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(54) Titre : ENCEINTE DOTEE D'UNE CONCEPTION DE CHARNIERE A CENTRAGE AUTOMATIQUE POUR UN SCELLEMENT CONCENTRIQUE

(54) Title: ENCLOSURE WITH SELF CENTERING HINGE DESIGN FOR CONCENTRIC SEALING

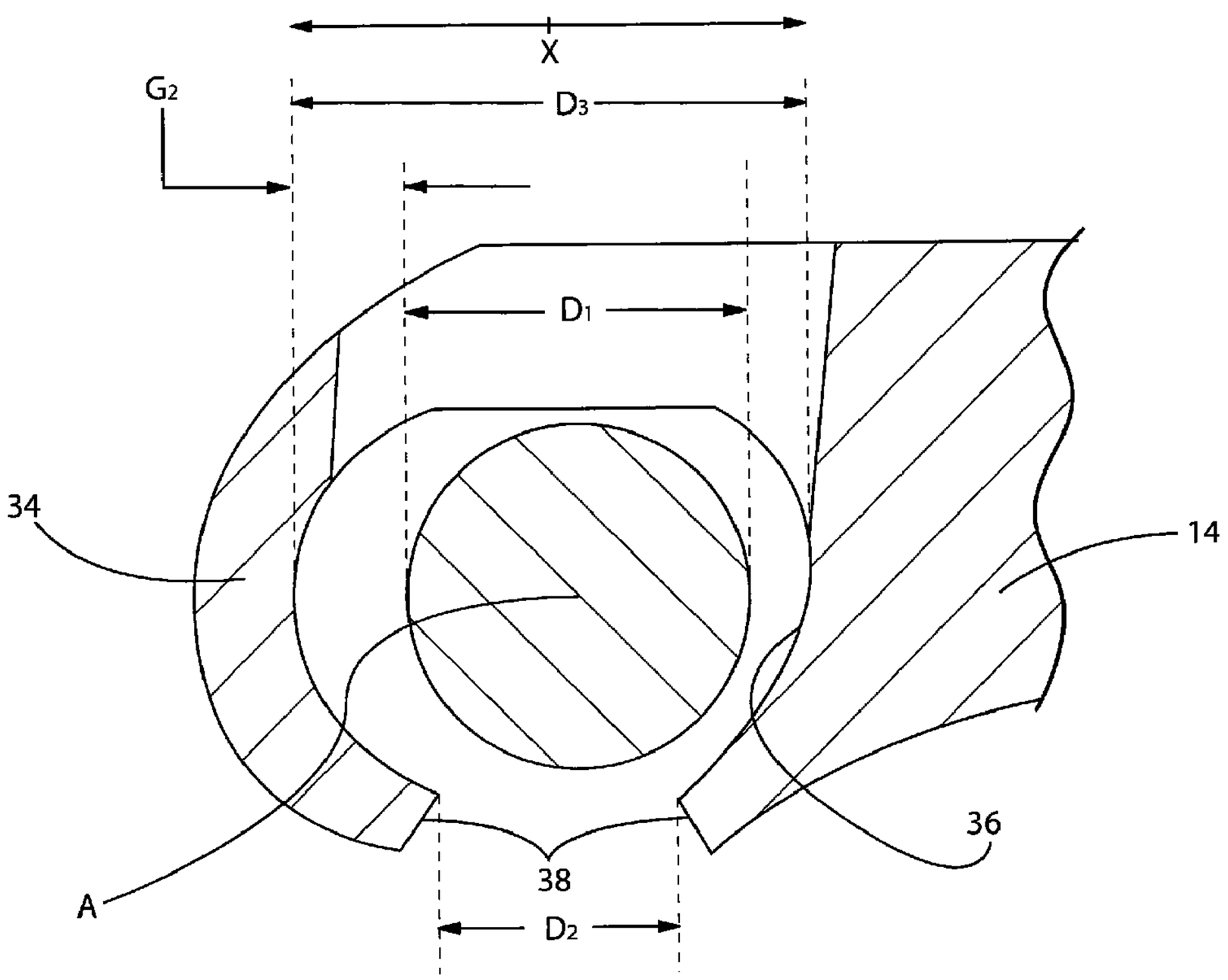

FIG. 5

(57) Abrégé/Abstract:
A waterproof, clam-shell style enclosure (10) including a first cover (14), a second cover (12) that is hingedly coupled to the first cover to pivot about an axis of rotation '?' between an open state and a closed state defining an enclosed interior region of the

CA 2811697 A1 2012/03/29

(21) 2 811 697

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(57) Abrégé(suite)/Abstract(continued):
enclosure, a seal (24) positioned to limit or prevent the passage of fluid into the enclosed interior region of the enclosure, and a hinge (16,18) that is configured to accommodate translation of the second cover with respect to the first cover in two different, perpendicular directions upon pivoting the second cover to a closed state to achieve uniform compression of the seal along its circumference.

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[Continued on next page]

(54) **Title**: ENCLOSURE WITH SELF CENTERING HINGE DESIGN FOR CONCENTRIC SEALING

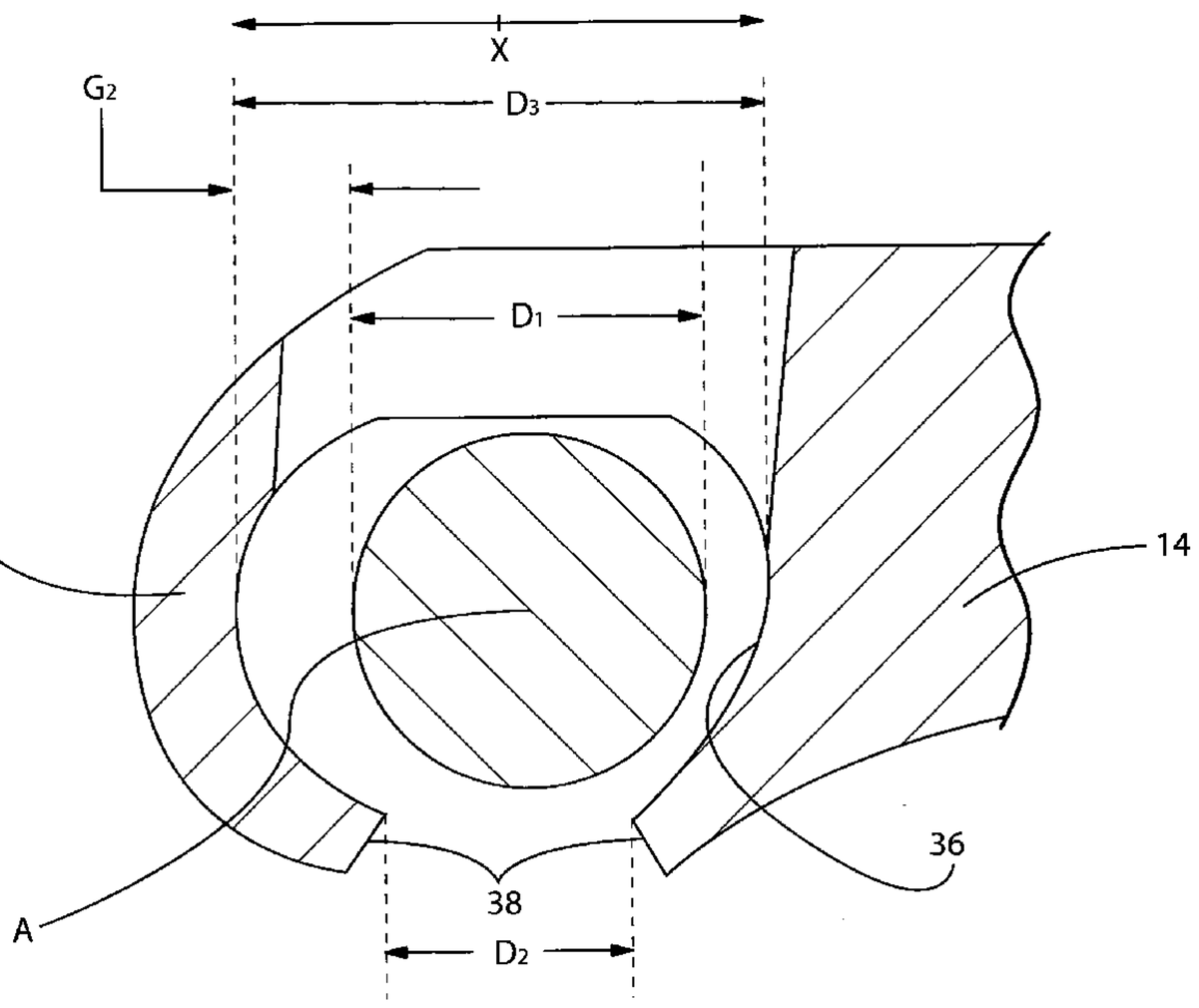

FIG. 5

(57) **Abstract**: A waterproof, clam-shell style enclosure (10) including a first cover (14), a second cover (12) that is hingedly coupled to the first cover to pivot about an axis of rotation 'A' between an open state and a closed state defining an enclosed interior region of the enclosure, a seal (24) positioned to limit or prevent the passage of fluid into the enclosed interior region of the enclosure, and a hinge (16,18) that is configured to accommodate translation of the second cover with respect to the first cover in two different, perpendicular directions upon pivoting the second cover to a closed state to achieve uniform compression of the seal along its circumference.

WO 2012/040289 A1

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ENCLOSURE WITH SELF CENTERING HINGE DESIGN FOR CONCENTRIC SEALING

TECHNICAL FIELD

This invention generally relates to sealable hinged enclosures and, more specifically, to a self centering hinge design for concentric sealing of such enclosures.

BACKGROUND OF THE INVENTION

Clamshell-style sealable enclosures are waterproof or weatherproof enclosures that are employed to safely store articles, such as electronics, batteries or phones, for example. Such enclosures may be more commonly referred to as dry boxes. One example of a clamshell style sealable enclosure is disclosed in U.S. Patent No. 7,341,144 to Tajiri et al., which is incorporated by reference.

Clamshell-style sealable enclosures generally include two covers that are rotatably connected together by a conventional fixed hinge. In use, upon mating the covers together, a seal that's positioned on one of the covers inhibits the introduction of water, air or other contaminants into the sealed interior of the enclosure. The fixed hinges of the enclosure are typically pinned or snapped together and rotate about a fixed axis.

It is a goal of sealed enclosure design to achieve a uniform seal across the entire perimeter of the enclosure to inhibit the introduction of water, air or other contaminants into the interior of enclosure. Due to the structural limitations of a fixed hinge and the cumulative dimensional tolerances of an enclosure, however, the seal may not be uniformly compressed across the perimeter of the enclosure, which can result in decreased or total failure of the enclosure seal. Specifically, the portion of the seal that is closest to the hinge may be more compressed than the portion of the seal that is furthest from the hinge. The enclosure seal may be compromised if compression of the seal is too high in one region and/or too low in another region.

While sealing arrangements that account for a fixed hinge design and cumulative dimensional tolerances are known, those sealing arrangements suffer from various drawbacks. For example, in a crush seal application, the crush seals are oversized to account for the dimensional tolerance accumulation, thereby increasing the weight of the enclosure. In certain applications, such as a night vision goggle battery pack, for example, additional weight is undesirable.

In view of the foregoing, there is a continuing need to further develop and refine hinges for enclosures, in the interests of performance, weight, cost, and manufacturability.

SUMMARY OF THE INVENTION

According to one aspect of the invention, a waterproof, clam-shell style enclosure comprises a first cover; a second cover that is hingedly coupled to the first cover to pivot about an axis of rotation between an open state and a closed state, wherein, in a closed state, the first cover and the second cover define an enclosed interior region of the enclosure for storing an object; a seal positioned on a sealing surface of either the first cover or the second cover, wherein the seal is positioned to inhibit the passage of fluid into the enclosed interior region of the enclosure in the closed state of the enclosure; and a hinge that is configured to accommodate translation of the second cover with respect to the first cover in two different, axially perpendicular directions upon pivoting the second cover to a closed state to achieve uniform compression of the seal along its circumference.

According to another aspect of the invention, a waterproof, clam-shell style enclosure comprises a first cover; a second cover that is hingedly coupled to the first cover to pivot about an axis of rotation between an open state and a closed state, wherein, in a closed state, the first cover and the second cover define an enclosed interior region of the enclosure; a seal positioned on a sealing surface of either the first cover or the second cover, wherein the seal is positioned to limit or prevent the passage of fluid into the enclosed interior region of the enclosure in the closed state of the enclosure; a hinge including a knuckle extending from either the first cover or the second cover and a pin positioned within a recess formed in the knuckle, wherein the knuckle is configured to rotate about the pin; and a gap, having a pre-determined size, defined between an exterior surface of the pin and the recess of the knuckle, wherein, upon pivoting the second cover to the closed state, the gap accommodates translation of the second cover with respect to the first cover in a direction that is orthogonal to both the axis of rotation and the sealing surface to achieve uniform compression of the seal along its circumference.

According to yet another aspect of the invention, a waterproof, clam-shell style enclosure comprises a first cover; a second cover that is hingedly coupled to the first cover to pivot about an axis of rotation between an open state and a closed state, wherein, in a closed state, the first cover and the second cover define an enclosed interior region of the enclosure; a seal positioned on a surface of either the first cover or the second cover, wherein the seal is positioned to inhibit the passage of fluid into the enclosed interior region of the enclosure in the closed state; and a gap, having a pre-determined size, defined between a hinge component of the first cover and a hinge component of the second cover, wherein, upon pivoting the second cover to the closed state, the gap accommodates translation of the second cover with respect

to the first cover in a direction that is parallel to the axis of rotation to achieve uniform compression of the seal along its circumference.

These and other aspects of the present invention will become clear from the detailed discussion below when taken into consideration with the drawings. It is to be understood that the following discussion is intended merely to illustrate the preferred embodiment of the present invention. However, the present invention is not limited to the illustrated embodiment, but is limited solely by the claims appended to this specification.

BRIEF DESCRIPTION OF THE FIGURES

The invention is best understood from the following detailed description when read in connection with the accompanying drawing. It is emphasized that, according to common practice, the various features of the drawing are not to scale. Included in the drawing are the following figures:

FIG. 1 depicts a perspective view of a clam-shell style enclosure that is rotated to an open position, according to one exemplary embodiment of the invention;

FIG. 2 depicts a side view of the open enclosure of FIG. 1;

FIG. 3 depicts a cross-sectional view of the enclosure of FIG. 1 illustrated in a closed position with batteries;

FIG. 4 depicts a plan view of the enclosure of FIG. 1;

FIG. 5 depicts a cross-sectional view of the hinge of the enclosure of FIG. 4 taken along the lines 5-5;

FIG. 6 depicts a detailed view of the hinge of the open enclosure of FIG. 1; and

FIGS. 7-10 depict the covers of the enclosure of FIG. 1 in an unassembled state.

DETAILED DESCRIPTION OF THE INVENTION

Referring generally to the figures, and according to one aspect of the invention, a waterproof, clam-shell style enclosure 10 comprises a first cover 14; a second cover 12 that is hingedly coupled to the first cover 14 to pivot about an axis of rotation 'A' between an open state and a closed state, wherein, in a closed state, the first cover 14 and the second cover 12 define an enclosed interior region of the enclosure 10. A seal 24 is positioned on a sealing surface 23 of either the first cover 14 or the second cover 12, wherein the seal 24 is positioned to inhibit the passage of fluid into the enclosed interior region of the enclosure 10 in the closed state of the enclosure 10. A hinge 16, 18 is configured to accommodate translation of the second cover 12 with respect to the first cover 14 in the 'X' and 'Y' directions upon pivoting the second cover 12 to a closed state to achieve uniform compression of the seal 24 along

its circumference. Uniform compression of the seal 24 along its circumference inhibits the escape of thermal energy in the form of heat from the sealed interior of enclosure 10 as well as the introduction of fluid or other contaminants into the sealed interior of enclosure 10.

According to another aspect of the invention, the hinge 16, 18 of the enclosure 10 includes a knuckle 34 and a pin 30 positioned within a recess 36 formed in the knuckle 34, wherein the knuckle 34 is configured to rotate about the pin 30. A gap G2, having a pre-determined size, is defined between an exterior surface of the pin 30 and the recess 36 of the knuckle 34, wherein, upon pivoting the second cover 12 to the closed state, the gap G2 accommodates translation of the second cover 12 with respect to the first cover 14 in the 'X' direction that is orthogonal to both the axis of rotation 'A' and the sealing surface 23 to achieve uniform compression of the seal 24 along its circumference.

According to yet another aspect of the invention, the enclosure 10 includes a gap G1, having a pre-determined size, defined between a hinge component 34 of the first cover 14 and a hinge component 32 of the second cover 12, wherein, upon pivoting the second cover 12 to the closed state, the gap G1 accommodates translation of the second cover 12 with respect to the first cover 14 in a direction 'Y' that is parallel to the axis of rotation 'A' to achieve uniform compression of the seal 24 along its circumference.

Referring now to FIGS. 1-6, enclosure 10 is a waterproof, clam-shell style container that generally includes a top cover 12 that is pivotably coupled to a bottom cover 14 along an axis of rotation 'A' by two hinges 16 and 18. Top cover 12 pivots between an open position (see FIG. 1) and a closed position (see FIG. 3) with respect to bottom cover 14, or vice versa. In a closed position, covers 12 and 14 define an interior region that is sized to contain an object. According to one aspect of the invention, enclosure 10 is a battery pack that includes circuitry for establishing an electrical connection to terminals of a battery 20 positioned within the interior region of enclosure 10. It should be understood that enclosure 10 is not limited to a battery pack, as enclosure 10 is capable of storing any object.

Covers 12 and 14 are injection-molded plastic components. Alternatively, covers 12 and 14 may be composed of aluminum and formed by a casting process, for example. It should be understood that covers 12 and 14 may be composed of any material and made by any forming process known to those skilled in the art without departing from the scope of the invention.

Bottom cover 14 includes an upwardly-extending flange 21. A gland 22, in the form of a rectangular slot, is defined around the circumference of the outwardly-

facing sealing surface 23 of flange 21. An elastomeric radial seal 24 is mounted in gland 22 to bear on an interior surface of top cover 12. In use, seal 24 is compressed in a downward direction (as shown) to prevent the introduction of water, air or other contaminants into the sealed interior of enclosure 10.

A flexible locking tab 26 extends from top cover 12. Locking tab 26 is configured for releasably mating with a rectangular slot 28 that is defined on the outer surface of bottom cover 14. Positive engagement between locking tab 26 and slot 28 locks covers 12 and 14 together such that seal 24 is compressed against the interior surface of top cover 12 and covers 12 and 14 are prevented from rotating with respect to each other to an open position. Locking tab 26 is released from its complimentary recess by translating the free end of locking tab 26 inwardly and rotating one of the covers 12 and 14 to an open position.

Enclosure 10 includes two hinges 16 and 18 that are each configured to accommodate translation of top cover 12 with respect to bottom cover 14 (or vice versa) in the 'X' and 'Y' directions. In other words, hinges 16 and 18 each accommodate transverse shifting of an axis of rotation 'A' of enclosure 10 along the X-axis, as well as axial shifting of top cover 12 along the axis of rotation 'A', i.e., along the Y-axis, as seal 24 is being compressed. The hinge design takes advantage of the forces applied by seal 24, as it is compressed, to center top cover 12 onto bottom cover 14. In other words, seal 24 induces translation of top cover 12 in the 'X' and 'Y' directions (which are non-parallel and orthogonal axes) such that a substantially uniform compressive force is applied along the circumference of seal 24.

Hinges 16 and 18 may be commonly referred to as floating, centering or self-centering hinges. Unlike many floating hinges which are only capable of floating along a single axis (typically the Z-axis), hinges 16 and 18 are configured to accommodate relative translation of one of covers 12 and/or 14 along an X-axis and a Y-axis of a Cartesian coordinate system. According to one aspect of the invention, hinges 16 and 18 are each configured to accommodate translation of cover 12 with respect to cover 14 in two different, perpendicular directions 'X' and 'Y' upon pivoting cover 12 to a closed state to achieve uniform compression of seal 24 along its circumference. It should be understood that enclosure 10 may include any number of hinges. Because hinges 16 and 18 are structurally and functionally equivalent, only the structure and function of hinge 18 will be described hereinafter for the purpose of simplifying the description of the invention.

Hinge 18 includes a pin 30 extending from top cover 12 and a knuckle 34 extending from bottom cover 14. Pin 30 and knuckle 34 may also be referred to herein as hinge components. Pin 30 is substantially cylindrical and defines an outer cylindrical

surface. Each end of pin 30 is integrally connected to top cover 12 by a rib 32 that extends from a hinge-side surface of top cover 12, as best shown in FIG. 3. Similarly, knuckle 34 is integrally connected to bottom cover 14 by two ribs 33 that extend from a hinge-side surface of bottom cover 14. Knuckle 34 defines an outer cylindrical surface and a substantially cylindrical interior recess 36. Recess 36 is open-ended, i.e., contains an opening at its lower end, for receiving pin 30. A distended portion 38 is defined on both free ends of recess 36. As best shown in FIG. 9, distended portions 38 extend along only a portion of width W2 of knuckle 34.

As best shown in FIGS. 3 and 5, recess 36 is sized to captively receive pin 30. More particularly, a gap D2 separating opposing distended portions 38 of knuckle 34 is smaller than diameter D1 of pin 30. Accordingly, once pin 30 is positioned within recess 36 it is captivated within recess 36, thereby captivating top cover 12 to bottom cover 14. In assembling pin 30 into recess 36 of knuckle 34, the distended portions 38 of knuckle 34 deflect outwardly to accommodate the larger diameter D1 of pin 30 and snap back to return to their original positions once pin 30 is contained within recess 36 (as shown in FIG. 5). Once pin 30 is captivated within recess 36, pin 30 can not be removed from recess 36 unless a sufficient downward force is applied to deflect distended portions 38 of knuckle 34 outwardly enough to accommodate diameter D1 of pin 30. It should be understood that once pins 30 of hinges 16 and 18 are released from their recesses 36, top cover 12 is detached from bottom cover 14, as shown in FIGS. 7-10.

Each hinge 16 and 18 accommodates translation of top cover 12 in the X and Y directions such that, immediately prior to locking enclosure 10 (i.e., by engaging locking tab 26 in recess 28), top cover 12 is configured to center itself in or along the 'X' and 'Y' axes relative to bottom cover 14 (or vice versa). Self-centering of covers 12 and 14 facilitates uniform compression of seal 24 against the interior surface of top cover 12 along the entire circumference of seal 24. In other words, the floating hinge design permits uniform compression of the entire circumference of seal 24 against the interior surface of top cover 12.

As best illustrated in FIG. 4, immediately prior to locking enclosure 10, covers 12 and 14 are capable of self-centering in the Y-direction (i.e., along the Y-axis) such that compression of seal 24 on side S1 is substantially the same as the compression of seal 24 on side S2 of enclosure 10. To accomplish the self-centering action of top cover 12 along the Y-axis, a gap G1 is defined on both sides of knuckle 34. Gap G1 is the difference between a distance W1 separating the inwardly facing surfaces of ribs 32 and a width W2 of the body of knuckle 34. According to one aspect of the invention gap G1 is about .013 inches and the total width 'W' of enclosure 10 is

about 2.769 inches. According to one aspect of the invention, a ratio of the total width 'W' of enclosure 10 to the gap G1 is about 213:1.

Top cover 12 can translate relative to bottom cover 14, or vice versa, along gap G1 in either direction along the Y-axis. In use, since top cover 12 is relatively unconstrained in the Y-direction (by virtue of gap G1), seal 24 will center top cover 12 along gap G1 until seal 24 applies substantially the same force against top cover 12 along sides S1 and S2 of enclosure 10. According to an aspect of the invention, gap G1 accommodates translation of cover 12 with respect to cover 14 in a direction 'Y' that is parallel to the axis of rotation 'A' to achieve uniform compression of the seal 24 along its circumference.

As best illustrated in FIG. 5, immediately prior to locking enclosure 10, covers 12 and 14 are also capable of centering themselves in the X-direction (i.e., along the X-axis) such that compression of seal 24 on side S3 is substantially the same as the compression of seal 24 on side S4 of enclosure 10 (sides S3 and S4 are shown in FIG. 4). To accomplish the self-centering action of top cover 12 along the X-axis, a gap G2 is defined on both sides of pin 30. Gap G2 is the difference between the diameter D1 of pin 30 and a width D3 of recess 36 of knuckle 34.

The gap G2 is sufficiently large, and larger than gap G1, such that cover 12 can pivot over seal 24 without interference toward the closed position of enclosure 10. According to one aspect of the invention gap G2 is about .045 inches and the total length 'L' of enclosure 10 (see FIG. 4) is about 2.482 inches. According to one aspect of the invention, a ratio of the total length 'L' of enclosure 10 to the gap G2 is about 55:1.

Top cover 12 can translate relative to bottom cover 14, or vice versa, along gap G2 in either direction along the X-axis. In use, since top cover 12 is relatively unconstrained in the X-direction (by virtue of gap G2), seal 24 will center the top cover along gap G2 until seal 24 applies substantially the same force against top cover 12 along sides S3 and S4 of enclosure 10. According to an aspect of the invention, gap G2 accommodates translation of the cover 12 with respect to the cover 14 in a direction 'X' that is orthogonal to both axis of rotation 'A' and sealing surface 23 to achieve uniform compression of the seal 24 along its circumference.

In designing a clam-shell enclosure having a fixed hinge, the following dimensional tolerances are accounted for to ensure sufficient compression of a radial seal: (1) the distance from a sealing surface of a first cover to the pin, (2) the size (e.g., diameter) of the pin, (3) the size (e.g., diameter) of the knuckle recess in the second cover, (4) the distance from the knuckle recess to the sealing surface of the second cover, (5) the distances between opposing sealing surfaces of the first cover,

(6) the distances between opposing sealing surfaces of the second cover, and (7) the protruding height of the seal. Ordinarily, the protruding height of the seal is oversized to account for tolerances (1) through (5).

Alternatively, by employing a floating hinge design, only the following dimensional tolerances are accounted for to ensure uniform compression of a radial seal: (a) the distances between opposing sealing surfaces of the first cover, (b) the distances between opposing sealing surfaces of the second cover, and (c) the protruding height of the seal. The floating hinge design compensates for tolerances (1) through (4) that were described above. Eliminating several of the accumulated tolerances provides for better control of the seal compression. In contrast, a large accumulation of tolerances makes it difficult to ensure appropriate compression of the seal. Additionally, eliminating several of the accumulated tolerances reduces the overall size of seal 24. A smaller seal is lighter, which reduces the entire weight of enclosure 10.

By way of non-limiting example the enclosure described herein, or modified versions thereof, may be used in the following applications: a storage container, a battery pack, and a battery pack for a helmet-mounted night vision system.

Although the invention is illustrated and described herein with reference to specific embodiments, the invention is not intended to be limited to the details shown. Rather, various modifications may be made in the details within the scope and range of equivalents of the claims and without departing from the spirit of the invention. For example, according to the exemplary embodiment of the invention, pins 30 are integral with top cover 12 and knuckle 34 is integral with bottom cover 14. According to another exemplary embodiment of the invention that is not shown herein, both covers 12 and 14 include knuckles and the pin is a separate component that engages the knuckles of both covers 12 and 14 (similar to a conventional door hinge). Additionally, it should be understood that pin 30 may be provided on bottom cover 14 and knuckle 34 may be provided on top cover 12 without departing from the scope or the spirit of the invention.

What is Claimed:

1. A waterproof, clam-shell style enclosure comprising:

a first cover;

a second cover that is hingedly coupled to the first cover to pivot about an axis of rotation between an open state and a closed state, wherein, in a closed state, the first cover and the second cover define an enclosed interior region of the enclosure for storing an object;

a seal positioned on a sealing surface of either the first cover or the second cover, wherein the seal is positioned to inhibit the passage of fluid or gas into or out of the enclosed interior region of the enclosure in the closed state of the enclosure; and

a hinge connecting the first cover to the second cover that is configured to accommodate translation of the second cover with respect to the first cover in two different, perpendicular directions 'X' and 'Y' upon pivoting the second cover to a closed state to achieve uniform compression of the seal along its circumference.

2. The enclosure of claim 1, wherein the hinge is configured to accommodate translation of the second cover with respect to the first cover along both an X-axis and a Y-axis of a Cartesian coordinate system.

3. The enclosure of claim 1, wherein the enclosure is a battery pack that includes circuitry for establishing an electrical connection to terminals of a battery.

4. The enclosure of claim 1, wherein the first cover is releasably captivated to the second cover.

5. The enclosure of claim 1, wherein the seal is formed from an elastomeric material.

6. The enclosure of claim 1 further comprising a flexible tab extending from one of the covers, wherein the flexible tab is configured to releasably engage the other cover to retain the enclosure in a closed state.

7. The enclosure of claim 6 further comprising a recess formed in said other cover, wherein the flexible tab is configured to releasably engage the recess of said other cover to retain the enclosure in a closed state.

8. A waterproof, clam-shell style enclosure comprising:

a first cover;

a second cover that is hingedly coupled to the first cover to pivot about an axis of rotation between an open state and a closed state, wherein, in a closed state, the first cover and the second cover define an enclosed interior region of the enclosure;

a seal positioned on a sealing surface of either the first cover or the second cover, wherein the seal is positioned to inhibit the passage of fluid into the enclosed interior region of the enclosure in the closed state of the enclosure;

a hinge connecting the first cover to the second cover that includes a knuckle extending from either the first cover or the second cover and a pin positioned within a recess formed in the knuckle, wherein the knuckle is configured to rotate about the pin; and

a gap, having a pre-determined size, defined between an exterior surface of the pin and the recess of the knuckle, wherein, upon pivoting the second cover to the closed state, the gap accommodates translation of the second cover with respect to the first cover in a direction that is orthogonal to both the axis of rotation and the sealing surface to achieve uniform compression of the seal along its circumference.

9. The enclosure of claim 8, wherein the recess of the knuckle and the outer surface of the pin are both substantially cylindrical, and a diameter of the recess is greater than a diameter of the pin such that a difference between the diameters establishes the gap.

10. A waterproof, clam-shell style enclosure comprising:

a first cover;

a second cover that is hingedly coupled to the first cover to pivot about an axis of rotation between an open state and a closed state, wherein, in a closed state, the first cover and the second cover define an enclosed interior region of the enclosure;

a seal positioned on a surface of either the first cover or the second cover, wherein the seal is positioned to inhibit the passage of fluid into the enclosed interior region of the enclosure in the closed state; and

a gap, having a pre-determined size, defined between a hinge component of the first cover and a hinge component of the second cover, wherein, upon pivoting the second cover to the closed state, the gap accommodates translation of the second cover with respect to the first cover in a direction that is parallel to the axis of rotation to achieve uniform compression of the seal along its circumference.

11. The enclosure of claim 10, wherein the hinge component of the first cover is a hinge knuckle and the hinge component of the second cover is two opposing ribs, wherein the hinge knuckle is positioned between the two opposing ribs, and the gap is formed between the hinge knuckle and at least one of the opposing ribs.

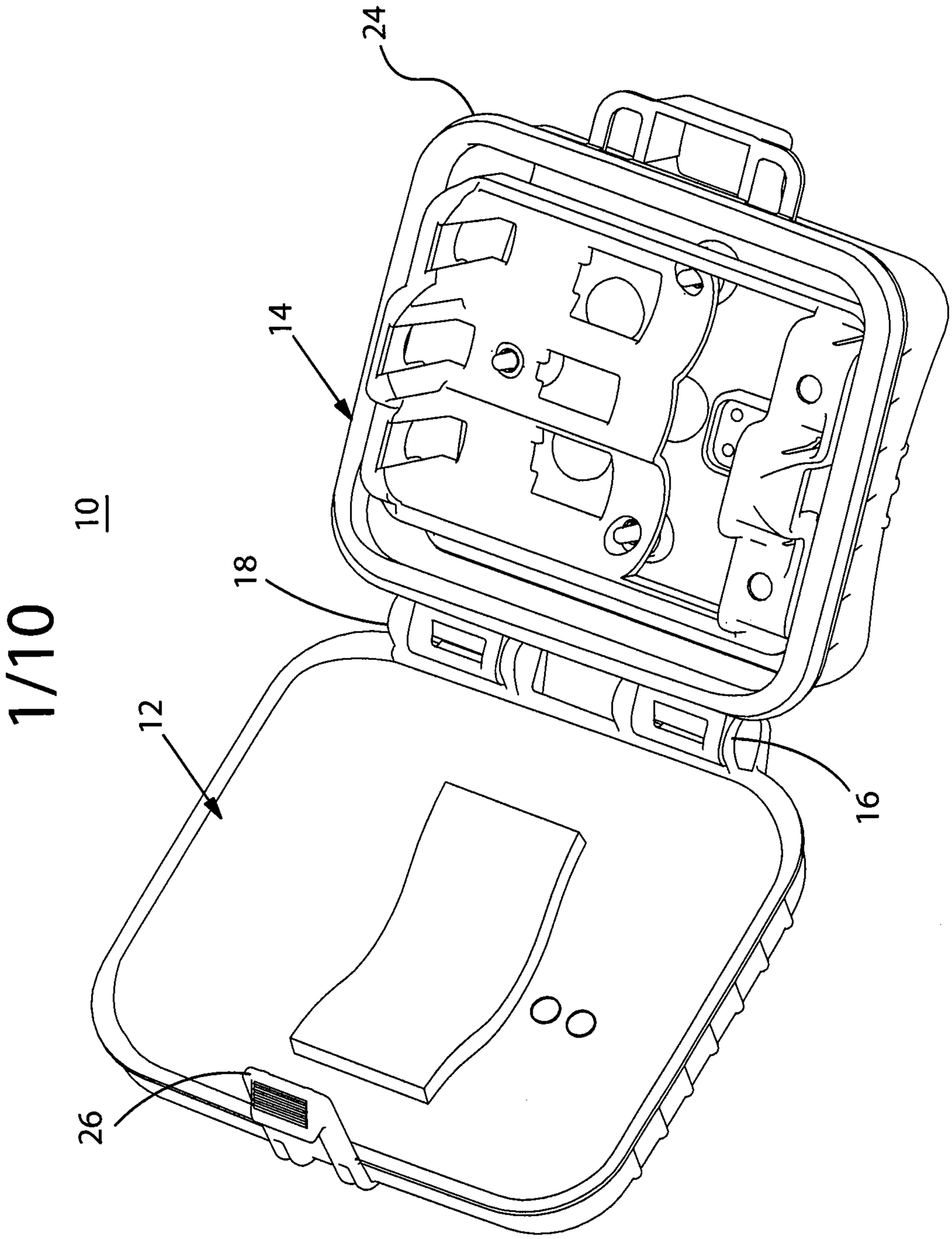


FIG. 1

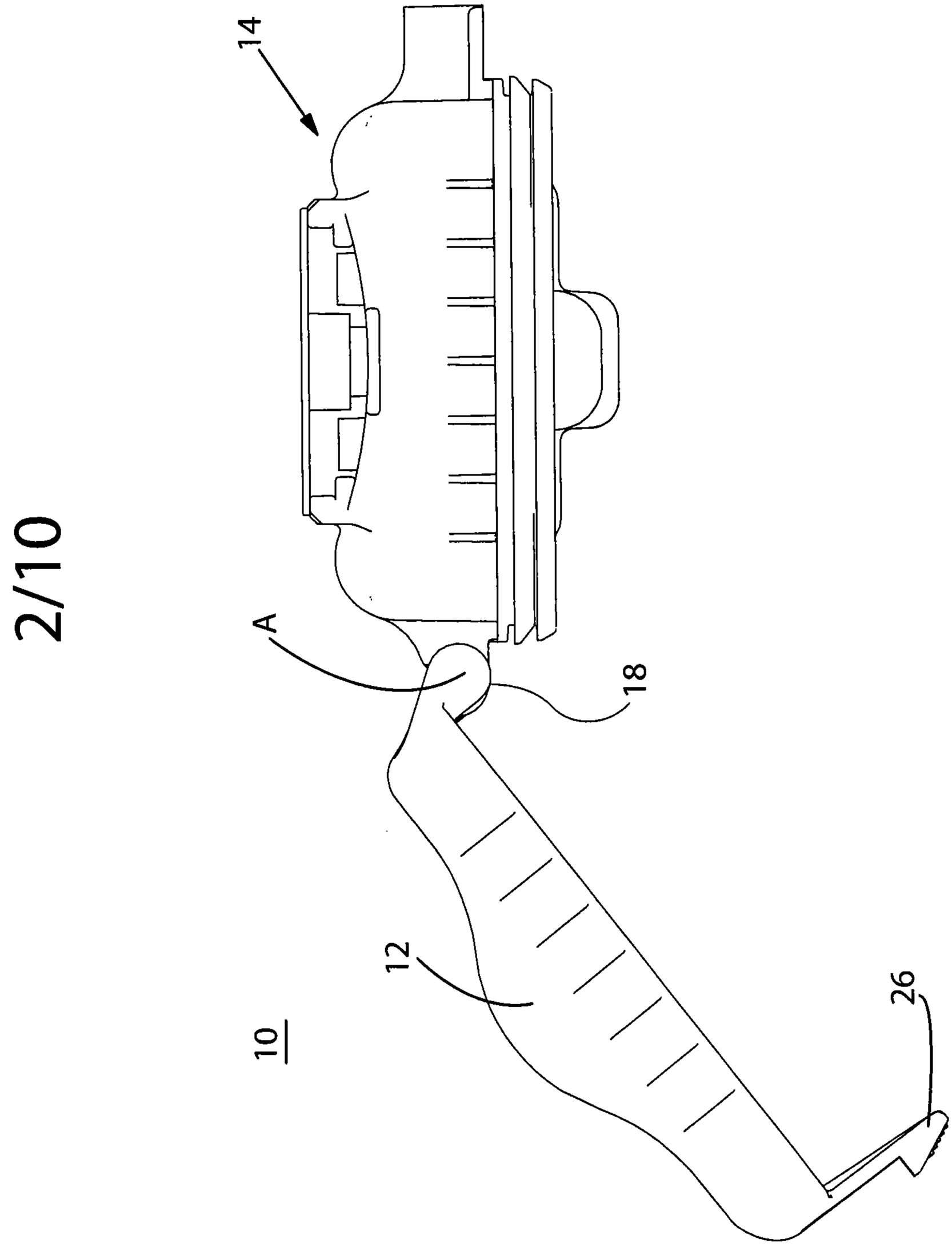


FIG. 2

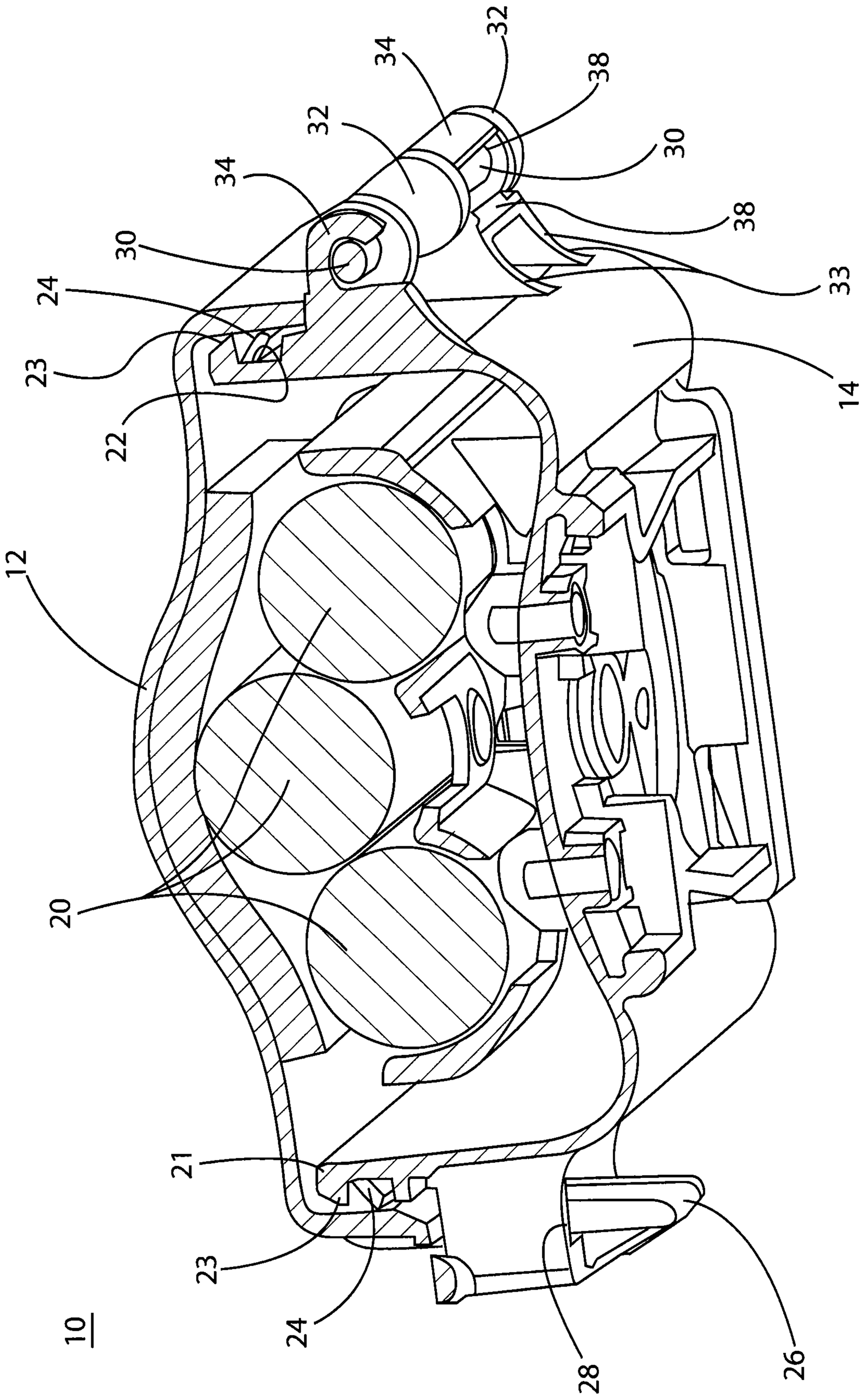


FIG. 3

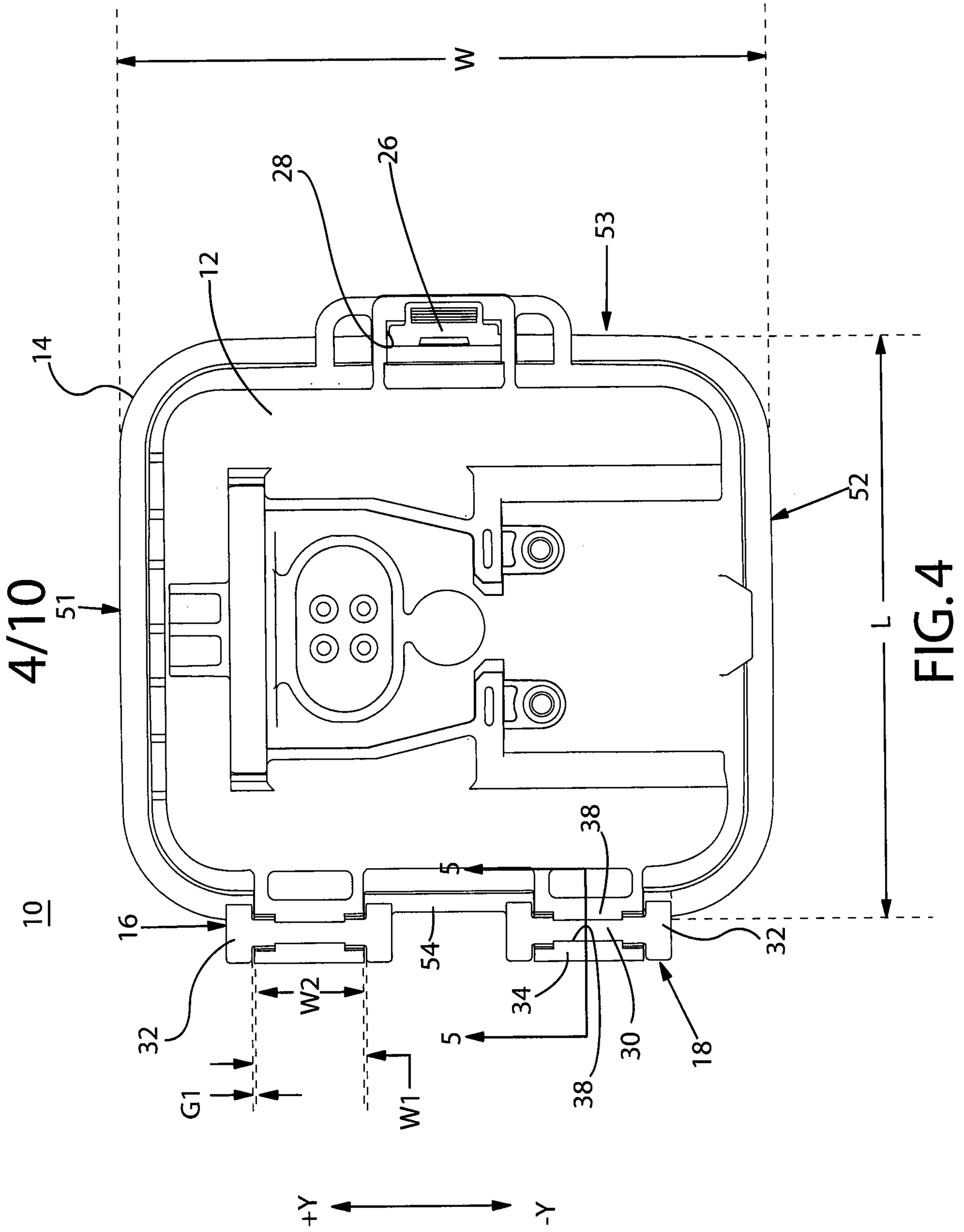
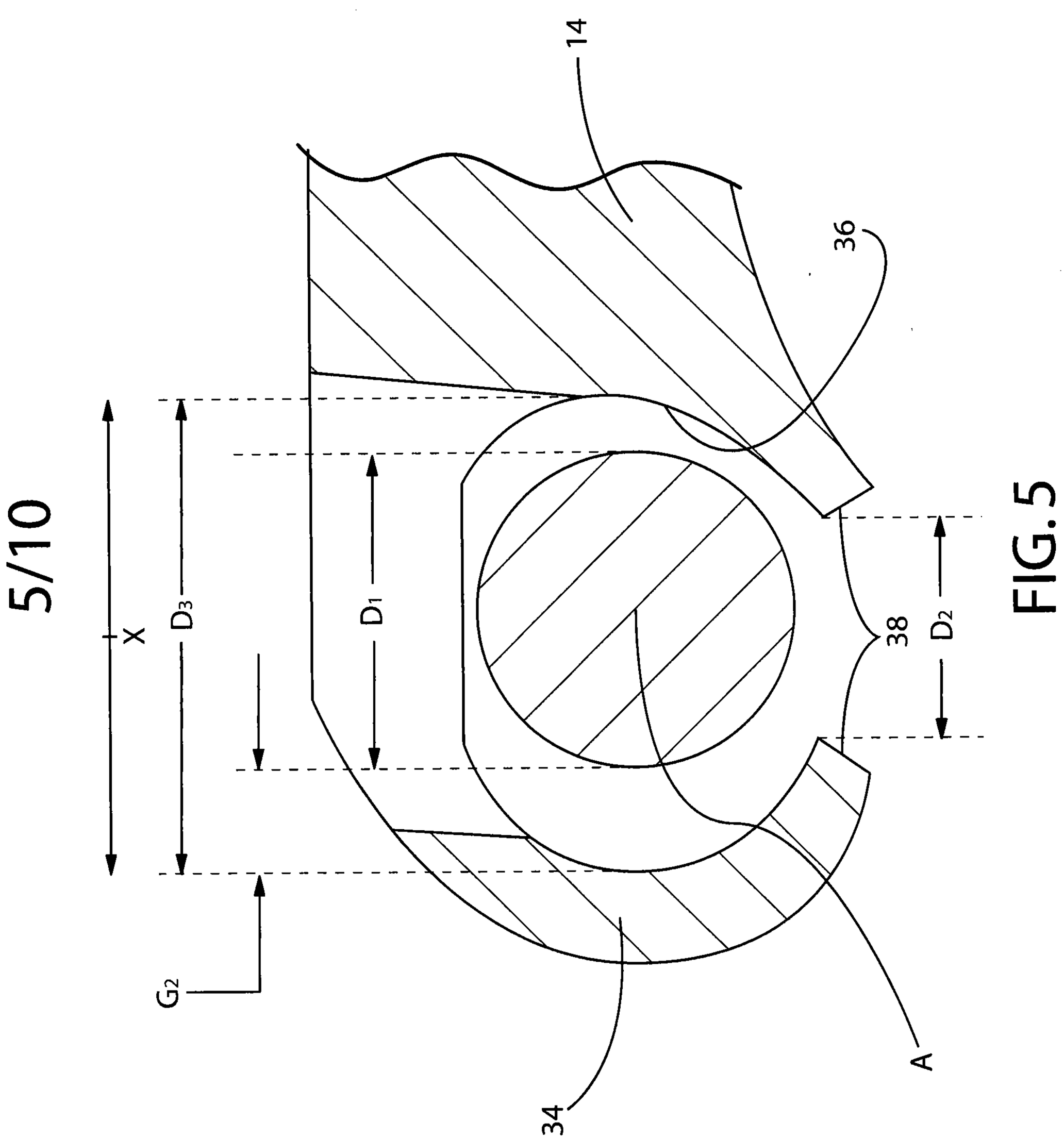


FIG.4



5/10

FIG.5

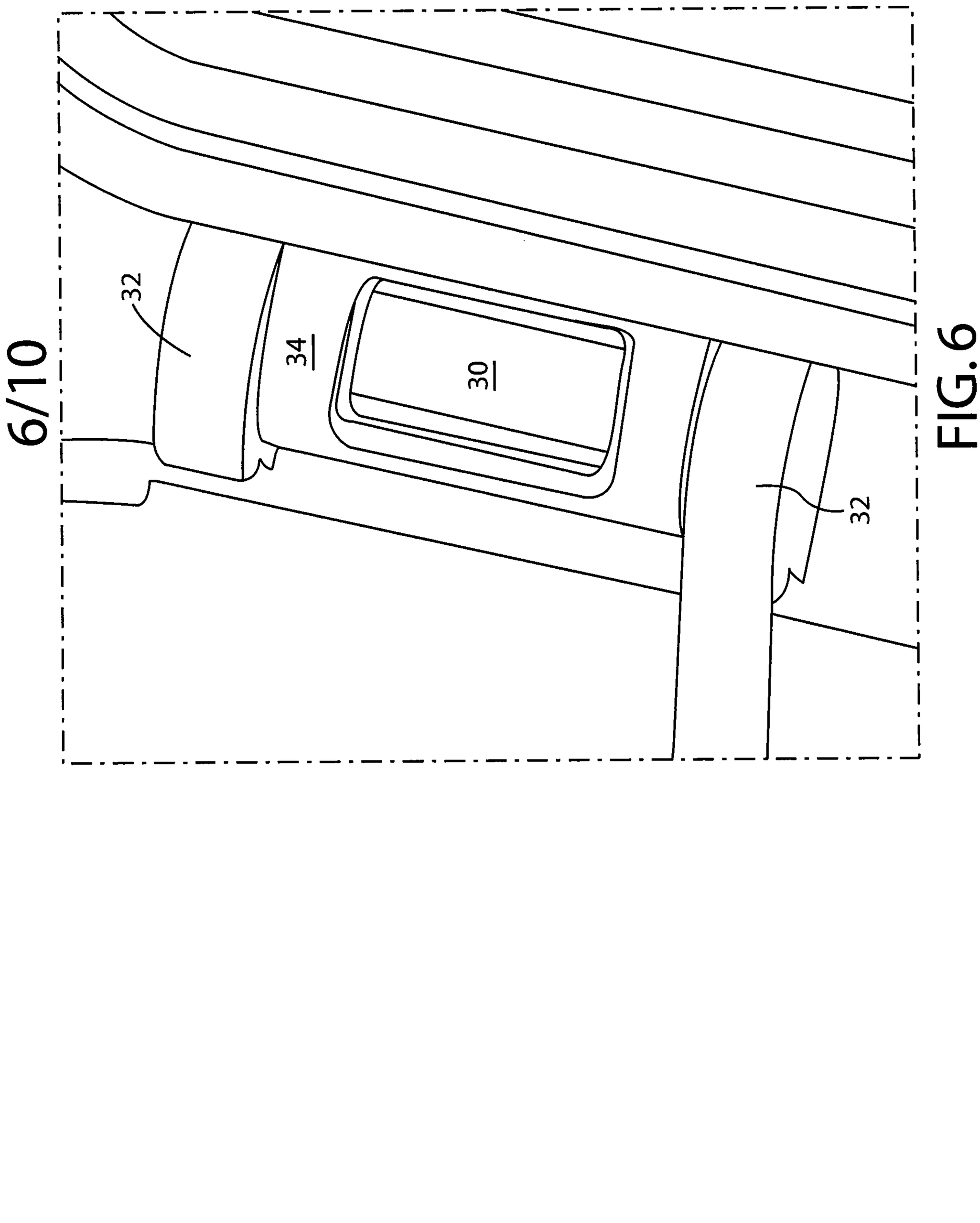


FIG.6

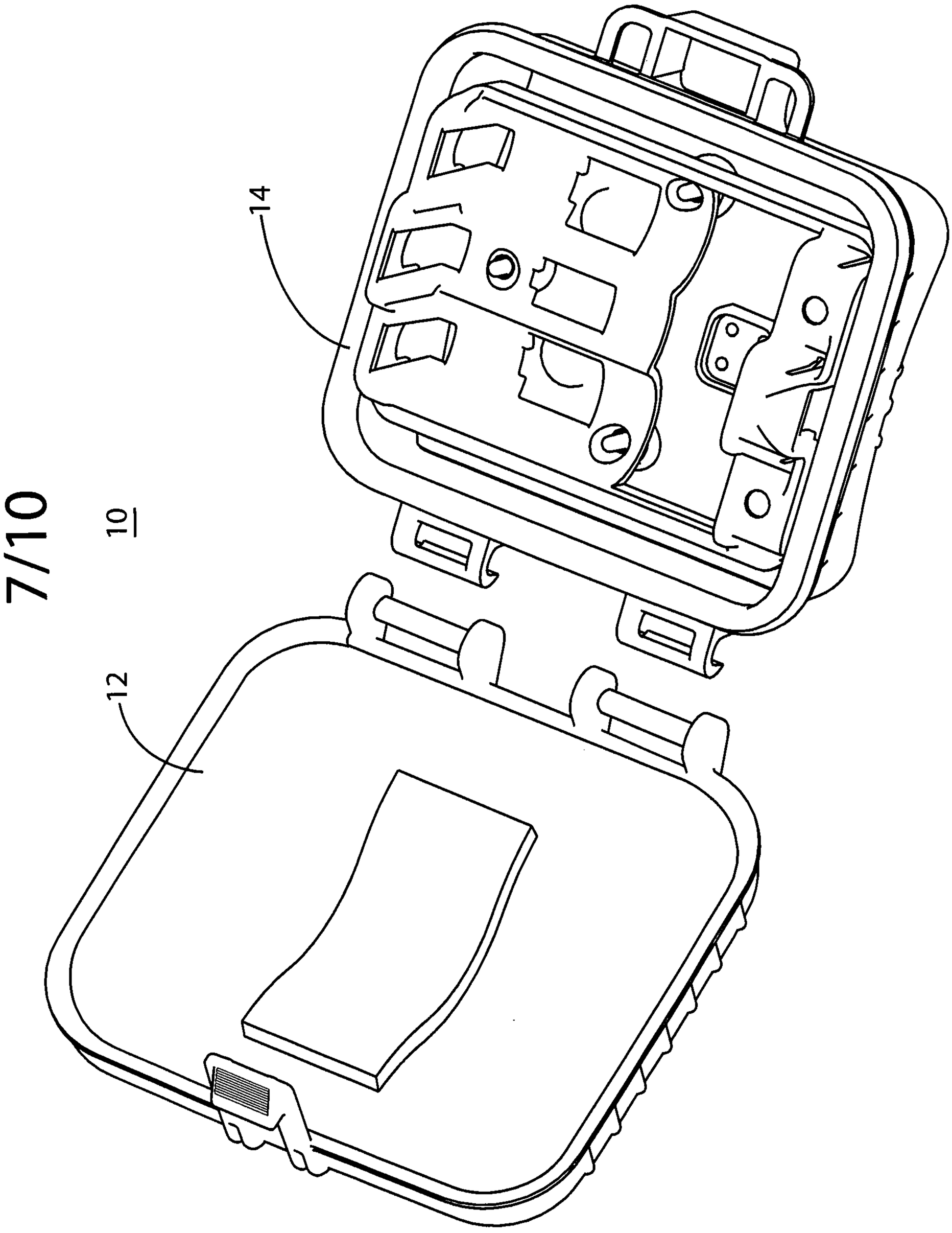


FIG. 7

8/10

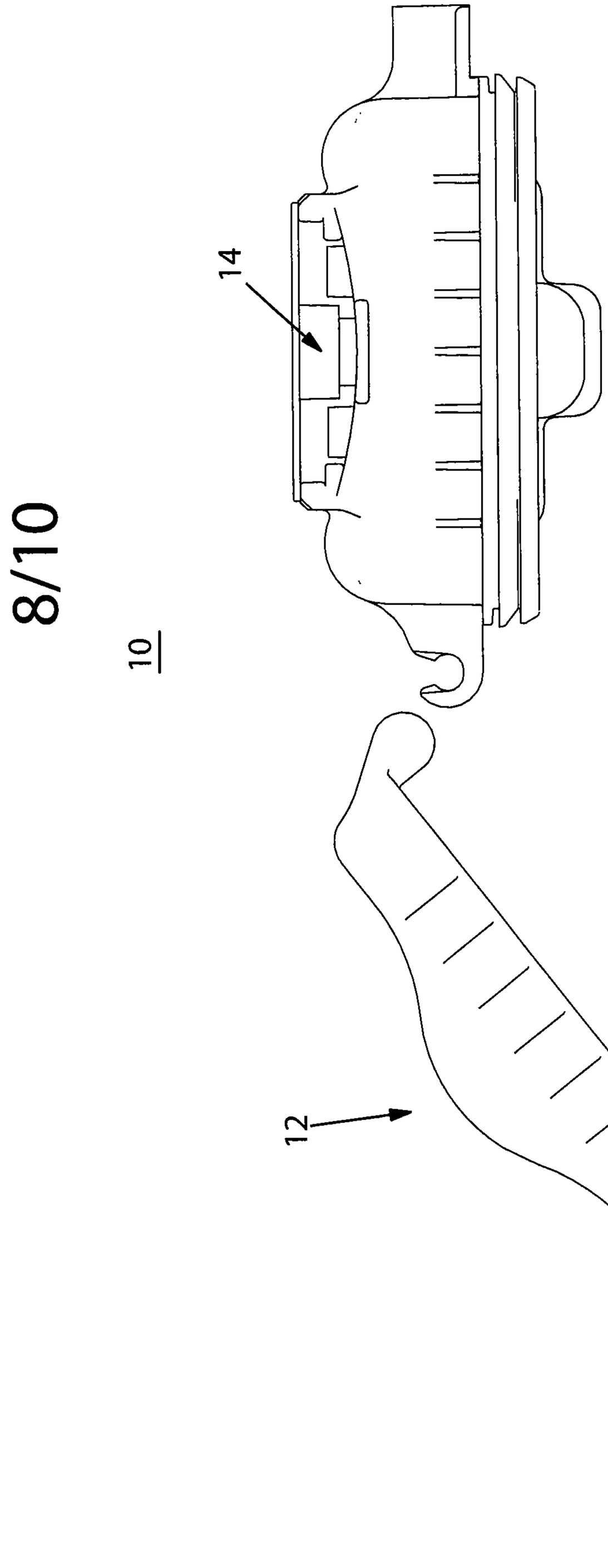


FIG.8

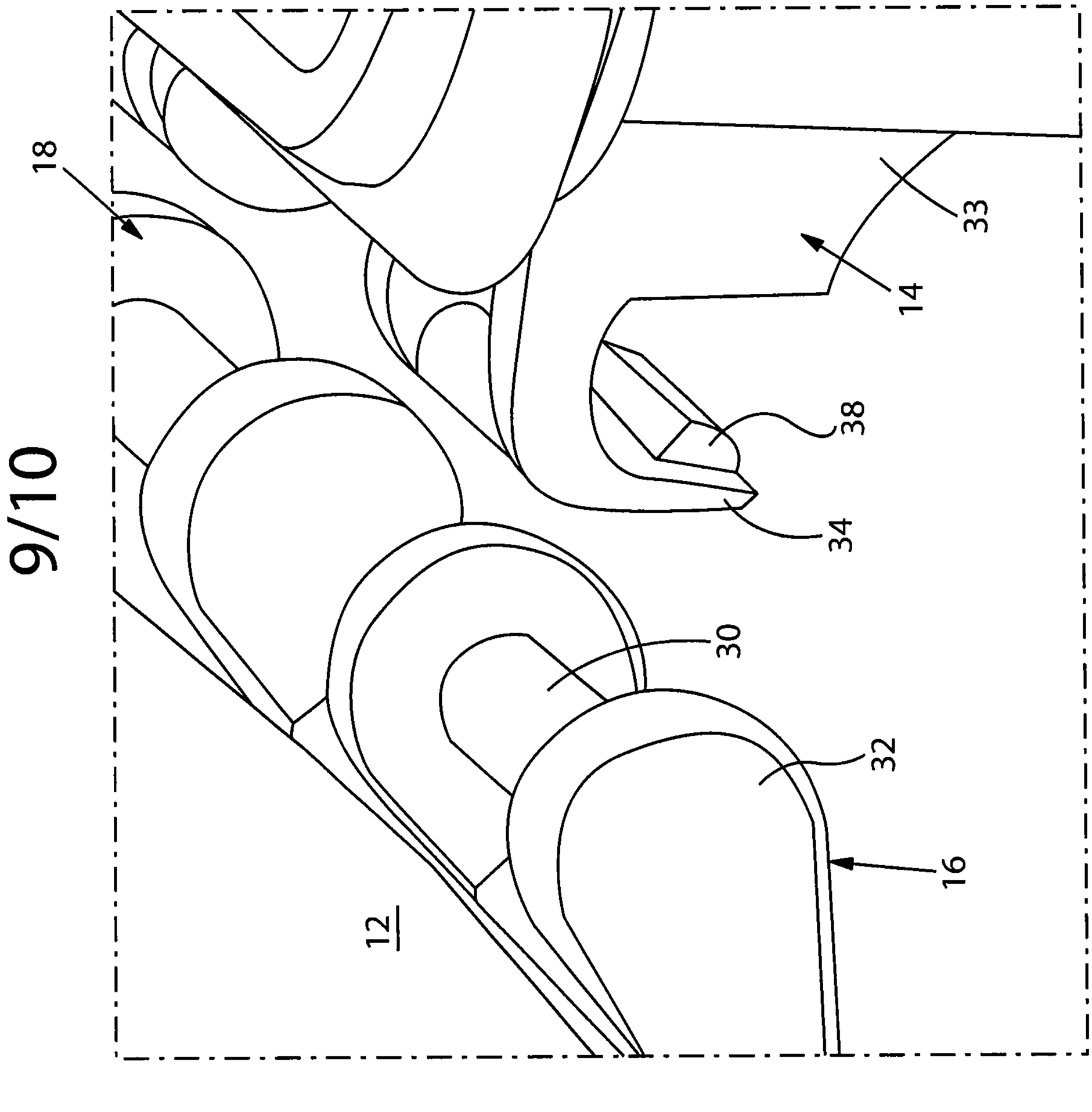


FIG. 9

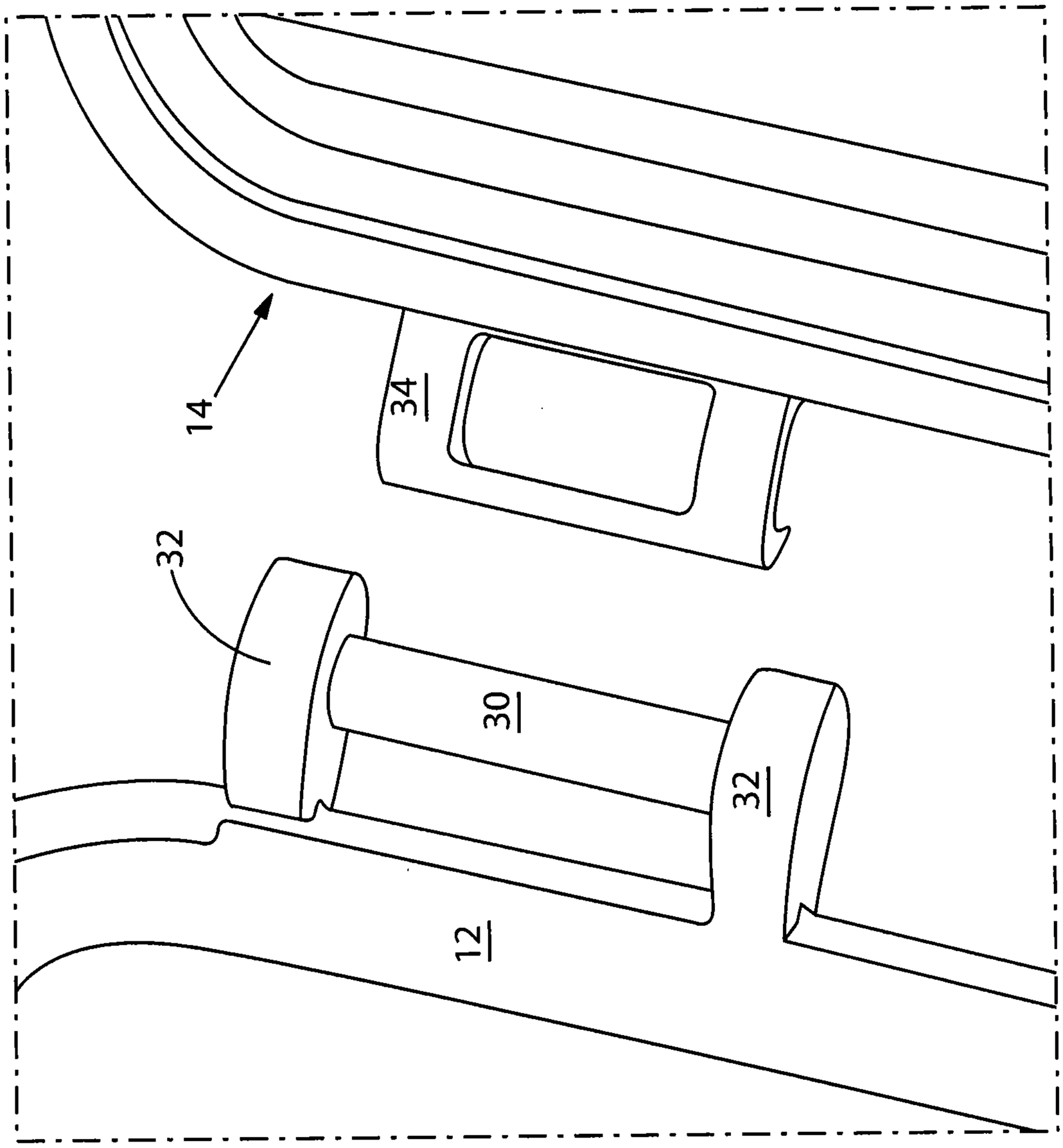


FIG. 10

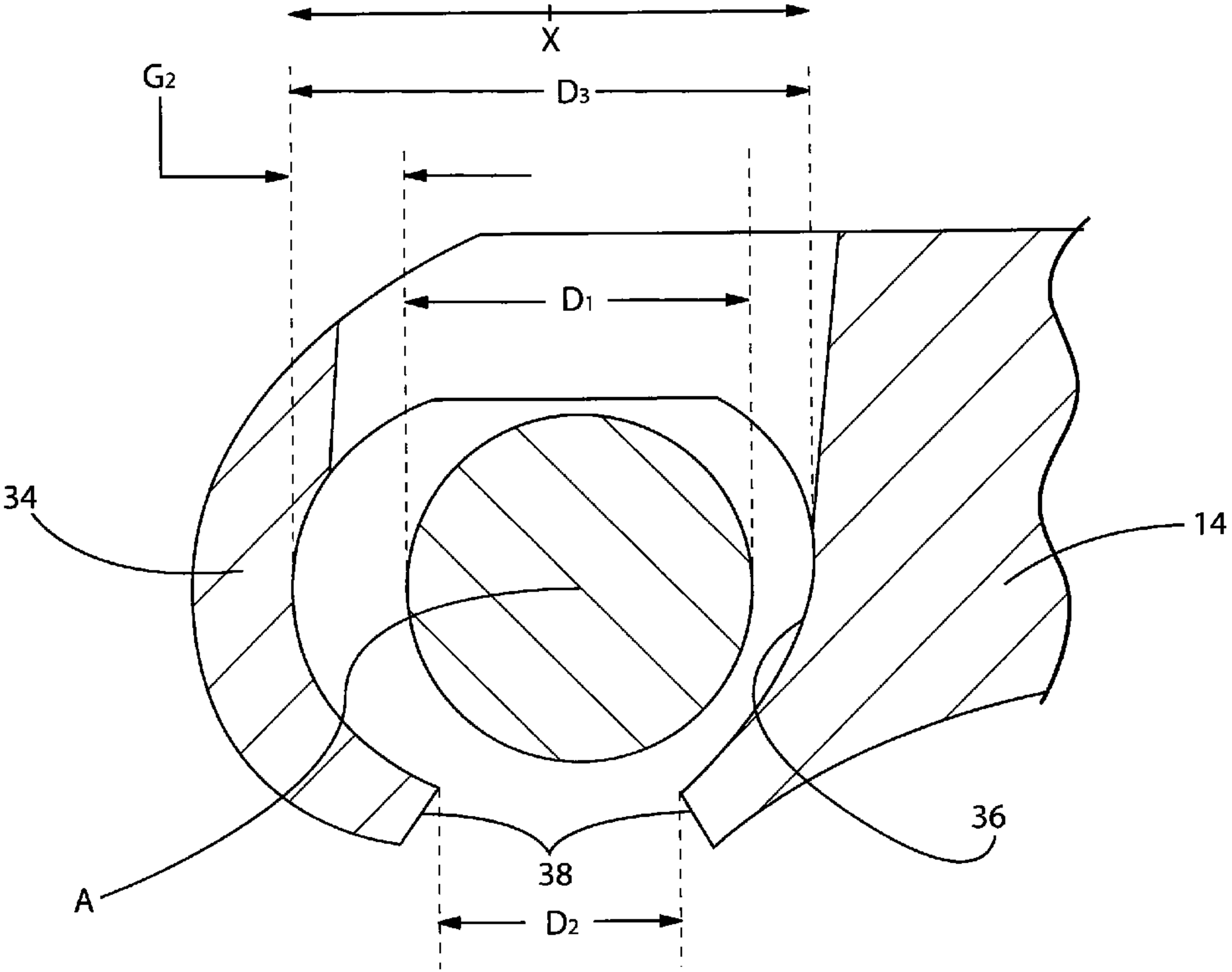


FIG. 5