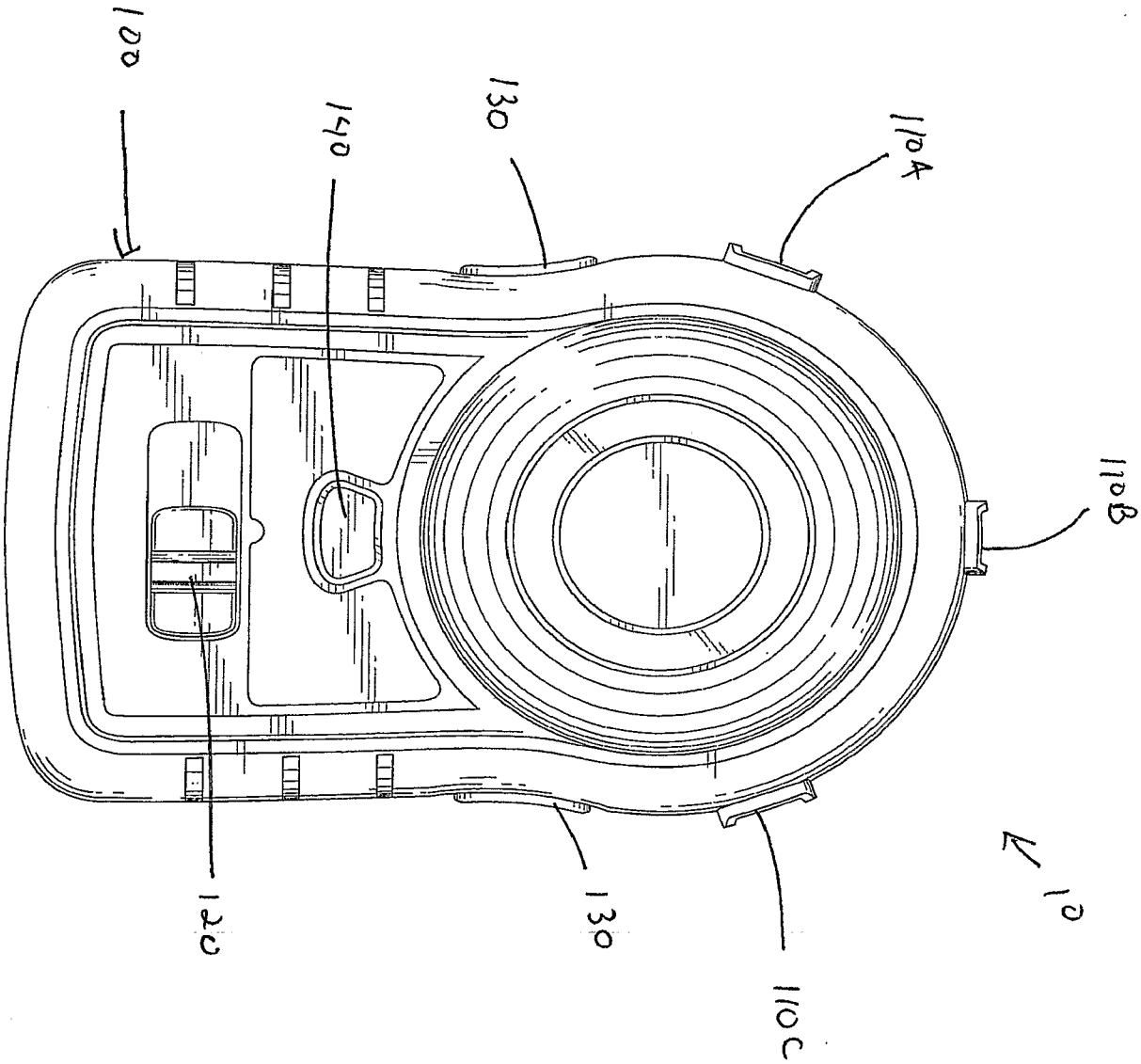

Fig. 1A

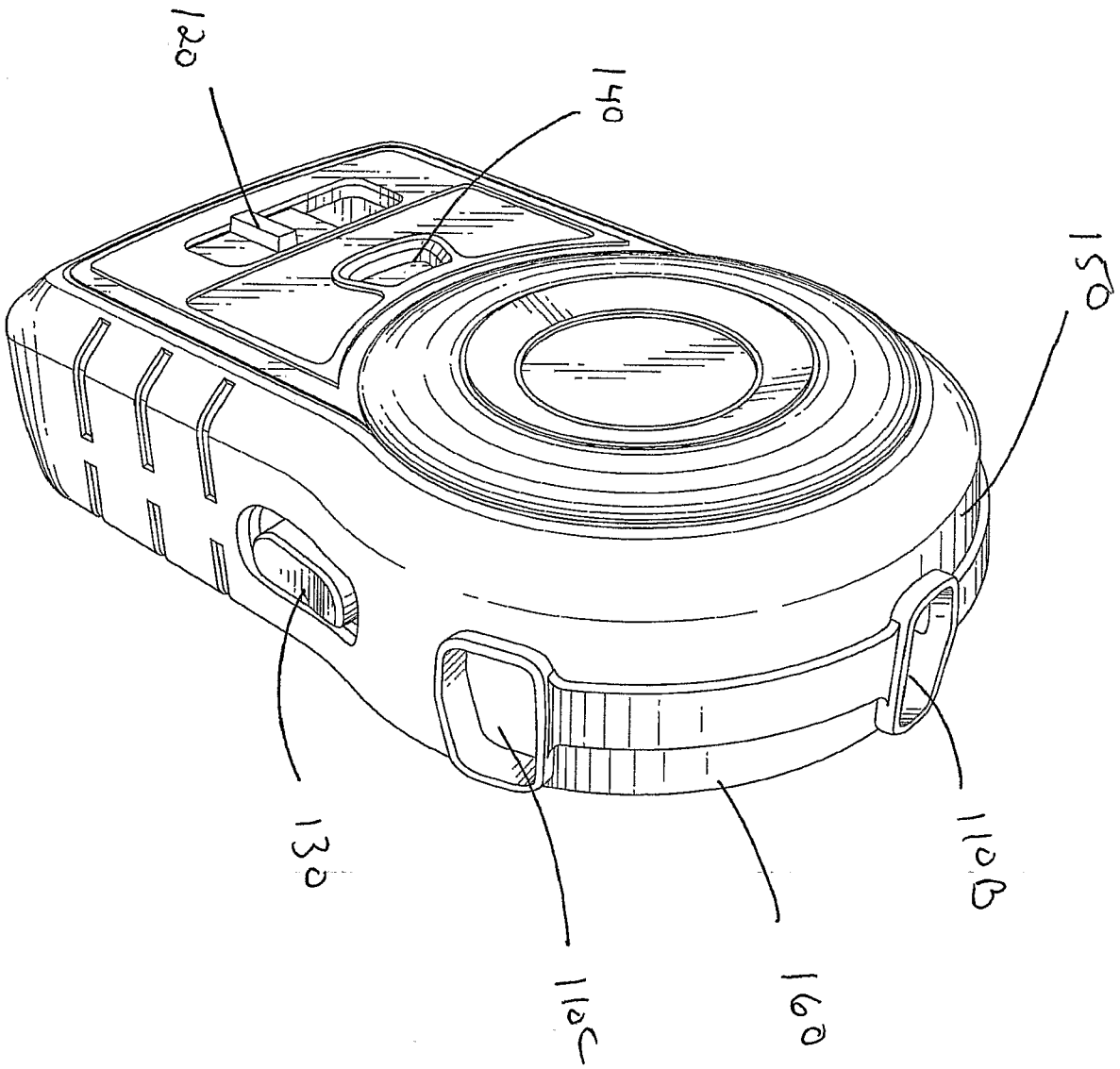

Fig. 1B

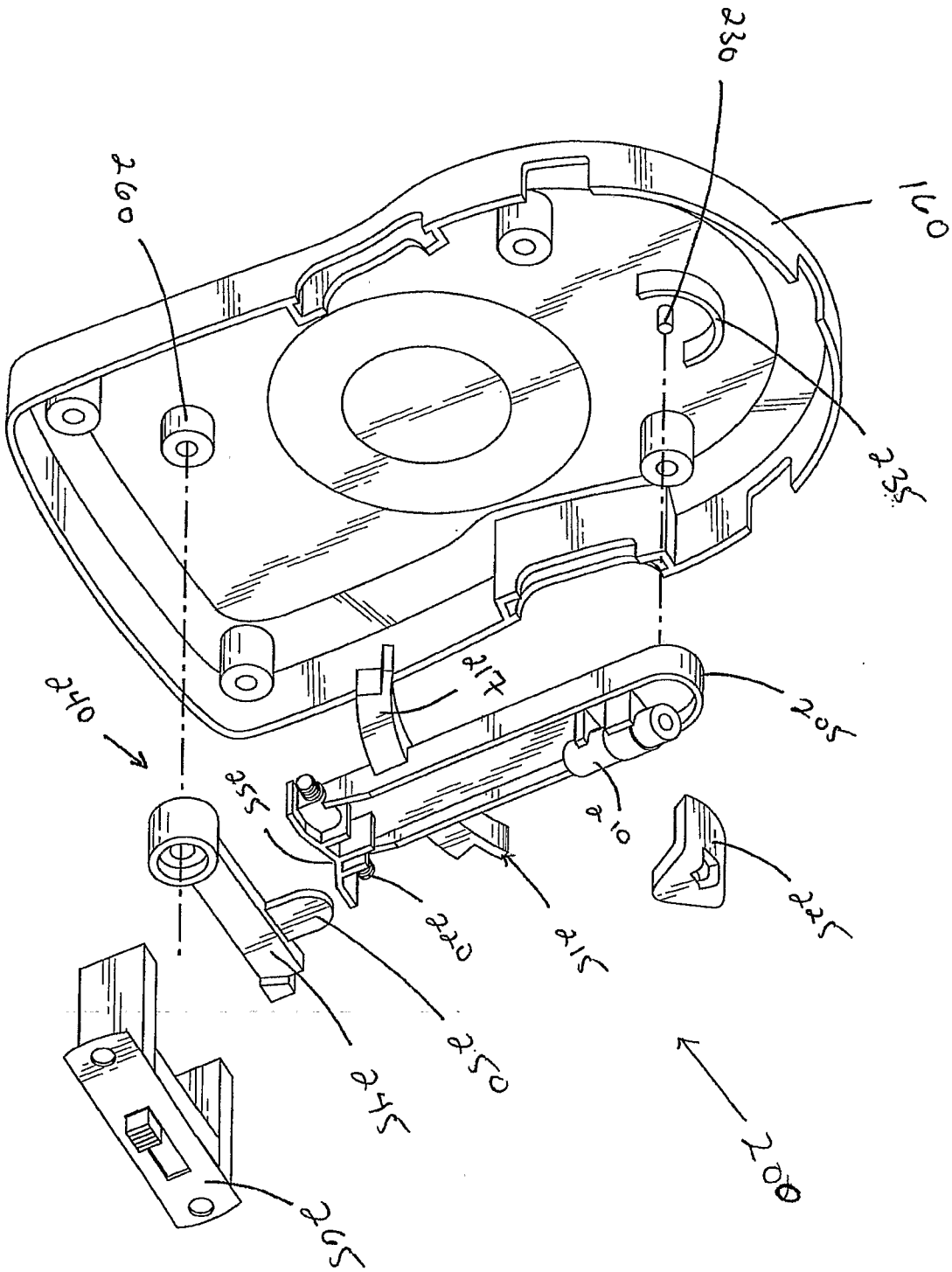

Fig. 2A

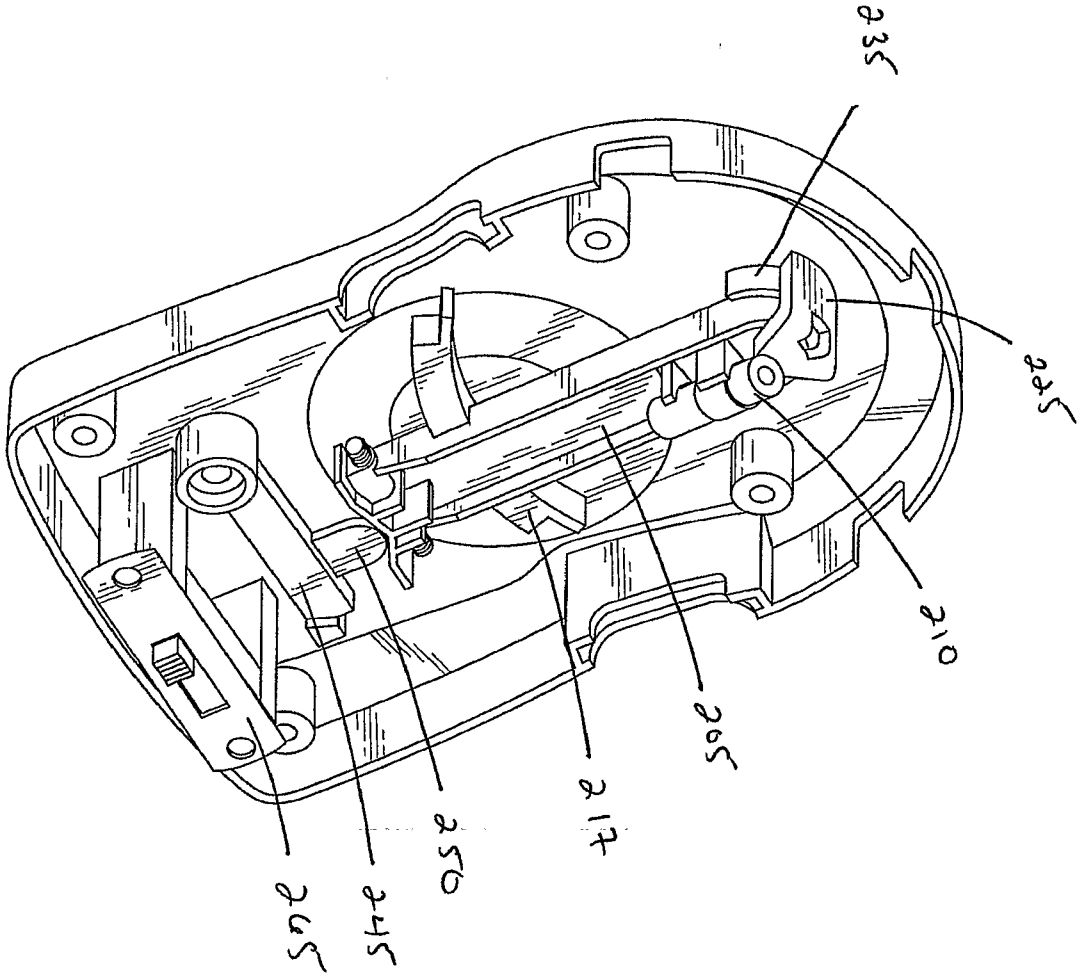

Fig. 2B

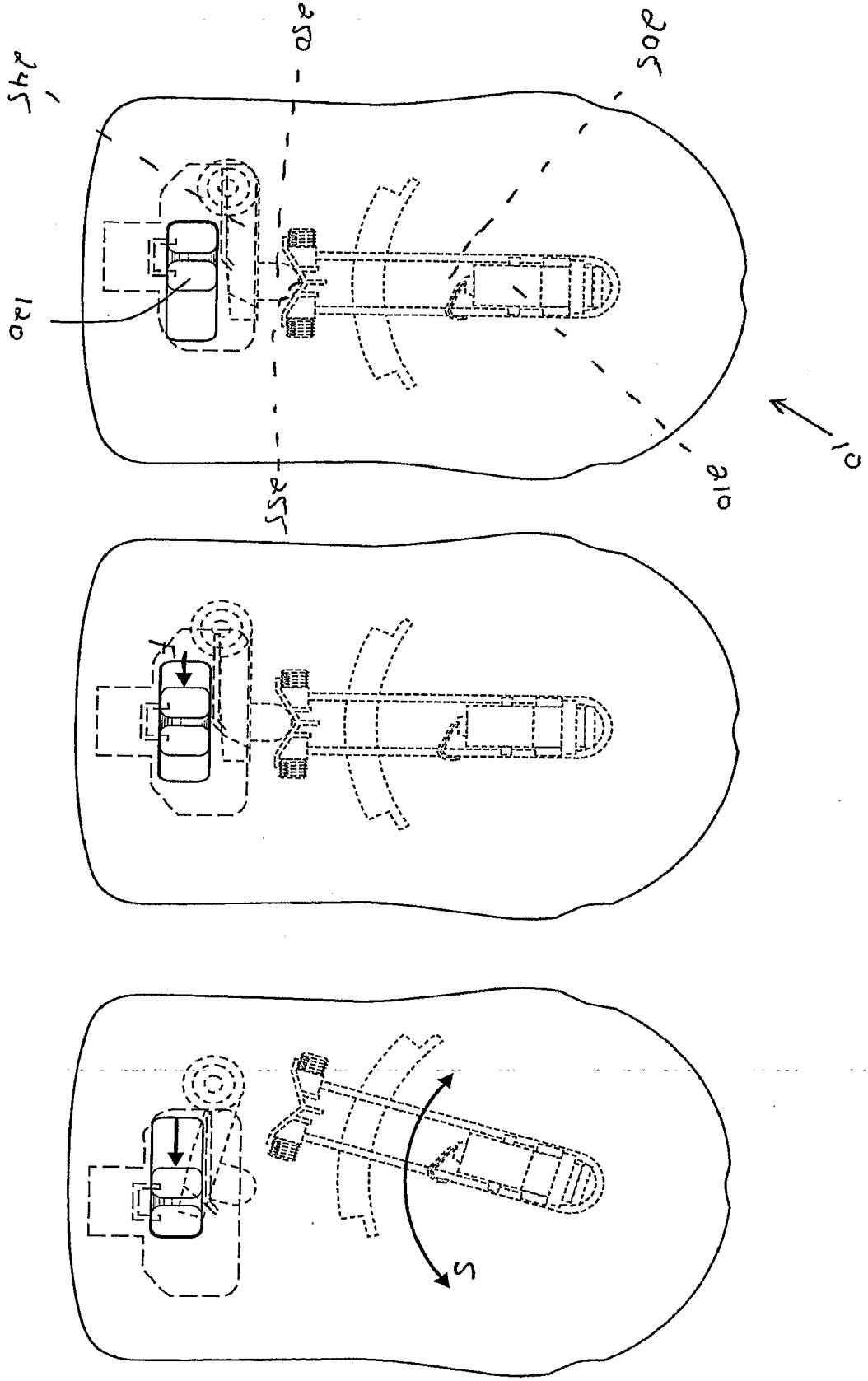

Fig. 3A

Fig. 3B

Fig. 3C

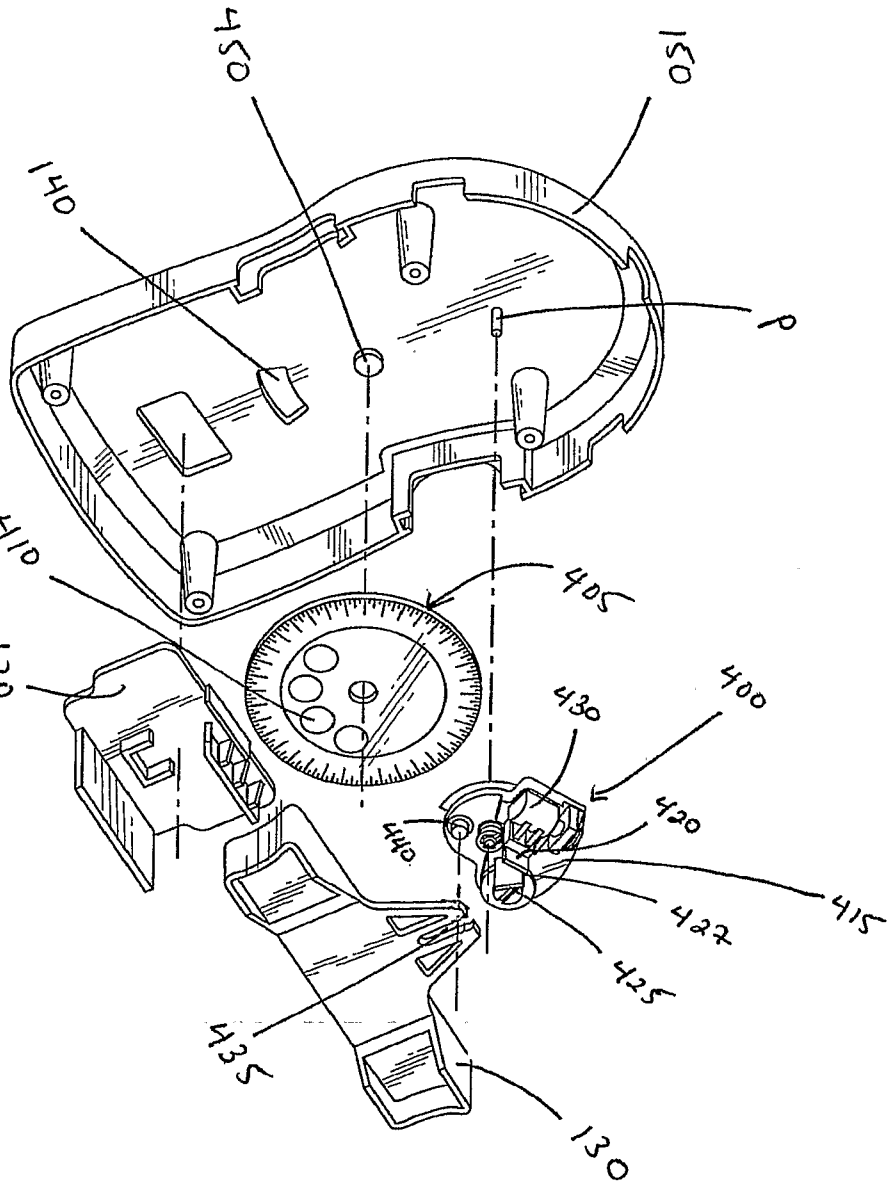

Fig. 4A

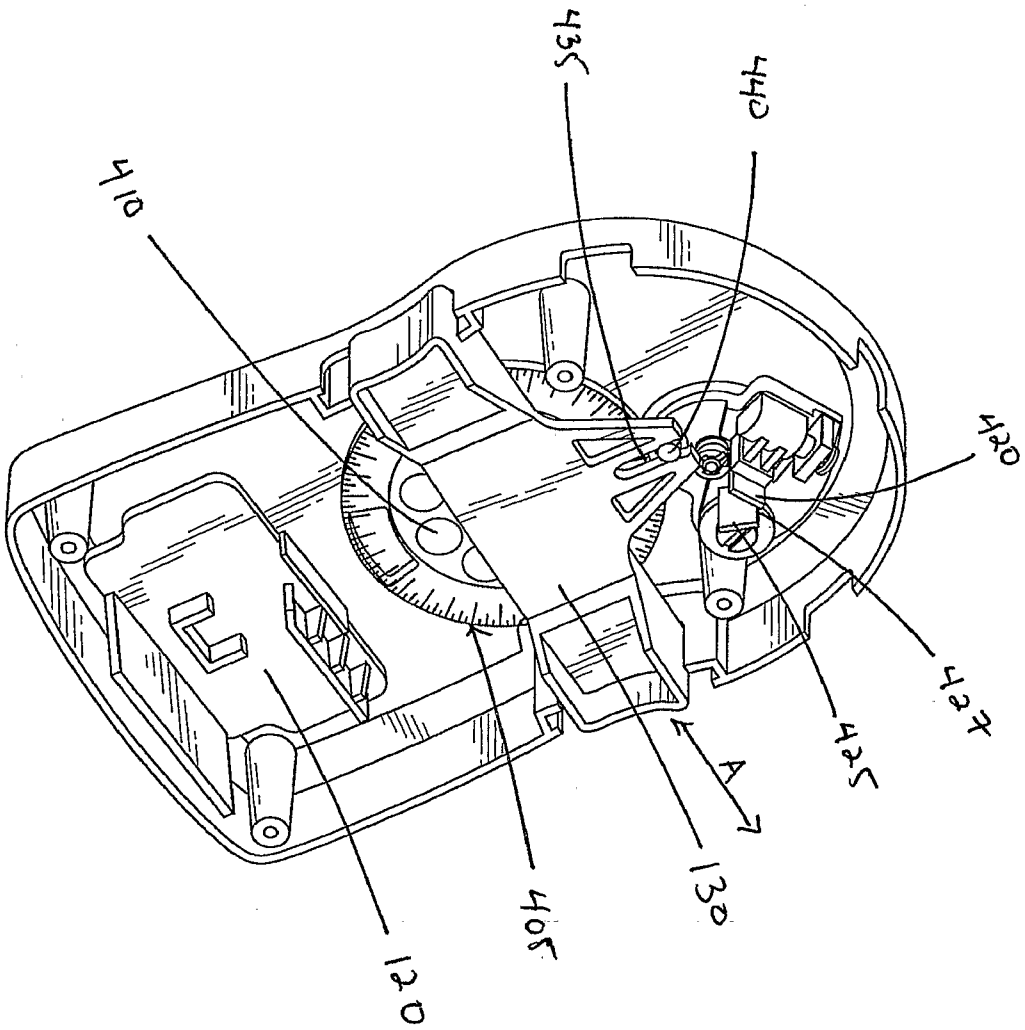

Fig 4B

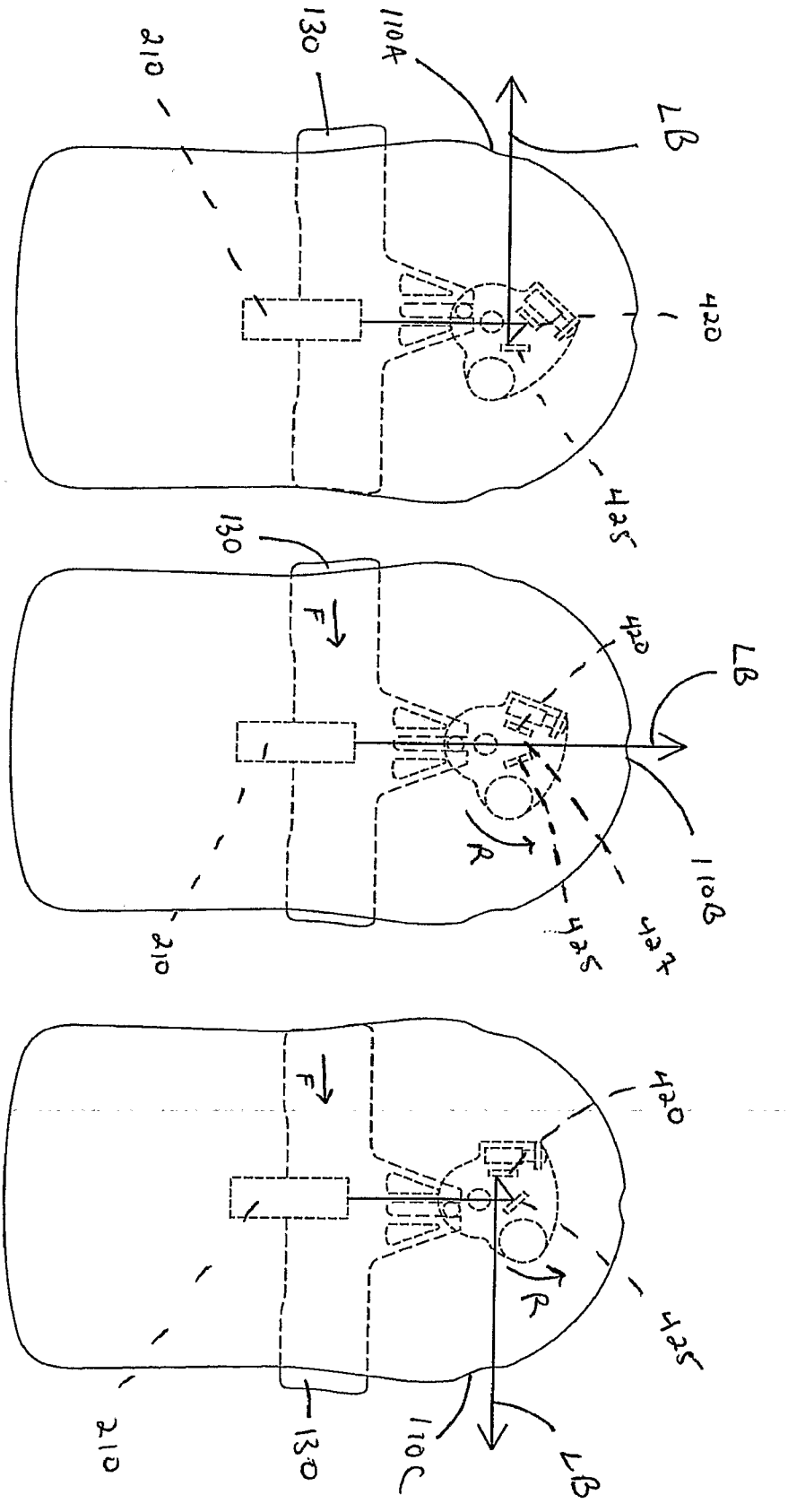

Fig. 5A

Fig. 5B

Fig 5C

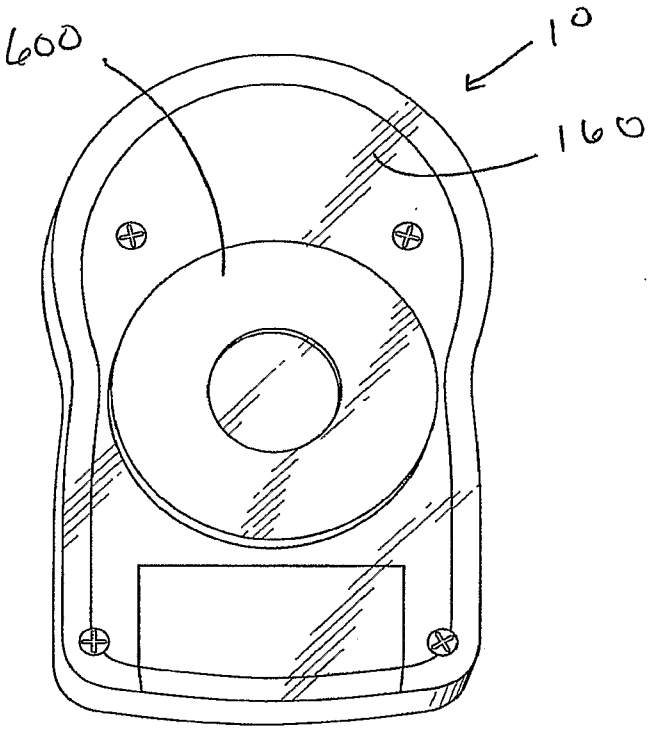

Fig. 6

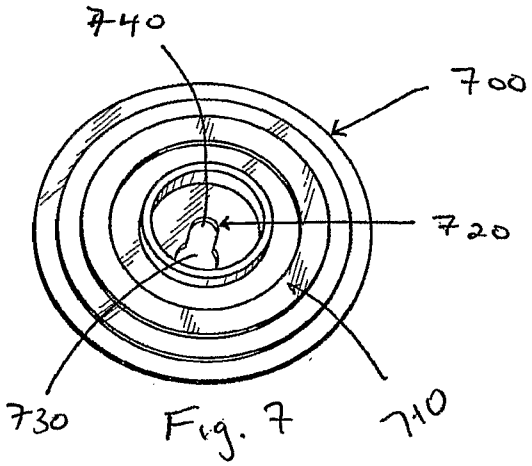

Fig. 7

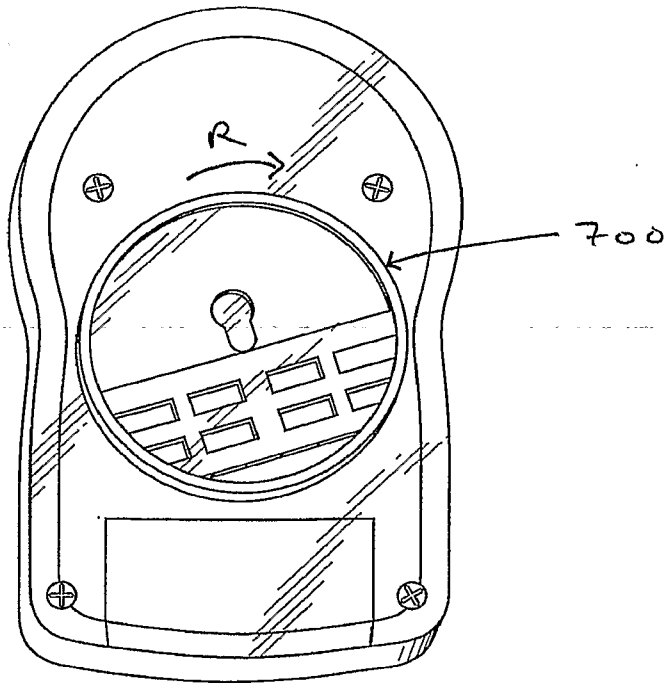

Fig. 8

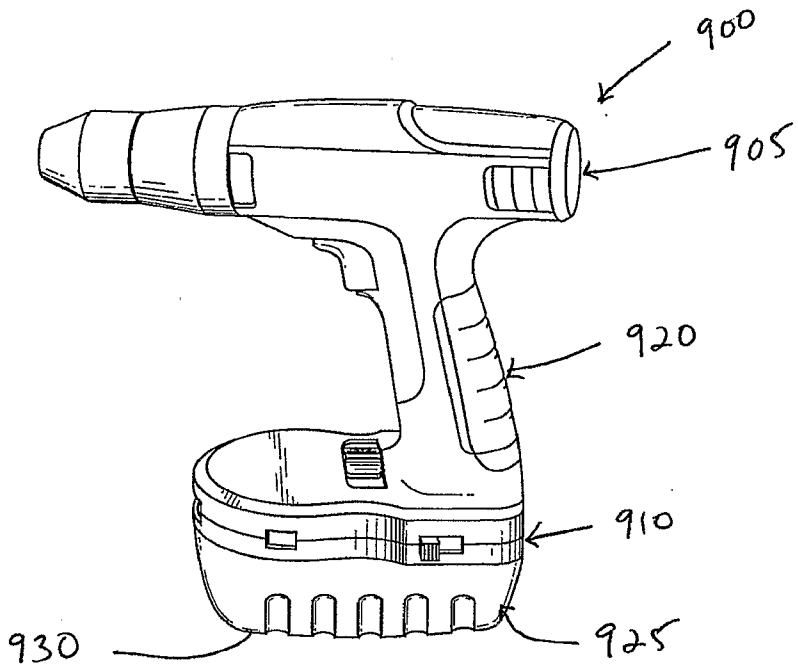

Fig. 9

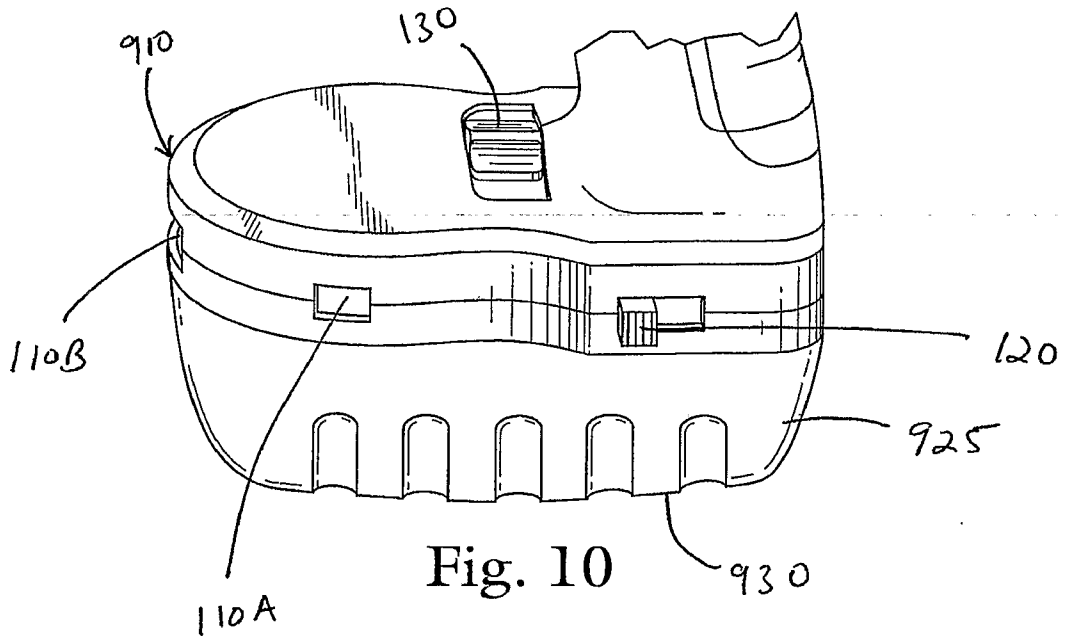

Fig. 10