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(54) **CMP BELT STRETCH COMPENSATION APPARATUS AND METHODS FOR USING THE SAME**

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(58) **Field of Search** 451/5, 41, 285–289, 451/297, 296, 311, 499

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,187,645 A * 2/1980 Lind 451/297
4,443,977 A * 4/1984 Gaiani 451/309
5,871,390 A * 2/1999 Pant et al. 451/5
6,261,163 B1 * 7/2001 Walker et al. 451/311
6,428,394 B1 * 8/2002 Mooring et al. 451/41

* cited by examiner

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(57) **ABSTRACT**

An apparatus for reducing non-uniform stretch of a belt used in the CMP system is disclosed. The belt that may be used with the apparatus extends between a first roller and a second roller to define a belt loop with an inner surface and an outer surface to be used for CMP. The apparatus includes a compensating roller that has a first end and a second end where the first end and second end extends a width of the belt. The first end and the second end have a first diameter. The center of the roller has a second diameter that is less than the first diameter. The compensating roller has a symmetrically tapered shape that extends between each of the first end and second end to the center. The compensating roller is positioned inside of the belt loop, and is applied to the inner surface of the belt loop to reduce non-uniform stretch of the belt.

16 Claims, 7 Drawing Sheets

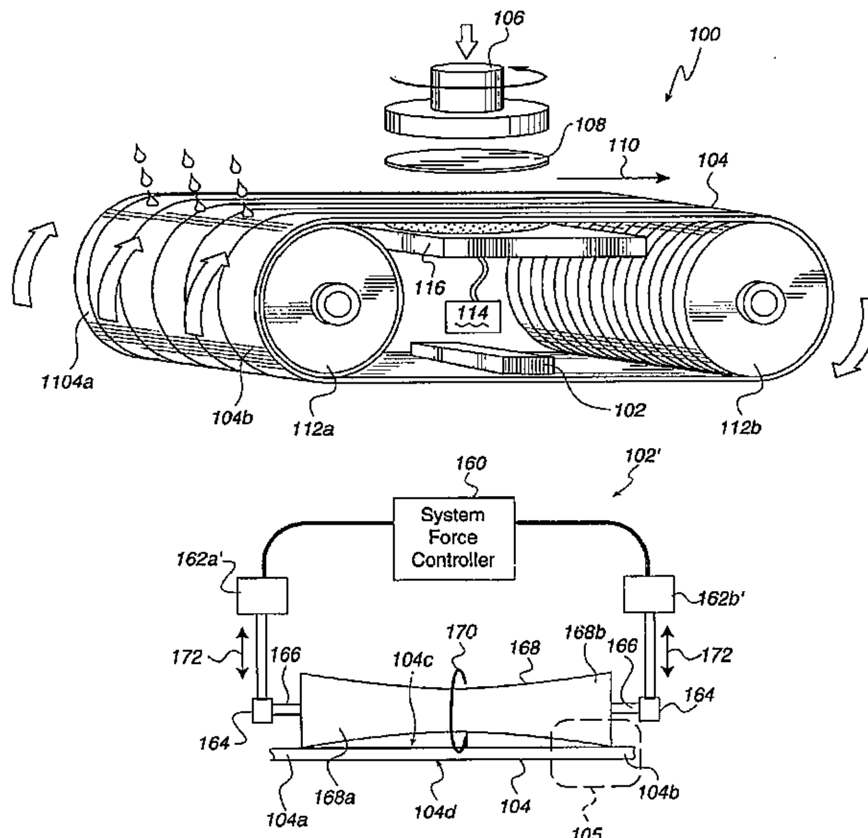

Fig. 1A (Prior Art)

Fig. 1B (Prior Art)

Fig. 1C (Prior Art)

Fig. 1D (Prior Art)

Fig. 1E (Prior Art)

Fig. 2

System Force Controller

104 (PAD)

Fig. 3A

Fig. 3B

System Force Controller

Fig. 4

System Force Controller

Force Applicator

Fig. 5

Removal Rate

Measurement Location

Fig. 6

stretch of the polishing belt **104**. By controlling which of the plurality of force transmitters **204** outputs air, pressure may be generated against various sections of the polishing belt **104**. Such flexibility can enable a wide range of polishing belt tension adjustments to adjust for polishing rate variances in different parts of the wafer.

In addition to utilizing air to create pressure on specific parts of the polishing belt **104**, in one embodiment, the plurality of force transmitters can also be mechanically moved up and down to generate pressure on the polishing belt **104**. In yet another embodiment, the plurality of force transmitters may be a plurality of rollers. Each of the plurality of rollers may be similar in structure and functionality to ones as described in reference to FIG. 4.

FIG. **6** shows a graph **300** illustrating the polishing rates of a CMP system using a tension compensating apparatus **102** in accordance with one embodiment of the present invention. The graph **300** shows a removal rate on the y-axis and a measurement location (as shown as distance from a center of a wafer) on the x-axis. A line **304** shows the relationship between wafer location and polishing rate for a wafer polished using the tension compensating apparatus **102** of the present invention. A line **302** shows polishing rates for a wafer polished by a prior art CMP system. As polishing rates from the center of the wafer (as shown by 0 on the measurement location axis) to the edge of the wafer (as shown by −100 and 100 on the measurement location axis) are measured, the variations in the removal rate (i.e. polishing rate) of the prior art CMP system are much greater than the variations in removal rate of the CMP system with the force application system of the present invention. The present invention is especially effective in reducing polishing variation near the edge of the wafer.

While this invention has been described in terms of several preferred embodiments, it will be appreciated that those skilled in the art upon reading the preceding specifications and studying the drawings will realize various alterations, additions, permutations and equivalents thereof. It is therefore intended that the present invention includes all such alterations, additions, permutations, and equivalents as fall within the true spirit and scope of the invention.

What is claimed is:

1. In a chemical mechanical planarization (CMP) system, an apparatus for reducing non-uniform stretch of a belt used in the CMP system, the belt extending between a first roller and a second roller to define a belt loop to be used for CMP, the belt loop having an inner surface and an outer surface, the apparatus comprising:

- a compensating roller having a first end and a second end, the first end and second end extending a width of the belt, the first end and the second end having a first diameter and a center of the roller having a second diameter that is less than the first diameter, the compensating roller having a symmetrically tapered shape extending between each of the first end and second end to the center;
- wherein the compensating roller is positioned inside of the belt loop, and is configured to be applied to the inner surface of the belt loop so as to reduce non-uniform stretch of the belt.

2. In a chemical mechanical planarization (CMP) system, an apparatus for reducing non-uniform stretch of a belt used in the CMP system as recited in claim **1**, wherein the belt is a single layer polymeric polishing pad.

3. In a chemical mechanical planarization (CMP) system, an apparatus for reducing non-uniform stretch of a belt used in the CMP system as recited in claim **1**, wherein the belt is a supported belt with polymeric polishing layer over a stainless steel layer.

4. In a chemical mechanical planarization (CMP) system, an apparatus for reducing non-uniform stretch of a belt used in the CMP system as recited in claim **1**, wherein the belt is a multilayer belt including a polishing pad, a cushioning layer, and a stainless steel layer.

5. In a chemical mechanical planarization (CMP) system, an apparatus for reducing non-uniform stretch of a belt used in the CMP system as recited in claim **1**, wherein the compensating roller is configured to apply pressure to a first edge and a second edge of the belt.

6. In a chemical mechanical planarization (CMP) system, an apparatus for reducing non-uniform stretch of a belt used in the CMP system as recited in claim **1**, wherein a force applicator is configured to supply a pressing motion to push the compensating roller against the belt.

7. In a chemical mechanical planarization (CMP) system, an apparatus for reducing non-uniform stretch of a belt used in the CMP system as recited in claim **1**, wherein the compensating roller is made from one of a polyurethane material and a hard rubber material.

8. In a chemical mechanical planarization (CMP) system, an apparatus for reducing non-uniform stretch of a belt used in the CMP system, the belt extending between a first roller and a second roller to define a belt loop to be used for CMP, the belt loop having an inner surface and an outer surface, the apparatus comprising:

- a compensating roller having a first end and a second end, the first end and second end extending a width of the belt, the first end and the second end having a first diameter and a center of the roller having a second diameter that is less than the first diameter, the compensating roller having a symmetrically tapered shape extending between each of the first end and second end to the center;
- a force applicator coupled to the compensating roller, the force applicator configured to supply a pressing motion to the compensating roller;
- a system force controller in communication with the force applicator, the system force controller being configured to manage an amount of force utilized by the force applicator; and
- wherein the compensating roller is positioned inside of the belt loop, and is configured to be applied to the inner surface of the belt loop so as to reduce non-uniform stretch of the belt.

9. In a chemical mechanical planarization (CMP) system, an apparatus for reducing non-uniform stretch of a belt used in the CMP system as recited in claim **8**, wherein the compensating roller is configured to rotate in a direction of the first roller and the second roller.

10. In a chemical mechanical planarization (CMP) system, an apparatus for reducing non-uniform stretch of a belt used in the CMP system as recited in claim **8**, wherein the belt is a single layer polymeric polishing pad.

11. In a chemical mechanical planarization (CMP) system, an apparatus for reducing non-uniform stretch of a belt used in the CMP system as recited in claim **8**, wherein the belt is a supported belt with polymeric polishing layer over a stainless steel layer.

12. In a chemical mechanical planarization (CMP) system, an apparatus for reducing non-uniform stretch of a belt used in the CMP system as recited in claim **8**, wherein the belt is a multilayer belt.

13. In a chemical mechanical planarization (CMP) system, an apparatus for reducing non-uniform stretch of a

belt used in the CMP system as recited in claim **8**, wherein the compensating roller is configured to rotate in a direction of the first roller and the second roller.

14. In a chemical mechanical planarization (CMP) system, an apparatus for reducing non-uniform stretch of a belt used in the CMP system as recited in claim **8**, wherein the compensating roller is configured to apply pressure to a first edge and a second edge of the belt.

15. In a chemical mechanical planarization (CMP) system, an apparatus for reducing non-uniform stretch of a belt used in the CMP system as recited in claim **8**, wherein the pressing motion pushes the compensating roller against the belt.

16. In a chemical mechanical planarization (CMP) system, an apparatus for reducing non-uniform stretch of a belt used in the CMP system as recited in claim **8**, wherein the compensating roller is made from one of a polyurethane material and a hard rubber material.

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