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Smith et al.

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(54) **VARIABLE TRANSMISSION MULTI-CHANNEL OPTICAL SWITCH**

(75) Inventors: **David A. Smith**, Atlanta, GA (US);
John E. Golub, Atlanta, GA (US);
Fariborz Farhan, Alpharetta, GA (US)

(73) Assignee: **Movaz Networks, Inc.**, Norcross, GA (US)

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Related U.S. Application Data

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(51) **Int. Cl.**⁷ **G02B 6/26; G02B 6/42**

(52) **U.S. Cl.** **385/18; 385/19**

(58) **Field of Search** **385/18, 19, 15, 385/33; 398/156**

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,696,062 A *	9/1987	LaBudde	398/156
4,911,526 A	3/1990	Hsu et al.	350/96.24
5,414,540 A	5/1995	Patel et al.	359/39
5,621,829 A	4/1997	Ford	385/22
5,745,271 A	4/1998	Ford et al.	359/130
5,771,320 A	6/1998	Stone	385/16
5,796,479 A	8/1998	Derickson et al.	356/326
5,828,800 A	10/1998	Henry et al.	385/20
5,915,063 A	6/1999	Colbourne et al.	385/140
5,960,133 A	9/1999	Tomlinson	385/18

6,097,859 A	8/2000	Solgaard et al.	385/17
6,101,299 A	8/2000	Laor	385/16
6,111,686 A *	8/2000	Toyohara	359/337.13
6,204,946 B1	3/2001	Aksyuk et al.	359/131
6,263,123 B1	7/2001	Bishop et al.	385/15

FOREIGN PATENT DOCUMENTS

EP	0 984 311	3/2000
EP	0 729 044	1/2003
JP	55-159402	12/1980
WO	W/O 02/25358	3/2000
WO	WO 00/20899	4/2000

OTHER PUBLICATIONS

Lin et al., "Micro-electro-mechanical systems (MEMS) for WDM optical-crossconnect networks", *Military Communication Conference Proceedings, 1999. MILCOM 1999. IEEE Atlantic City, NJ. USA 31, IEEE, US*, Oct. 31, 1999, 954-957 pp.

G. Jeong et al., "Comparison of Wavelength-interchanging and wavelength-selective cross-connects in multiwavelength all-optical networks", *IJEEP*, 1996, 156-163 pp.

* cited by examiner

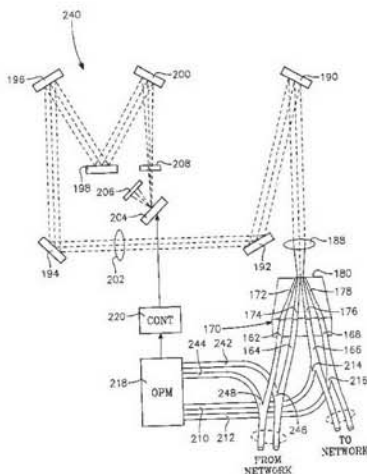
Primary Examiner—Chandrika Prasad

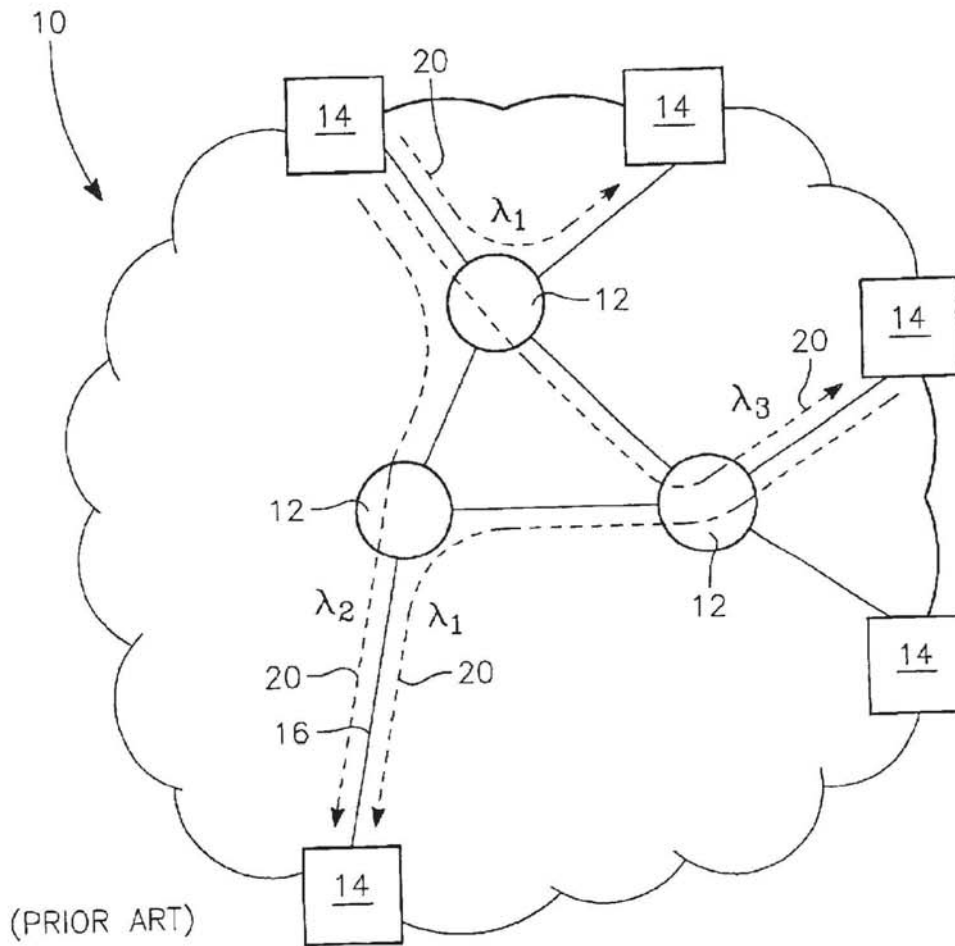
(74) *Attorney, Agent, or Firm*—Charles S. Guenzer

(57) **ABSTRACT**

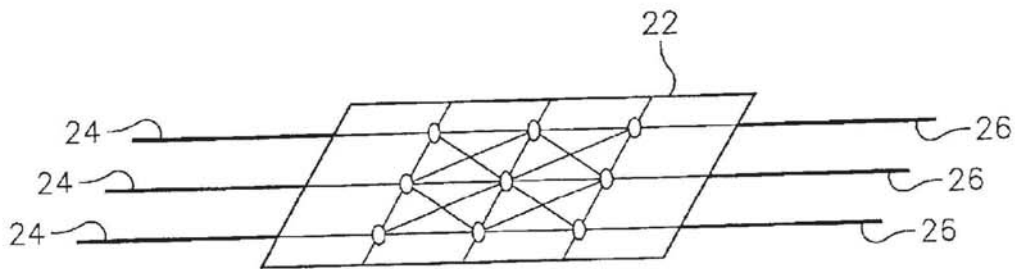
A multi-wavelength or white-light optical switch including an array of mirrors tiltable about two axes, both to control the switching and to provide variable power transmission through the switch, both for optimization and for power equalization between wavelength channels in a multi-wavelength signal. The output power of a channel is monitored, thereby allowing feedback adjustment of the transmitted power. The mirrors are preferably formed in a micro electromechanics system array to be tiltable in orthogonal directions and having electrostatically controlled tilting by two pairs of electrodes beneath the mirrors. Input power of the separate channels may also be monitored.

37 Claims, 11 Drawing Sheets





(PRIOR ART)
FIG. 1



(PRIOR ART)
FIG. 2

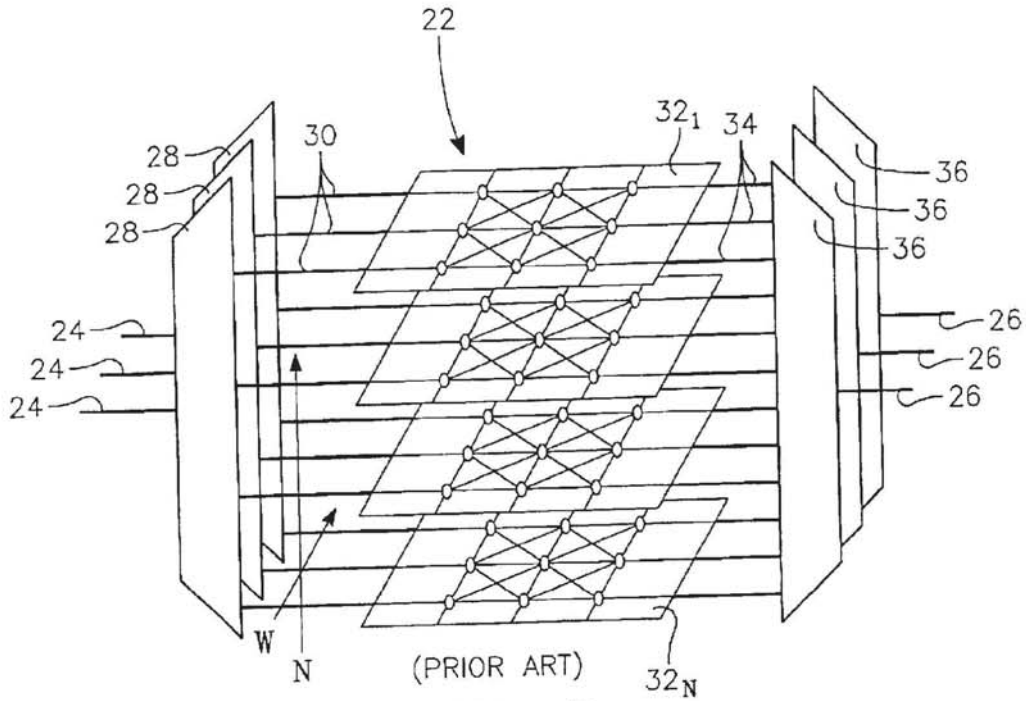


FIG. 3

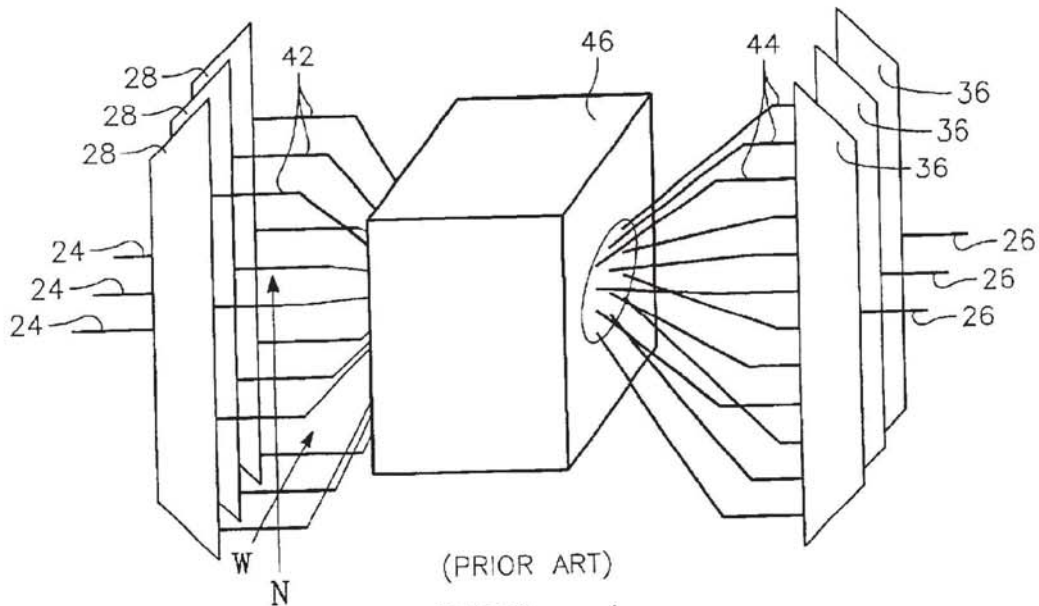


FIG. 4

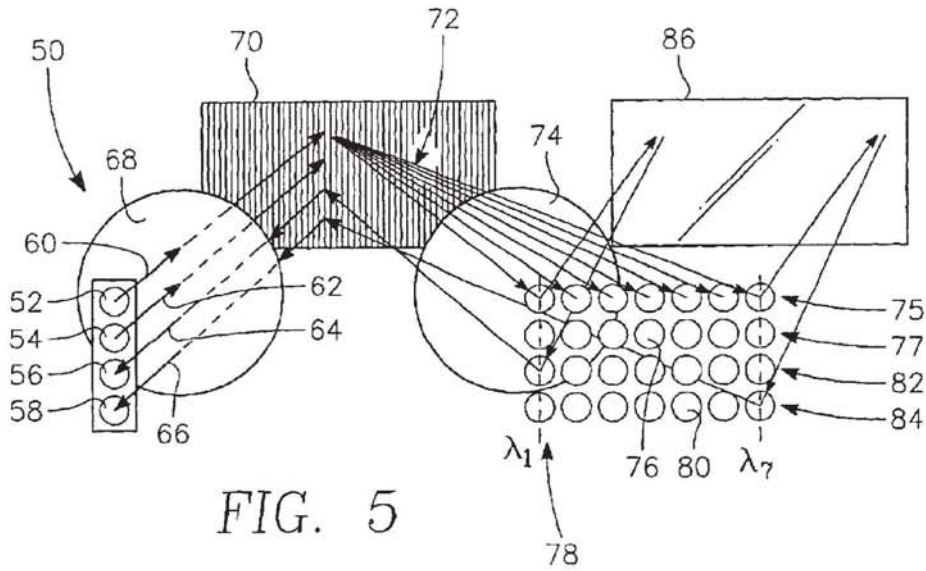


FIG. 5

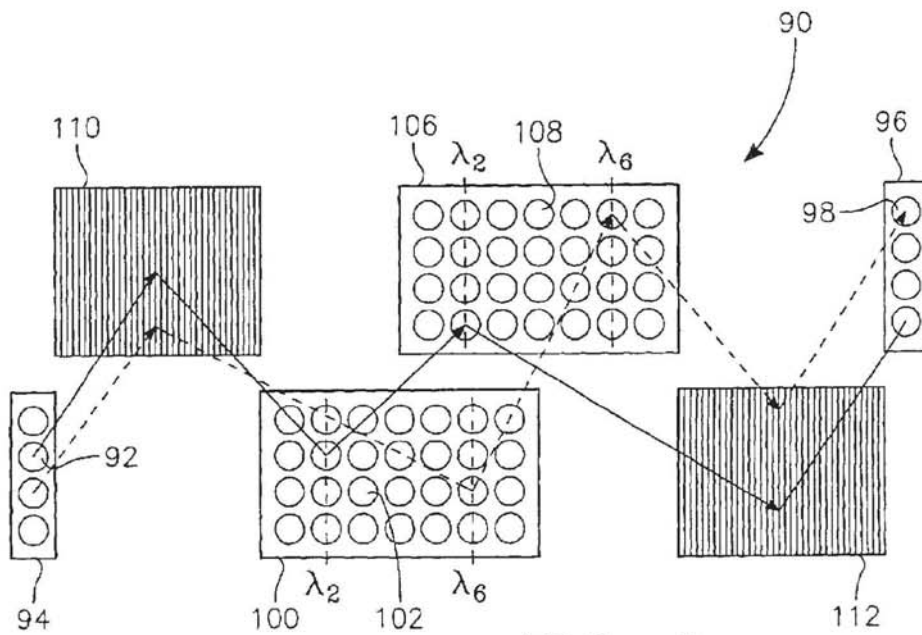


FIG. 6

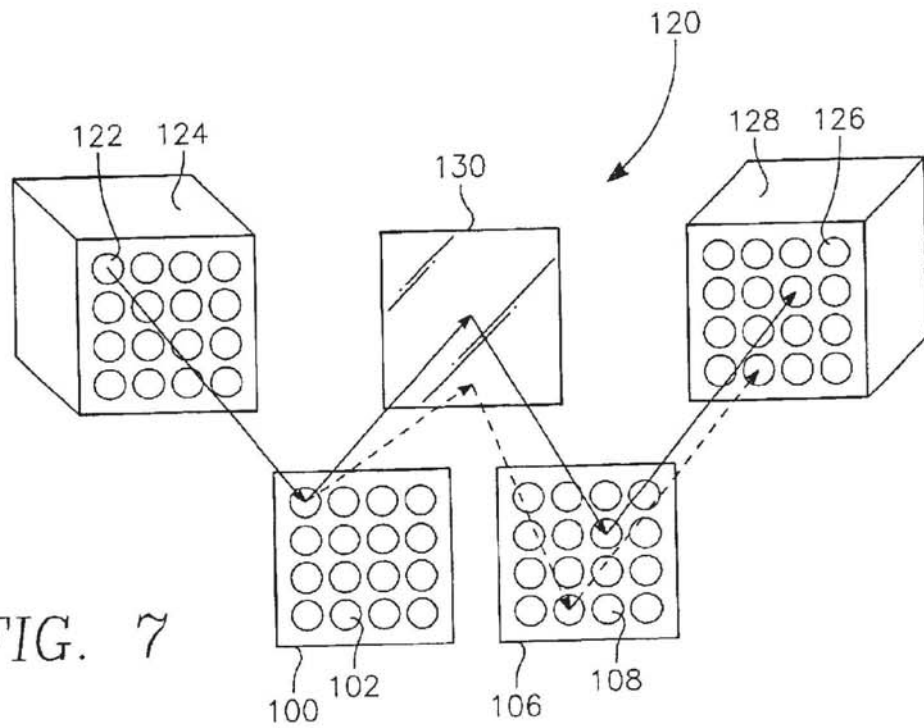


FIG. 7

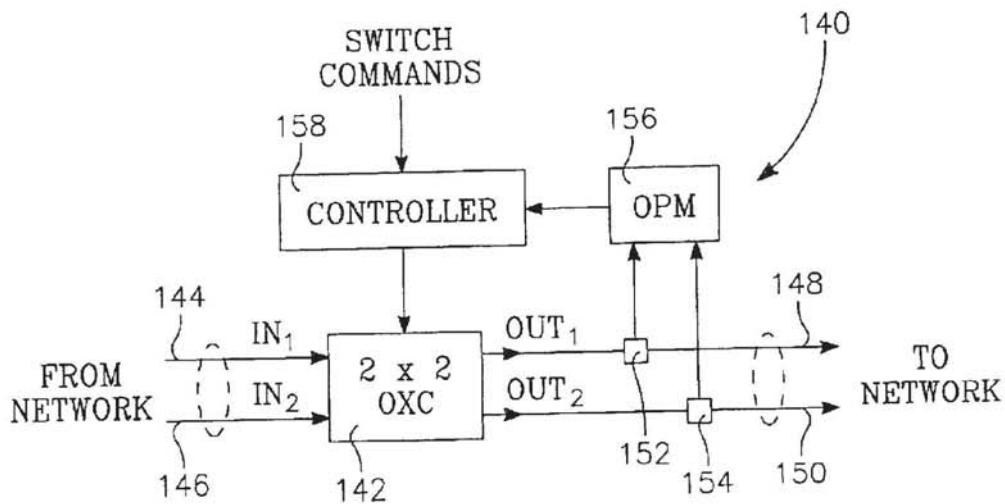


FIG. 8

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