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(54) RETAINING RING HAVING REDUCED WEAR AND CONTAMINATION RATE FOR A POLISHING HEAD OF A CMP TOOL

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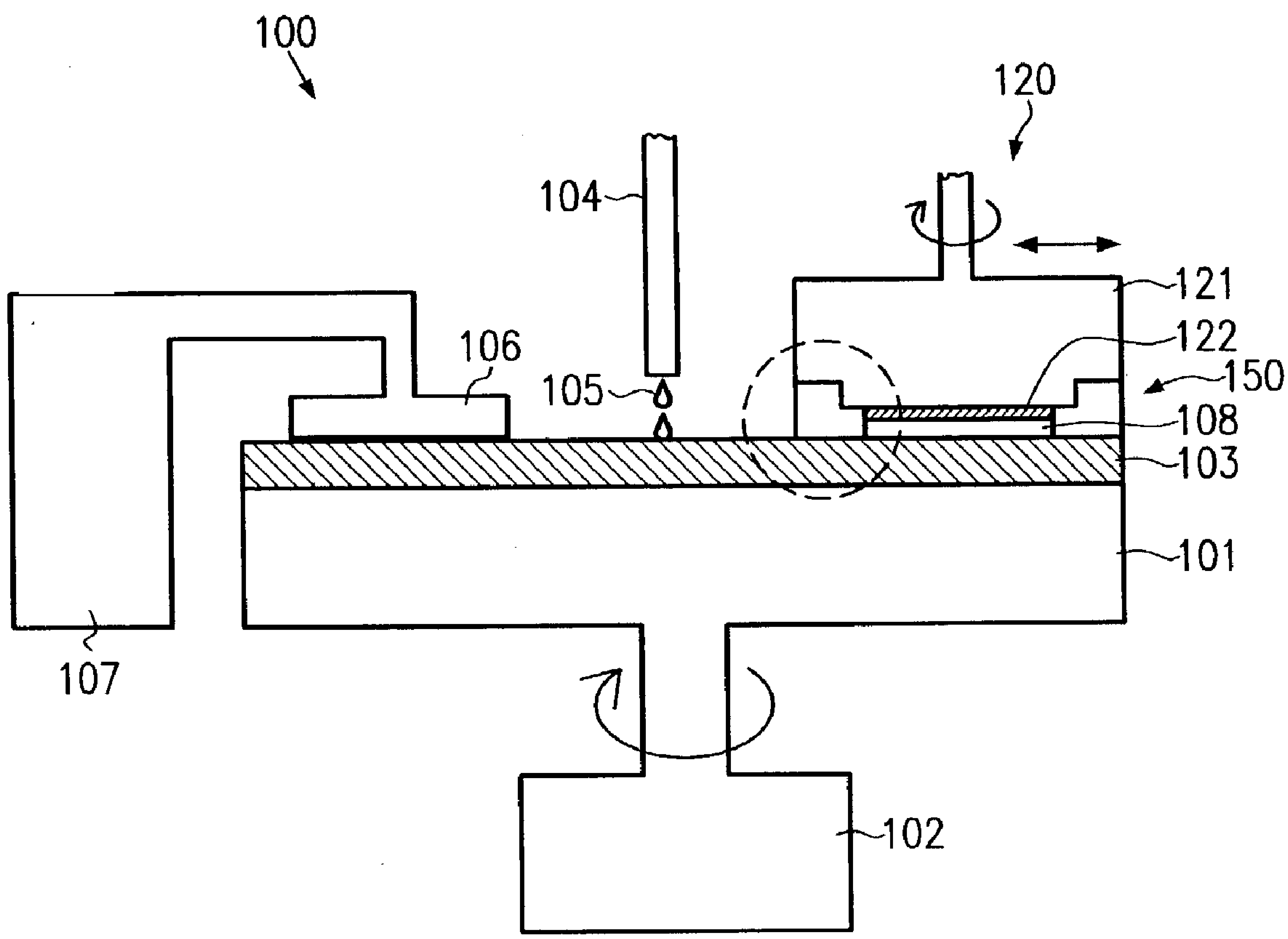
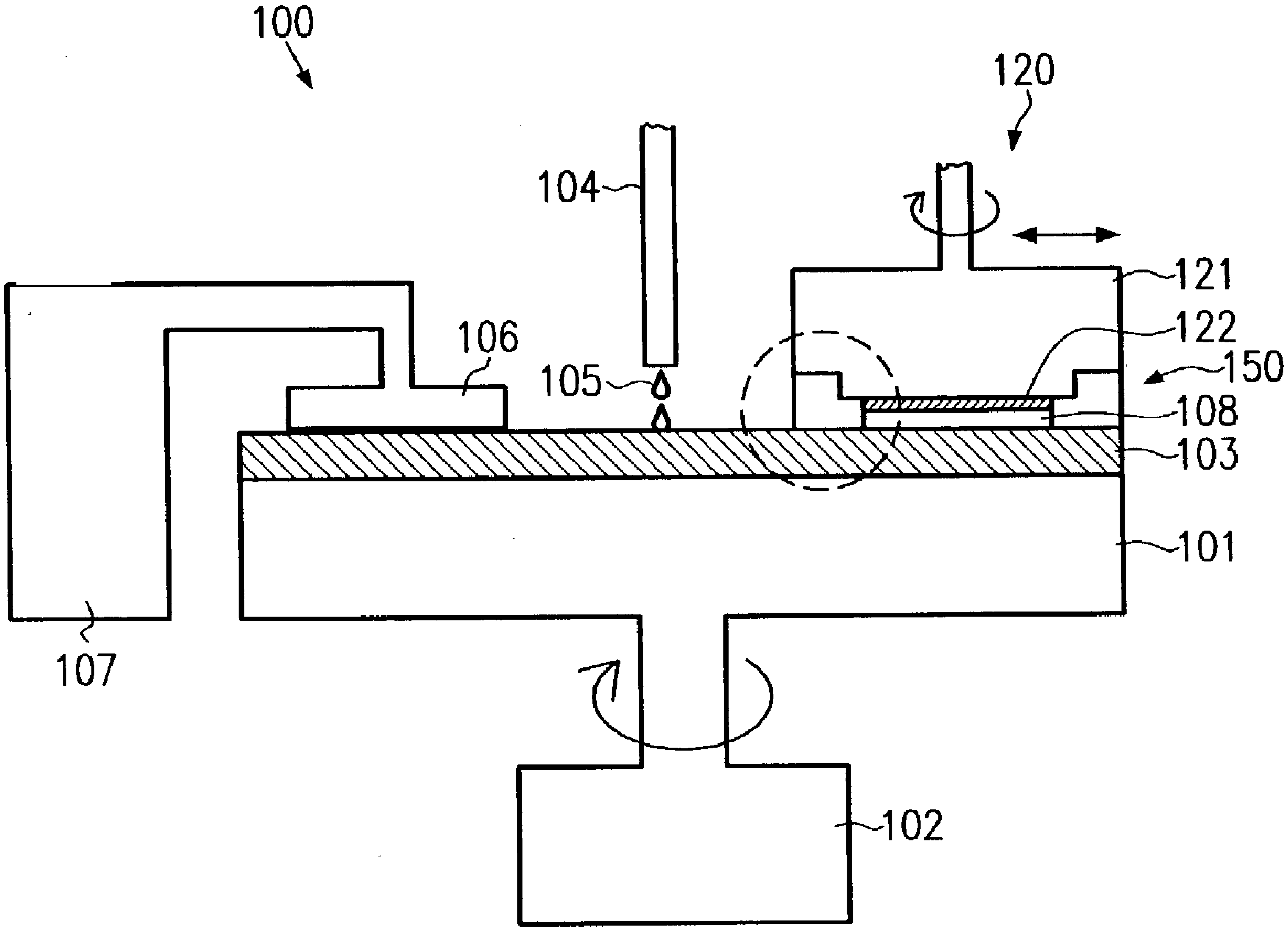
(57) **ABSTRACT**

A retaining member for a polishing head in a CMP apparatus comprises a bottom surface with silicon carbide. Due to the superior characteristics of silicon carbide, a low wear rate of the retaining member is secured, wherein, additionally, accumulation of electrostatic charges is substantially avoided due to the conductivity of silicon carbide. Consequently, cost of ownership is reduced, while at the same time process stability over a large number of substrates is increased.




100
120
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121
122
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103
101
107
102

FIG.1a

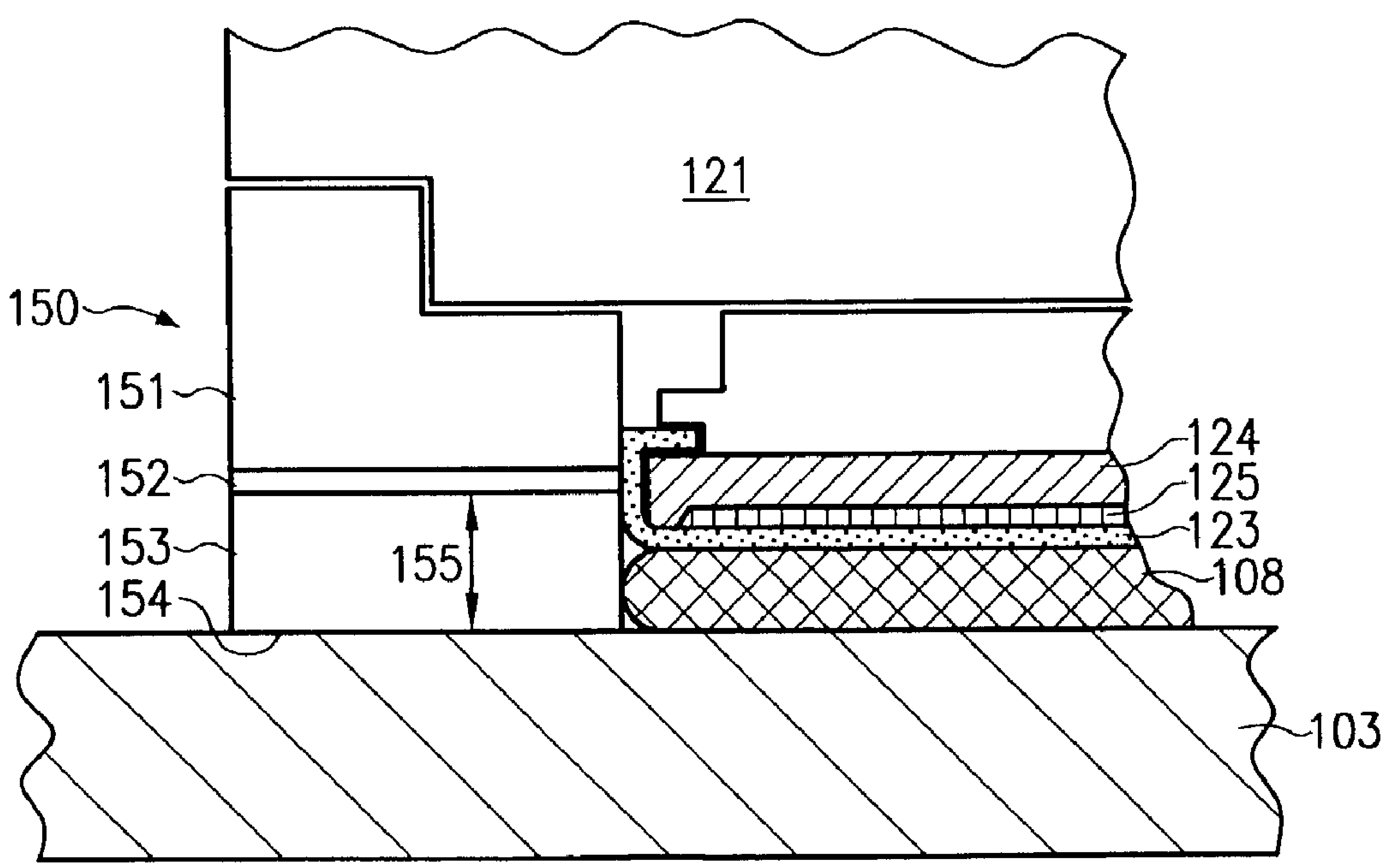
121
150
151
124
152
125
123
153
155
108
154
103

FIG.1b

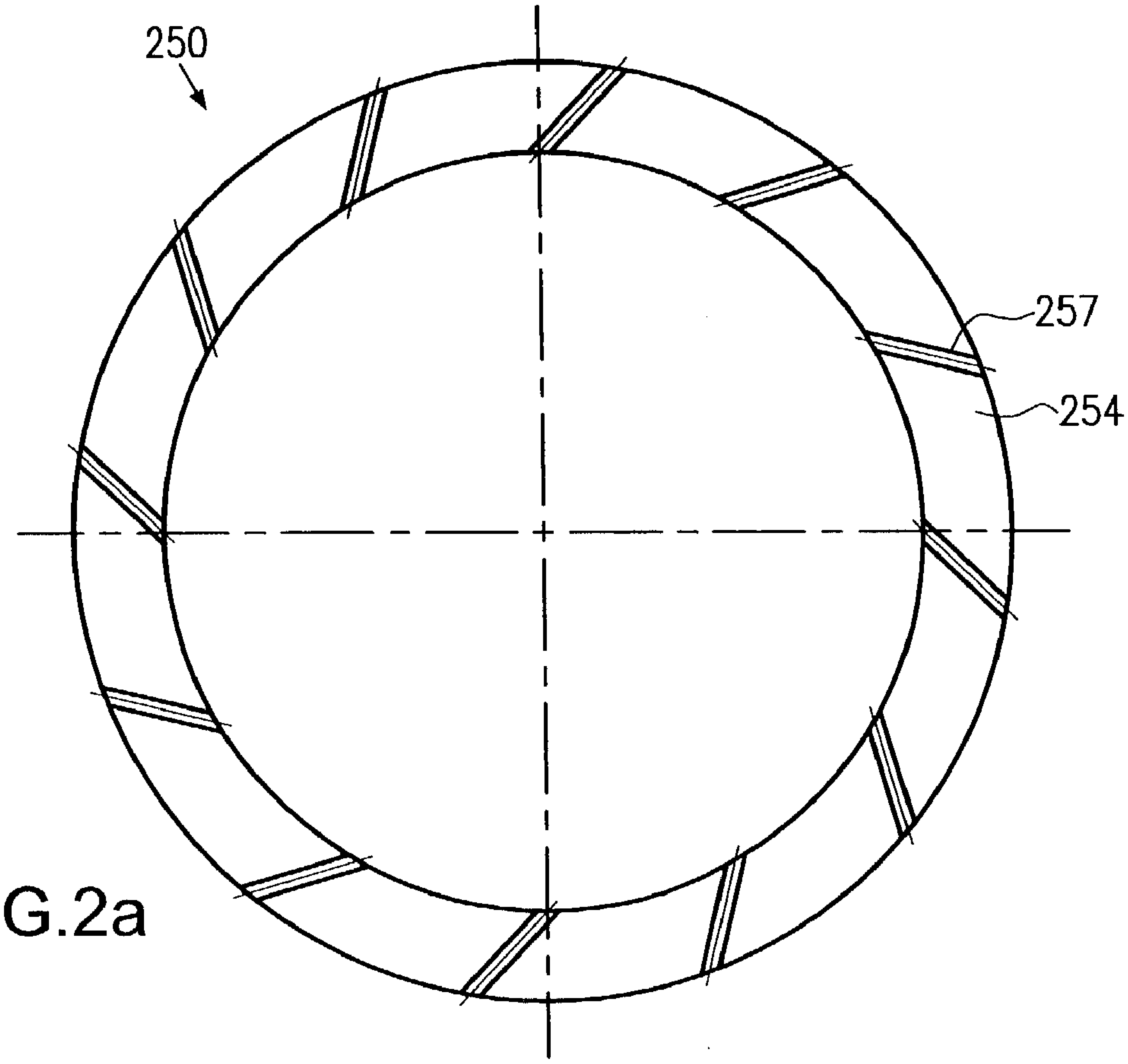

FIG.2a

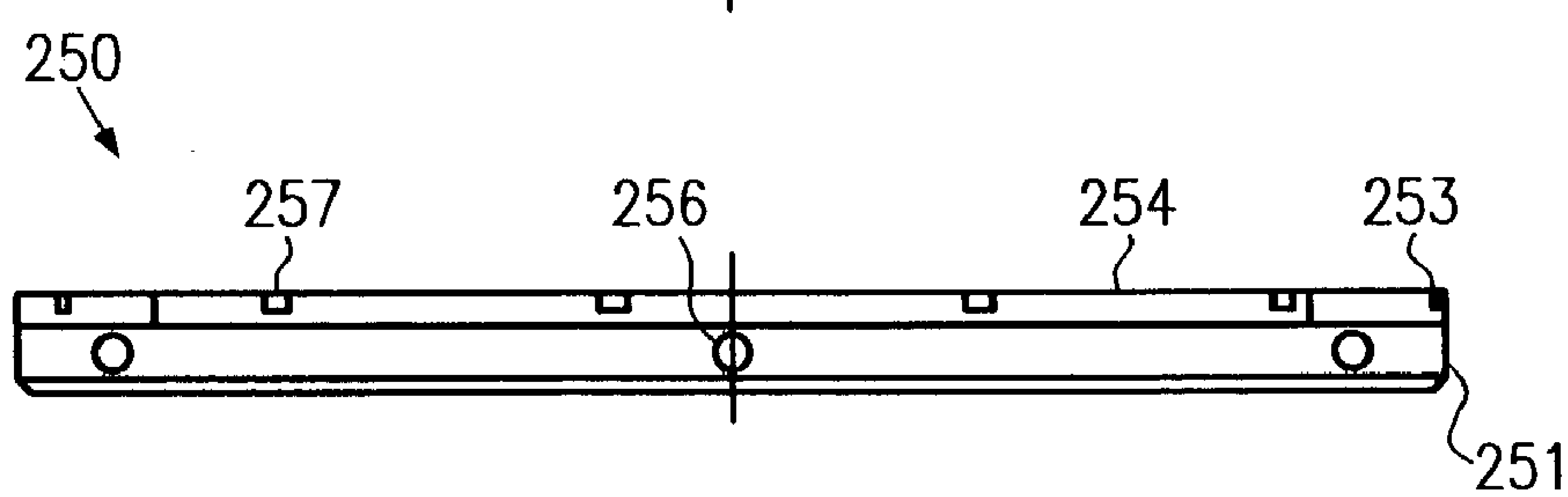

FIG.2b

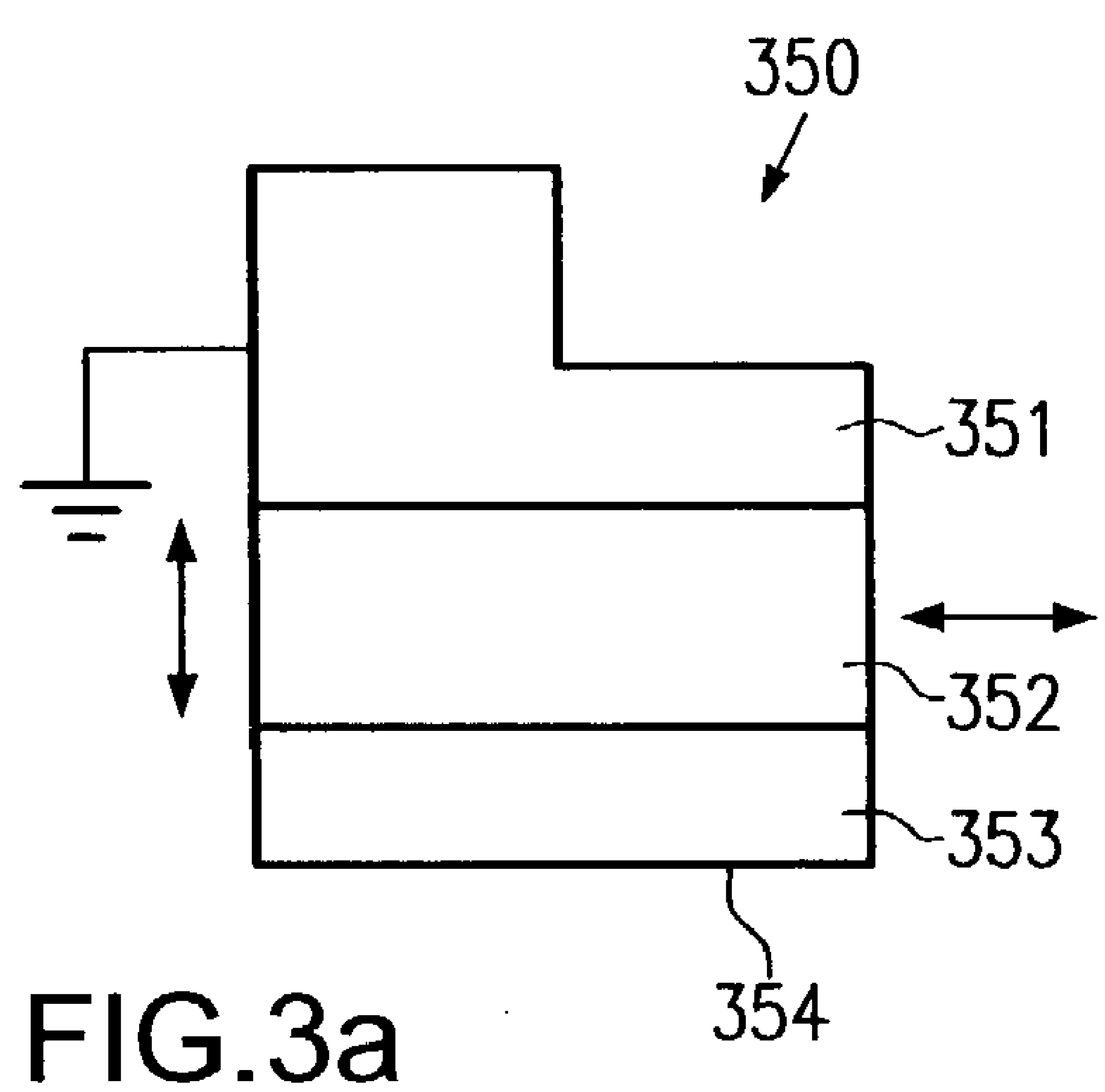

FIG.3a

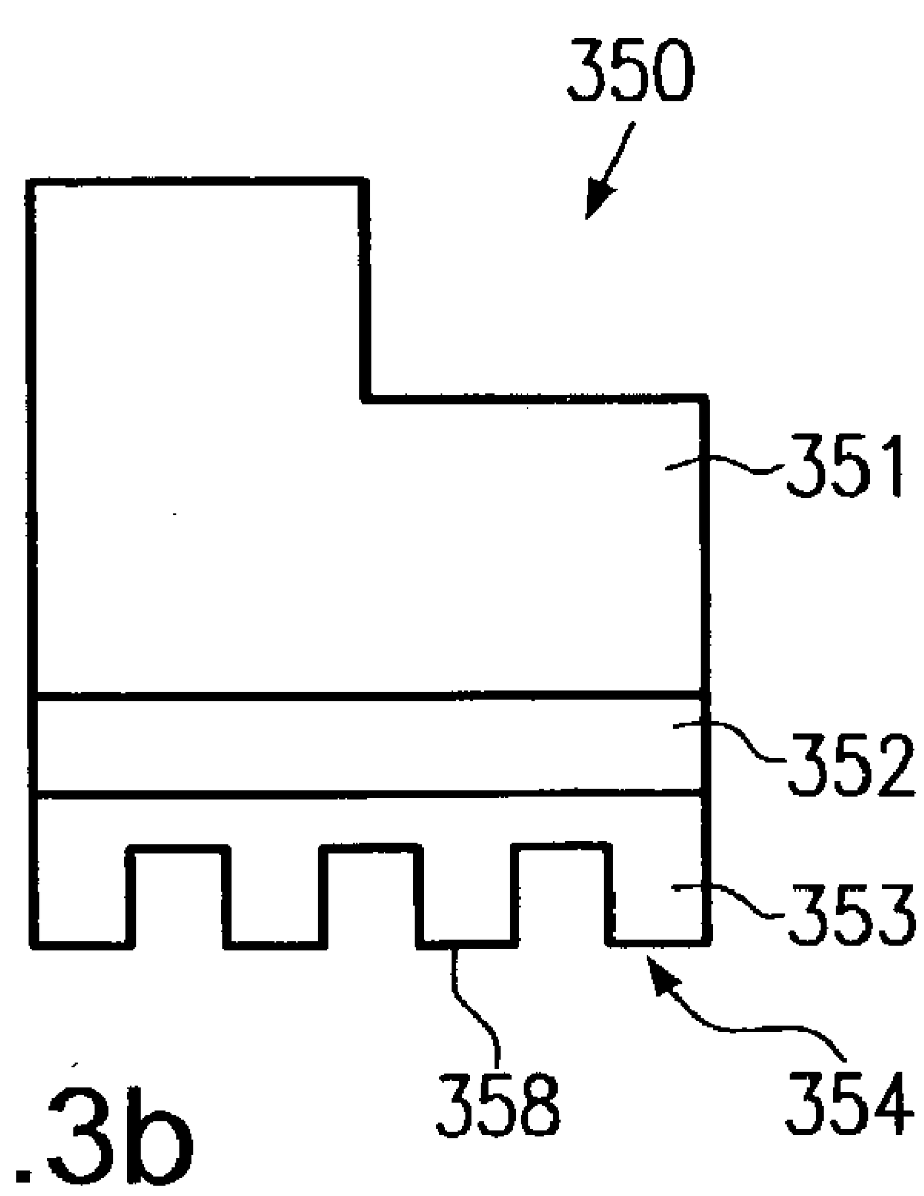

FIG.3b

RETAINING RING HAVING REDUCED WEAR AND CONTAMINATION RATE FOR A POLISHING HEAD OF A CMP TOOL

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] Generally, the present invention relates to the fabrication of microstructures, such as integrated circuits, and, more particularly, to the chemical mechanical polishing of substrates for removing excess material and planarizing the substrate surface.

[0003] 2. Description of the Related Art

[0004] In manufacturing microstructures and especially integrated circuits, it is typically necessary to form layers of different materials, such as semiconductors, insulators, metals, and the like, on an appropriate substrate and to subsequently pattern one or more of these layers by photolithography and etch techniques, thereby producing microstructure elements, such as transistors, capacitors, resistors, inductors, conductors and the like. With increasing complexity of the microstructures, especially of the integrated circuits, the number of material layers to be deposited and to be patterned on the substrate also increases and thus leads to an increasingly non-planar surface topography of the patterned material layers.

[0005] As there is an ongoing tendency to steadily shrink the dimensions of the circuit elements, the requirements posed on the photolithography and etch techniques may not sufficiently be met without periodically planarizing the substrate surface. For instance, the fabrication of highly sophisticated CPUs requires the formation of a plurality of metallization layers stacked on top of each other and having trenches and vias, i.e., vertical interconnects between the individual metallization layers, with feature sizes on the order of 0.2 μm and less with an aspect ratio of greater than **8**. A plurality of these metallization layers may not readily be formed as a layer stack without providing a well-planarized surface prior to the formation of a next level.

[0006] Chemical mechanical polishing (CMP) has become one of the most frequently used techniques in planarizing substrates during various manufacturing stages. In planarizing a substrate by chemical mechanical polishing, the substrate is typically mounted on a polishing head, wherein the surface to be polished is exposed so that it may be placed against a polishing pad, which in turn is mounted on a rotatable polishing platen. Usually a motion of the substrate relative to the polishing pad is generated by rotating the polishing head and the polishing platen. Simultaneously, a so-called slurry is supplied to the polishing pad, which typically includes at least one chemical reagent, allowing a chemical reaction with the material to be removed so that the effectiveness of material removal is significantly enhanced compared to a pure mechanical polishing technique. Depending on the type of polishing pad used, i.e., a standard pad or a fixed-abrasive pad, the slurry may additionally comprise abrasive particles to promote the removal of the material or materials from the substrate surface. By applying a controllable pressure on the substrate to press it against the polishing pad, by controlling the magnitude of the relative motion between the polishing pad and the substrate, by selecting an appropriate slurry with well-defined characteristics, such as pH value, type of reagent, type of abrasive particles, temperature, and the like, the rate of removal of material from the substrate may be adjusted.

[0007] In addition to a high removal rate for a high-throughput-polishing process, the final "quality" of the polished surface on a small scale, that is, the residual surface roughness and topography over adjacent circuit elements, as well as on a large scale, that is, the uniformity of material removal across the entire substrate surface, is also of great importance in view of tightly-set design requirements. Furthermore, chemically mechanically polishing a plurality of substrates sequentially is a challenging task as the polishing process per se is subjected to non-uniformity owing to wear of consumables such as the polishing pad, components of the polishing head in contact with the polishing pad, and the like. Additionally, the slurry consistency may change due to the accumulation of continuously removed material in the slurry during the polish process. For this reason, so-called pad conditioners are usually provided that move across the polishing pad during or after the polishing of the substrate in order to rework the surface of the polishing pad in an attempt to provide substantially stable conditions for a plurality of substrates.

[0008] Since chemical mechanical polishing has become a standard process in manufacturing integrated circuits, and since the substrate diameter is steadily increasing, for example, in fabricating modern integrated circuits, wafers of 200 mm diameter are used with the prospect of 300 mm substrates in the near future, with an ever increasing demand of improved throughput of the polishing tools, great efforts are being made to steadily improve the polishing process, i.e., to provide enhanced polish uniformity across large diameter substrates and to also improve process uniformity over a plurality of subsequently processed substrates.

[0009] For example, U.S. Pat. No. 6,251,215 describes a carrier head for a CMP tool having a multi-layer retaining ring with a lower portion for contacting the polishing pad during the polishing, which is made of a first material, and having an upper portion made of a second material which is more rigid than the first material. The first material is made of a plastic, e.g., polyphenylene sulfide, polyethylene terephthalate, and the like. The second material may be a metal, e.g., steel, aluminum or molybdenum, or a ceramic. The reduced rigidness of the first material is intended to reduce the so-called edge effect, i.e., the tendency of a different etch rate at the substrate perimeter compared to the center of the substrate. Although the provision of a material with improved elasticity may lead to a more uniform removal rate during the processing of an individual substrate, the relatively soft plastic material exhibits a significant wear rate so that substrate contamination by particles may become a major issue during the polishing of a plurality of substrates. Additionally, the relatively high wear rate requires frequent changing of the retaining ring and thus contributes to a reduced tool utilization and increased cost of ownership.

[0010] In view of the above-identified problems, a need exists for an improved technique that allows an increased CMP tool utilization while at the same time improving process quality.

SUMMARY OF THE INVENTION

[0011] Generally, the present invention is directed to a polishing head and/or a retaining member that laterally fixes a substrate mounted on the polishing head during the polishing, wherein at least a portion of the retaining member is formed of a durable non-metal exhibiting a certain degree of conductivity so that contamination of the substrate is significantly reduced due to the extremely low wear rate and the substantial lack of metal, wherein the conductivity additionally substantially prevents electrostatic charges from accumulating on the retaining member during the polishing process.

[0012] According to one illustrative embodiment of the present invention, a polishing head for a CMP apparatus comprises a support surface configured to receive a substrate. A retaining member is configured to laterally fix the substrate on the support surface, wherein the retaining member is at least partially comprised of silicon carbide.

[0013] According to another illustrative embodiment of the present invention, a retaining member for use in a polishing head is partially comprised of silicon carbide.

[0014] In accordance with still another illustrative embodiment of the present invention, a polishing head for a CMP apparatus comprises a support surface that is configured to receive a substrate. Moreover, a retaining member is configured to laterally fix the substrate on the support surface, wherein the retaining member comprises an upper portion made of a first material and a lower portion formed of a conductive non-metal. The conductive non-metal is more rigid than the first material.

[0015] According to still a further illustrative embodiment of the present invention, a retaining member for a polishing head includes an upper portion formed of a first material and a lower portion formed of a conductive non-metal, wherein the conductive non-metal is more rigid than the first material.

[0016] According to yet another illustrative embodiment of the present invention, a CMP apparatus comprises a polishing pad attached to a polishing plate and a polishing head including a retaining member that is partially comprised of silicon carbide. The apparatus further comprises a pad conditioner having a surface portion in contact with the polishing pad and comprised of silicon carbide.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The invention may be understood by reference to the following description taken in conjunction with the accompanying drawings, in which like reference numerals identify like elements, and in which:

[0018] **FIG. 1***a* schematically shows a polishing tool (in a simplified manner);

[0019] **FIG. 1***b* depicts a portion of the polishing head of the apparatus shown in **FIG. 1***a* in more detail;

[0020] **FIGS. 2***a* and **2***b* are a plan view and a side view, respectively, of a ring-shaped retaining member usable in the apparatus shown in **FIG. 1***a;* and

[0021] **FIGS. 3***a* and **3***b* schematically depict various forms of ring-shaped retaining members according to further illustrative embodiments of the present invention.

[0022] While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof have been shown by way of example in the drawings and are herein described in detail. It should be understood, however, that the description herein of specific embodiments is not intended to limit the invention to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF THE INVENTION

[0023] Illustrative embodiments of the invention are described below. In the interest of clarity, not all features of an actual implementation are described in this specification. It will of course be appreciated that in the development of any such actual embodiment, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit of this disclosure.

[0024] The present invention will now be described with reference to the attached figures. Although the various regions and structures of a semiconductor device are depicted in the drawings as having very precise, sharp configurations and profiles, those skilled in the art recognize that, in reality, these regions and structures are not as precise as indicated in the drawings. Additionally, the relative sizes of the various features and doped regions depicted in the drawings may be exaggerated or reduced as compared to the size of those features or regions on fabricated devices. Nevertheless, the attached drawings are included to describe and explain illustrative examples of the present invention. The words and phrases used herein should be understood and interpreted to have a meaning consistent with the understanding of those words and phrases by those skilled in the relevant art. No special definition of a term or phrase, i.e., a definition that is different from the ordinary and customary meaning as understood by those skilled in the art, is intended to be implied by consistent usage of the term or phrase herein. To the extent that a term or phrase is intended to have a special meaning, i.e., a meaning other than that understood by skilled artisans, such a special definition will be expressly set forth in the specification in a definitional manner that directly and unequivocally provides the special definition for the term or phrase.

[0025] **FIG. 1***a* schematically depicts a CMP apparatus **100** in a simplified manner. The CMP apparatus **100** comprises a polishing platen **101** supported and driven by a drive assembly **102**. A polishing pad **103** is attached to the polishing platen **101**. A slurry supply **104** is arranged in such a manner to allow the supply of a slurry **105** to the polishing pad **103**. A pad conditioner **106** is mounted on a respective drive means **107**. A polishing head **120** is radially moveably and rotatably supported by a respective drive assembly (not shown) and may further be movable so as to receive a substrate **108** and to bring the substrate into contact with the polishing pad **103**. The polishing head **120** comprises a retaining member **150**, which in the present example is provided as a generally annular element attached to a base member **121** of the polishing head **120**. The polishing head **120** may further comprise a plurality of fluid lines and manifolds (not shown) to provide gases and/or vacuum to a substrate receiving portion **122** enclosed by the retaining member **150**.

[0026] **FIG. 1***b* illustrates the encircled portion of **FIG. 1***a* in more detail. In the substrate receiving portion **122**, a flexible membrane **123** is in contact with the back side of the substrate **108**. A support member **124** is arranged such that the membrane **123** is fixed thereto and provides a sealed space **125**, which is connected to a gas supply (not shown), for providing an overpressure within the space **125**. The substrate **108** is laterally held in place by the retaining member **150**, which comprises an upper portion **151** made of a first material, such as aluminum, stainless steel, molybdenum, and the like. A lower portion **153** of the retaining member **150** has a surface **154**, at least a portion thereof may contact the polishing pad **103** during the operation of the CMP apparatus **100**. The lower portion **153** or at least the surface **154** being in contact with the polishing pad **103** may be comprised of a material having a high durability and thus a low wear rate during the operation of the apparatus **100**. In one particular embodiment, the surface **154** may comprise silicon carbide. In other embodiments, the surface **154** may be comprised of a conductive material having a Vickers hardness of approximately 15.0 GPa or more at room temperature. In still other embodiments, the lower portion **153** may be substantially completely made of silicon carbide and/or of a material having the above-identified hardness. Since silicon carbide exhibits a hardness that is comparable to that of diamond, the wear rate thereof is extremely low. Contrary to diamond, silicon carbide is conductive and therefore allows the drain-off of electrostatic charges that would otherwise build up in an insulating material. Furthermore, silicon carbide has a high heat conductivity exceeding that of steel and may therefore effectively conduct heat from and to the polishing pad **103** via the slurry **105**. The lower portion **153** may be attached to the upper portion **151** by a layer of adhesive **152**, for example in the form of an epoxy adhesive.

[0027] In operation, the substrate **108** is placed into the substrate receiving portion **122**, for example by moving the polishing head **120** to a respective substrate storage location (not shown) and establishing a vacuum in the portion **122** to fix the substrate **108** therein. Thereafter, the polishing head **120** is placed against the polishing pad **103**, which rotates at a predefined angular speed. Typically, the polishing head **120** is also rotated, wherein usually the rotation of the polishing head **120** and/or of the polishing pad **103** is controlled so as to achieve a substantially uniform relative motion across the entire substrate surface. To this end, the polishing head **120** may also be moved radially with respect to the polishing pad **103**, thereby allowing adjustment of the relative speed and also to improve the utilization of the polishing pad **103** so as to use substantially the whole surface thereof. During the polishing process, the substrate **108** is laterally fixed by the retaining member **150**, wherein the dimensions of the retaining member **150** and especially the dimensions of the lower portion **153** are selected so as to minimize a clearance of the substrate **108** within the substrate receiving portion **122**, thereby reducing the risk for any damage of the substrate **108**. During the polishing process, a pressurized gas may be supplied to the space **125** to exert a pressure via the membrane **123** onto the back side of the substrate **108**. Depending on the type of polishing head used, the space **125** may be divided into several sub-portions, allowing pressurization of different substrate areas with a different pressure. Since the removal rate during the polishing process is among others determined by the downforce exerted on the substrate **108**, pressurizing the back side of the substrate **108** with different pressures may assist in obtaining a desired removal rate at specified substrate areas. Moreover, the retaining member **150** may also be pressurized so as to exert a specified downforce on the polishing pad **103** to thereby establish predefined polishing conditions at the perimeter of the substrate **108**.

[0028] Prior to and/or during contacting the substrate **108** with the polishing pad **103** by moving the polishing head **120**, the slurry supply **104** provides the slurry **105** so that a layer of slurry is established on the polishing pad **103**. Depending on the type of polishing pad used, i.e., a standard pad or a fixed abrasive pad, the slurry includes at least one chemical reagent and possibly abrasive particles to create a chemical reaction and promote a mechanical removal of the one or more materials to be polished off the substrate **108**. As previously noted, silicon carbide is highly resistive against a plurality of chemical reagents and also exhibits excellent gliding qualities so that material removal by chemical reaction and/or abrasion at the surface **154** of the lower portion **153** is remarkably reduced compared to materials used in conventional devices, such as metal and plastic materials. Moreover, electrostatic charges that may build up owing to the friction between the substrate **108**, the surface **154** and the polishing pad **103** may not accumulate in the lower portion **153** due to the semiconductive qualities of the material that comprises the lower portion **153**, e.g., silicon carbide. In one embodiment, the lower portion **153** is substantially comprised of silicon carbide and the lower portion **153** may be electrically connected to ground, so that any electrostatic charge created during the polishing process may effectively be removed. For example, the adhesive layer **152** may comprise an electrically conductive component so that the charge carriers may effectively be drained off via the lower portion **153**, the electrically conductive adhesive layer **152** and the upper portion **151**. Thus, an influence of electrostatic charging, on the slurry components as well as on the substrate **108**, may significantly be reduced.

[0029] Prior to and/or during and/or after polishing the substrate **108**, the conditioner **106** may be activated to rework the surface of the polishing pad **103** to provide substantially similar polishing conditions on the pad **103** at least for some substrates **108** that have to be polished sequentially in the apparatus **100**. Typically, the conditioner **106** comprises a surface contacting the polishing pad **103** which exhibits an appropriate profile or topography to obtain the desired "conditioning" effect. Since substantially the same criteria apply to the conditioner **106** with regard to wear rate, resistivity against corrosion and particle contamination of the substrate **108** and electrostatic charge accumulation, in one embodiment, the conditioner **106** includes a silicon carbide surface portion.

[0030] After a required amount of material is removed from the substrate **108**, that is, the polishing process has been carried out for a specified time under the process conditions as explained above, the polishing pad **103** and thus the substrate **108** may be rinsed and/or the substrate **108**, with or without the polishing head **120**, may be conveyed to another polishing station for a further CMP sequence with differently adjusted process parameters. Due to the reduced wear rate of the retaining member **150**, i.e., the reduced amount of particles created during the polishing process, and due to its enhanced resistivity against the chemical agents contained in the slurry **105**, substantially stable process conditions may be maintained for a plurality of substrates **108**. For example, a thickness **155** of the lower portion **153** varies only slowly over a large number of substrates due to the low wear rate. Consequently, relatively stable polishing conditions especially at the substrate edge are maintained even if the retaining member **150** is not separately vertically pressurized and is pressed against the polishing pad **103** along with the substrate **108**, since a height difference between the surface **154** and the exposed substrate surface, for example with respect to the beginning of each polish process, varies only slightly over time.

[0031] **FIG. 2***a* is a plan view of a retaining member **250** provided as a ring-shaped element and **FIG. 2***b* shows a schematic cross-sectional view of the retaining member **250** according to a further embodiment of the present invention. The retaining member **250** comprises an upper portion **251**, for example made of aluminum, steel, plastic, ceramic, and the like, with openings **256** for receiving bolts, screws, and the like, to attach the retaining member **250** on the base of a polishing head. A lower portion **253** having a bottom surface **254** and substantially comprised of silicon carbide is attached to the upper portion **251**. Channels or grooves **257** are formed in the lower portion **253**, wherein the channels **257** may be inclined with respect to the radial direction, as shown in **FIG. 2***a,* to promote slurry transportation during operation, when the retaining member **250** is rotated. Due to the increased hardness and the low wear rate of the lower portion **253**, a large number of channels **257** may be provided compared to conventional devices. **FIG. 2***a* shows twelve channels **257**, wherein, however, more than twelve channels **257** may be provided. In other embodiments, the surface **254** may be provided substantially without any channels **257** so as to act as an "outer perimeter" of a substrate to be polished, thereby creating substantially similar polish conditions at the actual substrate perimeter and inner substrate areas.

[0032] **FIG. 3***a* schematically shows a further cross-sectional view of a retaining member **350** that may be attached to a polishing head, such as polishing head **120** shown in **FIG. 1***a*. The retaining member **350** comprises a lower portion **353** with a bottom surface **354**, wherein at least the bottom surface **354** is comprised of a conductive durable material such as silicon carbide. The lower portion **353** is attached to an upper portion **351** by means of an intermediate portion **352** having an increased elasticity so that the intermediate portion **352** may allow minute deformations in vertical and lateral directions. The elasticity of the intermediate portion **352** may thus reduce the risk of damage, such as cracks, in the lower portion **353** despite the high rigidness thereof. The intermediate portion **352** may be comprised of an adhesive providing a certain amount of elasticity, or may comprise any other appropriate elastic material attached to the upper portion **351** and the lower portion **353** by a suitable adhesive. In one embodiment, the intermediate portion **352** may comprise a conductive component or flexible conductive element to allow the application of a reference potential to the surface **354** to drain off charge carriers created by friction during the polishing process.

[0033] **FIG. 3***b* schematically shows the retaining member **350**, wherein the surface **354** has a specified profile. The profile may be selected so as to provide enhanced slurry supply to and from a substrate and/or may be provided to create a certain "conditioning" effect on a polishing pad. For example, the profiled surface **354** may comprise a plurality of naps **358** that allow slurry supply and removal and also rework the polishing pad. Due to the low wear rate of the lower portion **353** and especially of the naps **358**, the risk of particle contamination of the adjacent substrate is minimal, although wear of protruding regions is conventionally increased. Therefore, contrary to conventional retaining rings, an advanced "slurry channel" topography and/or a conditioning effect may be provided by the present invention. The specific shape as well as the dimensions of the naps **358** may be adapted to the specific requirements in view of enhanced slurry transportation or conditioning effect. Moreover, different areas having a different surface profile may be formed on the lower portion **353**. For instance, the lower portion **353** may comprise a substantially flat bottom surface portion adjacent to the substrate perimeter and, radially spaced from the substrate, profiled portions for an enhanced conditioning effect. In other embodiments, the surface **354** may be treated to receive a specified surface roughness, which allows enhanced slurry transport and conditioning effect at the same time. The surface roughness may differ from the profiled surface **354** shown in **FIG. 3***b* in that the roughness is provided on a microstructure scale, providing protrusions with a height of some hundred nanometers to a few micrometers and with a lateral distance of the same order of magnitude. A corresponding surface roughness may be obtained by well-established etch techniques.

[0034] As a result, the present invention allows significant stabilization of the process conditions during the chemical mechanical polishing of a plurality of substrates in that a retaining member of a polishing head is made of a conductive material having a high hardness so that its wear rate and thus particle contamination of the substrate is significantly reduced.

[0035] The particular embodiments disclosed above are illustrative only, as the invention may be modified and practiced in different but equivalent manners apparent to those skilled in the art having the benefit of the teachings herein. For example, the process steps set forth above may be performed in a different order. Furthermore, no limitations are intended to the details of construction or design herein shown, other than as described in the claims below. It is therefore evident that the particular embodiments disclosed above may be altered or modified and all such variations are considered within the scope and spirit of the invention. Accordingly, the protection sought herein is as set forth in the claims below.

What is claimed:

1. A retaining member for a polishing head, the retaining member being partially comprised of silicon carbide.

2. The retaining member of claim 1, having an upper portion and a lower portion, the lower portion having a bottom surface that is comprised of silicon carbide.

3. The retaining member of claim 1, wherein a plurality of slurry channels are formed in a bottom surface of said retaining member.

4. The retaining member of claim 2, wherein said bottom surface comprises a surface topography configured to obtain a conditioning effect in a polishing pad during operation.

5. The retaining member of claim 2, wherein said upper portion includes a flexible material.

6. The retaining member of claim 4, wherein said surface topography includes a plurality of protrusions.

7. The retaining member of claim 4, wherein said surface topography includes portions having a roughness on a microstructure scale.

8. A polishing head for a CMP apparatus, comprising:

a support surface configured to receive a substrate; and

a retaining member configured to laterally fix the substrate on the support surface, the retaining member being partially comprised of silicon carbide.

9. The polishing head of claim 8, wherein said retaining member comprises an upper portion and a lower portion, the lower portion having a bottom surface that is comprised of silicon carbide.

10. The polishing head of claim 8, wherein a plurality of slurry channels are formed in a bottom surface of said retaining member.

11. The polishing head of claim 9, wherein said bottom surface comprises a surface topography configured to obtain a conditioning effect in a polishing pad during operation.

12. The polishing head of claim 9, wherein said upper portion includes a flexible material.

13. The polishing head of claim 11, wherein said surface topography includes a plurality of protrusions.

14. The polishing head of claim 11, wherein said surface topography includes portions having a roughness on a microstructure scale.

15. A CMP apparatus, comprising:

a polishing pad attached to a polishing platen;

a polishing head including a retaining member that is partially comprised of silicon carbide; and

a pad conditioner having a surface portion in contact with the polishing pad and comprised of silicon carbide.

16. A retaining member, comprising:

a lower portion formed of a conductive non-metal material; and

an upper portion formed of a material other than said non-metal material, wherein said conductive non-metal material is more rigid than said other material.

17. The retaining member of claim 16, wherein said non-metal comprises silicon carbide.

18. The retaining member of claim 16, wherein a plurality of slurry channels are formed in a bottom surface of said retaining member.

19. The retaining member of claim 18, wherein said bottom surface comprises a surface topography configured to obtain a conditioning effect in a polishing pad during operation.

20. The retaining member of claim 18, wherein said upper portion includes a flexible material.

21. The retaining member of claim 19, wherein said surface topography includes a plurality of protrusions.

22. The retaining member of claim 19, wherein said surface topography includes portions having a roughness on a microstructure scale.

23. The retaining member of claim 16, wherein said lower portion comprises a material having a hardness of 15.0 GPa or more.

24. A polishing head for a CMP apparatus, comprising:

a support surface configured to receive a substrate; and

a retaining member configured to laterally fix said substrate on said support surface, said retaining member comprising a lower portion including a conductive nonmetal material, and an upper portion formed of a material other than said conductive non-metal material, wherein said other material is less rigid than said conductive non-metal material.

25. The polishing head of claim 24, wherein said non-metal material comprises silicon carbide.

26. The polishing head of claim 24, wherein a plurality of slurry channels are formed in a bottom surface of said retaining member.

27. The polishing head of claim 24, wherein a bottom surface of said retaining member comprises a surface topography configured to obtain a conditioning effect in a polishing pad during operation.

28. The polishing head of claim 24, wherein said upper portion includes a flexible material.

29. The polishing head of claim 27, wherein said surface topography includes a plurality of protrusions.

30. The polishing head of claim 27, wherein said surface topography includes portions having a roughness on a microstructure scale.

31. The polishing head of claim 24, wherein at least a bottom surface of said lower portion is comprised of a material having a hardness of 15.0 GPa or more.

* * * * *