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(54) **BACKING PLATE ASSEMBLY**

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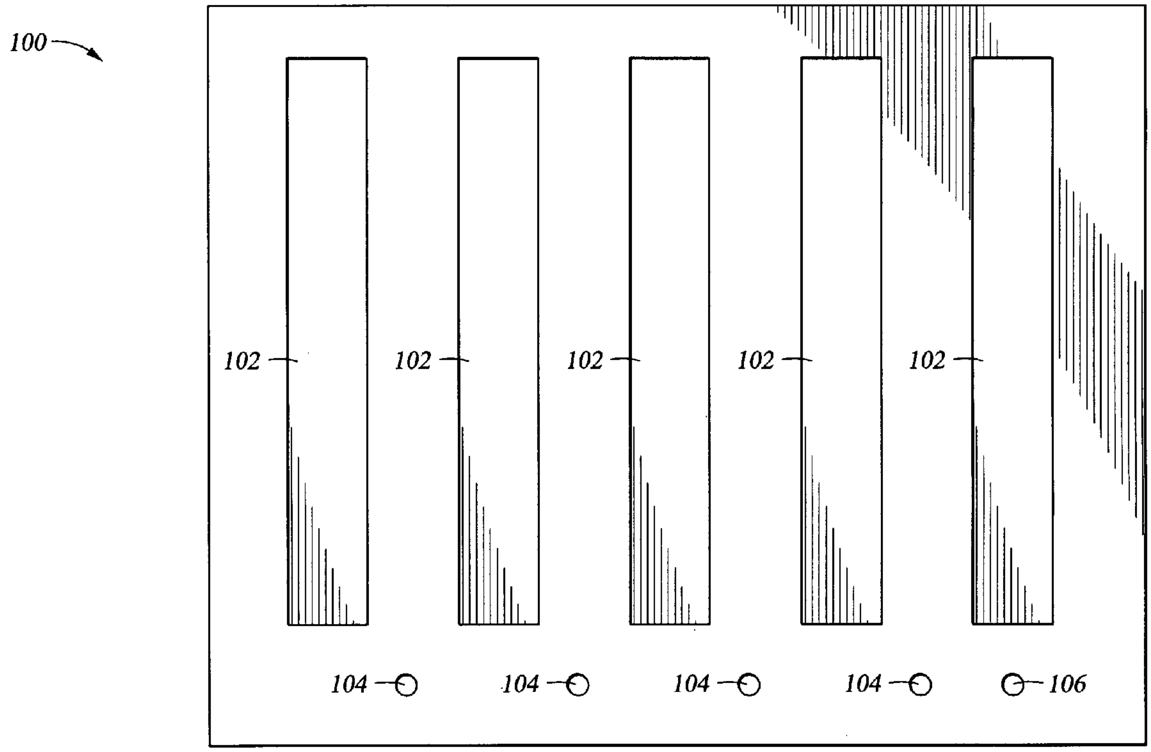
(57) **ABSTRACT**

In certain embodiments, the invention comprises a backing plate for accommodating large area sputtering targets is disclosed. The backing plate assembly has cavities carved into the back surface of the backing plate. The backing plate may further include cooling channels that run through the backing plate to control the temperature of the backing plate and the target. The cavities may be filled with a material that has a lower density than the backing plate. Additionally, the entire back surface may be covered with the material to produce a smooth surface upon which a magnetron may move during a PVD process.



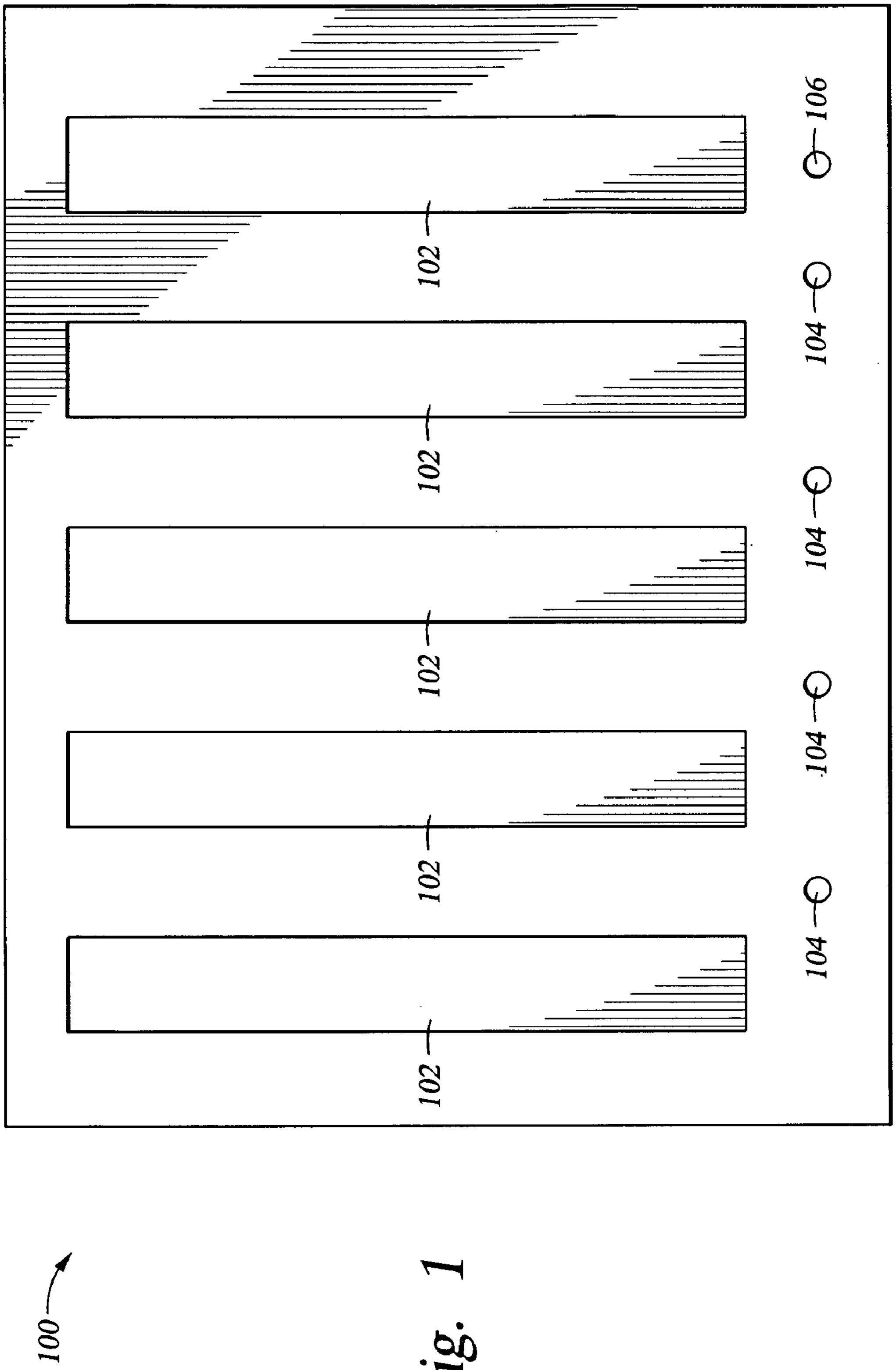


Fig. 1

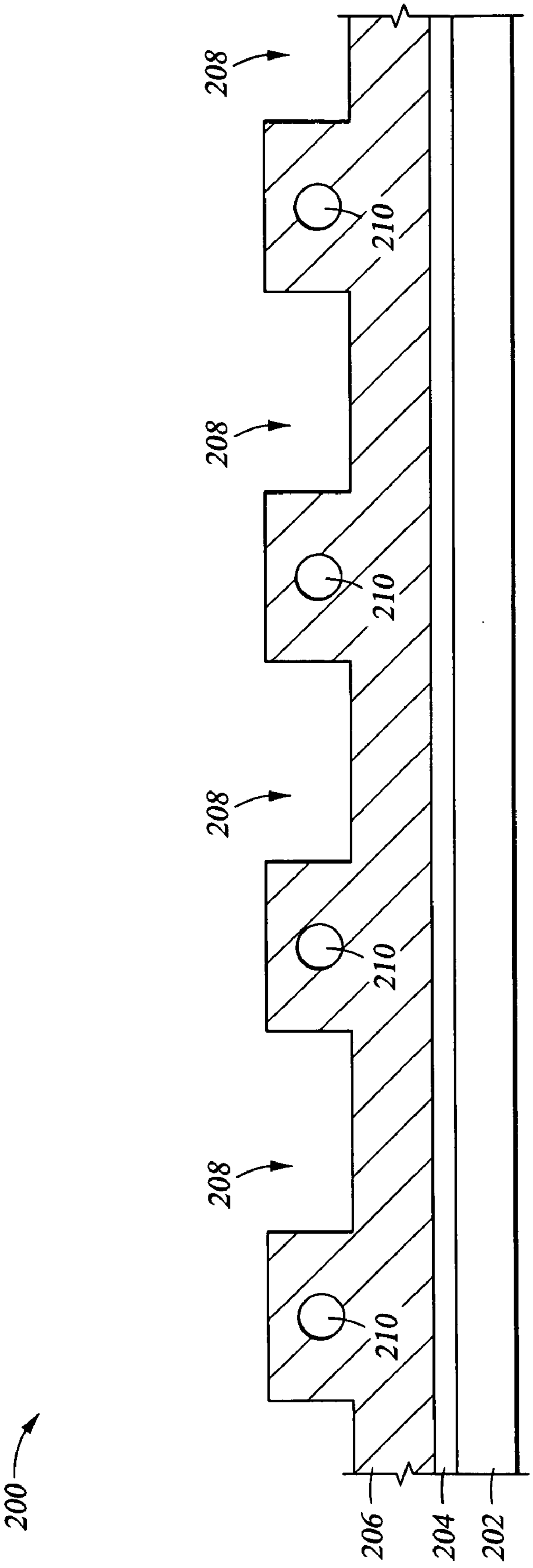


Fig. 2

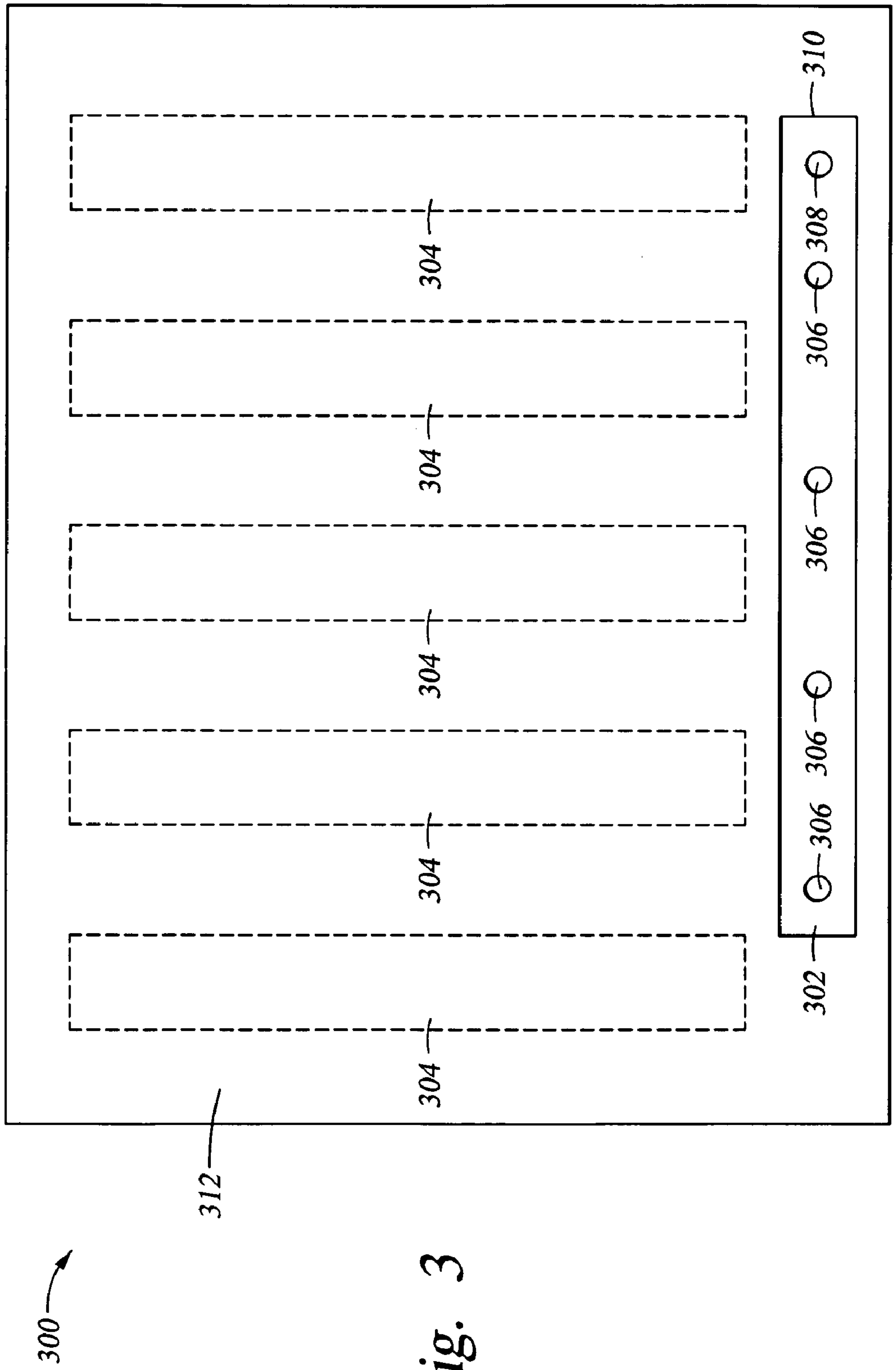


Fig. 3

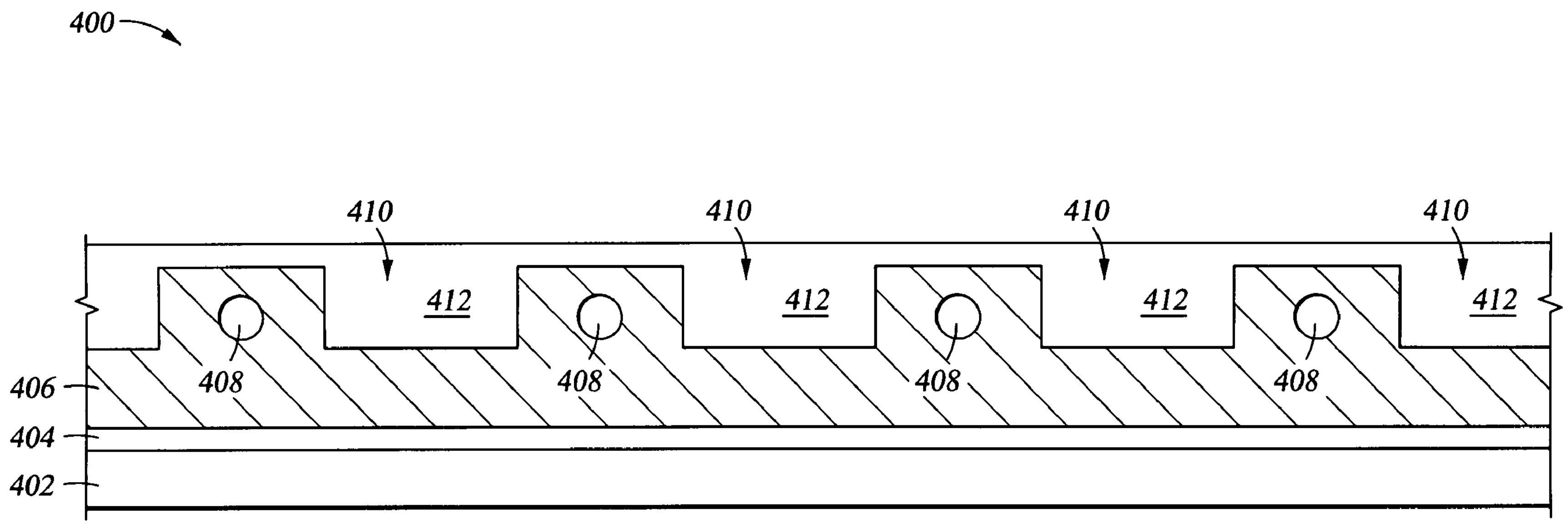


Fig. 4

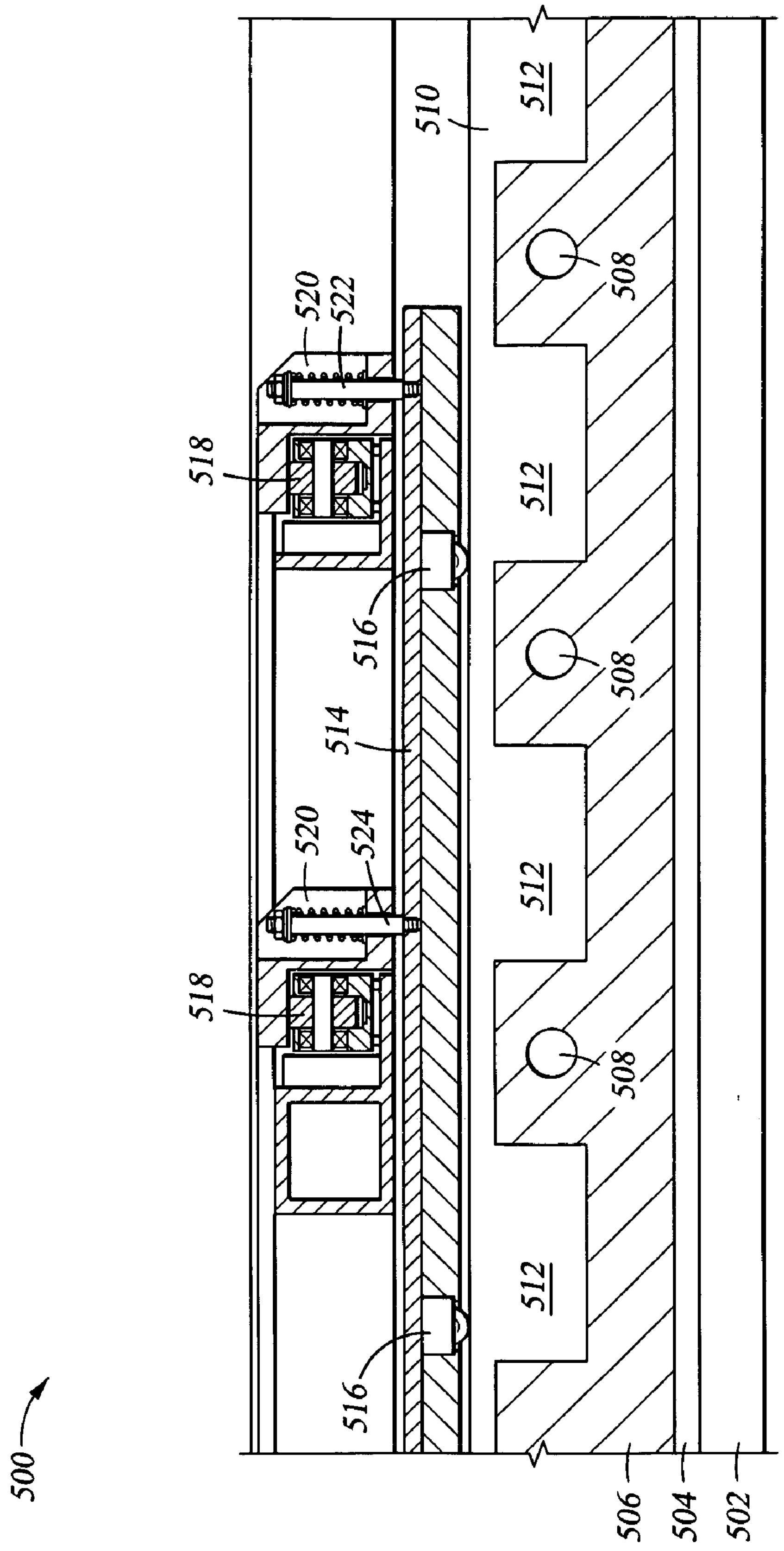

500
502
504
506
508
508
508
510
512
512
512
512
514
516
516
518
518
520
520
522
524

Fig. 5

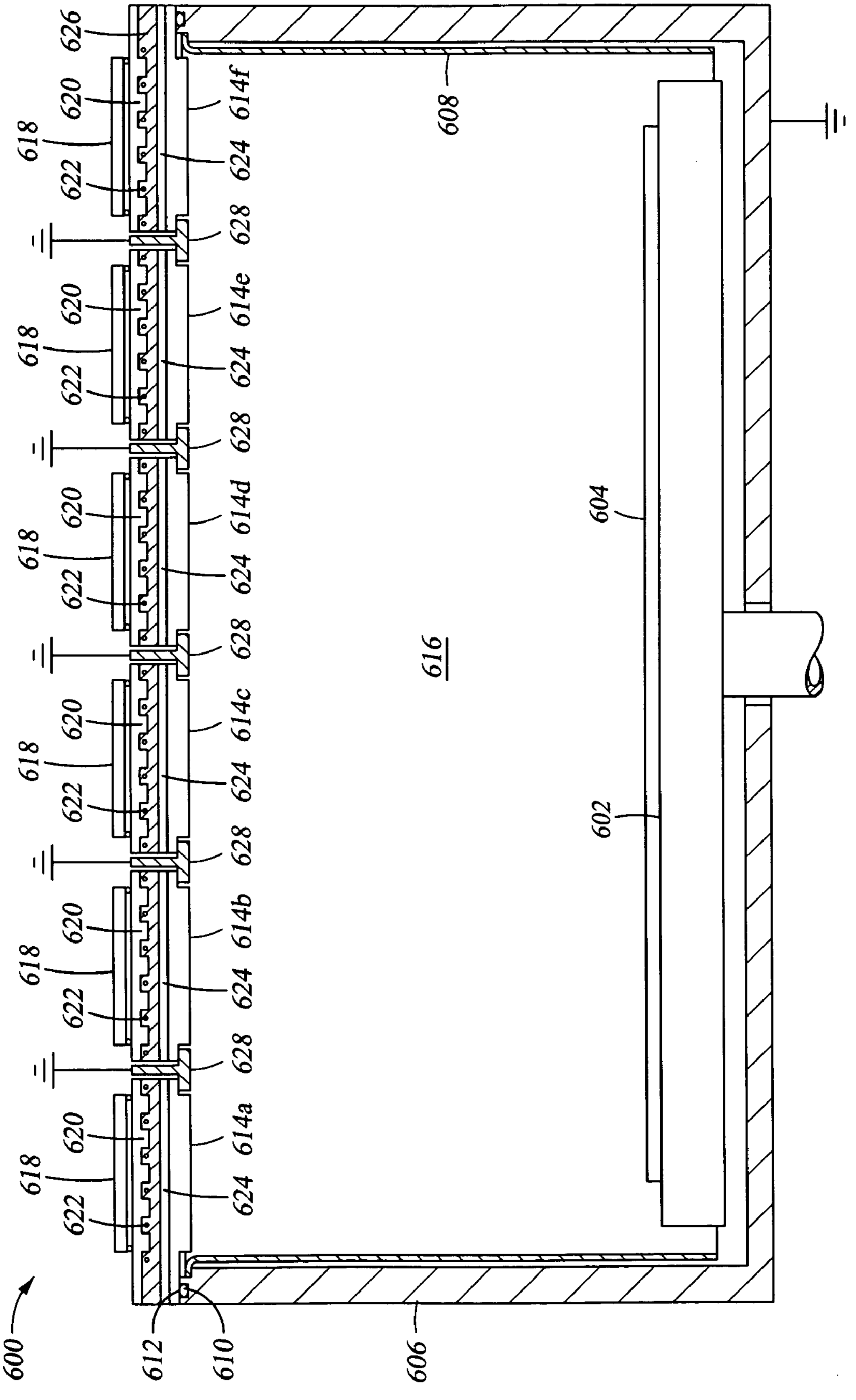

600
612
610
606
618
622
620
624
614a
628
614b
614c
614d
614e
614f
626
608
604
602
616

Fig. 6

BACKING PLATE ASSEMBLY

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of co-pending U.S. patent application Ser. No. 11/426,271 (APPM/011105), filed Jun. 23, 2006, which is herein incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] Embodiments of the present invention generally relate to a backing plate assembly for a physical vapor deposition (PVD) apparatus.

[0004] 2. Description of the Related Art

[0005] PVD using a magnetron is one method of depositing material onto a substrate. During a PVD process a target may be electrically biased so that ions generated in a process region can bombard the target surface with sufficient energy to dislodge atoms from the target. The process of biasing a target to cause the generation of a plasma that causes ions to bombard and remove atoms from the target surface is commonly called sputtering. The sputtered atoms travel generally toward the substrate being sputter coated, and the sputtered atoms are deposited on the substrate. Alternatively, the atoms react with a gas in the plasma, for example, nitrogen, to reactively deposit a compound on the substrate. Reactive sputtering is often used to form thin barrier and nucleation layers of titanium nitride or tantalum nitride on the substrate.

[0006] Direct current (DC) sputtering and alternating current (AC) sputtering are forms of sputtering in which the target is biased to attract ions towards the target. The target may be biased to a negative bias in the range of about −100 to −600 V to attract positive ions of the working gas (e.g., argon) toward the target to sputter the atoms. Usually, the sides of the sputter chamber are covered with a shield to protect the chamber walls from sputter deposition. The shield may be electrically grounded and thus provide an anode in opposition to the target cathode to capacitively couple the target power to the plasma generated in the sputter chamber.

[0007] To deposit thin films over large area substrates such as glass substrates, flat panel display substrates, solar panel substrates, and other suitable substrates, a sputtering target, and hence, the backing plate must be of substantial size. As backing plates increase in size, the weight of the backing plate may also increase.

[0008] Therefore, there is a need in the art for large area backing plates that can be used in PVD chambers for large area substrates.

SUMMARY OF THE INVENTION

[0009] In certain embodiments, the invention comprises a backing plate for accommodating large area sputtering targets is disclosed. The backing plate assembly has cavities carved into the back surface of the backing plate. The backing plate may further include cooling channels that run through the backing plate to control the temperature of the backing plate and the target. The cavities may be filled with a material that has a lower density than the backing plate. Additionally, the entire back surface may be covered with the material to produce a smooth surface upon which a magnetron may move during a PVD process.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] So that the manner in which the above recited features of the present invention can be understood in detail, a more particular description of the invention, briefly summarized above, may be had by reference to embodiments, some of which are illustrated 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.

[0011] FIG. **1** is a top view of a backing plate assembly **100** having cavities **102** formed therein.

[0012] FIG. **2** is a cross sectional view of a backing plate assembly **200** according to another embodiment of the invention.

[0013] FIG. **3** is a top view of a backing plate assembly **300** with cavities **304** filled with material **312**.

[0014] FIG. **4** is a cross sectional view of a backing plate assembly **400** according to another embodiment of the invention.

[0015] FIG. **5** is a cross sectional view of a backing plate assembly **500** having a magnetron plate **514** positioned behind the backing plate.

[0016] FIG. **6** is a cross sectional view of an apparatus **600** according to another embodiment of the invention.

[0017] To facilitate understanding, identical reference numerals have been used, where possible, to designate identical elements that are common to the figures. It is contemplated that elements disclosed in one embodiment may be beneficially utilized in other embodiments without specific recitation.

DETAILED DESCRIPTION

[0018] In certain embodiments, the invention comprises a backing plate for accommodating large area sputtering targets is disclosed. The backing plate assembly has cavities carved into the back surface of the backing plate. The backing plate may further include cooling channels that run through the backing plate to control the temperature of the backing plate and the target. The cavities may be filled with a material that has a lower density than the backing plate. Additionally, the entire back surface may be covered with the material to produce a smooth surface upon which a magnetron may move during a PVD process.

[0019] The invention is illustratively described and may be used in a physical vapor deposition system for processing large area substrates, such as a PVD system, available from AKT®, a subsidiary of Applied Materials, Inc., Santa Clara, Calif. However, it should be understood that the backing plate may have utility in other system configurations, including those systems configured to process large area round substrates. An exemplary system in which the present invention can be practiced is described in U.S. patent application Ser. No. 11/225,922, filed Sep. 13, 2005, which is hereby incorporated by reference in its entirety.

[0020] As the size of substrates increases, so must the size of the sputtering target and hence, the backing plate. For flat panel displays and solar panels, backing plates having a length of greater than 1 meter are not uncommon. As the size of the backing plate increases, so does the weight. Therefore, a backing plate spanning a length of greater than 1 meter may bow due to the significant weight of the backing plate. Additionally, the backing plate may have cooling channels formed therein to control the temperature of the backing plate and the sputtering target. The cooling channels and fluid flowing therein may add to the weight of the backing plate.

[0021] Placing an additional support member in the middle of the backing plate to compensate for any bowing is not practical and may interfere with the cooling channels. Any magnetron movement behind the backing plate may be impeded by the support structure. The support structure may impede the movement of the magnetron because the support structure may be positioned in the location where bowing is most likely to occur (i.e., the middle of the backing plate). The bowing is most likely to occur in the middle of the backing plate because the middle is the location furthest away from the edges of the backing plate where the backing plate is supported. The magnetron may be placed behind a backing plate to create a uniform plasma across a sputtering target and hence, uniformly erode the sputtering target. An additional support structure within the chamber is also not practical. The support structure within the chamber greatly increases the likelihood of non-uniform deposition on a substrate positioned opposite the target because the support structure may be placed between the target and the substrate. It would be beneficial to increase the size of the backing plate while not increasing the weight of the backing plate.

[0022] One manner of increasing the size of the backing plate while not increasing the weight of the backing plate is to remove a portion of the backing plate material. FIG. **1** is a top view of a backing plate assembly **100** having cavities **102** formed therein. In one embodiment, the cavities **102** are formed by removing backing plate material from the backing plate. In another embodiment, the cavities **102** are formed by pouring backing plate material into a mold having a cavity forming protrusion and allowing the backing plate material to harden. In another embodiment, the cavities **102** are formed by positioning cooling channels within backing plate material to form backing plate hills and then positioning the hills across the back surface of the backing plate with cavities **102** spaced therebetween. The backing plate assembly **100** may have a plurality of cooling fluid inlets/outlets **104** and a power coupling interface **106** positioned adjacent the cavities **102**. It is to be understood that while five cavities **102** have been shown, more or less cavities **102** may be present.

[0023] In one embodiment, the backing plate comprises aluminum, copper, stainless steel, titanium, or alloys thereof. By having cavities **102** in the backing plate assembly **100**, the weight of the backing plate assembly **100** is reduced. The weight of the backing plate assembly **100** is reduced by an amount equal to the weight of the backing plate material that would normally be present within the cavities **102**. Thus, a backing plate assembly **100** that has at least one cavity **102** will be lighter and hence, less likely to bow.

[0024] FIG. **2** is a cross sectional view of a backing plate assembly **200** according to another embodiment of the invention. The backing plate assembly **200** comprises a sputtering target **202** bonded to a backing plate **206** using a bonding material layer **204**. Within the backing plate **206**, cavities **208** have been formed. Cooling channels **210** may also be present within the backing plate **206**. The cavities **208** and cooling channels **210** alternate along the back surface of the backing plate **206**. While only three cooling channels **210** have been shown, it is to be understood that the number of cooling channels **210** may be greater or less than three. Additionally, the shape of the cavities **208** is not restricted. The cavities **208** are shown with a rectangular cross section, but other shapes including dovetail, half-circle, triangular, etc. may be used.

[0025] A magnetron may be placed behind a backing plate in order to confine the plasma created during sputtering. The magnetron confines the plasma across the sputtering target to ensure that the sputtering target erodes uniformly. Uniform target erosion maximizes a target's useful life and reduces processing downtime. A non-uniform back surface of a backing plate may present a problem for a magnetron to move smoothly across the backing plate. A cavity may limit the pattern of movement for a magnetron across a backing plate. It should be noted, however, that a magnetron may be beneficially used with a backing plate that has a cavity formed therein. The magnetron may be suspended just above the backing plate so that the magnetron may move across the, back surface of the backing plate without interference by the cavity.

[0026] FIG. **3** is a top view of a backing plate assembly **300** with the cavities **304** filled with a filling material **312**. The filling material **312** covers the entire back surface of the backing plate **302** except for an interface opening **310**. The interface opening **310** permits a technician to easily access the cooling inlets/outlets **306** and a power coupling interface **308**. In between the cavities **304**, cooling channels are present within the backing plate **302**. The fill material **312** covers the backing plate **302** both within the cavities **304** and on top of the backing plate **302** through which the cooling channels are positioned. In one embodiment, the fill material **312** is a single, unitary piece.

[0027] When fill material **410** is formed into the cavities **412** of a backing plate **406**, it is also formed across the backing plate **406** where cooling channels **408** are positioned so that a smooth, planar surface of fill material **410** covers a portion of the backing plate. FIG. **4** is a cross sectional view of a backing plate assembly **400** according to another embodiment of the invention. A sputtering target **402** is bonded to the backing plate **406** by a bonding material layer **404**. The fill material **410** should have a lower density than the backing plate **406**. Thus, the backing plate assembly **100** with fill material **410** formed within cavities **412** of the backing plate **406** has a lower weight than a backing plate **406** of the same thickness, but without cavities **412** formed therein.

[0028] In one embodiment, the fill material **410** is a polymer. The polymer may be any polymer having a density less than the density of the backing plate **406**. In another embodiment, the fill material **410** is a metal having a density lower than the backing plate **406** material. The fill material **410** is not restricted, but should have a lower density than the backing plate **406**. Additionally, the fill material **410** should comprise a material that does not interfere with the magnetic field generated by a magnetron that may be placed behind the backing plate **406**. By having a lower density than the backing plate **406**, the fill material **410** weighs less when filling the cavity **412** than backing plate material remaining in the cavity **412**.

[0029] FIG. **5** is a cross sectional view of a backing plate assembly **500** having a magnetron plate **514** positioned behind the backing plate **506**. An exemplary magnetron that may be used is described in U.S. patent application Ser. No. 11/347,667, filed Feb. 3, 2006, which is hereby incorporated by reference in its entirety. The backing plate assembly **500** comprises a sputtering target **502** bonded to the backing plate **506** using a bonding material layer **504**. Cooling channels **508** are positioned within the backing plate **506**. Fill material **510** is deposited into cavities **512** formed into the backing plate **506**. The fill material **510** fills the cavities **512** and also is present on the backing plate **506** where the cooling channels **506** are positioned. The surface of the fill material **510** that is opposite the backing plate **506** is smooth to permit a magnetron plate **514** to move across the fill material **510**.

[0030] The fill material **510** may be smoothed by conventional techniques well known in the art and is not restricted to any particular smoothing technique. The fill material **510** may be smoothed so that any friction between the fill material **510** and the rollers **526** upon which the magnetron plate **514** rests is minimal. The rollers **526** may move across the fill material **510** to adjust the location of the magnetic field across the target **502**. The rollers **526** are coupled with roller ball assemblies **516**. It is to be understood that the invention is not to be limited to rollers **526** for moving the magnetron plate **514** across the fill material **510**. Low friction sliding contact pads may also be used either in place of the rollers **526** or in addition to the rollers **526**.

[0031] The magnetron plate **514** may be partially supported from above by coupling it to rails **520** and rolling on cylindrical roller assemblies **518** through multiple spring-loaded stud assemblies **522**. Each stud assembly **522** includes a threaded stud **524** screwed into a tapped hole in the magnetron plate **514**. The rollers **526** provide additional support for the magnetron plate **514** as it moves across the fill material **510**. A ball transfer Model NSMS ¼, available from Ball Transfer Systems of Perryopolis, Pa., may be used as the rollers **526**. The rollers **526** may contact a back surface of the fill material **510**.

[0032] FIG. **6** is a cross sectional view of an apparatus **600** according to another embodiment of the invention. Within the apparatus **600**, a plurality of sputtering targets **614***a-f* are positioned opposite a substrate **604**. The substrate **604** is positioned on a susceptor **602**. The processing area **616** is between the substrate **604** and the plurality of sputtering targets **614***a-f*. The apparatus **600** has chamber walls **606** which are shielded by a shield **608** during sputtering. The targets **614***a-f* may be sealed with the chamber walls **606** by a sealing surface **612** present on the targets **614***a-f* and a sealing member **610**. In one embodiment, the sealing member **610** is an O-ring. The targets **614***a-f* are coupled with a backing plate **626** by a bonding material layer **624**. Cooling channels **622** may be positioned within the backing plate **626**. The cavities may be filed with filling material **620** to provide a smooth surface upon which a magnetron **618** may move. Anodes **628** are positioned between the adjacent sputtering targets **614***a-f* and may be grounded.

[0033] It should be understood that while FIG. **6** shows six separate, isolated targets **614***a-f* with a corresponding backing plate **626** and magnetron **618**, more or less sputtering targets **614***a-f* may be present. The targets **614***a-f* may be individually powered. An exemplary power coupling for the targets **614***a-f* is described in U.S. patent application Ser. No. 11/428,226, filed Jun. 30, 2006, which is hereby incorporated by reference in its entirety. The targets **614***a-f* may comprise target strips or target tiles placed adjacent one another to create a target strip in a manner described in U.S. patent application Ser. No. 11/424,467, filed Jun. 15, 2006 and U.S. patent application Ser. No. 11/424,478, filed Jun. 15, 2006, both of which are hereby incorporated by reference in their entirety.

[0034] The number of backing plates **626** need not equal the number of sputtering targets **614***a-f*. In one embodiment, a single backing plate **626** is coupled to a plurality of targets **614***a-f*. Additionally, the number of magnetrons **618** need not correspond to the number of targets **614***a-f* or backing plates **626**. In one embodiment, a single backing plate **626** is used and a single magnetron **618** is used while a plurality of targets **614***a-f* are used. In another embodiment, a single backing plate **626** may be used while a plurality of magnetrons **626** and a plurality of targets **614***a-f* may be used. In yet another embodiment, a plurality of backing plates **626** may be used with a plurality of sputtering targets **614***a-f* and a plurality of magnetrons **618** may be used. In still another embodiment, a plurality of sputtering targets **614***a-f* may be coupled to a plurality of backing plates **626** with a single magnetron **618** positioned in back of the backing plates **626**.

[0035] 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, and the scope thereof is determined by the claims that follow.

1. A backing plate assembly, comprising:
a backing plate comprising a front surface and a back surface having at least one cavity; and
a fill material formed over the back surface and within the at least one cavity, the fill material having a substantially smooth back surface.

2. The assembly of claim **1**, wherein the fill material is a polymer.

3. The assembly of claim **1**, wherein the backing plate comprises a material selected from the group consisting of aluminum, copper, stainless steel, titanium, and alloys thereof.

4. The assembly of claim **1**, further comprising:
at least one cooling channel within the backing plate, wherein the at least one cooling channel is adjacent to the at least one cavity.

5. The assembly of claim **1**, wherein the fill material has a lower density than the backing plate.

6. A backing plate assembly, comprising:
a backing plate having a front surface and a back surface, the back surface comprising one or more cavity portions and one or more raised portions; and
a fill material formed over the one or more cavity portions and the one or more raised portions.

7. The assembly of claim **6**, wherein the fill material is a polymer.

8. The assembly of claim **6**, wherein the backing plate comprises a material selected from the group consisting of aluminum, copper, stainless steel, titanium, and alloys thereof.

9. The assembly of claim **6**, further comprising:
at least one cooling channel within the backing plate.

10. The assembly of claim **6**, wherein the fill material has a lower density than the backing plate.

11. An apparatus, comprising:
a backing plate, the backing plate comprises:
  a front surface and a back surface; and
  at least one cavity formed in the back surface;

a sputtering target coupled with the front surface of the backing plate;

a fill material within the at least one cavity and covering the back surface of the backing plate; and

a magnetron movable between a first position and a second position along the fill material.

12. The apparatus of claim **11**, wherein the fill material has a lower density than the backing plate.

13. The apparatus of claim **11**, further comprising:

at least one cooling channel within the backing plate and adjacent the at least one cavity.

14. The apparatus of claim **13**, further comprising:

a plurality of cavities and a plurality of cooling channels, wherein the cavities and cooling channels alternate along the back surface of the backing plate.

15. The apparatus of claim **11**, wherein the fill material that is within the at least one cavity and covering the back surface of the backing plate is a single, unitary piece of polymer.

16. The apparatus of claim **11**, further comprising:

a plurality of backing plates, wherein each backing plate comprises:

a front surface and a back surface; and

at least one cavity formed in the back surface;

a fill material within the at least one cavity and covering each backing plate.

17. The apparatus of claim **16**, further comprising:

a plurality of magnetrons, wherein each backing plate has a corresponding magnetron.

18. The apparatus of claim **11**, further comprising:

a plurality of sputtering targets.

19. The apparatus of claim **11**, wherein the magnetron is coupled with at least one roller ball for moving the magnetron.

20. The apparatus of claim **11**, wherein the magnetron is coupled with at least one low friction sliding contact pad for moving the magnetron.

21. A sputtering target assembly, comprising:

a backing plate, the backing plate comprising:

a front surface and a back surface;

at least one cavity formed in the back surface of the backing plate;

a sputtering target coupled with the front surface of the backing plate; and

fill material within the at least one cavity and across the back surface of the backing plate, the fill material has a lower density than the backing plate.

22. The assembly of claim **21**, wherein the fill material comprises a polymer.

23. The assembly of claim **21**, further comprising:

at least one cooling channel within the backing plate, wherein the at least one cooling channel is adjacent the at least one cavity.

24. The assembly of claim **23**, further comprising:

a plurality of cavities and a plurality of cooling channels, wherein the cavities and cooling channels alternate along the back surface of the backing plate.

25. The assembly of claim **21**, wherein the backing plate comprises a material selected form the group consisting of aluminum, copper, stainless steel, titanium, and alloys thereof.

26. A sputtering method, comprising:

providing a backing plate having a front surface and a back surface with at least one cavity, the at least one cavity is filled with a material that has a lower density than the backing plate;

providing a target coupled to the front surface of the backing plate; and

applying a bias to the sputtering target assembly.

27. The method of claim **26**, further comprising:

moving a magnetron across the back surface of the backing plate.

28. The method of claim **27**, wherein the magnetron is moved by rolling the magnetron on at least one roller ball that is coupled with the magnetron.

29. The method of claim **27**, wherein the magnetron is moved by moving at least one low friction sliding contact pad that is coupled with the magnetron.

* * * * *