

(57) Abstract: In some embodiments, a target assembly, for use in a substrate processing chamber having a process shield, may include a backing plate having a first side and an opposing second side, wherein the second side comprises a first surface having a first diameter bounded by a first edge; a target material having a first side bonded to the first surface of the backing plate; wherein the first edge is an interface between the backing plate and the target material; and a plurality of slots disposed along an outer periphery of the backing plate to align the target assembly with respect to the process shield during use, wherein the plurality of slots are formed in the first side of the backing plate and extend only partially into the backing plate.

PVD TARGET FOR SELF-CENTERING PROCESS SHIELD

FIELD

[0001] Embodiments of the present invention generally relate to physical vapor deposition processing equipment.

BACKGROUND

[0002] In current physical vapor deposition (PVD) chambers, a process shield is typically mounted to the main body of the PVD chamber, separately from the target. The target is typically mounted on a removable lid of the PVD chamber and then lowered onto the chamber body for processing. However, the inventors have discovered that such a configuration may undesirably result in the process shield and the target being inaccurately aligned. The inventors have further discovered for applications using higher frequencies of radio frequency (RF) energy applied to the target, the alignment between the target and shield becomes more critical to controlling any plasma irregularity and arc events, which may negatively affect the quality of deposition in the PVD chamber. Current PVD chambers utilize features that are separate from the target and the process shield to align the two components. However, the inventors have observed that such features fail to adequately align the target and process shield for certain applications.

[0003] Accordingly, the inventors have provided improved apparatus for PVD processing.

SUMMARY

[0004] Apparatus for physical vapor deposition are provided. In some embodiments, a substrate processing chamber may include a chamber body having an inner volume; a chamber lid disposed atop the chamber body, wherein the chamber lid comprises an axis of rotation configured to rotate the chamber lid onto the chamber body; a process shield disposed within the chamber body and below the chamber lid; and a target assembly coupled to a lower surface of the chamber lid that faces the inner volume when in a closed position, the target assembly comprising a backing plate having a first side and an opposing second side, wherein

the second side comprises a first surface having a first diameter bounded by a first edge; a target material having a first side bonded to the first surface of the backing plate; wherein the first edge is an interface between the backing plate and the target material; and a plurality of slots disposed along an outer periphery of the backing plate to align the target assembly with respect to the process shield when the lid is in the closed position, wherein the plurality of slots are formed in the first side of the backing plate and extend toward the second side of the backing plate to a depth that is less than a thickness of the backing plate.

[0005] In some embodiments, a target assembly, for use in a substrate processing chamber having a process shield, may include a backing plate having a first side and an opposing second side, wherein the second side comprises a first surface having a first diameter bounded by a first edge; a target material having a first side bonded to the first surface of the backing plate; wherein the first edge is an interface between the backing plate and the target material; and a plurality of slots disposed along an outer periphery of the backing plate to align the target assembly with respect to the process shield during use, wherein the plurality of slots are formed in the first side of the backing plate and extend only partially into the backing plate.

[0006] Other and further embodiments of the present invention are described below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Embodiments of the present invention, briefly summarized above and discussed in greater detail below, can be understood by reference to the illustrative embodiments of the invention depicted in the appended drawings. It is to be noted, however, that the appended drawings illustrate only typical embodiments of this invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

[0008] Figure 1 depicts a schematic cross-sectional view of a process chamber in accordance with some embodiments of the present invention.

[0009] Figure 2A-2C depict various views of a target assembly in accordance with some embodiments of the present invention.

[0010] Figures 3A-3B depict a sectional view of a target assembly and surrounding structure in a first position in accordance with some embodiments of the present invention.

[0011] Figures 4A-4B depict a sectional view of a target assembly and surrounding structure in a second position in accordance with some embodiments of the present invention.

[0012] Figures 5A-5B depict a sectional view of a target assembly and surrounding structure in a third position in accordance with some embodiments of the present invention.

[0013] To facilitate understanding, identical reference numerals have been used, where possible, to designate identical elements that are common to the figures. The figures are not drawn to scale and may be simplified for clarity. It is contemplated that elements and features of one embodiment may be beneficially incorporated in other embodiments without further recitation.

DETAILED DESCRIPTION

[0014] Methods and apparatus for improved physical vapor deposition (PVD) processing equipment are provided herein. The present invention provides improved target assembly designs that may be utilized with a range of very high frequency RF frequencies and/or source materials for sputter deposition in a PVD chamber. Embodiments of the target assembly of the present invention may advantageously reduce or prevent arcing between the target material and the process shield and improve wafer deposition symmetry by providing improved alignment between the process shield and the target material. As used herein, the term align or alignment refers to the concentric placement of the target material and the process shield, such that a gap of a first distance between an outer edge of the target material and an inner surface of the process shield body proximate the target material is substantially uniform.

[0015] Figure 1 depicts a schematic, cross-sectional view of a physical vapor deposition chamber, or process chamber 100, in accordance with some embodiments of the present invention. Examples of suitable PVD chambers include

the ENDURA[®] PVD processing chamber, commercially available from Applied Materials, Inc., of Santa Clara, California. Other processing chambers from Applied Materials, Inc. or other manufactures may also benefit from the inventive apparatus disclosed herein.

[0016] In some embodiments, the process chamber 100 has a chamber lid 134 disposed atop a chamber body 136. The chamber body has an inner volume 144. The process chamber 100 further comprises a process shield 150, disposed within the chamber body 136 and below a target assembly 138. The process shield 150 prevents deposition of sputtered target material onto the sidewalls of the chamber, for example, the upper chamber adapter 142. As depicted in Figure 1, the process shield 150 is supported within the chamber body 136 atop a first support member 176. In some embodiments, the first support member 176 may be a ledge of the upper chamber adapter 142.

[0017] The process shield 150 comprises an elongated annular body 164 having an outer surface 154 and an inner surface 152 defining a central opening 158 of the elongated annular body 164. In some embodiments, the elongated annular body 164 is made of a conductive material, such as stainless steel, aluminum, or the like. A lip 156 extends radially outward from the outer surface 154 of the elongated annular body 164 proximate a first end 166 of the elongated annular body 164 such that a first portion 168 of the elongated annular body 164 extends beyond the lip 156 toward the first end 166. The lip 156 comprises a plurality of openings 160. A pin 162 is disposed in each of the openings 160. The pins 162 may be made of a suitable process-compatible dielectric material to electrically isolate the RF hot target assembly 138 from the grounded process shield 150. In some embodiments, the pins 162 are fabricated from ceramic (e.g., aluminum oxide). In some embodiments, the pins 162 are press fit into the openings 160 and cannot be removed from the openings. In some embodiments, the pins 162 can be fit into the openings by cooling the pins 162 to contract their size while heating the shield to enlarge the openings 160 before placing the pins 162 therein. At room temperature, the pins 162 will enlarge and the openings will contract, improving the fit of the pins 162 within the openings 160.

[0018] The chamber lid 134 can be rotatably opened from atop the chamber body 136, for example, to install or replace a target or for performing maintenance on the process chamber 100. In some embodiments, the chamber lid 134 may be moveable about a horizontal axis of rotation at least from a closed position, as illustrated in Figure 1, to an open position. For example, the chamber lid 134 moves in an arc about the axis of rotation between the closed position and the open position. In some embodiments, the chamber lid 134 includes a target assembly 138. The target assembly 138 is coupled to a lower surface of the chamber lid 134 that faces the inner volume 144 of the chamber body 136 when the chamber lid 134 is in the closed position.

[0019] Figures 2A-2C depicts various views of the target assembly 138 in accordance with some embodiments of the present invention. The target assembly 138 comprises a backing plate 146 that supports a target material 106. The backing plate 146 comprises a first side 200 and an opposing second side 202 and may be circular or other shape as required to support a target having a particular shape and to fit in a chamber having a particular geometry. The second side 202 comprises a recess 226 defined by a first surface 210 having a first diameter 212 bounded by a first edge 214 (as shown in Figure 2C). In some embodiments, the first diameter 212 is about 17.10 inches to about 17.60 inches.

[0020] In some embodiments, the backing plate 146 may comprise a conductive material, such as copper-zinc, copper-chrome, or the same material as the target material 106, such that RF and DC power can be coupled to the target material 106 via the backing plate 146. Alternatively, the backing plate 146 may be non-conductive and may include conductive elements (not shown) such as electrical feedthroughs or the like. In some embodiments, the thickness of the backing plate is about between about 0.50 inches to about 0.620 inches.

[0021] As best seen in Figure 2C, the target material 106 is disposed in the recess 226 and has a first side 216 bonded to the first surface 210 of the backing plate 146. The first edge 214 is an interface, also referred to as the bond line, between the backing plate 146 and the target material 106. The first diameter 212, is selected to ensure that only the target material 106 and not the backing plate 146 is within the

dark space region, between the outer edge of the target material 106 and the inner surface 152 of the elongated annular body 164 shown in Figure 1. Not having the backing plate 146 within the dark space region advantageously avoids sputtering of the backing plate material. The target material 106 comprises a material to be deposited on a substrate 104 during sputtering, such as a metal or metal oxide. In some embodiments, the target material may be titanium, cobalt, tantalum, or copper.

[0022] Returning to Figures 2A-2C, a plurality of slots 204 are disposed along an outer periphery 224 of the backing plate 146. As shown in Figure 2A and 2C, the plurality of slots 204 are formed in the first side 200 of the backing plate 146 and extend only partially into the backing plate 146. The plurality of slots 204 are configured to align the target assembly 138 above the process shield 150. As depicted in Figure 2A, each slot is generally U-shaped, having the opening facing radially outward. For example, each slot 204 may include a first linear surface 218 parallel to a second linear surface 220 connected by an arched surface 222. The distance between the first linear surface 218 and the second linear surface 220 is about 0.75 inches to about 1.00 inch.

[0023] As discussed below with respect to Figures 3A-3B, 4A-4B, and 5A-5B, as the chamber lid 134 rotates into the closed position; the plurality of slots 204 engage the process shield 150, for example by the pins 162 configured to fit into the slots 204, to guide the entire target assembly 138 into alignment atop the process shield 150 such that the outer edge of the target material is advantageously disposed a first distance 170, representing the dark space region, from the inner surface 152 of the elongated annular body 164 proximate the first end 166 in order to reduce arcing and enhance uniformity of the deposition process. In some embodiments, the first distance is between about 0.030 inches to about 0.065 inches.

[0024] In some embodiments, as depicted in Figures 2A-2C, the plurality of slots 204 are three slots 204, although other numbers of slots, for example a number of slots 204 equal to the number of pins 162 in the process shield 150, may be provided in other embodiments. In such embodiments, the first slot, the second slot and the third slot engage the process shield 150 to align an outer edge of the target material 106 a first distance 170 from an inner surface of the process shield 150.

[0025] In some embodiments with three slots, a first slot and a second slot are aligned with and closer to an axis of rotation of the chamber lid 134 than a third slot, thereby allowing the first and second slots to engage the process shield 150 prior to the third slot. The first slot and second slot engage the process shield 150, for example by the pins, at substantially the same time. This advantageously allows the pins 162 of the process shield 150 to share the weight of the chamber lid 134 at two points, as it descends atop the chamber body 136. This initial engagement of the target assembly 138 with the first pin and second pin begins to align the target assembly 138. The engagement of the third slot with the process shield 150 advantageously provides a final alignment of the target assembly 138 before the chamber lid 134 closes atop the chamber body 136. As discussed below with respect to Figures 3A-3B, 4A-4B, and 5A-5B, the final alignment of the target assembly 138 aligns an outer edge of the target material 106 a first distance 170 from an inner surface 152 of the elongated annular body 164 proximate the first end 166.

[0026] In some embodiments having three slots 204, a center of the first slot is located about 115 degrees from a center of the second slot and the center of the second slot is located about 115 degrees from a center of the third slot. Thus, the center of the first slot and the center of the third slot are located about 130 degrees from each other. In some embodiments having three slots, the center to center location of the slots as discussed above can be greater than or less than 115 degrees from each other. Providing slots having centers at $>115^\circ$ leads to a more vertical component (*i.e.*, the pins and slots engage while the lid is more vertical), and hence more front to back misalignment. Providing slots having centers at $<115^\circ$ leads to a less vertical component (*i.e.*, the pins and slots engage when the lid is less vertical), and hence less front to back misalignment. However, a greater amount of force would be needed to overcome o-ring friction. Although three slots and pins are shown in the drawings, more pins (*i.e.*, >3) can also be used to provide greater alignment.

[0027] As depicted in Figure 2C, a plurality of counterbore holes 206 disposed along an outer periphery 224 of the backing plate 146 extends through the backing plate 146 from the first side 200 of the backing plate 146 toward the second side 202

of the backing plate 146. The plurality of counterbore holes 206 is configured to couple the target assembly 138 to the chamber lid 134.

[0028] In some embodiments, a groove 208 is disposed along an outer periphery 224 of the second side 202 of the backing plate 146 between the plurality of slots 204 and the first edge 214. A seal is disposed in the groove 208 to create a seal between the backing plate 146 and an opposing surface.

[0029] Figure 3A depicts the target assembly 138, the pin 162 and surrounding structure, prior to engagement between the target assembly 138 and the pin 162. The chamber lid 134 is in a partially closed position. As described above, the slot 204 is disposed along an outer periphery 224 of the backing plate 146 extending from the first side 200 of the backing plate 146 and extending only partially into the backing plate 146 toward the second side 202 of the backing plate 146. The pin 162 may extend in a substantially normal direction from a bottom of the opening 160 in the lip 156.

[0030] In some embodiments, the process shield 150 may comprise alignment features, such as pins 162, to interface with, or fit into, the slots 204 in the target assembly 138. In some embodiments, as depicted in Figure 3A, the process shield 150 may comprise a pin 162 configured to engage the slot 204 in the backing plate 146. The number of pins 162 in the process shield 150 equal the number of slots 204 in the backing plate. The placement of the pins 162 in the process shield 150 mirror the placement of the slots 204 in the backing plate 146 to allow the pins 162 to engage the slots 204 and align the target assembly 138 with the process shield 150. As depicted in Figure 3B, prior to engagement between the target assembly 138 and the process shield 150, the target material 106 is disposed above the process shield 150.

[0031] Figure 4A depicts the backing plate 146, the pin 162 within opening 160, and surrounding structure, as a slot 204 closest to the axis of rotation of the chamber lid 134 makes contact with one of the pins 162 of the process shield 150. In some embodiments, as depicted in Figure 4A, the outer edge of slot 204 contacts the beveled peripheral edge 400 of the pin 162. The beveled peripheral edge 400 advantageously allows the slot 204 to slide down the beveled peripheral edge 400

and over a portion of the side wall 402 extending above the top surface of the lip 156. As depicted in Figure 4B, as the pin 162 contacts the slot 204, the target material 106 enters the central opening 158 of the process shield 150 proximate the first end 166. As depicted in Figure 4B, the outer edge of the target material 106 is configured to avoid contacting an inner surface of the process shield 150 as the target assembly 138 rotates in an arc onto the process shield 150. In some embodiments, the outer edge of the target material 106 is angled toward the center of the target material 106 at about 10 degrees to about 20 degrees from vertical (or normal to the target surface).

[0032] Figure 5A depicts the backing plate 146, the pin 162 and surrounding structure as the target assembly 138 aligns with the process shield 150. In some embodiments, as depicted in Figure 5A, a first portion of the pin 162 comprising the first surface 500, the beveled peripheral edge 400 and a first portion 502 of the sidewall 402 is engaged within the slot 204. The first surface 500 of the pin 162 does not contact the upper surface 504 of the slot 204. Once the pin 162 is fully engaged with the slot 204 in the target assembly 138, the target material 106 is aligned with the process shield 150 to prevent or minimize arcing between the target material 106 and process shield 150. As depicted in Figure 5B, the first edge 214, representing an interface between the backing plate 146 and the target material 106, extends the target material 106 above a first portion 168 of the elongated annular body 164 from the inner surface 152 to the outer surface 154 to advantageously reduce re-sputtering of the backing plate 146.

[0033] Returning to Figure 1, in some embodiments, the feed structure 110 couples RF and, optionally, DC energy to the target assembly 138. Although a particular feed structure 110 is described below, other feed structures having other configurations may also be utilized. In some embodiments, the feed structure 110 may include a body 112 having a first end 114 that can be coupled to an RF power source 118 and, optionally, a DC power source 120, which can be respectively utilized to provide RF and DC energy to the target assembly 138. A second end 116 of the feed structure 110, opposite the first end 114, is coupled to the chamber lid 134. In some embodiments, the body 112 further includes a central opening 115 disposed through the body 112 from the first end 114 to the second end 116. The

feed structure 110 may be fabricated from suitable conductive materials to conduct the RF and DC energy from the RF power source 118 and the DC power source 120.

[0034] In some embodiments, the chamber lid 134 may further include a source distribution plate 122 to distribute the energy applied via the feed structure 110 to the peripheral edge of the target assembly 138 via a conductive member 125. As such, in some embodiments, the second end 116 of the body 112 may be coupled to the source distribution plate 122. The source distribution plate includes a hole 124 disposed through the source distribution plate 122 and aligned with the central opening 115 of the body 112. The source distribution plate 122 may be fabricated from suitable conductive materials to conduct the RF and DC energy from the feed structure 110.

[0035] The conductive member 125 may be a tubular member having a first end 126 coupled to a target-facing surface 128 of the source distribution plate 122 proximate the peripheral edge of the source distribution plate 122. The conductive member 125 further includes a second end 130 coupled to a source distribution plate-facing surface 132 of the target material 106 (or to the backing plate 146 of the target material 106) proximate the peripheral edge of the target material 106.

[0036] A ground shield 140 may be provided to cover the outside surfaces of the chamber lid 134. The ground shield 140 may be coupled to ground, for example, via the ground connection of the chamber body 136. In some embodiments, the ground shield 140 may have a central opening to allow the feed structure 110 to pass through the ground shield 140 to be coupled to the source distribution plate 122. The ground shield 140 may comprise any suitable conductive material, such as aluminum, copper, or the like. An insulative gap 139 is provided between the ground shield 140 and the outer surfaces of the source distribution plate 122, the conductive member 125, and the target material 106 (and/or backing plate 146) to prevent the RF and DC energy from being routed directly to ground. The insulative gap may be filled with air or some other suitable dielectric material, such as a ceramic, a plastic, or the like.

[0037] The chamber body 136 contains a substrate support pedestal 102 for receiving a substrate 104 thereon. The substrate support pedestal 102 may be located within a grounded enclosure wall 108, which may be a chamber wall (as shown) or a grounded shield. The ground shield 140 may cover at least some portions of the process chamber 100 above the target material 106.

[0038] The process shield 150 extends along the walls of the upper chamber adapter 142 and the enclosure wall 108 downwardly to below a top surface of the substrate support pedestal 102 and returns upwardly until reaching a top surface of the substrate support pedestal 102. A cover ring 186 rests on the top of the upwardly extending inner portion 188 of the process shield 150 when the substrate support pedestal 102 is in its lower, loading position but rests on the outer periphery of the substrate support pedestal 102 when it is in its upper, deposition position to protect the substrate support pedestal 102 from sputter deposition.

[0039] While the foregoing is directed to embodiments of the present invention, other and further embodiments of the invention may be devised without departing from the basic scope thereof.

Claims:

1. A target assembly for use in a substrate processing chamber having a process shield, the target assembly comprising:
 - a backing plate having a first side and an opposing second side, wherein the second side comprises a first surface having a first diameter bounded by a first edge;
 - a target material having a first side bonded to the first surface of the backing plate; wherein the first edge is an interface between the backing plate and the target material; and
 - a plurality of slots disposed along an outer periphery of the backing plate to align the target assembly with respect to the process shield during use, wherein the plurality of slots are formed in the first side of the backing plate and extend only partially into the backing plate.
2. The target assembly of claim 1, wherein the target material is one of titanium, cobalt, tantalum, or copper.
3. The target assembly of claim 1, wherein the thickness of the backing plate is between about 0.50 inches to about 0.62 inches.
4. The target assembly of claim 1, wherein the backing plate comprises a conductive material.
5. The target assembly of claim 1, further comprising a groove disposed along an outer periphery of the second side between the plurality of slots and the first edge, and a seal disposed in the groove.
6. The target assembly of claim 1, wherein the first diameter is about 17.10 inches to about 17.60 inches.

7. The target assembly of claim 1, wherein an outer edge of the target material is tapered to avoid contacting an inner surface of the process shield as the target assembly rotates in an arc onto the process shield.
8. The target assembly of any of claims 1-7, wherein the plurality of slots are three slots.
9. The target assembly of claim 8, wherein a center of a first slot is located about 115 degrees from a center of a second slot and wherein the center of the second slot is located about 115 degrees from a center of a third slot.
10. The target assembly of claim 9, wherein the first slot and the second slot engage the process shield prior to the third slot.
11. The target assembly of claim 10, wherein the first slot, the second slot and the third slot engage the process shield to align an outer edge of the target material a first distance from an inner surface of the process shield.
12. The target assembly of any of claims 1-7, further comprising a plurality of counterbore holes disposed along an outer periphery of the backing plate extending from the first side of the backing plate through the second side of the backing plate.
13. The target assembly of any of claims 1-7, wherein each slot comprises a first linear surface parallel to a second linear surface, and wherein the first linear surface and the second linear surface are connected by an arched surface.
14. The target assembly of claim 13, wherein a distance between the first linear surface and the second linear surface is about 0.75 inches to about 1.00 inch.
15. A substrate processing chamber, comprising:
a chamber body having an inner volume;

a chamber lid disposed atop the chamber body, wherein the chamber lid comprises an axis of rotation configured to rotate the chamber lid onto the chamber body;

a process shield disposed within the chamber body and below the chamber lid; and

a target assembly coupled to a lower surface of the chamber lid that faces the inner volume when in a closed position, the target assembly as described in any of claims 1 to 14.

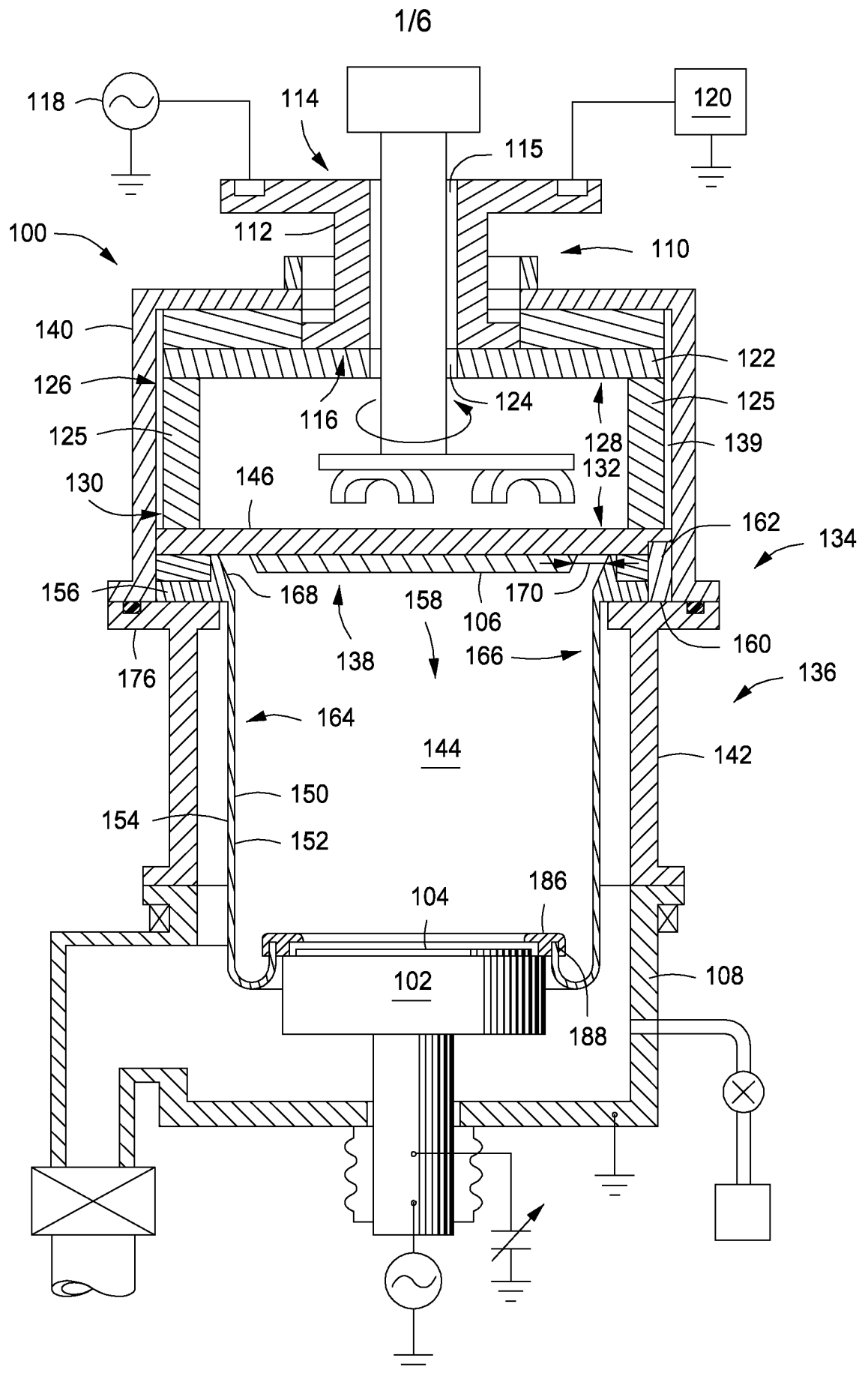


FIG. 1

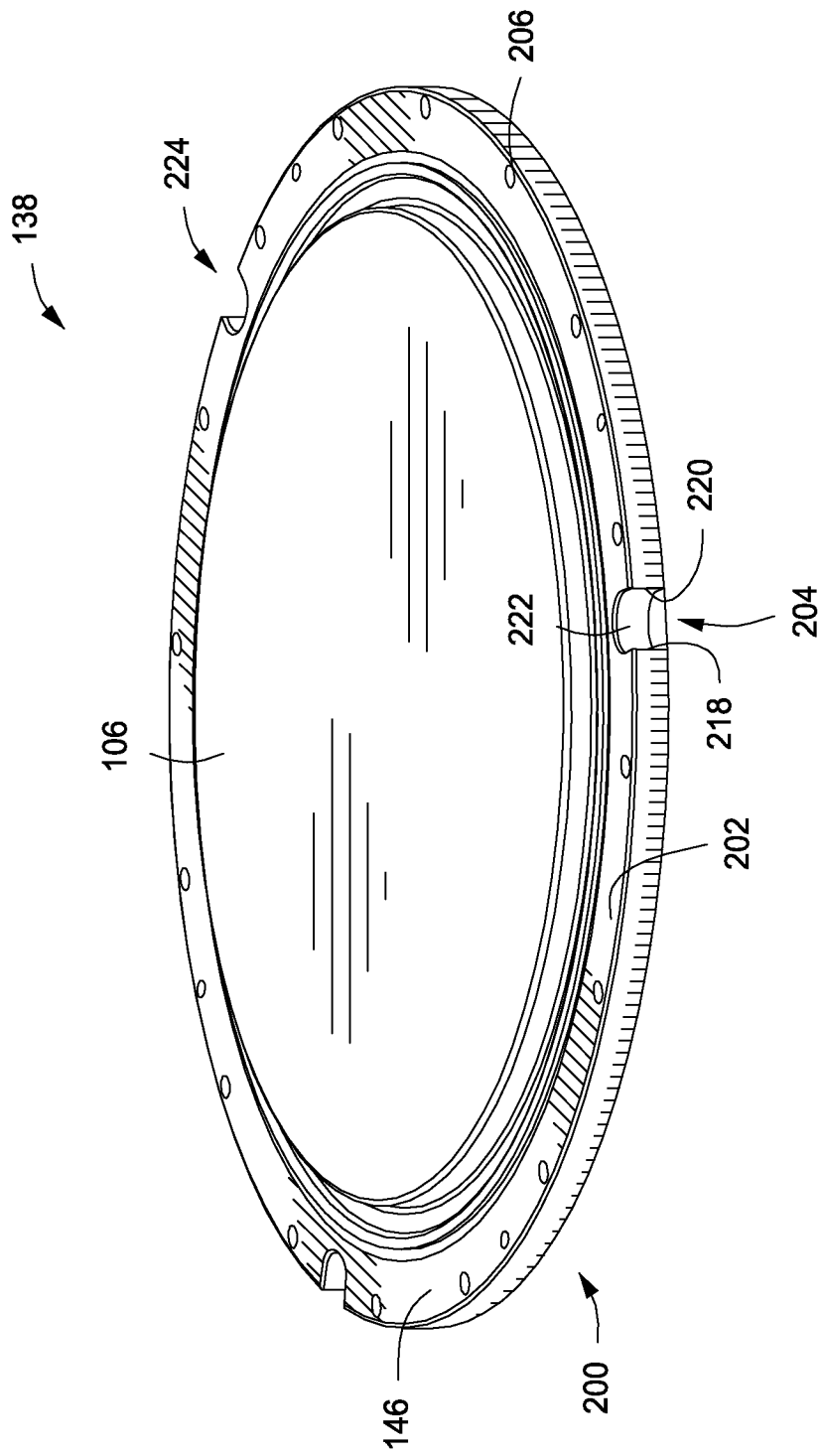


FIG. 2A

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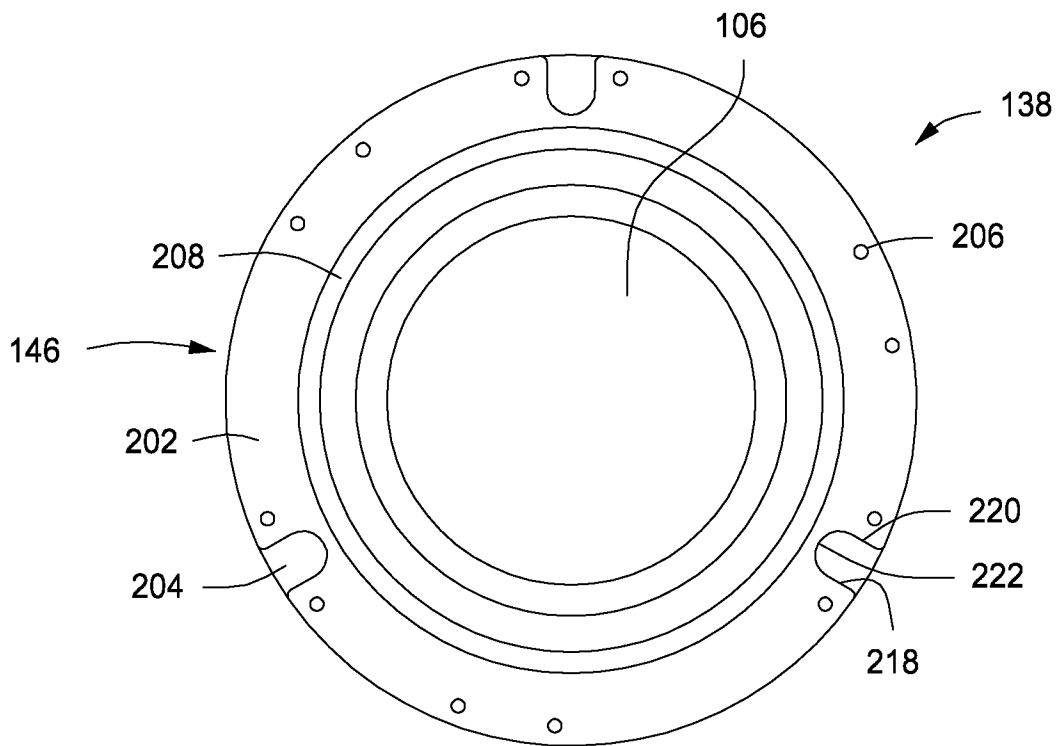


FIG. 2B

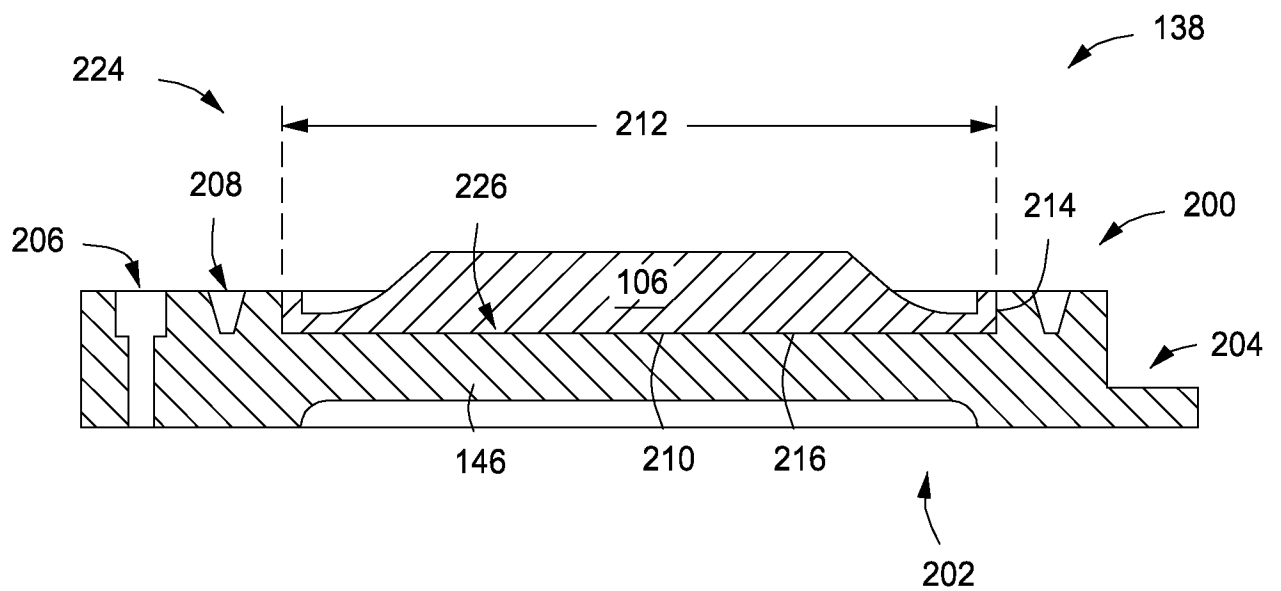


FIG. 2C

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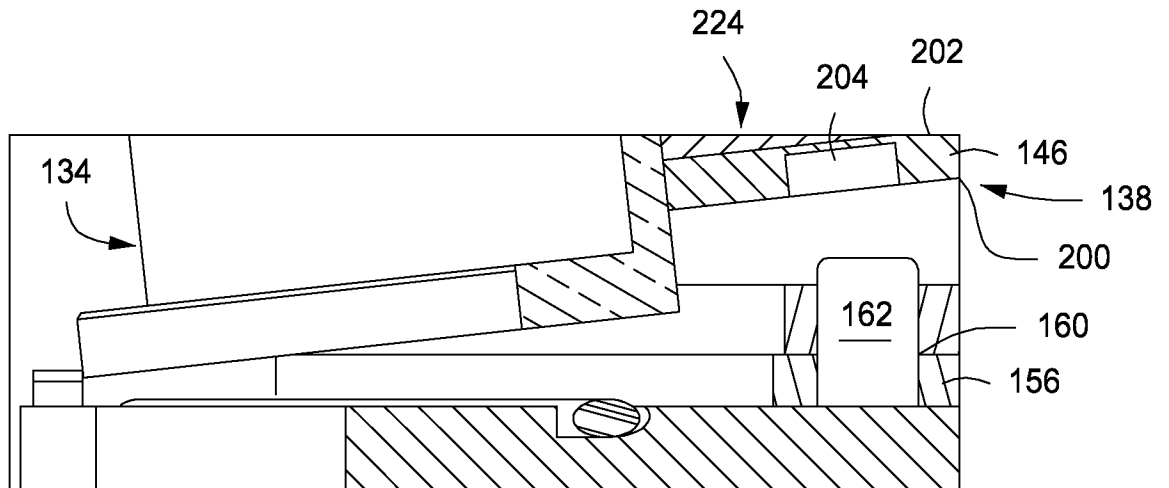


FIG. 3A

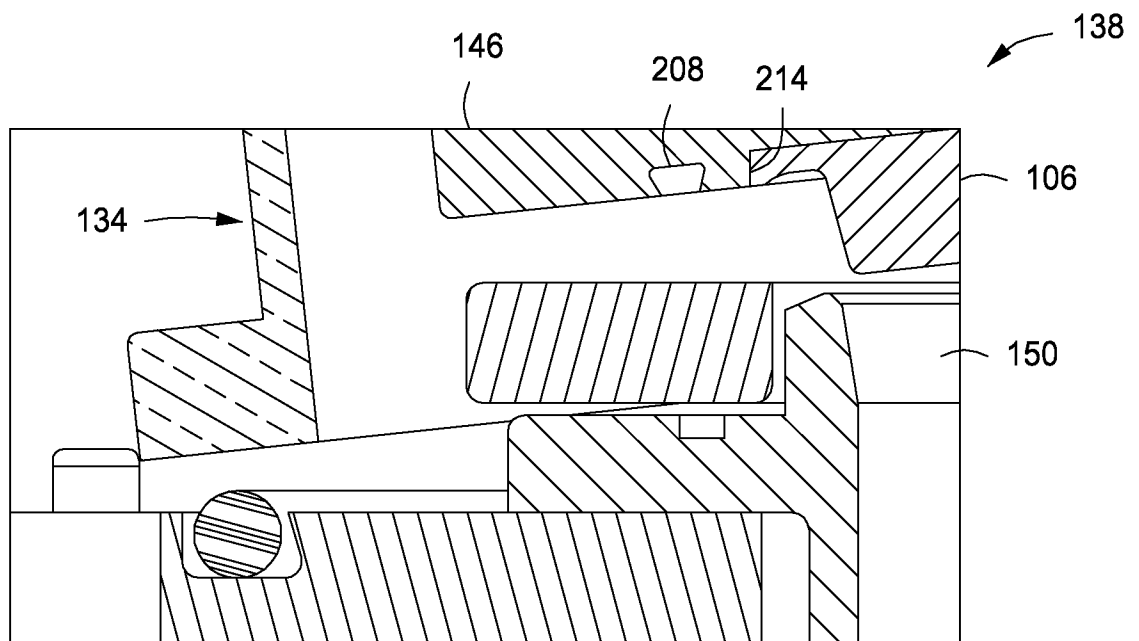


FIG. 3B

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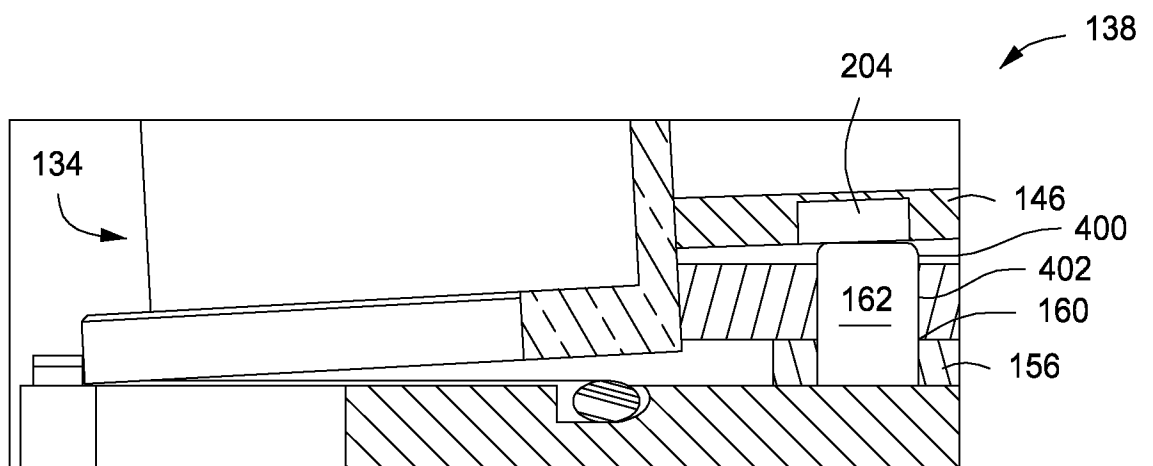


FIG. 4A

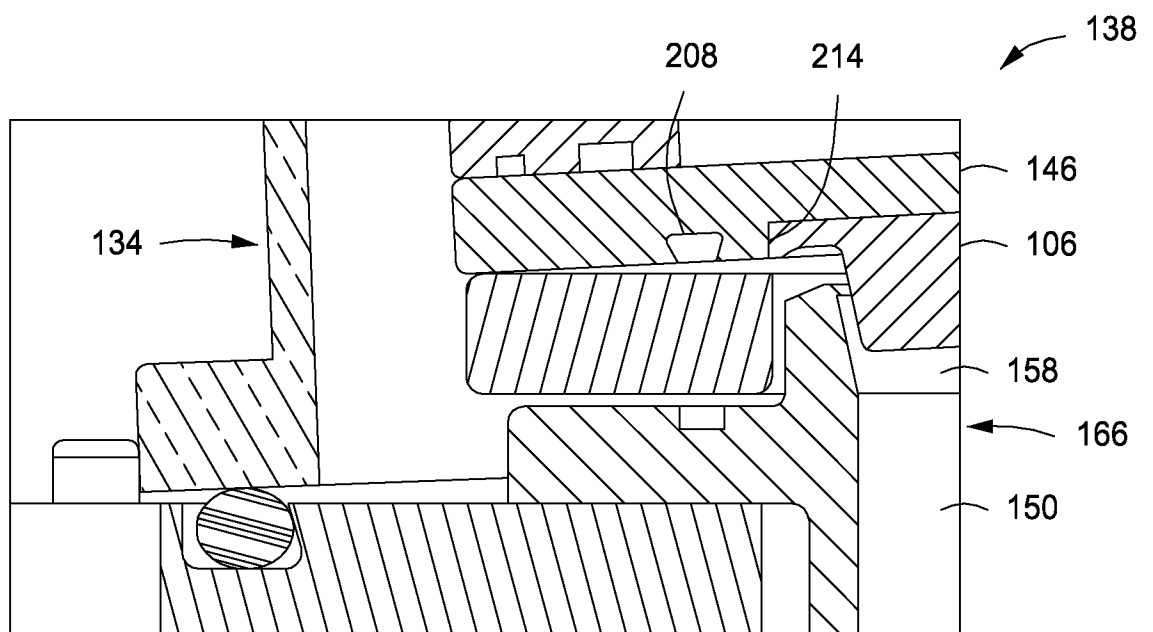


FIG. 4B

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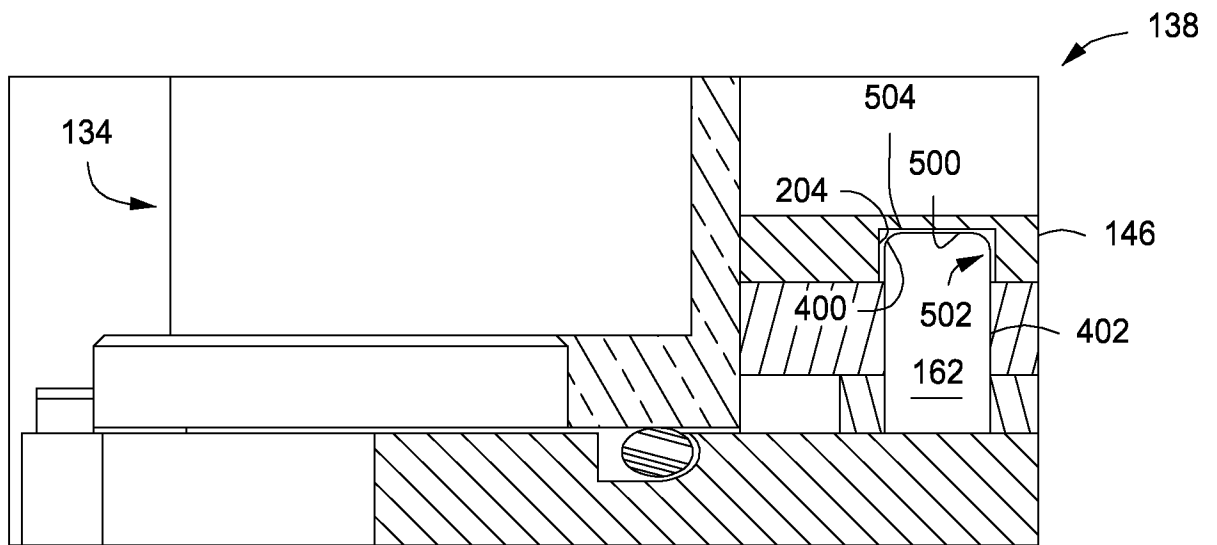


FIG. 5A

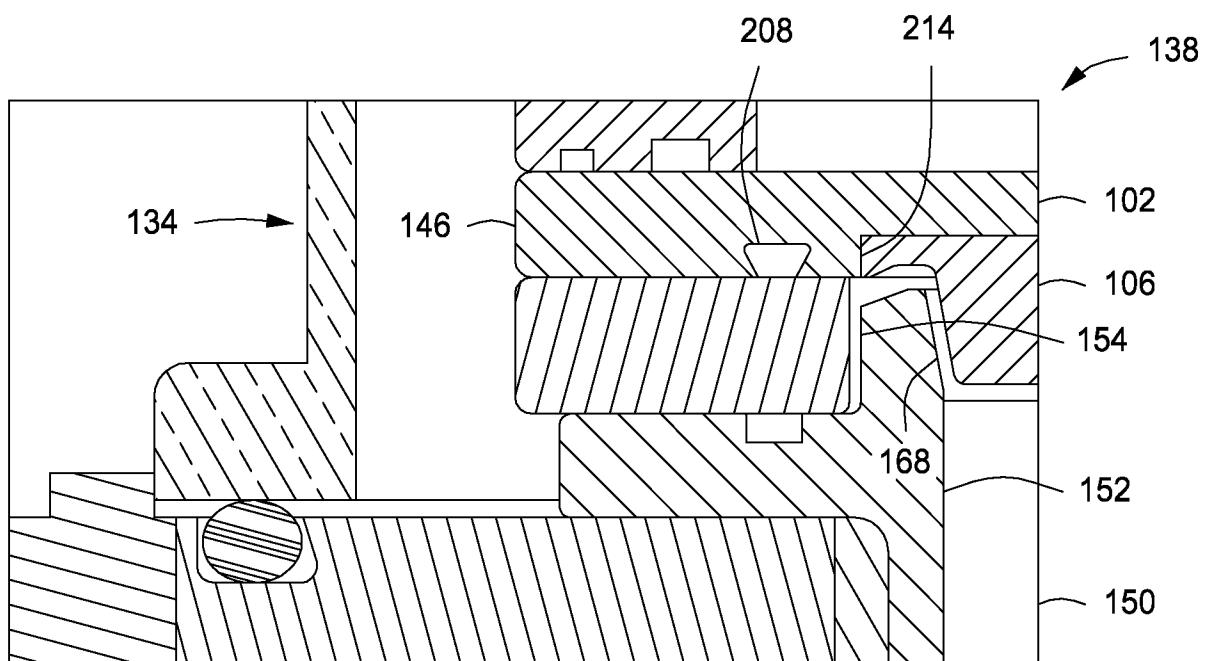


FIG. 5B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/021658**A. CLASSIFICATION OF SUBJECT MATTER****C23C 14/34(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C23C 14/34; C25B 9/00; B23K 1/20; C23C 14/50; B21D 39/00; C23C 14/14; H01L 21/44

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & keywords: target, backing plate, slot, shield, and sputter

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2004-0251130 A1 (LIU et al.) 16 December 2004 See paragraphs [0027],[0037],[0057]; claims 1,20,23; and figures 2a,3a,6a.	1-9, 12, 15
A		10, 11, 13, 14
Y	US 6073830 A (HUNT et al.) 13 June 2000 See column 6, lines 13-33; claim 1; and figure 2.	1-9, 12, 15
Y	US 2012-0199469 A1 (RASHEED et al.) 9 August 2012 See paragraphs [0031],[0039],[0040]; and figures 1A-1C.	3, 5, 7, 12
A	JP 08-053757 A (FUJITSU LTD.) 27 February 1996 See abstract; paragraph [0016]; and figure 2.	1-15
A	US 2009-0045051 A1 (FERRASSE et al.) 19 February 2009 See paragraph [0047]; and figure 1A.	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

12 June 2014 (12.06.2014)

Date of mailing of the international search report

16 June 2014 (16.06.2014)

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2014/021658

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004-0251130 A1	16/12/2004	US 7097744 B2	29/08/2006
US 6073830 A	13/06/2000	AU 1999-65010 A1	01/05/2000
		CN 1198191 A0	04/11/1998
		EP 0826075 A1	04/03/1998
		EP 0826075 A1	03/11/1999
		EP 1125000 A1	22/08/2001
		EP 1125000 B1	06/08/2008
		JP 11-510557 A	14/09/1999
		JP 2002-527618 A	27/08/2002
		KR 10-0602767 B1	20/07/2006
		KR 10-1999-0007896 A	25/01/1999
		US 5836506 A	17/11/1998
		WO 00-22185 A1	20/04/2000
		WO 96-33294 A1	24/10/1996
US 2012-0199469 A1	09/08/2012	CN 103348037 A	09/10/2013
		JP 2014-508222 A	03/04/2014
		KR 10-2014-0044306 A	14/04/2014
		TW 201243078 A	01/11/2012
		WO 2012-109069 A2	16/08/2012
		WO 2012-109069 A3	03/01/2013
JP 08-053757 A	27/02/1996	None	
US 2009-0045051 A1	19/02/2009	JP 2010-537043 A	02/12/2010
		KR 10-2010-0040799 A	21/04/2010
		TW 200925310 A	16/06/2009
		US 8702919 B2	22/04/2014
		WO 2009-023529 A1	19/02/2009