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**Doyle et al.**

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(54) **LEVEL WITH REMOVABLE END CAP**

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See application file for complete search history.

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U.S.C. 154(b) by 14 days.

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claimer.

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(57) **ABSTRACT**

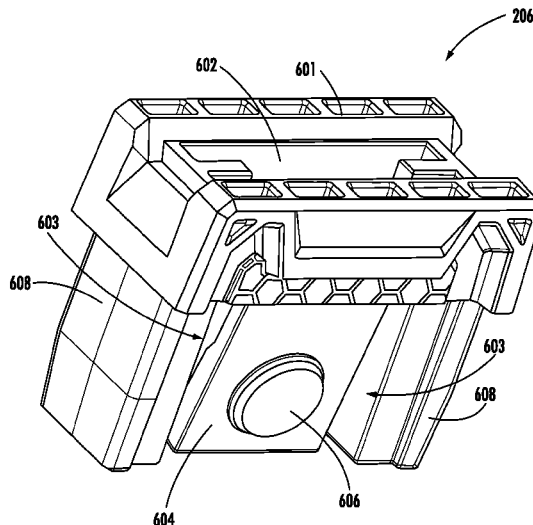
(51) **Int. Cl.**  
**G01C 9/34** (2006.01)  
**G01C 9/02** (2006.01)

A level with a removable end cap is provided. The level  
includes a hollow level body. The end cap includes an outer  
member and locking member received within the outer  
member. The locking member is inserted into the outer  
member pushing a moveable portion of the outer member  
into a frictional engagement that holds the end cap assembly  
in place relative to the level body.

(52) **U.S. Cl.**  
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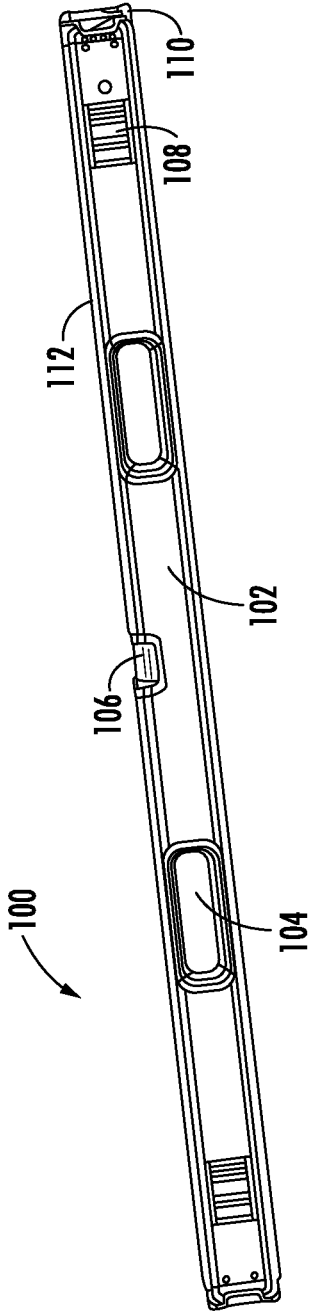


FIG. 1

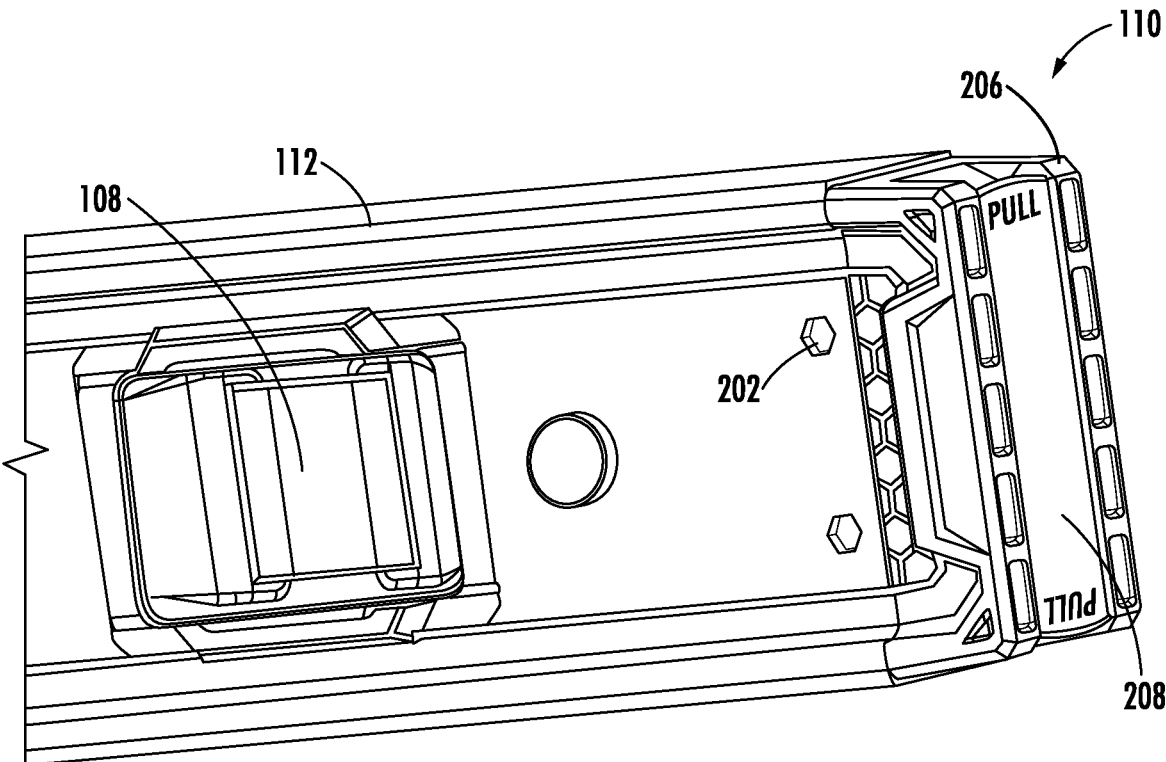


FIG. 2

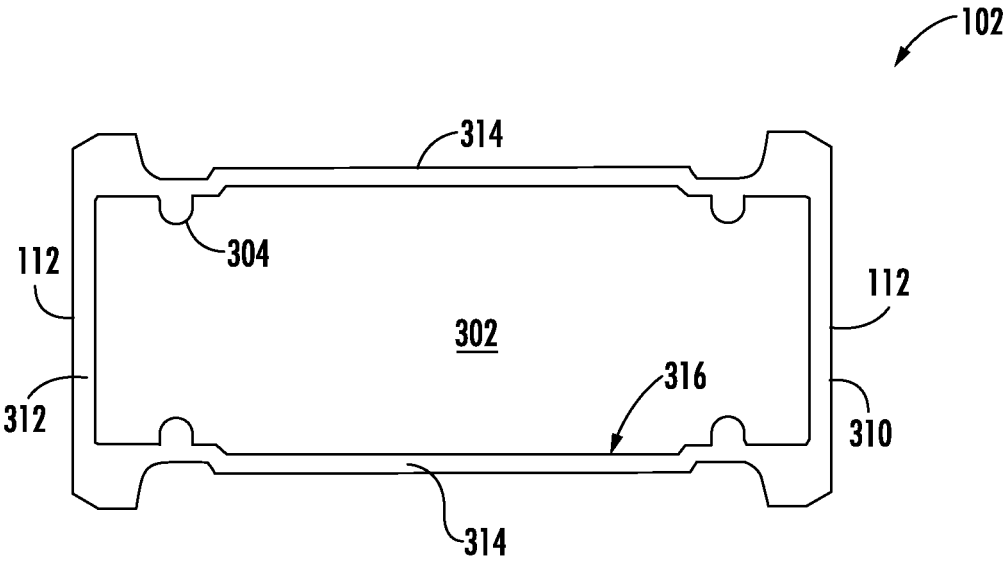


FIG. 3

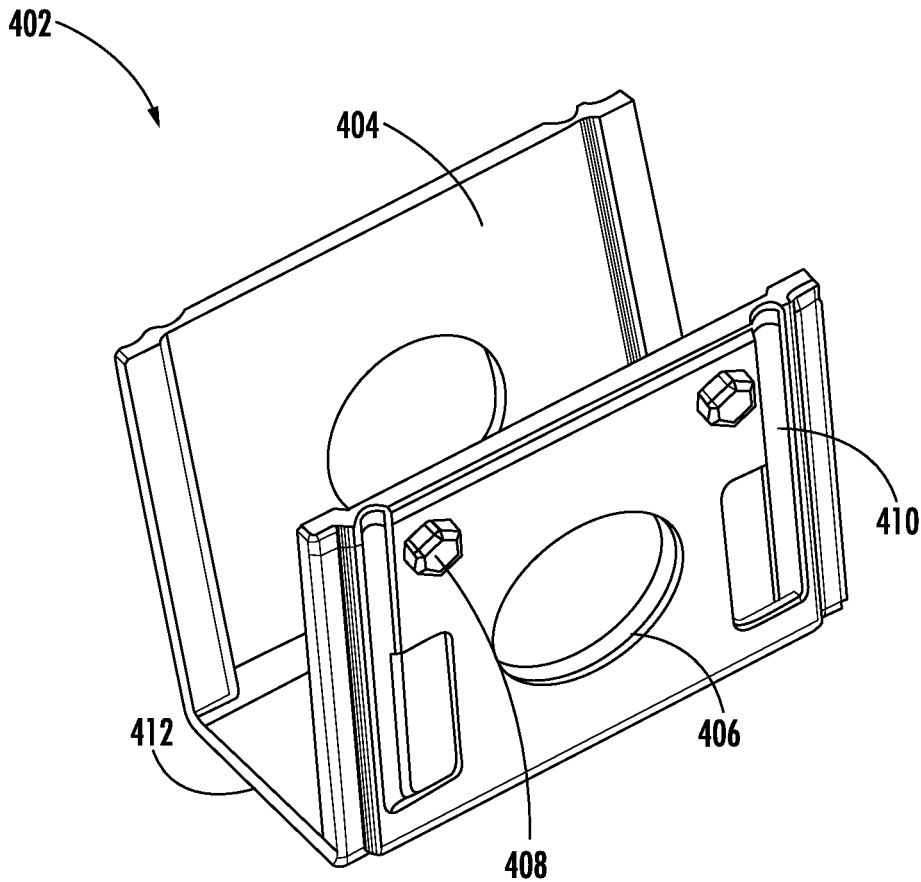


FIG. 4

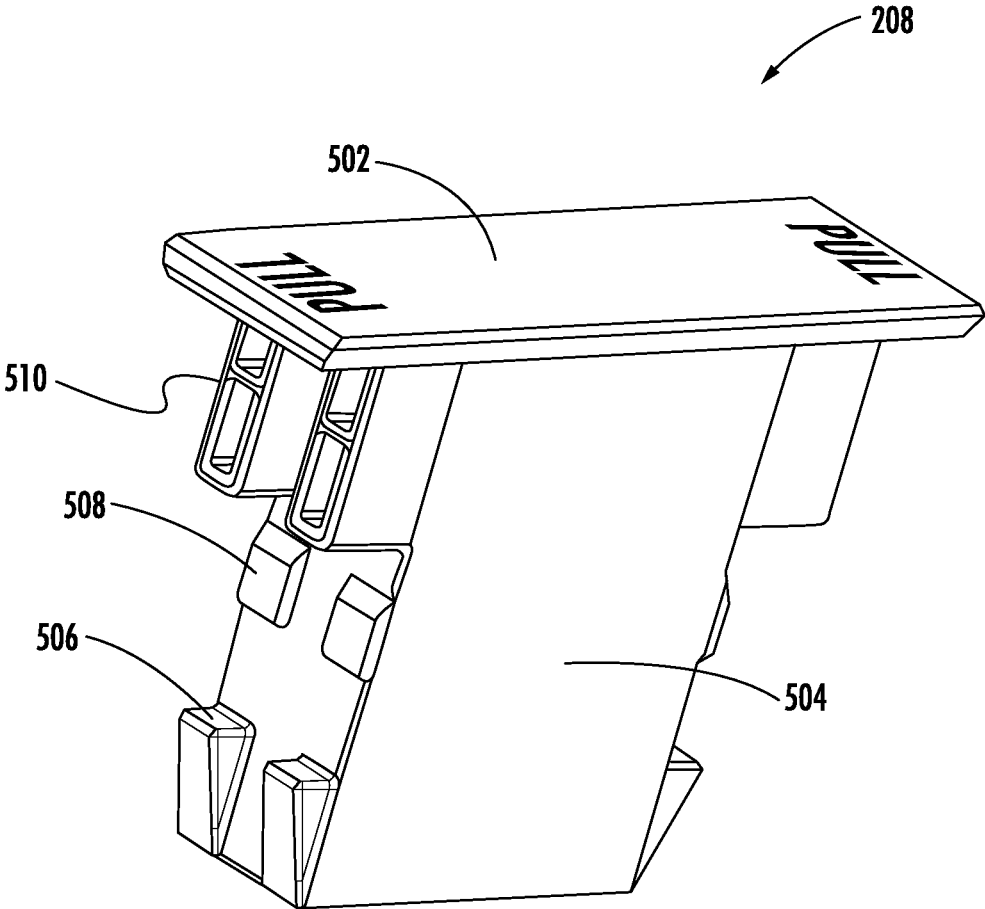
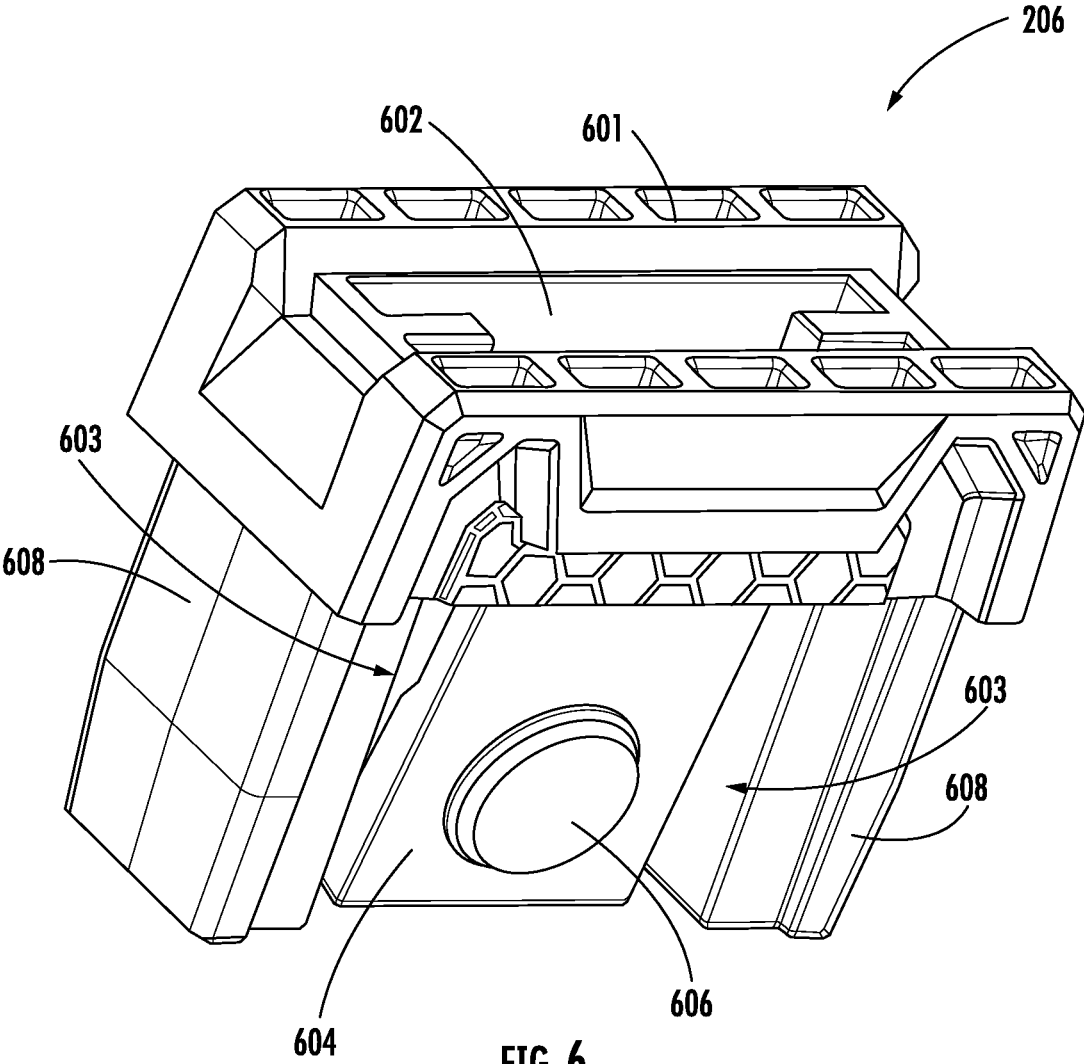


FIG. 5





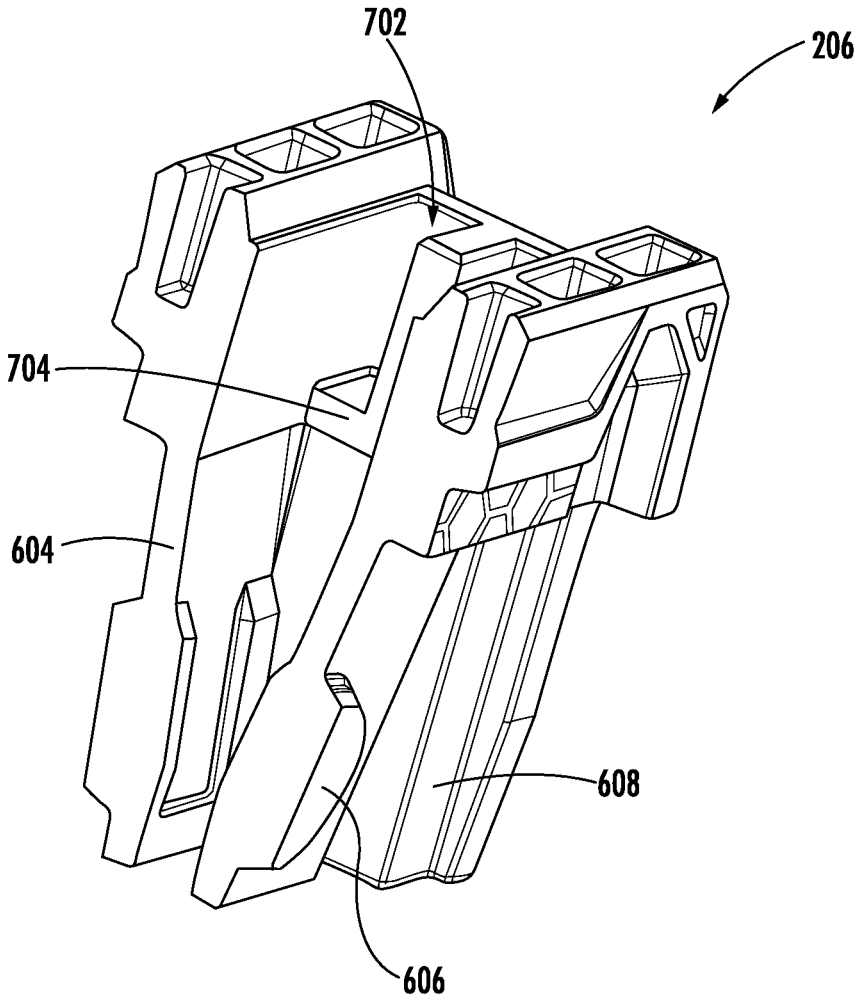


FIG. 7

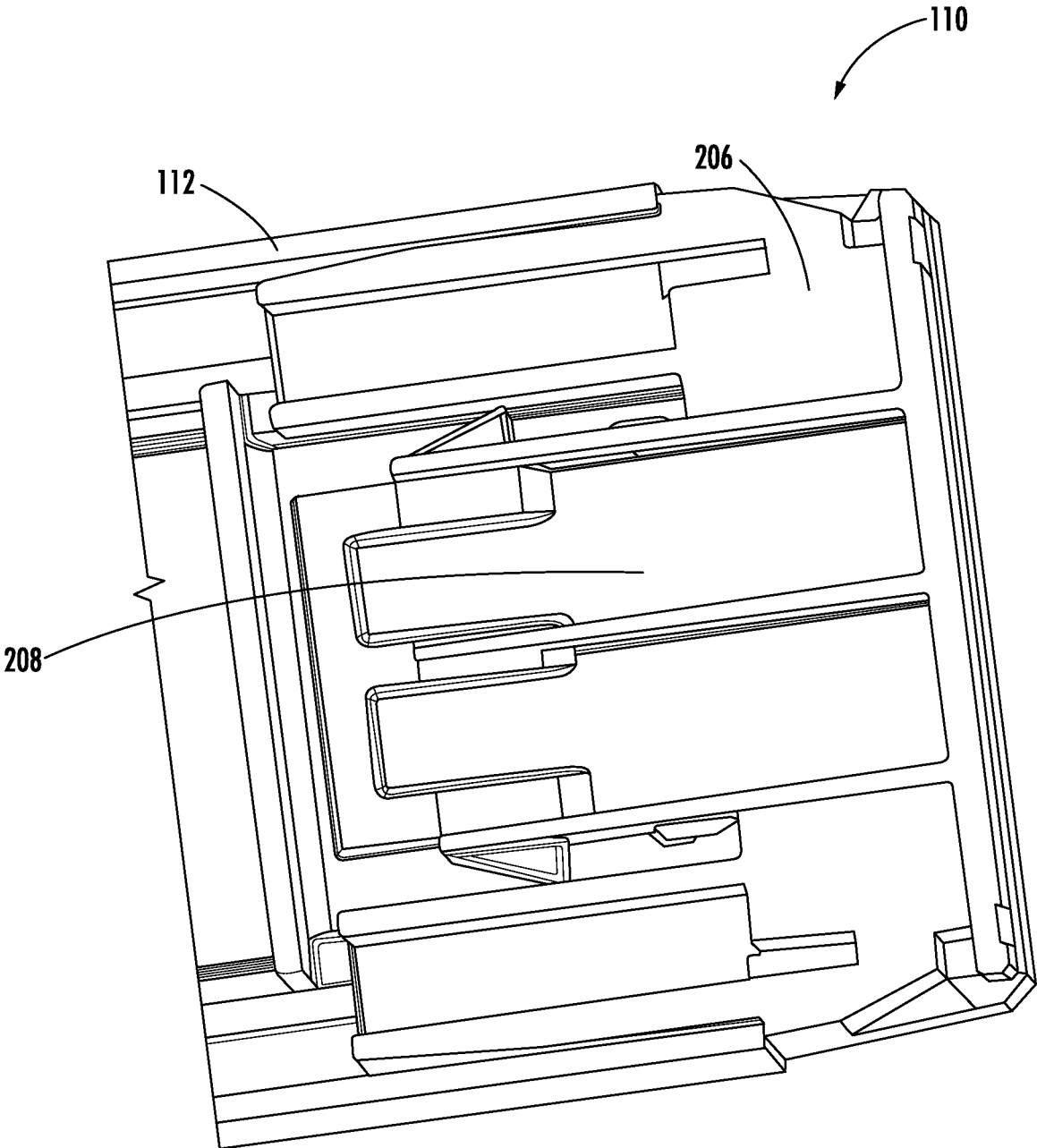


FIG. 8

**LEVEL WITH REMOVABLE END CAP**

## CROSS-REFERENCE TO RELATED PATENT APPLICATIONS

This application is a continuation of U.S. application Ser. No. 15/849,104, filed Dec. 20, 2017 which is a continuation of International Application No. PCT/US2017/067601, filed Dec. 20, 2017, which claims priority to and the benefit of U.S. Provisional Application No. 62/437,416, filed Dec. 21, 2016, which are incorporated herein by reference in their entireties.

## BACKGROUND OF THE INVENTION

Levels are used to measure the angle of surfaces on construction sites and in other locations.

## BRIEF DESCRIPTION OF THE DRAWINGS

To easily identify the discussion of any particular element or act, the most significant digit or digits in a reference number refer to the figure number in which that element is first introduced.

FIG. 1 is a perspective view of a level.

FIG. 2 is an enlarged perspective view of the level of FIG. 1 including an end cap.

FIG. 3 is an end view of the level illustrating the cross section of the level body.

FIG. 4 is a perspective view of an end cap clip.

FIG. 5 is a perspective view of an end cap locking member.

FIG. 6 is a perspective view of an end cap outer member.

FIG. 7 is a section view of the end cap outer member of FIG. 6.

FIG. 8 is a perspective longitudinal cross sectional view of the end cap of the level of FIG. 1.

## DETAILED DESCRIPTION

FIG. 1 illustrates a level **100** of the type typically used to measure the level or the plumb of various surfaces during construction or home remodeling. The illustrated level **100** includes a body **102** that defines a planar surface **112** and first and second handles **104**. The body **102** also supports a center vial **106** that is arranged to measure the level (relative to horizontal) orientation of a surface and at least one plumb vial **108** arranged to measure the plumb (vertical orientation) of a surface. In the illustrated construction, spirit vials are used to measure the surfaces with other constructions including other arrangements including digital levels or accelerometers.

In the illustrated construction, the level **100** is a box-type level where the body **102** is substantially box shaped as illustrated in FIG. 3. As shown in FIG. 3, in one embodiment, body **102** is formed from a piece of material (e.g., metal material) that is contiguous at at least some longitudinal cross-sectional positions. Level body includes upper wall **310**, lower wall **312** and opposing sidewalls **314**, and the inner surfaces **316** of these walls define a hollow open area, shown as hollow space **302**. In this construction, the body **102** defines a hollow space **302** and includes a first rib **304** that extends along the interior surface **316** of the body **102**. The illustrated construction includes ribs **304** disposed adjacent each corner of the body **102**.

Returning to FIG. 1, the level **100** includes an end cap assembly, shown as an end cap **110**, at each end of the level

**100**. The end cap **110** is arranged to protect the end of the level **100** and is also arranged to be removable by the user without damaging the end cap **110**. With reference to FIG. 2 the end cap **110** includes an outer member **206**, a locking member **208**, and a clip **402** (illustrated in FIG. 4) that fit within the body **102** or engage the body **102** to form the end cap **110**.

In general, clip **402** is received within hollow area **302** of level body **102**, and outer member **206** is received within hollow area **302** of level body **102** and within clip **402**. Next locking member **208** is received within outer member **206** and pushes a moveable portion of outer member **206** in to a frictional engagement that couples outer member **206** in a fixed position relative to the level body. As will be discussed below, in a specific embodiment, this pushing causes a projection on the outer member **206** to engage an aperture of the clip **402** coupling the outer member to the level body. In this manner, the locking member **208** is moveable within the outer member **206** between a locked in which frictional coupling is generated coupling the end cap to the level body and unlocked position in which the end cap is removable from the level body.

With reference to FIG. 4 the clip **402** is illustrated in its uninstalled or free configuration. The clip **402** includes clip sidewalls, shown as a first wall **404** and a second wall **404** opposite the first wall **404**, that both extend outward from a clip end wall **412**. The walls **404** are arranged to define an oblique angle therebetween when in the free configuration. Each wall **404** includes an aperture **406** in about the center of each wall **404**, and a rib slot **410** and a hexagonal boss **408** on each end of the wall **404**. As shown, rib slot **410** and boss **408** are formed along the outer surface of wall **404**, and boss **408** projects outward from the outer surface of wall **404**.

To mount end cap **110** to level body **102**, the clip **402** is arranged in the body **102** with each of the clip sidewalls **404** running along and generally parallel to the inner surfaces of body sidewalls **314** with each hexagonal boss **408** disposed within a hexagonal aperture **202** (shown in FIG. 2). Of course, shapes other than hexagonal could be employed if desired. In addition, each rib slot **410** receives a rib **304** to properly align the clip **402** within space **302** of body **102**. To position the clip **402** in the body **102**, the walls **404** are moved inward toward one another (e.g., by squeezing walls **404**) allowing clip **402** to slide into body **102**. Walls **404** are biased outward, and this bias helps to retain the clip **402** within the body **102**. In other constructions, an adhesive can be used to permanently attach the clip **402** to the body **102**.

As shown in FIG. 6, the outer member **206** is an elongated member with a cap portion **601** that remains outside of the body **102** when installed, and a side arm **608** at each of the upper and lower ends and extending away from the cap portion **601** and arranged to engage the inner surfaces of the body **102**. When installed side arms **608** are positioned along the inner surfaces of upper wall **310** and lower wall **312** of level body **102**. A moveable portion, shown as first movable wall **604**, includes a projection, shown as locking button **606**, that is fixed with respect to the movable wall **604** and is preferably formed as one piece with the movable wall **604**. A second movable wall (best illustrated in FIG. 7) is positioned opposite the movable wall **604** and is substantially identical to the movable wall **604**. In generally moveable walls **604** are separated from side arms **608** by gaps **603**. As will be explained below, this separation allows side arms **608** to be pushed outward by locking member **208** to create a frictional coupling that secures the end cap to the

level body. A locking member aperture 602 is formed down the center of the outer member 206 and is sized to receive the locking member 208.

Turning to FIG. 5, the locking member 208 includes a pull portion 502 and a block portion 504 that extends from the pull portion 502. The pull portion 502 is arranged to remain outside of the outer member 206 to give the user a surface to grab to move the locking member to the unlocked position relative to outer member 206 when it is desired to remove the end cap 110. The block portion 504 is a rectangular cross section portion that is substantially rigid. In addition, at least one engagement bump 508, one tab 506, and one guide member 510 are formed on each side of the outer member 206.

FIG. 7 best illustrates the interior of the locking member aperture 602 and the space between the first movable wall 604 and the second movable wall. As shown in FIG. 7, the outer member 206 includes a guide slot 702 positioned and sized to receive the guide member 510 of the locking member 208. The outer member 206 also defines a cooperating surface, shown as locking surface 704, that operates to maintain the connection between the locking member 208 and the outer member 206 when the end cap 110 is removed. In general and as will be explained in more detail below, locking member 208 includes a stop structure that engages a cooperating surface of outer member 206 such that full removal of the locking member from the outer member is prevented when the locking member is in an unlocked position (i.e., outer member 206 and locking member 208 are held together when the end cap is removed from the level body).

With reference to FIGS. 4-8 the assembly and use of the end cap 110 will now be described. First, the clip 402 is installed into the body 102 as discussed above. When installed walls 404 and clip 402 generally are positioned adjacent to and/or in contact with the inner surfaces of body 102 that defines hollow area 302. In this manner, clip 402 positions its openings 406 within level body 102. In this manner, as will be explained in more detail below, clip 402 allows for mounting of outer member 206 via engagement between locking button 606 and clip openings 406, without requiring engagement between outer member 206 and holes formed through the side walls of level body 102. In some embodiments, the clip 402 is not intended to be removed once installed into the body 102.

Once the clip 402 is mounted into level body 102, the outer member 206 is then installed into the body 102 and into the clip 402. The outer member 206 is preferably manufactured from a relatively resilient or soft material such as rubber. Thus, the movable walls 604 are generally free to move and do not engage the aperture 406 to lock the outer member 206 in place until insertion of locking member 208.

The locking member 208 is next inserted into the locking member aperture 602 of outer member 206. The locking member 208 is preferably formed from a hard, less resilient material than the outer member 206. For example, a hard plastic might be used for the locking member 208, while a softer or more flexible material may be used for at least portions of outer member 206. In specific embodiments, at least a portion of moveable walls 604 are formed from a material that is more flexible than locking member 208. In specific embodiments, moveable walls 604 are formed, at least in part, from a material that has a lower durometer and/or higher modulus of elasticity than that of a material of locking member 208.

When locking member 208 is installed into outer member 206 for the first time, each tab 506 is forced past the locking

surface 704 of the outer member 206. The resiliency of the outer member 206 along with the ramped arrangement of each tab 506 facilitate this insertion. As the block portion 504 moves between the movable walls 604 of outer member 206, the movable walls 604 are deflected outward until each locking button 606 engages an aperture 406 of clip 402 to lock the end cap 110 in position relative to level body 102. In this arrangement, locking button 606 is located completely within the hollow area 302 and does not extend through level body 102. In this position, each guide member 510 is received in a guide slot 702. In addition, each engagement bump 508 cooperates with the guide member 510 to sandwich the locking surface 704 and hold the locking member 208 in the locked position.

To remove the end cap 110, the user pulls on the locking member 208 to remove the block portion 504 from between the movable walls 604 moving locking member outward away from level body 102. In the embodiment shown, each tab 506 engages the locking surface 704 to inhibit the full removal of the locking member 208 from the outer member 206. In other words, engagement between tabs 506 and locking surface 704 acts to hold locking member 208 to outer member 206, when in the unlocked position. With locking member 208 in the unlocked position, block portion 504 is moved such that block portion 504 does not push moveable walls 604 into engagement with the openings of the clip. Thus, without the block portion 504 providing structural support for the movable walls 604, the movable walls 604 are free to deflect inwardly to release each locking button 606 from each aperture 406, thereby allowing the removal of the end cap 110. In specific embodiments, moveable walls 604 are not biased inward, and in such embodiments, the end cap structure is shaken such that buttons 606 disengage from apertures 406.

It should be understood that the figures illustrate the illustrative embodiments in detail, and it should be understood that the present application is not limited to the details or methodology set forth in the description or illustrated in the figures. It should also be understood that the terminology is for the purpose of description only and should not be regarded as limiting.

Further modifications and alternative embodiments of various aspects of the invention will be apparent to those skilled in the art in view of this description. Accordingly, this description is to be construed as illustrative only. The construction and arrangements, shown in the various exemplary embodiments, are illustrative only. Although only a few embodiments have been described in detail in this disclosure, many modifications are possible (e.g., variations in sizes, dimensions, structures, shapes and proportions of the various elements, values of parameters, mounting arrangements, use of materials, colors, orientations, etc.) without materially departing from the novel teachings and advantages of the subject matter described herein. Some elements shown as integrally formed may be constructed of multiple parts or elements, the position of elements may be reversed or otherwise varied, and the nature or number of discrete elements or positions may be altered or varied. The order or sequence of any process, logical algorithm, or method steps may be varied or re-sequenced according to alternative embodiments. Other substitutions, modifications, changes and omissions may also be made in the design, operating conditions and arrangement of the various illustrative embodiments without departing from the scope of the present invention.

Unless otherwise expressly stated, it is in no way intended that any method set forth herein be construed as requiring

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that its steps be performed in a specific order. Accordingly, where a method claim does not actually recite an order to be followed by its steps or it is not otherwise specifically stated in the claims or descriptions that the steps are to be limited to a specific order, it is in no way intended that any particular order be inferred. In addition, as used herein, the article “a” is intended to include one or more component or elements, and is not intended to be construed as meaning only one. As used herein, rigidly coupled refers to two components being coupled in a manner such that the components move together in fixed positional relationship when acted upon by a force.

Various embodiments of the invention relate to any combination of any of the features, and any such combination of features may be claimed in this or future applications. Any of the features, elements, or components of any of the illustrative embodiments discussed above may be utilized alone or in combination with any of the features, elements, or components of any of the other embodiments discussed above.

What is claimed is:

**1.** A level comprising:

a level body comprising an upper wall, a lower wall and two sidewalls extending therebetween, wherein inner surfaces of each of the upper wall, of the lower wall and of the two sidewalls define a hollow open area;

a device coupled to the level body that measures an orientation of a surface of the level body;

an end cap assembly removably coupled to an end of the level body, the end cap assembly comprising:

a clip received within the hollow open area of the level body and coupled to the level body, the clip comprising an aperture; and

an outer member comprising a movable wall received within the clip and a projection extending from the movable wall, wherein the projection engages the aperture of the clip coupling the outer member in a fixed position relative to the level body.

**2.** The level of claim **1**, the clip comprising a pair of opposing clip sidewalls that extend from a clip end wall, wherein the aperture of the clip is defined in one of the clip sidewalls.

**3.** The level of claim **2**, the clip comprising a second aperture, wherein one of the apertures is defined in each of the clip sidewalls.

**4.** The level of claim **2**, the clip comprising a boss extending outward from an outer surface of each of the clip sidewalls, and wherein each sidewall of the level body comprises an opening that receives the bosses of the clip.

**5.** The level of claim **2**, the clip comprising a rib slot defined along an outer surface of each of the clip sidewalls, wherein the inner surfaces of each of the level body sidewalls define a rib that is received in one of the rib slots of the clip.

**6.** The level of claim **1**, further comprising a locking member received within the outer member.

**7.** The level of claim **6**, the outer member comprising a sidearm, and wherein the locking member pushes the sidearm to create a frictional coupling that secures the end cap assembly to the level body.

**8.** The level of claim **6**, wherein the locking member is formed from a material that is more rigid than a material of the outer member.

**9.** The level of claim **6**, the locking member comprising a stop structure that engages a cooperating surface of the outer member such that full removal of the locking member

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from the outer member is prevented when the locking member is in an unlocked position.

**10.** The level of claim **1**, the outer member comprising a cap portion, a first sidearm extending outward from an upper end of the cap portion and a second sidearm extending outward from a lower end of the cap portion.

**11.** The level of claim **10**, wherein the first sidearm extends along the inner surface of the upper wall of the level body and the second sidearm extends along the inner surface of the lower wall of the level body when the outer member is received within the clip.

**12.** A level comprising:

a level body comprising an upper wall, a lower wall and two sidewalls extending therebetween, wherein inner surfaces of each of the upper wall, of the lower wall and of the two sidewalls define a hollow open area;

a device coupled to the level body that measures an orientation of a surface of the level body;

an end cap assembly removably coupled to an end of the level body, the end cap assembly comprising:

a clip received within the hollow open area of the level body and coupled to the level body;

an outer member received within the clip; and

a locking member received within the outer member, wherein the locking member is moveable within the outer member between a locked position and an unlocked position, wherein, in the locked position, the end cap assembly is engaged in a fixed position relative to the level body.

**13.** The level of claim **12**, the outer member comprising a sidearm, and wherein the locking member pushes the sidearm to create a frictional coupling that secures the end cap assembly to the level body.

**14.** The level of claim **12**, the clip comprising:

a pair of opposing clip sidewalls that extend from a clip end wall; and

an aperture defined in one of the sidewalls;

wherein the device coupled to the level body that measures an orientation of a surface of the level body comprises a spirit level vial, a digital level and an accelerometer.

**15.** The level of claim **14**, the clip comprising a boss extending outward from an outer surface of each of the clip sidewalls, and wherein each sidewall of the level body comprises an opening that receives the bosses of the clip.

**16.** The level of claim **14**, the clip comprising a rib slot defined along an outer surface of each of the clip sidewalls, wherein the inner surfaces of each of the level body sidewalls define a rib that is received in one of the rib slots of the clip.

**17.** A level comprising:

a level body comprising an upper wall, a lower wall and two sidewalls extending therebetween, wherein inner surfaces of each of the upper wall, of the lower wall and of the two sidewalls define a hollow open area;

a device coupled to the level body that measures an orientation of a surface of the level body; and

an end cap assembly removably coupled to an end of the level body, the end cap assembly comprising:

a clip received within the hollow open area of the level body and coupled to the level body, the clip comprises:

a pair of opposing clip sidewalls that extend from a clip endwall, wherein the pair of clip sidewalls each extend along the inner surface of one of the sidewalls of the level body; and

a rib slot defined along an outer surface of each of the clip sidewalls, wherein inner surfaces of each of the level body sidewalls define a rib that is received in one of the rib slots of the clip; and a locking member received within the clip. 5

**18.** The level of claim **17**, the clip comprising a boss extending outward from an outer surface of each of the clip sidewalls, and wherein each sidewall of the level body comprises an opening that receives the bosses of the clip.

**19.** The level of claim **17**, further comprising an outer member received within the clip, wherein the locking member is received within the outer member and the clip, and wherein the locking member is moveable within the outer member between a locked position and an unlocked position, wherein, in the locked position, the end cap assembly is engaged in a fixed position relative to the level body. 15

**20.** The level of claim **19**, the clip comprising an aperture and the outer member comprises a movable wall and a projection extending from the movable wall, wherein the projection engages the aperture of the clip thereby coupling the outer member in a fixed position relative to the level body. 20

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