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CA 2960991 A1 2015/05/07

(21) 2 960 991

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

(86) Date de dépôt PCT/PCT Filing Date: 2014/10/31
(87) Date publication PCT/PCT Publication Date: 2015/05/07
(85) Entrée phase nationale/National Entry: 2017/03/10
(86) N° demande PCT/PCT Application No.: US 2014/063408
(87) N° publication PCT/PCT Publication No.: 2015/066464
(30) Priorité/Priority: 2013/11/01 (US61/898,927)

(51) Cl.Int./Int.Cl. *H01R 13/04* (2006.01),
H01R 13/50 (2006.01)

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(54) Titre : GARNITURE DE CONNECTEUR ELECTRIQUE FLEXIBLE A TRES FAIBLE INDUCTANCE
(54) Title: VERY LOW INDUCTANCE FLEXIBLE ELECTRICAL CONNECTOR INSERT

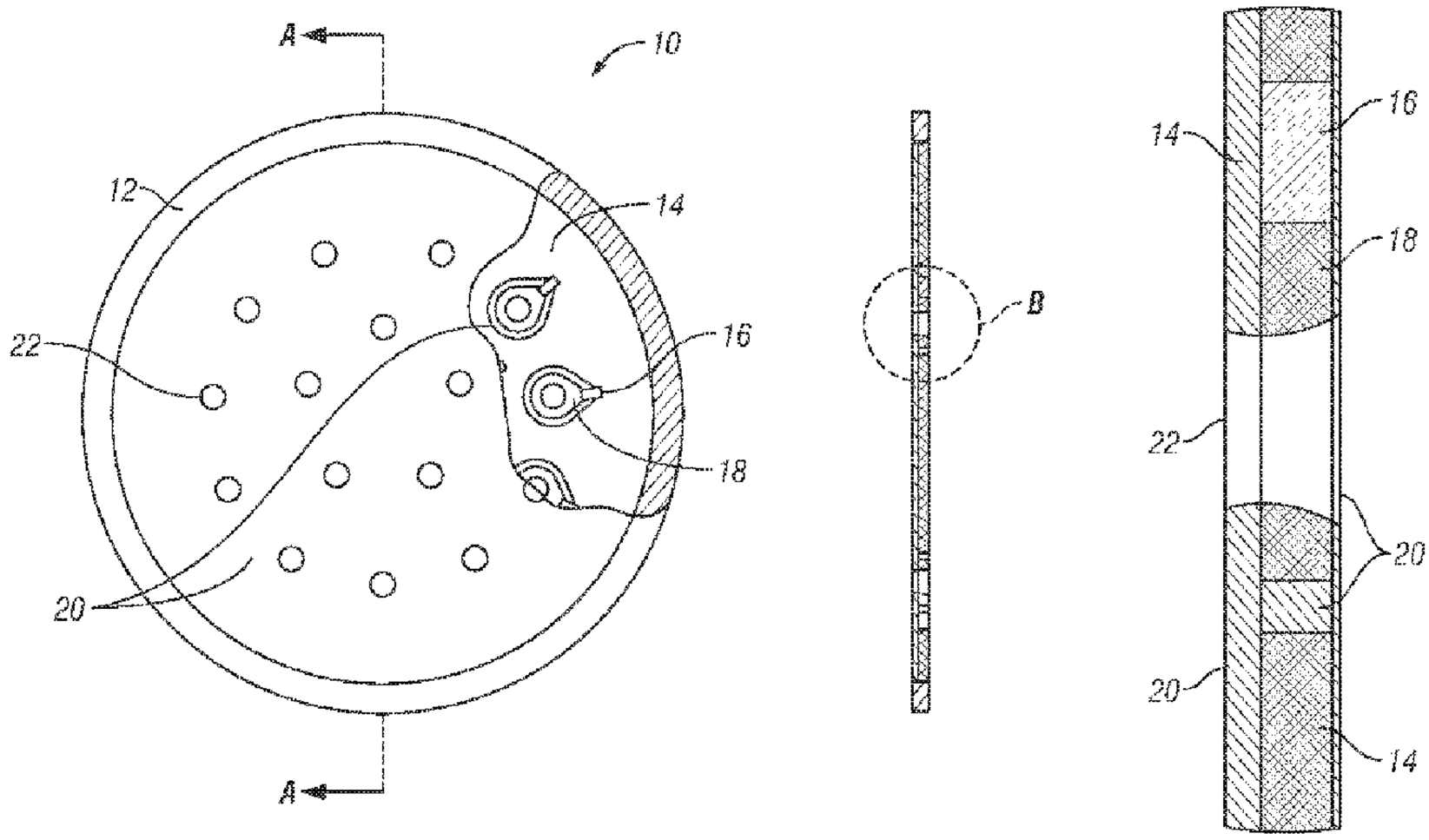

FIG. 1

(57) Abrégé/Abstract:
A connector insert comprising a plurality of layers of conductive elastomer, and a concomitant method of employing a connector insert, the method comprising the steps of fabricating a plurality of layers of conductive elastomer as an insert and placing the insert into a connector.

ABSTRACT

A connector comprising a plurality of layers of conductive elastomer, and a concomitant method of employing a connector insert, the method comprising the steps of fabricating a plurality of layers of conductive elastomer as an insert and placing the insert into a connector.

PATENT APPLICATION

VERY LOW INDUCTANCE FLEXIBLE ELECTRICAL CONNECTOR INSERT

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to and the benefit of the filing of U.S. Provisional Patent Application Serial No. 61/898,927, entitled "Very Low Inductance Design for Electrical Connector Insert", filed on November 1, 2013.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not Applicable.

INCORPORATION BY REFERENCE OF MATERIAL SUBMITTED ON A COMPACT DISC

[0003] Not Applicable.

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[0004] Not Applicable.

BACKGROUND OF THE INVENTION

Field of the Invention (Technical Field):

[0005] The present invention relates to inserts installed into an existing or new electrical connector to reliably add electrical circuitry to the system and concomitant methods of use and construction.

Description of Related Art:

[0006] The present invention primarily relates to an insert installed into an existing or new electrical connector to reliably add electrical circuitry to the system. Current

technology in this field uses either standard circuit board technology or EESeal® silicone inserts. The circuit board technology corrupts the existing environmental seal of the connector, and so is unsuitable for high-reliability connectors. The EESeal technology is made primarily from silicone elastomer, and so does not corrupt the existing seal. However, the filament wire interconnects within the insert introduce unwanted stray inductance and are labor intensive to construct. The additional stray inductance limits EESeal effectiveness at frequencies above 100 MHz. Both technologies incorporate discrete surface mount devices, primarily capacitors, whose stray inductance is typically a minimum of 0.5nH. The stray inductance of the surface mount devices also limits high frequency performance.

BRIEF SUMMARY OF THE INVENTION

[0007] The present invention is of a connector insert comprising one or more layers of conductive elastomer. Preferably, the layers have a volume resistivity less than about 0.010 ohms/cm. The insert can be placeable into an existing connector. The layers have holes for pins of the connector, and provide at least a connector shell contact, a ground plane, and a pin contact. The connector insert can additionally comprise a capacitor, preferably comprising a plurality of layers of conductive elastomer, with separation provided by at least one layer of non-conductive material, and most preferably wherein the at least one layer of non-conductive material comprises non-conductive elastomer. The insert may additionally comprise one or more other electrical components, and one or more electrical components may comprise elastomer.

[0008] The invention is additionally of a concomitant method of employing a connector insert, the method comprising the steps of: fabricating one or more layers of conductive elastomer as an insert; and placing the insert into a connector. The layers preferably have a volume resistivity less than about 0.010 ohms/cm. The connector may be an existing connector. Holes are formed in the insert for the pins of the connector, and the insert provides at least a connector shell contact, a ground plane, and a pin contact for the connector. A capacitor may be formed in the insert, preferably wherein the capacitor comprises a plurality of layers of conductive elastomer, with separation provided by at least one layer of non-conductive material, and most preferably wherein the at least one layer of non-conductive material comprises non-conductive elastomer. One or more electrical

components may be formed in the insert, and one or more of the electrical components may comprise elastomer.

[0009] The invention is further of a capacitor for a connector insert, the capacitor comprising a plurality of layers of elastomer, with separation provided by at least one layer of non-conductive material.

[0010] Further scope of applicability of the present invention will be set forth in part in the detailed description to follow, taken in conjunction with the accompanying drawings, and in part will become apparent to those skilled in the art upon examination of the following, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and attained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0011] The accompanying drawings, which are incorporated into and form a part of the specification, illustrate one or more embodiments of the present invention and, together with the description, serve to explain the principles of the invention. The drawings are only for the purpose of illustrating one or more preferred embodiments of the invention and are not to be construed as limiting the invention. In the drawings:

[0012] Fig. 1 is a schematic diagram of a discrete capacitor connector insert with planar conductive elastomer construction according to the invention;

[0013] Fig. 2 is a schematic diagram of a conductive elastomer capacitor according to the invention;

[0014] Fig. 3 is a schematic diagram of a conductive elastomer capacitor integrated into a connector insert according to the invention;

[0015] Fig. 4 is a schematic diagram of a conductive elastomer “perimeter” capacitor integrated into a connector insert according to the invention;

[0016] Fig. 5 is a schematic diagram of a discrete capacitor connector insert with planar conductive elastomer construction integrated into a connector assembly according to the invention; and

[0017] Fig. 6 is a schematic diagram of an insert according to the invention placed into a pre-existing connector (retrofit).

DETAILED DESCRIPTION OF THE INVENTION

[0018] The present invention employs planar conductive layers rather than the wire interconnects within a connector insert, which provides a number of advantages. The conductive layers can be conductive elastomer or other conductive element(s) such as a thin metal sheet, but the preferred construct is conductive silicone elastomer, with a volume resistivity preferably less than about 0.010 ohms/cm. Electrically opposing conductive layers are insulated from each other by the non-conductive elastomer. A surface mount device, such as a 0402 sized capacitor, transient voltage suppressor, or resistor, is connected between the two conductive layers. This planar arrangement of the conductors greatly reduces unwanted stray inductance. Further, a small capacitor can be formed by overlapping the opposing conductors and separating them with a thin layer of non-conductive elastomer, or other non-conductive material with high dielectric constant, such as polypropylene. A relative permittivity greater than 2 is preferred for any of these non-conductive layers. The planar construction of this integrated capacitor, and the elimination of a discrete capacitor, yields ultra-low stray inductance, providing effective filtering well into the GHz frequencies. An insert can employ a discrete device and/or an integral capacitor to achieve a parallel configuration, with the discrete device providing filtering at lower frequencies and the integral capacitor taking over at higher frequencies.

[0019] In addition to being installed at the mating interface of a connector pair in a retrofit manner, this assembly can be built into a single connector half, creating a filtered connector. Two capacitive inserts, separated by an inductive element, can be built into a connector, thereby creating a Pi filter. A “T” or “L” type filter can be similarly configured.

[0020] This type of electronic circuit construction, utilizing flexible conductive elastomer interconnections between circuit elements and external electrical contacts, has application in fields other than electrical connectors, such as medical and consumer electronics where the circuitry is required to be compressed or flexed.

[0021] Turning to the figures, Fig. 1 shows one possible construction of a discrete capacitor connector insert **10** with planar conductive elastomer layers, comprising conductive elastomer shell contact **12**, conductive elastomer ground plane **14**, capacitor **16**, conductive elastomer pin contact **18**, non-conductive elastomer **20**, and pin holes **22**. This insert would typically be installed over the pins of a high reliability circular connector to provide EMI filtering.

[0022] Contact to each pin is made using a layer of conductive elastomer with a hole therein. The diameter of the hole is preferably smaller than the pin diameter, so that when the pin is inserted, the conductive elastomer stretches to accommodate it. This stretching of the conductive elastomer results in a tight fit around the pin, and electrical contact from the pin to the conductive elastomer is thereby achieved. One end of a surface mount device, e.g., a 0402 SMD capacitor, is placed so that it makes contact to the conductive elastomer pin contact. The other end of the capacitor makes contact with the planar conductive elastomer ground plane. The pin contact and the ground plane are separated from each other with a layer of non-conductive elastomer placed between them. The conductive ground plane is exposed around the periphery of the insert and along the top surface periphery. Its outside diameter is slightly larger than the connector shell's inside diameter, so that it is compressed when installed, achieving electrical contact with the connector shell. It can also make contact to the mating connector shell along the top surface periphery. The resulting planar construction of the insert results in a very low stray inductance, and much better filtering performance, as compared to existing technology.

[0023] Fig. 2 shows an example of a capacitor **16** created using conductive elastomer and non-conductive elastomer, comprising dielectric non-conductive elastomer **20**, conductive elastomer first terminal **24**, and conductive elastomer second terminal **26**. A capacitor comprises a plurality of conductive plates separated by an insulating material. The value of the capacitor is determined by the overlapping surface

area of the plates, the distance between the plates, and the dielectric constant of the insulating material.

[0024] By using elastomers for both the conductive and insulating components of a capacitor, the resulting part can change shape through compression, distension, flexure and other external forces while maintaining its electrical performance and mechanical integrity.

[0025] This type of capacitor can be incorporated into a connector insert as shown in Fig. 3, comprising non-conductive elastomer **20**, pin holes **22**, conductive elastomer pin contact plate **28**, and conductive elastomer ground plane **30**. In this example, the conductive elastomer pin contact plate is positioned above the conductive elastomer ground plate and separated by a thin layer of non-conductive elastomer. The overlapping area of the two conductive elastomers, thickness of the non-conductive elastomer layer, and the dielectric constant of the insulating material determine the value of the resulting capacitor. Since no discrete device is used, the resulting filter is extremely low inductance and provides effective filtering well into the 10's of GHZ.

[0026] Instead of using overlapping layers, this type of capacitor can also be created using the perimeter of the conductive elastomer pin contact as one plate, the surface of the conductive elastomer ground plane around the pin contact as the other plate, and the gap between these surfaces filled with a non-conductive elastomer as the dielectric as shown in Fig. 4. This embodiment comprises conductive elastomer shell contact **12**, conductive elastomer ground plane **14**, conductive elastomer pin contact **18**, non-conductive elastomer **20**, and pin holes **22**. The perimeter of the conductive elastomer pin contact can be any shape, but the preferred shape is a circle. The surface area of the perimeter of the conductive elastomer pin contact, the thickness of the gap filled with the non-conductive elastomer and the dielectric constant of the non-conductive elastomer determine the value of the resulting capacitor. Since no discrete device is used, the resulting filter is extremely low inductance and provides effective filtering well into the 10's of GHZ.

[0027] With minor dimensional modifications, the embodiments described above can also be made an integral part of a connector as shown in Fig. 5, instead of an insert

between a connector pair. This embodiment comprises conductive elastomer ground plane **14**, capacitor **16**, conductive elastomer pin contact **18**, non-conductive elastomer **20**, o-ring **32**, interfacial seal **34**, connector shell **36**, pins **38**, and connector insert **40**. One example involves placing the assembly between the connector insert and the interfacial seal. This permits the necessary contact with the pins and the connector shell while preserving the mating and sealing features of a standard connector pair. With further modifications to a standard connector, the filter assembly can be installed elsewhere within the connector as well.

[0028] Fig. 6 illustrates placement of an insert **10** according to the invention into a pre-existing connector, thereby providing a retrofit improvement to the connector. Insert **10** is shown as installed over pins **38** and as oriented with respect to interfacial seal **34**, o-ring **32**, and connector shell **36**.

[0029] Note that in the specification and claims, "about" or "approximately" means within twenty percent (20%) of the numerical amount cited.

[0030] Although the invention has been described in detail with particular reference to these preferred embodiments, other embodiments can achieve the same results. Variations and modifications of the present invention will be obvious to those skilled in the art and it is intended to cover in the appended claims all such modifications and equivalents.

CLAIMS

What is claimed is:

1. A connector insert comprising one or more layers of conductive elastomer.

2. The connector insert of claim 1 wherein said layers have a volume resistivity less than about 0.010 ohms/cm.

3. The connector insert of claim 1 placeable into an existing connector.

4. The connector insert of claim 1 wherein said layers have holes for pins of the connector.

5. The connector insert of claim 1 wherein said layers provide at least a connector shell contact, a ground plane, and a pin contact.

6. The connector insert of claim 1 additionally comprising a capacitor.

7. The connector insert of claim 6 wherein said capacitor comprises a plurality of layers of conductive elastomer, with separation provided by at least one layer of non-conductive material.

8. The connector insert of claim 7 wherein said at least one layer of non-conductive material comprises non-conductive elastomer.

9. The connector insert of claim 1 additionally comprising one or more electrical components.

10. The connector insert of claim 9 wherein said one or more electrical components comprise elastomer.

11. A method of employing a connector insert, the method comprising the steps of: fabricating one or more layers of conductive elastomer as an insert; and placing the insert into a connector.

12. The method of claim 11 wherein the layers have a volume resistivity less than about 0.010 ohms/cm.

13. The method of claim 11 wherein the connector is an existing connector.

14. The method of claim 11 additionally comprising the step of forming in the layers holes for pins of the connector.

15. The method of claim 11 wherein the insert provides at least a connector shell contact, a ground plane, and a pin contact for the connector.

16. The method of claim 11 additionally comprising the step of forming a capacitor in the insert.

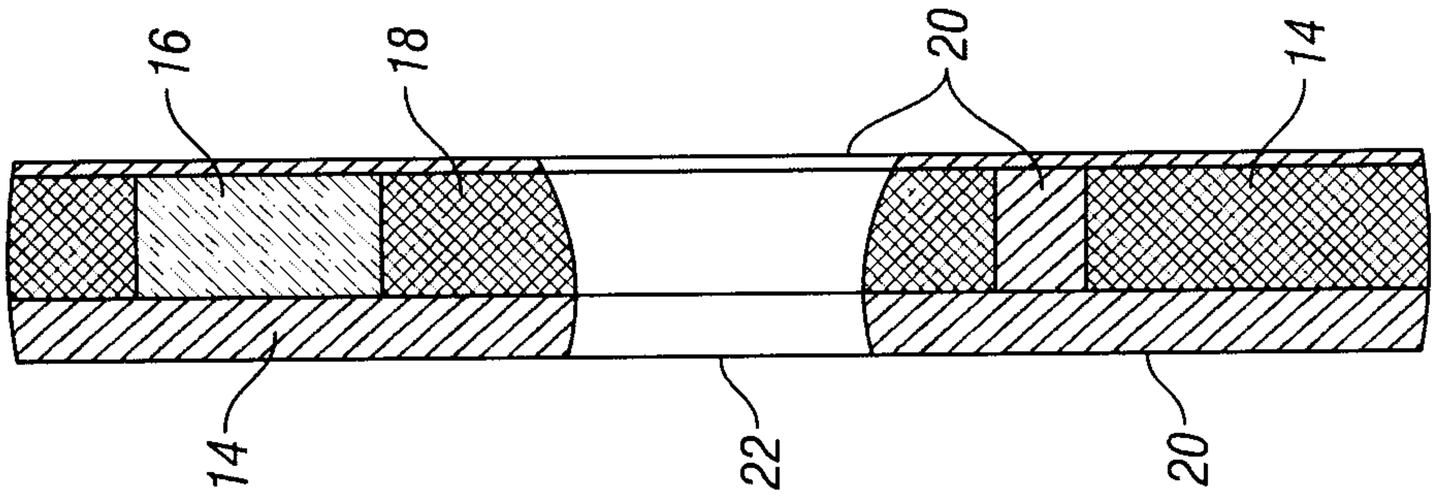
17. The method of claim 16 wherein the capacitor comprises a plurality of layers of conductive elastomer, with separation provided by at least one layer of non-conductive material.

18. The method of claim 17 wherein the at least one layer of non-conductive material comprises non-conductive elastomer.

19. The method of claim 11 additionally comprising the step of forming one or more electrical components in the insert.

20. The method of claim 19 wherein the one or more electrical components comprise elastomer.

21. A capacitor for a connector insert, said capacitor comprising a plurality of layers of elastomer, with separation provided by at least one layer of non-conductive material.



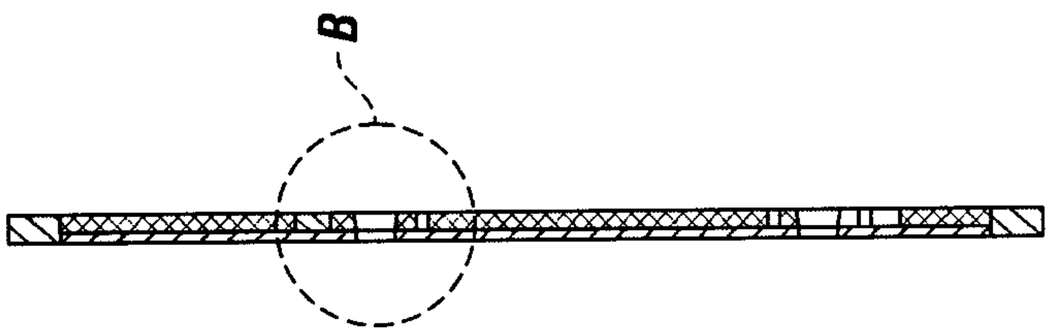
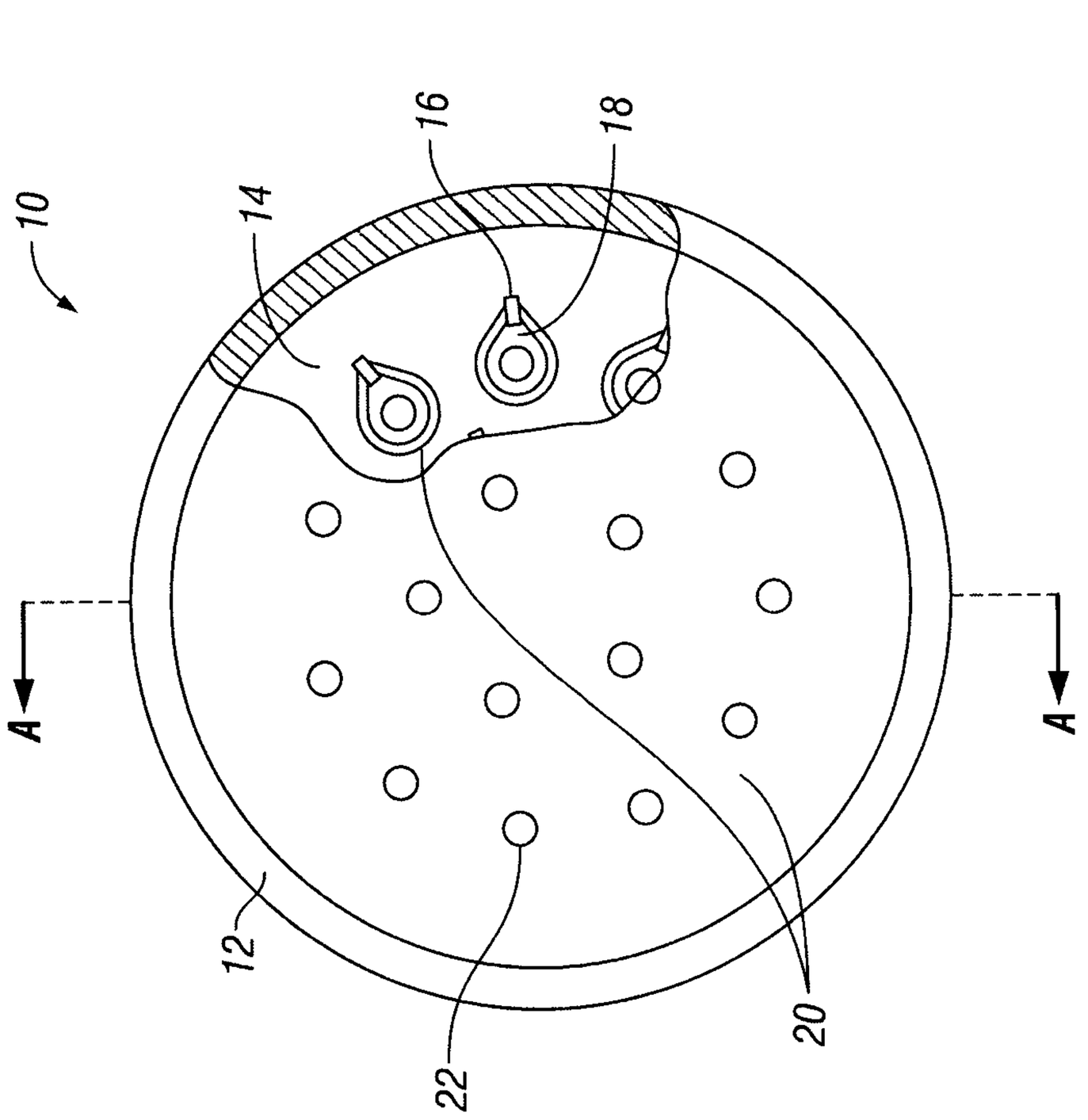


FIG. 1



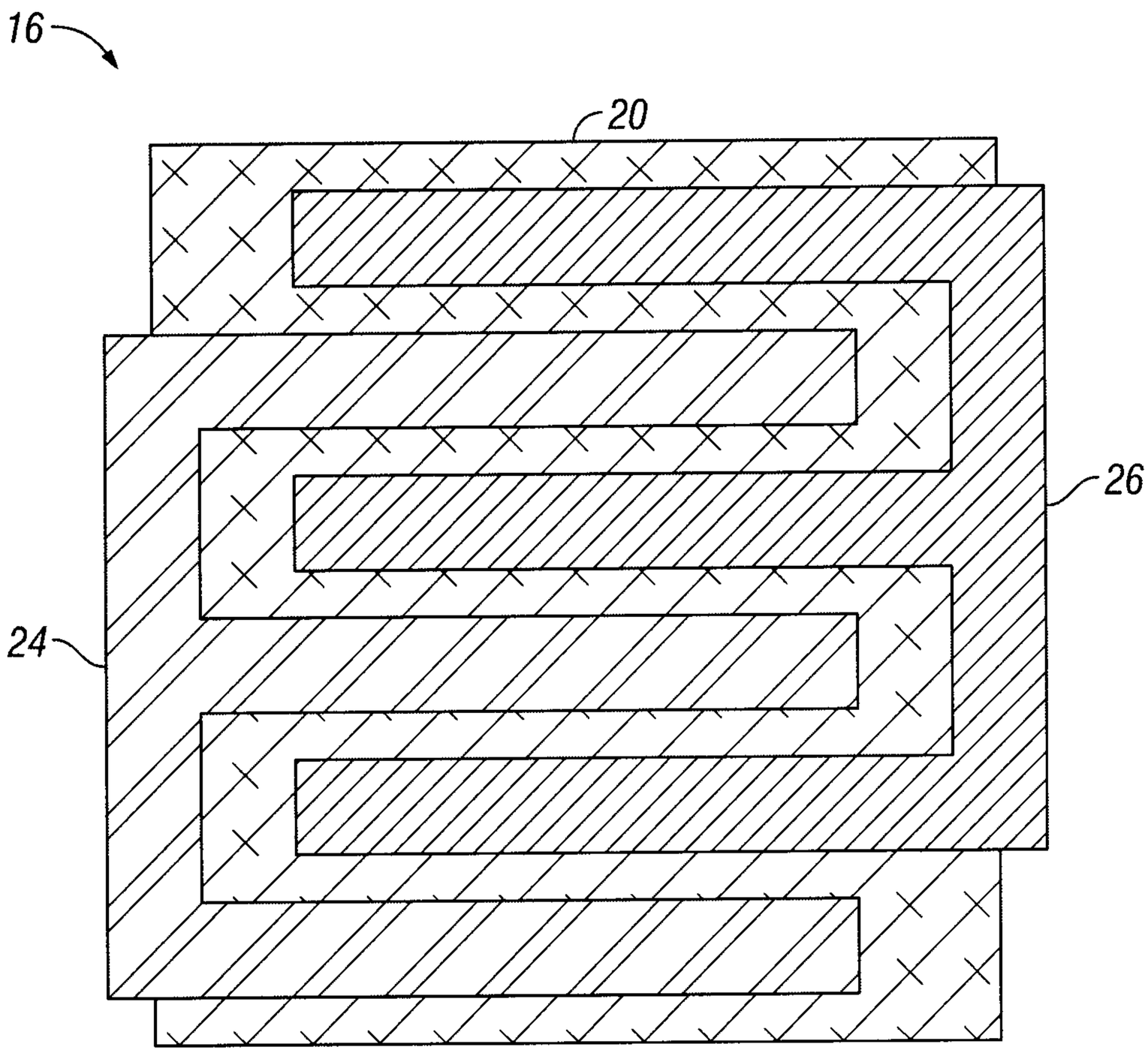


FIG. 2

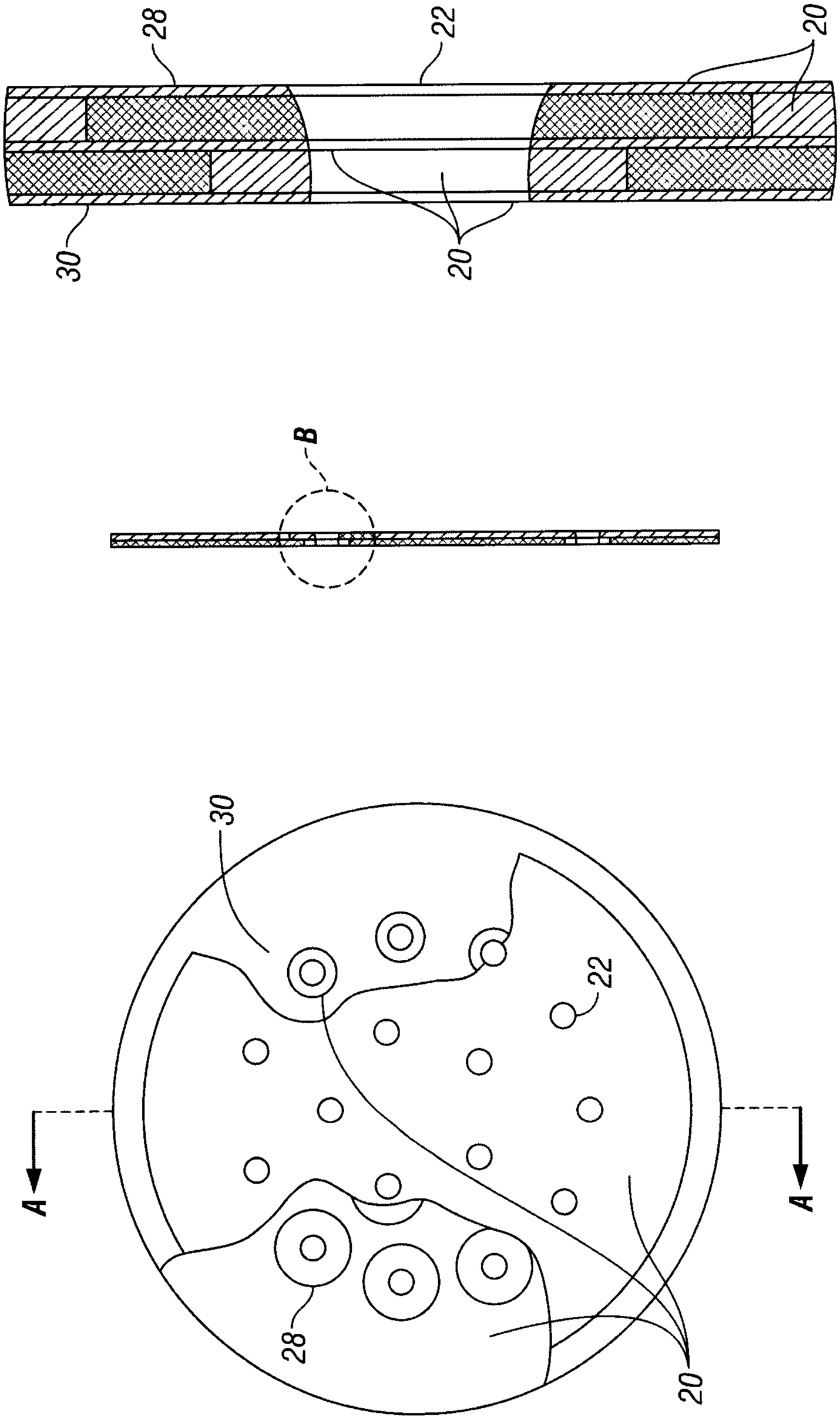
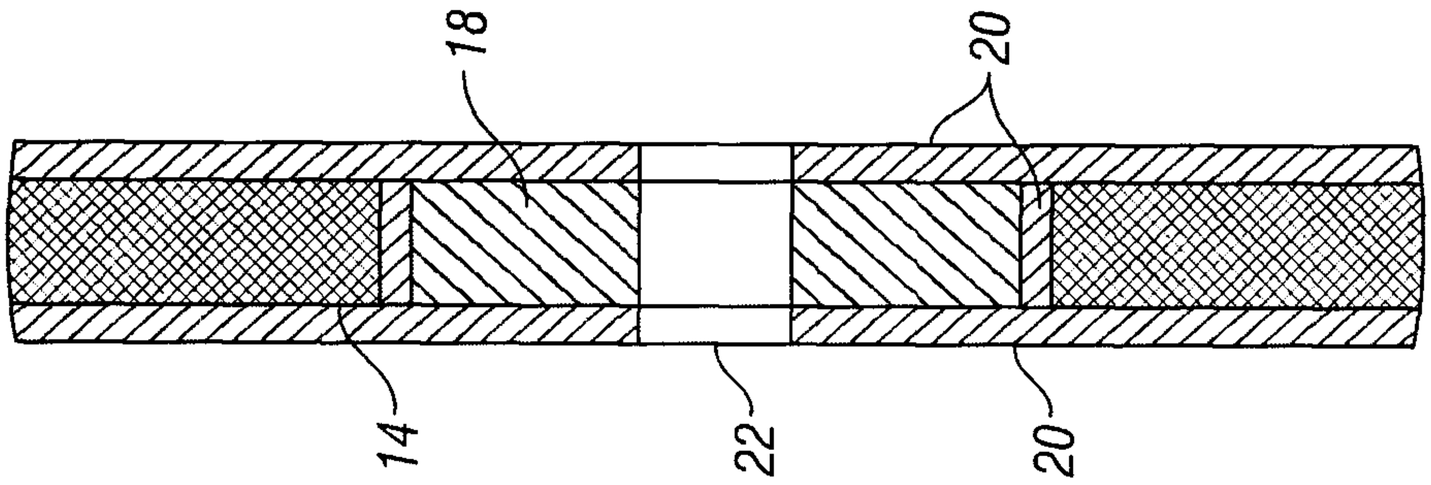


FIG. 3



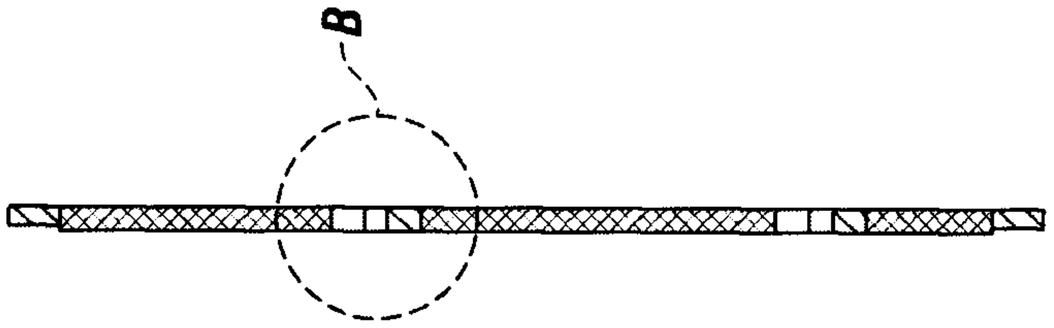
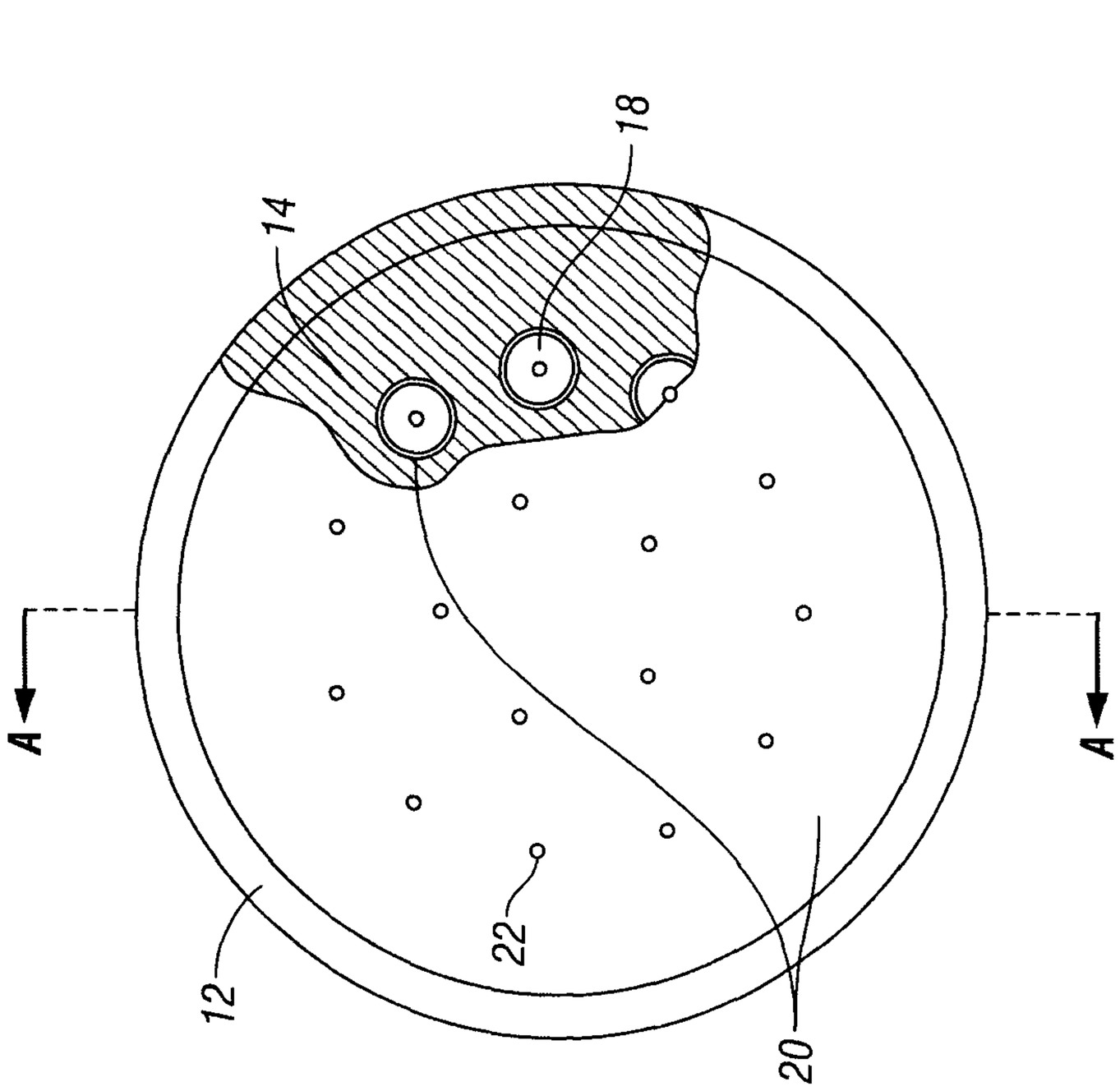


FIG. 4



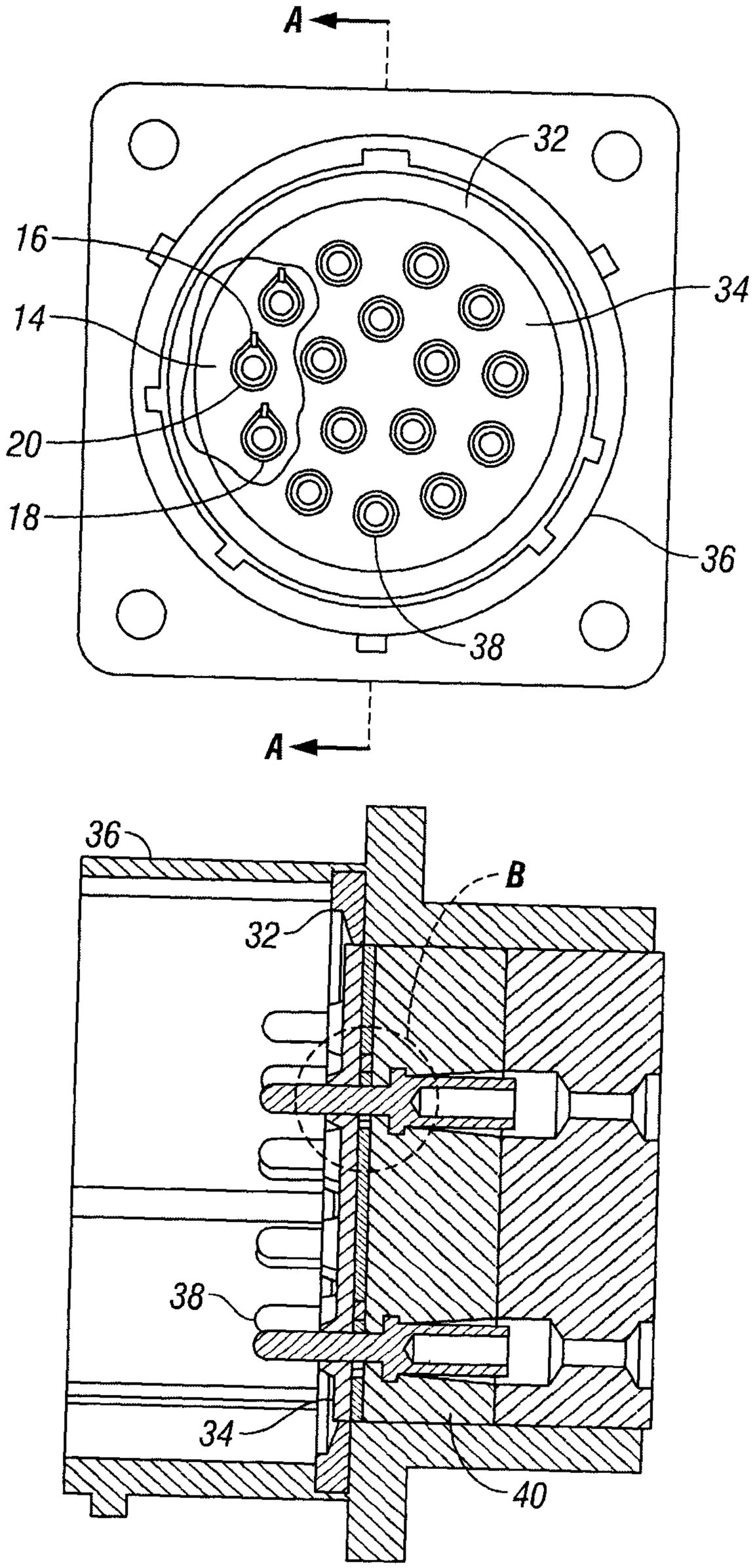


FIG. 5

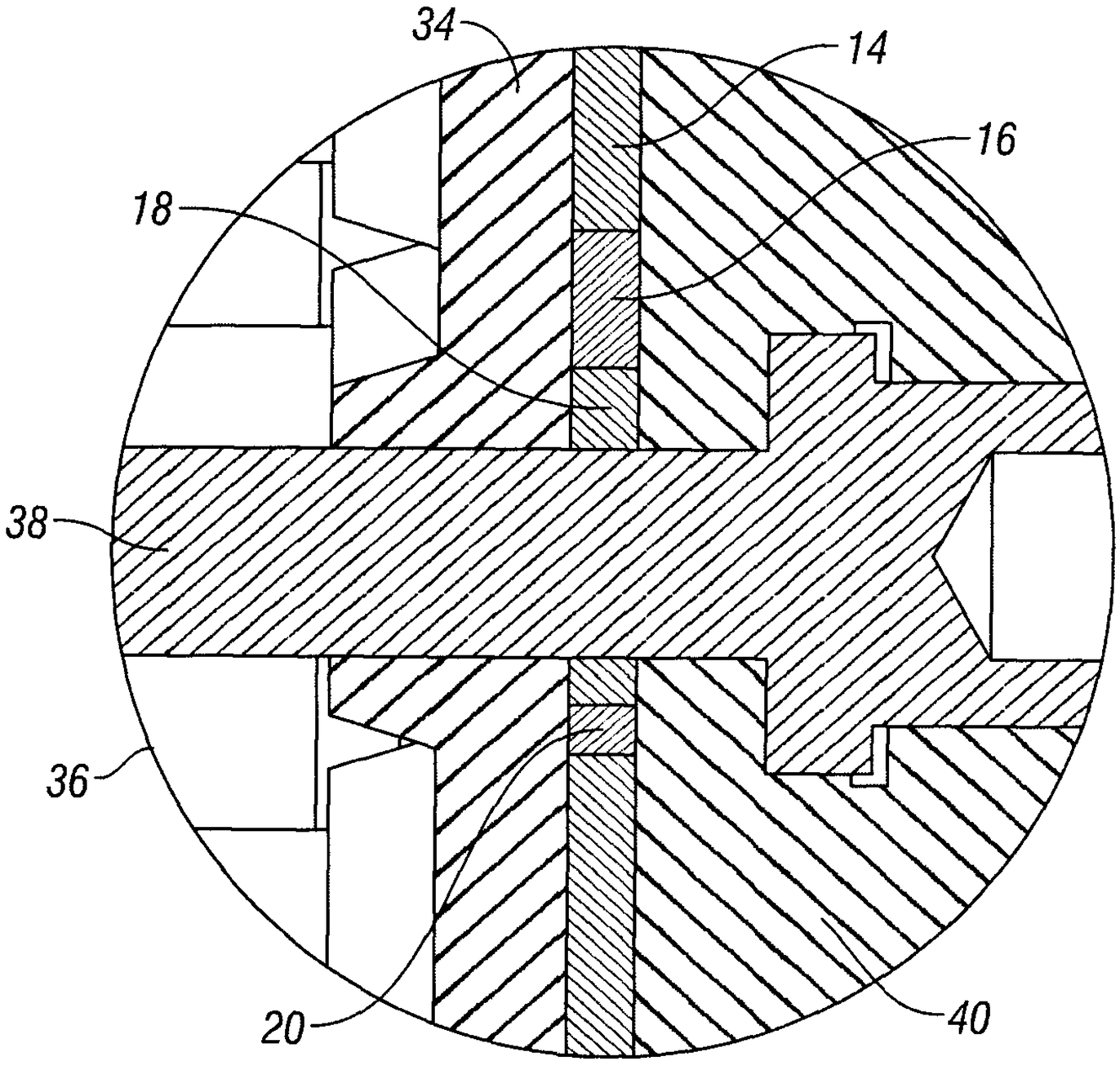


FIG. 5
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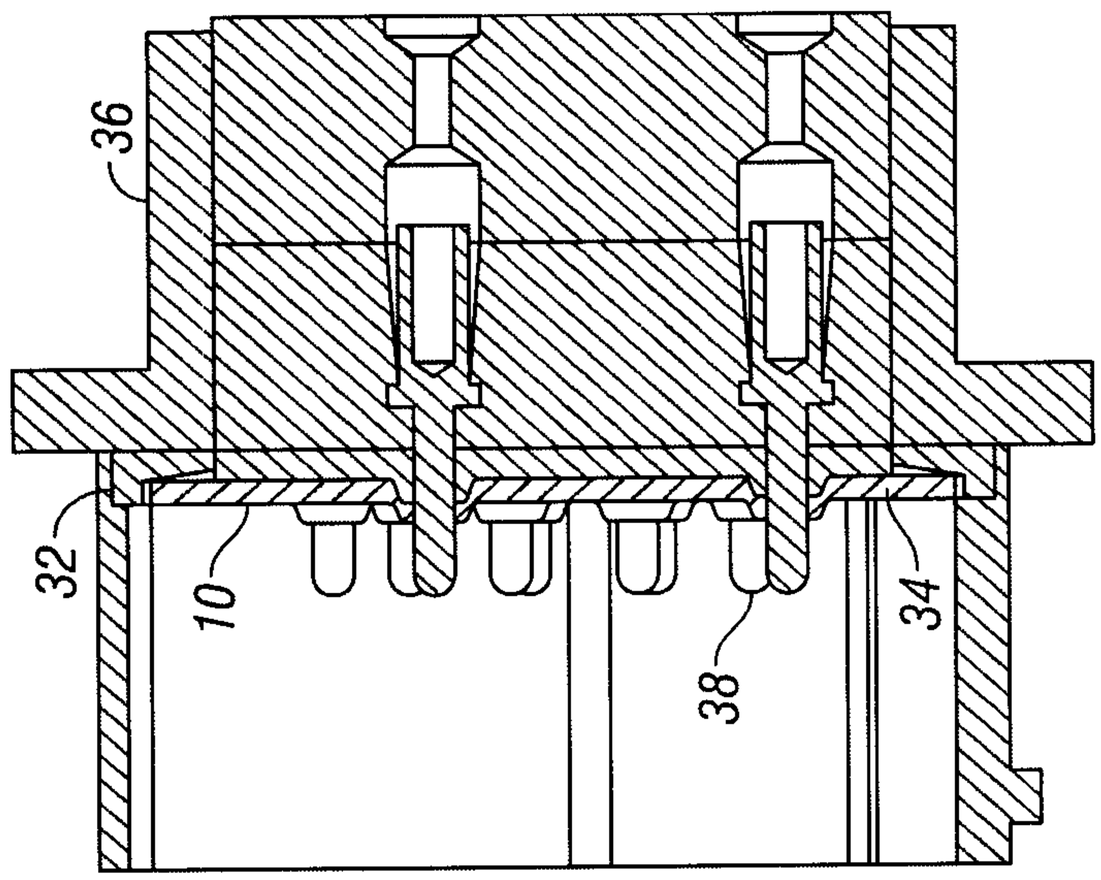

FIG. 6

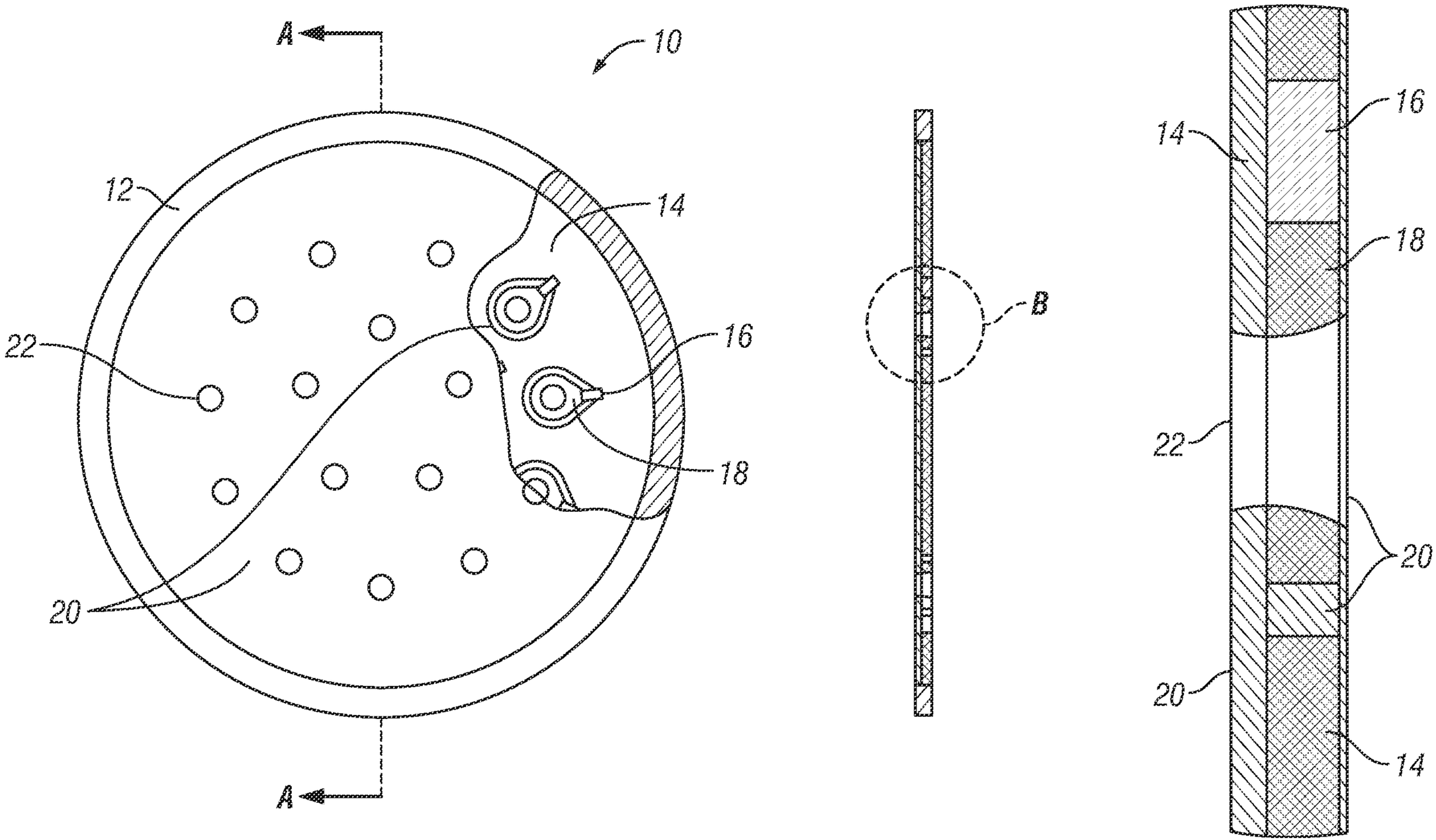

FIG. 1