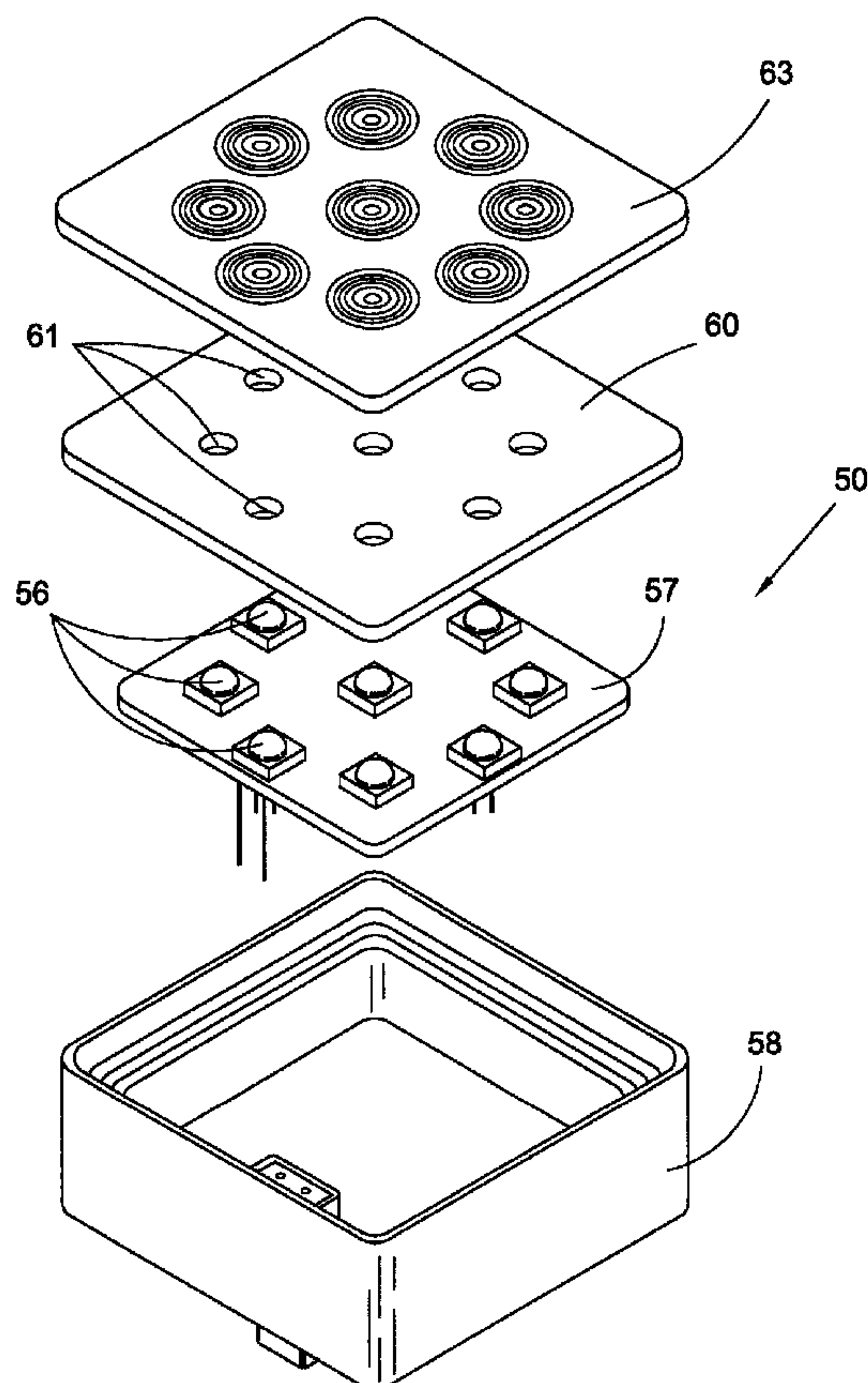




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(54) **Titre : ENSEMBLE LAMPE**
 (54) **Title: LAMP ASSEMBLY**



(57) **Abrégé/Abstract:**

A lamp assembly including at least one light source, a housing formed from a first moisture barrier composition and a sealing cap formed from a second moisture barrier composition, wherein the at least one light source is arranged within the housing and the sealing cap is hermetically bonded to the housing and the at least one light source, and the sealing cap is arranged to enclose the at least one light source within a volume formed by the housing and the sealing cap.

1 ABSTRACT

2 A lamp assembly including at least one light source, a housing formed from a first
3 moisture barrier composition and a sealing cap formed from a second moisture barrier
4 composition, wherein the at least one light source is arranged within the housing and the sealing
5 cap is hermetically bonded to the housing and the at least one light source, and the sealing cap
6 is arranged to enclose the at least one light source within a volume formed by the housing and
7 the sealing cap.

1 LAMP ASSEMBLY

2 FIELD OF THE INVENTION

3 **[0001]** The present invention relates generally to articles protected by sorbents, and
4 more particularly, to improved injection molding compositions and articles of manufacture
5 fabricated therefrom comprising adsorbing additives in a resinous base, and even more
6 particularly, to a lamp assembly having a moisture barrier enclosure comprising resin bonded
7 sorbent material.

8 BACKGROUND OF THE INVENTION

9 **[0002]** Incorporation of sorbents, *e.g.*, desiccants, into resin matrices has been revealed
10 in several contexts. Formation of these resins into structural or functional shapes by various
11 processes has been described in certain applications. Similarly, fillers have been added to
12 structural molding resins. Low cost mineral or other fillers have been added to resin-containing
13 compositions to extend the resin and reduce costs, while maintaining strength sufficient for the
14 intended end-use application of the molded article. It is also a frequent practice to add
15 reinforcing materials, such as glass fibers or beads to enhance mechanical properties of
16 molding resins, *e.g.*, hardness, tensile displacement, and so on. With reinforcing additives, just
17 as with fillers, it has been found there are ranges within which the desired effects of extending
18 the resin or reinforcing the molded article are accomplished while maintaining satisfactory
19 injection molding and mechanical properties.

20 **[0003]** Nevertheless, molding compositions comprising reinforcing additives have not
21 been entirely satisfactory for a number of end-use applications. For example, a molding
22 composition having relatively high loading levels of reinforcing additives, such as glass fibers
23 and glass beads have the affect of limiting the loading factor of sorbent additives which may be
24 introduced into such molding compositions for optimal adsorption performance. However, with
25 a corresponding reduction in the loading of reinforcing additives and an increase in the loading
26 of sorbent additives, there was also a potential for a reduction in desirable mechanical
27 properties, such as hardness, tensile strength, and other mechanical properties.

28 **[0004]** Thus, existing resin/sorbent matrices suffer from several drawbacks. The
29 materials are often brittle and insufficient to survive standard drop testing. Additionally,
30 particulate material may be released from the matrices thereby degrading part performance
31 and/or device functionality. Due to the structure of these matrices, water may be adsorbed or
32 absorbed at a faster rate, which in fact may be too fast for common manufacturing procedures.
33 In other words, the ability for a part to adsorb water may be exhausted prior to its assembly in a
34 device because environmental conditions are not controlled in the manufacturing area. Existing

1 resin/sorbent matrices are often quite expensive to manufacture and use due to the use of
2 exotic resin, additional processing steps and the use of multi-resin materials having phase
3 boundaries. Additionally, existing resin/sorbent matrices may pose compatibility issues due to
4 materials typically used as binders.

5 **[0005]** It is well known that lamp assemblies, in particular, lamp assemblies used in the
6 automotive and marine industries, are exposed to aggressive environments under a variety of
7 conditions. For example, tractor trailers typically include a plurality of lamps about the base of
8 the trailer as well as about the tractor portion. As tractor trailers carry goods in a variety of
9 environments, *e.g.*, from the cold winters of high latitude regions to the humid summer heat of
10 equatorial regions, lamp assemblies experience a wide range of temperature as well as ambient
11 relative humidity. While in marine applications, *e.g.*, runner and indicator lamps, lamp
12 assemblies may be exposed to fluids such as salt water.

13 **[0006]** In addition to the environmental factors, lamp assemblies are exposed to harsh
14 cleaning solutions. For example, tractors are cleaned with a variety of solutions, while trailers
15 may be cleaned with even more aggressive solutions as the trailers may be used to carry items
16 which are difficult to remove. Similarly, it is common to use acidic solutions such as a 50/50
17 blend of muratic acid and water to clean boat hulls, thereby exposing the lamp assemblies to
18 extremely aggressive solutions.

19 **[0007]** In view of the foregoing, it should be appreciated that internal electronic
20 components of lamp assemblies are exposed to a variety of environmental conditions which
21 degrade their performance and useful life. For example, lamp assemblies commonly include
22 light emitting diodes (LEDs) as light sources, and these LEDs require driving circuitry and
23 electrical connections in order to function properly. The above described environmental
24 conditions, in particular elevated relative humidity levels, have detrimental effects on the
25 electronics of the lamp assemblies due to moisture ingress through the thermoplastic housing,
26 the lens covers, and wiring harnesses and connector entry points. Compounding the problem is
27 that the thermoplastic or thermoset polymers most commonly used for these types of
28 applications are extremely poor moisture barriers and are primarily selected for these types of
29 applications because of their dimensional stability or ability to be bonded together to form the
30 assemblies. Heretofore, the ingress of contaminates have been slowed through the use of
31 epoxy fillers, potting materials, and designed in gaskets or seals. Thus, preventing the
32 exposure of the electronics to humidity is important, although heretofore has required expensive
33 and labor intensive solutions.

1 **[0008]** For example, United States Patent No. 5,632,551 entitled "LED Vehicle Lamp
2 Assembly" teaches hermetically sealing a lamp assembly by introducing an epoxy resin over the
3 entire circuit board thereby protecting the LEDs and circuit board from vibration, fatigue,
4 moisture and the like. Arrangements of this type are expensive to manufacture, time consuming,
5 labor intensive and use materials that are not environmentally friendly, and in some instance
6 may require the use of special protective equipment, *e.g.*, ventilator systems.

7 **[0009]** As can be derived from the variety of devices and methods directed at providing
8 a hermetically sealed lamp assembly, many means have been contemplated to accomplish the
9 desired end, *i.e.*, prevention of the ingress of moisture within the lamp assembly. Heretofore,
10 tradeoffs between performance and cost were required. Thus, there is a long-felt need for a
11 hermetically sealed lamp assembly which prevents the ingress of moisture therein and is cost
12 effective and easy to manufacture.

13 BRIEF SUMMARY OF THE INVENTION

14 **[0010]** It is therefore a principal object of the invention to provide an improved lamp
15 assembly which forms a moisture barrier about internally disposed electronic circuitry. It should
16 be appreciated that the foregoing lamp assembly is advantageously formed from the resin
17 bonded sorbent material described herein.

18 **[0011]** It has been discovered that certain sorbents, in certain resins, properly
19 processed, have the beneficial effect of reinforcing the resin while retaining the adsorptive
20 capacity and as a result the moisture barrier properties of the resin are enhanced. It has also
21 been found that within limits these resins can be processed and formed by modern high-speed
22 injection molding processes into fully functional component parts for various applications. It has
23 been further found that the sorbent material by way of its adsorptive capacity prevents
24 ingress of moisture into the resin and enhances the barrier properties of selective
25 thermoplastic and thermoset polymers. Additionally, the enhanced physical and mechanical
26 properties resulting from the sorbent material allows for the use of low cost thermoplastic and
27 thermoset polymers that do not exhibit good molding characteristics in raw form. Moreover, the
28 adsorptive capacity keeps the resin dry and thus enhances molding properties while eliminating
29 the need for drying just prior to use in the injection molding process, thereby reducing
30 processing time and cost.

31 **[0012]** At the same time it is a common and frequent practice to add reinforcing
32 materials such as glass fibers to resins to enhance mechanical properties. With reinforcing
33 additives just as with fillers it is found that there are ranges within which the desired effects of
34 extending or reinforcing the resin are accomplished while maintaining satisfactory injection

1 molding and mechanical properties. It is an object of this invention to add sorbent particles in
2 such a way that mechanical properties such as tensile modulus and flex modulus are increased
3 as they are with common reinforcing additives.

4 **[0013]** Certain resins are commonly considered less desirable for injection molding,
5 olefins in particular, due to excessive shrinkage resulting in distortion of shapes and poor
6 dimensional stability. It has been found that when certain sorbents are properly compounded so
7 that particles are substantially fully dispersed so that substantially all particles are isolated from
8 each other, the shrinkage of olefins is reduced to a range equivalent to resins considered good
9 for molding such as polyamides. It is a further object of this invention to describe
10 sorbent/polymer compounding techniques

11 **[0014]** With these things in mind, the properties of sorbents added at various
12 proportions to molding resins were investigated.

13 **[0015]** The present invention broadly comprises a lamp assembly including at least one
14 light source, a housing formed from a first moisture barrier composition and a sealing cap
15 formed from a second moisture barrier composition, wherein the at least one light source is
16 arranged within the housing and the sealing cap is hermetically bonded to the housing and the
17 at least one light source, and the sealing cap is arranged to enclose the at least one light source
18 within a volume formed by the housing and the sealing cap. In some embodiments, the first
19 moisture barrier composition includes a blend of a first resin and a first sorbent and the second
20 moisture barrier composition includes a blend of a second resin and a second sorbent. In some
21 of these embodiments, the first resin and/or the second resin is a thermoplastic resin, while in
22 others of these embodiments, the first resin and/or second resin are selected from the group
23 consisting of polyamide, polyolefin, styrenic polymer, polyester and homogeneous mixtures
24 thereof, and in some of these embodiments, the polyolefin is selected from the group consisting
25 of high density polyethylene, low density polyethylene and polypropylene. In some
26 embodiments, the first sorbent and/or the second sorbent are selected from the group
27 consisting of a molecular sieve, a silica gel, an ion exchange resin, an activated alumina, a clay,
28 a salt, a zeolite and mixtures thereof. In other embodiments, the sealing cap is hermetically
29 bonded to the housing and the at least one light source with welding, while in yet other
30 embodiments, the sealing cap is hermetically bonded to the housing and the at least one light
31 source with an adhesive or an epoxy. In some of these embodiments, the welding technique is
32 selected from the group consisting of: sonic welding, ultrasonic welding, spin welding, hot plate
33 welding and vibration welding. In still yet other embodiments, the sealing cap is hermetically

1 bonded to the housing and the at least one light source by molding the sealing cap over the
2 housing.

3 **[0016]** In yet other embodiments, the at least one light source includes at least two
4 electrical connections and the housing includes at least two openings arranged to receive the at
5 least two electrical connections therethrough, and wherein the at least two electrical
6 connections and the at least two openings are hermetically encapsulated by a third moisture
7 barrier composition. In some embodiments, the third moisture barrier composition includes a
8 blend of a third resin and a third sorbent. In some of these embodiments, the third resin is a
9 thermoplastic resin, while in others of these embodiments, the third resin is selected from the
10 group consisting of polyamide, polyolefin, styrenic polymer, polyester and homogeneous
11 mixtures thereof, and in some of these embodiments, the polyolefin is selected from the group
12 consisting of high density polyethylene, low density polyethylene and polypropylene. In other
13 embodiments, the third sorbent is selected from the group consisting of a molecular sieve, a
14 silica gel, an ion exchange resin, an activated alumina, a clay, a salt, a zeolite and mixtures
15 thereof. In still yet other embodiments, the at least two electrical connections and the at least
16 two openings are hermetically encapsulated by the third moisture barrier composition with
17 welding, while in other embodiments, the at least two electrical connections and the at least two
18 openings are hermetically encapsulated by the third moisture barrier composition with an
19 adhesive or an epoxy. In some of these embodiments, the welding technique is selected from
20 the group consisting of: sonic welding, ultrasonic welding, spin welding, hot plate welding and
21 vibration welding. In still yet further embodiments, the at least two electrical connections and
22 the at least two openings are hermetically encapsulated by the third moisture barrier
23 composition by molding the third moisture barrier composition over the at least two electrical
24 connections and the at least two openings.

25 **[0017]** It is an object of the invention to provide a lower cost and easily produced lamp
26 assembly by incorporating a sorbent into an injection molding resin according to the disclosure
27 herein which maintains its adsorptive function, maintains the molding properties of the resin,
28 enhances the mechanical properties and enhances the barrier properties to provide extended
29 service life without elaborate seals, gaskets, fillers and potting compounds.

30 **[0018]** For purposes of this invention the expression "resin bonded sorbent", as
31 appearing in the specification and claims, is intended to mean a surface compatibility occurring
32 between the sorbent and the resin through a loss of crystallinity of the resin, whereby the
33 sorbent becomes wetted and miscible with the resin due to a reduction in surface tension. The
34 expression "resin bonded sorbent" is intended to include binding between the resin and sorbent,

1 which can occur, for example, through heating the sorbent with the resin, or which can be bound
2 through suitable, non-contaminating coupling, surfactant or compatibilizing agents, discussed in
3 greater detail below. Additionally, the term "resin" as used in blends of resin/sorbent material
4 means the resin in the matrix, whereas "sorbent" means the material actually adsorbing or
5 absorbing contaminants which may itself be a polymeric or resinous material.

6 BRIEF DESCRIPTION OF THE DRAWINGS

7 **[0019]** The features of the invention believed to be novel and the elements characteristic
8 of the invention are set forth with particularity in the appended claims. The figures are for
9 illustration purposes only and are not necessarily drawn to scale. The invention itself, however,
10 both as to organization and method of operation, may best be understood by reference to the
11 detailed description which follows taken in conjunction with the accompanying drawings in
12 which:

13 Figure 1 is an end view of an accumulator in accordance with the present invention;

14 Figure 2 is a partial cross sectional side view of an accumulator in accordance with the
15 present invention;

16 Figure 3 is an exploded view of a filter/desiccant bag/aluminum fitting component of a
17 refrigeration system in accordance with the prior art;

18 Figure 4 is a side view of the component of Figure 3;

19 Figure 5 is a one-piece filter/fitting made in accordance with the composition of the
20 present invention;

21 Figure 6 is an illustration of the use of the device shown in Figure 5 along with a
22 desiccant bag;

23 Figure 7 shows a cross sectional view of an embodiment of the part shown in Figure 5 in
24 use atop a condenser;

25 Figure 8 illustrates a mobile refrigeration accumulator baffle portion of a refrigerant
26 vapor/liquid separator, such as is used in the receive of an automobile air conditioning system,
27 made in accordance with the present invention;

28 Figure 9 illustrates a cap portion for the separator of Figure 8;

29 Figure 10 shows a cross sectional view of an embodiment of the present invention;

30 Figure 11 is a perspective view of an embodiment of a present invention lamp assembly;

31 Figure 12 is an exploded view of the lamp assembly of Figure 11;

32 Figure 13 is a cross sectional view of the lamp assembly of Figure 11 taken generally
33 along line **13-13** of Figure 11;

1 Figure 14 is a cross sectional view of the lamp assembly of Figure 11 taken generally
2 along line 14-14 of Figure 11;

3 Figure 15 is a cross sectional view of another embodiment of a present invention lamp
4 assembly; and,

5 Figure 16 is a perspective view of yet another embodiment of a present invention lamp
6 assembly.

7 DETAILED DESCRIPTION OF THE INVENTION

8 **[0020]** As one of ordinary skill in the art appreciates, the term “fluid” is defined as an
9 aggregate of matter in which the molecules are able to flow past each other without limit and
10 without fracture planes forming. “Fluid” can be used to describe, for example, liquids, gases
11 and vapors. Additionally, a salt of a CO₂ releasing anion as used herein refers to any salt that
12 will release CO₂ vapor upon contact with an acid stronger than carbonic acid, *e.g.*, carbonates
13 and bicarbonates. The permeability of water vapor through high density polyvinylidene chloride
14 is herein defined as impermeable, while the permeability of water vapor through water swellable
15 water insoluble hydroxycellulose is herein defined as substantially permeable. Water swellable
16 water insoluble hydroxycellulose as used herein is intended to mean cellulose with sufficient
17 hydroxy substitution to be water swellable to an extent of fifteen percent (15%), but insufficient
18 to cause water solubility. “Vapor permeability” as used herein refers to the rate of permeability
19 as described above, independent of the actual permeability of any vapor or gas, except water,
20 through high density polyvinylidene chloride or water swellable water insoluble hydroxycellulose.
21 When the term “permeable” or “impermeable” is used herein, it is intended to refer to transfer of
22 fluid through a material either through pores therein or at a molecular level.

23 **[0021]** It would be desirable for reasons of cost and productivity to incorporate a sorbent
24 into a resin, and in particular one suitable for injection molding, in such a way that its adsorptive
25 properties are preserved and the molding properties of the resin are maintained without
26 degrading mechanical properties. Surprisingly, the novel molding compositions of the invention
27 and parts fabricated therewith are multi-functional, beneficially combining structural, mechanical
28 and adsorptive capabilities without requiring the usual reinforcing additives. Consequently, with
29 the omission of reinforcing additives the novel molding compositions of the invention are further
30 characterized by higher moisture adsorptive capacities by allowing for higher sorbent loading
31 factors than prior adsorbent-containing molding compositions.

32 **[0022]** Serendipitously, it was discovered as a part of the present invention, that
33 sorbents of the “resin bonded sorbent” molding compositions have the beneficial effect of
34 imparting reinforcement to the molding compositions of the invention while retaining their

1 moisture adsorptive capacity, but without requiring the usual and customary strengthening
2 additives, such as glass beads, glass fiber, and the like. This allows for higher loading factors of
3 sorbent additives for maximizing adsorptive properties of the molding composition without trade-
4 offs occurring in terms of significantly altered mechanical properties of the molding composition.

5 **[0023]** While the present invention relates principally to the discovery that the
6 mechanical properties of molding resins comprising sorbent additives are capable of eliminating
7 the usual requirement specifically for reinforcement additives, such as glass beads and glass
8 fibers, the invention also contemplates multifunctional sorbent-resin molding compositions
9 comprising moisture adsorbing-mechanical property enhancing amounts of adsorbent in
10 combination with reinforcing additives and resin, wherein reduced amounts of reinforcing
11 additives can be employed than otherwise normally required for enhanced mechanical
12 properties. That is, the invention also provides desiccant-containing molding compositions, but
13 with reduced quantities of strength enhancing additives, such as glass fibers and glass beads.
14 This will enhance the mechanical properties of the molding composition without the potential for
15 degrading the strength characteristics of the molded article. More specifically, proportional
16 ranges of sorbent, reinforcing additives and resin can be from about 5 to about 50 Wt%
17 sorbent; from about 0 to about 15 wt% reinforcing additive and from about 45 to about 95 wt%
18 resin. Additionally, it has been found that a resin/sorbent matrix having a blowing agent
19 incorporated therein maintains its structural integrity while reducing material density by about
20 30%.

21 **[0024]** It has also been found as a part of the present invention that, within limits, the
22 resins can be processed and formed by several techniques, including modern high-speed
23 injection molding processes into fully functional component parts, including parts for various
24 sealed systems and assemblies. In these later applications, the structural and functional
25 features of the inventive concepts are served while ambient and ingressed moisture are
26 adsorbed to protect sensitive materials or components of systems or assemblies from
27 degradation by moisture; *e.g.* hydrolysis or corrosion.

28 **[0025]** In accordance with the above, the present invention comprises reinforced
29 structural resin compositions suitable for injection molding with improved mechanical properties,
30 satisfactory melt handling properties, and substantial moisture adsorption properties. Most
31 thermoplastic resins are suitable for use in the resin bonded adsorbent compositions of the
32 invention, and include homopolymers and copolymers comprising two or more monomers.
33 Representative examples include the polyamides, such as Nylon 6; Nylon 6,6; Nylon 610, and
34 so on. Other representative examples include the polyolefins, such as high and low density

1 polyethylenes, polypropylene; copolymers of ethylene-vinyl acetate; polystyrene; polyesters,
2 e.g., PET, to name but a few.

3 **[0026]** As previously discussed, according to one aspect of the invention, compositions
4 of the present invention may comprise from about 5 to about 55 wt% sorbent and the balance
5 resin, and more specifically, from about 25 to about 45 wt% sorbent with the balance resin.
6 More preferred compositions may comprise from about 35 to about 42 wt% sorbent, such as a
7 molecular sieve, and the balance resin. A most preferred resin bonded sorbent composition
8 may comprise from about 60% nylon molding resin, such as Zytel® 101, commercially available
9 from E.I. duPont, compounded with 40% molecular sieve, such as W. R. Grace 4A molecular
10 sieve powder. The molecular sieves of the invention can have a nominal pore size of 4Å, and a
11 particle size range of about 0.4 to about 32μ. It is to be noted, however, that other molecular
12 sieve pore-sizes can be used as well, such as 3Å, 5Å, or 10Å, for example.

13 **[0027]** Generally, sorbents which are useful and functional in this invention are those
14 which bond mechanically to the resin without special additives, such as molecular sieve, as
15 previously discussed. Still others, according to the instant invention, can be induced to bond to
16 the resin through use of a suitable additive, *i.e.*, bind with the aid of a coupling or compatibilizing
17 agent. In addition to molecular sieve, other representative sorbents that are useful in the
18 compositions of the invention include silica gel, activated carbon, activated alumina, clay, other
19 natural zeolites, and combinations thereof. Those sorbents found to perform with coupling or
20 compatibilizing agents include such members as activated carbon and alumina.

21 **[0028]** The additives which perform as compatibilizers fall into either of two categories,
22 namely those which bond with the resin or the sorbent, and those having some affinity with both
23 resin and sorbent, and act as solid state surfactants. Reactive coupling agents include such
24 classes as maleates, epoxies and silanes. More specifically, reactive coupling agents include
25 such representative examples as maleic anhydride grafted polymers used in amounts ranging
26 from about 2 to about 5 Wt%. In particular, they can include such representative examples as
27 maleic anhydride grafted to polypropylene or ABS resins, the latter being useful as coupling
28 agents with styrenic polymers. Similarly, silanes with various functional groups attached may
29 be used.

30 **[0029]** The present invention also contemplates the use of so called non-reactive type
31 compatibilizing agents in binding sorbent and resin. This comprises such representative
32 examples as metals (e.g., zinc or sodium), acrylates, stearates and block copolymers, e.g., zinc
33 stearate, sodium stearate in a range from about 0.01 to about 0.02 wt% based of the sorbent.
34 The actual level is driven by the surface area, which is in-turn proportional to the particle size.

1 For a molecular sieve with mean particle size of 10 μ , 100 ppm of aluminum stearate would be a
2 typical starting level for compatibilization with a polyamide resin. With both reactive and non-
3 reactive coupling/compatibilizing agents, their incorporation within the resin matrix does not
4 create phase boundaries.

5 **[0030]** The resin bonded sorbent compositions may be prepared in accordance with the
6 present invention using plastic compounding techniques generally familiar among ordinary
7 skilled artisans. Molecular sieve, a preferred sorbent, may be incorporated into the resin, e.g.,
8 polyamide, polyolefin, or the like, by feeding the sorbent in powdered format along with beads of
9 the chosen resin to a plastics extruder with good mixing characteristics. Although single-screw
10 extruders may be used to compound a resin and sorbent, a resin and sorbent blend normally
11 needs to be double-compounded in order to produce a suitable resin bonded sorbent material.
12 Even after double compounding, phase separation sometimes occurs. It has been found that
13 resin bonded sorbent materials compounded with twin-screw extrusion equipment with
14 extensive back mixing is needed to attain nearly complete dispersion of the sorbent and develop
15 the superior mechanical and physical characteristics which are an object of this invention. In
16 other words, resin bonded sorbent materials formed via a twin-screw extruder show little or no
17 migration of sorbent within the resin matrix and thus these resin bonded sorbent materials
18 maintain a homogeneous appearance. Therefore, twin-screw extruder compounding is typically
19 used to form resin bonded sorbent materials of the present invention, as the resin is melted and
20 the sorbent mixed throughout. It is a necessary condition that the melt blend be heated above
21 the melt point of the resin as determined by DSC (differential scanning calorimetry). That is, in
22 preparing the resin bonded sorbents of the invention, the temperature should be raised to the
23 point where all crystallinity is lost in order to achieve complete miscibility of the sorbent in the
24 resin melt. For example, DuPont's Zytel® 101 polyamide resin would be heated above 262°C.
25 The extruded resin is cooled and then cut or crushed into pellets or granules. Because
26 compounding is performed at elevated temperatures, the sorbent tends not to adsorb moisture
27 during this processing period, but retains its adsorption capacity when molded into a component
28 part and installed in a working environment.

29 **[0031]** One further advantage realized with the resin bonded sorbent system of the
30 present invention, wherein the resin and sorbent are intimately bonded, is that gram for gram it
31 is more effective than adsorbent systems employing a bagged adsorbent, *i.e.*, adsorbent
32 capacity per unit volume. According to earlier methods wherein bags were used for
33 containerizing sorbent, the sorbent required beading to prevent it from entering the refrigerant
34 stream, for example. This required the sorbent to be bonded within a binder resin, typically 15

1 wt% binder, such as in the form of a powder. Thus, when 40 grams of a commercially prepared
2 sorbent was placed into a bag, in reality only 34 grams of sorbent were introduced into the
3 system (with 6 grams of binder). In contradistinction, the resin bonded sorbents of the present
4 invention require no additional binder resin because the sorbent is placed directly into the
5 molding resin from which the components are fabricated. Advantageously, with the immediate
6 invention, no intermediary binder resin is required, allowing for higher sorbent loading factors
7 than otherwise achieved with the usual bagged sorbents.

8 **[0032]** The compounded resin blend of the invention, previously discussed, can then be
9 extruded into a sheet or film, or injection molded in the form of a part. An exemplary part is a
10 refrigerant vapor liquid separator, such as is used in the receiver of an automotive air
11 conditioning system. The strength of the silicate-reinforced resin results in a structurally sound
12 molded part. As such, it is self-supporting and suitable for mounting in the same ways that
13 metal or plastic refrigeration components are presently mounted. See, for example, Figs. 1 and
14 2, which show an end and partial cross sectional side view, respectively, of a U-Tube assembly
15 **100**. This embodiment, which uses the composition of the present invention to form a liner or
16 sleeve **110** out of the resin bonded sorbent of the present invention, contains a U-tube **120**
17 within accumulator canister **130**. This design provides a means of drying against an exposed
18 inner surface of liner **110**. This embodiment is an alternative to a "baffle" type accumulator of
19 the prior art (not shown).

20 **[0033]** Alternatively, the resin formed in accordance with the present invention, instead
21 of being melted and injection molded into a functional sorbent part, may be milled or otherwise
22 formed or pelletized into pieces which are then sintered into parts, such as a flow-through
23 monolith structure, or a flow-through dryer component, *e.g.*, electronics filtration for a hard drive.
24 In this case, the part is not injection molded, but is molded from the compounded sorbent-
25 loaded resin into a functional part having sufficient porosity for its intended application, such as
26 for use in a receiver dryer assembly.

27 **[0034]** Parts fabricated from the resin bonded sorbents of the present invention are
28 particularly well suited to replace multiple-component parts of the prior art. For example, in the
29 past many specialized structures have been developed to fit and secure a desiccant material
30 (which was loose) in various parts of a refrigeration system. Welded or sewn bags containing
31 beaded or granular molecular sieve or aluminum oxide would be disposed within a flow path.
32 Additionally, and specifically with respect to stationary refrigeration applications, beads or
33 granules of desiccant were bonded together in a heated mold with a suitable heat-cured resin or
34 ceramic binder to produce a rigid shape which would serve as a drying block or partial filter.

1 Such a structure would be built into a housing. These solutions, however, involved complicated
2 multiple part pieces. The present invention, however, joins the performance of the desiccant
3 with the structural purpose of a part such that a one-piece device serves both functions
4 simultaneously.

5 **[0035]** For example, the present invention is contemplated for use with an Integrated
6 Receiver Dehydrator Condenser, such as those which are starting to find their way into a
7 growing number of vehicles. Such mobile refrigeration cycle components basically combine the
8 drying function with the condenser for a number of reasons. It reduces the number of system
9 components, therefore making better use of under-hood space, and concomitantly reduces the
10 number of fittings and connections minimizing the potential for system leaks. It also has some
11 performance gains relative to cooling efficiencies. The current technology is illustrated in Figs. 3
12 and 4 which show aluminum threaded plug **300** with O-rings **305** and **306**, an injection molded
13 filter **310**, and desiccant bag **320**. By converting this system to a one-piece injection molded
14 plug/filter assembly, such as that shown in Fig. 5, a one piece plug **500** with O-ring **510** can be
15 utilized. In such a case, plug **500** could be assembled with desiccant bag **600** as shown in Fig.
16 6. Fig. 7 illustrates a partial cross section of the device assembled.

17 **[0036]** More specifically, Fig. 7 shows the device **700** disposed adjacent condenser **710**.
18 Device **700** is comprised of desiccant bag **720** disposed within receiver dryer tube **730**. On the
19 end of device **700** is filter tube **740** housing integral threaded plug and filter **750**. O-rings **705**
20 are also shown. Desiccant bag **720** is connected to integral threaded plug and filter **750** at
21 interface **760**. This design would eliminate all the separate assembly steps and create a part
22 with fewer separate pieces, as compared to the aluminum threaded plug described above.

23 **[0037]** Still another embodiment incorporating the present invention is shown in Fig. 8,
24 which illustrates a mobile refrigeration accumulator upper portion **800** of a refrigerant
25 vapor/liquid separator, such as is used in the receiver of an automobile air conditioning system.
26 As can be seen in Fig. 8, accumulator upper portion **800** contains J-Tube **810** which is mounted
27 within it. In this case, one or both of these pieces are molded from the resin bonded sorbent
28 composition of the present invention. Fig. 9 illustrates cap **900** which would be placed over top
29 accumulator upper portion **800**. In a preferred embodiment of such an accumulator apparatus,
30 both upper portion **800** and cap **900** would be injection molded and then welded, or possibly
31 injection blow-molded in halves. Completing the device would be a lower portion (not shown)
32 which could also be molded from the resin bonded sorbent composition of the present invention.

33 **[0038]** In order to demonstrate the benefits of the resin bonded sorbents of the present
34 invention, the following experiments were performed:

1 EXAMPLE 1

2 **[0039]** Test samples of resin bonded sorbents were prepared according to the claimed
3 invention employing the following protocols. The resins are procured from a supplier in pellet
4 form (most common is cylindrical (.03-.12 inch diameter x .06-.25 inch long), other forms
5 included tear drop format (.06-.19 inch). The ratio of molecular sieve to the resin is determined
6 by weight of the components. The resin was premixed in a poly bag by hand (5-15 min). The
7 pre-blend was emptied into the hopper of a Brabender single screw extruder. Action from the
8 screw further blends and melts the resin and molecular sieve as it travels through the extruder
9 barrel. The resin bonded sorbent then exits through the single strand die (1 circular hole) at the
10 end of the extruder forming one strand of molten material. The nylon based resin was heated
11 above 262°C. The strand was then cooled by air. The strands were broken into pieces. The
12 pieces were placed in a hopper of an injection molding machine and parts molded. The parts
13 were broken into pieces and re-introduced back into the injection molding machine where the
14 tensile specimens (dog bones) were injection molded for testing. Although a single screw
15 extruder was used in this example, as described *supra*, a twin-screw extruder may also be used
16 to compound a resin and sorbent, and such variations are within the spirit and scope of the
17 claimed invention.

18 **[0040]** The resin chosen was one known to be compatible with refrigerants used in
19 modern air conditioning systems, specifically R-134a and R-152a. The resin was also
20 compatible with compressor lubricants entrained in the refrigerant stream. The desiccant was
21 the same as that most commonly used in conventional systems, namely a 3A or 4A molecular
22 sieve.

23 **[0041]** For comparison, a commonly used reinforcing glass bead was compounded at
24 about the same loading. Glass beads are added to a polymer melt to control shrinkage and to
25 uniformly enhance mechanical properties. Glass beads were effective in this application
26 because they bonded mechanically to the resin, so that after molding an isotropic structure
27 resulted.

28 **[0042]** The compounded resin mechanical properties are compared with the pure
29 polymer and with glass reinforced polymer in Table I.

1

Table I: Properties of Reinforced Nylon				
Property:	Material:	Nylon Neat	Molecular Sieve Reinforced Nylon	Glass Bead Reinforced Nylon
Loading (%)		0	36.6	38.2
Hardness – Shore D (ASTM D 2440)		81.4	93	86.6
Tensile Modulus (psi) (ASTM D 638)		203779	307252	361470
Tensile Displacement @ Max Load (in.) (ASTM D 638)		0.62	0.144	0.132
Tensile Stress @ Max. Load (psi) (ASTM D 638)		10907	10519	10412
Flex Modulus (psi) (ASTM D 790)		336577	439087	506988
Flex Displacement @ Yield (in.) (ASTM D 790)		0.531	0.142	0.156
Flex Stress @ Yield (psi) (ASTM D 790)		17114	16662	15132
Heat Deflection Temp. (°F) (ASTM D 648)		111.7	144.5	131.8

2

3 **[0043]** When the resin was reinforced, the hardness increased and with it the tensile
4 displacement and flex displacement decreased dramatically as the material became more
5 metal-like. Accordingly, the tensile and flex modulus were increased significantly. With glass
6 and sorbent reinforced nylon (without glass reinforcement), the tensile and flex stress was
7 substantially maintained. The important feature and the significance of this finding was that the
8 properties of the sorbent reinforced nylon vary from pure nylon in the same way as does glass
9 reinforced nylon, both in direction and magnitude. In addition, the heat deflection temperature

1 was increased. Heat deflection temperature is a measure of heat resistance. This term is
2 known among those skilled in the art. It is an indicator of the ability of the material to withstand
3 deformation from heat over time. A further implication of the increased heat deflection
4 temperature was an increase in the service temperature of a part molded from the sorbent
5 reinforced resin.

6 **[0044]** It was also found that structures molded from sorbent reinforced nylon resin
7 (without glass reinforcement) are isotropic as evidenced by the fact that tensile and flex
8 modulus were substantially the same in one direction as another. As further evidence,
9 shrinkage out of a mold is minimal and symmetrical.

10 **EXAMPLE 2**

11 **[0045]** Further experiments were performed using compositions comprising
12 polypropylene, namely Huntsman Polypropylene 6106. This resin was also compatible with
13 refrigerants, as well as with compressor lubricant. It was compounded in a similar fashion as
14 nylon in Example 1, namely: 60% polypropylene resin and 40% molecular sieve Type 4A. The
15 resin was heated above 174°C. The compounded resin had similar advantageous mechanical
16 properties compared to the pure resin, and performs, structurally, close to that of a glass
17 reinforced resin. Its properties are summarized in Table II. The values were determined by the
18 same ASTM standards as provided in Table I.

1

Table II: Properties of Reinforced Polypropylene					
Property:	Material:	PP Neat	Molecular Sieve Reinforced Polypropylene	Glass Bead Reinforced Polypropylene	Glass Fiber Reinforced Polypropylene
Loading (%)		0	37.5	41.9	39.4
Hardness – Shore D		66.8	74.6	65.6	75.4
Tensile Modulus (psi)		131242	228023	159321	342977
Tensile Displacement @ Max Load (in.)		0.330	0.137	0.274	0.222
Tensile Stress @ Max. Load (psi)		3583	3169	2188	15996
Flex Modulus (psi)		113251	219377	158136	737113
Flex Displacement @ Yield (in.)		0.597	0.356	0.468	0.176
Flex Stress @ Yield (psi)		14.368	14.298	9.781	60.7
Heat Deflection Temp. (°F)		121.3	145.1	128.8	n/a

2

3 **[0046]** Reinforcement of polypropylene resulted in increased hardness and increases in
4 tensile and flex modulus. For each of these properties the sorbent alone demonstrated even
5 greater reinforcement effect than glass bead reinforcement. Accordingly, tensile displacement
6 and flex displacement were reduced as the material became more rigid. Again, the effect of the
7 sorbent was directionally the same as, but greater than glass bead reinforcement. Tensile and
8 flex stress were reduced only slightly with sorbent reinforcement. However, the reduction was
9 greater with glass reinforcement. With polypropylene, the reinforcement with sorbent was
10 generally more effective than with glass bead reinforcement. The heat deflection temperature
11 was increased. Here again, a further implication of the increased heat deflection temperature
12 was an increase in the service temperature of a part molded from the sorbent reinforced resin.

13 **[0047]** Similarly, it was further found that structures molded from sorbent reinforced
14 polypropylene resin were isotropic as evidenced by the fact that tensile and flex modulus were
15 substantially the same in one direction, as another. As further evidence, shrinkage out of a
16 mold was minimal and symmetrical.

1 **EXAMPLE 3**

2 **[0048]** As may be seen in Table III, melt flow was reduced with sorbent reinforced nylon
 3 compared with nylon neat (pure polymer) or glass bead reinforced nylon. Nevertheless it was in
 4 a workable range and was higher than polypropylene. Melt flow of sorbent reinforced
 5 polypropylene was improved relative to polypropylene neat or glass reinforced polypropylene.

Table III: Melt Flow Properties of Sorbent Reinforced Polymers			
Melt Flow Index (g/10 min) (ASTM D 1238)	Neat	Molecular Sieve Reinforced	Glass Bead Reinforced
Nylon	56.3	14.7	55.5
Polypropylene	5.3	7.3	2.1

6

7 **EXAMPLE 4**

8 **[0049]** Moisture adsorption as a percentage of part weight is significant. This may be
 9 seen in Table IV. In practice, molecular sieve will adsorb about 25% of its own weight. It is
 10 reasonable then to expect a 40% loaded polymer to adsorb 10% of its own weight. In the case
 11 of nylon, however, adsorption reaches 13% in a 90% relative humidity (RH) environment, while
 12 the capacity is closer to 10% in an 80% RH environment. This was presumably the result of the
 13 action of the sorbent coupled with adsorption of some water by the nylon itself. The fact that the
 14 body as a whole adsorbs in excess of 10% indicates that the sorbent in addition to reinforcing
 15 the nylon was fully functional as a sorbent even though dispersed in the polymer. There was, in
 16 effect, a synergistic effect, or a double duty by the sorbent. Table IV shows results of
 17 adsorption at 36 - 38% molecular sieve loading.

18

Table IV: Adsorption Properties of Sorbent Reinforced Polymers				
Moisture Adsorption @ 29°C, 90% r.h.	2 Days	10 days	23 days	38 Days
Molecular Sieve Reinforced Nylon	5.4%	12.4%	13%	13%
Molecular Sieve Reinforced Polypropylene	1.1%	2.8%	4.4%	5.7%

19

1 **[0050]** Polypropylene is hydrophobic and is thus much slower to adsorb moisture. But it
2 is fully functional as a sorbent while being fully functional as a molding resin.

3 **[0051]** Additional applications of this invention are numerous. Such applications would
4 include any resin bonded component or structure used in an air conditioning or refrigeration
5 system. As discussed above, examples include J-tubes that are injection molded in halves and
6 welded or possibly injection blow-molded, sleeve liners, coatings for an interior part or shell, co-
7 injection molded composite structures, and insert molded filter-dryer assemblies. Diagnostic
8 applications would include test strip substrates, case or supports for E-trans cases, containers
9 or components of containers for diagnostic products. Pharmaceutical applications would
10 include parts of a tablet container, such as a base, or closure, or the body of the container itself,
11 an insert into a tablet container such as a bottom support or a neck insert to aid in dispensing, a
12 thermoformed sheet or as a layer of a multilayer thermoformable sheet suitable for one-at-a-
13 time or two-at-a-time dose dispensing from a blister or other compartmented package.
14 Monolithic cylindrical canisters for use in pharmaceutical bottles may also be formed from resin
15 bonded sorbent materials, thereby providing a drop-in replacement for hollow canisters filled
16 with particulate sorbent material. Electronics and electro-optical device applications would
17 include complete breather filter bodies, inserts for night vision sensor units, or inserts for rear
18 view camera bodies.

19 **[0052]** It will be appreciated that there are many other potential applications for a
20 sorbent loaded injection moldable resin in closed systems and sealed packaging applications. It
21 must also be appreciated that a sorbent loaded injection molding resin can also be extruded into
22 a rod or channel or any other shape with a uniform cross-section because extrusion is a less
23 demanding process than injection molding.

24 **[0053]** The resin bonded sorbents described above and herebelow overcome the
25 drawbacks of the prior art materials. Specifically, the instant invention is less brittle, *e.g.*, parts
26 formed from the resin bonded sorbents are capable of passing drop tests without part failure,
27 the parts adsorb fluid at slower rates thereby extending their useful life and minimizing the
28 effects of manufacturing environments, they can be regenerated slowly and by combining
29 sorbent properties with structural characteristics, the number of parts within an assembly may
30 be reduced, *i.e.*, a cost reduction as one part will serve two purposes. The instant invention
31 resin/sorbent matrices are less expensive to manufacture and use due to the use of
32 conventional resin, reduced processing steps and the use of multi-resin materials which do not
33 create phase boundaries. Additionally, older metal housings can be replaced with resin bonded
34 sorbent housings thereby providing an active barrier against moisture or other fluid ingress,

1 providing far greater design flexibility, weight reduction and cost savings as previously
2 mentioned.

3 **[0054]** When a circuit board is heated to melt and reflow the solder to secure electrical
4 connections, the board may be subject to damage due to moisture adsorbed within the board
5 material. Thus, in one embodiment, resin bonded sorbents may be used to form a circuit board.
6 A circuit board having a sorbent entrained in the board material will remain dry and greatly
7 reduce or eliminate damage during solder reflow. In a sealed electronic device housing having
8 a circuit board formed from a resin bonded sorbent, other components within the sealed housing
9 will be protected over the service life of the device.

10 **[0055]** In another embodiment, resin bonded sorbents may be used to form overmolded
11 pressed multiforms. First, a sorbent is formed by pressing, sintering or molding a resin bonded
12 sorbent material. Pressing and molding can be accomplished with heat and/or pressure.
13 Subsequently, the sorbent is overmolded with a structural, protective resin, which at least
14 partially encloses the sorbent. The overmold may include tabs or other features suitable for
15 mounting within or attaching to a sealed electronic or data storage device. As with the
16 examples described above, the sorbent may be any of the desiccant class or volatile adsorbent
17 class chosen to adsorb moisture or other fluids which could damage or limit the service life of
18 the protected device. In this embodiment, the overmolding resin may be any suitable
19 thermoplastic or thermoset resin which has the required properties and is otherwise compatible
20 with the sealed electronic or data storage device being protected.

21 **[0056]** In yet another embodiment, resin bonded sorbents may be used to form
22 structural components of optical and electro-optical devices. For example, a lens, lens mount,
23 lens retaining ring, aperture, housing, etc. may be formed from a resin bonded sorbent material
24 and thereafter incorporated within an assembly as the pre-existing part was incorporated. Thus,
25 in this embodiment, the resin bonded sorbent will prevent condensation within the assembly
26 which would typically cloud lenses or other optical surfaces thereby degrading of image quality.
27 Furthermore, if the sorbent material is of the indicating type, *e.g.*, color change above a specific
28 moisture content, the condition of the part will be readily apparent in so far as whether the part
29 is still capable of adsorbing. When using indicating sorbent material, the devices which
30 incorporate such material may include a window to allow a user to see, for example, the color
31 change which communicates the need to change the part to the user.

32 **[0057]** In still another embodiment, resin bonded sorbents may be used to form
33 components that merely fill available empty space while providing sorbent capabilities. Thus, no
34 additional enclosure space is required to include a sorbent in a pre-existing assembly. For

1 example, a hard drive typically has very little space available within its housing, however
2 sorbent capacity is still required to provide a suitable environment for prolonged life of the drive.
3 According to this embodiment, multifunctional sorbents may be incorporated into the interior
4 drive components or provided as an overmolded multiform, as described *supra*. As with other
5 embodiments, the sorbents may include desiccants, volatile organic adsorbers, volatile acid
6 adsorbers or oxygen adsorbers.

7 **[0058]** Some electronic devices may be used in exceedingly aggressive environments,
8 *e.g.*, aerospace and aviation applications. Electronic devices are used extensively in avionics
9 and communications systems in aircraft and aerospace applications. Moisture and other
10 volatiles may adversely affect the service life of such devices. Devices such as sensors,
11 transmitters, antennae, radar units, etc. which are externally mounted are particularly at risk
12 from moisture ingress due to temperature and pressure changes leading to evaporation and
13 recondensation of moisture within the housings of such devices. Moreover, internally mounted
14 devices are vulnerable due to variations in temperature as service conditions vary. Thus, resin
15 bonded sorbent articles are quite beneficial when included in these types of devices.

16 **[0059]** Similarly, automotive electronics are used in environments which may vary in
17 type from a desert to a mountain top to a tundra. These devices may include, for example,
18 backup and night vision cameras and sensing and control circuitry mounted in the exterior, or
19 under the hood of an automobile or truck. By using resin bonded sorbent material to form a
20 housing or internal part, moisture ingress may be prevented or its effects mitigated. Additionally,
21 electronically controlled braking systems can be protected from moisture ingress, as these
22 systems are subject to conditions at extreme temperatures. For example, brake fluid, which is
23 hygroscopic and in contact with several electronic controls, may change from an ambient winter
24 temperature of zero degrees centigrade (0°C) to three hundred fifty degrees centigrade (350°C)
25 in a very short period of time under high braking condition, *e.g.*, going down a large hill.
26 Preventing moisture ingress into the brake fluid not only prolongs electronic component service
27 life, but also maintains safer conditions, *i.e.*, as water content increases in brake fluid, its boiling
28 point lowers so that under normal operating conditions the liquid becomes a vapor and braking
29 power is essentially lost. In like fashion, gauges and electronic displays for boats, RVs, ATVs
30 and military rough terrain vehicles are also exposed to aggressive environments where the
31 incorporation of the instant invention would be quite beneficial. In particular, marine and
32 submersible applications expose electronics to electrolyte solutions where corrosion is
33 accelerated. In like fashion, automotive and marine devices benefit by incorporating resin
34 bonded sorbent articles within the device.

1 **[0060]** Surveillance and security devices, e.g., light/motion/heat sensors and security
2 cameras, must operate reliably in a wide range of temperature and humidity. For example, an
3 external security camera mounted on a bank in Buffalo, New York can see temperatures as high
4 as thirty seven degrees centigrade (37°C) and as low as minus twenty three degrees centigrade
5 (-23°C), while experiencing relative humidity levels from ninety five percent (95%) down to
6 twenty percent (20%). Thus, using the instant invention resin bonded sorbents to form a device
7 housing or internal component is particularly advantageous for extending service life of such
8 devices.

9 **[0061]** Another aggressive environment where electronic devices are prevalent is in
10 hazardous chemical production and use. Sensors, controls and switch gear must operate in
11 these environments while being protected from hazardous and/or corrosive vapors. Thus, using
12 an appropriate sorbent, e.g., desiccant, activated carbon, zeolites, clays and organic sorbents,
13 in a resin bonded sorbent housing or internal component of such devices will prolong its service
14 life. Similarly, industrial use personal computers (PCs) and programmable logic controllers
15 (PLCs) must operate in harsh industrial environments, e.g., high humidity. Hence, forming a
16 housing or internal component of these devices from the instant invention resin bonded
17 sorbents will prolong the service life of these PCs and PLCs.

18 **[0062]** Yet another aggressive environment where electronic devices are becoming
19 more prevalent is inside the human body, i.e., implantable and/or attachable electronic medical
20 devices. These types of devices must function continuously and reliably in a moist, saline
21 environment, or in other words, an environment where corrosion conditions are optimal. An
22 appropriate resin bonded sorbent housing, or internal resin bonded sorbent part, can maintain
23 dryness and enhance longevity and reliability of these devices. In addition to the implantable
24 and attachable medical devices, medical diagnostic equipment must also be maintained in
25 reliable working condition, i.e., dry electronics. Thus, using the instant invention to form a
26 housing or internal component is particularly advantageous.

27 **[0063]** Mobile and stationary telecommunication devices are also exposed to adverse
28 and aggressive environments. Terminals and switch gear would have longer service life and
29 lower maintenance if the interior of their housings were kept dry. Thus, a housing or internal
30 part formed from the instant invention would keep the device dry, thereby minimizing current
31 leakage and shorts, inhibiting dendrite formation and electrolytic/chemical corrosion. In addition
32 to moisture adsorption, suitable sorbents may be included to address other volatiles present
33 within the housing.

1 **[0064]** Other electronic devices, *e.g.*, solar panels or day/night sensors, present other
2 problems to overcome. Commercial photovoltaic devices consist of flat, nearly all glass panels
3 which are coated with a moisture sensitive photoactive substance. The panels are sealed to
4 each other in the manner of a thermo-pane window. Sealants may be used around the
5 perimeter, or the panels may be mounted in a frame. Additionally, ports and openings into the
6 panel for electrical connections must be sealed. Frame materials or fitments for electrical
7 connections may be made from resin bonded sorbent which can simultaneously provide the
8 mechanical strength and sorbent properties required to contain and protect moisture sensitive,
9 fragile solar panels.

10 **[0065]** Radio frequency identification (RFID) devices are made from semiconductor
11 chips and associated circuitry. Circuit boards may be used, however imprinted circuitry is more
12 prevalent. RFID devices, and in particular organic RFID devices, are often used in adverse
13 environments where they may degrade due to moisture, oxygen or volatile chemicals. Thus,
14 RFID devices may be improved by manufacturing support structures or housings from polymeric
15 resins with properties enhanced by sorbent additives capable of extending the life of RFID
16 devices, *e.g.*, desiccants or oxygen adsorbents.

17 **[0066]** Light emitting diodes (LEDs) and liquid crystal diodes (LCDs) are made from
18 materials which are moisture sensitive. In particular, organic LEDs and LCDs are highly
19 moisture sensitive. Sorbent materials are added to displays to improve and extend service life,
20 usually in thin film or sheet form. According to the instant invention, a structural support or
21 sealant material can be made from resin bonded sorbents, thereby providing moisture
22 protection, *i.e.*, extending service life, while also providing the structural, mounting or sealing
23 functionality of a pre-existing component. In like fashion, flexible electronic displays are highly
24 moisture sensitive. Chromophores used in their construction are moisture sensitive and
25 therefore can be stabilized by incorporating a resin bonded sorbent within the displays.

26 **[0067]** Even traditional lighting devices, for example, household lighting and automobile
27 headlamps, will benefit by including the instant invention. Condensation on lenses may be
28 prevented, thereby prolonging bulb and service life of such devices, while eliminating loss of
29 reflected light.

30 **[0068]** Solid state surface mount electronic devices housed in plastic enclosures are
31 considered nonhermetic due to the moisture permeability of the plastic. The basic issue is
32 vapor pressure change of water during solder reflow cycle causing damage, which may lead to
33 delamination, cracking, leaking and "popcorning". Currently, low moisture sensitivity is achieved
34 by the choice of materials, design of package and good processes. Resin bonded sorbent

1 enclosures will inhibit moisture ingress, effectively making a hermetic seal until the sorbent
2 becomes saturated. Examples of such devices include, but are not limited to, radio frequency,
3 wireless, local area network (LAN) and broadband devices, as well as electronic chip mountings
4 and packaging.

5 **[0069]** As described *supra*, imaging devices present issues different than part
6 degradation. The presence of moisture combined with a change in temperature can cause
7 condensation on a lens or window of an imaging device. Condensation quickly degrades image
8 quality and may render imaging devices non-functional. Such devices are known to require
9 moisture control when the service environment is moist and subject to temperature fluctuation.
10 Thus, an article made from resin bonded sorbent, e.g., lens retaining ring, aperture, housing,
11 etc., may be incorporated within the assembly thereby providing sorbent capabilities as well as
12 structural support. Such optical devices may be used for sighting and/or sensing an object, for
13 example, target acquisition and guidance sensors and systems. In these systems, lasers and
14 other sensing devices form a crucial part of the target acquisition and guidance systems, thus
15 peak optical performance is necessary, *i.e.*, no condensation on optical surfaces.

16 **[0070]** In addition to sorbent capabilities, resin bonded sorbent material may be blended
17 with other materials, e.g., static dissipative (conductive) material, thereby providing multifunction
18 capability, for example, moisture control and antistatic properties. Thus, these materials may be
19 used in any of the above described electronic applications by adsorbing moisture while
20 dissipating static charges.

21 **[0071]** Figure 10 shows a cross sectional view of an embodiment of the present
22 invention, device 11. Device 11 includes housing 12 which includes first and second walls 14
23 and 16, respectively, and shoulder 18. As described *supra*, housing 12 may be formed from a
24 resin bonded sorbent thereby slowing or preventing the ingress of fluid. Shoulder 18 provides a
25 seat for lens 20, while first wall 14 provides a mounting location for sorbent article 22 and
26 second wall 16 provides a mounting location for stand-offs 24 which fixedly secure circuit board
27 26 to housing 12. Sorbent article 22 includes sorbent 28 enclosed within overmold resin 30.
28 Overmold resin 30 includes tabs 32 which are used to hold sorbent article 22 to first wall 14 via
29 fasteners 34. As described above, circuit board 26 may also be formed from a resin bonded
30 sorbent thereby providing sorbent capability within housing 12. Device 11 further includes
31 gasket 36 and retaining ring 38. Gasket 36 is disposed between shoulder 18 and lens 20, while
32 retaining ring 38 provides a positive force in the direction of gasket 36, thereby compressing
33 gasket 36. The compression of gasket 36 seals housing 12 and prevents the ingress of fluids
34 therein. Additionally, gasket 36, retaining ring 38 and/or lens 20 may be formed from a resin

1 bonded sorbent material, which would provide a greater level of protection from fluid ingress.
2 Device **11** further includes aperture **40** disposed between lens **20** and circuit board **26**. Aperture
3 **40** may also be formed from a resin bonded sorbent thereby providing further sorbent capacity.
4 Although aperture **40** is shown as being formed from a resin bonded sorbent material, one of
5 ordinary skill in the art will recognize that other articles may be formed from such materials and
6 incorporated within device **11**, for example, baffles, fasteners or stand-offs. Surface mount
7 device **42** is fixedly secured to circuit board **26** via contacts **44**. Surface mount device **42** further
8 includes enclosure **46**. Typically, surface mount device **42** would not be considered
9 hermetically sealed as the enclosure materials are permeable to some fluids. Thus, by forming
10 enclosure **46** from a resin bonded sorbent material, surface mount device **42** can be
11 hermetically sealed.

12 **[0072]** As one of ordinary skill in the art will recognize, device **11** and the components
13 contained therein are not limited to the particular embodiment shown in Figure 10. For example,
14 housing **12** may be a fully sealed container having no lens **20** and/or no aperture **40**. Thus, it is
15 within the and scope of the invention that device **11** can comprise at least one article formed
16 from resin bonded sorbent material which is selected from the group consisting of a lens, circuit
17 board, housing, case, frame, support structure, mount structure, retaining structure, seal
18 material, solid state surface mount device, electronic chip packaging, telecommunications
19 terminal, telecommunications switch, a data storage device, electronic device, electro-optical
20 device, scope, sensor, transmitter, antenna, radar unit, photovoltaic device, radio frequency
21 identification device, light emitting diode, liquid crystal diode, semiconductor enclosure, imaging
22 device, sighting device, cellular phone, target acquisition and guidance sensor, implantable
23 electronic medical device, attached electronic medical device, mobile telecommunications
24 device, stationary telecommunications device, automobile sensing circuit, automobile control
25 circuit, braking control system, hazardous chemical sensor, hazardous chemical control, gauge,
26 electronic display, personal computer, programmable logic unit, medical diagnostic equipment,
27 light sensor, motion sensor, heat sensor, security camera, flexible electronic device, lighting
28 fixture, marine gauge, marine light, external aircraft sensing device, external aircraft monitoring
29 device, external aircraft measuring device, power tool sensing device, power tool sighting
30 device, power tool measuring device, laser and combinations thereof.

31 **[0073]** Figure 11 is a perspective view of an embodiment of a present invention lamp
32 assembly **50**, while Figure 12 is an exploded view of lamp assembly **50**. Figure 13 is a cross
33 sectional view of lamp assembly **50** taken generally along line **13-13** of Figure 11, while Figure
34 14 is a cross sectional view of lamp assembly **50** taken generally along line **14-14** of Figure 11.

1 Figure 15 is a cross sectional view of another embodiment of a present invention lamp
2 assembly, *i.e.*, lamp assembly **52**, while Figure 16 is a perspective view of yet another
3 embodiment of a present invention lamp assembly, *i.e.*, lamp assembly **54**. The following
4 discussion is best understood in view of Figures 11 through 16.

5 **[0074]** Lamp assembly **50** comprises at least one light source, *e.g.*, light sources **56**. It
6 should be appreciated that the at least one light source may be an LED or other type of light
7 source, and such variations are within the scope of the claimed invention. Furthermore, the at
8 least one light source may be arranged on a mounting board, *e.g.*, circuit board **57**, or may be
9 positioned as a discrete component. Lamp assembly **50** further comprises housing **58** formed
10 from a first moisture barrier composition and sealing cap **60** formed from a second moisture
11 barrier composition. The at least one light source, *e.g.*, light sources **56**, is arranged within
12 housing **58** and sealing cap **60** is hermetically bonded to housing **58** and the at least one light
13 source. As can be seen in the figures, in some embodiments, sealing cap **60** includes at least
14 one hole, *e.g.*, holes **61**, arranged for receipt of the at least one light source therein. Sealing
15 cap **60** is arranged to enclose the at least one light source within volume **62** formed by housing
16 **58** and sealing cap **60**. It should be further appreciated that lamp assembly **50** may also
17 comprise lens **63** arranged to control the path of light emitting from the at least one light source;
18 however, lens **63** is not particularly germane to the present invention.

19 **[0075]** In the embodiments shown in the figures, the first moisture barrier composition
20 comprises a blend of a first resin and a first sorbent and the second moisture barrier
21 composition comprises a blend of a second resin and a second sorbent; however, it should be
22 appreciated that other variations are also possible. For example, the first resin can be the same
23 as the second resin and the first sorbent can be the same as the second resin, the first resin
24 can be different than the second resin and the first sorbent can be the same as the second resin,
25 the first resin can be the same as the second resin and the first sorbent can be different than the
26 second resin, or the first resin can be different than the second resin and the first sorbent can be
27 different than the second resin. Such variations are within the scope of the claimed invention.

28 **[0076]** As described above, the resins used for the present invention lamp assembly
29 may be thermoplastic or may be selected from the groups consisting of polyamide, polyolefin,
30 styrenic polymer, polyester and homogeneous mixtures thereof. Examples of polyolefins
31 include high density polyethylene, low density polyethylene and polypropylene. Similarly, the
32 sorbents used for the present invention lamp assembly may be selected from the group
33 consisting of a molecular sieve, a silica gel, an ion exchange resin, an activated alumina, a clay,
34 a salt, a zeolite and mixtures thereof.

1 **[0077]** Several techniques of hermetically sealing a present invention lamp assembly
2 can be used and such techniques are within the scope of the claimed invention. For example,
3 sealing cap **60** is hermetically bonded to housing **58** and the at least one light source, *e.g.*, light
4 sources **56**, with welding, or sealing cap **60** is hermetically bonded to housing **58** and the at
5 least one light source with an adhesive or an epoxy. In various embodiments, the welding
6 technique may be selected from the group consisting of: sonic welding, ultrasonic welding, spin
7 welding, hot plate welding and vibration welding, and such techniques are well known in the art.
8 In both embodiments, surface **64** of sealing cap **60** is hermetically bonded to surface **65** of
9 housing **58** and surface **66** of light sources **56**. As used herein, "hermetically sealed" and
10 "hermetically bonded" are intended to mean a seal or bond which prevents the flow of fluid, gas
11 or vapor from one side of the sealed or bonded region to the opposite side of the sealed or
12 bonded region. For example, when sealing cap **60** is hermetically bonded to housing **58** and
13 the at least one light source, no fluid, gas or vapor can flow from outside of housing **58** to
14 volume **62**, *i.e.*, the volume created within housing **58** and sealing cap **60**. It should be
15 appreciated that any sonic welding techniques known in the art to bond two plastic substrates
16 together may be used to bond the present invention lamp assembly, *e.g.*, lamp assembly **50**.
17 Similarly, any adhesive or epoxy known in the art to bond two plastic substrates together may
18 be used to bond the present invention lamp assembly.

19 **[0078]** In some embodiments, for example the embodiment shown in Figure 15, sealing
20 cap **60** can be molded directly over and to housing **58** and the at least one light source, *e.g.*,
21 light sources **56**. Such a technique is commonly known as overmolding, and creates a hermetic
22 bond or seal between sealing cap **60**, housing **58** and the at least one light source. As with the
23 above described embodiments, any overmolding techniques known in the art to bond two plastic
24 substrates together may be used to bond the present invention lamp assembly.

25 **[0079]** In some embodiments, the at least one light source further comprises at least two
26 electrical connections, *e.g.*, electrical connections **68**, and housing **58** further comprises at least
27 two openings, *e.g.*, openings **70**, arranged to receive the at least two electrical connections
28 therethrough. In such embodiments, the at least two electrical connections and the at least two
29 openings are hermetically encapsulated by a third moisture barrier composition. Similar to the
30 embodiments described above, the third moisture barrier composition comprises a blend of a
31 third resin and a third sorbent, and the third resin and/or the third sorbent may be the same as
32 or different than the first and second resins and the first and second sorbents, respectively.
33 Also as described above, the third resin may be a thermoplastic resin, or may be selected from
34 the group consisting of polyamide, polyolefin, styrenic polymer, polyester and homogeneous

1 mixtures thereof. Examples of preferred polyolefins include high density polyethylene, low
2 density polyethylene and polypropylene. The third sorbent is again selected from the group
3 consisting of a molecular sieve, a silica gel, an ion exchange resin, an activated alumina, a clay,
4 a salt, a zeolite and mixtures thereof.

5 **[0080]** Several techniques of hermetically encapsulating the at least two electrical
6 connections and the at least two openings can be used, and such techniques are within the
7 spirit and scope of the claimed invention. For example, the at least two electrical connections,
8 *e.g.*, electrical connections **68**, and the at least two openings, *e.g.*, openings **70**, can be
9 hermetically encapsulated by the third moisture barrier composition with welding or with an
10 adhesive or an epoxy, as described above. As used herein, "hermetically encapsulated" is
11 intended to mean surrounding or encasing an item in such a way that the encasing prevents the
12 flow of fluid, gas or vapor from one side of the encased region to the opposite side of the
13 encased region. For example, when the at least two electrical connections and the at least two
14 openings are hermetically encapsulated, no fluid, gas or vapor can flow from outside of housing
15 **58** to volume **62**, *i.e.*, the volume created within housing **58** and sealing cap **60**, via the at least
16 two openings. Similar to the embodiments described above, an overmolding technique may
17 also be used to provide hermetic encapsulation of the at least two electrical connections and the
18 at least two openings.

19 **[0081]** As can be seen in Figure 16, the present invention lamp assembly may take
20 other forms than the embodiments shown in the previous figures, *e.g.*, lamp assembly **54**.
21 Lamp assembly **54** comprises cylindrical housing **72** and round lens **74**. It should be
22 appreciated that other shapes are also possible, *e.g.*, triangular or rhombus, and such shapes
23 are within the scope of the claimed invention.

24 **[0082]** As described above, various embodiments of resin bond sorbent may be used as
25 a barrier to the transmission of a vapor through a resin material, *e.g.*, a barrier to the
26 transmission of water vapor through a polypropylene resin in combination with a molecular sieve.
27 Thus, a lamp assembly comprising a housing and sealing cap, wherein both the housing and
28 sealing cap are formed from a resin bonded sorbent material, effectively prevents the ingress of
29 moisture into the lamp assembly.

30 **[0083]** Resins used in the present invention are prepared using specialized plastics
31 compounding techniques. A preferred sorbent is molecular sieve which can be incorporated
32 into polyamide and polyolefin resins by feeding the sorbent in powder form along with beads of
33 the chosen resin to a plastics extruder with good mixing characteristics at a temperature and at
34 a rate and concentration required to achieve full dispersion of the sorbent additive such that

1 sorbent particles are fully wetted and coated with resin such that particles are separated from
2 each other. A twin screw extruder is typically used. Multiple compounding steps may be used
3 as necessary to achieve the claimed dispersion. Thus, the resin is melted and the sorbent is
4 mixed throughout. The extruded resin is cooled with air and then cut or crushed into pellets or
5 granules. Since the compounding is accomplished at high temperature, the sorbent tends not to
6 adsorb moisture and thus retains its capacity.

7 **[0084]** Although the present invention has been particularly described in conjunction
8 with specific preferred embodiments, it is evident that many alternatives, modifications, and
9 variations will be apparent to those skilled in the art. It is therefore contemplated that the
10 appended claims will embrace any such alternatives, modifications, and variations as falling
11 within the scope of the invention as outlined in the appended claims.
12

What we claim is:

1. A lamp assembly comprising:
 - at least one light source;
 - a housing formed from a first moisture barrier composition; and,
 - a sealing cap formed from a second moisture barrier composition, wherein said at least one light source is arranged within said housing and said sealing cap is hermetically bonded to said housing and said at least one light source, and said sealing cap is arranged to enclose said at least one light source within a volume formed by said housing and said sealing cap.
2. The lamp assembly of Claim 1, wherein said first moisture barrier composition comprises a blend of a first resin and a first sorbent and said second moisture barrier composition comprises a blend of a second resin and a second sorbent.
3. The lamp assembly of Claim 2, wherein said first resin, said second resin, or said first resin and said second resin is a thermoplastic resin.
4. The lamp assembly of Claim 2, wherein said first resin, said second resin, or said first resin and said second resin is selected from the group consisting of polyamide, polyolefin, styrenic polymer, polyester and homogeneous mixtures thereof.
5. The lamp assembly of Claim 4, wherein said polyolefin is selected from the group consisting of high density polyethylene, low density polyethylene and polypropylene.
6. The lamp assembly of Claim 2, wherein said first sorbent, said second sorbent, or said first sorbent and said second sorbent is selected from the group consisting of a molecular sieve, a silica gel, an ion exchange resin, an activated alumina, a clay, a salt, a zeolite and mixtures thereof.
7. The lamp assembly of Claim 1, wherein said sealing cap is hermetically bonded to said housing and said at least one light source with welding.

8. The lamp assembly of Claim 7, wherein said welding is selected from the group consisting of: sonic welding, ultrasonic welding, spin welding, hot plate welding and vibration welding.
9. The lamp assembly of Claim 1, wherein said sealing cap is hermetically bonded to said housing and said at least one light source with an adhesive or an epoxy.
10. The lamp assembly of Claim 1, wherein said sealing cap is hermetically bonded to said housing and said at least one light source by molding said sealing cap over said housing and said at least one light source.
11. The lamp assembly of Claim 1, wherein said at least one light source comprises at least two electrical connections and said housing comprises at least two openings arranged to receive said at least two electrical connections therethrough, and wherein said at least two electrical connections and said at least two openings are hermetically encapsulated by a third moisture barrier composition.
12. The lamp assembly of Claim 11, wherein said third moisture barrier composition comprises a blend of a third resin and a third sorbent.
13. The lamp assembly of Claim 12, wherein said third resin is a thermoplastic resin.
14. The lamp assembly of Claim 12, wherein said third resin is selected from the group consisting of polyamide, polyolefin, styrenic polymer, polyester and homogeneous mixtures thereof.
15. The lamp assembly of Claim 14, wherein said polyolefin is selected from the group consisting of high density polyethylene, low density polyethylene and polypropylene.
16. The lamp assembly of Claim 12, wherein said third sorbent is selected from the group consisting of a molecular sieve, a silica gel, an ion exchange resin, an activated alumina, a clay, a salt, a zeolite and mixtures thereof.

17. The lamp assembly of Claim 11, wherein said at least two electrical connections and said at least two openings are hermetically encapsulated by said third moisture barrier composition with welding.
18. The lamp assembly of Claim 17, wherein said welding is selected from the group consisting of: sonic welding, ultrasonic welding, spin welding, hot plate welding and vibration welding.
19. The lamp assembly of Claim 11, wherein said at least two electrical connections and said at least two openings are hermetically encapsulated by said third moisture barrier composition with an adhesive or an epoxy.
20. The lamp assembly of Claim 11, wherein said at least two electrical connections and said at least two openings are hermetically encapsulated by said third moisture barrier composition by molding said third moisture barrier composition over said at least two electrical connections and said at least two openings.

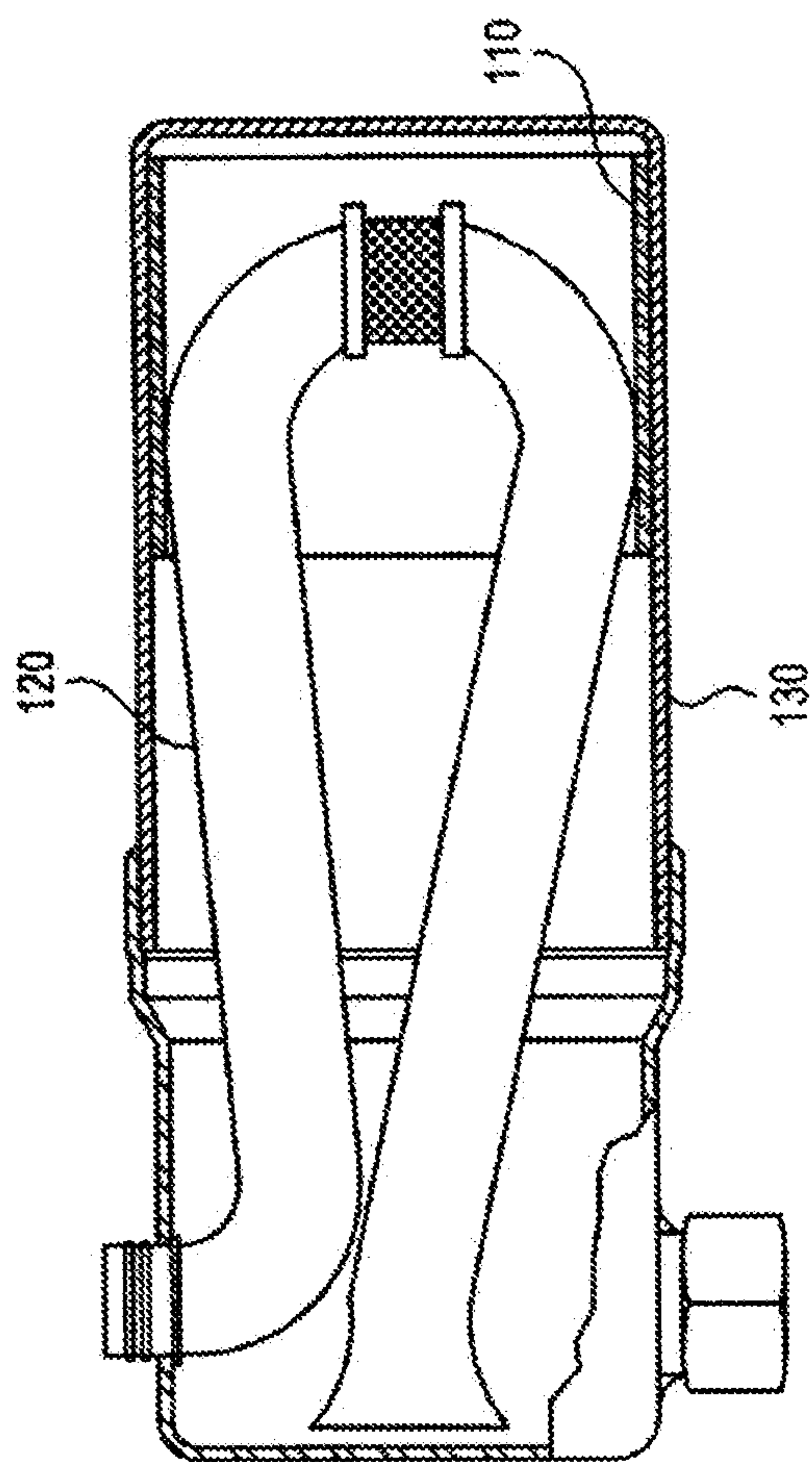


FIG. 2

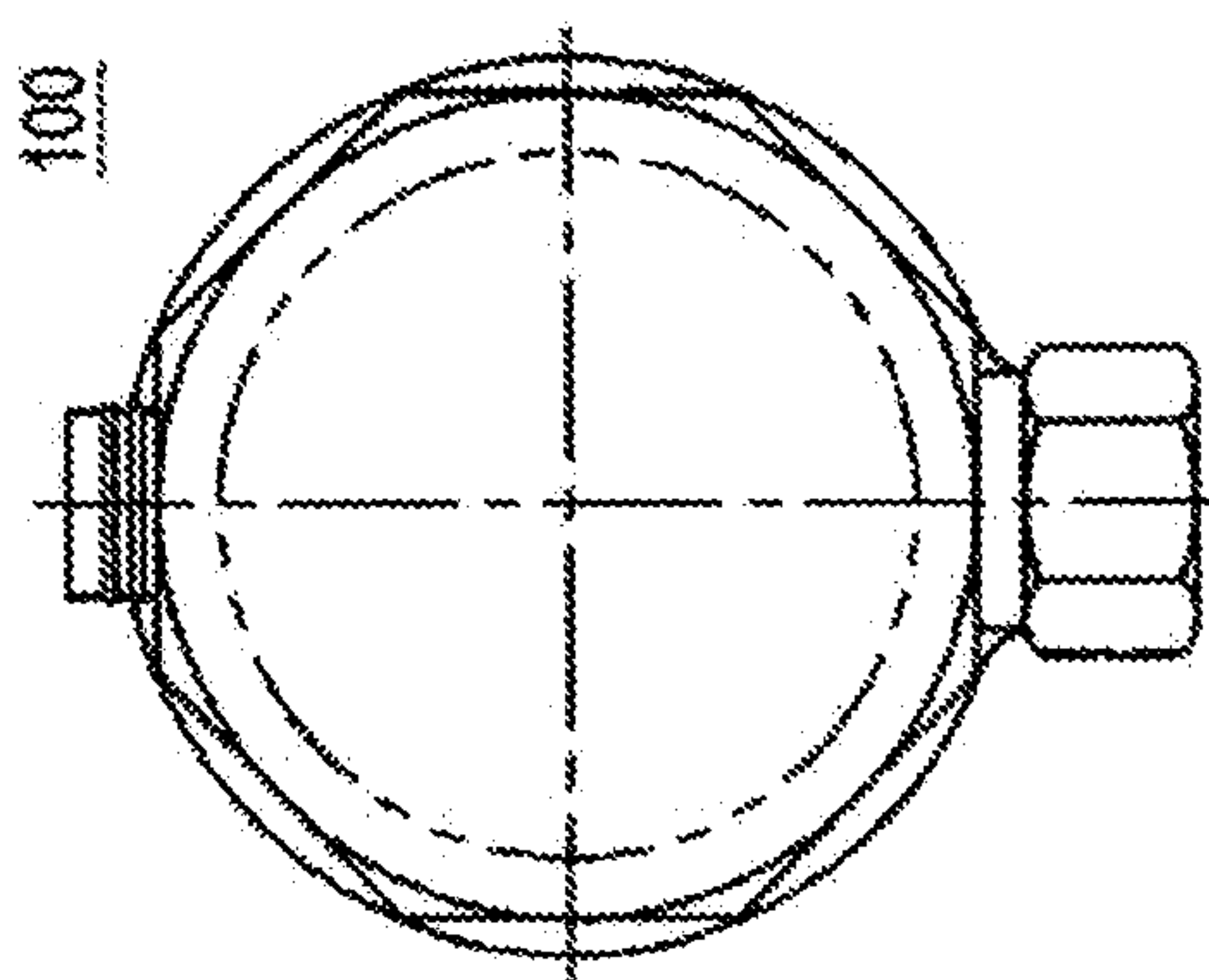
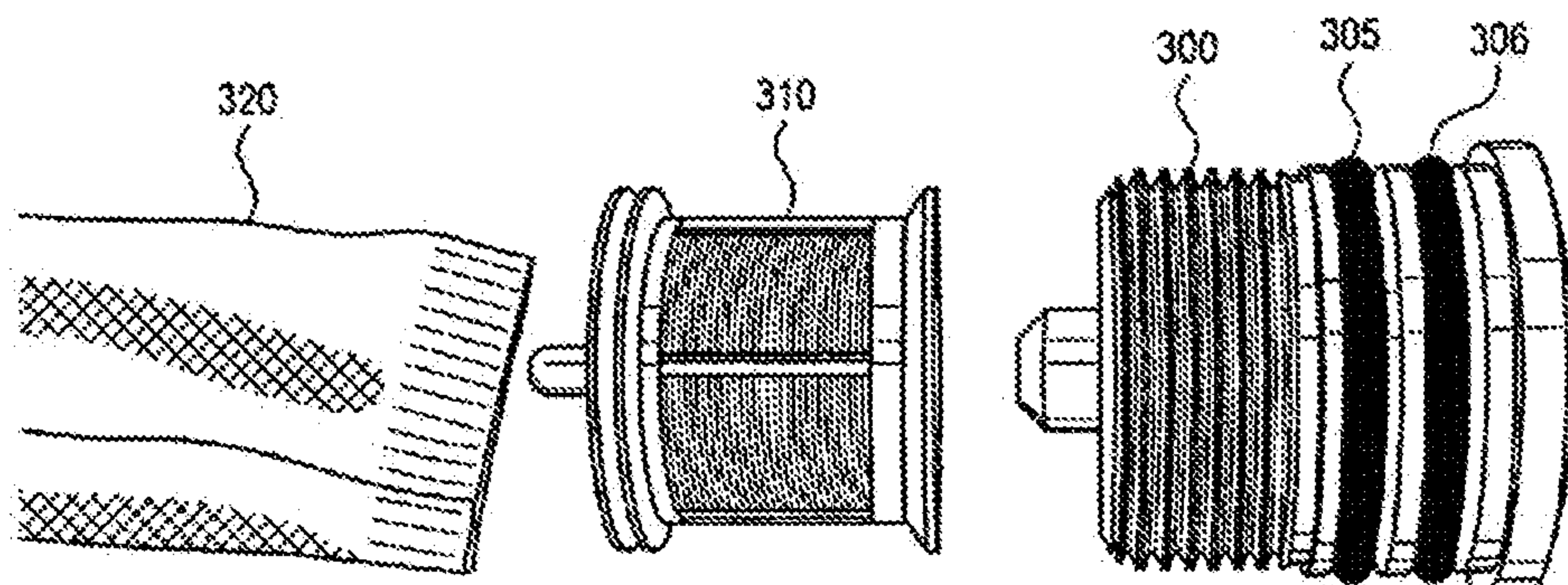
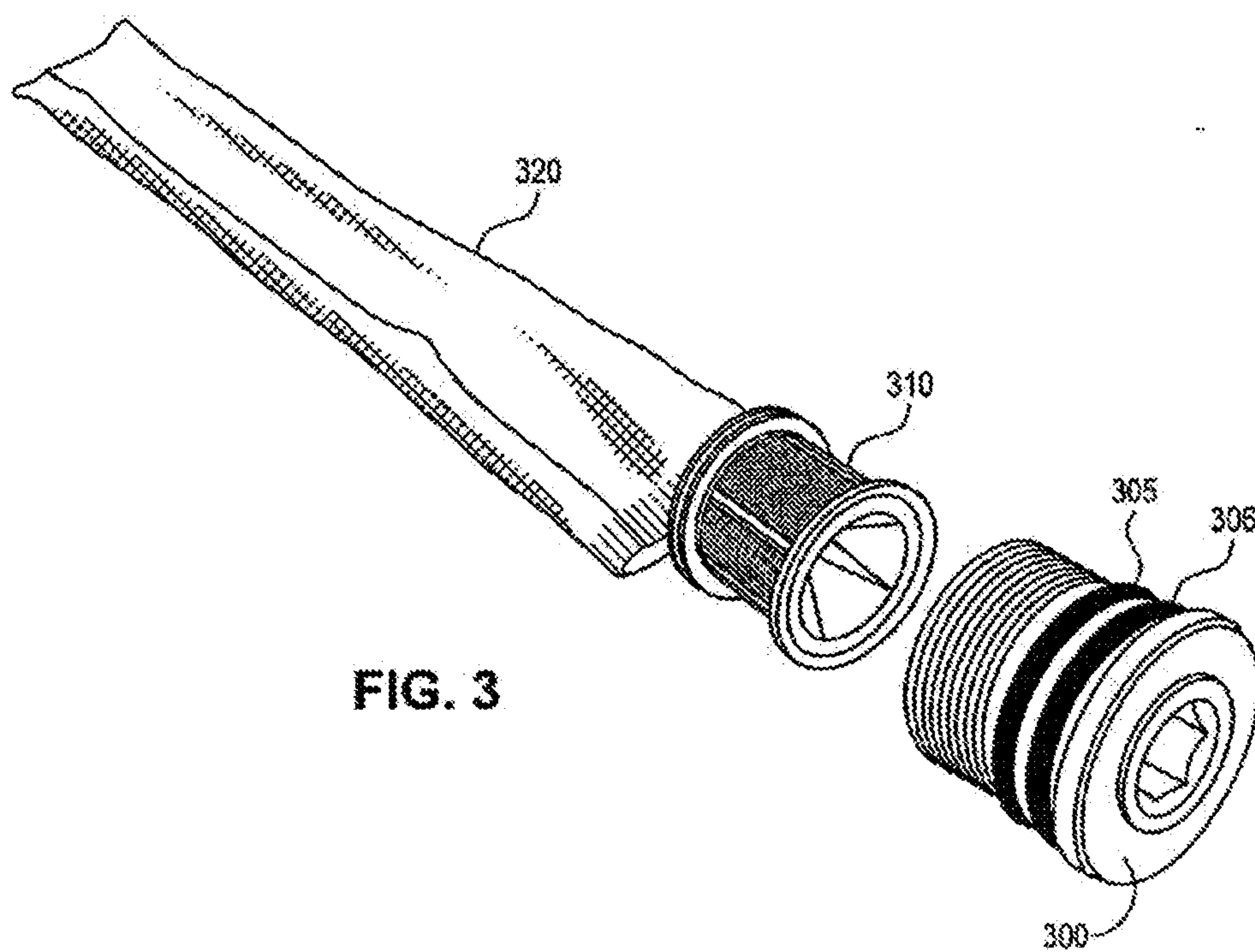


FIG. 1

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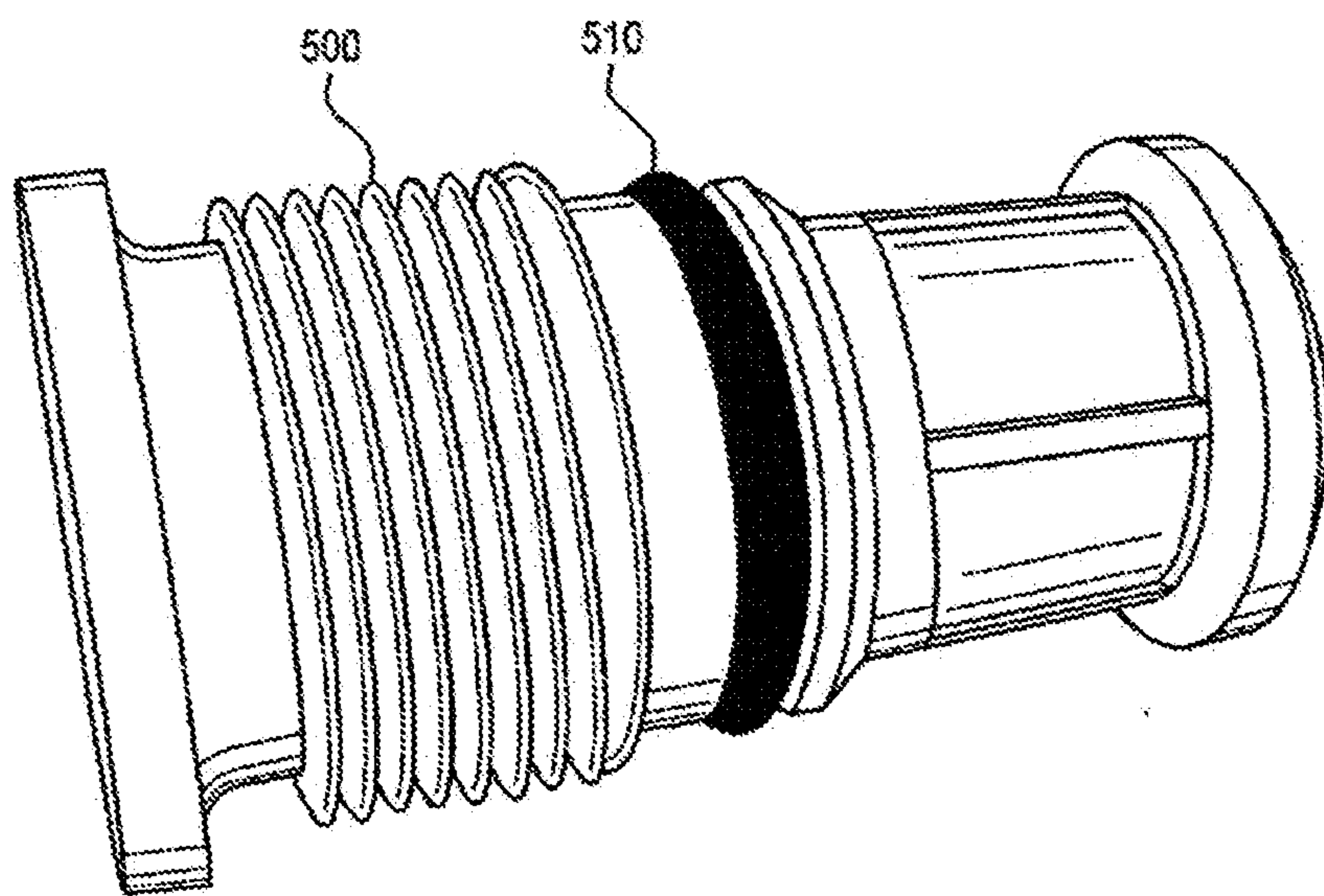


FIG. 5

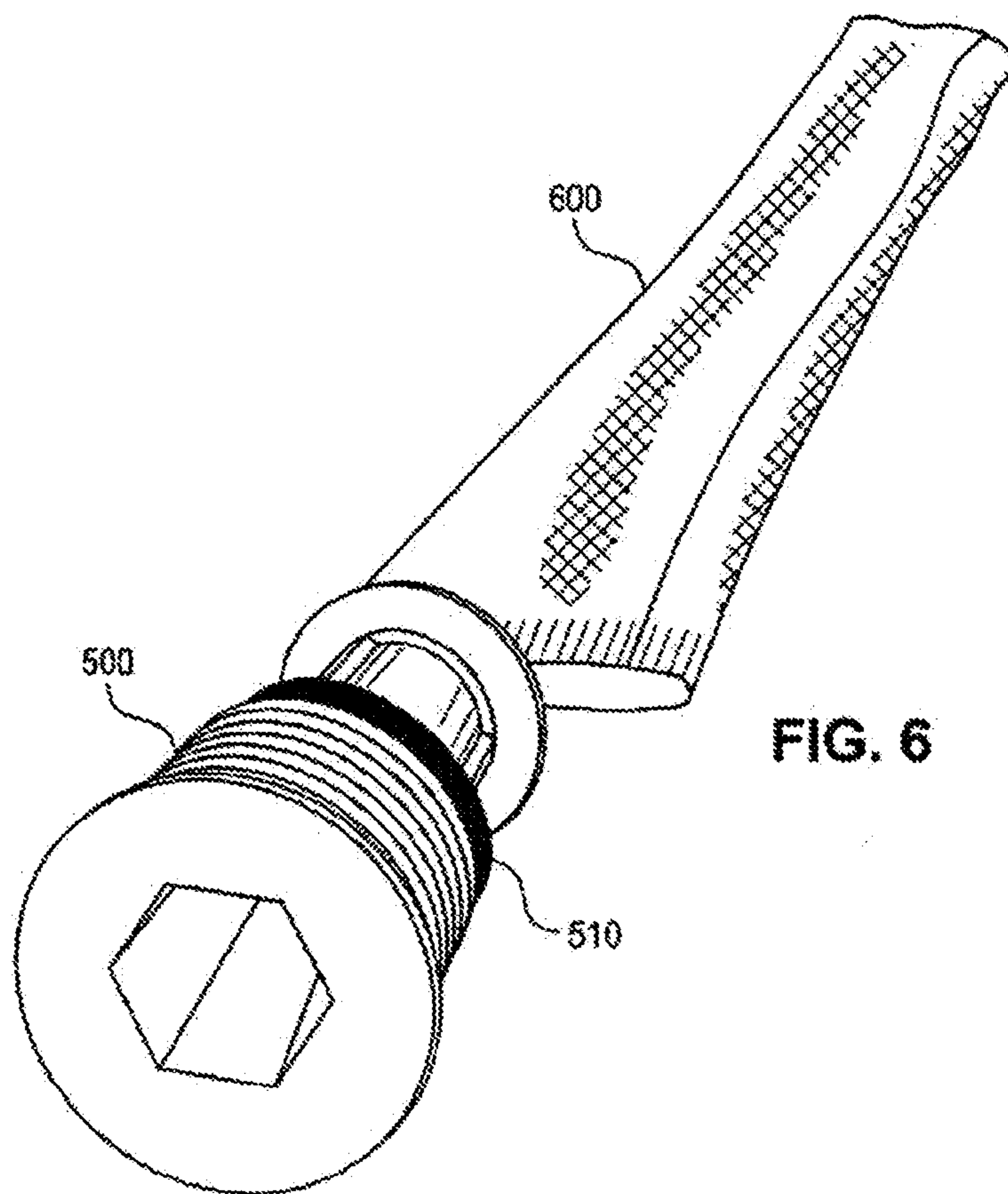


FIG. 6

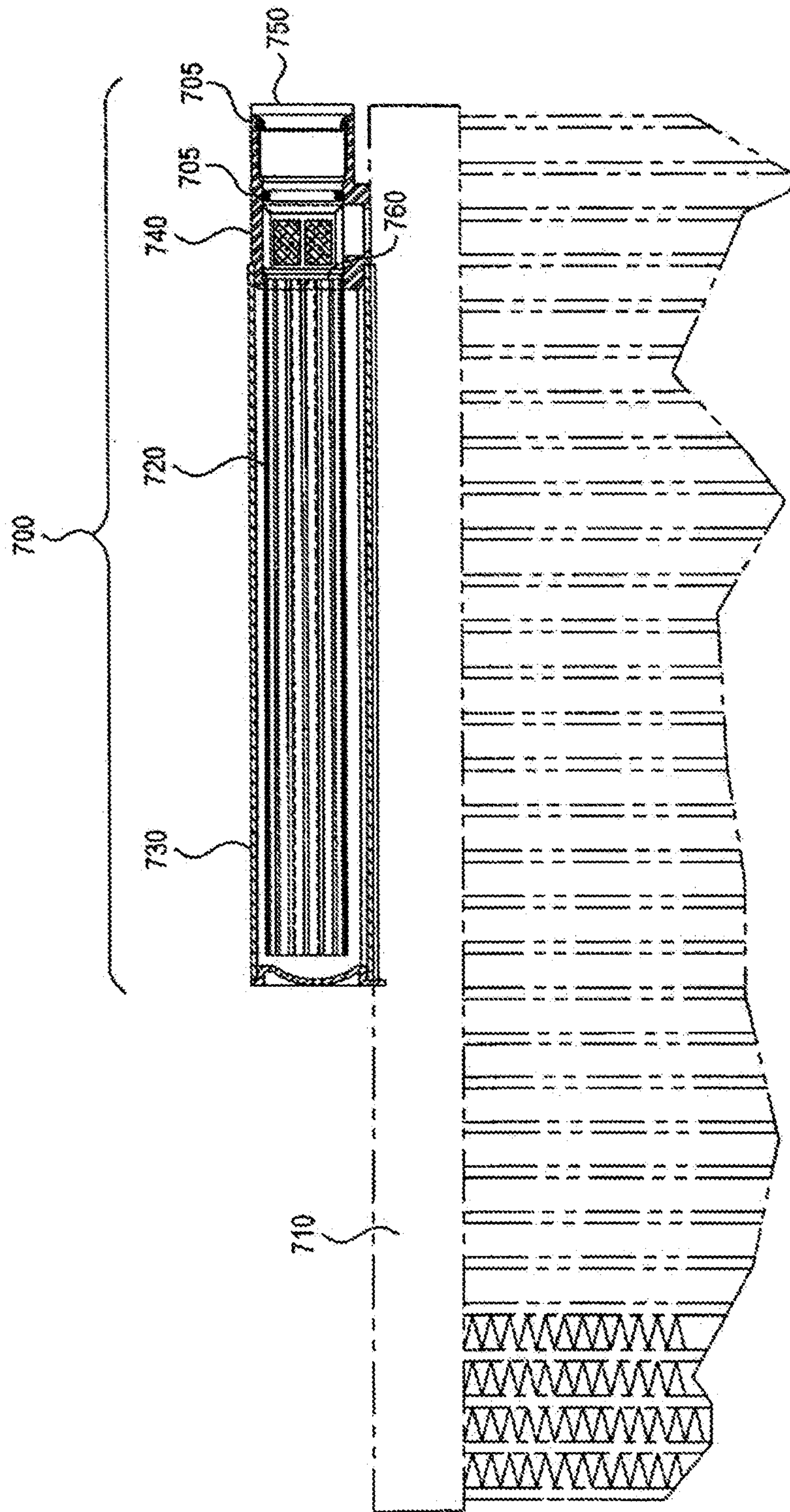


FIG. 7

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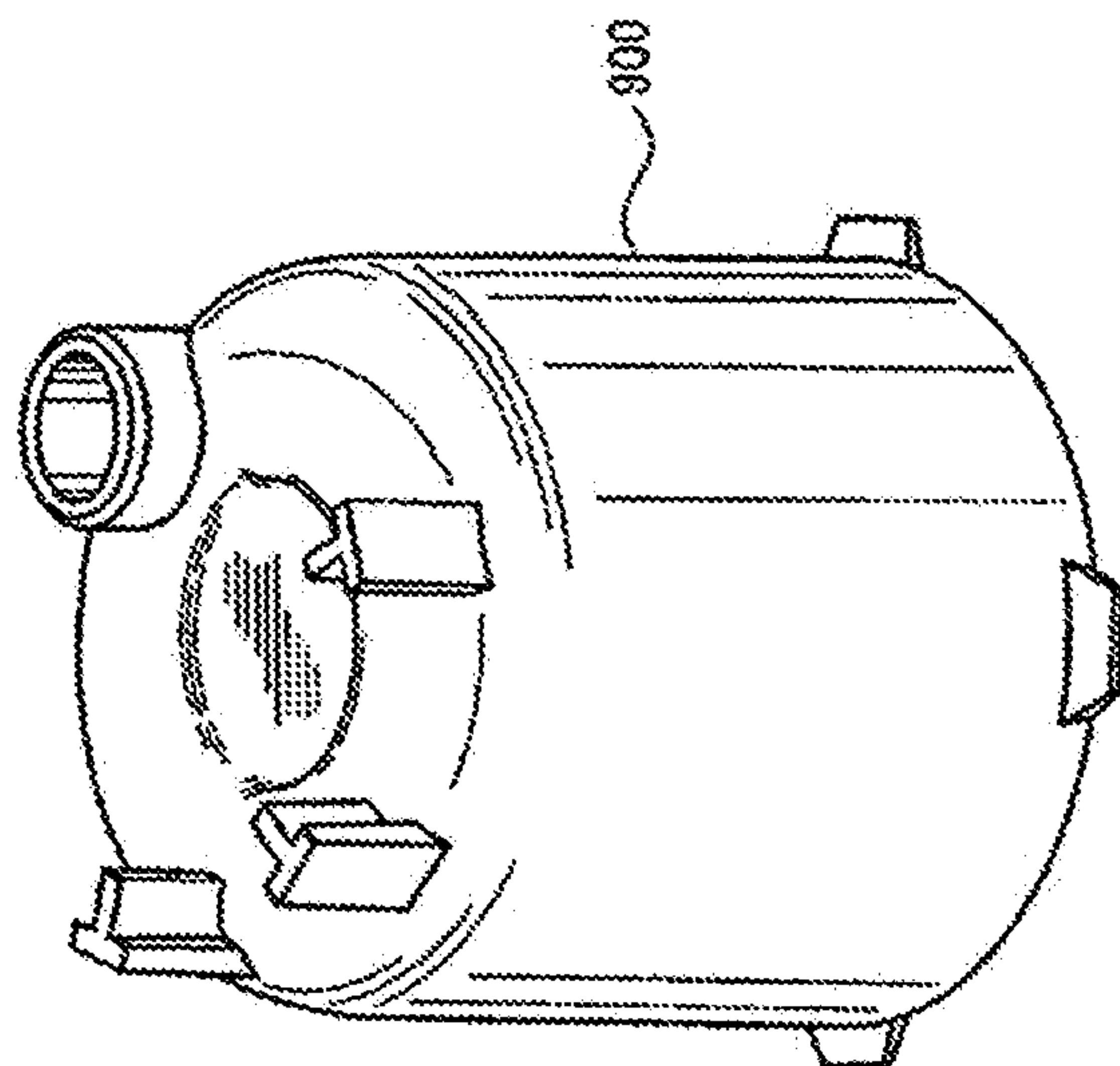


FIG. 9

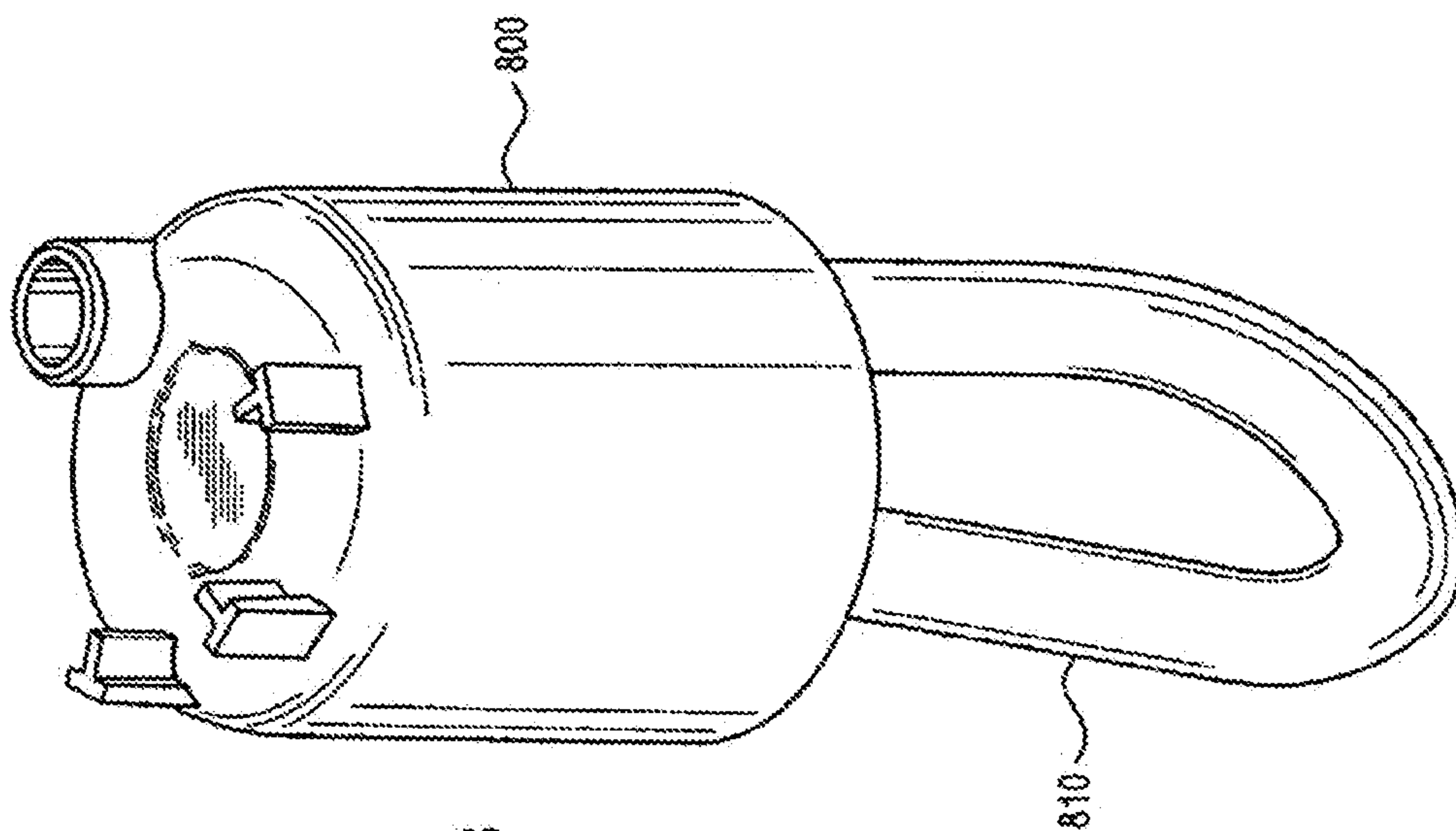


FIG. 8

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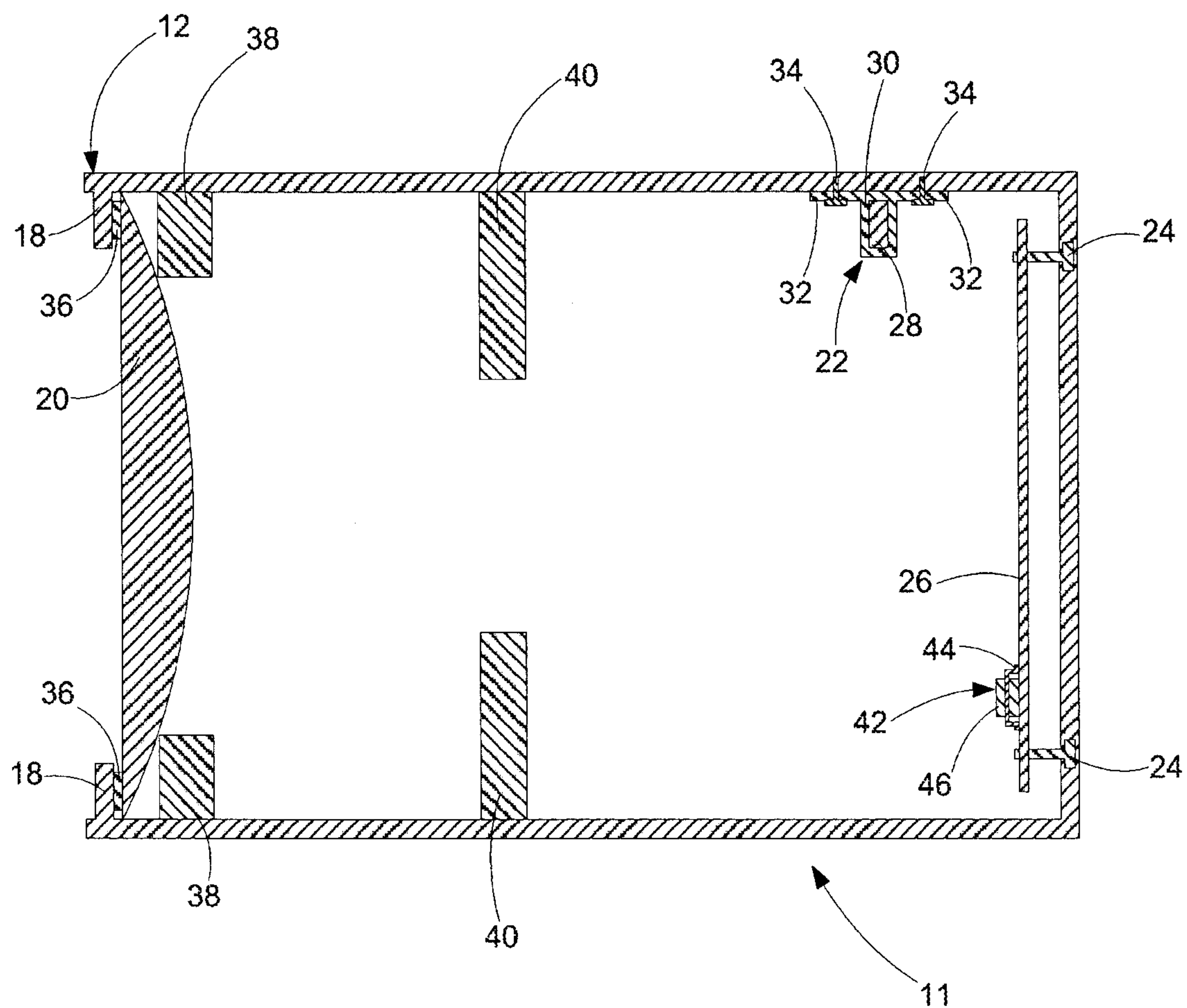


FIG. 10

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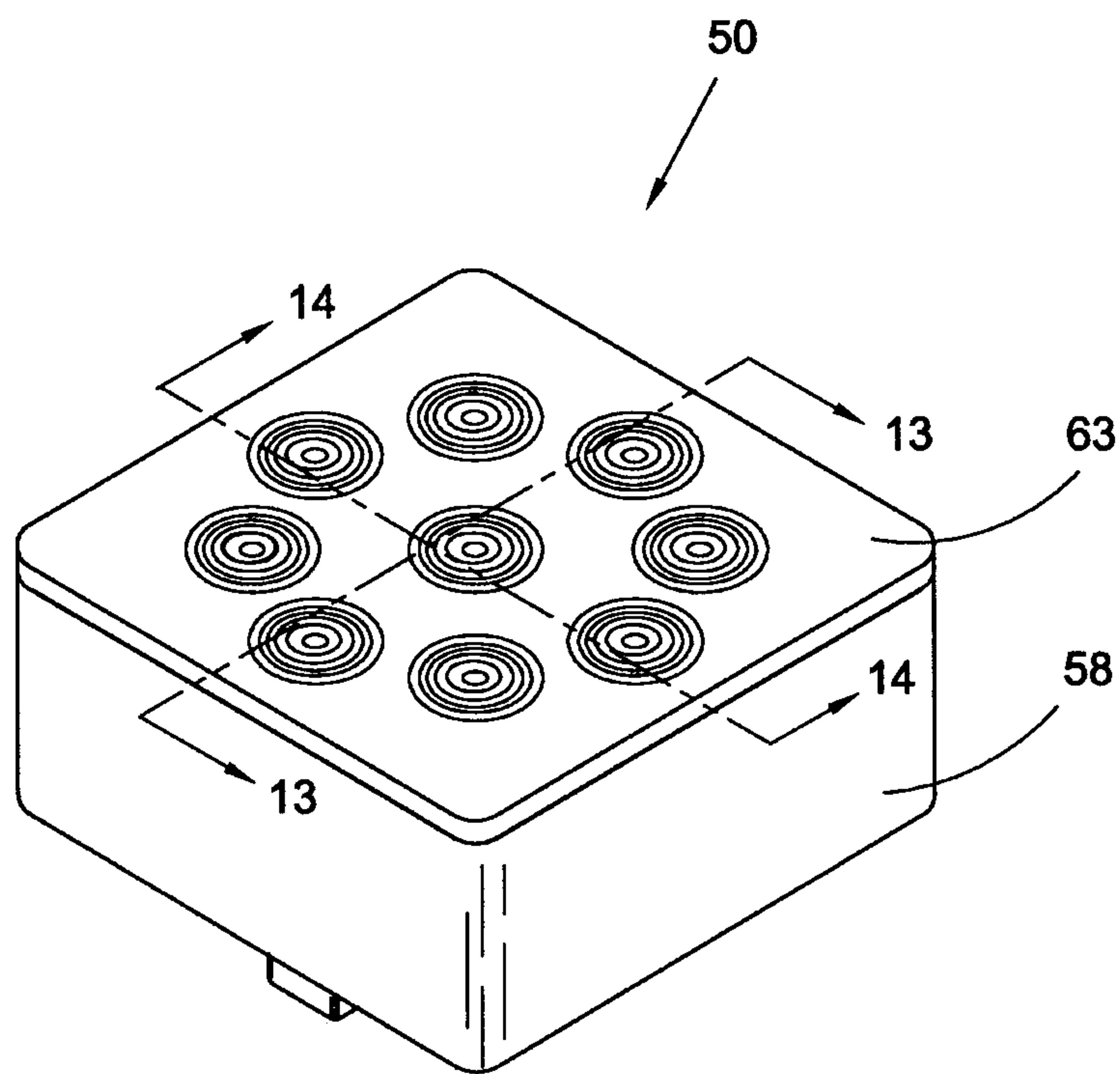


Fig. 11

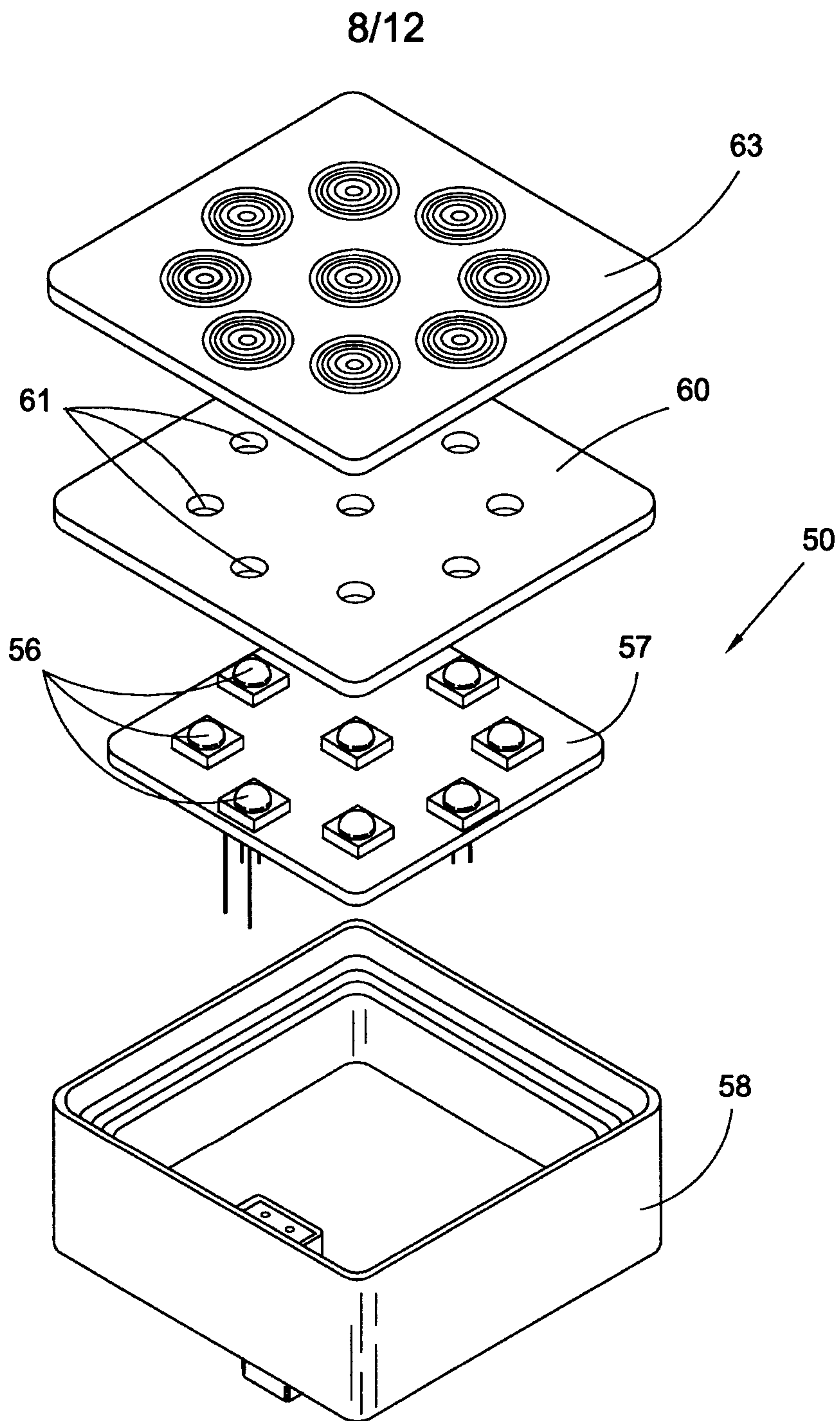


Fig. 12

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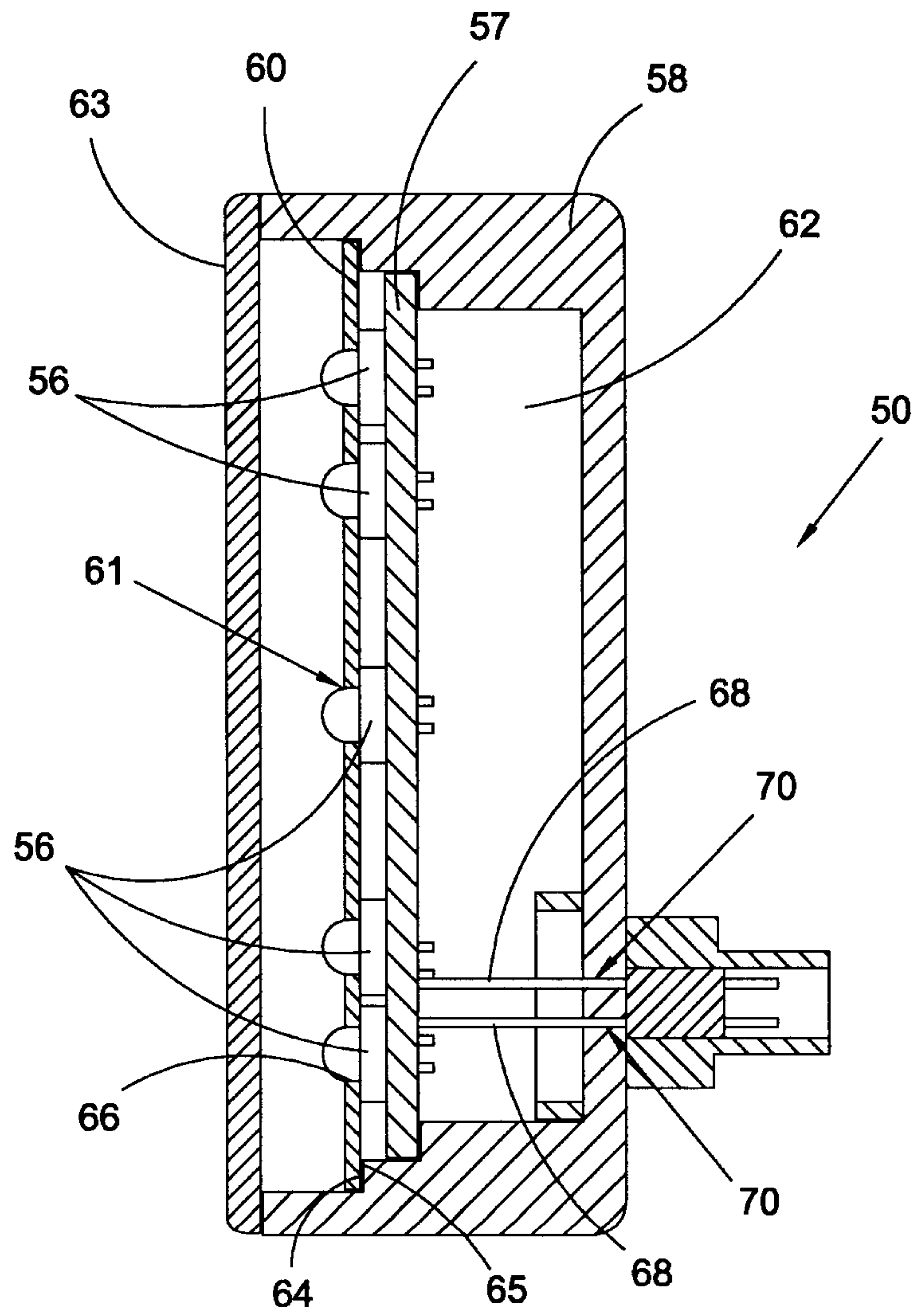


Fig. 13

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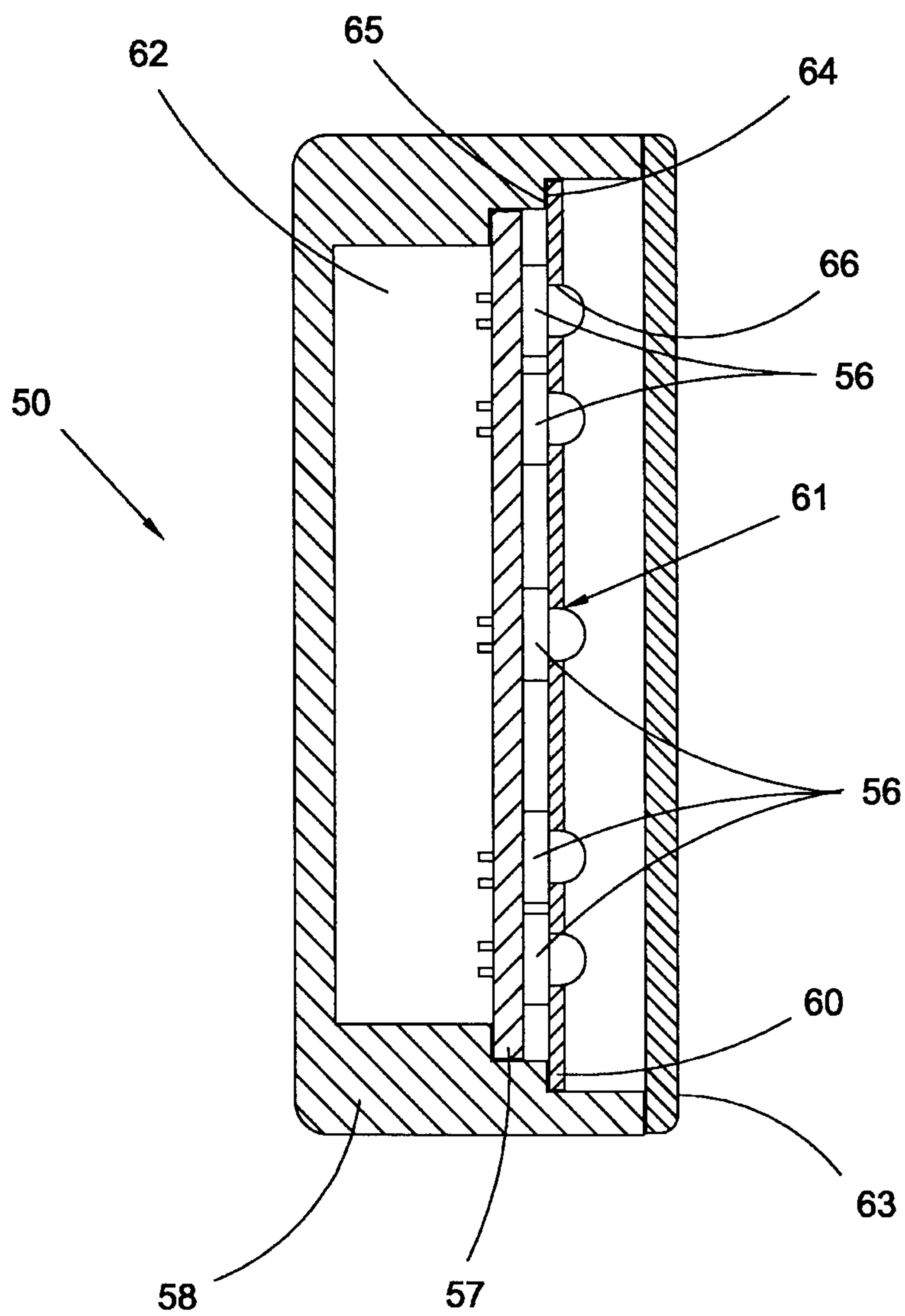


Fig. 14

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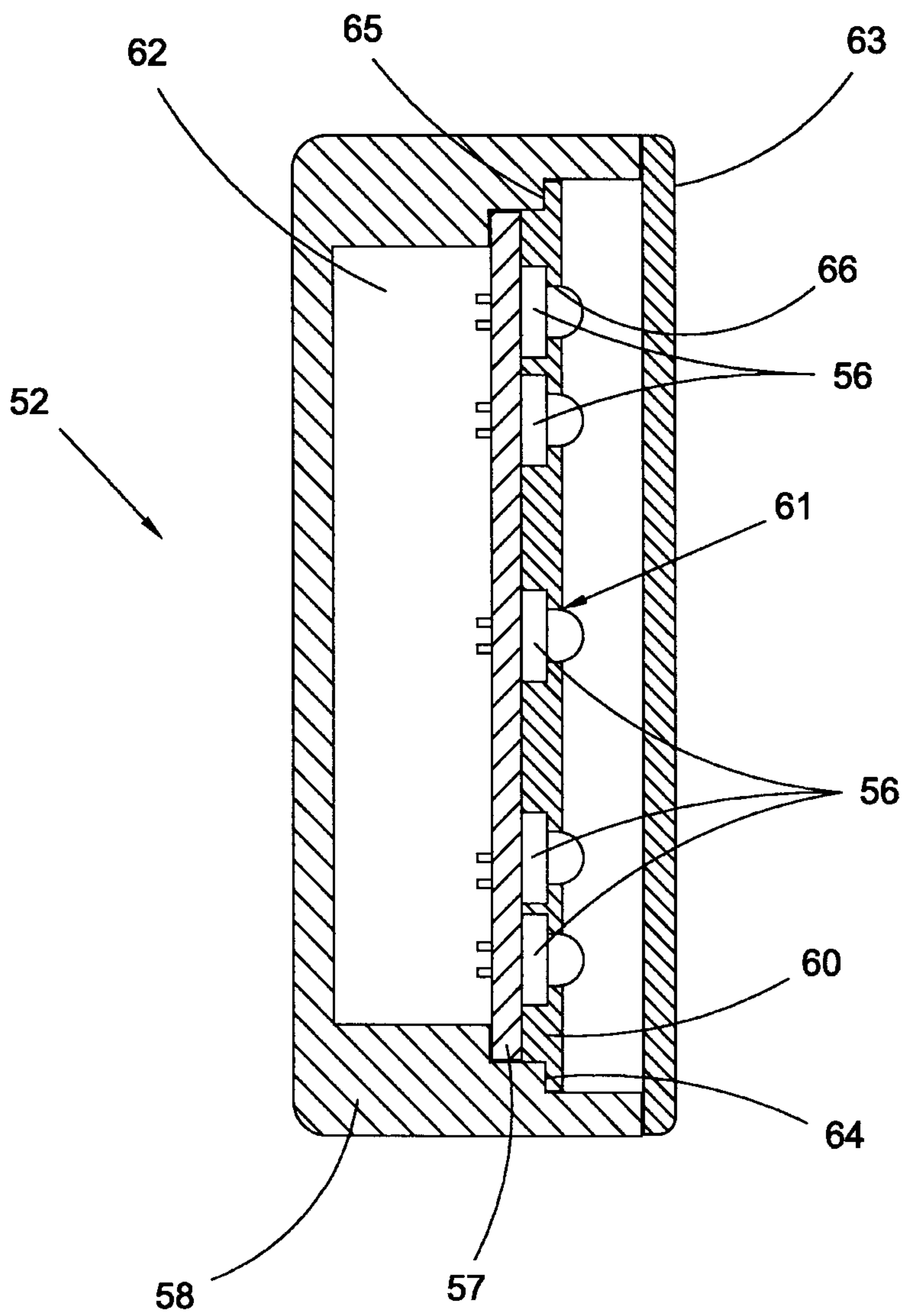


Fig. 15

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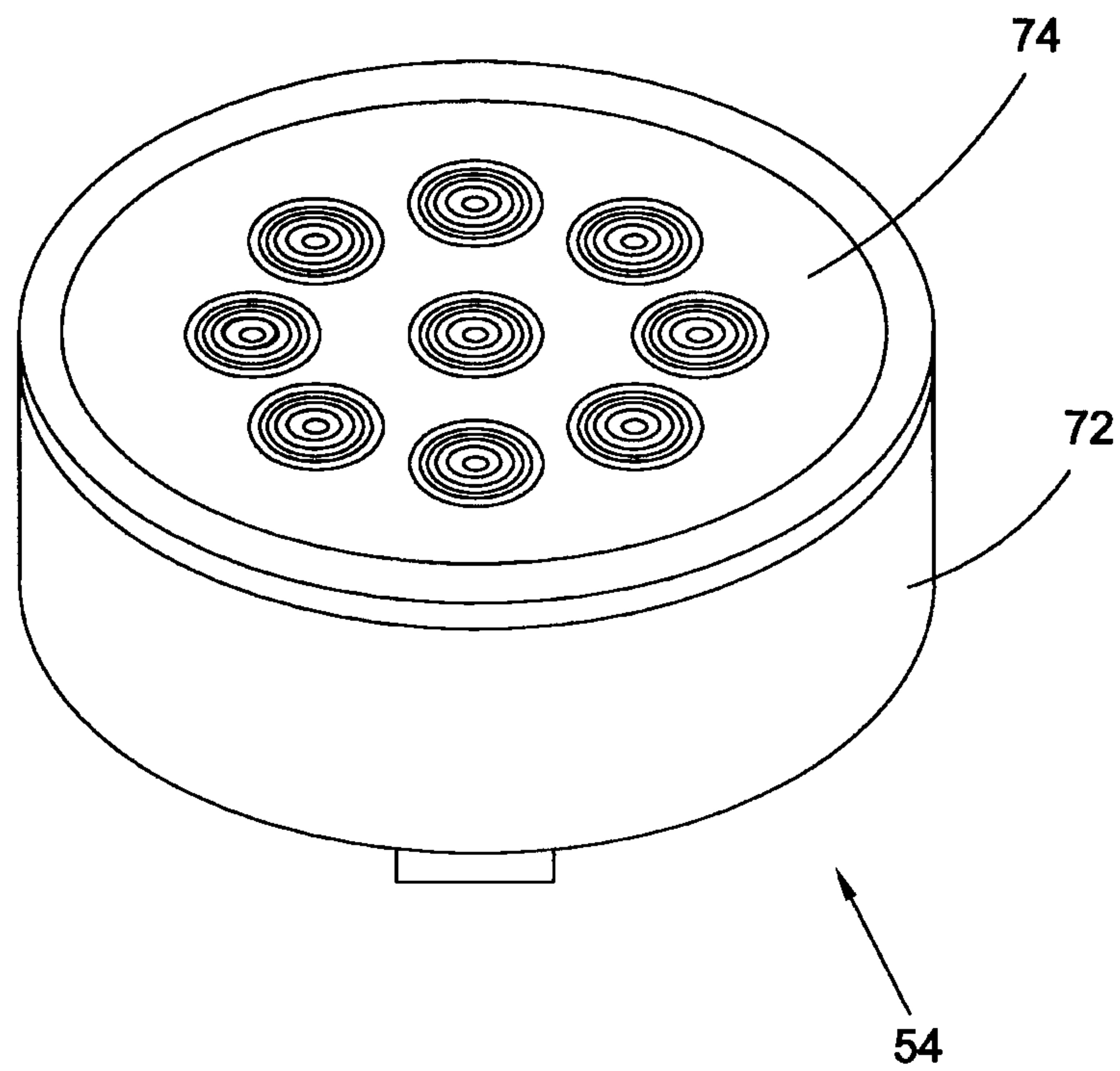


Fig. 16

