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(54) **OPTICAL COUPLER HUB FOR CHEMICAL-MECHANICAL-PLANARIZATION POLISHING PADS WITH AN INTEGRATED OPTICAL WAVEGUIDE.**

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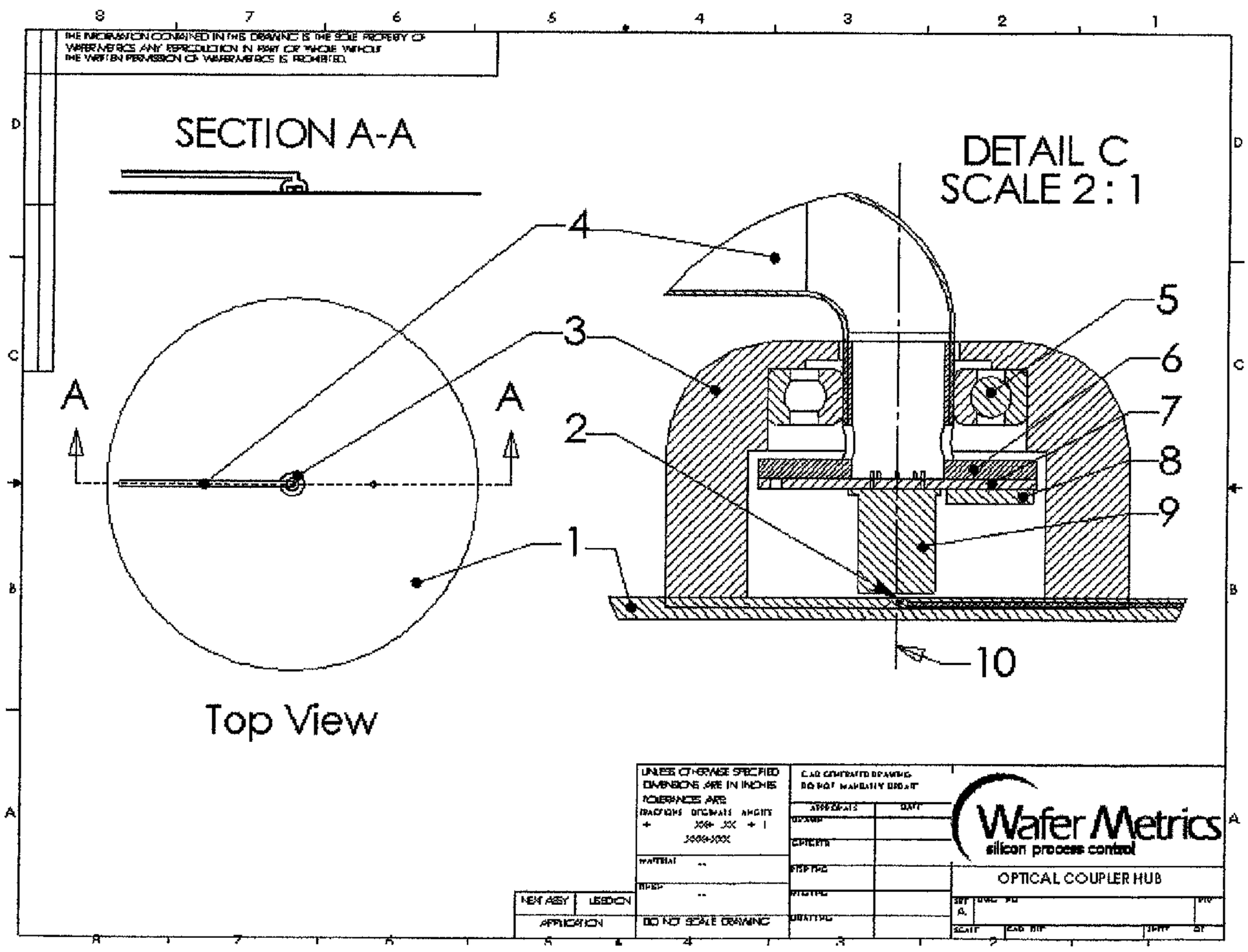
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(57) **ABSTRACT**

An apparatus is disclosed which improves the optical monitoring of semi-conductor wafers undergoing chemical mechanical planarization (CMP). The apparatus consists of a hub containing printed circuit board mounted optical and electronic devices, which couple light into a waveguide integrated into a CMP polishing pad. The hub is attached to the CMP polishing pad and rotates with the pad during the CMP operation. The electronics sense light emitting from the waveguide, convert the light into an electrical signal, amplify and analyze the electrical signal, and communicate the result of the analysis to remote CMP tool control systems.



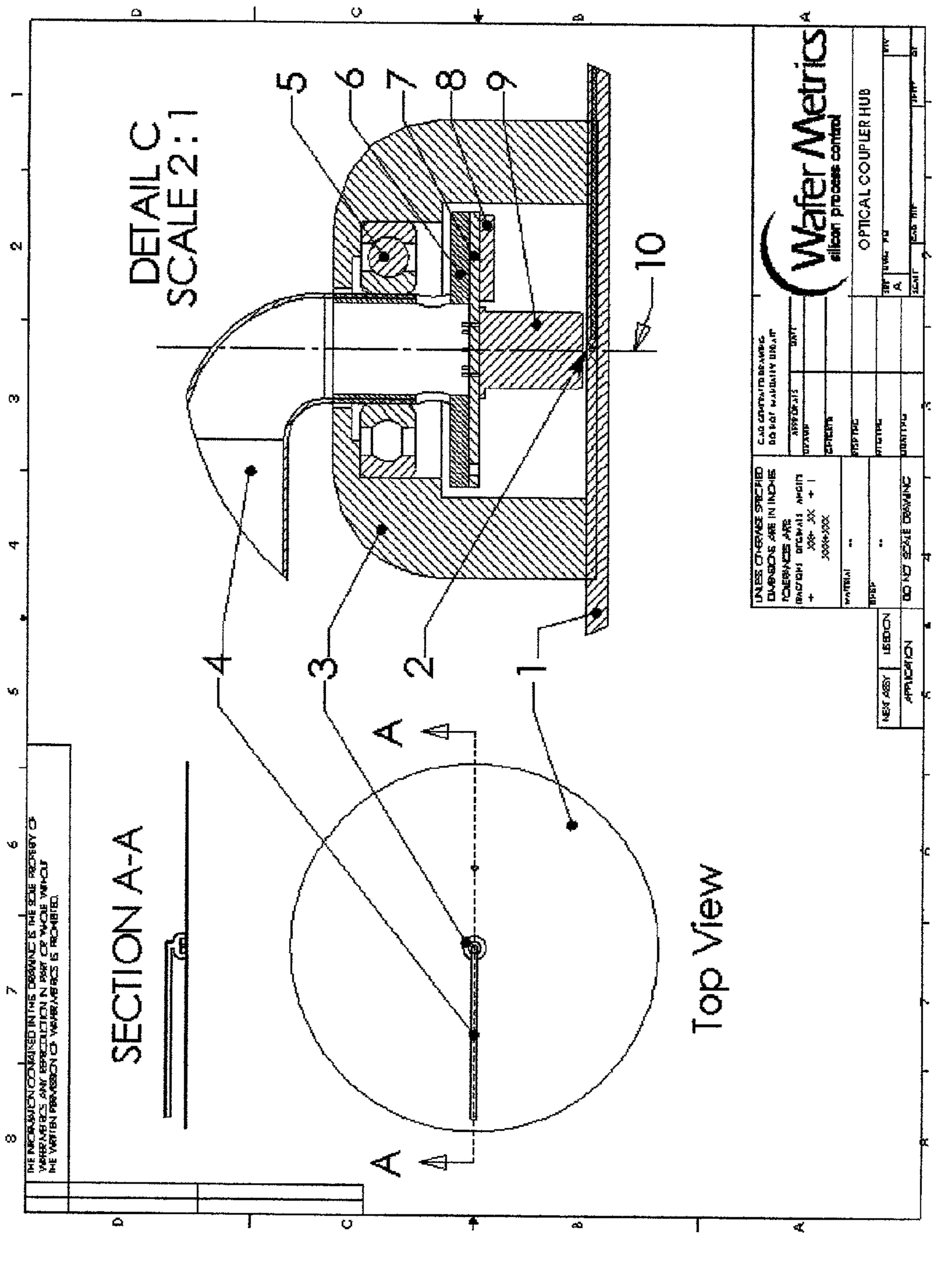

DETAIL C
SCALE 2:1
5
6
7
8
9
10
4
3
2
1
A
A
SECTION A-A
Top View
Wafer Metrics
silicon process control
OPTICAL COUPLER HUB
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE
DO NOT SCALE DRAWING
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF
WAFER METRICS. ANY REPRODUCTION IN PART OR WHOLE WITHOUT
THE WRITTEN PERMISSION OF WAFER METRICS IS PROHIBITED.

Figure 1.

OPTICAL COUPLER HUB FOR CHEMICAL-MECHANICAL-PLANARIZATION POLISHING PADS WITH AN INTEGRATED OPTICAL WAVEGUIDE.

BACKGROUND OF TH INVENTION

[0001] Chemical-mechanical-planarization (hereafter CMP) is a polishing process employed in the fabrication of semiconductors whereby a silicon wafer substrate containing numerous semiconductor devices on its surface is brought into contact with a rotating platen covered with a urethane-foam polishing pad. Chemicals are added onto the pad to accelerate and enhance the polishing process. It is possible to monitor the polishing process by reflecting light from the wafer's surface, and measuring the characteristics of the reflection. This technique is known in the semiconductor industry as "optical endpoint control". Most CMP tools do not allow for direct optical inspection of the wafer's surface during the CMP processing, because the wafer is sandwiched between a chuck and the polishing pad. Polishing pads can be manufactured with an integrated optical waveguide to provide a path for indirect optical access. The CMP process can then be monitored by coupling light into this waveguide and measuring the light, reflected by the wafer, emitting from the waveguide.

SUMMARY OF THE INVENTION

[0002] The object of the present invention is to provide a means of coupling light into the integrated waveguide of the CMP polishing pad, and of measuring the light reflected back out of the waveguide, while allowing the CMP polishing pad to rotate freely about an axis.

DETAILED DESCRIPTION OF THE INVENTION

[0003] The present invention is an apparatus for coupling light into and receiving light emitting from a CMP polishing pad containing an integrated waveguide. It does so by positioning a hub containing opto-electronic devices at the center of rotation of the CMP polishing pad. The hub is free to rotate with the pad during the CMP operation. The opto-electronic devices couple light into the waveguide and convert any light emitting from the waveguide into an electrical signal. The hub also contains electronic devices, which amplify this electrical signal and transmit it to remote analysis systems. Alternately, the hub contains these analysis systems onboard, in the form of microprocessors and/or data acquisition devices and circuitry, which digitize, store, and numerically process the electrical signal from the opto-electronic devices.

[0004] **FIG. 1** shows a mechanical drawing of the optical coupler hub assembly. At lower left is the top view of the optical coupler hub with its electrical conduit radiating outwards from the center of a circular polishing pad. At upper left is section view "A-A" of the polishing pad, optical coupler hub, and electrical conduit. On the right is detailed view "C" of section view "A-A".

[0005] Detail view "C" shows the optical coupler hub and its internal components. When the outer shell **(3)** with all of its internal components is located onto the polishing pad **(1)** precisely over the center of the waveguide entrance pupil **(2)** then bearing assembly **(5)** allows the outer shell **(3)** to rotate about the optical axis **(10)**. The opto-electronic device **(9)**, micro-processing device **(8)**, and printed circuit board **(7)** are firmly attached to a flange **(6)**, and secured to conduit tube **(4)**, and form the stationary member of the assembly. In summary, bearing **(5)** allows components **(1)**, **(2)**, and **(3)** to rotate about stationary components **(4)**, **(6)**, **(7)**, **(8)**, and **(9)**, while positioning opto-electronic component **(9)** in such a way as to couple light into the waveguide and to convert light emitting from the waveguide into a usable electrical signal.

An article of manufacture comprising:

An optical coupling hub, which is free to rotate about an axis extending through the center of rotation the entrance pupil of a waveguide integrated into a CMP polishing pad.

1. The article of claim 1 wherein said optical coupling hub contains an opto-electronic device placed in close proximity (approximately 10 mm) to the entrance pupil of said waveguide to couple light into said waveguide, and also to convert light emitting from said waveguide into an electrical signal.

2. The article of claim 1 wherein said optical coupling hub contains additional printed circuit board mounted electronics to perform amplification, digital signal processing, and communication of said electrical signal.

3. The article of claim 1 wherein said optical coupling hub contains a bearing to allow the hub to rotate about an axis extending through the center of the waveguide entrance pupil.

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