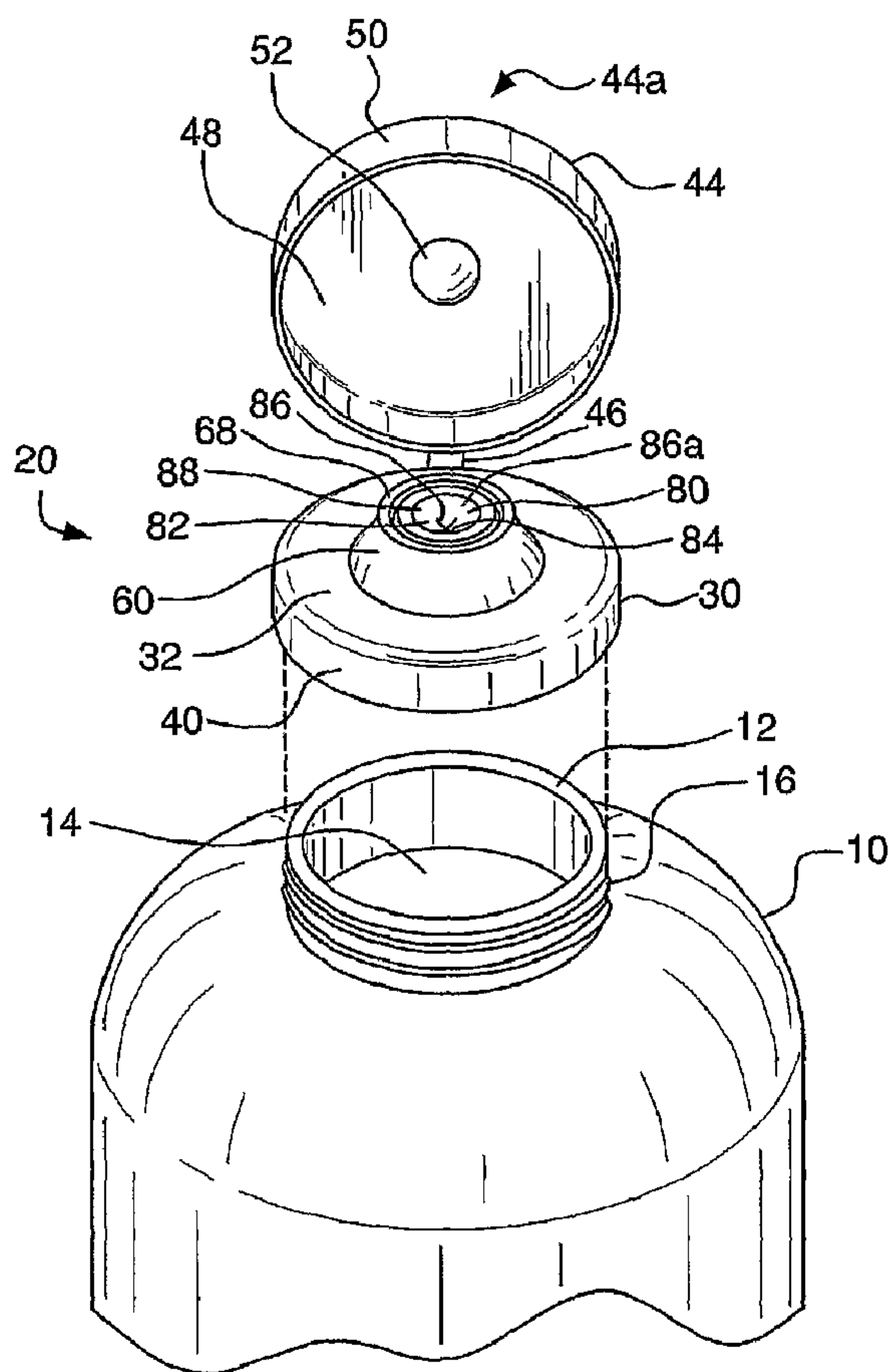




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 (54) Title: CONTAINER CLOSURE AND METHOD OF ASSEMBLY



(57) **Abrégé/Abstract:**

A container closure includes a base with a valve mount portion formed from a first thermoplastic material and a valve formed from a second thermoplastic material. The valve is bonded to the valve mount portion. A lid is hingebly attached to the base and includes

(57) Abrégé(suite)/Abstract(continued):

a sealing rim extending from a surface of the lid and designed to engage the valve at the location where the valve seals to the valve mount portion. The engagement of the sealing rim with the valve forming a seal between the two components.

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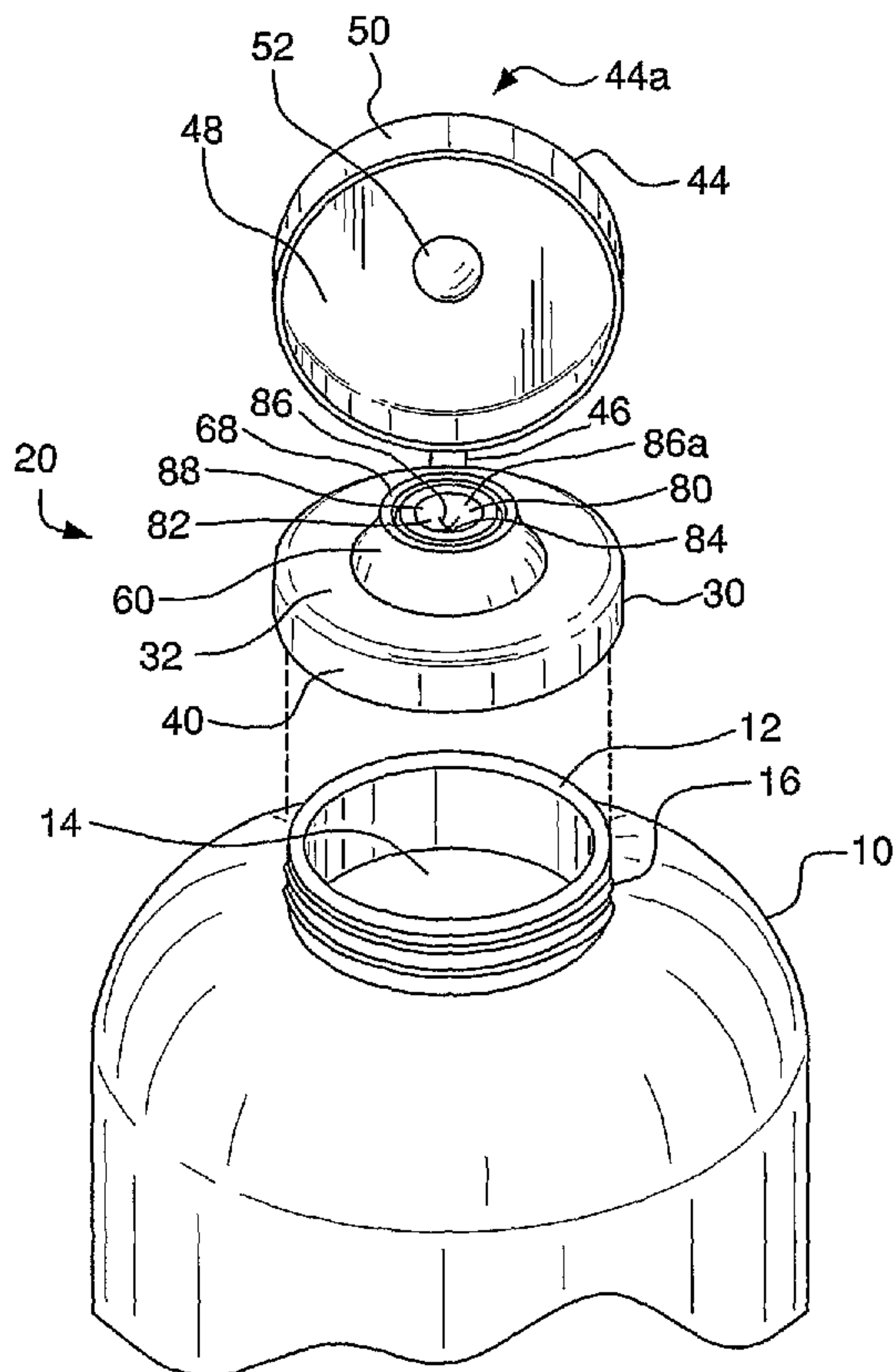
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(54) Title: CONTAINER CLOSURE AND METHOD OF ASSEMBLY

(57) Abstract: A container closure includes a base with
a valve mount portion formed from a first thermoplastic
material and a valve formed from a second thermoplastic
material. The valve is bonded to the valve mount portion. A
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CONTAINER CLOSURE AND METHOD OF ASSEMBLY

FIELD OF THE INVENTION

[0001] The invention relates generally to containers used to dispense fluids and other substances, such as foodstuffs (for example, ketchup) or cosmetics. More particularly, the invention relates to a closure for a squeeze-type container wherein contents can be discharged from the container through a self-closing valve.

BACKGROUND OF THE INVENTION

[0002] Many different configurations of self-sealing valves for use with squeeze-type containers are known in the prior art. U.S. Patent No. 6,230,940 (Manning *et al.*) and U.S. Patent No. 6,530,504 (Socier) both disclose a self-sealing valve mechanically retained in a closure. U.S. Patent No. 5,927,566 (Mueller) discloses a self-sealing valve bonded by a molding process to a closure. U.S. Patent No. 5,743,443 (Hins) discloses a valve bonded to a base, the valve/base combination in turn being retained against a container neck by a fastening element. U.S. Patent No. 6,152,324 (Baudin) discloses a valve bonded directly to a container. U.S. Patent No. 4,728,006 (Drobish *et al.*) discloses several embodiments of a self-sealing valve mechanically retained by a closure against a bottle neck. In each of these inventions, the valve or the combination of the valve and the component to which it is attached for subsequent engagement with a container must be designed for a specific container configuration.

[0003] It is an object of the invention to provide a self-sealing valve and adapter assembly which is inexpensively manufactured and is readily adaptable for use with containers having a wide variety of configurations.

BRIEF DESCRIPTION OF THE INVENTION

[0004] In a first aspect, the invention is a closure for use with a container having a container neck. The closure includes an adapter formed from a first thermoplastic material. The adapter preferably has a cylindrical shell defining a passage through the adapter and a first end and a second end. At least one adapter connector is proximate the first end. An attachment surface is proximate the second end. The closure further includes a valve formed from a second thermoplastic material. The valve has a flexible central portion having at least one opening. The aperture flexes between a normally closed position and an open position when a predetermined force is applied to the central portion at the aperture. The valve includes an outer peripheral portion molded to the adapter at the attachment surface to form an adapter and valve assembly.

[0005] The closure may also include a base having a top including a periphery. A skirt depends from the periphery of the top. An opening is provided within the base. At least one base connector is sized and shaped to engage the at least one adapter connector. The adapter and valve assembly is directly connectable to the base by engagement of the adapter connector with the base connector.

[0006] The closure is connectable to the container neck in a conventional manner, such as by threads or inter-engaging snap elements, or the closure may be permanently affixed to the container neck.

[0007] Preferably, the first thermoplastic material is a polyolefin such as polypropylene and the second thermoplastic material is a thermoplastic elastomer.

[0008] The closure preferably further includes a lid hingedly attached to the base for rotation or pivoting between an open position and a closed position. The lid may include a protrusion sized, shaped and positioned on an interior side of a top of the lid to prevent the aperture from opening when the lid is in the closed position.

[0009] The valve may further include a pleated portion disposed between the central portion and the outer peripheral portion. Various styles of connectors may be used to form the adapter and base connectors, including hook-like connectors, inter-engaging bead-like

protrusions and recesses, inter-engaging parts having an interference fit, or connectors which are interlocking corrugations.

[0010] In a second aspect, the invention includes a method of assembling a closure to a container having a neck. The closure includes an adapter formed from a first thermoplastic material. The adapter has an attachment surface. The closure further includes a valve formed from a second thermoplastic material. The valve has an outer peripheral portion molded to the adapter at the attachment surface to form an adapter and valve assembly. The closure further includes a base connectable to the container and to the adapter and valve assembly. The method includes the steps of: forming the adapter and valve assembly by a multi-material injection molding process; directly connecting the adapter and valve assembly to the base to form the closure; and connecting the closure to the container neck.

[0011] In one embodiment, a lid is hingedly attached to the base and rotates between an open position and a closed position. The lid has an inner surface. A sealing rim is located on the lid and extends downward from the inside surface when the lid is in its closed position. The sealing rim includes a lower tip which is positioned so as to contact the outer peripheral portion of the valve. The contact between the tip and the outer peripheral portion forms a substantial seal between the sealing rim and the outer peripheral portion.

[0012] In one configuration of the invention, the lid includes a protrusion positioned on the inner surface of the lid and located to as to be positioned adjacent to the central portion of the valve when the lid is in its closed position. The protrusion is designed to inhibit the valve from opening when the lid is in the closed position.

[0013] The sealing rim is preferably substantially cylindrical in shape and sized to locally compress the outer peripheral portion of the valve when the lid is in its closed position.

[0014] The basic aspects of the present invention may be combined in a number of forms. The preferred aspects of the various constructions may be used in conjunction with one another or used alone. The various features provide certain advantages over the prior art. These advantages will be described herein and will be understood by those skilled in the art upon reviewing the description and drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0015] For the purpose of illustrating the invention, there are shown in the drawings forms of the invention which are presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown. In the drawings:

[0016] Figure 1 is a perspective view of a first preferred embodiment of the closure of the present invention shown removed from a container and showing a lid of the closure in an open position.

[0017] Figure 2 is an exploded cross-sectional view of the closure of Figure 1.

[0018] Figure 3 is cross-sectional view of the closure of Figures 1 and 2, showing the lid in a closed position.

[0019] Figure 3A is an enlarged view of a portion of the closure of Figures 1-3, showing connections between first embodiments of a valve, an adapter and a base.

[0020] Figure 4 is a view similar to Figure 3A, showing connections between second embodiments of the valve, adapter and base.

[0021] Figure 5 is a view similar to Figure 3A, showing connections between third embodiments of the valve, adapter and base.

[0022] Figure 6 is a view similar to Figure 3A, showing connections between fourth embodiments of the valve, adapter and base.

[0023] Figure 7 is a view similar to Figure 3A, showing connections between fifth embodiments of the valve, adapter and base.

[0024] Figure 8 is an enlarged cross-sectional view of a portion of the closure of Figure 1 including a novel cap for assisting in sealing the valve.

[0025] Figure 8A is an enlarged detail of a portion of the closure of Figure 8.

DETAILED DESCRIPTION OF THE DRAWINGS

[0026] As used herein, the term “multi-material molding” means any conventional molding process in which two or more materials are injected simultaneously or in sequence into a single mold during a single molding cycle. Multi-material molding is intended to include co-injection molding, bi-injection molding, two-shot molding and insert molding techniques well known to those of ordinary skill in the art of injection molding.

[0027] Referring to the drawings, and initially to Figures 1-3A, a closure for a container is indicated generally by the reference numeral 20. The closure 20 is adapted for use with a conventional container 10. The container 10 comprises a container neck 12, defining a container opening 14. The container neck 12 may be provided with an external helical thread 16 for threaded engagement with the closure 20. Alternatively, the container 10 and closure 20 may be connectable with inter-engaging snap elements (*e.g.*, raised beads and recesses) (not shown). Also, the closure 20 could be permanently affixed to the container neck 12 by any number of conventional techniques including induction melting, ultrasonic melting or use of adhesive.

[0028] The container 10 is preferably squeezable with at least one flexible wall capable of being manually deformed to compress the contents therein and increase the pressure within the container to force the contents out of the container.

[0029] The closure 20 is an assembly of a base 30, an adapter 60 and a valve 80. In a first preferred embodiment, the base 30 includes a top 32 having an outer periphery. An opening 34 is formed in the top 32, the opening 34 being surrounded by a lip 36. As discussed further below, in this embodiment, the lip 36 is sized and shaped to be engaged by an adapter connector 70, and thus the lip 36 serves as a base connector 38. A base skirt 40 depends from the outer periphery, generally perpendicular to the top 32. A base helical internal thread 42 may be provided on an interior surface of the base skirt 40, allowing the base 30 to be connected to the container neck 12 by threaded engagement of the internal thread 42 with the external thread 16. While threads are shown in the figures, those skilled in the art would readily appreciate that many other conventional attachments may be used for a engaging the base with the container neck.

[0030] The base 30 further preferably includes a lid 44 hingedly attached to the base 30 by a hinge 46. The hinge permits that lid 44 to rotate or pivot between an open position 44a and a closed position 44b. The lid 44 includes a lid top 48 having a periphery, and a lid skirt 50 extending from the lid top 48. Preferably, the lid 44 includes a protrusion 52 on an interior side of the top 48 of the lid. The protrusion 52 is preferably sized, shaped and positioned to prevent a valve aperture 86 from opening when the lid 44 is in the closed position 44b.

[0031] The base 30, including the lid 44, is preferably fabricated using conventional thermoplastic materials such as polyolefins, including polypropylene, and using conventional fabrication techniques, such as injection molding, well known to those of ordinary skill in the art of bottle closures.

[0032] The adapter 60 is formed from a first thermoplastic material, preferably a polyolefin material such as polypropylene. The adapter 60 includes a shell or housing 62, which is preferably cylindrical in shape and which defines a passage 64 through the adapter. The adapter 60 has a first end 66 and a second end 68. At least one adapter connector 70 is provided proximate the first end 66. In a first preferred embodiment, the adapter connector 70 is a hook element that engages and latches with the base connector 38 to connect the adapter 60 to the base 30. The adapter 60 further includes a valve attachment surface 72. It is along this surface 72 that the valve 80 is connected to the adapter 60. As should be readily apparent in view of this disclosure, numerous variations are possible for forming the inter-engaging base and adapter connectors 38, 70, as well as the valve attachment surface 72.

[0033] The valve 80 is formed from a second thermoplastic material, preferably a thermoplastic elastomer. The valve 80 has a resiliently flexible central portion 82 provided with at least one opening 84 forming an aperture 86. The aperture 86 has a closed position 86a and an open position 86b. The resiliency of the flexible central portion 82 biases the aperture 86 into the closed position 86a. Upon application of a predetermined pressure to the central portion 82 near the aperture 86, the central portion 82 flexes from a retracted position 82a into an extended position 82b, such that the aperture 86 moves to the open position 86b. When the pressure applied to the central portion 82 decreases below the predetermined level, the resilient nature of the aperture 86 biases it back to the closed position 86a. Preferably, at least the central portion 82 of the valve 80 has a substantially uniform wall thickness.

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[0034] The valve 80 includes an outer peripheral portion 88. The valve outer peripheral portion 88 is molded to the adapter 60 at the attachment surface 72 thereby bonding the valve 80 to the adapter 60 to form an adapter and valve assembly. A pleated portion 90, forming a bellows-like fold, may be provided to allow increased flexure of the central portion 82. The pleated portion 90 acts to bias the central portion 82 into the retracted position 82a.

[0035] Figures 1-3 illustrate a presently preferred embodiment wherein the base opening 34 is formed in the top 32. Alternatively, the base opening 34 (and the base connector 38) could be positioned elsewhere on the base 30, for example on a side portion of the base 30.

[0036] In one preferred embodiment, the adapter and valve assembly of the closure 20 are formed by a multi-material molding process. In summary, this process entails sequentially injecting first and second thermoplastic materials into a single mold such that the adapter 60 is formed from the first thermoplastic material, the valve 80 is formed from the second thermoplastic material and a physical bond between the adapter 60 and valve 80 is formed during the molding process, eliminating the need for any subsequent assembly using adhesive or other types of fasteners to join the adapter 60 to the valve 80. It has been found to be advantageous to form valve 80 using a so-called "center-gated" molding technique, whereby the valve 80 material is injected into the mold through a port which is centrally and symmetrically positioned relative to the valve body. Using this center-gated approach, it is found that non-symmetric residual stresses that might otherwise occur are eliminated or minimized, thus enhancing performance of the valve 80.

[0037] After the adapter and valve assembly are integrally formed, the assembly is connected to the base to form the closure 20. As discussed above, the connection is made by engagement of the adapter connector 70 with the base connector 38. As discussed below, numerous embodiments of the adapter connector and base connector are possible. Preferably the connection is one that is performed in a manner that prevents subsequent disconnection. Also, it is preferred that the connection be a snap connection wherein the assembly is snapped downward on, onto or into engagement with the base, thus forming the complete closure.

[0038] After the closure is formed, it is connected to the container neck, for example, by screwing the closure 20 onto the container neck 12 (for containers 10 having a conventional

threaded design), snapping the closure 20 onto the container neck 12 (for containers having a conventional snap-on design), or by permanently affixing the closure 20 to the container neck 12.

[0039] Upon assembly of the closure 20 to the container 10, the adapter 60 does not interface directly with the container neck 12. That is, the valve and adapter assembly, when incorporated into the closure 20 and installed on the container 10, is separated from the container 10 by the base 30. In this manner, as the valve and adapter assembly does not directly connect or otherwise directly interface with the container, the design of the valve and adapter assembly is generally independent of the design of the container, and a single valve and adapter assembly design may be adapted for use with different types of containers.

[0040] In use, the lid 44 is placed in the open position 44a and the container 10 is squeezed, pressurizing and forcing contents of the container 10 against an interior side of the valve central portion 82. When the pressure within the container exceeds the predetermined level necessary to open the aperture 86, contents of the container 10 are dispensed. When the pressure within the container 10 falls below the predetermined level, the aperture 86 moves back to the closed position 86a. After use, the lid 44 is rotated back into the closed position 44b. As discussed above, the lid preferably includes a lid protrusion 52 formed on the lid that moves with the remainder of the lid 44, into a position adjacent to the aperture 86. The lid protrusion 52 blocks the aperture 86 so as to prevent or inhibit the valve central portion 82 from flexing and/or rotating open. Thus, the lid protrusion 52 operates to prevent discharge of the container contents should the container 10 be squeezed when the lid 44 is in the closed position 44b.

[0041] From this disclosure, those skilled in the art will recognize that it is possible to omit the base 30 from the closure 20, and design a container 10 having a neck 12 provided with a connector corresponding to the base connector 38, adapted to engage the adapter connector 70, thus allowing the valve and adapter assembly to be mounted directly to the container 10.

[0042] With reference now to Figures 4-7, second through fifth embodiments of the base 30, adapter 60 and valve 80 illustrate that connections between the base 30 and adapter 60 and between the adapter 60 and valve 80 can be made in various ways. In Figures 4-7, elements

of the second through fifth embodiments corresponding to like elements of the first embodiment are numbered in increments of 100, 200, 300, 400 and 500, respectively, above the reference number of the corresponding first embodiment element.

[0043] A second embodiment base 130, adapter 160 and valve 180 are illustrated in Figure 4. The adapter connector 170 is in the form of a pin, having a hook-like portion adapted to engage the base connector 138. The base connector 138 is in the form of an opening in the base 130, and is sized and shaped to receive and engage the adapter connector 170. Furthermore, the peripheral portion 188 of the valve 180 is bifurcated and engages the valve attachment surface 172 along multiple planes.

[0044] A third embodiment base 230, adapter 260 and valve 280 are illustrated in Figure 5. The adapter connector 270 is in the form of a raised bead, adapted to engage the base connector 238, in the form of a recess in the base 230, sized and shaped to receive and engage the adapter connector 270. Furthermore, the peripheral portion 288 of the valve 280 engages the valve attachment surface 272 along an exterior portion of the adapter 260.

[0045] A fourth embodiment base 330, adapter 360 and valve 380 are illustrated in Figure 6. The adapter connector 370 is in the form of a shaft having an outer extent with a first dimension, adapted to engage the base connector 338, in the form of a recess in the base 330, the recess having an inner bore with a second dimension such that an interference fit occurs when the adapter connector 370 is inserted into the base connector 338. Furthermore, the peripheral portion 388 of the valve 380 forms a channel-like structure which engages the valve attachment surface 372 of the adapter 360 in an interlocking fashion.

[0046] A fifth embodiment base 430, adapter 460 and valve 480 are illustrated in Figure 7. The adapter connector 470 has a plurality of corrugated or tooth-like structures which are adapted to engage similar corrugated structures on the base connector 438. Furthermore, the peripheral portion 488 of the valve 480 is adapted to be received within a slot forming the valve attachment surface 472 of the adapter 460.

[0047] Referring now to Figure 8, a cross-sectional view of a portion of the bottle closure is shown with a novel lid design. As discussed above, the lid 44 preferably includes a protrusion 52 which is designed to lie adjacent to or against the valve in the closed position

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so as to prevent inadvertent opening or flexure of the valve central portion 82. In the embodiment illustrated in Figure 8, the lid 44 includes not only the protrusion 52, which in this embodiment is preferably one or more spaced apart ribs 200, but also a sealing rim 210 that extends from the lower surface of the lid 44 and is positioned to engage the valve outer peripheral portion 88 at the point where it mounted to the attachment surface 72 of the adapter 60.

[0048] The sealing rim is designed to provide a physical engagement or seal between the lid 44 and the valve, thus preventing material from passing to or from the valve are inside the lid. More particularly, as shown in Figs. 8 and 8A, the sealing rim 210 extends down from the lower or inside surface of the lid 44 and has a length of sufficient dimension to contact, and more preferably, press into the sealing outer peripheral portion 88 of the valve. As shown in Fig. 8A, the sealing rim 210 locally compresses the elastic valve material, thus creating a tight seal. The sealing rim 210 may include a tip end designed to facilitate a tight seal, such as a pointed tip as shown.

[0049] The sealing rim 210 may be completely cylindrical so as to completely seal the outer peripheral portion 88. Alternately, the sealing rim 210 may constitute a series of spaced apart rim portions to contact the outer peripheral portion at spaced apart areas. The rim portion may be formed as a substantially rigid member as shown in the figures, or may be designed to flex to some degree to accommodate manufacturing tolerances.

[0050] While the figures illustrate a sealing rim 210 in combination with the protrusion 52, it should be readily apparent that the lid need not include both. For example, since the sealing rim 210 is designed to provide sealing around the valve, it may be desirable to not include a protrusion in the lid.

[0051] The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification, as indicating the scope of the invention.

[0052] Although distinct embodiments have been described, those skilled in the art will understand how features from different embodiments may be combined.

[0053] Furthermore, while the invention has been described and illustrated with respect to the exemplary embodiments thereof, it should be understood by those skilled in the art that the foregoing and various other changes, omissions and additions may be made therein and thereto, without parting from the spirit and scope of the present invention.

CLAIMS

What is claimed is:

1. A closure for a container having a container neck, the closure comprising:
 - an adapter formed from a first thermoplastic material and having a housing with a passage extending through the adapter, the adapter including a first end and a second end, at least one adapter connector on the adapter at or near the first end, and a valve attachment surface formed on the adapter at or near the second end;
 - a valve made from a second thermoplastic material, the valve having a flexible central portion with at least one valve opening, and an outer peripheral portion molded to the adapter at the valve attachment surface using a multi-material injection process so as to form an adapter and valve assembly; and
 - a base having:
 - a top with a periphery from which a skirt depends;
 - at least one base connector adapted to engage with the at least one adapter connector such that the adapter and valve assembly can be directly connected to the base by engagement of the adapter connector with the base connector; and
 - a base opening arranged near the base connector to be in fluid communication with the valve opening of the adapter and valve assembly installed on the base.
2. The closure of claim 1, wherein the base opening is located in the top of the base.
3. The closure of claim 1, wherein at least the central portion of the valve has a substantially uniform wall thickness.
4. The closure of claim 1, the container neck having an external thread, the base skirt further including an internal thread, wherein the closure connects to the container neck by engagement of the external and internal threads.
5. The closure of claim 1, the container neck being provided with a first inter-engaging snap element, the base skirt further including a second inter-engaging snap element,

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wherein the closure connects to the container neck by engagement of the first snap element with the second snap element.

6. The closure of claim 1, wherein the closure is permanently affixed to the container neck.

7. The closure of claim 1, wherein the first thermoplastic material is a polyolefin and the second thermoplastic material is a thermoplastic elastomer.

8. The closure of claim 7, wherein the polyolefin is polypropylene.

9. The closure of claim 1 further comprising a lid hingedly attached to the base for rotation between an open position and a closed position.

10. The closure of claim 9, wherein the lid includes a protrusion positioned on an inner surface of the lid and located to as to be adjacent to the central portion of the valve when the lid is in its closed position, the protrusion adapted to inhibit the valve from opening when the lid is in the closed position.

11. The closure of claim 9, wherein the lid has an inner surface, and a sealing rim formed on the lid and extending downward from the inside surface when the lid is in its closed position, the sealing rim including a lower tip which is positioned so as to contact the outer peripheral portion of the valve, the contact between the tip and the outer peripheral portion forming a substantial seal between the sealing rim and the outer peripheral portion.

12. The closure of claim 11, wherein the sealing rim is substantially cylindrical in shape and sized to locally compress the outer peripheral portion of the valve when the lid is in its closed position.

13. The closure of claim 1, wherein the valve further includes a pleated portion disposed between the central portion and the outer peripheral portion.

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14. The closure of claim 1, wherein the adapter connector includes a hook portion which engages the base connector.

15. The closure of claim 1, wherein the adapter connector is a raised bead and the base connector is a mating recess.

16. The closure of claim 1, wherein the adapter connector has an outer extent having a first dimension and the base connector has an inner bore having a second dimension such that when connected an interference fit exists between the adapter and base connectors.

17. The closure of claim 1, wherein the adapter and base connectors are interlocking corrugations.

18. A method of assembling a closure to a container having a neck, the closure including an adapter formed from a first thermoplastic material and having an attachment surface; a valve formed from a second thermoplastic material and having an outer peripheral portion molded to the adapter at the attachment surface to bond the valve to the adapter to form an adapter and valve assembly; and a base connectable to the container and to the adapter and valve assembly, comprising the steps of

forming the adapter and valve assembly by a multi-material molding process; and directly connecting the adapter and valve assembly to the base to form the closure.

19. A method of forming a closure according to claim 18 wherein the step of directly connecting the adapter connector to the base connector includes the step of pressing the adapter connector downward onto the base connector to force the adapter connector to engage the base connector.

20. A method of forming a closure to a container having a neck, the closure adapted to engage with the neck of the container, the method comprising the steps of:

providing a mold having a mold contour that defines an adapter and a valve, the mold contour of the adapter including a portion that defines an adapter housing and a portion that defines an adapter connector, the portion defining the adapter connector being located near

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one end of the housing, and the mold contour of the valve including a portion that defines a valve attachment, the valve attachment portion of the mold being located near a second end of the housing;

channeling a first thermoplastic material into the mold to form the adapter;

channeling a second thermoplastic material into the mold to form the valve, the second thermoplastic material being different from the first thermoplastic material;

allowing the two thermoplastic materials to cool forming an adapter and valve assembly;

providing a base of the closure having a portion adapted to connect to the neck of a container; the base including a base connector; and

directly connecting the adapter connector to the base connections to form the closure.

21. A method of forming a closure according to claim 20 wherein the step of directly connecting the adapter connector to the base connector includes the step of pressing the adapter connector downward onto the base connector to force the adapter connector to engage the base connector.

22. A closure for a container having a container neck, the closure comprising:

an adapter formed from a first thermoplastic material and having:

a housing defining a passage through the adapter;

a first end and a second end on the adapter;

at least one adapter connector on the adapter at or near the first end;

and

an attachment surface on the adapter at or near the second end;

a valve formed from a second thermoplastic material and having:

a flexible central portion having at least one opening forming an

aperture; and

an outer peripheral portion molded to the adapter at the attachment surface and bonded to the adapter to form an adapter and valve assembly; and

a base having:

a top including a periphery;

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a skirt depending from the periphery;
an opening within the top;
at least one base connector sized and shaped to engage the at least one adapter connector such that the adapter and valve assembly can be directly connected to the base by engagement of the adapter connector with the base connector;

wherein the closure is connectable to the container neck such that the adapter and valve assembly is separated from the container by the base.

23. A closure for a container having a container neck, the closure comprising:

an adapter formed from a first thermoplastic material and having a cylindrical housing with a passage extending through the housing, the adapter including a first end and a second end, at least one adapter connector on the adapter at or near the first end, and a valve attachment surface formed on the adapter at or near the second end; and

a valve made from a second thermoplastic material, the valve having a flexible central portion with at least one opening forming an aperture, and an outer peripheral portion molded to the adapter at the valve attachment surface using a multi-material injection process so as to form an adapter and valve assembly.

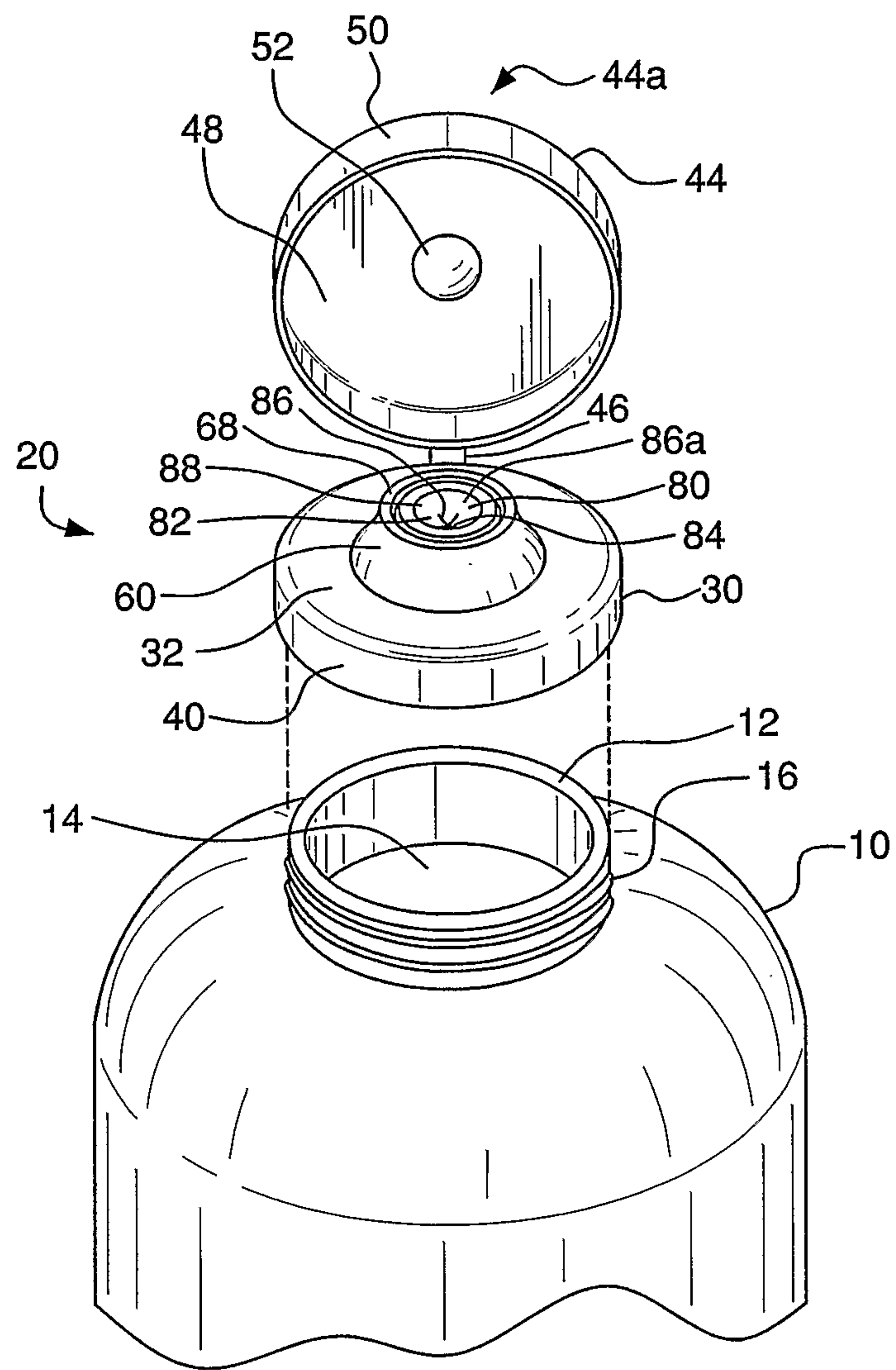


FIG. 1

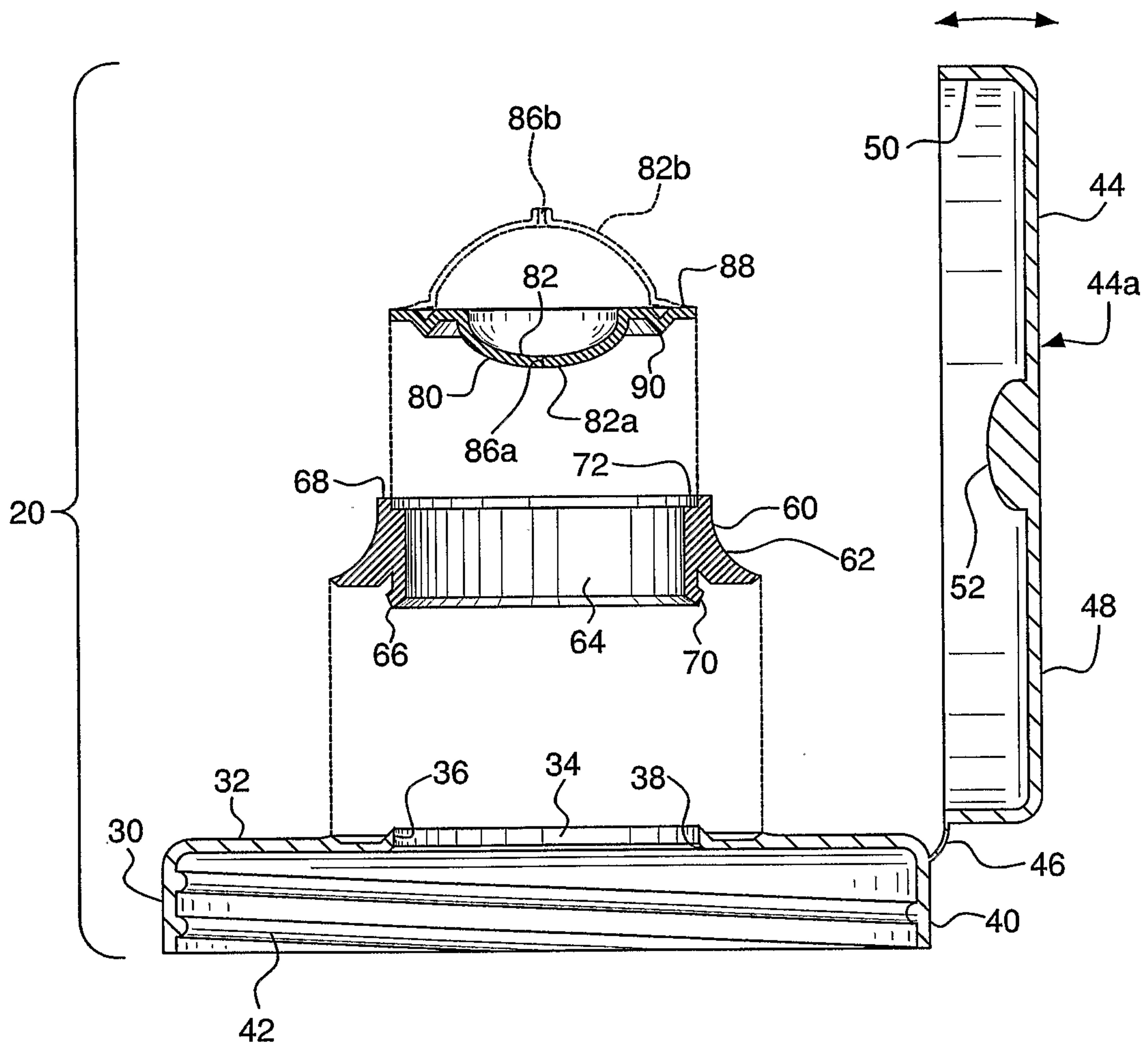


FIG. 2

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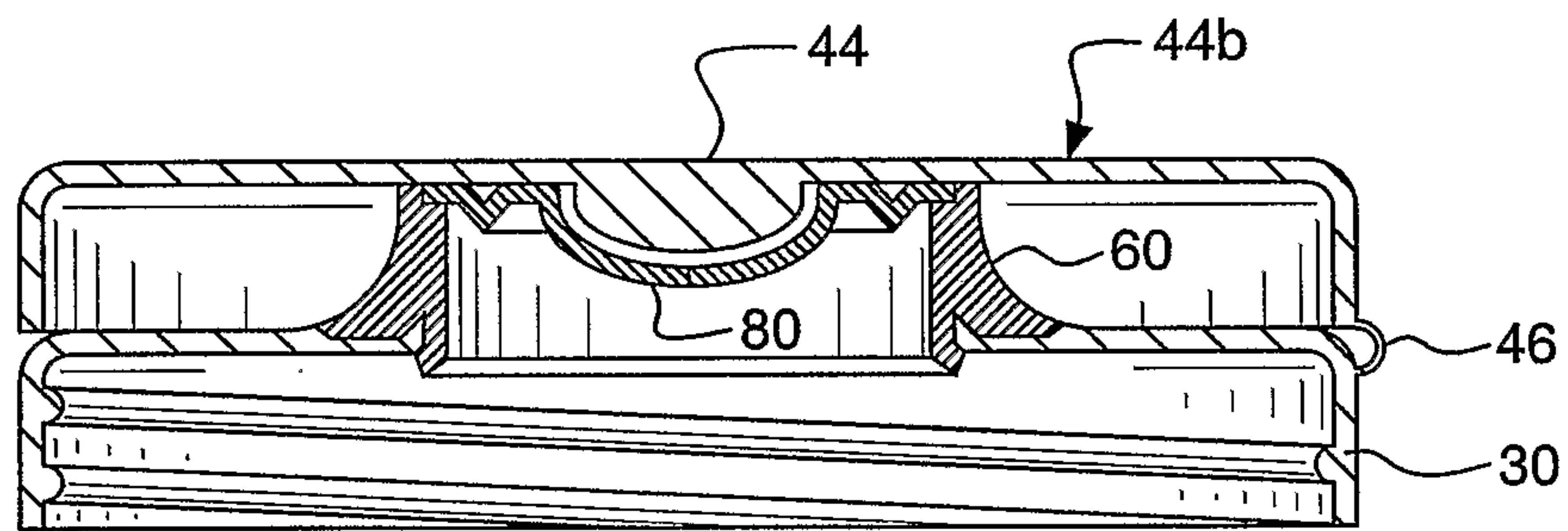


FIG. 3

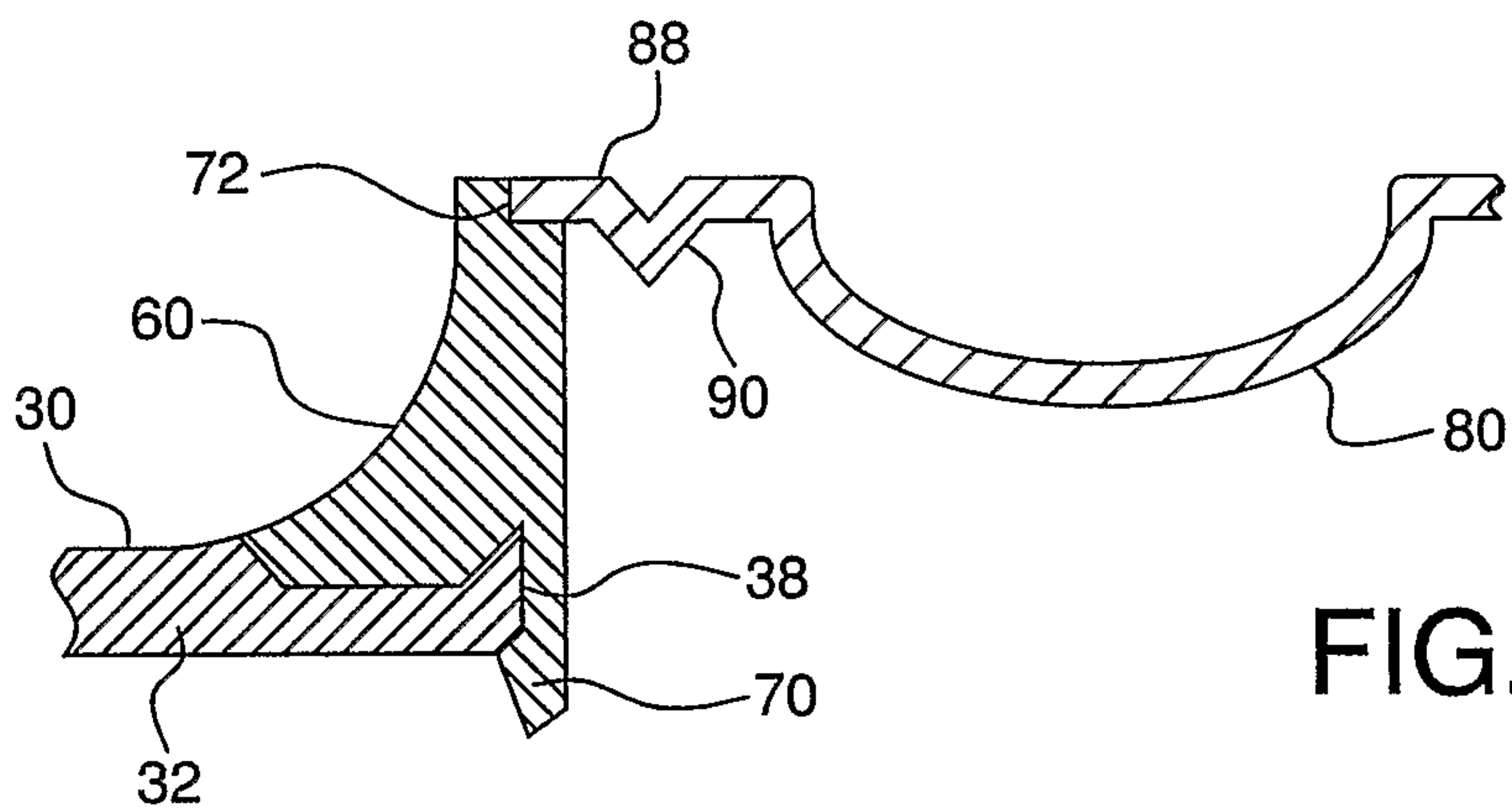


FIG. 3A

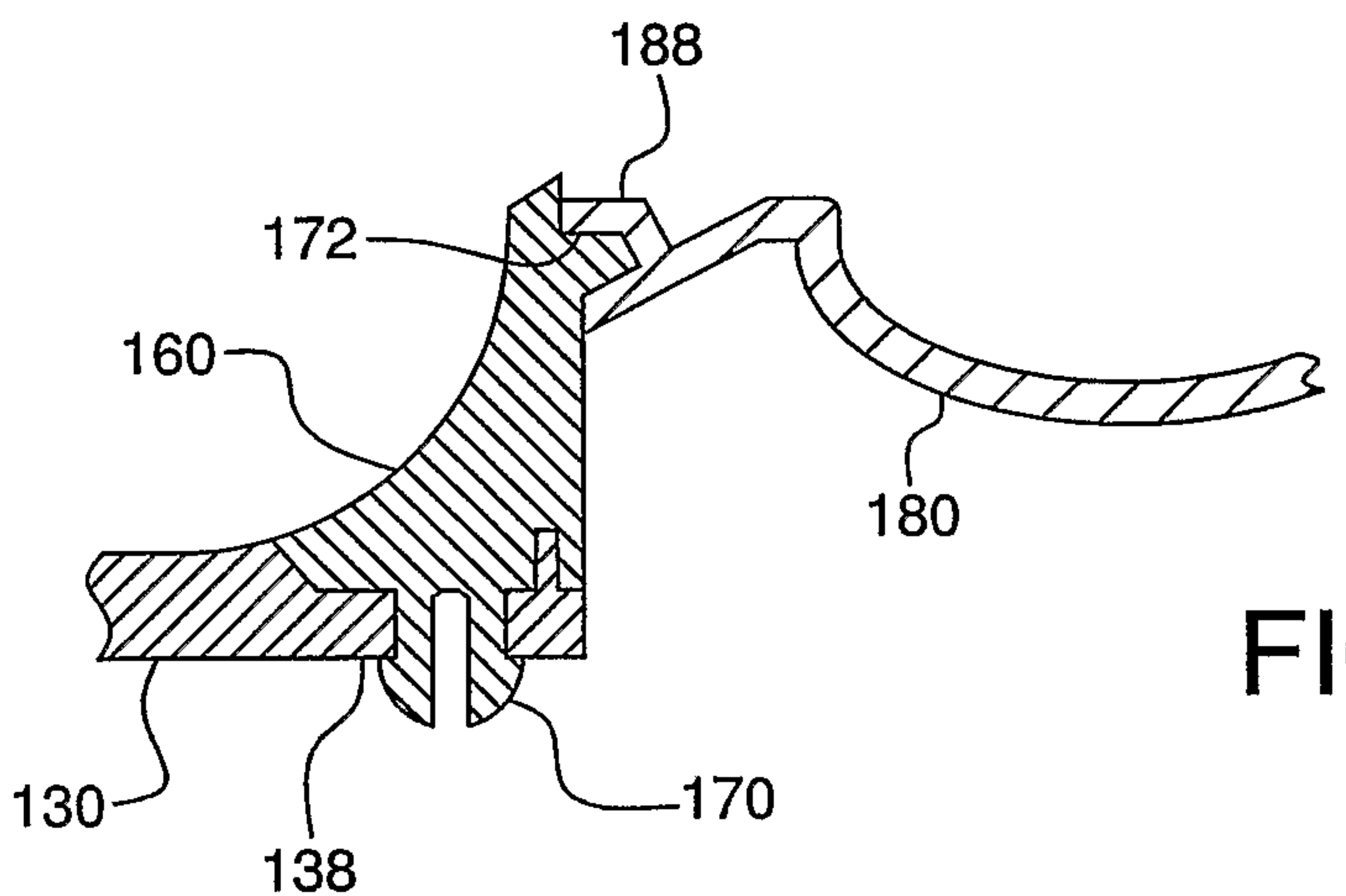


FIG. 4

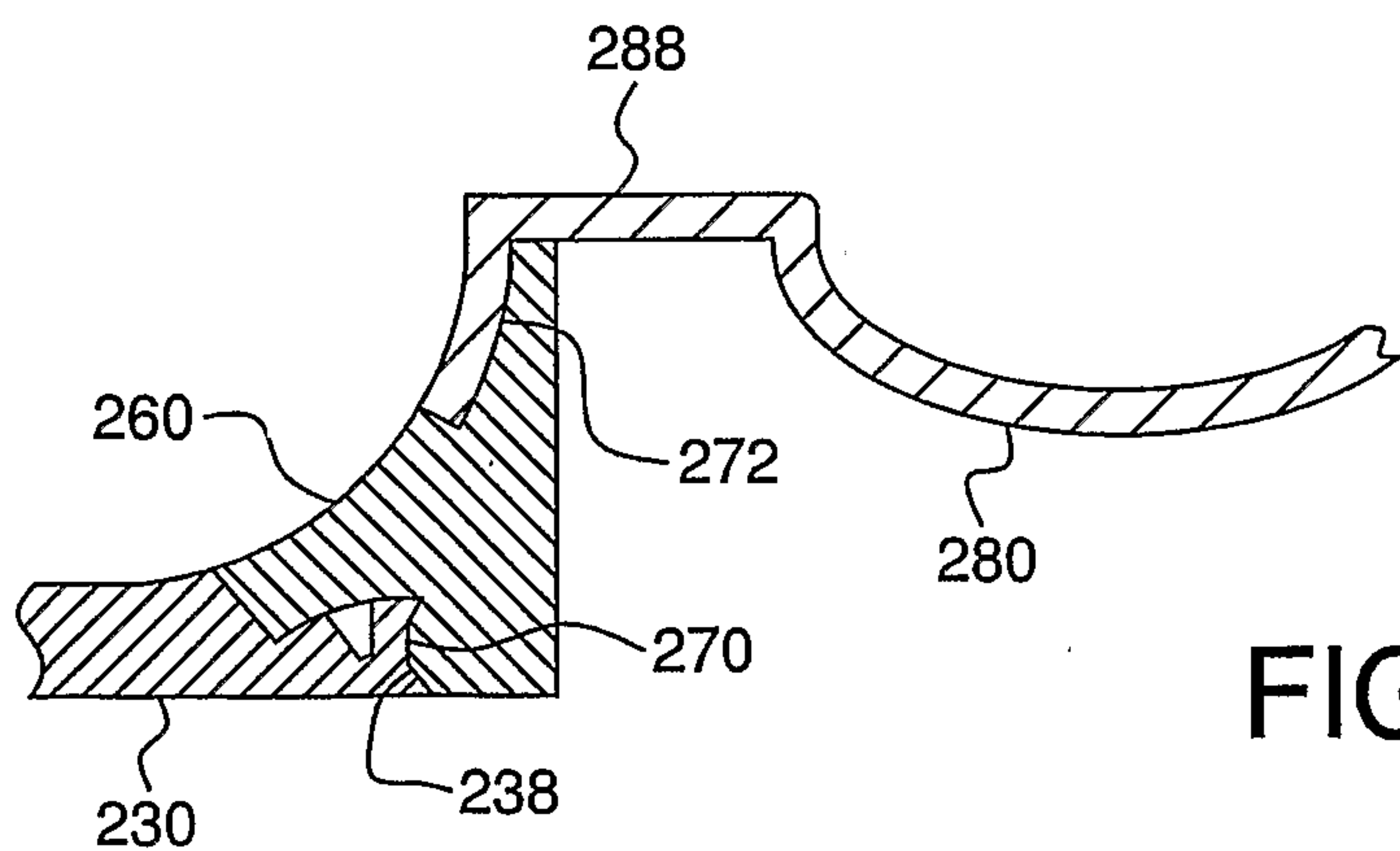


FIG. 5

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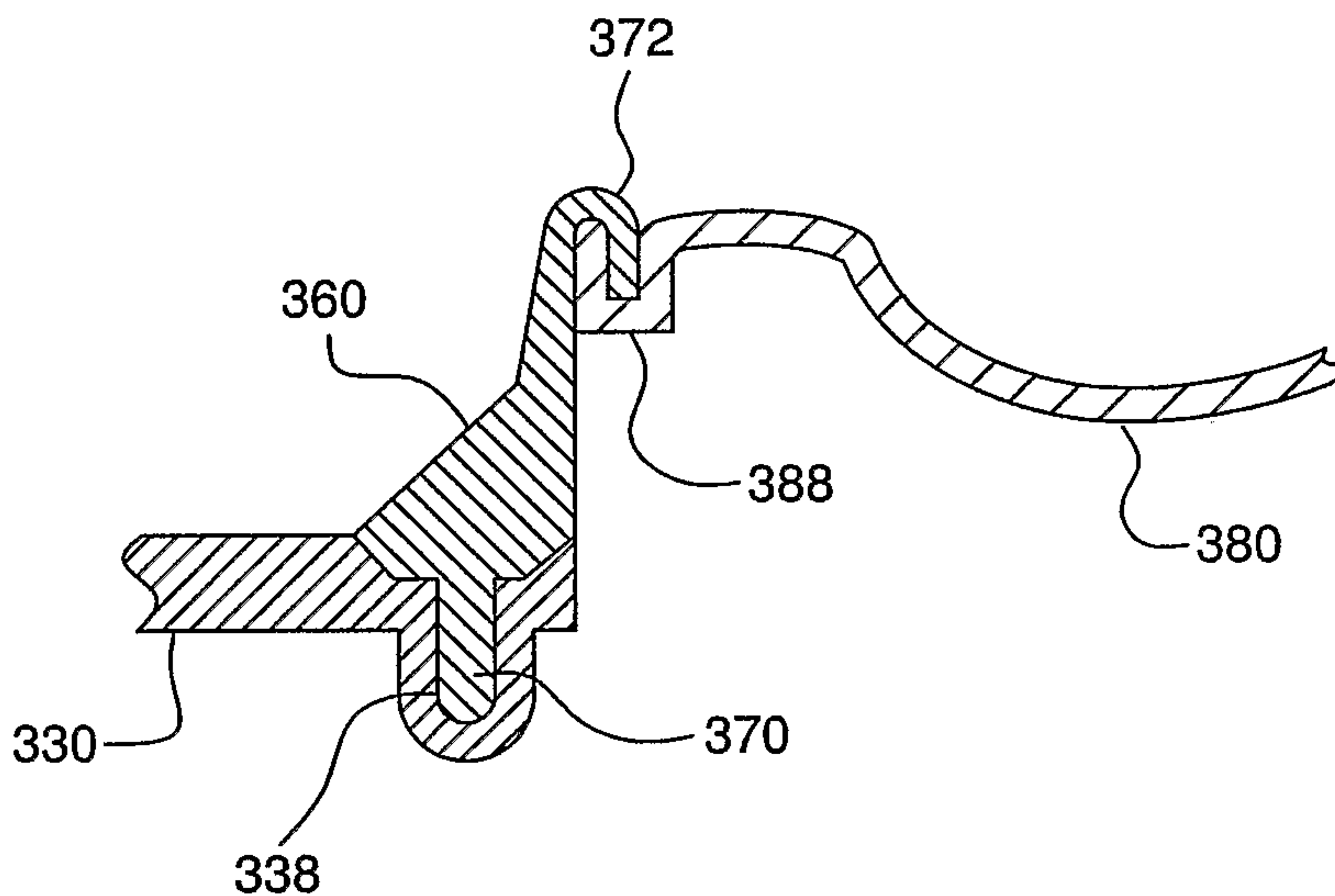


FIG. 6

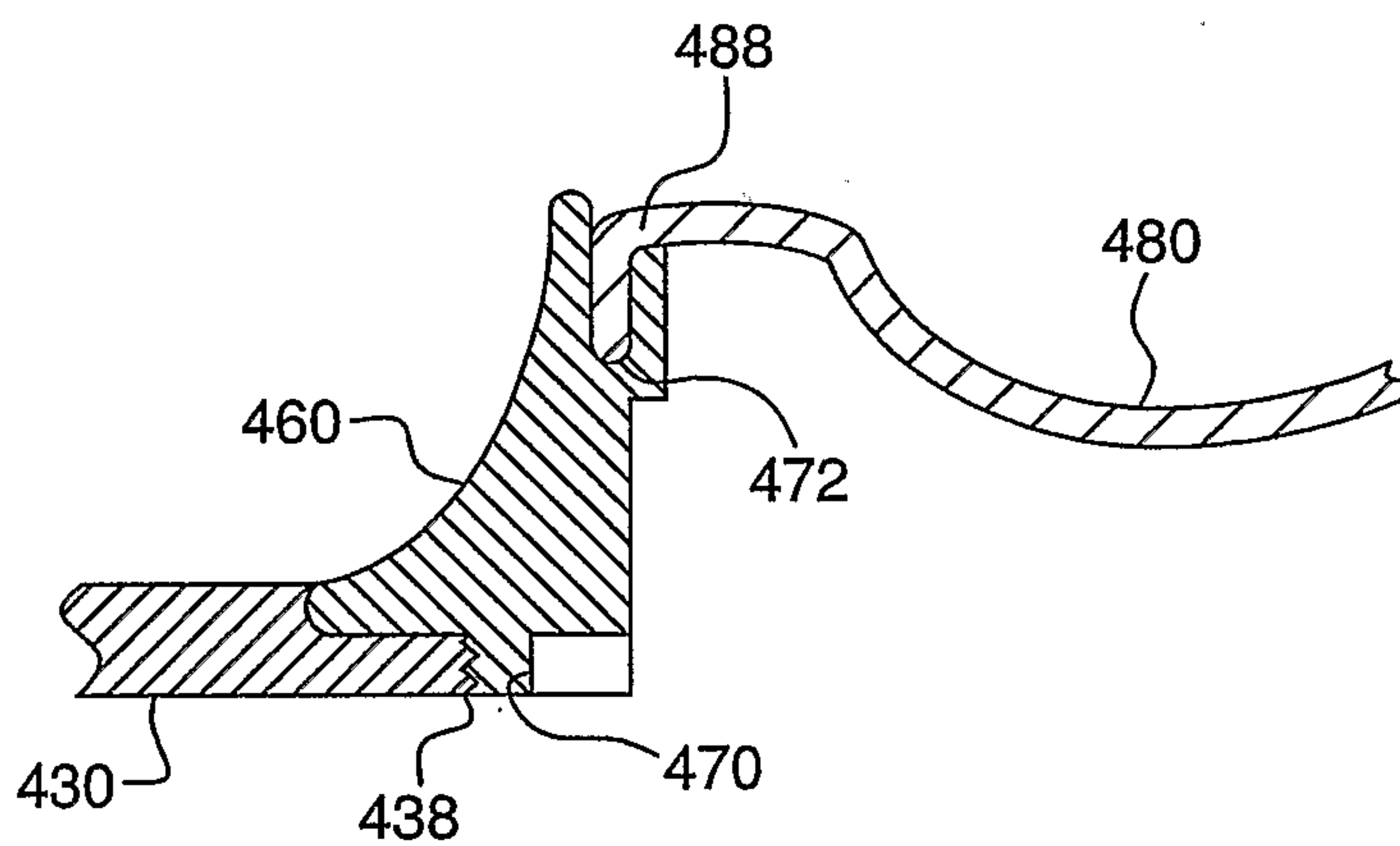


FIG. 7

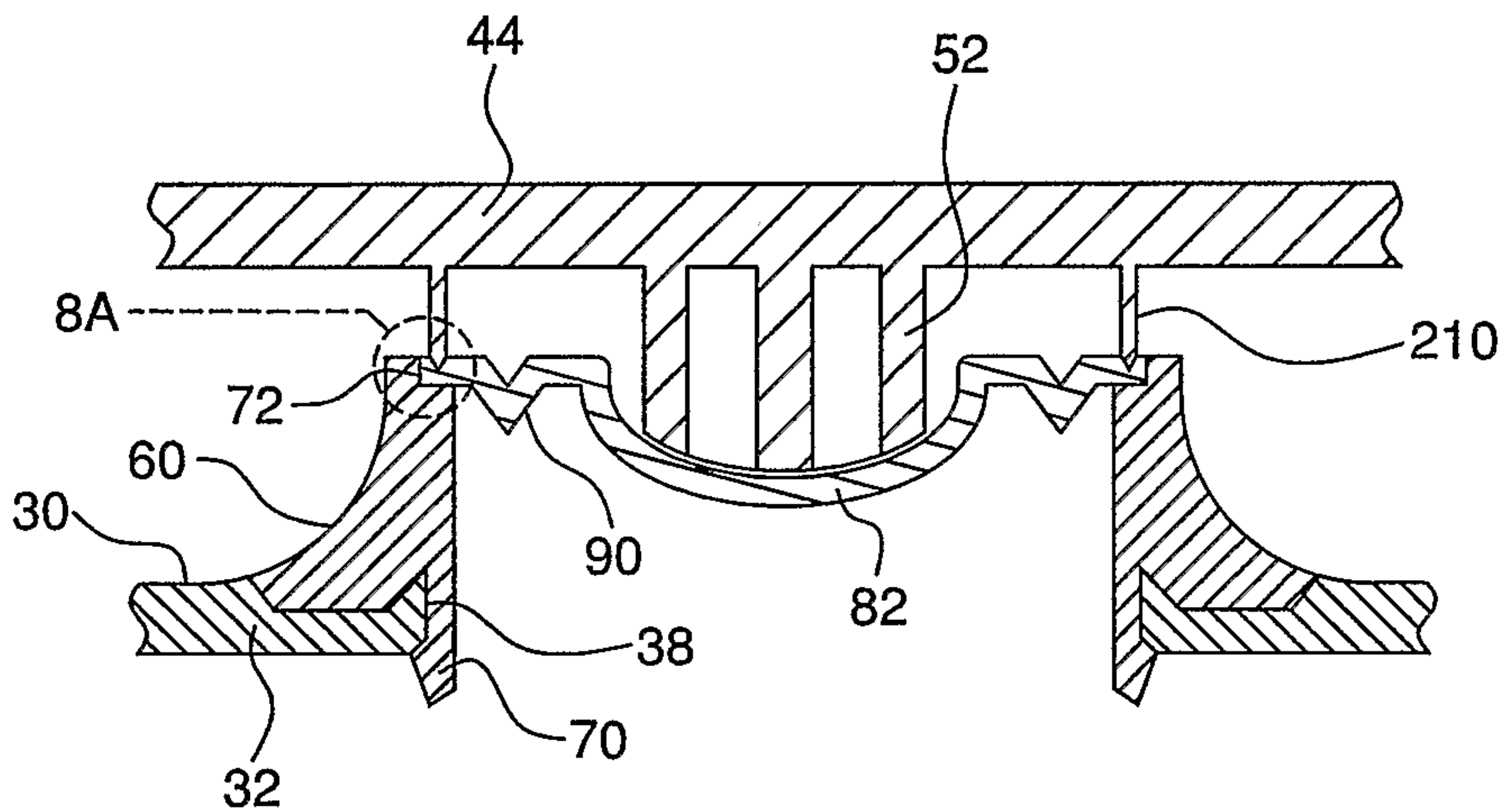


FIG. 8

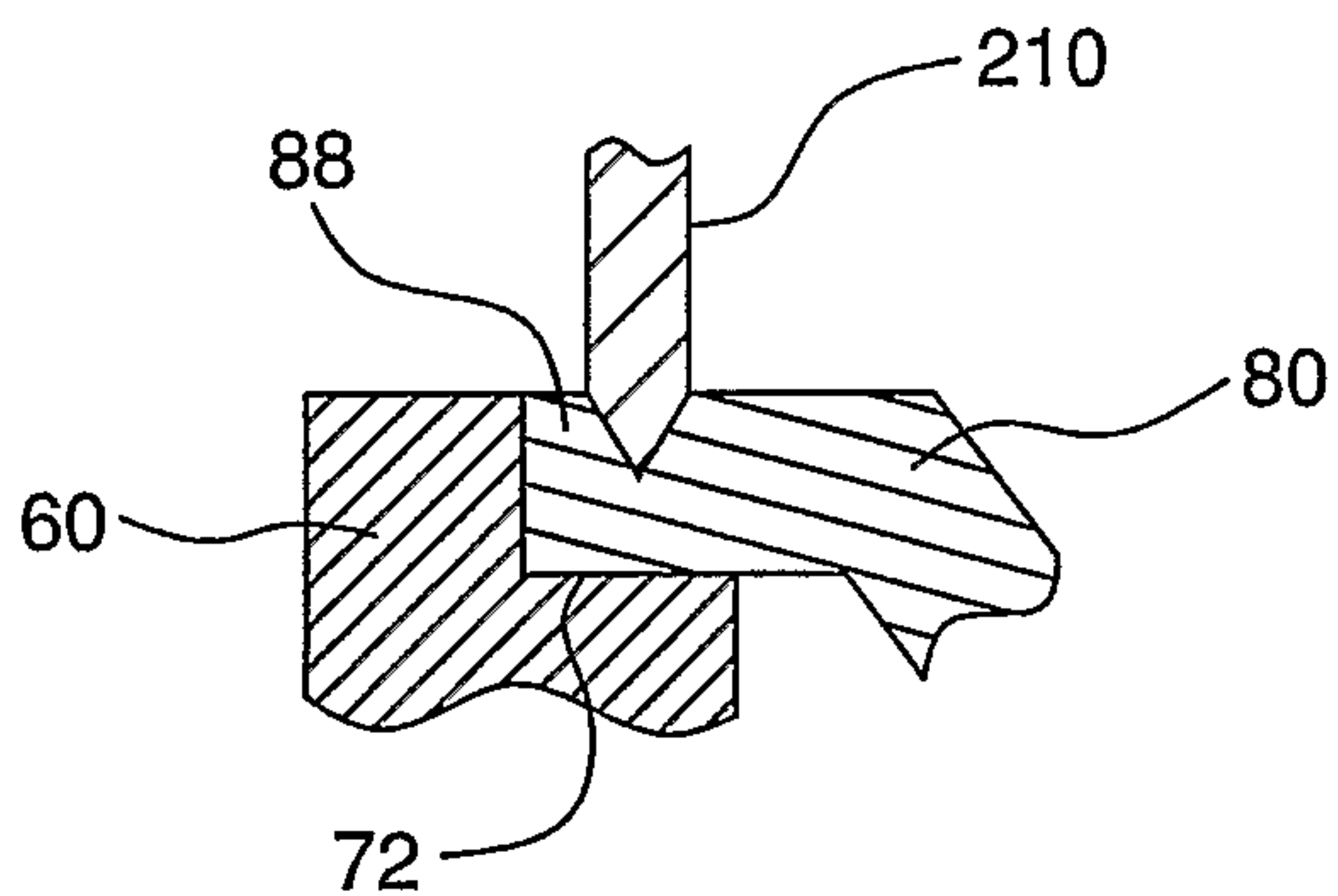


FIG. 8A

