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(54) CONNECTION-VERIFICATION IN OPTICAL MEMS CROSSCONNECTS VIA MIRROR-DITHER

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385/16-19, 12-14; Field of Search ... 359/212, 223, 225; 250/216, 234

(56)References Cited

U.S. PATENT DOCUMENTS

5,136,671	8/1992	Dragone	385/46
5,155,623	10/1992	Miller et al	359/495
5,206,497	4/1993	Lee 25	0/201.1
5,960,132	9/1999	Lin	385/18
6,144,781	11/2000	Goldstein et al	385/18

OTHER PUBLICATIONS

H. Toshiyoshi et al., "Electrostatic Micro Torsion Mirrors for an Optical Switch Matrix," Journal of Microelectrome-chanical Systems, vol. 5, No. 4, Dec. 1996, pp. 231-237. B. Behin et al., "Magnetically Actuated Micromirrors for Fiber-Optic Switching," Solid-State Sensor and Actuator Workshop, Hilton Head, South Carolina, Jun. 8-11, 1998, pp. 273-276.

K. S. J. Pister et al., "Microfabricated Hinges," Sensors and Actuators, vol. A, No. 33 (1992), pp. 249-256.

T. Akiyama et al., "A Quantitative Analysis of Scratch Drive Actuator Using Buckling Motion," IEEE Workshop on Micro Electro Mechanical Systems, Amsterdam, The Netherlands, Jan. 29-Feb. 2, 1995, pp. 310-315.

R. T. Chen et al., "A Low Voltage Micromachined Optical Switch By Stress-Induced Bending," 12th IEEE International Conference On Micro Electro Mechanical Systems, Orlando, Florida, Jan. 17-21, 1999, 5 pages.

Cronos Integrated Microsystems, Inc., "Three-Layer Polysilicon Surface Micromachine Process," Aug. 24, 1999, pp. 1-8 (http://mems.mcnc.org).

L. Y. Lin et al., "Free-Space Micromachined Optical Switches for Optical Networking," *IEEE Journal of Selected* Topics in Quantum Electronics, vol. 5, No. 1, Jan./Feb. 1999,

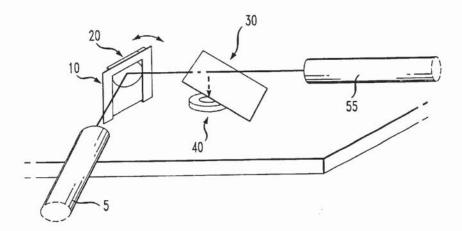
(List continued on next page.)

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ABSTRACT

Integrated connection-verification system for use in a microelectro-mechanical system (MEMS) crossconnect device. The system uses application of a dithering signal such as a sinusoidal bias to an electrode plate associated with a micro-mirror switching element to dither the micro-mirror. The optical signal from the dithering micro-mirror is fed through a beam splitter, a portion of the optical signal thus being directed to a photodetector. If intensity modulation in the optical signal corresponding to the frequency of the dithering signal is detected by the photodetector associated with the micro-mirror, the connection path between the desired input and output ports is verified.

11 Claims, 9 Drawing Sheets





OTHER PUBLICATIONS

L. Y. Lin et al., "High-Density Micromachined Polygon Optical Crossconnects Exploiting Network Connection-Symmetry, "IEEE Photonics Technology Letters, vol. 10, No. 10, Oct. 1998, pp. 1425–1427.

E. L. Goldstein et al., "National–Scale Networks Likely to Be Opaque," Lightwave, Feb. 1998, pp. 91–95.

C–K. Chan et al., "A Novel Optical–Path Supervisory

Scheme for Optical Cross Connects in AlloOptical Transport

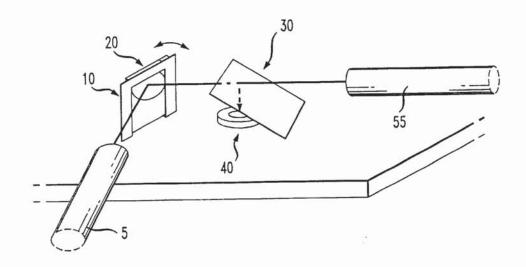
Networks," IEEE Photonics Technology Letters, vol. 10, No. 6, Jun. 1998, pp. 899-901.

L. Y. Lin et al., "Optical Cross-connect Integrated Systesm (OCCIS): A Free-Space Micromachined Module for Signal and Switching Configuration Monitoring," *IEEE LECS* Summer Topical Meeting: Optical MEMS, Monterey, California, Jul. 20–22, 1998, 3 pages.

* cited by examiner



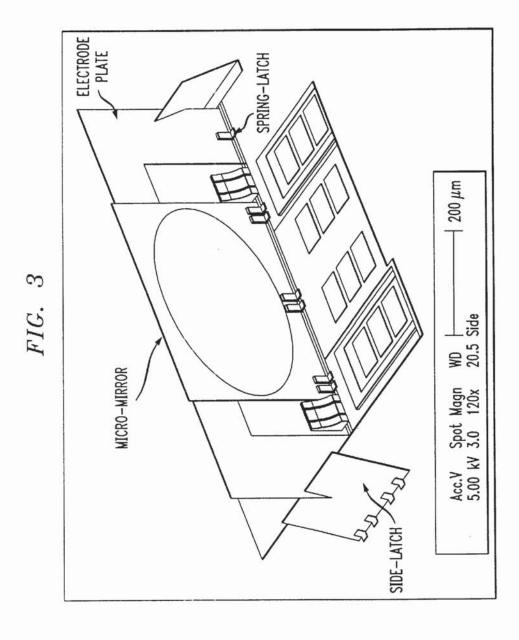
FIG. 1



- MICRO-HINGES 200 µm \sim WD 22.1 Acc.V Spot Magn 5.00 kV 3.0 120x



Jun. 5, 2001





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