US 20090047884A1

(19) **United States**
(12) **Patent Application Publication**
Swisher et al.
(10) **Pub. No.: US 2009/0047884 A1**
(43) **Pub. Date: Feb. 19, 2009**

(54) **CHEMICAL MECHANICAL POLISHING PAD STRUCTURE MINIMIZING TRAPPED AIR AND POLISHING FLUID INTRUSION**

(75) Inventors: **Robert G. Swisher**, Pittsburgh, PA (US); **William C. Allison**, Murrysville, PA (US)

Correspondence Address:
Deborah M. Altman
PPG Industries, Inc.
Law Department - Intellectual Property, One PPG Place - 39th Floor
Pittsburgh, PA 15272-0001

(73) Assignee: **PPG INDUSTRIES OHIO, INC.**, Cleveland, OH (US)

(21) Appl. No.: **11/839,243**

(22) Filed: **Aug. 15, 2007**

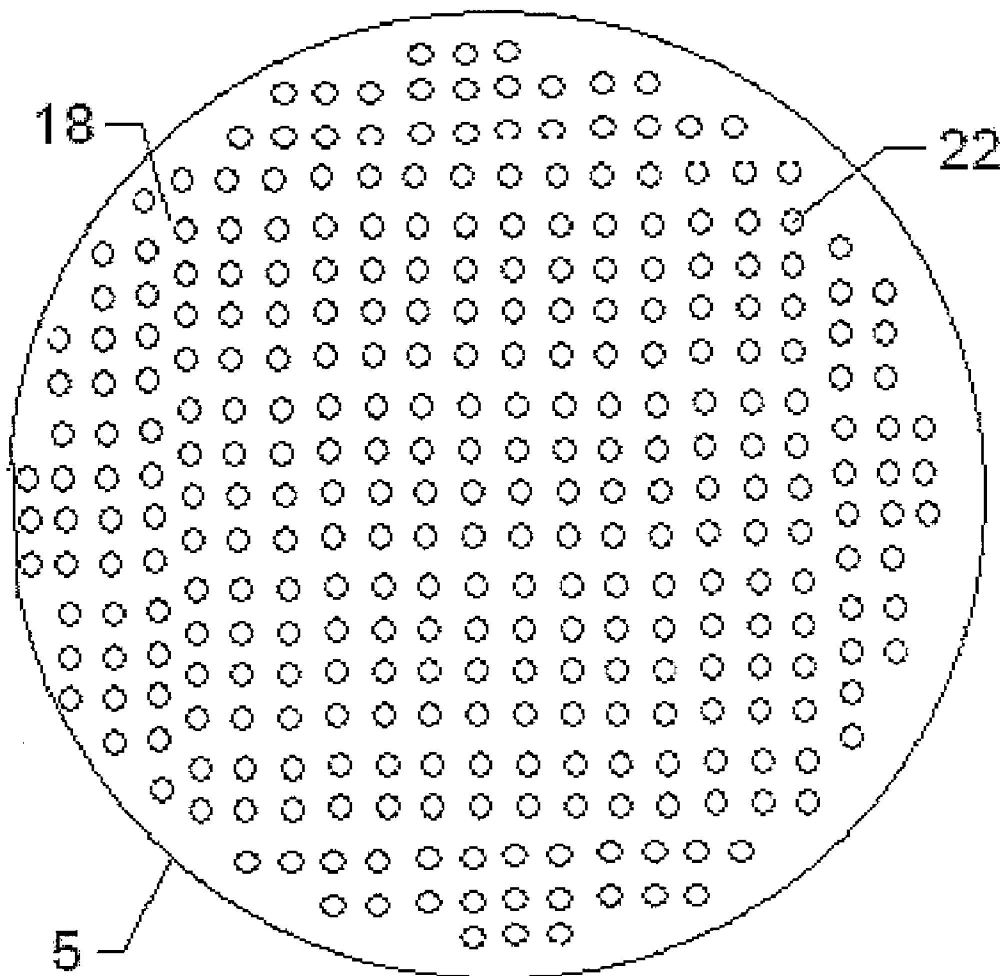
Publication Classification

(51) **Int. Cl.**
B24B 29/02 (2006.01)
B24B 7/04 (2006.01)

(52) **U.S. Cl.** **451/533**

(57) **ABSTRACT**

A polishing pad is attachable to a platen to minimize trapped air and polishing fluid intrusion. The pad comprises a polishing layer having a polishing surface on a first end of the pad and a polishing layer peripheral edge extending away from the polishing surface; a gas impermeable attaching layer defines an attachment surface for securing the pad to the platen at an opposed second end of the pad, the attaching layer having an attaching layer peripheral edge extending away from the attachment surface, wherein a peripheral edge of the pad extends from the polishing surface to the attaching surface formed of the peripheral edges of each pad layer; and a plurality of openings extending through the attaching layer. During pad attachment, trapped air flows through the attaching layer openings and out of the peripheral edge of the pad at a position spaced from the attaching layer peripheral edge.



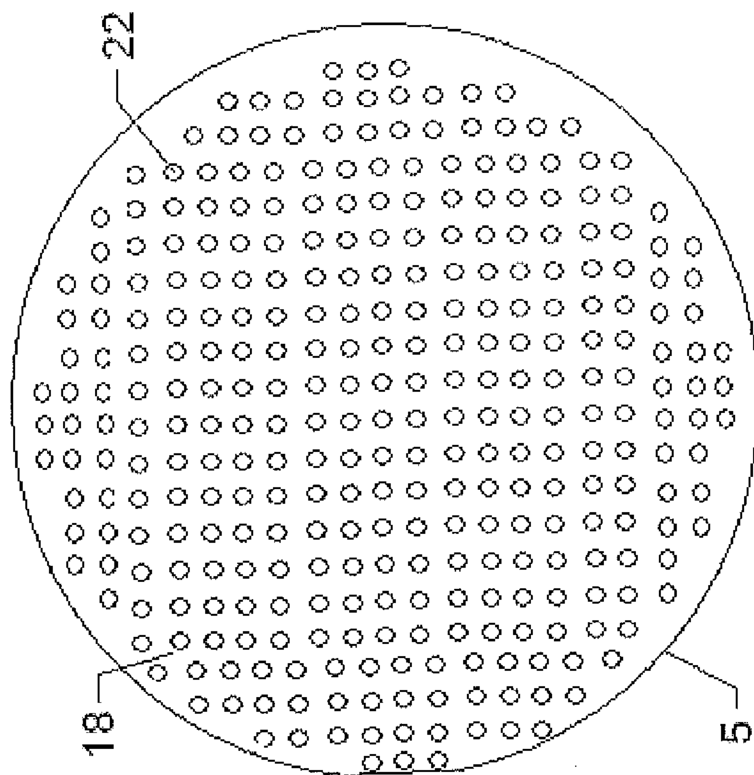


Figure 1

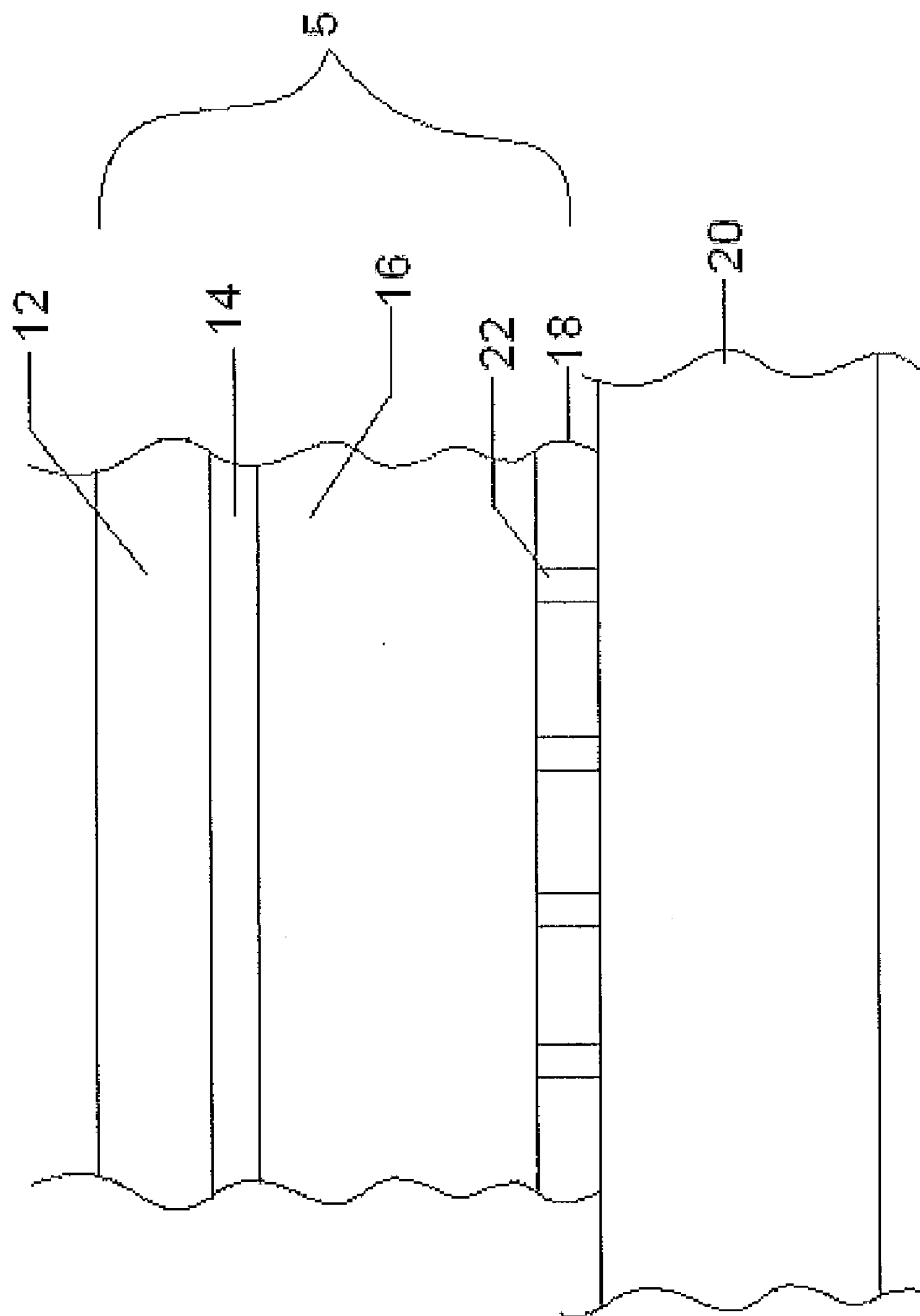


Figure 2

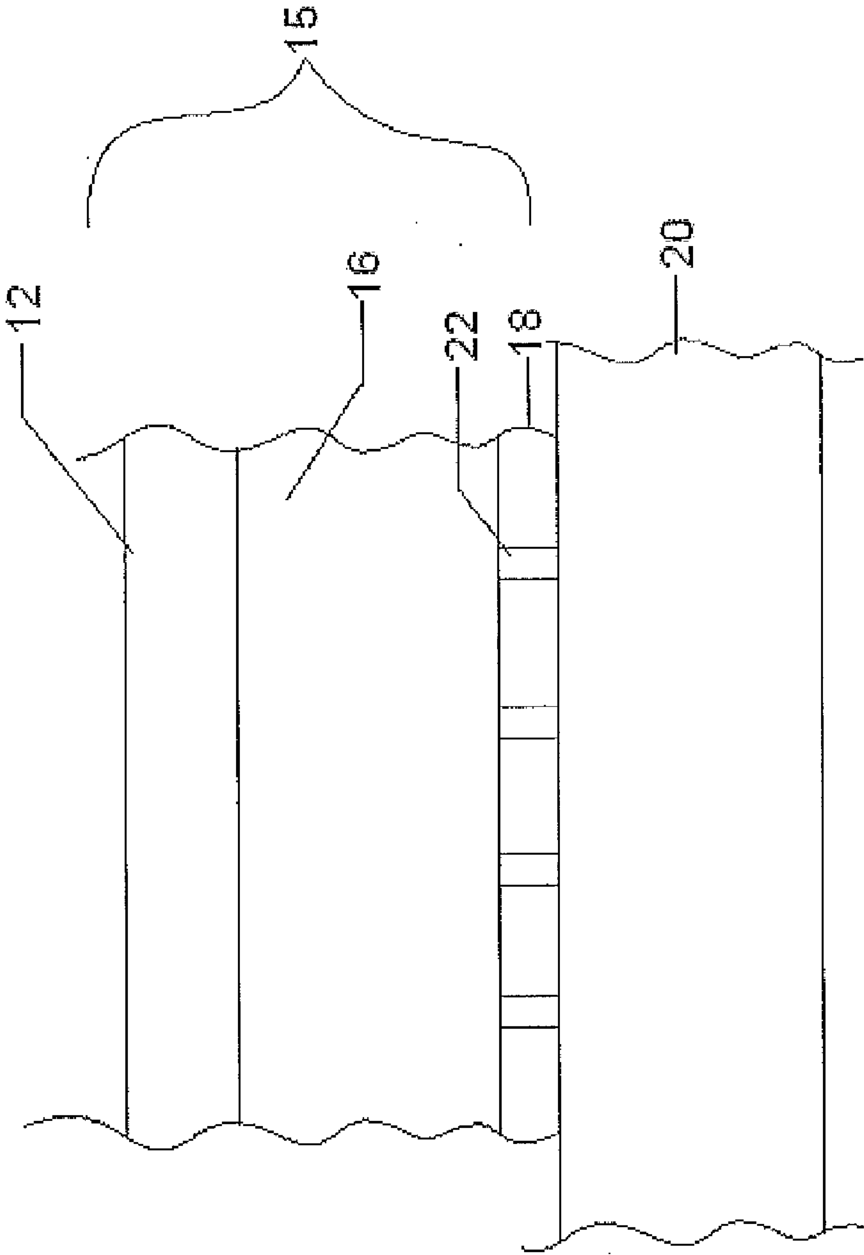


Figure 3

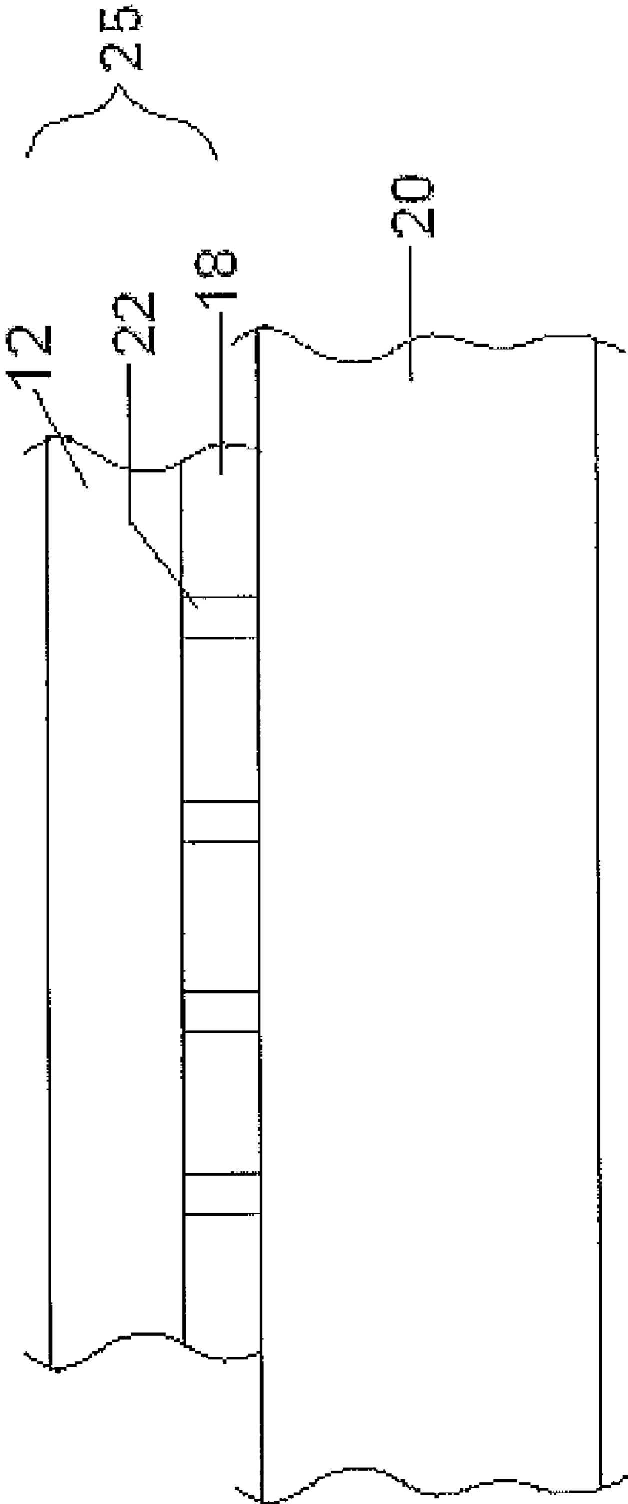


Figure 4

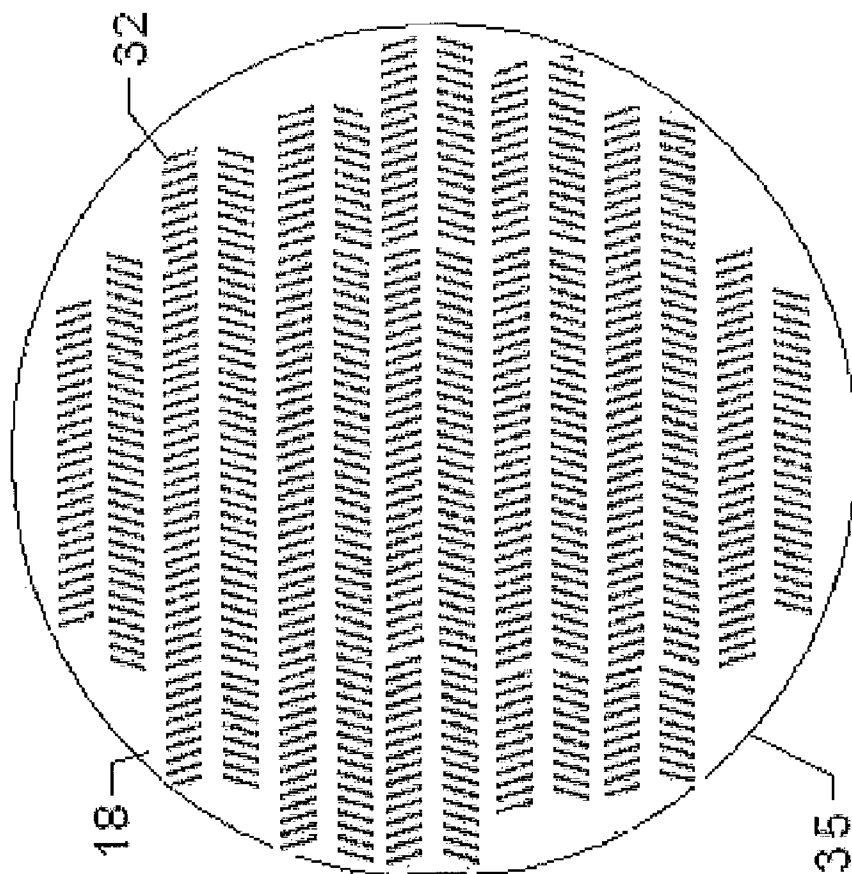


Figure 5

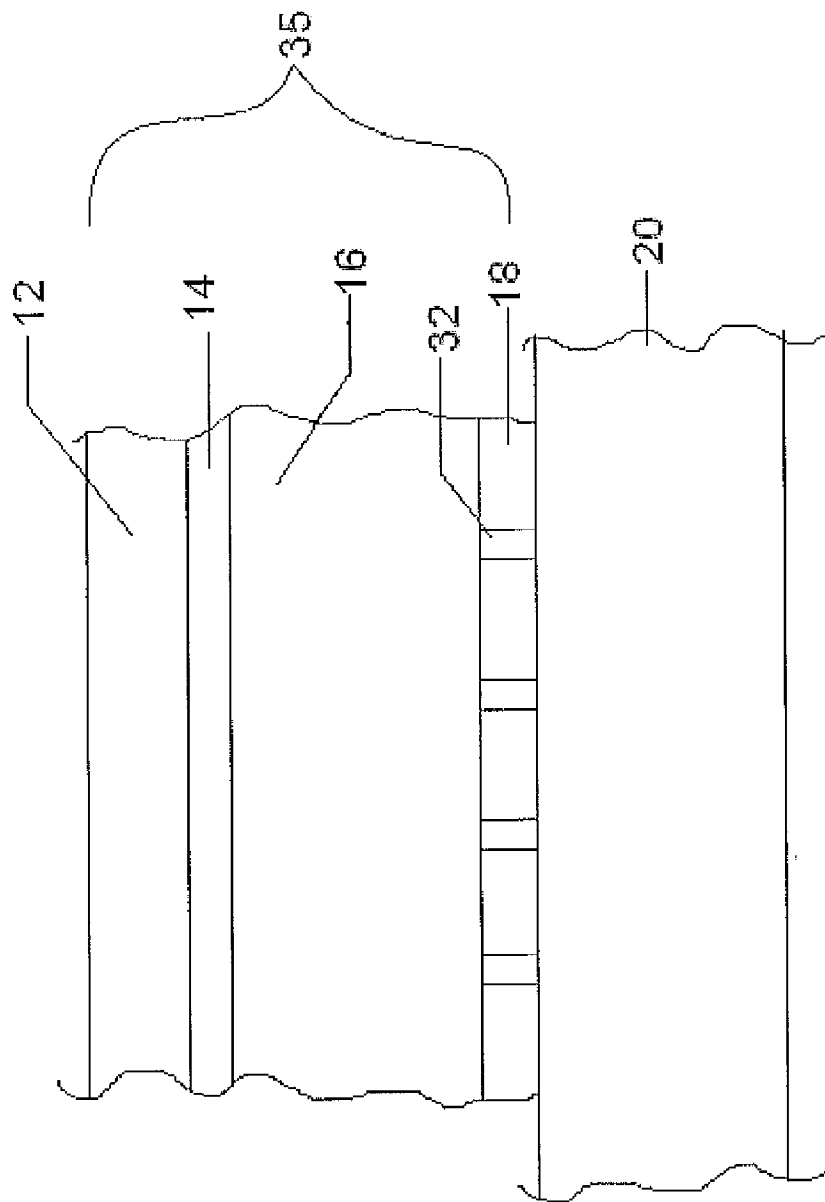


Figure 6

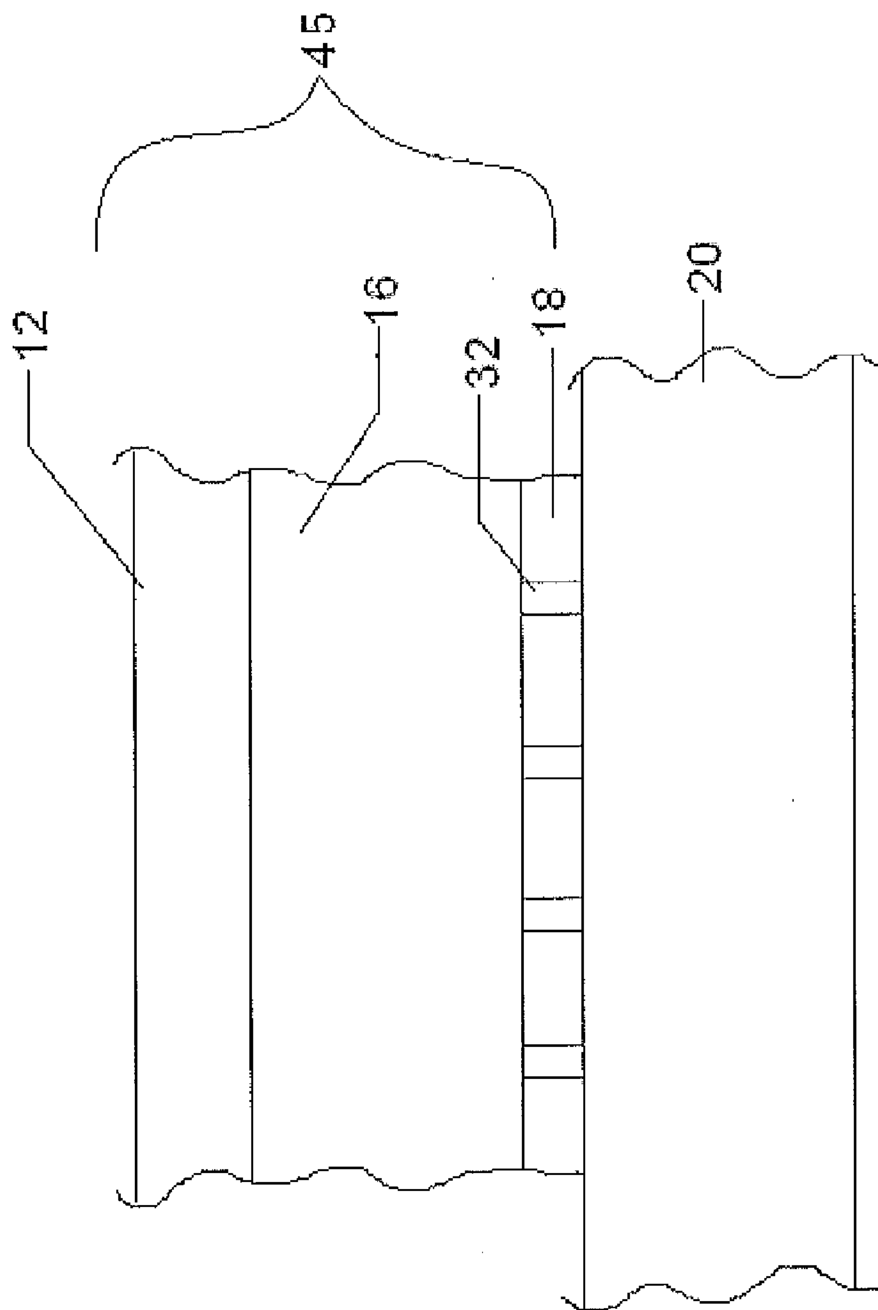


Figure 7

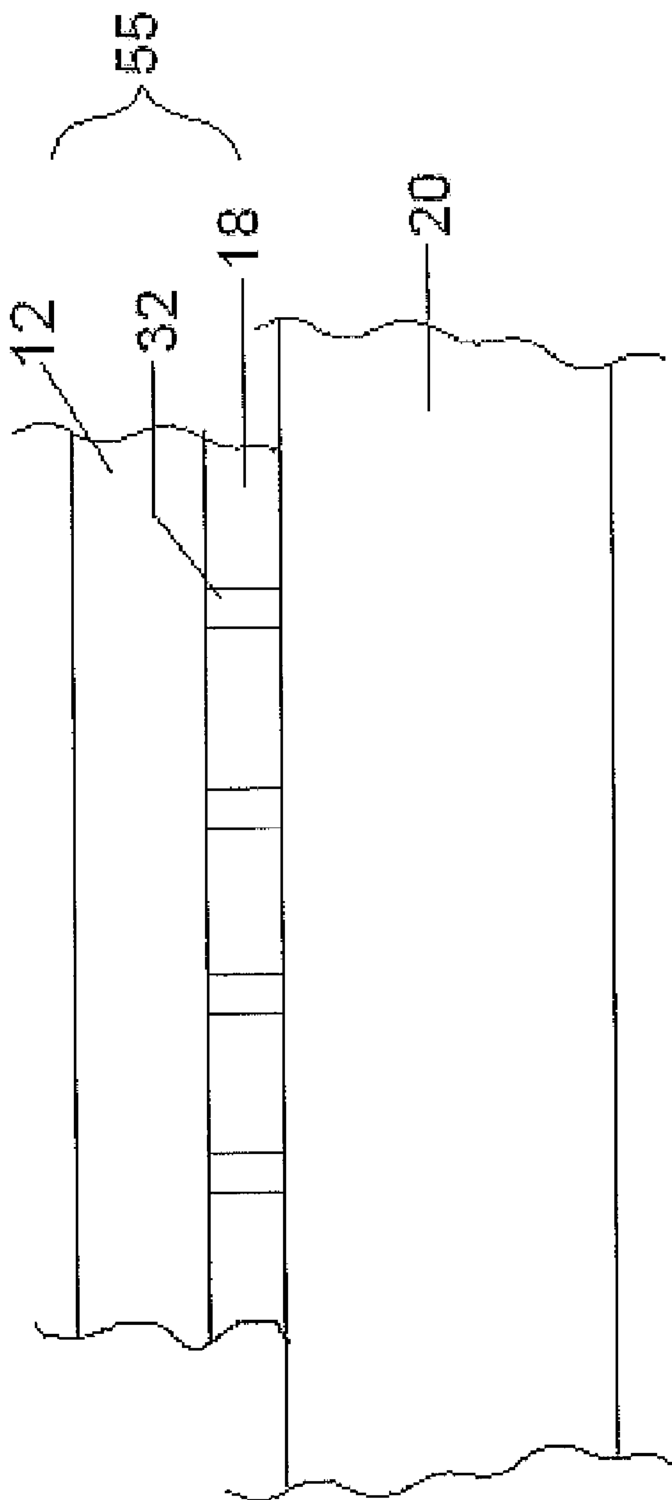


Figure 8

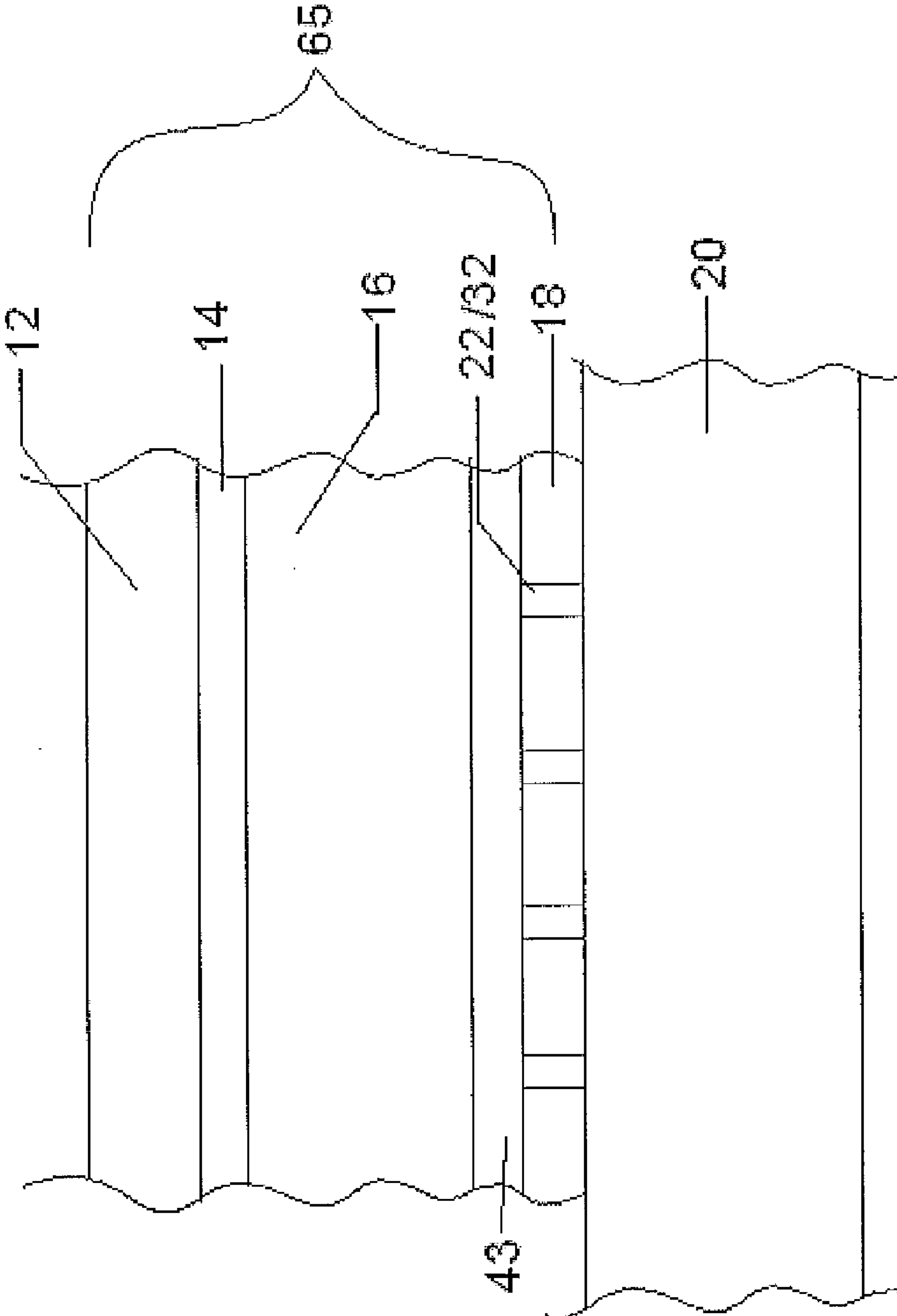


Figure 9

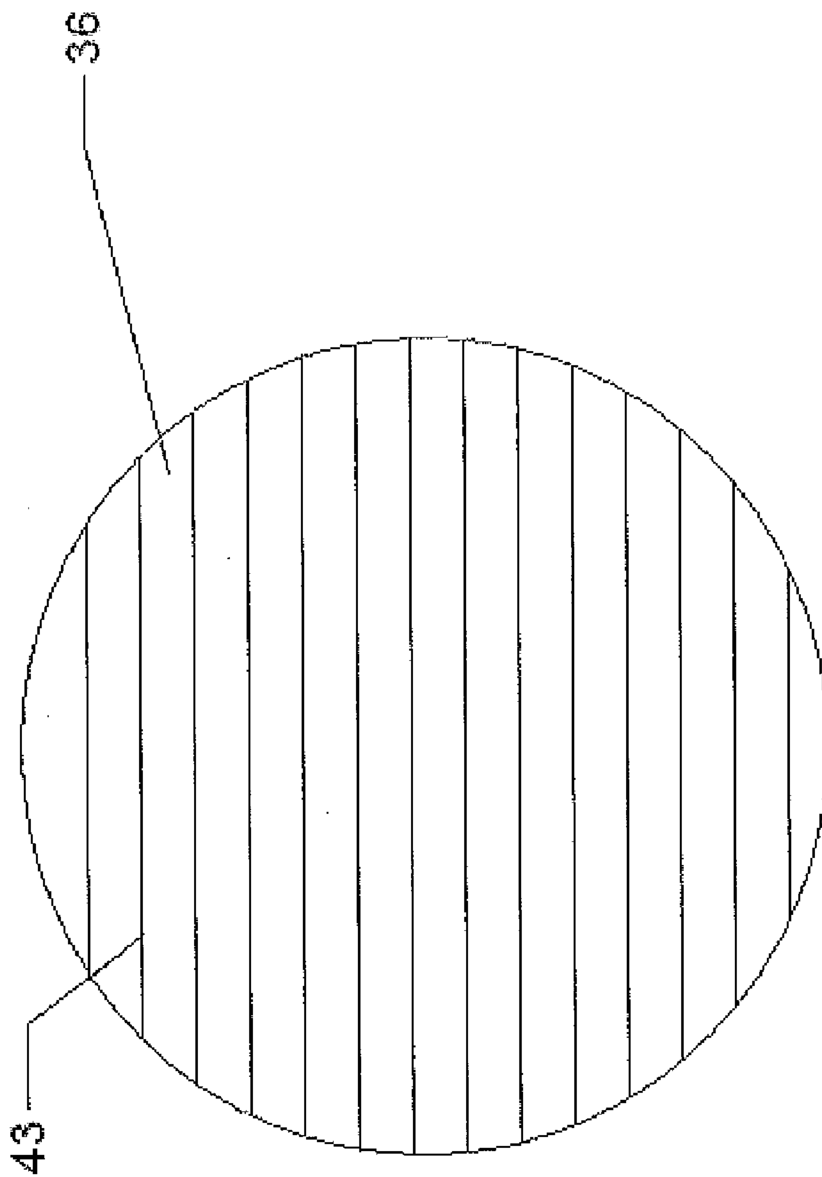


Figure 10

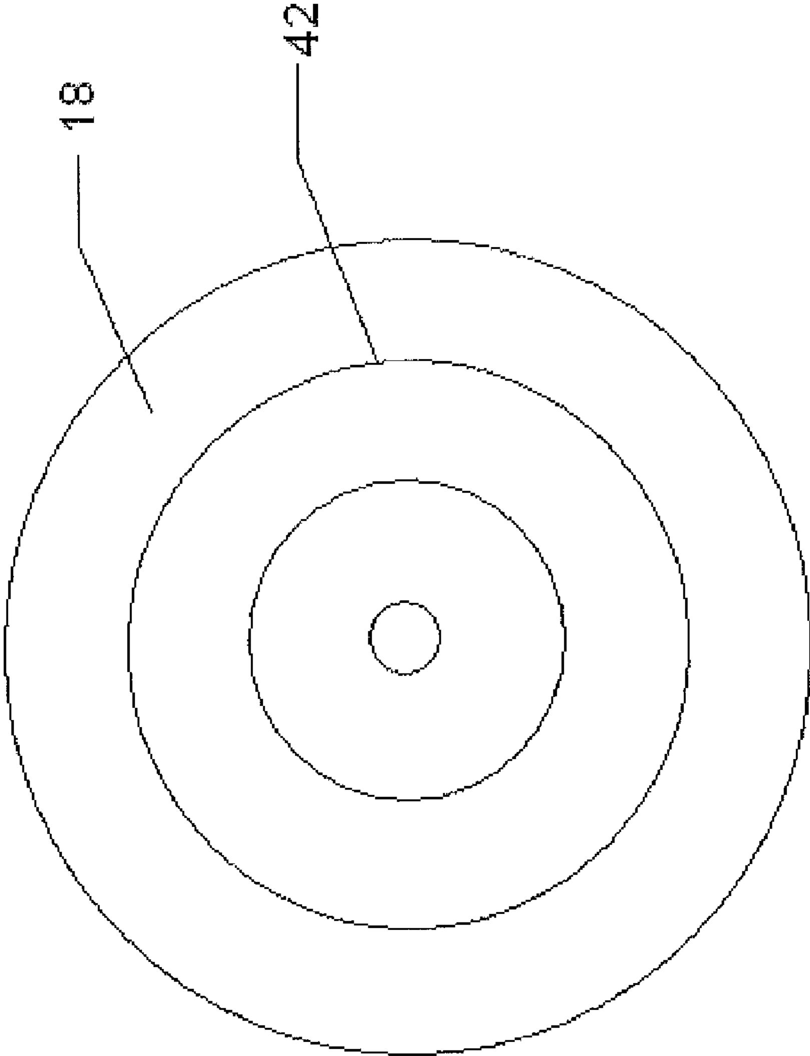


Figure 11

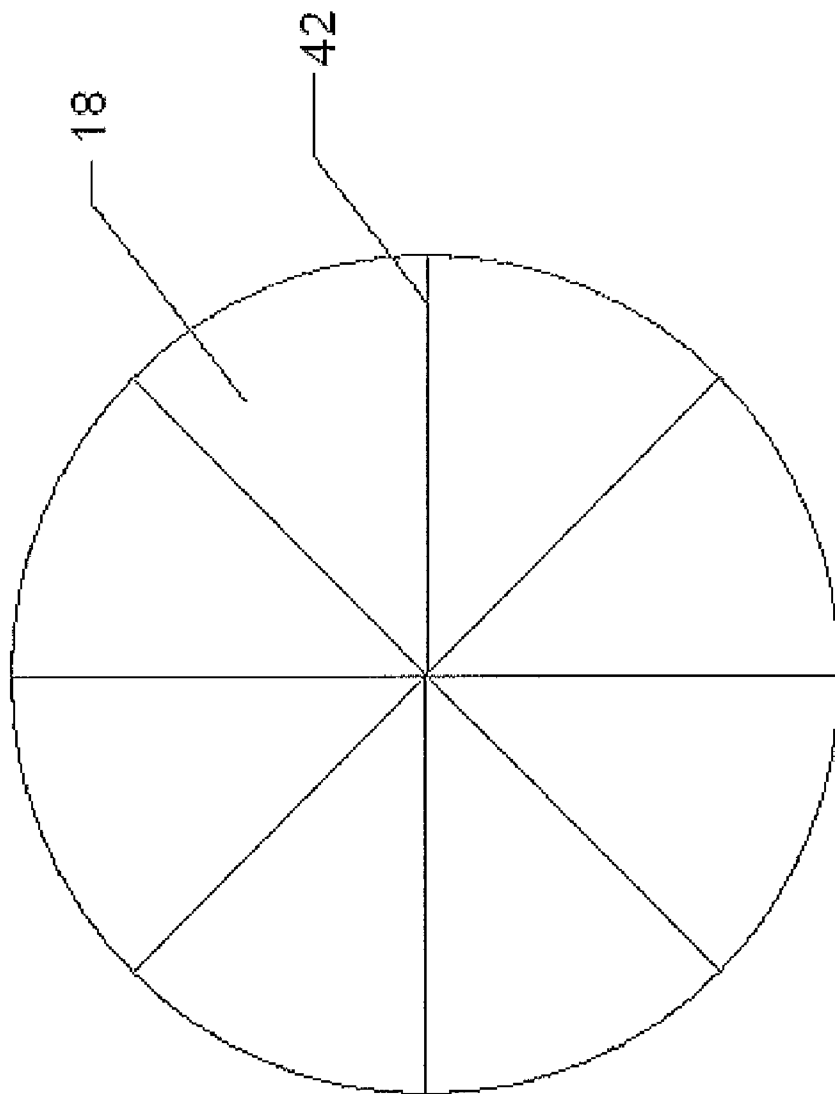


Figure 12

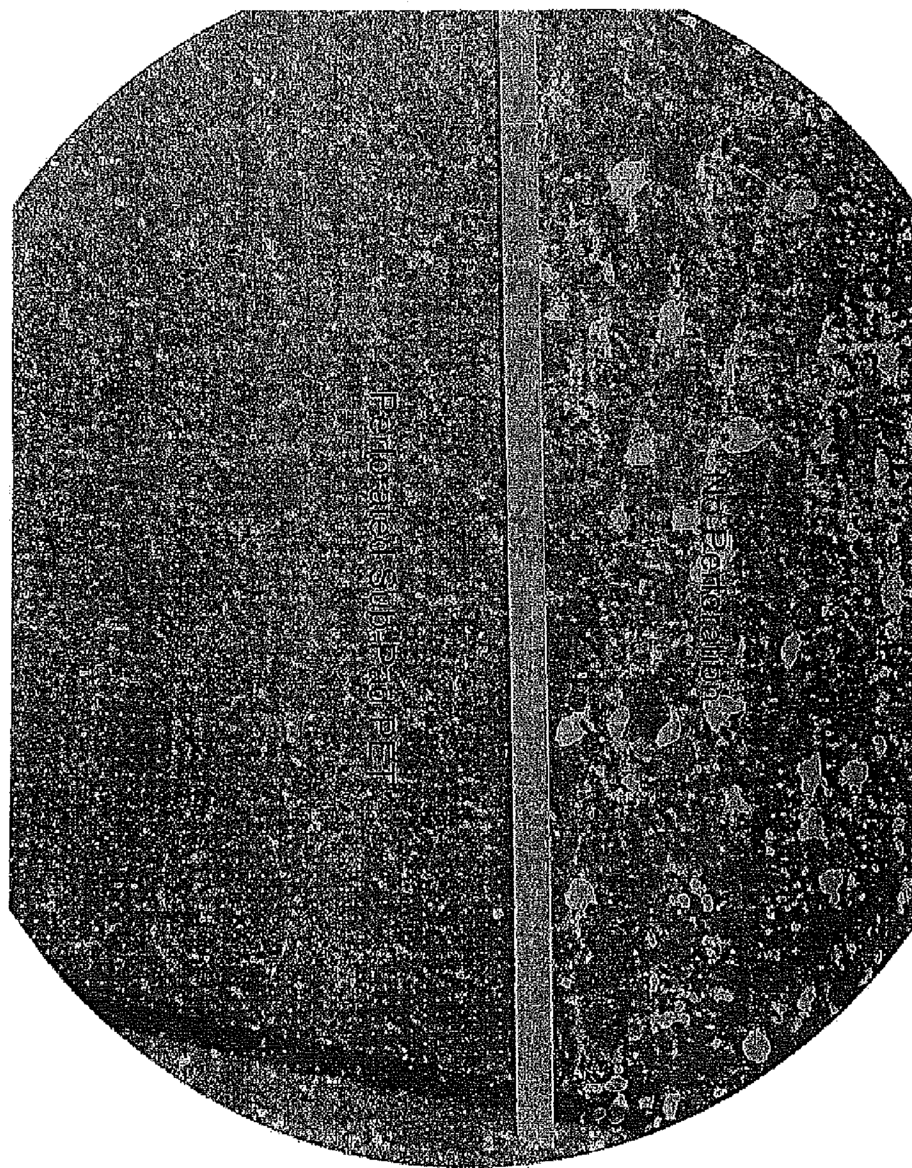


FIGURE 13

CHEMICAL MECHANICAL POLISHING PAD STRUCTURE MINIMIZING TRAPPED AIR AND POLISHING FLUID INTRUSION

FIELD OF THE INVENTION

[0001] The present invention relates to chemical mechanical polishing (CMP) pad structures, and more particularly the present invention relates to CMP pad structures that minimize trapped air and polishing fluid intrusion.

BACKGROUND OF THE INVENTION

[0002] Chemical-mechanical planarization or Chemical-mechanical polishing, commonly abbreviated CMP, is a technique used in semiconductor fabrication for planarizing the top surface of an in-process semiconductor wafer or other substrate. The process typically uses an abrasive and reactive chemical slurry, commonly a colloid, (collectively called the polishing fluid) in conjunction with a polishing pad and retaining ring, typically of a greater diameter than the wafer. The pad and wafer are pressed together by a dynamic polishing head and held in place by the retaining ring. The dynamic polishing head and pad are rotated, with different axes of rotation (i.e., not concentric) to remove material and tends to even out any irregular topography, making the wafer flat or planar. This is generally necessary in order to set up the wafer for the formation of additional circuit elements. For example, this might be necessary in order to bring the entire surface within the depth of field of a photolithography system, or to selectively remove material based on its position. Typical depth-of-field requirements are down to nanometer levels. Other systems using polishing belts have also been proposed, but rotary polishing pads are more common in the industry.

[0003] A polishing pad for a rotary CMP polishing apparatus is a relatively thin, planar, disk-shaped article. The pad includes at least a polishing layer having a polishing surface on a first end of the polishing pad and a polishing layer peripheral edge extending away from the polishing surface. If only the polishing layer is present the pad is typically referred to as a "single layer pad". The pad may be comprised of multiple layers which is sometimes referred to as a stacked pad construction. Within the meaning of this application each layer of a pad will have two opposed surfaces or faces, which are the circular faces of the layer and the surfaces are connected by the peripheral edge of the layer which forms the side of the layer. The "ends" of the pad are, within this application, the outer facing surfaces of the pad. A "peripheral edge" of the pad, within this application, extends from the polishing surface to other outer facing surface and is comprised of the peripheral edges of each layer of the pad (which may be one or more). Examples of single layer and stacked pads are commercially available, for example, from PPG Industries and Rohm & Haas Electronic Materials (R&H).

[0004] The CMP polishing pad typically is placed on a platen of a polishing machine, or on another mounting surface (herein collectively called platens), and secured to the platen by a pressure sensitive adhesive on the back surface of an attaching layer on the polishing pad. The attaching layer typically is a gas impermeable layer such as a polyethylene terephthalate (PET) type layer. Examples of attaching layers are sold by 3M, Inc., Adhesives Research, Inc. and Adchem, Inc., for example. As the polishing pad is placed on the platen, bubbles of air tend to get trapped between the attaching layer and the platen. Any trapped air can distend the relatively thin pad, thereby causing raised areas or bulges in the polishing surface of the polishing pad. The presence of trapped air prevents the air entrapping portion of the attaching layer from contacting and adhering to the platen. These bulges are very difficult to eliminate by conventional means, e.g., by forcing the air bubbles out from under the pad with a roller. Some sources have suggested that the bulges be manually pierced with a hand tool and then the pad around the pierced bulge can be pressed flat against the platen or other mounting surface to obtain the flattest possible polishing surface. This proposed manual process would be time-consuming, and some small bulges that remain undetected would cause bulges to remain in the polishing surface. Any bulges in the polishing surface of the pad tend to generate non-uniformities on the polished surface of the wafer work piece during polishing, thereby causing defects in the polished surface of the wafer. Also, bulges in the polishing surface of the pad can cause the surface to wear at a faster rate than the remainder of the pad, thus resulting in shortened pad life.

[0005] Other features which are included in some polishing pads for specific purposes include "windows" that allow for "through-the-pad" measurement of wafer flatness during polishing. Early versions of this feature merely consisted of an opening completely through the pad such that metering equipment within or below the platen can measure through the opening. In some instances the opening through the pad contains a transparent window member that will prevent polishing fluid from filling the window opening thereby disrupting the polishing process in the area of the window opening. It is difficult to design transparent window members in the window opening that allow for the through-the-pad wafer measurement but do not detrimentally effect the pad polishing. Regarding the focus of the present invention such a window opening, even when not filled with a window member, fails to adequately address the air entrapment during pad attachment as the window opening is limited to a single spot on the pad (i.e., the spot that must be aligned with the measuring equipment in the platen).

[0006] Also known is a type of pad used on polishing tools that pumps polishing fluid through the platen and through polishing fluid holes in the pad. In such a pad polishing fluid holes are provided in a grid work of about tol inch spacing along the pad. The holes extend entirely through the pad and generally must be aligned with associated polishing fluid supply features in a specialized platen. These polishing fluid holes, however, generally are spaced too far apart to adequately minimize air entrapment during attachment. Regardless of other design features, the issue of air entrapment remains.

[0007] U.S. Pat. No. 6,699,104 attempted to address this trapped air problem by providing a polishing pad having a polishing layer and a bottom attaching layer below the polishing layer. The attaching layer has an adhesive bottom surface and a plurality of hollow air transmitting pathways or channels in the attaching layer extending to the peripheral edge of the adhesive layer. When the attaching layer bottom surface is applied to a platen, air which is trapped between the adhesive backed attaching layer and the platen can escape through the channels. The channels however must be "sealed" with a special edge sealing tool that minimizes the channel openings at the peripheral edge such that air can escape but the channel is below a minimum capillary level to allow polishing fluid to enter, based upon the "surface tension" of a

given polishing fluid. This edge sealing technique seems to be too time consuming or impractical to be widely commercially adopted.

[0008] U.S. Pat. No. 6,197,397 discloses an adhesive that has a "micro-replicated topography" prepared from contacting a micro-embossed pattern to a layer of adhesive. The patent proposes that when an adhesion interface is established between the layer of adhesive and a supporting substrate, the topography of the adhesive surface controls the performance of the adhesion interface. The reference suggests that the adhesive surfaces also have the advantage of providing micro-channels for fluid egress for an effective period of time. In practice, however, it has been noted that upon application of CMP pads with pressure sensitive adhesives such channels in the adhesive itself will be "rolled" out with the application of the pad and therefore will not be effective to allow trapped air to escape, for example, where the pad is constructed of a flexible material.

[0009] Thus there remains a need to expand the development of CMP pad structures that minimize trapped air during pad attachment and minimize polishing fluid intrusion at the pad and platen interface.

SUMMARY OF THE INVENTION

[0010] It is noted that, as used in this specification and the appended claims, the singular forms "a," "an," and "the" include plural referents unless expressly and unequivocally limited to one referent. The "top" of a CMP pad will reference the polishing layer end of the pad, and the "bottom" of a CMP pad will reference the attaching surface end of the pad, but "top" and "bottom" are merely used for relative orientation and not intended to define operational orientation of the pad itself (e.g. the polishing layer "top" may be vertically below the attaching layer "bottom" of the pad in certain polishing machines). The reference to "through" a pad layer indicates that the structure (e.g. an opening) is extending from one surface of the layer to the opposed surface of the layer. The reference to "across" a pad layer will indicate that the structure (e.g. a channel") is extending along a given surface of the pad layer but not "through" the layer as defined herein.

[0011] For the purposes of this specification, unless otherwise indicated, all numbers expressing quantities of ingredients, reaction conditions, and other parameters used in the specification and claims are to be understood as being modified in all instances by the term "about." Accordingly, unless indicated to the contrary, the numerical parameters set forth in the following specification and attached claims are approximations that may vary depending upon the desired properties to be obtained by the present invention. At the very least, and not as an attempt to limit the application of the doctrine of equivalents to the scope of the claims, each numerical parameter should at least be construed in light of the number of reported significant digits and by applying ordinary rounding techniques.

[0012] All numerical ranges herein include all numerical values and ranges of all numerical values within the recited numerical ranges. Notwithstanding that the numerical ranges and parameters setting forth the broad scope of the invention are approximations, the numerical values set forth in the specific examples are reported as precisely as possible. Any numerical value, however, inherently contain certain errors necessarily resulting from the standard deviation found in their respective testing measurements.

[0013] The various embodiments and examples of the present invention as presented herein are each understood to be non-limiting with respect to the scope of the invention. In accordance with one embodiment of the invention a polishing pad is configured to be removably attached to a platen in a manner minimizing trapped air and polishing fluid intrusion. The pad comprises a polishing layer having a polishing surface on a first end of the polishing pad and a polishing layer peripheral edge extending away from the polishing surface; a gas impermeable attaching layer defining an attachment surface for securing the polishing pad to a platen at a second end of the polishing pad which is opposed from the first end, the attaching layer having an attaching layer peripheral edge extending away from the attachment surface, wherein a peripheral edge of the pad extends from the polishing surface to the attaching surface formed of the peripheral edges of each layer of the pad; and a plurality of openings extending through the attaching layer. During pad attachment trapped air can flow through the openings in the attaching layer and out of the peripheral edge of the pad at a position spaced from the attaching layer peripheral edge. The attaching layer peripheral edge has no openings which minimize the polishing fluid from being directed to the attaching layer and platen interface.

[0014] These and other advantages of the present invention will be described in the following description taken together with the attached figures in which like reference numeral represent like elements throughout.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. **1** is a schematic bottom plan perspective view of a CMP pad structure that minimizes trapped air and polishing fluid intrusion in accordance with one embodiment of the present invention;

[0016] FIG. **2** is an enlarged schematic section view of the CMP pad structure of FIG. **1**;

[0017] FIG. **3** is an enlarged schematic section view of a modified CMP pad structure that minimizes trapped air and polishing fluid intrusion in accordance with another embodiment of the present invention;

[0018] FIG. **4** is an enlarged schematic section view of a further modified CMP pad structure that minimizes trapped air and polishing fluid intrusion in accordance with another embodiment of the present invention;

[0019] FIG. **5** is a schematic bottom plan perspective view of a CMP pad structure that minimizes trapped air and polishing fluid intrusion in accordance with another embodiment of the present invention;

[0020] FIG. **6** is an enlarged schematic section view of the CMP pad structure of FIG. **5**;

[0021] FIG. **7** is an enlarged schematic section view of a further modified CMP pad structure that minimizes trapped air and polishing fluid intrusion in accordance with another embodiment of the present invention;

[0022] FIG. **8** is an enlarged schematic section view of a further modified CMP pad structure that minimizes trapped air and polishing fluid intrusion in accordance with another embodiment of the present invention;

[0023] FIG. **9** is an enlarged schematic section view of a further modified CMP pad structure that minimizes trapped air and polishing fluid intrusion in accordance with another embodiment of the present invention;

[0024] FIG. **10** is a schematic bottom plan view of a sub-pad layer structure for the CMP pad structure of FIG. **9**;

[0025] FIG. **11** is a schematic bottom plan perspective view of a CMP pad structure that minimizes trapped air and polishing fluid intrusion in accordance with another embodiment of the present invention;

[0026] FIG. **12** is a schematic bottom plan view of a sub-pad layer structure for the CMP pad structure of FIG. **11**; and

[0027] FIG. **13** comparative illustration of the minimization of the trapped air with the CMP pad structure in accordance with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0028] FIGS. **1-2** illustrate a rotary circular CMP polishing pad **5** that minimizes trapped air and polishing fluid intrusion in accordance with one embodiment of the present invention and that is configured to be removably attached to a platen **20**. The pad **5** can be of any desired diameter that is associated with conventional platens **20**. Typical diameters for pads **5**, in inches, are 10, 12, 16.35, 20, 22, 22.5, 23.62, 24, 27, 28, 29.13, 30, and 32.

[0029] The pad **5** is a stacked pad formed of several pad layers. Within this application, adjacent pad layers are attached to each other in conventional fashion. Adhesive or direct casting (layers directly bonded together) are typically utilized to attach adjacent pad layers, but any conventional attachment technology can be used for adjacent layers (e.g. ultrasonic welding of certain materials).

[0030] The term "Layer" within this application defines a structural pad layer, which is generally a film, foam, fiber structure, or the like. The term "layer" does not include the typical adhesive material (pressure sensitive adhesives) used solely to bond adjacent structural pad layers together, even though such materials are sometimes referenced in the art as "adhesive layers", "adhesive films" and "adhesive film layers." The pressure sensitive adhesives typically have no meaningful material strength by themselves, i.e. no significant tensile strength, no significant modulus, etc. The adhesive is present only to hold the structural pad elements or pad layers together and does not generally form a structural aspect of the pad. Pressure sensitive adhesives form a bond by the application of light pressure to marry the adhesive with the adherend(s). They are designed with a balance between flow and resistance to flow. The bond forms because the adhesive is soft enough to flow, or wet, the surface(s) to be adhered. The bond has strength (i.e., bond strength) because the adhesive has sufficient resistance to flow when stress is applied to the bond. Once the adhesive and the surface(s) to be adhered are in close proximity, molecular interactions, such as van der Waals forces, become involved in the bond, contributing significantly to its ultimate strength. Pressure sensitive adhesives (PSAs) are designed for either permanent (pad layer to pad layer) or removable applications (pad to platen). Consequently the term "layer" within the meaning of this application is a structural pad layer, such as film, foam, fibers and the like, having no substantial flow (ability to wet a bonding surface) under ambient conditions.

[0031] It should also be apparent that a pad "layer" within the meaning of this application may be attached to an adjacent pad "layer", as noted above, without a separate "adhesive". For example a pad layer can be a thermoplastic resin that is placed in contact with an adjacent layer or layers in a heated state and will bond directly thereto as the resin sets (e.g. a hot melt adhesive).

[0032] The pad **5** includes a polishing layer **12** having a polishing surface on a first end of the polishing pad **5** and a polishing layer peripheral edge extending away from the polishing surface.

[0033] The polishing layer **12** may be formed in any conventional fashion, and can have, for example, an open cell structure or a closed cell structure. Representative non limiting examples of the material for the polishing layer **12** of the CMP pad **5** include but are not limited to felts and polymer impregnated felts, such as those described in U.S. Pat. No. 4,728,552, commercially available under the trade name SUBA™ IV pads from R&H; microporous synthetic leather, available as POLITEX™ pads from R&H; porous polymer sheet, available as IC1000 and IC1010 from R&H, and FastPad™ CS7 and FastPad™ S7 available from PPG Industries, Inc.; and unfilled textured polymer sheet. The polishing layer typically will be 0.050 to 0.080 inches in thickness, but any desired polishing layer thickness can be utilized.

[0034] Adjacent the polishing layer **12**, in pad **5**, is a barrier layer **14** that is attached to the polishing layer **12**. The barrier layer **14** typically is a gas and liquid impermeable layer provided between the polishing layer and a sub-pad layer **16**, and minimizes the movement of polishing fluid into the sub-pad layer **16**. Where the barrier layer **14** is formed as a double sided adhesive structure the layer **14** serves as an attaching structure for easily assembling the stacked pad **5**.

[0035] Non-limiting examples of materials suitable for use as the barrier layer include polymer and metallic films and foils. Examples of polymers that may be used as the barrier layer in the present invention include polyesters and co-polyesters, such as PET and PET glycol; polyolefin, such as low density polyethylene, high density polyethylene ultra-high molecular weight polyethylene and polypropylene; polyvinylchloride; cellulose-based polymers, such as cellulose acetate and cellulose butyrate; acrylic; polycarbonate; and polyamide, such as nylon 6/6 and nylon 6/12; Examples of metallic films that may be used in the barrier layer of the present invention include, but are not limited to: aluminum; copper; brass; nickel; and stainless steel. The barrier layer **14** typically will be 1 to 4 mils (about 25 to 100 micrometers) in thickness, but any desired barrier layer **14** thickness can be utilized.

[0036] A gas permeable sub-pad layer **16** is adjacent the barrier layer **14**. The gas permeable sub-pad layer **16** will allow gas, such as trapped air that enters the sub-pad layer **16** to flow out of the sub-pad layer peripheral edge (e.g. the side) of the pad **5**. The gas permeable sub-pad layer **16** can be formed as an open cell foam or non-woven fiber mat or any other known gas permeable CMP pad layer constructions.

[0037] Non-limiting examples of materials suitable for the gas permeable sub-pad layer include but are not limited to non-woven fabric impregnated with polyurethane as describe in U.S. Pat. No. 4,728,552, i.e. polyurethane impregnated felt, and open cell foam sheet made of polyurethane, natural rubber, synthetic rubber, and thermoplastic elastomer. An example of a suitable commercial material is a subpad which is available from R&H under the tradename SUBA™ IV. The sub-pad layer **16** typically will be 0.030 to 0.060 inches in thickness, but any desired sub-pad layer **16** thickness can be utilized.

[0038] A gas impermeable attaching layer **18** is adjacent the sub-pad layer **16** in pad **5** and defines an attachment surface for securing the polishing pad **5** to the platen **20** at a second end of the polishing pad **5** (which is opposed from the

first end of the pad **5** at the polishing surface). The attaching layer **18** has an attaching layer peripheral edge extending away from the attachment surface. The peripheral edge of the pad **5** extends from the polishing surface to the attaching surface and is formed of the peripheral edges of each layer of the pad **5**, namely the peripheral edges of the polishing layer **12**, the barrier layer **14** the sub-pad layer **16** and the attaching layer **18**. The gas impermeable attaching layer **18** will, without other structure, trap air between the layer **18** and the platen which can be detrimental to the operation of the pad **5** as discussed above.

[0039] The attaching layer **18** can, effectively, be formed substantially the same as barrier layer **14** discussed above. The attaching layer **18** will typically be 1 to 4 mils in thickness, but any conventional or desired attaching layer **18** thickness can be utilized.

[0040] The present invention provides a plurality of openings **22** extending through the attaching layer **18**, whereby trapped air, during pad attachment, can flow through the openings **22** in the attaching layer **18** and out of the peripheral edge of the pad **5** at a position spaced from the attaching layer peripheral edge. The plurality of openings **22** may form a pattern of openings **22** on the attaching layer **18** such as the grid work of openings **22** as shown in FIG. **1**, or they may be randomly arranged. The spacing between adjacent openings **22** is less than about ¾", more specifically less than ½" between openings. The pattern of openings **22** on the attaching layer **18** is about ¼" between openings **22** (this is the spacing between each adjacent opening **22** in the same row or column of the grid pattern) which are formed of substantially circular holes about 0.02" in diameter. In a random distribution of openings **22**, the spacing measurement (e.g. an opening **22** distribution with less than ¾" between openings **22**, or an opening **22** distribution with less than ½" between openings **22** or an opening **22** distribution with about ¼" between openings **22**) for the random distribution of openings **22** would define the maximum spacing between adjacent openings **22** in the distribution, rather than a constant spacing.

[0041] Preferably the size of the openings **22** should be large enough to allow the free flow of trapped air through the openings **22** during attachment of the pad **5**, and small enough not affect the support or attachment of the pad **5**. The above sizes and spacing for the opening **22** have been found to be effective. During attachment the pressure sensitive adhesive may cover an opening **22**, but the air pressure of the trapped air beneath the pad **5** adjacent the opening **22** will force through the opening **22** as the adhesive has no significant material strength by itself. Where the openings **22** are made extremely small (i.e. smaller than a minimum effective area) the adhesive may contain enough strength to keep the opening **22** sealed and keep air trapped. The minimum effective area of the opening **22** will likely vary with different adhesives and attaching layer **18** forming material. The specific ranges of the minimum and maximum effective areas of openings **22** for any given adhesive and layer **18** are believed to be discovered through routine experimentation.

[0042] The openings **22** may be formed in the layer **18** after the formation of the pad **5** or after formation of the layer **18**, such as using a perforating roller on either the pad **5** or the layer **18** (before layer **18** is attached to the pad **5**). Alternatively the opening **22** could be formed in the layer **18** with the formation of the layer **18**, such as casting the openings in place (e.g. removable pins). However, a perforating roller on the formed layer **18**, or formed pad **5**, seems more practical.

[0043] The pad **5** as shown and described minimizes trapped air and the intrusion of polishing fluid into the interface between the platen **20** and attaching layer **18**. The polishing fluid intrusion is minimized because the attaching layer **18** does not have openings or channels at its peripheral edge. The trapped air is directed "up and out" in the present invention. This construction will help avoid having the polishing fluid that may be sitting on the platen **20** adjacent the attaching layer **18** from being channeled across the interface between the platen **20** and attaching layer **18**.

[0044] FIG. **3** is an enlarged schematic section view of a modified CMP pad **15** that minimizes trapped air and polishing fluid intrusion in accordance with another embodiment of the present invention. The pad **15** is a stacked pad similar to pad **5**. The sole distinction is that pad **15** does not include a barrier layer **14**, and has the polishing layer **12** attached directly to the sub-pad **16**. The function and operation of the pad **15** is essentially the same as pad **5** described above. Where polishing layer **12** is gas permeable the trapped air can escape though the polishing layer **12** as well, but the essence of the invention remains unchanged. The invention is not limited to a single pad type.

[0045] FIG. **4** is an enlarged schematic section view of a further modified CMP pad **25** that minimizes trapped air and polishing fluid intrusion in accordance with another embodiment of the present invention. The pad **25** is generally not considered a "stacked" pad, but is similar to pads **5** and **15**. The sole distinction between pad **25** and pad **15** is that pad **25** does not include a sub-pad layer **16**, and has the polishing layer **12** attached directly to the attaching layer **18**. The attaching layer **18** is sometimes considered as a mechanism for attaching the pad to the platen **20**, such that pad **25** can be considered as a "single" layer pad type. The function and operation of the pad **25** is essentially the same as pads **5** and **15** described above. Here polishing layer **12** is gas permeable and the trapped air can escape though the polishing layer **12**. This embodiment is to again demonstrate that the present invention is not limited to a single pad type.

[0046] FIGS. **5-6** illustrate a rotary circular CMP polishing pad **35** that minimizes trapped air and polishing fluid intrusion in accordance with another embodiment of the present invention and that is configured to be removably attached to a platen **20**. The pad **35** is a stacked pad similar to pad **5**. The sole distinction is that pad **35** forms the openings, now **32**, in the attaching layer **18** as elongated slits as shown in FIG. **5**. The plurality of opening **32** form a pattern of openings on the attaching surface **18** as shown in FIG. **5** that is less than about ¾", more specifically less than ½" between openings. The pattern of openings **32** on the attaching surface **18** is about ¼" between adjacent openings **32** which are formed of substantially slits about 0.02" in width. The length of the slits is not critical. The function and operation of the pad **35** is essentially the same as pad **5** described above.

[0047] FIG. **7** is an enlarged schematic section view of a modified CMP pad **45** that minimizes trapped air and polishing fluid intrusion in accordance with another embodiment of the present invention. The pad **45** is a stacked pad similar to pad **15** described above in connection with FIG. **3**. The sole distinction is that pad **45** utilizes slit type openings **32** similar to FIGS. **5-6** described above. The function and operation of the pad **45** is essentially the same as pads **5**, **15**, **25**, and **35** described above.

[0048] FIG. **8** is an enlarged schematic section view of a modified CMP pad **55** that minimizes trapped air and polish-

ing fluid intrusion in accordance with another embodiment of the present invention. The pad **55** is a single layer pad similar to pad **25** described above in connection with FIG. **4**. The sole distinction is that pad **55** utilizes slit type openings **32** similar to FIGS. **5-7** described above. The function and operation of the pad **55** is essentially the same as pads **5**, **15**, **25**, **35** and **45** described above.

[0049] All of the above embodiments illustrate a construction where the pad layer adjacent the attaching layer **18** is gas permeable. There are pad layers that are gas impermeable and such layers can be positioned adjacent the attaching layer **18**. FIGS. **9-12** address the construction of CMP pads in accordance with the present invention in which the pad layer adjacent the attaching layer **18** is gas impermeable (as well as the attaching layer **18**). FIG. **9** an enlarged schematic section view of a further modified CMP pad **65** that minimizes trapped air and polishing fluid intrusion in accordance with another embodiment of the present invention. The pad **65** is a stacked pad similar to pads **5** and **35**, and can use opening **22** or **32** or combinations thereof. The sole distinction is that sub-pad layer **16** of pad **65** is a gas impermeable layer, e.g. closed cell foam, and has channels **43** extending across the pad **65** to the peripheral edges of the sub-pad layer **16**. FIG. **10** is a schematic bottom plan view of the sub-pad layer **16** for the CMP pad **65** of FIG. **9**. Each opening **22** or **32** will align with and engage at least one channel **43**. The openings **22/32** and channels **43** combine to form an "up and out" pathway for trapped air similar to that describe above. It should be apparent that channels **43** can be formed in any layer that is adjacent the attaching layer **18**, as the present invention is not intended to be limited to a specific pad type. Further the opening **22/32** and channel **43** configurations are not limited either. For example, FIG. **11** is a schematic bottom plan perspective view of a CMP pad that minimizes trapped air and polishing fluid intrusion in accordance with another embodiment of the present invention in which the openings **32** are circular grooves. This configuration of openings would optimally be formed after the attaching layer **18** is attached to the pad. Further, FIG. **12** is a schematic bottom plan view of a sub-pad layer structure for the CMP pad structure of FIG. **11**. FIGS. **11** and **12** are merely to evidence the wide variety of modifications within the scope of the present invention, and these do not change the fundamental operation of the present invention.

EXAMPLE

[0050] An example of the present invention was formed by using a pad roller perforator on top of an attaching layer **18** of a stacked pad (similar to pad **5** above) wherein the perforator penetrated the layer **18** but not the sub-pad layer **16**, whereby any trapped air during pad mounting can escape through perforations into the sub-pad and out. The Pad perforator is a hand held roller about 4.0" wide, 15 point row, with points ¼" apart. A 3/16" thick sheet of clear acrylic was used as a representative platen **20** for mounting purposes to allow for observation.

[0051] The Pad was placed on laboratory bench top with attaching layer **18**, and release liner that will be removed upon pad attachment, facing up. The Perforator applied to about ½ of pad to be observed. A piece of opaque tape applied to other side of clear acrylic sheet to show perforated & un-perforated side of experimental pad. The experimental Pad was applied to the simulated plexiglass platen while pulling liner off. A one Kilogram weight was used to force any trapped air pockets out (to the extent possible) by moving it along the top (polishing) surface of the experimental pad as the liner was being pulled off. The results, illustrated in FIG. **13**, clearly shows elimination of air pockets on perforated side of the pad made in accordance with the present invention.

[0052] Whereas particular embodiments of this invention have been described above for purposes of illustration, it will be evident to those skilled in the art that numerous variations of the details of the present invention may be made without departing from the invention as defined in the appended claims.

What is claimed is:

1. A polishing pad configured to be removably attached to a platen, the pad comprising:

a polishing layer having a polishing surface on a first end of the polishing pad and a polishing layer peripheral edge extending away from the polishing surface;

a gas impermeable attaching layer defining an attachment surface for securing the polishing pad to a platen at a second end of the polishing pad which is opposed from the first end, the attaching layer having an attaching layer peripheral edge extending away from the attachment surface, wherein a peripheral edge of the pad extends from the polishing surface to the attaching surface formed of the peripheral edges of each layer of the pad; and

a plurality of openings extending through the attaching layer, whereby trapped air during pad attachment can flow through the openings in the attaching layer and out of the peripheral edge of the pad at a position spaced from the attaching layer peripheral edge.

2. The polishing pad of claim **1** wherein the pad layer adjacent the attaching layer is gas permeable and wherein the openings terminate before the polishing surface.

3. The polishing pad of claim **2** further including a gas-permeable sub-pad layer adjacent the attaching layer and the sub-pad layer having a sub-pad layer peripheral edge.

4. The polishing pad of claim **3** further including a gas impermeable barrier layer between the polishing layer and the sub-pad layer, whereby the trapped air flows out of the sub-pad layer peripheral edge.

5. The polishing pad of claim **1** wherein the plurality of openings form a pattern of openings on the attaching surface that is less than about ½" between openings.

6. The polishing pad of claim **5** wherein the pattern of openings on the attaching surface is about ¼" between openings which are formed of holes about 0.02" in diameter.

7. The polishing pad of claim **5** wherein the pattern of openings are formed by a series of circular holes terminating before the polishing surface.

8. The polishing pad of claim **5** wherein the pattern of openings are formed by a series of elongated slits terminating before the polishing surface.

9. The polishing pad of claim **1** wherein the pad layer adjacent the attaching layer is gas impermeable and further including a plurality of channels extending across the pad layer adjacent the attaching layer to the peripheral edge of the pad layer adjacent the attaching layer, wherein each opening through the attaching layer is aligned with at least one channel, whereby the trapped air flows out of the peripheral edge of the pad layer adjacent to the attaching layer.

10. The polishing pad of claim **9** wherein the plurality of openings form a pattern of openings on the attaching surface that is less than about ¾ between openings.

11. A polishing pad configured to be removably attached to a platen, the pad comprising:

a polishing layer having a polishing surface on a first end of the polishing pad and a polishing layer peripheral edge extending away from the polishing surface;

an attaching layer defining an attachment surface for securing the polishing pad to a platen at a second end of the polishing pad which is opposed from the first end, the attaching layer having an attaching layer peripheral edge extending away from the attachment surface,

a gas-permeable sub-pad layer adjacent the attaching layer and the sub-pad layer having a sub-pad layer peripheral edge, wherein a peripheral edge of the pad extends from the polishing surface to the attaching surface formed of the peripheral edges of each layer of the pad; and

a plurality of openings extending through the attaching layer and terminating before extending through the sub-pad layer, whereby trapped air during pad attachment can flow through the openings in the attaching layer and out of the peripheral edge of the pad at a position spaced from the attaching layer peripheral edge.

12. The polishing pad of claim **11** further including a gas impermeable barrier layer between the polishing layer and the sub-pad layer, whereby the trapped air flows out of the sub-pad layer peripheral edge.

13. The polishing pad of claim **11** wherein the plurality of openings form a pattern of openings on the attaching surface that is less than about ¾" between openings.

14. The polishing pad of claim **13** wherein the pattern of openings on the attaching surface is less than about ½" between openings.

15. The polishing pad of claim **13** wherein the pattern of openings on the attaching surface is about ¼" between openings which are formed of holes about 0.02" in diameter.

16. The polishing pad of claim **13** wherein the pattern of openings are formed by a series of circular holes.

17. The polishing pad of claim **13** wherein the pattern of openings are formed by a series of elongated slits.

18. A polishing pad configured to be removably attached to a platen, the pad comprising:

a polishing layer having a polishing surface on a first end of the polishing pad and a polishing layer peripheral edge extending away from the polishing surface;

a gas impermeable attaching layer defining an attachment surface for securing the polishing pad to a platen at a second end of the polishing pad which is opposed from the first end, the attaching layer having an attaching layer peripheral edge extending away from the attachment surface, wherein a peripheral edge of the pad extends from the polishing surface to the attaching surface formed of the peripheral edges of each layer of the pad;

sub-pad layer adjacent the attaching layer and the sub-pad layer having a sub-pad layer peripheral edge, wherein a peripheral edge of the pad extends from the polishing surface to the attaching surface formed of the peripheral edges of each layer of the pad; and

a plurality of openings extending through the attaching layer and terminating before extending through the sub-layer layer, whereby trapped air during pad attachment can flow through the openings in the attaching layer and out of the peripheral edge of the pad at a position spaced from the attaching layer peripheral edge.

19. The polishing pad of claim **18** wherein the sub-pad layer adjacent the attaching layer is gas impermeable and further including a plurality of channels extending across the sub-pad layer to the sub-pad layer peripheral edge, wherein each opening through the attaching layer is aligned with at least one channel, whereby the trapped air flows out of the peripheral edge of the sub-pad layer adjacent to the attaching layer.

20. The polishing pad of claim **18** wherein the plurality of openings form a pattern of openings on the attaching surface that is less than about ¾" between openings.

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