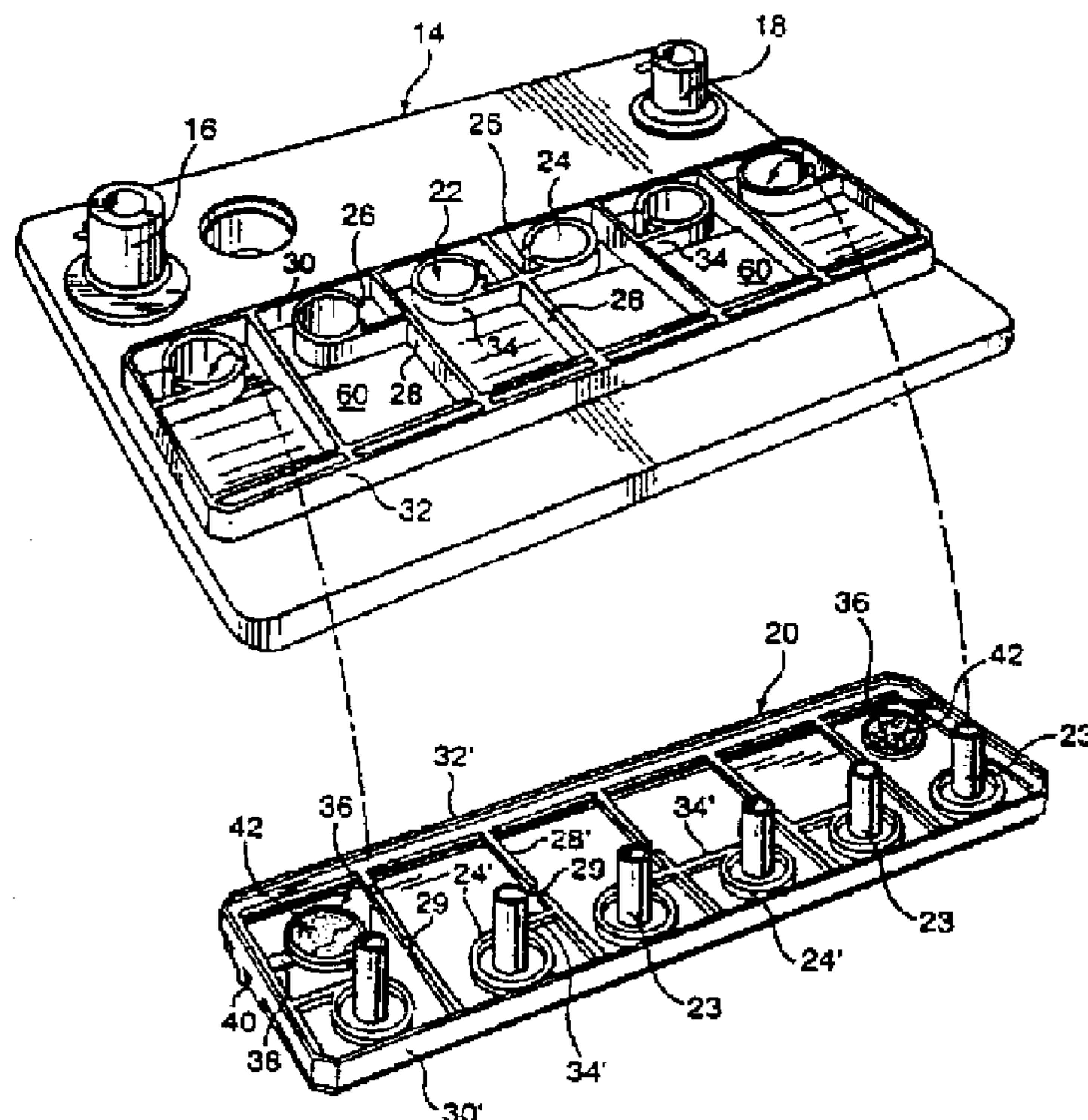




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(54) Titre : ACCUMULATEUR AU PLOMB A PILE OUVERTE CAPABLE D'INCLINAISON
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(57) Abrégé/Abstract:

In a battery configuration including a casing (14) having a bottom, side and top surfaces, the top surface having a plurality of cell openings (22) therein, an improved flowpath is provided for liquid electrolyte when the battery is tilted onto any of its side surfaces. The flowpath includes a cover chamber for each cell opening defined by a substantially rectangular peripheral wall surrounding a cell opening; a cylindrical wall (24) surrounding and substantially concentric with the cell opening and located within the substantially rectangular wall, the cylindrical wall interrupted by a relatively small circumferential gap (26), and a wall (34) extending between the cylindrical wall and the adjacent side of the peripheral wall, the wall tangential to the cylindrical wall and adjacent the gap. A porous polytetrafluoroethylene disc (42) seated in the battery cover vent openings prevents spillage even if the battery casing is inverted.



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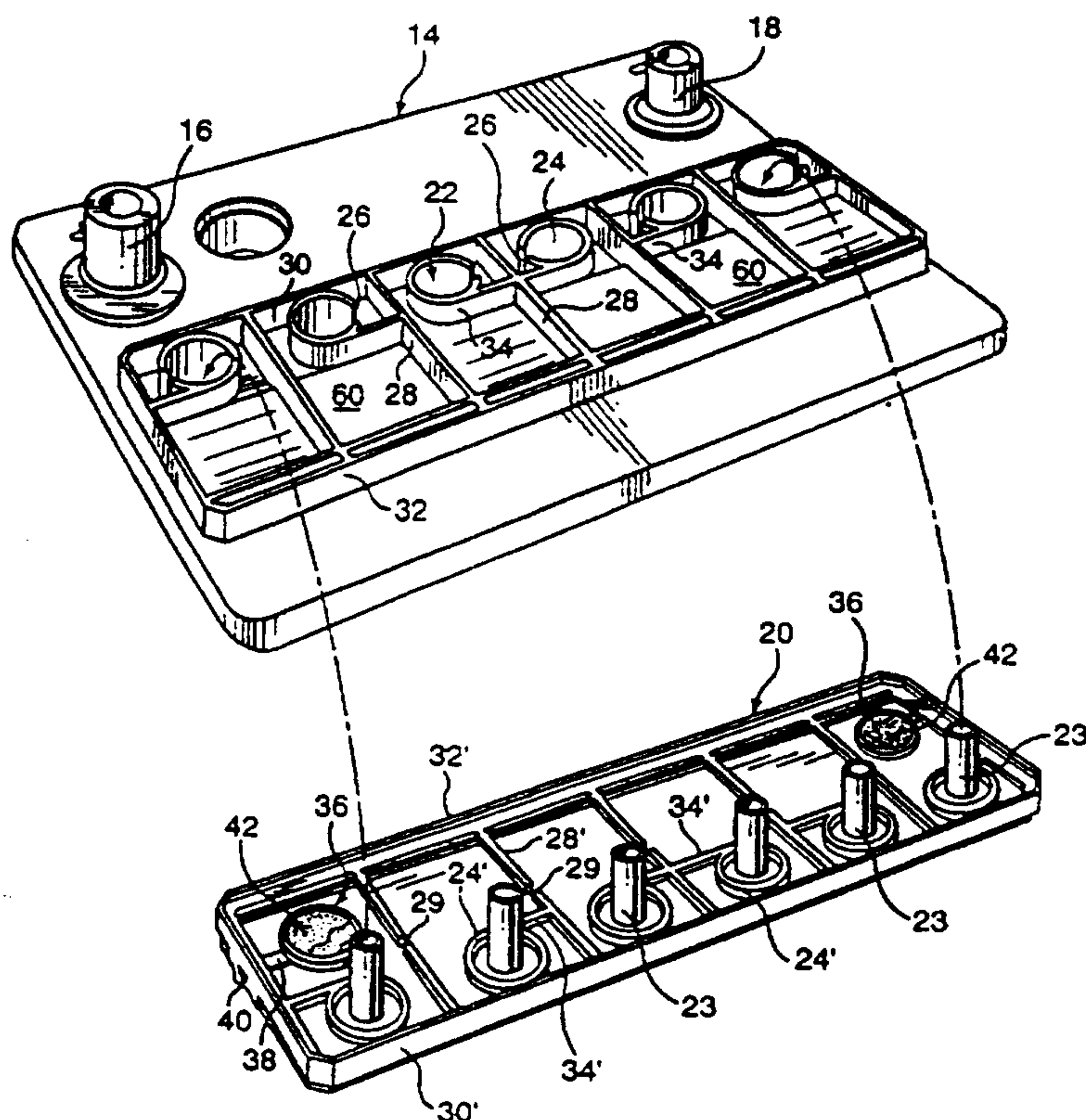
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(57) Abstract

In a battery configuration including a casing (14) having a bottom, side and top surfaces, the top surface having a plurality of cell openings (22) therein, an improved flowpath is provided for liquid electrolyte when the battery is tilted onto any of its side surfaces. The flowpath includes a cover chamber for each cell opening defined by a substantially rectangular peripheral wall surrounding a cell opening; a cylindrical wall (24) surrounding and substantially concentric with the cell opening and located within the substantially rectangular wall, the cylindrical wall interrupted by a relatively small circumferential gap (26), and a wall (34) extending between the cylindrical wall and the adjacent side of the peripheral wall, the wall tangential to the cylindrical wall and adjacent the gap. A porous polytetrafluoroethylene disc (42) seated in the battery cover vent openings prevents spillage even if the battery casing is inverted.



FLOODED LEAD ACID BATTERY WITH TILT-OVER CAPABILITY

TECHNICAL FIELD

This invention relates to lead acid batteries in general, and to improved battery casing
5 cover and vent configurations which prevent corrosive acids from being spilled when the
battery is tilted over on any of its four sides, or even inverted as the result of mishandling the
battery, vehicle accident or the like.

BACKGROUND AND SUMMARY OF THE INVENTION

Flooded lead acid batteries (batteries with liquid electrolyte) designed for starting,
10 lighting and ignition (SLI) experience a variety of rough handling during manufacture, storage
and distribution including an occasional accidental tilting of the battery on its side, a variety of
angled inclines once the battery is installed within a vehicle, as well as normal vibrations.
During normal operation of a battery, water is electrolyzed into hydrogen and oxygen while
temperature excursions produce water vapor, both of which will tend to be lost through the
15 battery venting system. A well designed vent network must minimize or prevent this loss by
capturing, condensing and draining the acid back into the cells. The vent system must also
prevent or minimize spilling even when the battery is inverted, and safeguard the battery
against external ignition sources. Typically, the vent system is incorporated into individual cell
closures or, in the more modern battery designs, in vent manifold covers which extend over
20 several or all of the cell openings. The vent system usually includes an electrolyte flowpath
arrangement in combination with one or more vent recesses or ports in which flame arresters
are seated. These flame arresters are usually in the form of glass or polypropylene "frits"
which permit the passage of vapor out of the battery casing but prevent flame intrusion into the
battery. At the same time, the electrolyte flowpath is designed to minimize spilling, at least
25 when the battery is tilted 90° to one side or the other. See, for example, commonly owned
U.S. Patent No. 5,565,282.

Tougher criteria are currently being implemented, or will be implemented in the future,
regarding spillage of electrolyte from flooded lead acid batteries to the extent of requiring

spillage prevention even when the battery is turned over, i.e., inverted. Thus, there is a need to have flooded lead acid batteries designed to prevent the spilling of corrosive acids not only when the batteries are subjected to a high degree of tilt or even turned on one side, but also when the battery is turned completely upside down as may happen in an automobile accident or as a result of accidental mishandling during installation, removal or transit. Presently, this goal is accomplished by an expensive lead acid battery design utilizing gelled electrolytes, or by using AGM oxygen recombinant valve regulated (VRLA) batteries.

In accordance with this invention, the battery vent cover or manifold cover is designed to cooperate with a complementary or mating surface configurations on the battery casing lid to establish an electrolyte flowpath which substantially confines the liquid electrolyte to specific areas adjacent the cell opening, and which prevents lateral spillage into adjacent cells in all battery orientations with the exception of a complete invasion. Thus, the flowpath arrangement in accordance with the invention is effective for battery tilt orientations 90° in any direction, i.e., where the battery rests on any of its four peripheral sides. Spillage of the electrolyte out of the battery casing when the battery is inverted can be prevented by the use of a unique porous, hydrophobic polytetrafluoroethylene disc (PTFE) or frit within the existing battery vent recesses as replacements for the conventional polypropylene flame retardant frits. These porous PTFE discs are sealed within the battery vent cavities and permit the passage of gas but prevent passage of liquid, while also preventing flame intrusion. No modification of current battery component designs is required, since the frit can be shaped and sized to fit existing vent cavities. While these two design features can be incorporated individually or in combination, the greatest benefit is achieved when they are combined in a single battery.

In one exemplary embodiment, a manifold vent cover is provided which is formed on its underside with ribs and walls which, in use, are heat sealed to mating, complementary ribs and walls on the upper surface of the battery casing cover or lid, and which together define substantially closed electrolyte flow paths for each cell. Since the flowpath for each cell is substantially identical, the description of one is sufficient. Part of the flowpath for each cell is defined by a hollow, cylindrical "chimney" formed in the battery casing cover and which extends below the underside thereof. In the area below the cover, the chimney is provided with vertically offset 180° ramps or baffles, in diametrically opposed relationship. The ramps are in

fact, conical surfaces with central openings, i.e., each has a half circle cutout concentric with the longitudinal axis of the chimney. These ramps serve as splash guards and also facilitate drainage of splashed or spilled electrolyte back into the cell. The cooperative interfit of the splash tubes within the staggered ramps obviates the need for special "guides" inside the manifold cover which are notorious acid collectors and tend to accumulate beads of acid which will eventually find their way out of the cover.

At the same time, the underside of the manifold cover is formed with a plurality of downwardly extending splash guard tubes which are sized and located to extend into the chimneys on the battery cover. These tubes are open at their lower ends and closed by the manifold cover at their upper ends. The tube radius approximates the radius of the opening in the upper ramp so that, when the manifold cover is sealed to the battery cover, the tips of the tubes lie concentrically within the upper ramp. Thus, to escape the battery cover, any electrolyte from a given cell must follow a somewhat circuitous path around the lower ramp, upper ramp, and then upwardly around the splash tubes. In addition, the very nature of the double ramp arrangement provides splash protection by deflecting the electrolyte back into the cell.

On the upper side of the battery casing cover, vertical walls define a rectangular chamber around each chimney, each chamber having a pair of side walls and a pair of end walls. The chimney extends above the battery cover surface to the same extent as the chamber peripheral walls, and is open at the top. In addition, a circumferential gap is formed in the chimney wall so that, when the manifold cover is sealed to the battery cover, the vertically oriented, circumferential gap is the only opening by which electrolyte can escape the chimney and pass into the rectangular chamber between the battery casing lid and the manifold cover.

Within the rectangular chamber, there is also a wall tangential to the chimney, which extends to one of the chamber sidewalls. This tangential wall is substantially adjacent the circumferential gap in the chimney, and extends parallel to the chamber end walls, lying on the opposite side of the chimney from the nearest one of the end walls. As a result, any electrolyte passing through the circumferential gap must then pass around the outside of the chimney, approximately 180°, to enter the main area of the rectangular chamber.

It will be appreciated that the manifold cover has complementary or mating ribs so that the chamber for each cell is closed (including the upper end of the respective chimney), except as noted below, when the manifold cover is sealed to the battery casing cover.

5 The ribs on the underside of the manifold cover which define part of the sidewalls of the chamber each have a notch located between the end walls, permitting vapor to escape from any one or more of the cells to the vent ports at opposite ends of the manifold cover. Thus, under normal circumstances, vapor within the cells can escape by following a flowpath up through the chimneys and through the individual chambers in the manifold cover by means of
10 the notches in the chamber sidewalls, and then passing through the vent ports containing the flame arrester frits. Should any splashing of electrolyte occur during use, the chimney and splash tube arrangement in conjunction with the chamber arrangement within the manifold cover will confine the electrolyte to the individual cells and will facilitate quick drainage of electrolyte back into the battery. In this connection, the "floor" of the chamber in the manifold
15 cover is tilted back toward the cell opening.

As further described in detail hereinbelow, the flowpath arrangement will also confine the electrolyte within the individual cell chamber areas in the event the battery is tilted over onto any one of its four sides. In this regard, the vapor passage notches in the chamber side
20 walls are located at strategic positions in the chamber side walls such that it is not likely that any electrolyte will reach those notches and pass between the adjacent chambers when the battery is tilted over.

With regard to the unique PTFE frit which prevents spillage even when the battery is
25 inverted, it is desirable that the frit dimensions be substantially the same as conventional frits so that no change in the battery is required to accommodate the frits. In accordance with associated manufacturing techniques, it has been possible to obtain similar dimensional and physical features along with adequate air flow rate so that no changes in the existing battery cover or gang vent configuration is required to permit substitution of the existing frits and
30 thereby achieve the desired anti-spillage goal.

In addition, the porous PTFE frit in accordance with this invention can be used wherever battery vents are currently located in individual threaded or push-in vent caps, in removable gang vent covers, or in manifold covers heat sealed to the battery cover.

5 A number of manufacturing techniques for sealing the PTFE discs within existing battery vents have proven successful. In a first technique, a slab of silicone grease is applied to the periphery of the PTFE disc. Subsequently, the upper rim of the polypropylene wall which defines the vent opening is crimped over the upper annular edge of the disc, utilizing applied heat.

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Another technique is to mold the PTFE disc with a polypropylene skin or ring surrounding at least the side wall of the disc. This allows the disc assembly to be conventionally and easily welded to the polypropylene vent material. In a variation of the above technique, the frit/ring assembly can be sonically welded to the cover. Further in this regard, it may well be possible to mold the polypropylene battery cover manifold around the PTFE disc, but this arrangement would be more costly due to the requirement for new mold designs.

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Another sealing technique is to mold the PTFE disc so as to have an outer diameter establishing an interference fit within the vent cavity. While this technique may be viable in many situations, the temperature range of the battery environment must be maintained below 190°F. to avoid relaxation of the polypropylene which would otherwise break the seal.

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Finally, it is possible to utilize a high temperature horn for melting an upper annular edge of the PTFE disc so that the heat is transmitted to the outer polypropylene walls to form a "skin" seal.

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Accordingly, in one aspect of the present invention there is provided a battery including a casing having bottom, side and top surfaces, the top surface having a plurality of cell openings therein, and an improved flowpath for liquid electrolyte when the battery is tilted onto any one of its side surfaces, the flowpath comprising:

5 a chamber for each cell opening defined by a substantially rectangular peripheral wall surrounding the cell opening;

 a cylindrical wall surrounding and substantially concentric with the cell opening and located within the substantially rectangular wall, said cylindrical wall being interrupted by a gap; and

10 a wall extending between said cylindrical wall and an adjacent side of said peripheral wall, said wall being tangential to said cylindrical wall and adjacent said gap.

Other objects and advantages of the present invention will become apparent from the detailed description which follows:

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BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a perspective view of a battery incorporating a vent manifold cover and anti-spill frit;

20 FIGURE 2 is a perspective view of the battery cover removed from the battery shown in Figure 1, and with the manifold cover removed from the battery cover;

FIGURE 3 is side elevation of the manifold cover shown in Figures 1 and 2;

FIGURE 4 is a perspective view similar to Figure 2 but illustrating a recessed manifold cover in a flat battery cover arrangement;

5 FIGURE 5 is a side elevation of the battery cover illustrated in Figure 4;

FIGURE 6 is a partial section of the cover shown in Figure 5;

10 FIGURE 6A is a partial plan view of the battery cover shown in Figures 4 and 5, showing a single cell chamber and cell opening;

FIGURE 7 illustrates schematically the electrolyte flowpath for one vent in a manifold cover in accordance with this invention when the battery is tilted onto a first of its four sides;

15 FIGURE 8 is similar to Figure 5 but illustrates the flowpath when the battery is tilted onto a second of its four sides;

FIGURE 9 is similar to Figure 5 but illustrates the flowpath when the battery is tilted onto a third of its four sides;

20 FIGURE 10 is also similar to Figure 5 but illustrates the flowpath when the battery is tilted onto a fourth of its four sides;

FIGURES 11A and 11B illustrate one technique for sealing an anti-spill frit within a vent cavity in a manifold cover;

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FIGURE 12A is a perspective view of a anti-spill frit in accordance with another exemplary embodiment of the invention;

30 FIGURE 12B is a partial section view illustrating the manner in which a frit as shown in Figure 12A can be secured within a manifold cover vent cavity;

FIGURES 13A and 13B illustrate another assembly and sealing technique for an anti-spill frit in accordance with the invention;

FIGURES 14A through 14D illustrate still another manner of assembly of an anti-spill frit in a manifold cover in accordance with the invention;

FIGURE 15 is an exploded view of an individual vent cap incorporating a frit in accordance with the invention; and

FIGURE 16 is a bottom plan view of a gang vent cover incorporating a frit in accordance with the invention.

BEST MODE FOR CARRYING OUT THE INVENTION

With reference to Figure 1, a maintenance-free battery 10 includes a casing 12 in which are located the individual cells and liquid electrolyte, and a cover or lid 14 which is typically heat sealed to the casing. Lead posts 16, 18 provide positive and negative terminals, respectively, which project from the cover and which are adapted to receive cable connections in a conventional manner. A manifold vent cover 20 overlies the cell openings 22 (shown in phantom in Figure 1 but see also Figure 2) formed in the cover. In maintenance free batteries, the manifold cover 20 is heat sealed to the battery cover 14, i.e., the manifold cover 20 is not intended to be removed during the useful life of the battery.

With specific reference to Figures 2 and 3, the underside of the manifold cover 20 in accordance with this invention is formed with a plurality of hollow manifold or splash tubes 23 which extend down into the cell openings or chimneys 22 formed in the battery casing cover. As illustrated in Figure 2, the chimneys 22 on the battery casing cover are defined in part by upstanding cylindrical walls 24, each discontinuous in the circumferential direction, thus providing a circumferential gap 26. At the same time, each chimney is surrounded by a generally rectangular chamber area as defined primarily by upstanding, parallel ribs or walls 28 of equal height with walls 24, along with end walls 30, 32. Each of the chimney walls 24 is also connected to an adjacent wall 28 by a transverse wall section 34, also of equal height and

tangent to the wall 24. Note that the transverse wall section 34 is parallel to the chamber end walls 30, 32, and that wall section 34 lies on the opposite side of the chimney from the nearest end wall 30. This arrangement, in cooperation with a similar arrangement on the underside of the manifold cover 20, establishes a desired flow pattern for the electrolyte in each cell, in the event of battery tilt or turn over. Thus, cylindrical walls 24' mate with similar walls 24; transverse wall sections 34' mate with similar sections 34; and ribs 28' mate with similar ribs 28 to form substantially closed chambers for each cell vent when the manifold is heat sealed to the battery casing cover. It is noted, however, that gaps 26 become closed-periphery apertures when the manifold 20 is sealed to the battery casing cover, and gaps 29 in the ribs 28' also form closed periphery openings in the combined ribs 28, 28'.

At the remote ends of the manifold cover 20, round vent recesses or ports 36 are integrally formed which are connected to atmosphere by passages 38 internal to the manifold. These passages open at slits 40 at opposite ends of the manifold cover 20. In these vent recesses or ports 36, porous PTFE discs or frits 42 may be located and sealed as described in greater detail below. While conventional polypropylene or other frits may be employed with the preferred electrolyte path, PTFE frits are preferred to insure spillage protection in the event the battery is inverted, e.g., during a vehicle accident. Gaps or notches 29 in the walls 28' permit vapor to pass between the cells and eventually to the vent ports 36 and passages 38.

With specific reference to Figure 2, the battery casing cover is also formed with cell vent slots 46, one for each of the cells. These vent slots permit air and/or vapor to escape during initial filling of the cells and before the manifold cover is sealed in place. They also provide a visual mechanism by which the electrolyte levels in each of the cells can be equalized. When the manifold cover is heat sealed in place, the slots are closed.

Figure 4 illustrates an alternative battery casing cover and manifold cover configuration where the battery cover design is such that the manifold cover, when in place, lies flush with the remaining upper surface portion of the battery cover in the area of terminals 116, 118. This is unlike the previously described embodiment shown in Figures 1-3 where the manifold cover projects above the battery casing cover. Otherwise, however, the electrolyte flowpath configuration and the arrangement of vent ports at opposite ends of the manifold cover are

substantially identical and need not be described in detail. For convenience, similar reference numerals have been used to designate corresponding components but with the prefix "1" added in Figures 3 and 4, where appropriate. Note that frits 142 are enclosed within a polypropylene sleeve or skin 43, the purpose for which will be described further herein.

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With specific reference to Figures 5, 6 and 6A, the configuration of each chimney 122 is seen in greater detail. At the lower end of the each substantially open cylindrical chimney, there are a pair of diametrically opposed baffles or "half moon" ramps 148, 150, each of which extends substantially 180°, but which are offset in a vertical direction. Each baffle has a tapered conical surface 152, 154, respectively, which extends radially inwardly toward the center axis of the chimney. Each baffle has a half circle cutout 156, 158 concentric with the center axis and of the same or different radius. These baffles or ramps provide a flow obstacle to liquid trying to escape a respective cell, but also promote splashback, and facilitate drainage of acid back into the cell without beading and accumulating due to the sharp angular drop of the baffles. Moreover, when tubes 123 are inserted into the chimneys 122, the ramps 148, 150 tend to "lock" in place, obviating the need for any additional interior guides.

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Turning now to Figures 7-10, the manner in which acid spillage is prevented for any given cell is shown substantially for 4 different tilt orientations, using the reference numerals found in Figure 2 to indicate corresponding manifold and casing cover components. recognizing, of course that, in use, the manifold cover 20 is sealed to the battery casing cover 14 or lid. Figure 7 shows cell cavity A within the cover 14, when the battery as shown in Figure 1 is tilted onto side S₁ and with the liquid electrolyte stabilized. Electrolyte will flow out of the cell opening 22 and into the chamber defined by walls 28, 30, 32. Notice that electrolyte is free to flow through the gap 26 into an area outside the wall 24 but constrained by walls 28, 30. The electrolyte will simply seek its own level - approximately at the center of chimney 22, and will not spill into the remainder of the chamber. In this way, only vapor is free to transfer between chambers, via gaps or notches 29.

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Figure 8 illustrates the cell orientation when the battery is tilted over onto side S₂. In this state, the electrolyte fills the cell opening, even above the center of the opening, but does not escape through the notch 26, and therefore remains confined within the cylindrical wall 24.

Figure 9 illustrates the battery tilted onto side S_1 . In this orientation, electrolyte flows into the chamber and through the gap 26 into the area to the left of the wall 24, seeking its own level which is below the maximum height of the wall 24, so that the liquid does not flow into the chamber. Note that wall 34 prevents the electrolyte from escaping into the chamber area.

Figure 10 illustrates the battery tilted onto side S_2 . Here, the electrolyte flows into the chamber through the gap 26, seeking its own level which is just above the center of the vent opening but confined by the end wall and parallel wall 28. In each case, the electrolyte or acid is entrapped so that no electrolyte reaches the vent port 36 (and hence the frit), and no electrolyte passes through the appropriately located openings 29 into the adjacent cell area.

It will be appreciated that this same flow action takes place in each adjacent cell area, with the overall result that, one stabilized, no electrolyte escapes into adjacent cell compartments, and no electrolyte reaches the vent cell and frit arrangement. During the tilting action (prior to stabilization) or during severe vibration conditions, any splashing of electrolyte is inhibited by the baffles 148, 150 and even if escaping into chamber will quickly drain back into the chimney via slanted chamber floor 60, then down into the cell along the baffles. Finally, the chambers formed by the combined battery casing cover and manifold cover are purposefully designed to minimize sharp corners or angles where electrolyte will accumulate, with highly polished surfaces promoting drain back.

As explained above, in the event of a complete inversion of the battery, no electrolyte will escape the battery casing by reason of the use of frits 42 or 142. Thus, while the flowpath alone provides a high degree of tilt capability, the combined use of PTFE frits 42, 142 and the above described flowpath configuration provides even further benefits with regard to roll-over protection.

The preferred PTFE material for the frits 42, 142 is available from Performance Plastics Products, a division of EGC Corporation, under the trade name Permeon™. The material could be specified, however, and supplied under other trade names as well. This is an unfilled,

hydrophobic and relatively rigid PTFE material with an open structure which allows consistent permeation of vapors but not liquids. The properties of the Permeon™ material are as follows:

5	Tensile strength.....	1,500-3,000 psi
	Elongation (D638).....	100 - 200%
	Flexural modulus (D747).....	50,000 - 90,000 lb/in ²
	Impact strength, Izod (D256).....	2 ft. lbs/in
	Hardness durometer (D1706).....	D50 - 65
10	Coefficient of linear thermal expansion.....	5.5 x 10 ⁻⁵
	per °F, 73 - 140°F (D696)	
	Water absorption (D570).....	<.01%
	Flammability (D635).....	Nonflammable
	Specific gravity (depending on leak.....	1.9 - 2.16 g/cc
	rate specified) (D792)	
15	Maximum use temperature.....	500°F

The leak rate of liquid through the frit 42 or 142 can be varied to suit customer specifications by choice of particle size and frit dimensions, particularly thickness. For this application, the frit material is engineered to prevent any liquid leak when the frit is located under a 10 inch high column of water (average SLI battery height) for a period of 24 hours. By way of example, the frit may have a thickness of from about 0.080 to about 0.225 inch and a diameter of about 0.5 inch to 1.0 inch. In other words, no liquid electrolyte will leak out of the battery through the frits 42 for at least 24 hours when the battery is fully inverted. It should also be noted here that the frit 42 in accordance with this invention also provides the necessary flame intrusion prevention of current polypropylene frits. In fact, the frits of this invention may be superior in this respect in light of the high temperature assistance of the porous PTFE.

With this frit construction, increasingly specified tests such as the BMW "Rollover Test" is easily met. Moreover, because the frit in accordance with this invention requires no change to existing battery and manifold covers, nor to current screw-in or push-in vent caps, it is easily incorporated simply by customer preference, at little added cost.

Figures 11A, 11B show the manner in which the frits 42 are secured within the vent cavities or ports 36, each of which is defined in part by an upstanding cylindrical wall 62. An internal radial shoulder 64 provides edge support for the frit, and note again the internal

passage 38 terminating at slit 40. Because the PTFE frit 42 is not compatible with polypropylene (at least in terms of welding or heat sealing), typically used for the battery casing 12, cover 14 and manifold 20, it was necessary to develop new retention/sealing techniques to insure that the frit is properly and effectively sealed within the vent opening to prevent liquid leakage around the frit. The approach in Figures 11A and 11B includes application of a chemically inert (up to 500°F.) silicone grease 66 to the peripheral edge of the PTFE disc 42, followed by crimping the upper annular edge of wall 62 radially inwardly about the upper edge of the disc 42 with the application of heat at a temperature which softens the material sufficiently to enable it to be uniformly crimped about the upper edge of the frit. This creates a continuous mechanical seal about the upper edge of the frit which, combined with the liquid seal created by the grease 66, precludes any liquid from escaping to the passage 38 around the periphery of the disc 42.

A different approach to sealing the disc within the vent recess is illustrated in Figures 12A and 12B. Here, a porous PTFE frit 68 is molded to include an annular outer ring or "skin" 70 of polypropylene (similar to frit 42' in Figure 4). The frit peripheral wall 72 may taper downwardly and inwardly, and the ring 70 conforms to the taper on its interior side but has a straight outer surface which matches the internal surface of the vent cavity wall 74. The skin 70 also has an upper radial flange or edge 76 which overlaps the edge of the frit. The latter is seated on the radial shoulder 78 in the vent cavity. With the frit 68 enclosed by the polypropylene ring 70, the assembly is easily welded and sealed to the polypropylene cover incorporating the vent cavity. In this regard, a hot weld seal can be formed at the top of the frit. Alternatively, a sonic seal can be implemented where the frit sleeve or skin 70 engages the shoulder 78 on the vent cavity wall.

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Turning now to Figures 13A and 13B, another sealing technique is shown which involves compression fitting a porous PTFE frit 80 into the vent cavity as defined by peripheral wall 82 and radial shoulder 84. More specifically, an oversized, right-cylinder shaped frit 80 is molded with an interference fit, i.e., with a diameter 0.005" - 0.010" over the inside diameter of the cylindrical vent cavity wall 82 so that when the frit is pressed into the vent cavity, it is under peripheral compression and thus sealed. While this method has proven effective, the

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temperature range of the battery must be maintained below 190°F. to avoid relaxation of the polypropylene vent cavity and consequent breaking of the seal.

Figures 14A-D illustrate still another viable sealing technique. In this embodiment, the PTFE frit 86 is seated within the cylindrical vent cavity as defined by peripheral wall 88 (Fig. 13A). A hot melt tool 90 (at about 680°F.) is applied to the upper edge of the frit (Fig. 13B), melting a localized region of the frit and transferring heat to the polypropylene wall 88. The latter melts at 293°F. As a result, the melted PTFE will flow over and onto the polypropylene material, with some blending of the materials to a thickness of about .005-.010 inch, indicated at 92. This technique has proven successful despite the apparent incompatibility of the materials. In Figure 14D, a heat sealing horn 94 is illustrated which is effective to seal the entire 360° frit/wall interface, using the annular tip 96.

The subject invention is not limited to use of a porous PTFE disc or frit in a battery cell manifold cover. It is equally applicable to other battery types, such as those which utilize, for example, individual screw-on or push-in plugs. An example is shown in Figure 15 where an individual vent plug 98 of otherwise conventional construction, includes a threaded shank 100 and a bolt-like head 102, formed to include a vent cavity 104 which typically receives a polypropylene frit (not shown). Here, however, a porous PTFE frit 106 is seated within the cavity and sealed by one of the techniques described above. A cap 108 may be employed to protect the frit, noting that the cavity, above the frit, is vented to atmosphere.

Figure 16 illustrates still another application for the porous PTFE frit. In this embodiment, a rectangular-shaped frit 110 is seated within a similarly shaped cavity defined by wall 112 on the underside of a battery gang vent cover 114. The latter is described in more detail in commonly owned U.S. Patent No. 5,565,282. This merely exemplifies the adaptability of the present invention to different already existing battery types.

The frit is also useful in batteries other than SLI batteries including marine and military batteries.

Finally, it should be noted that the frit or disc in accordance with this invention can be used without also having a complex electrolyte flow path as described herein, to at least prevent spillage through the flame arresters when the battery is inverted.

- 5 While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not to be limited to the disclosed embodiment, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

What is Claimed is:

1. A battery including a casing having bottom, side and top surfaces, the top surface having a plurality of cell openings therein, and an improved flowpath for liquid electrolyte when the battery is tilted onto any one of its side surfaces, the flowpath comprising:
 - a chamber for each cell opening defined by a substantially rectangular peripheral wall surrounding the cell opening;
 - a cylindrical wall surrounding and substantially concentric with the cell opening and located within the substantially rectangular wall, said cylindrical wall being interrupted by a gap; and
 - a wall extending between said cylindrical wall and an adjacent side of said peripheral wall, said wall being tangential to said cylindrical wall and adjacent said gap.
2. The battery of claim 1 wherein said flowpath is formed by mating surfaces on said top surface of said casing and an underside of a manifold vent cover.
3. The battery of claim 2 wherein vapor escape ports are provided at opposite ends of said manifold vent cover.
4. The battery of claim 3 wherein said peripheral walls have openings therein remote from said cell openings to thereby permit vapor to escape said battery via said escape ports.
5. The battery of claim 3 wherein each cylindrical wall extends downwardly below said casing top surface, and wherein opposed baffles are located in the lower portion of the cylindrical wall.
6. The battery of claim 5 wherein each baffle extends substantially 180 degrees and is tapered in a radial inward and downward direction.

7. The battery of claim 5 wherein said manifold vent cover has a plurality of tubular projections depending therefrom, each adapted to seat inside a respective one of said cylindrical walls.

5 8. The battery of claim 6 wherein each baffle is formed with a half circle cut-out concentric with a center axis of said cylindrical wall.

9. The battery of claim 3 wherein each vapor escape port has a flame arrester frit located therein.

10

10. The battery of claim 9 wherein said frit is made of porous polytetrafluoroethylene.

11. The battery of any one of claims 2 to 10 further including means for
15 venting air from said plurality of cells openings when liquid electrolyte is introduced into cells of said battery before said manifold vent cover is sealed to said top surface of said casing.

12. The battery of any one of claims 1 to 11 further including means for
20 preventing escape of liquid electrolyte when the battery is inverted.

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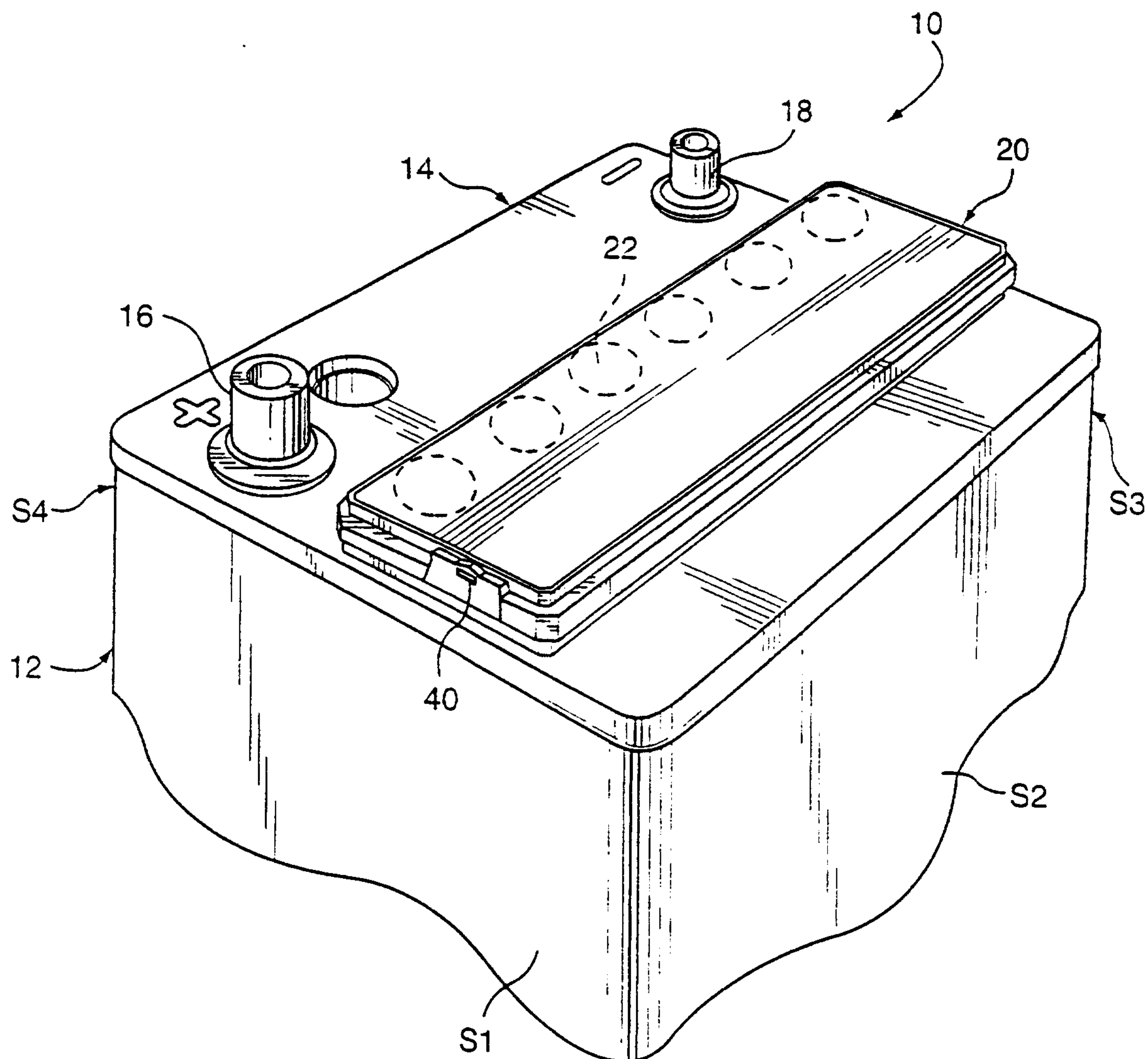


FIG. 1

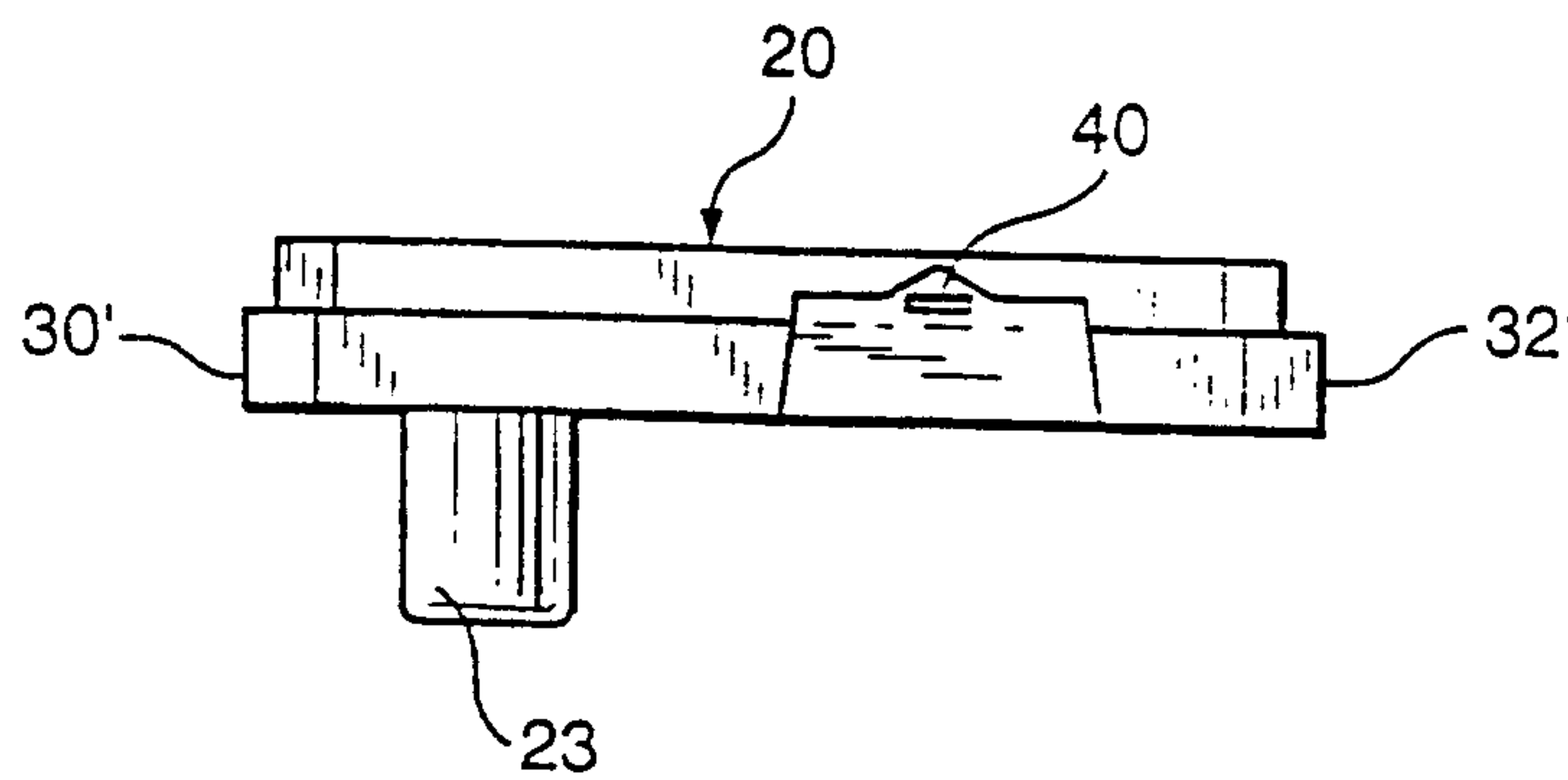


FIG. 3

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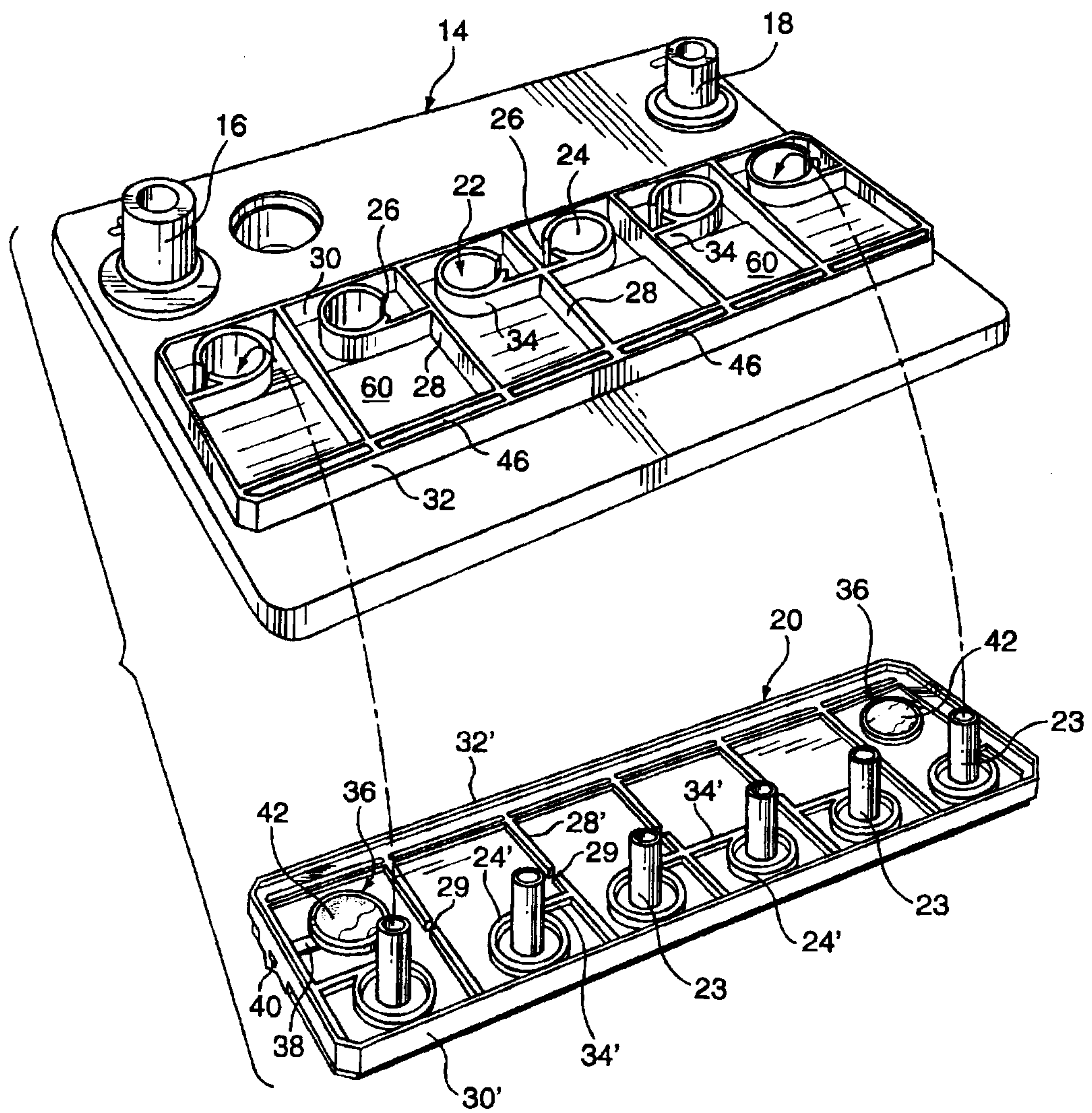


FIG. 2

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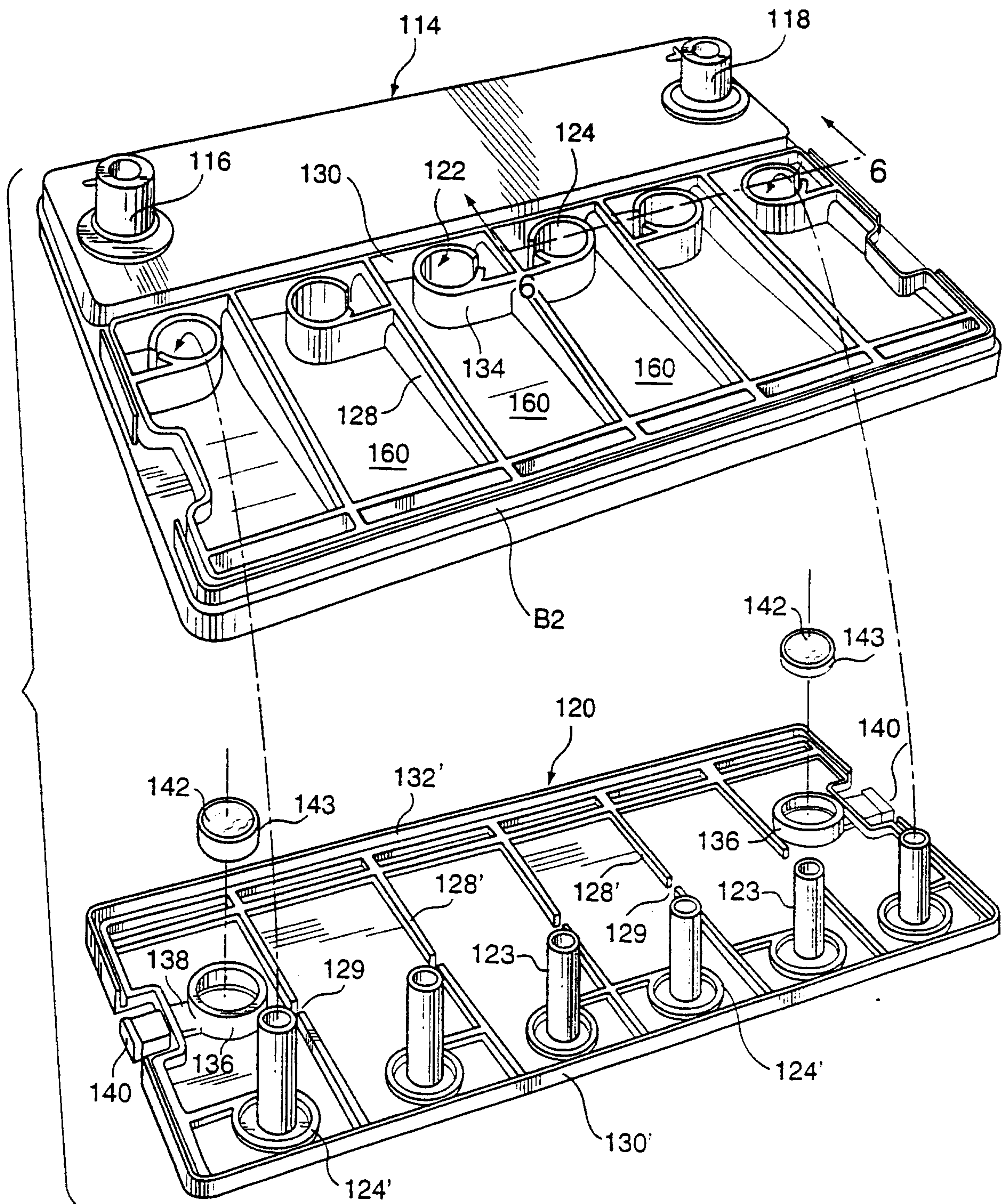


FIG. 4

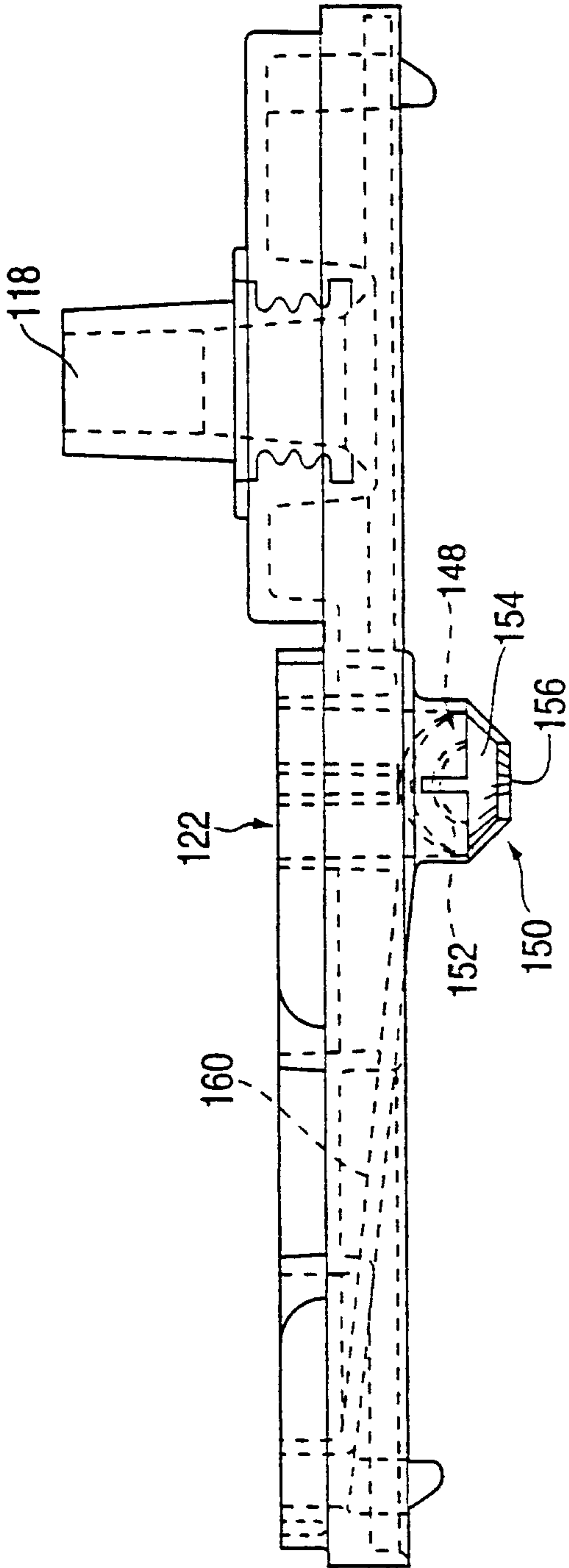


FIG. 5

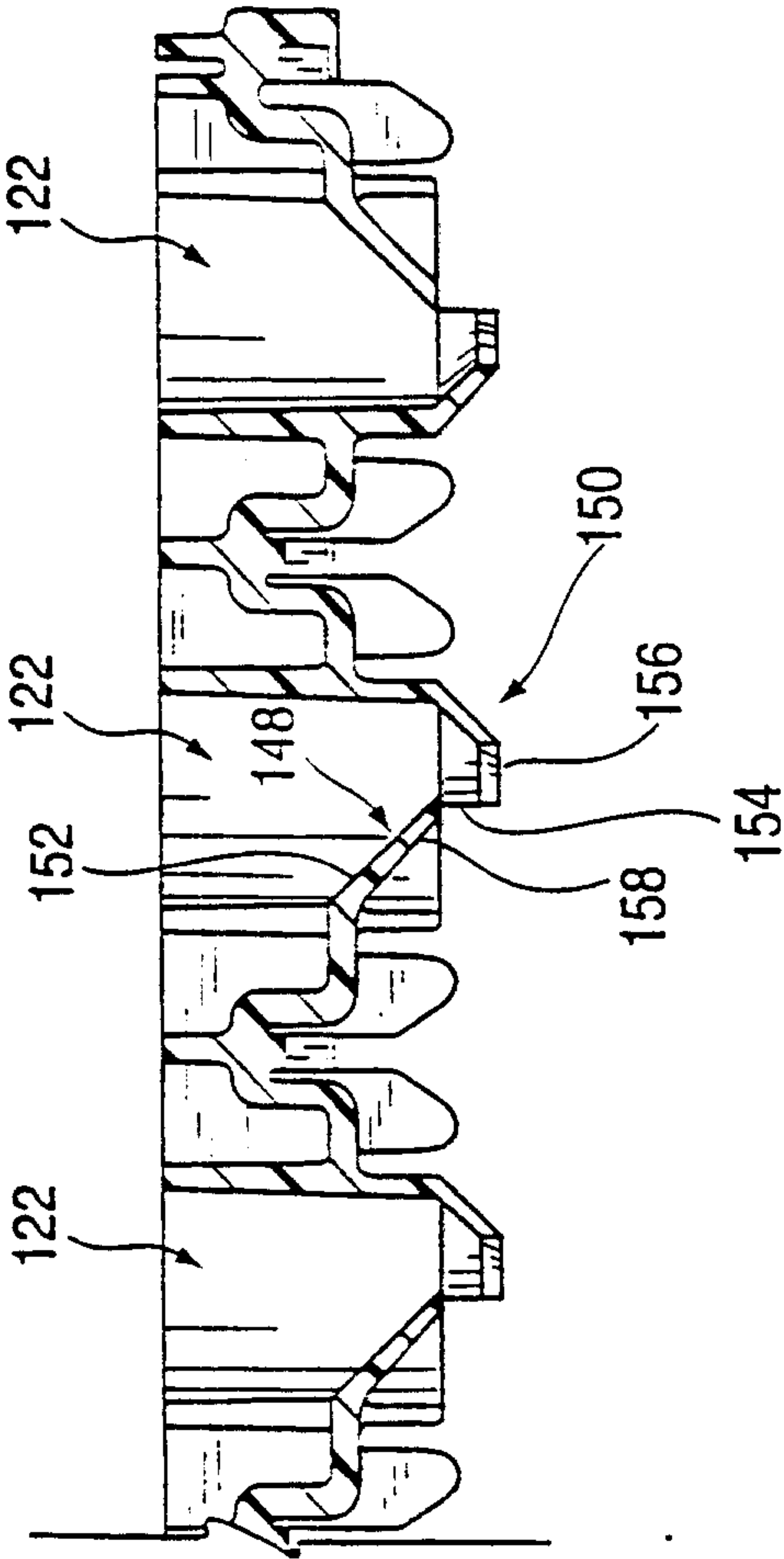


FIG. 6

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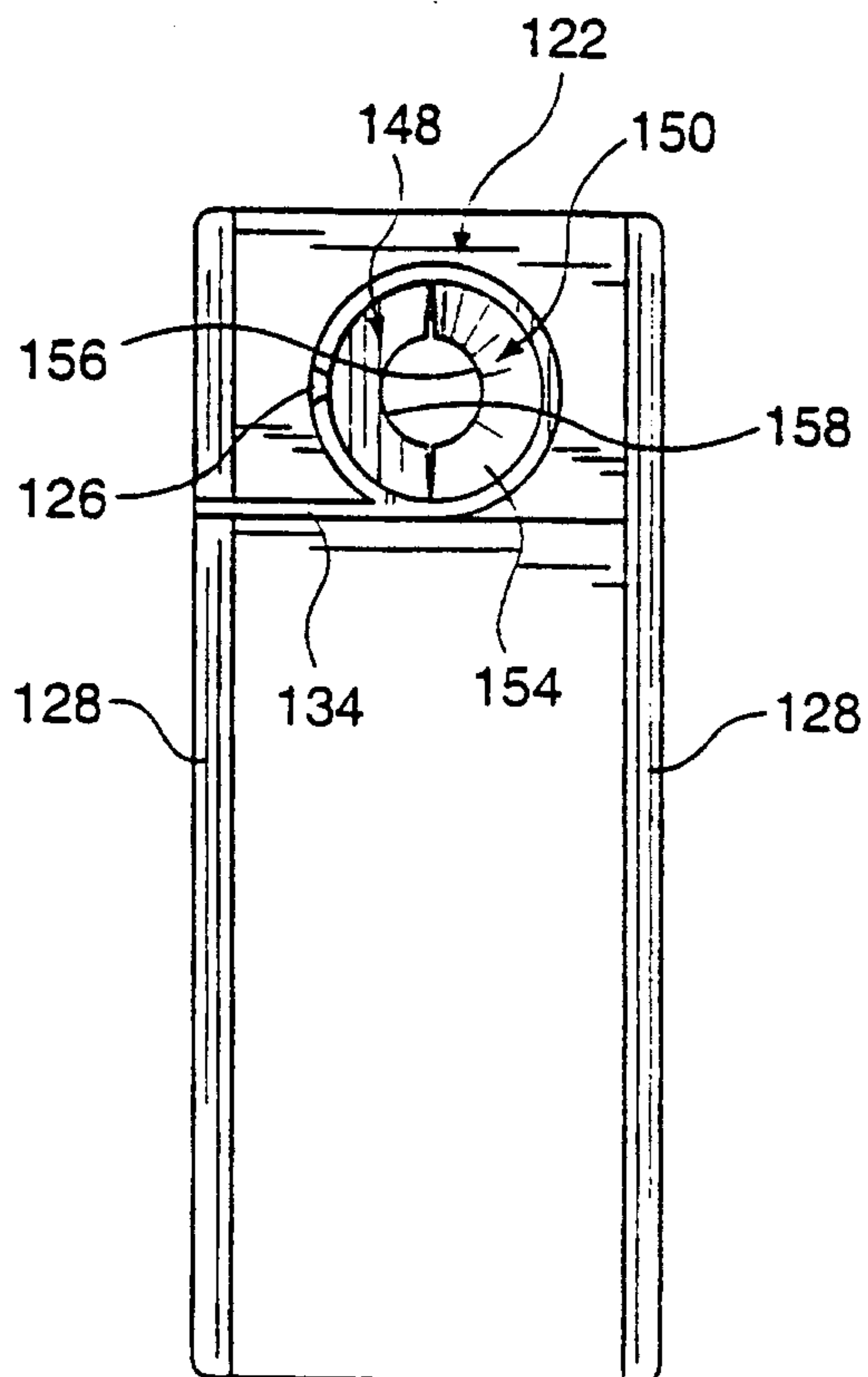


FIG. 6A

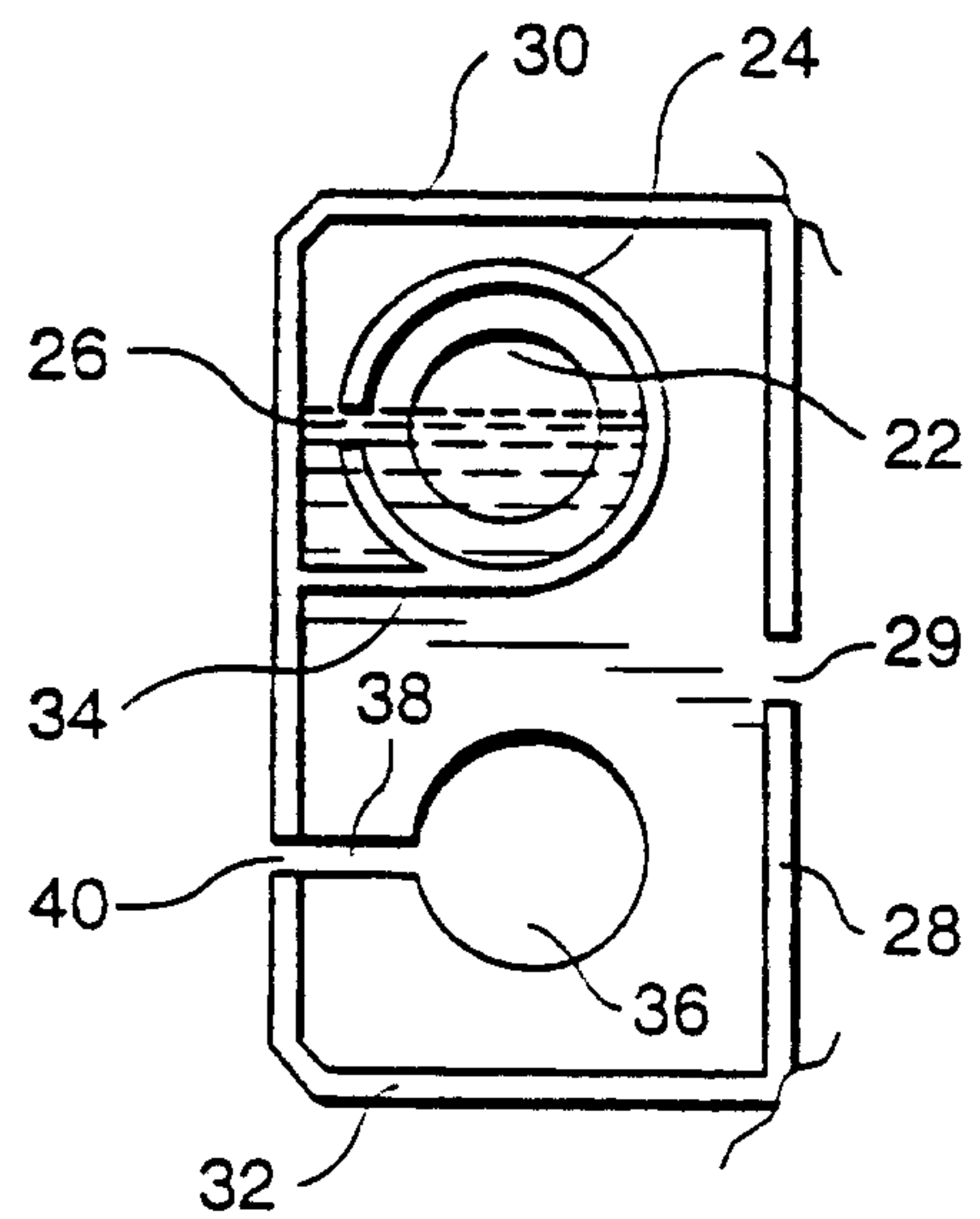


FIG. 7

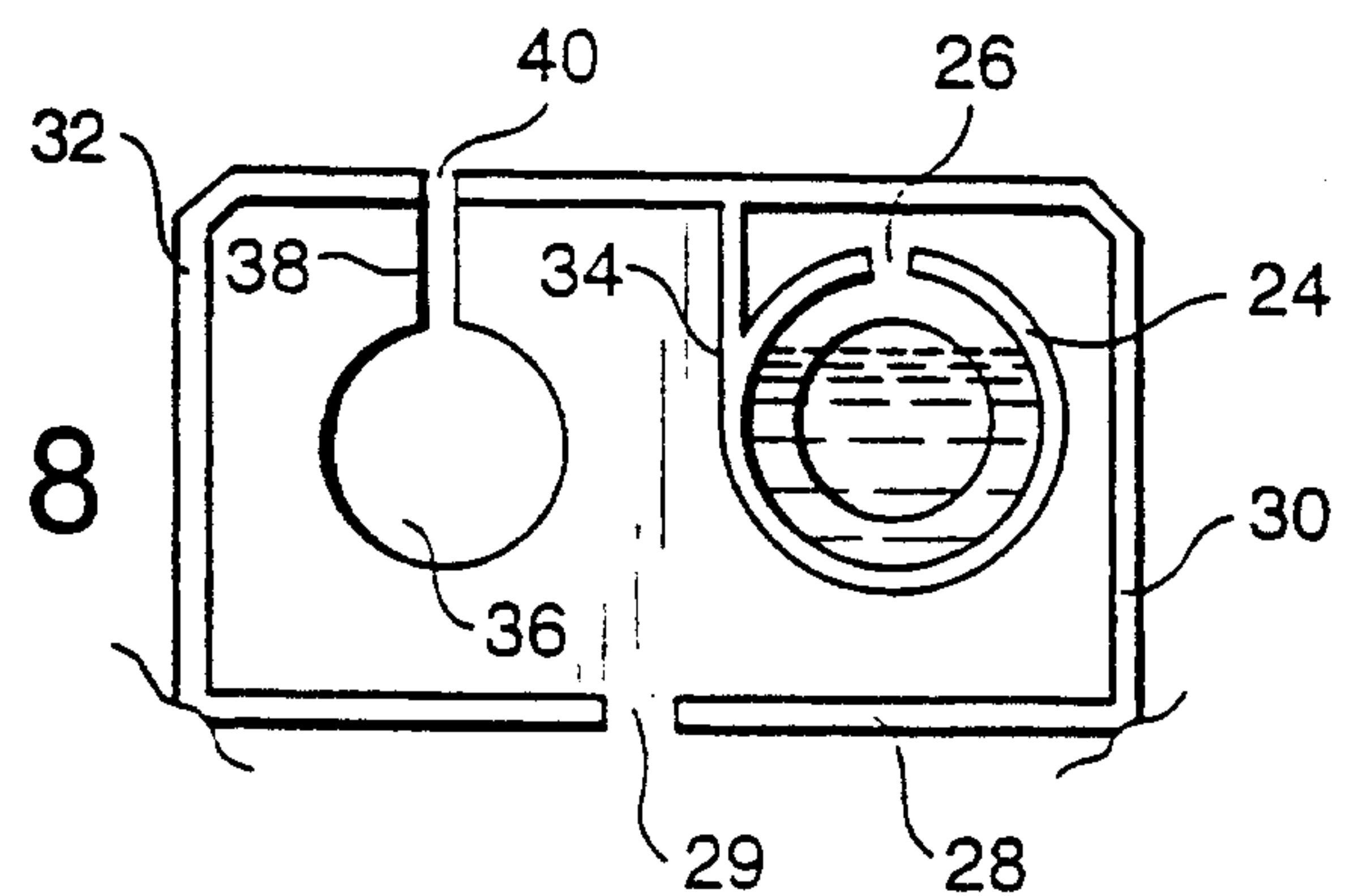


FIG. 8

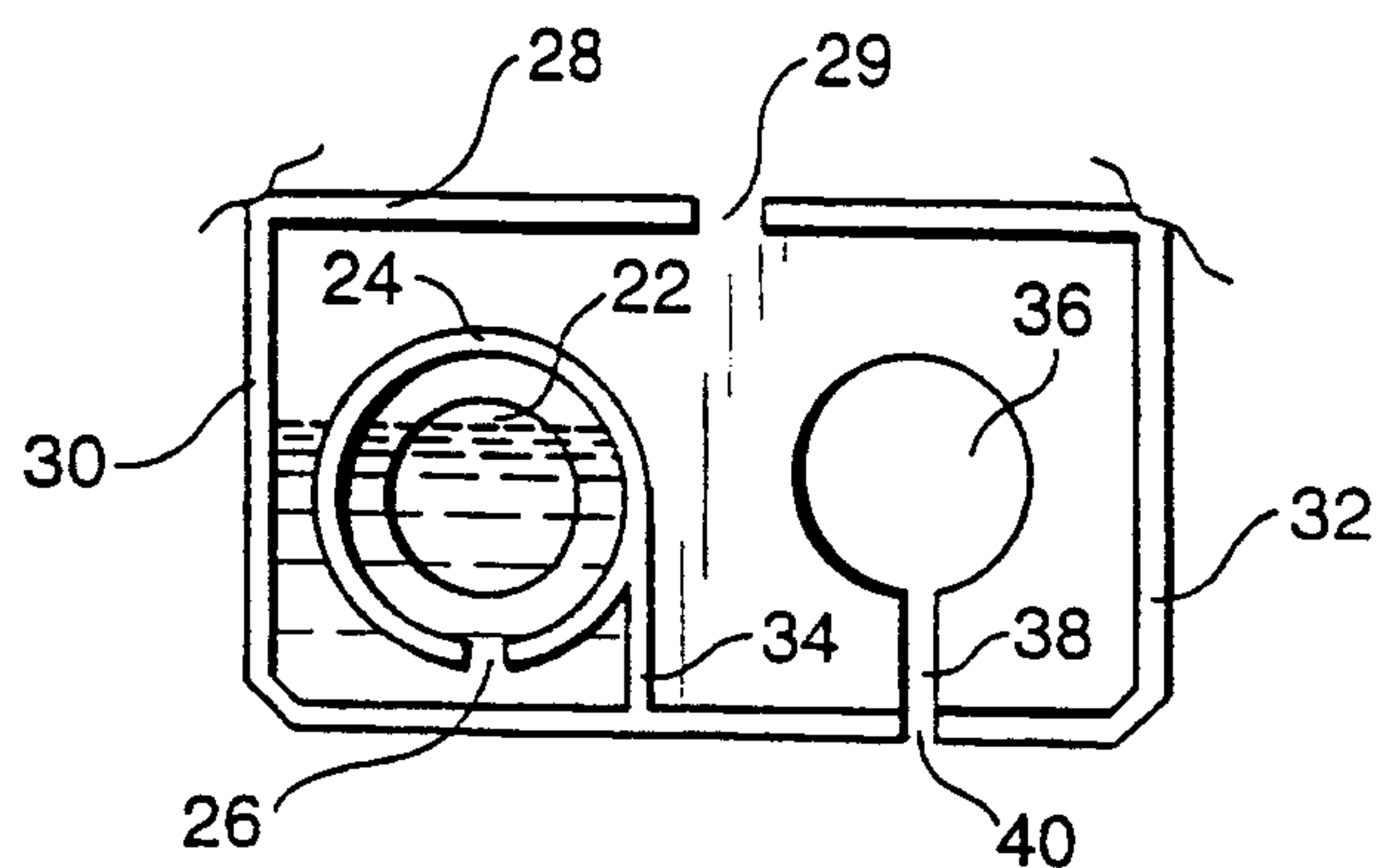


FIG. 9

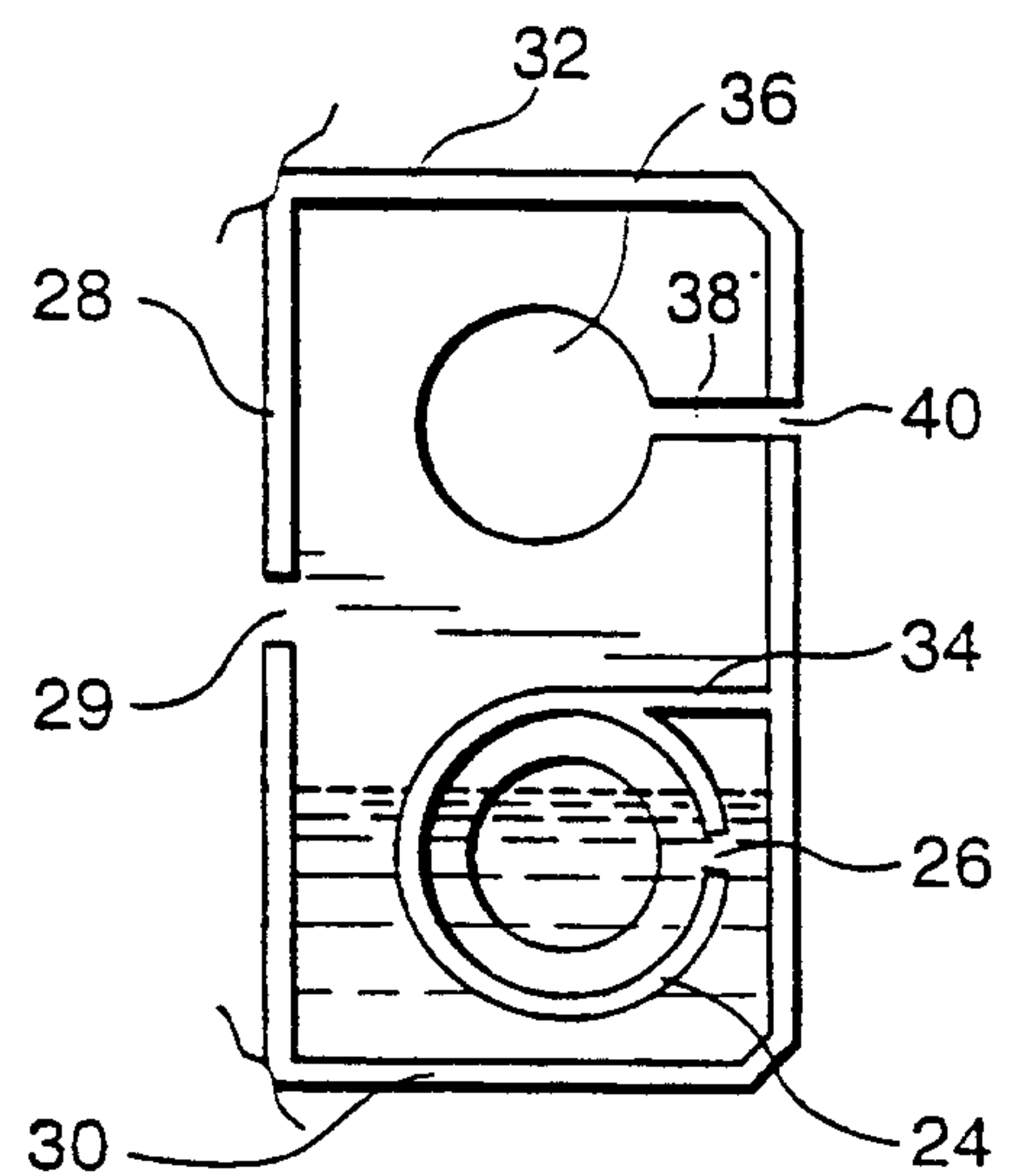


FIG. 10

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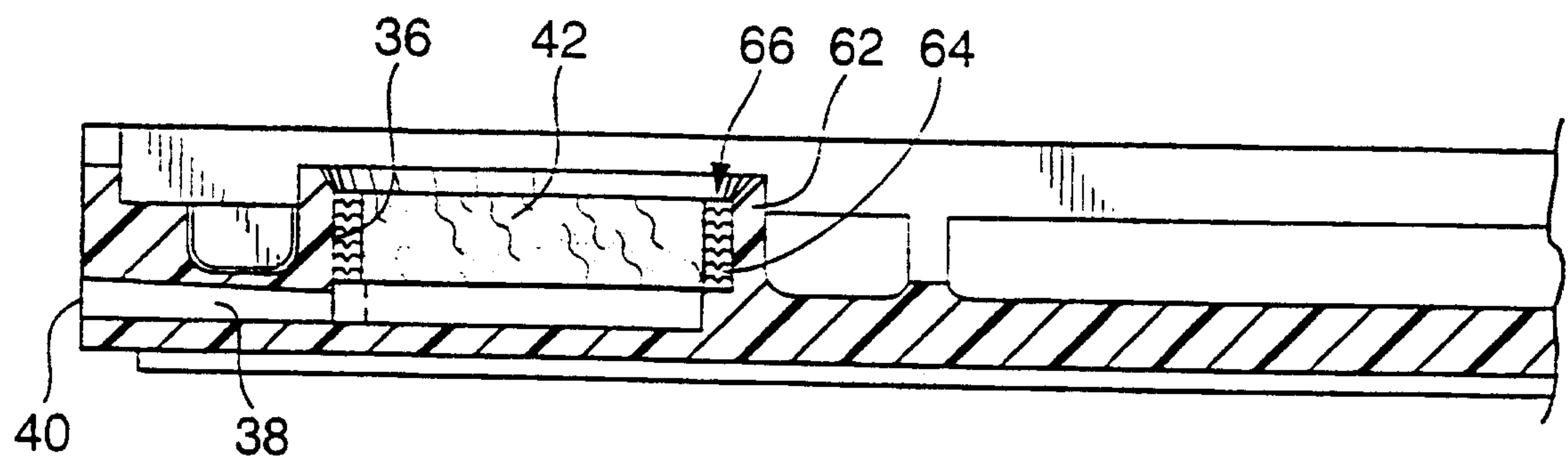


FIG. 11A

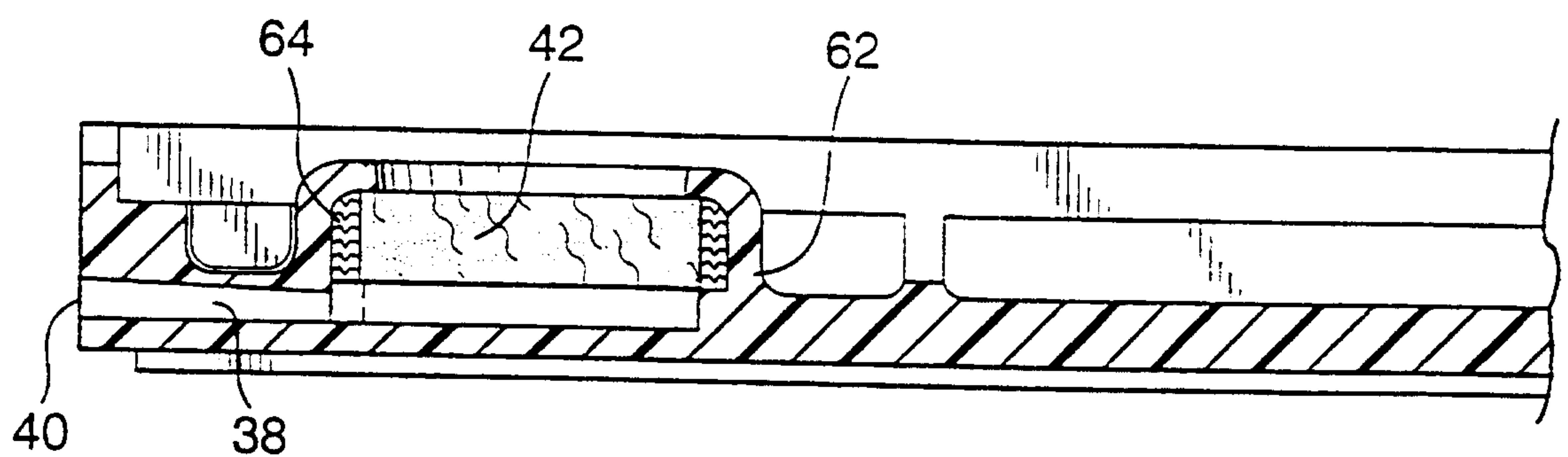


FIG. 11B

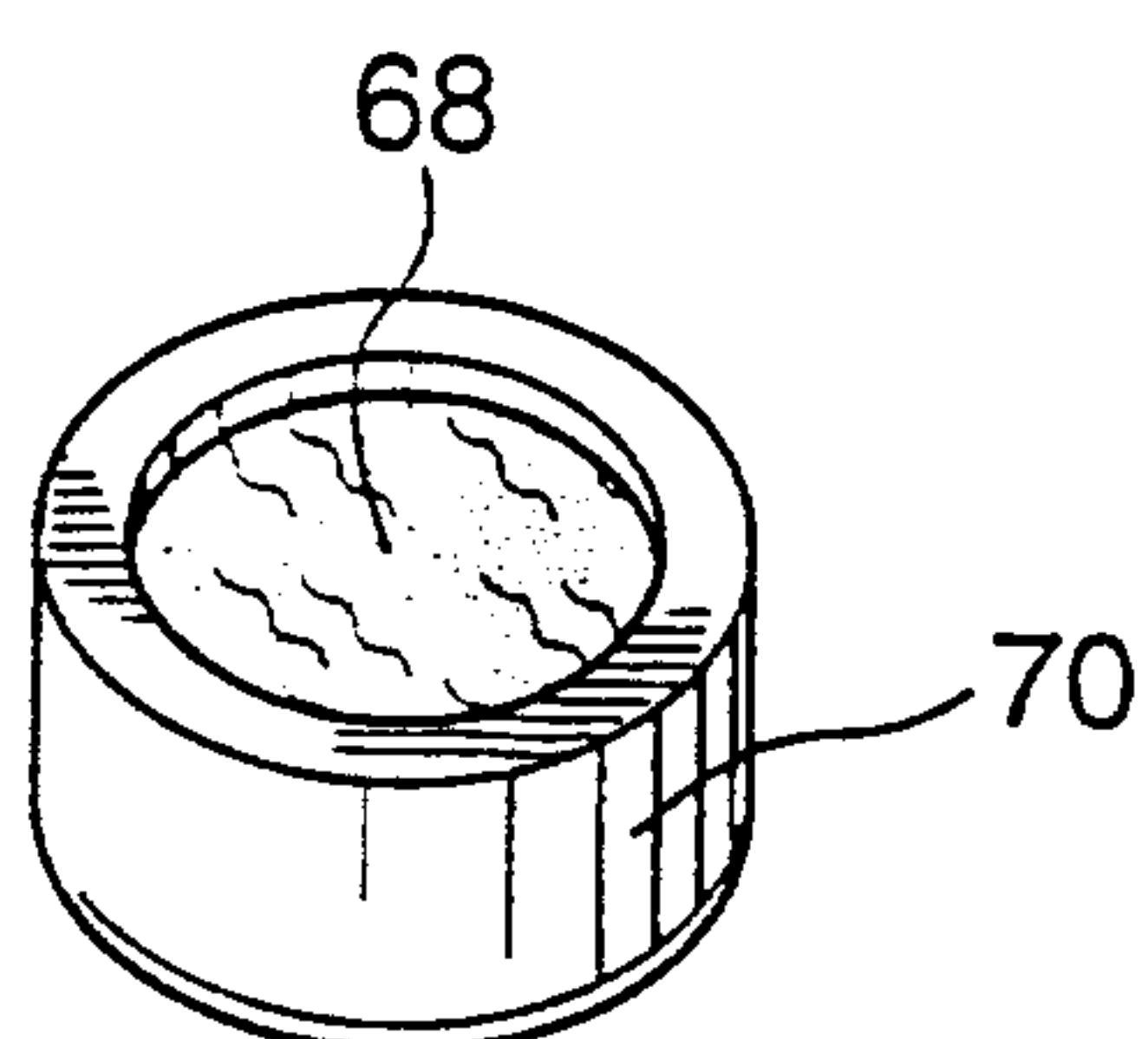


FIG. 12A

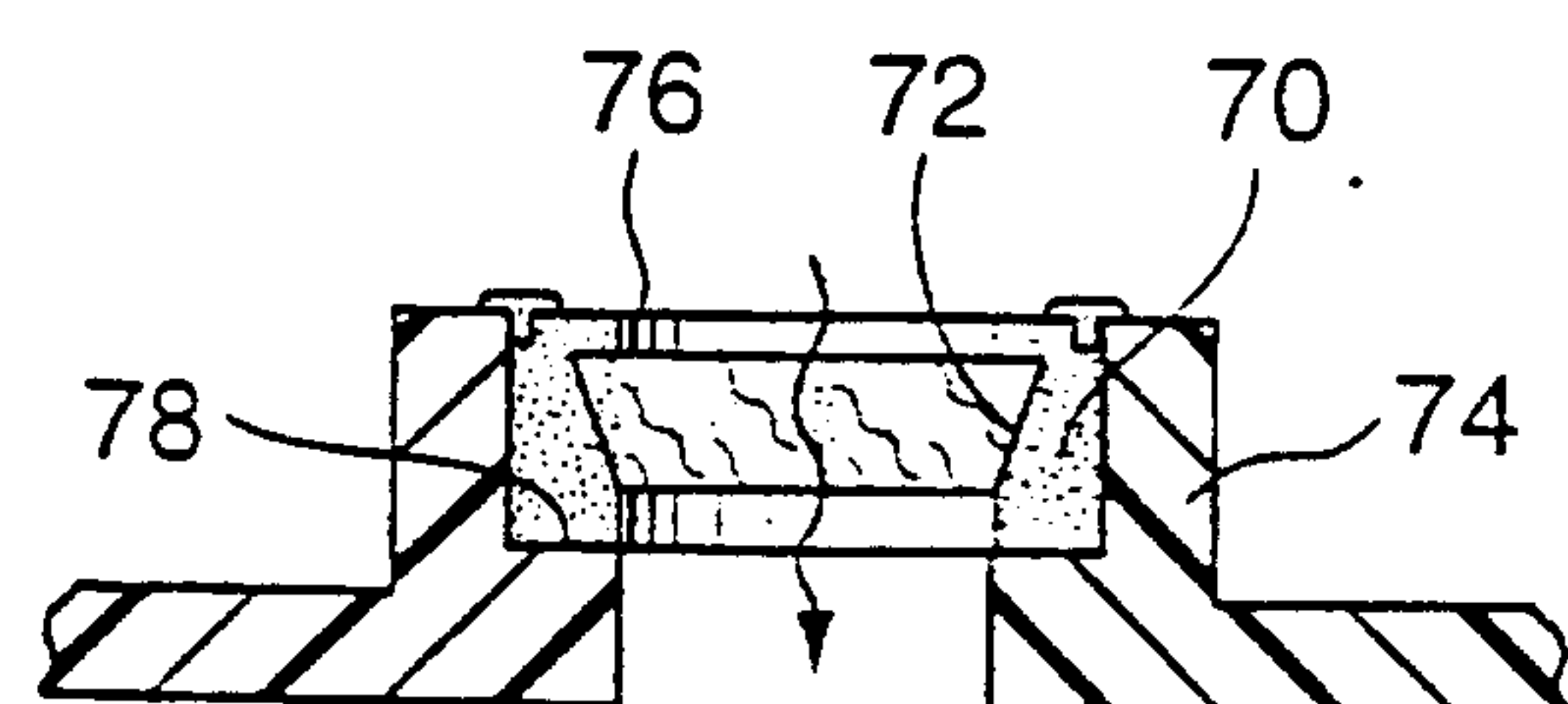


FIG. 12B

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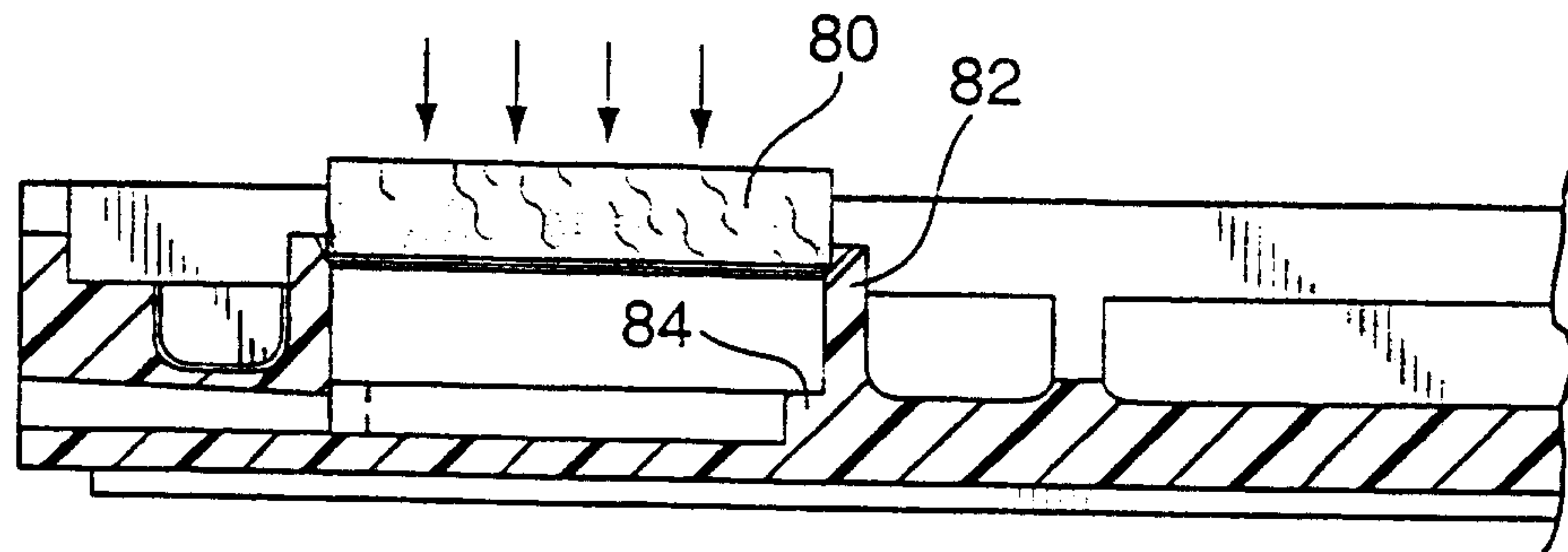


FIG. 13A

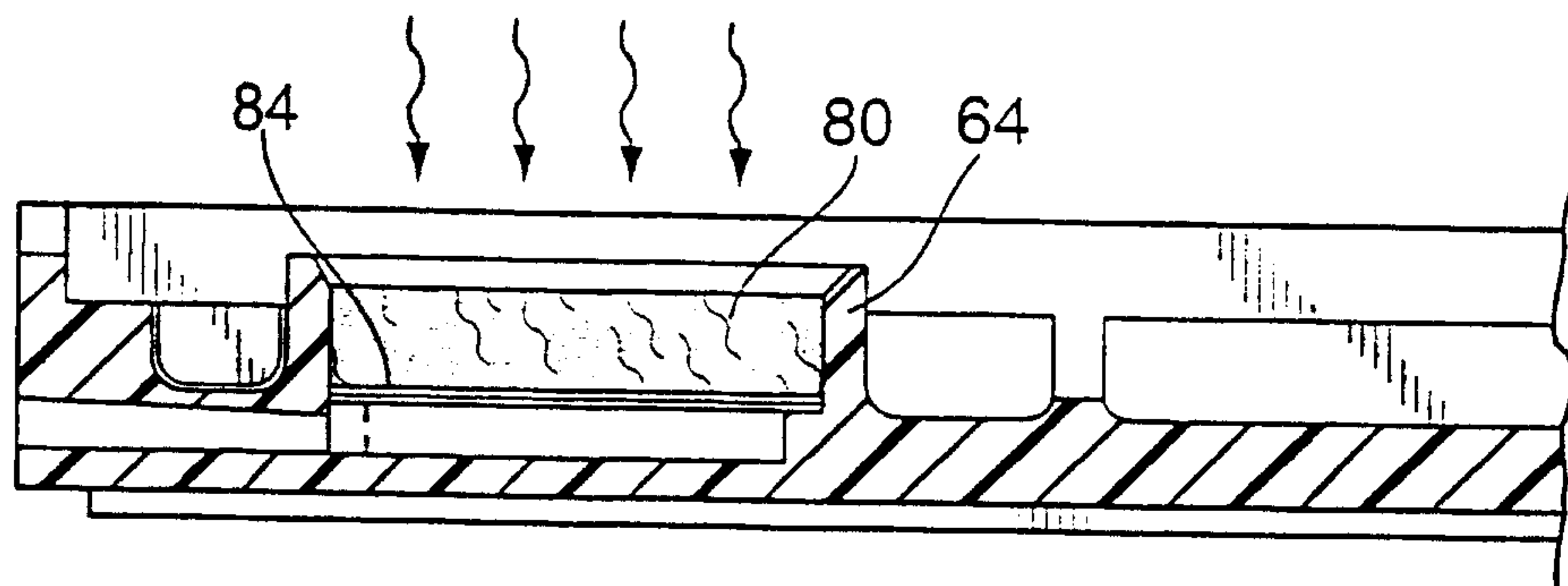


FIG. 13B

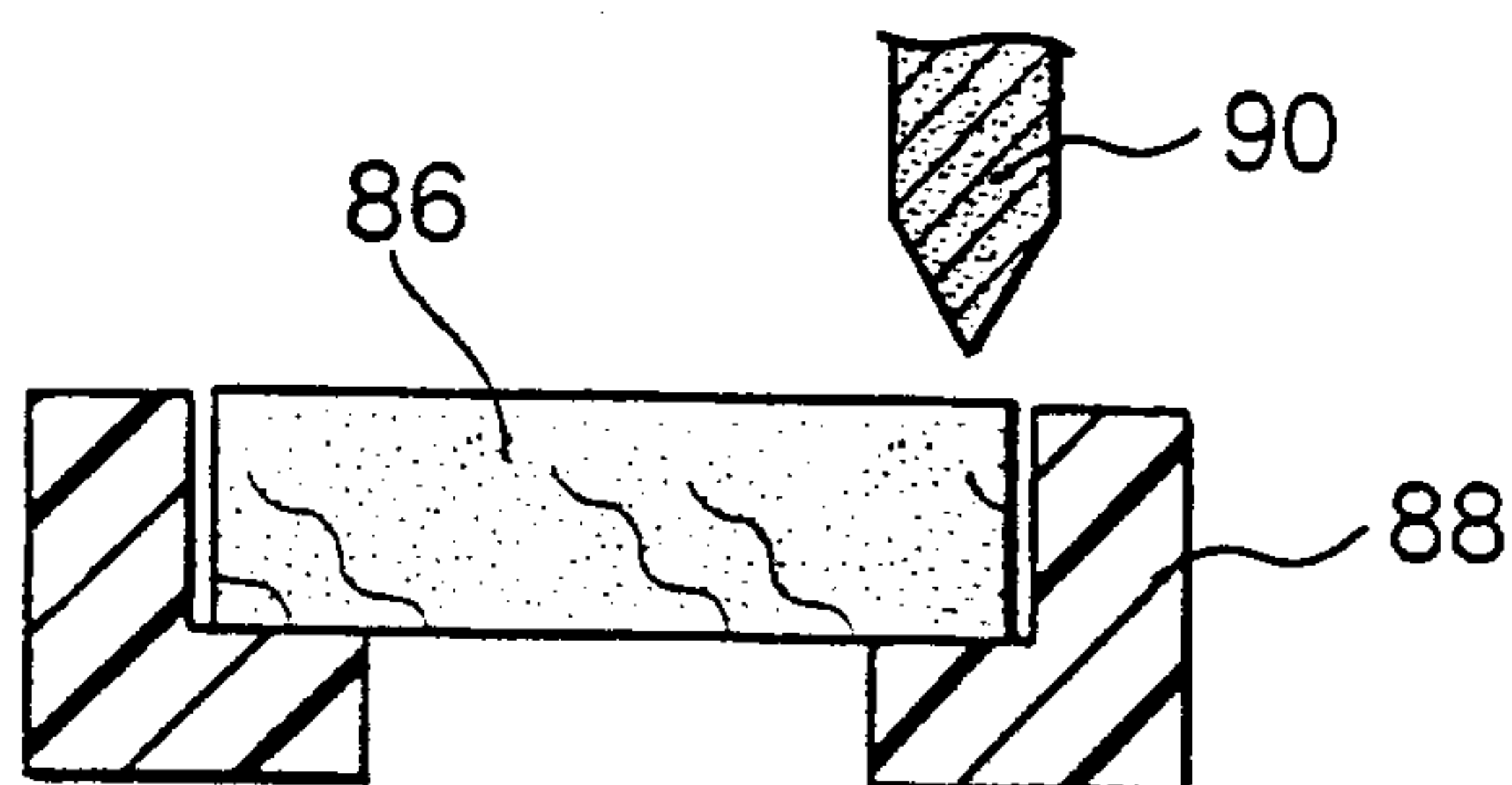


FIG. 14A

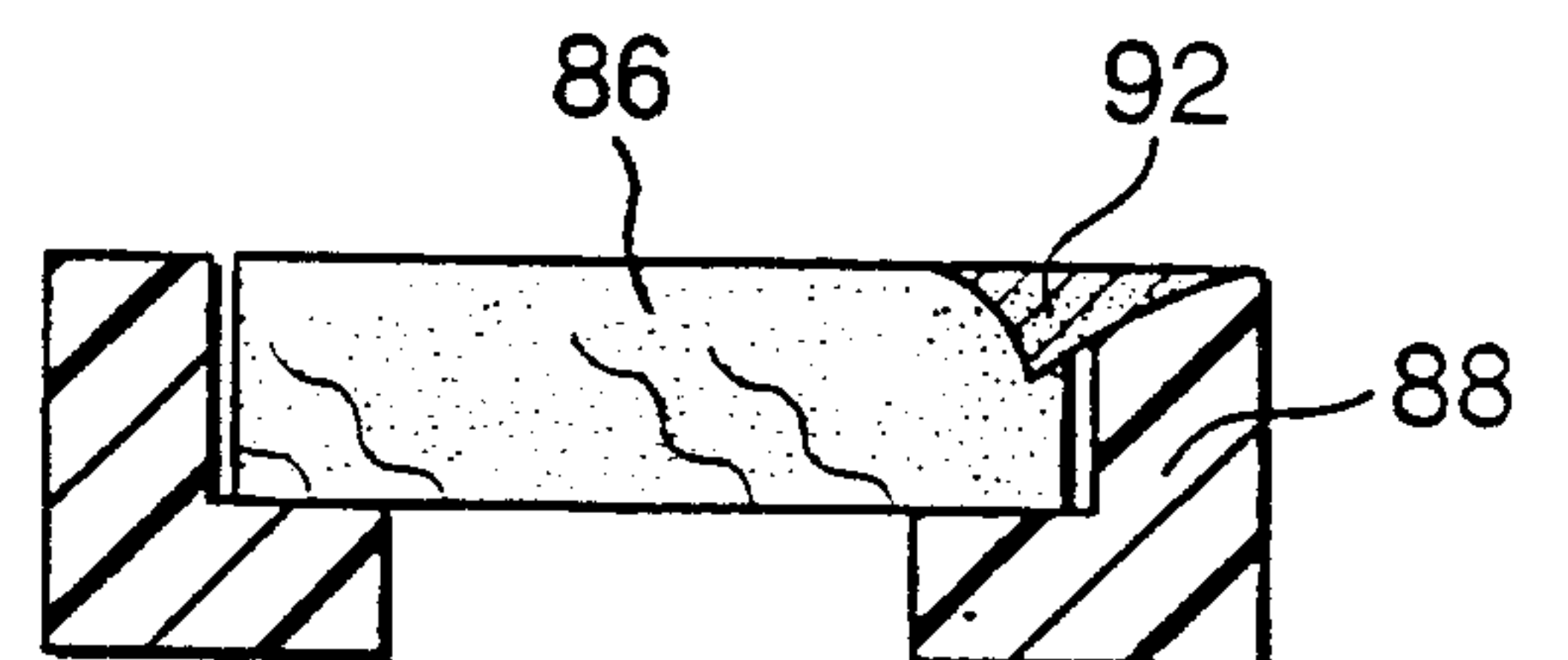


FIG. 14C

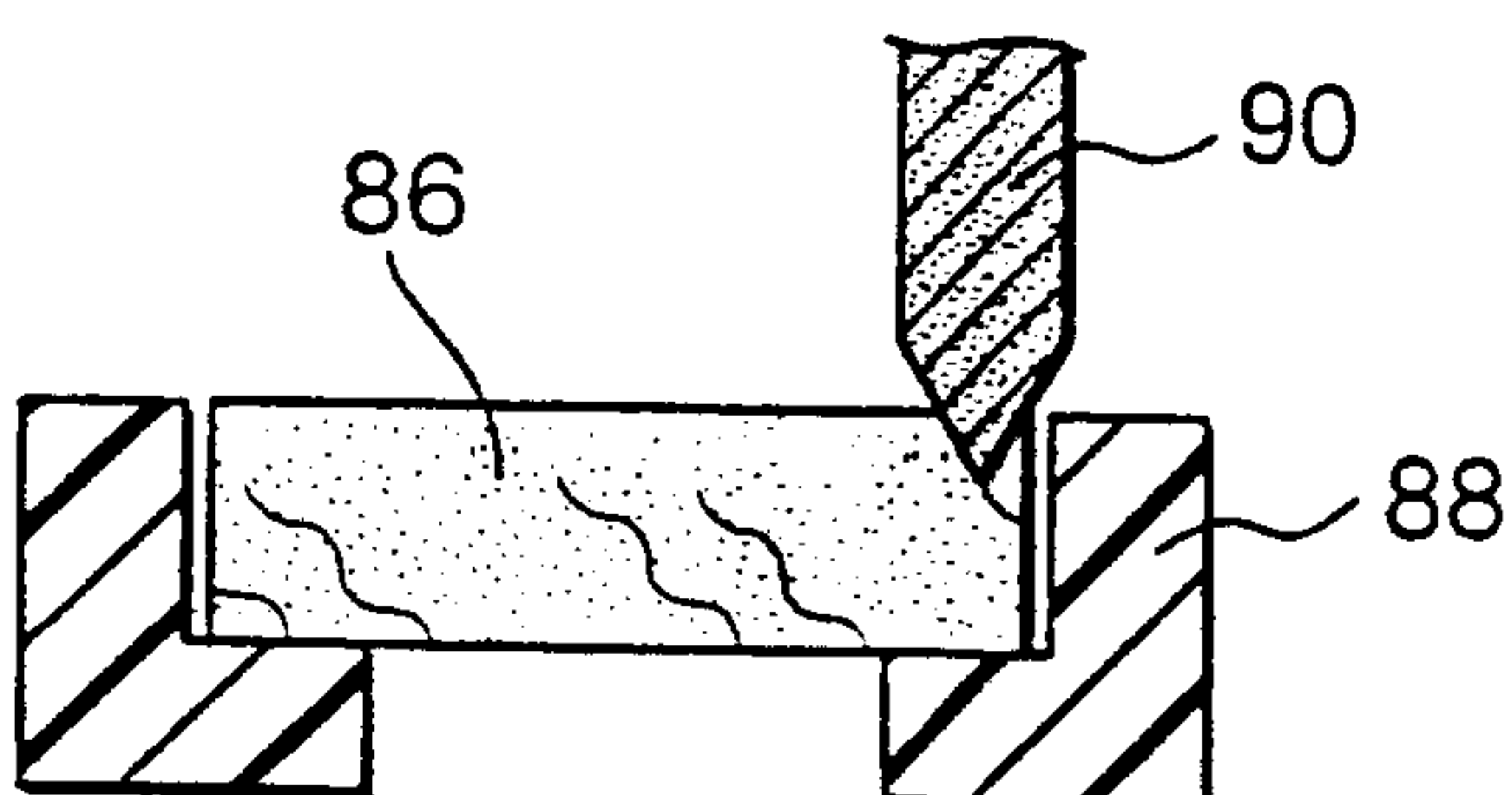


FIG. 14B

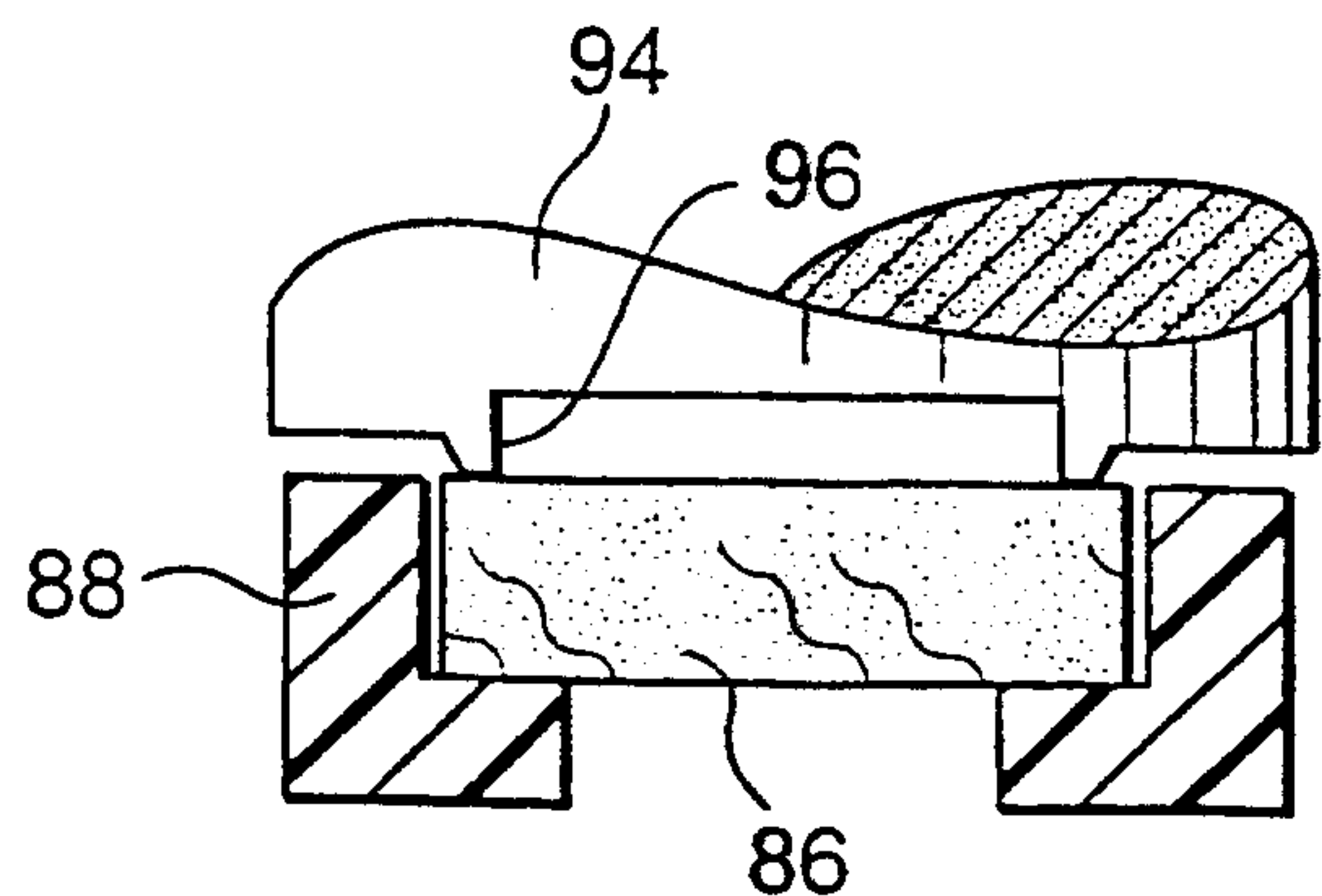


FIG. 14D

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FIG. 15

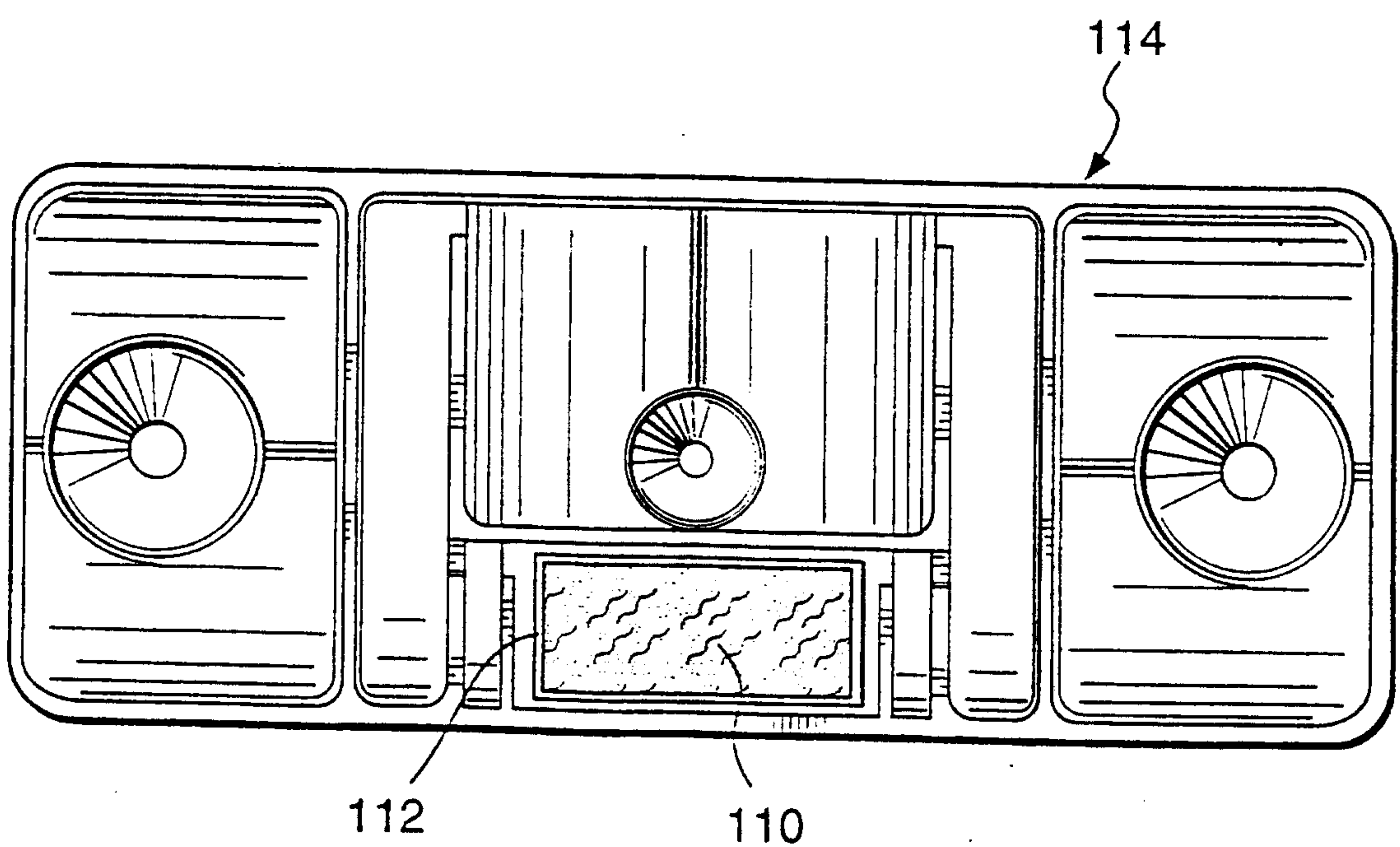
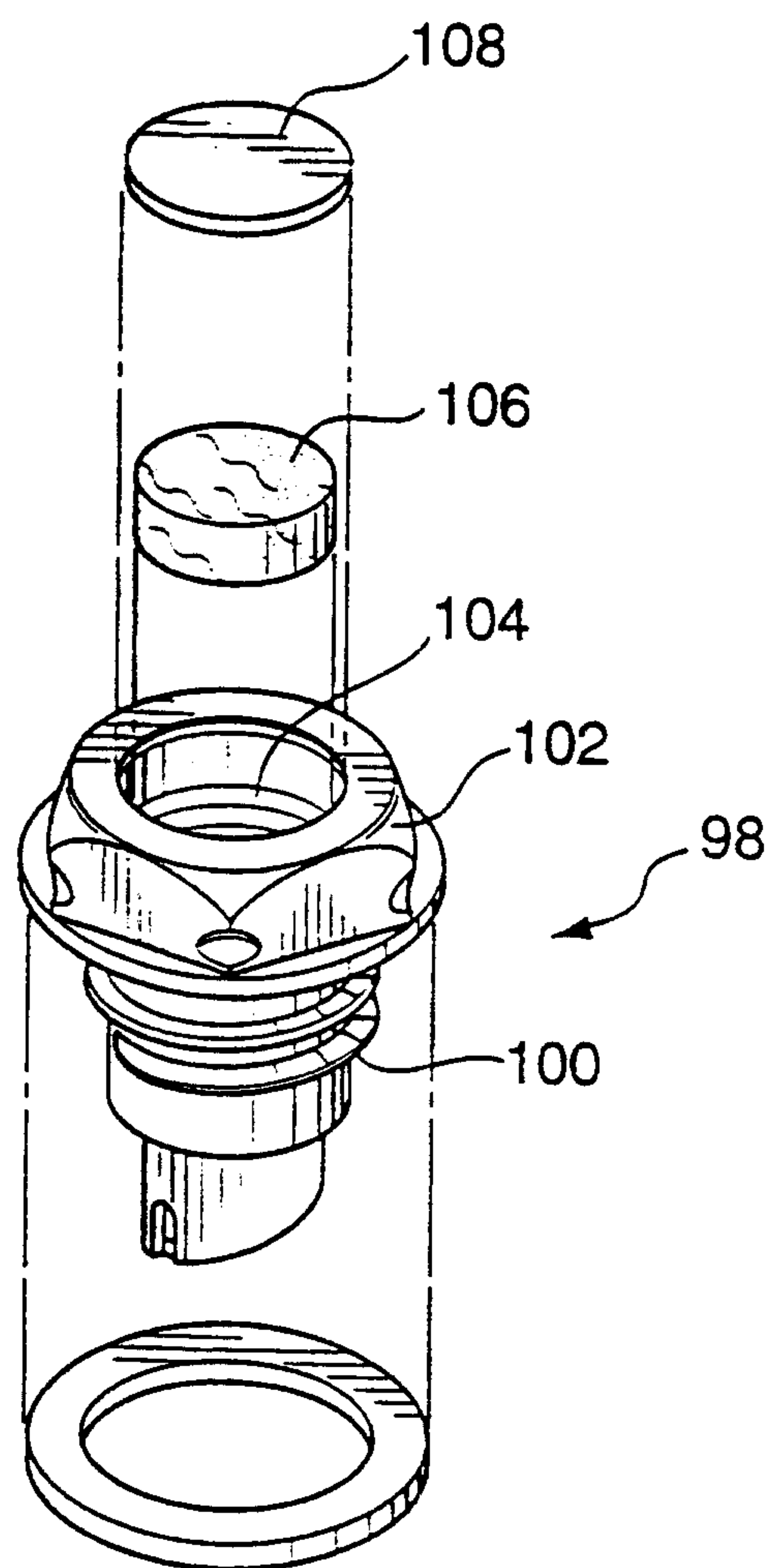


FIG. 16

