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Smith et al.

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(54) **VARIABLE TRANSMISSION MULTI-CHANNEL OPTICAL SWITCH**
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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 Akshuk et al. 359/131
6,263,123 B1 7/2001 Bishop et al. 385/15

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

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 78 days.

OTHER PUBLICATIONS

(21) Appl. No.: **09/957,312**

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.

(22) Filed: **Sep. 20, 2001**

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

(65) **Prior Publication Data**

US 2002/0071627 A1 Jun. 13, 2002

* cited by examiner

Related U.S. Application Data

(60) Provisional application No. 60/234,683, filed on Sep. 22, 2000, and provisional application No. 60/267,285, filed on Feb. 7, 2001.

Primary Examiner—Chandrika Prasad

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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

(57) **ABSTRACT**

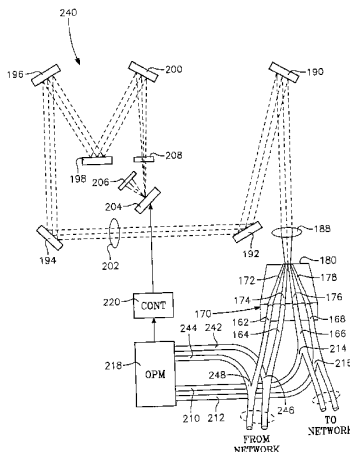
A multi-wavelength or white-light optical switch including an array of mirrors tiltable about two axes, both to control the switching and to provide variable power transmission through the switch, both for optimization and for power equalization between wavelength channels in a multi-wavelength signal. 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.

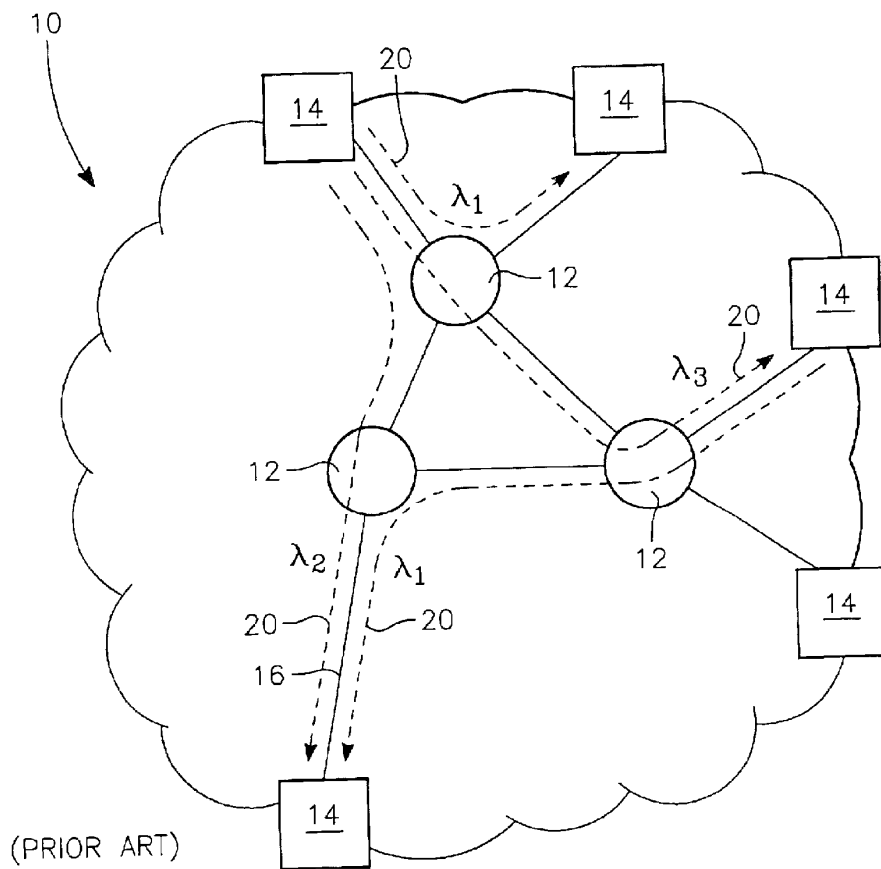
(56) **References Cited**

U.S. PATENT DOCUMENTS

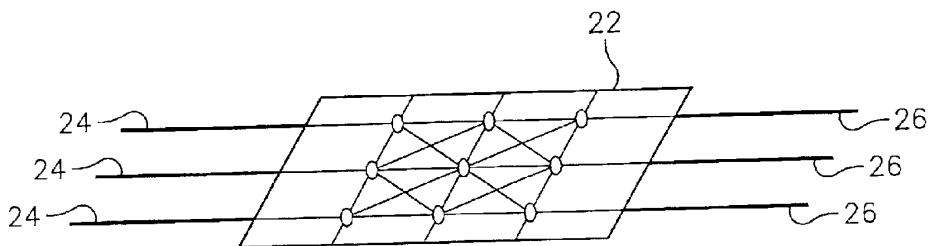
4,696,062 A * 9/1987 LaBudde 398/156
4,911,526 A 3/1990 Hsu et al. 350/96.24
5,414,540 A 5/1995 Patel et al. 359/39
5,621,829 A 4/1997 Ford 385/22
5,745,271 A 4/1998 Ford et al. 359/130
5,771,320 A 6/1998 Stone 385/16
5,796,479 A 8/1998 Derickson et al. 356/326
5,828,800 A 10/1998 Henry et al. 385/20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

37 Claims, 11 Drawing Sheets

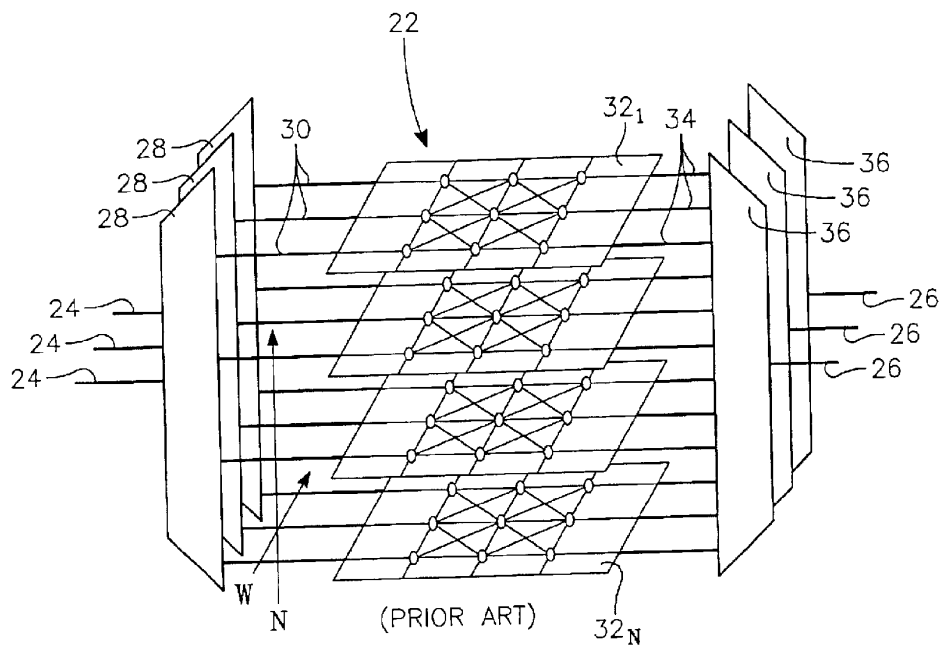




(PRIOR ART)
FIG. 1

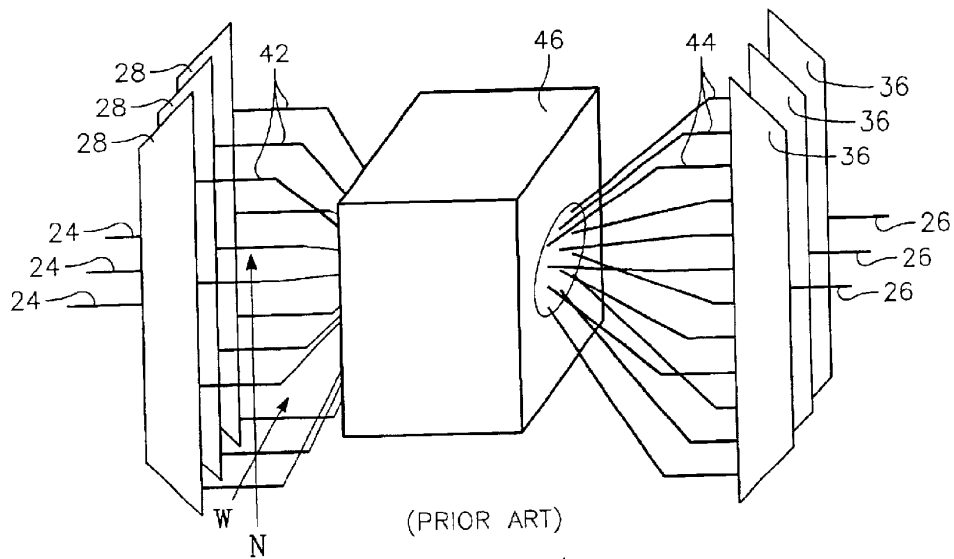


(PRIOR ART)
FIG. 2



(PRIOR ART)

FIG. 3



(PRIOR ART)

FIG. 4

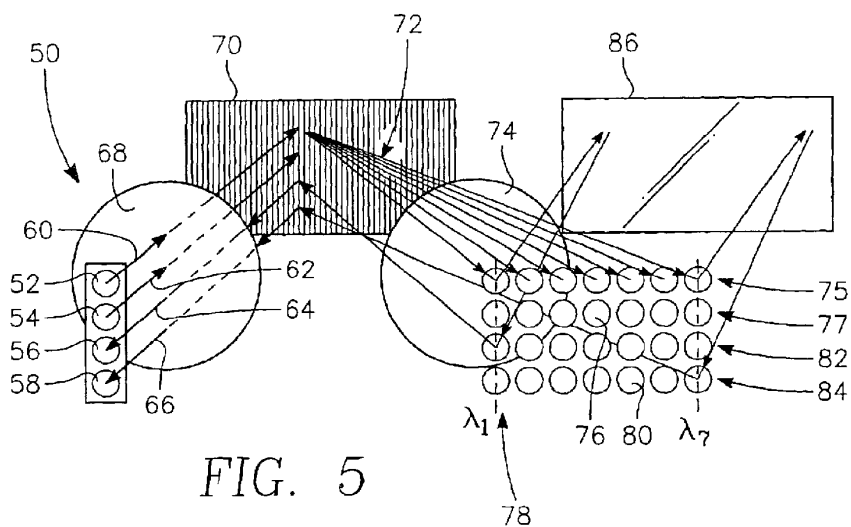


FIG. 5

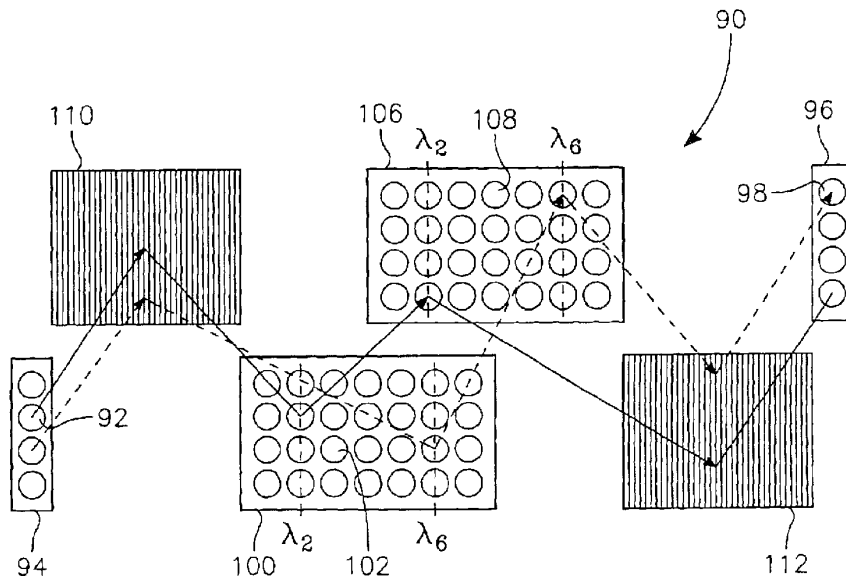


FIG. 6

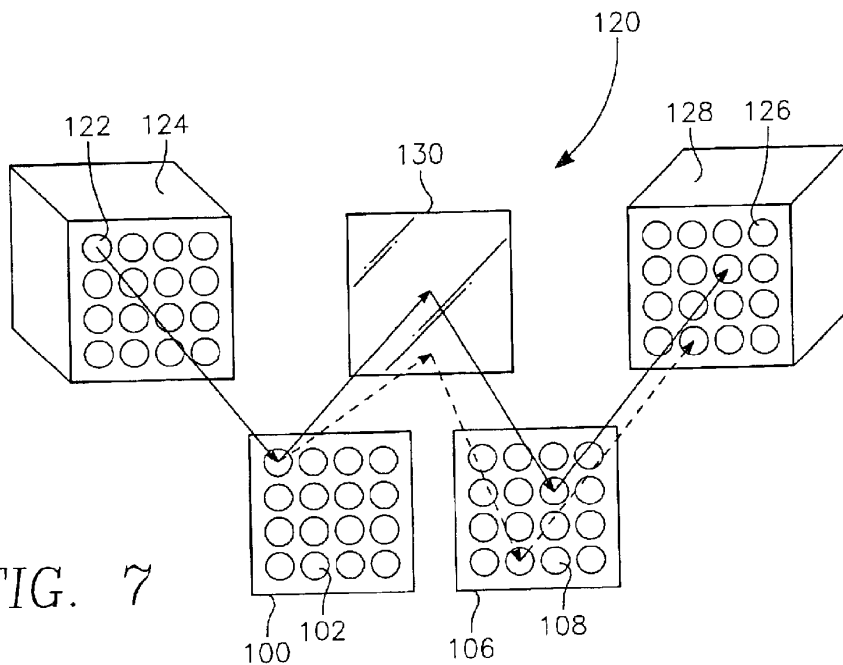


FIG. 7

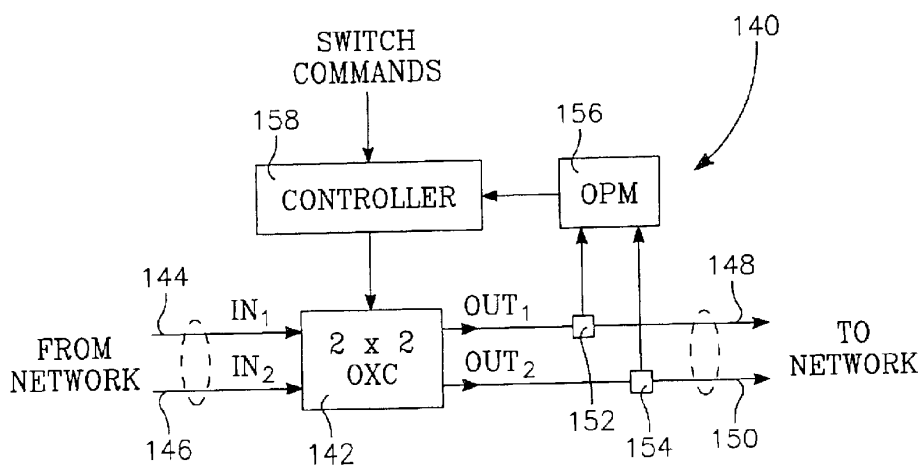


FIG. 8

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