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United States Patent [19]

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Lin et al.

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[54] **OPTICAL SWITCH HAVING AN ANALOG BEAM FOR STEERING LIGHT**

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[57] **ABSTRACT**

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A spatial light modulator (**40,70,80,90,130**) operable in the analog mode for light beam steering or scanning applications. A deflectable mirror (**42, 72**) and which may be hexagonal (**92, 132**) is supported by a torsion hinge (**44,86, 94**) ends along a torsion axis. A plurality of flexure hinges (**48,82,106**) are provided to support the ends of the mirror (**42,72,92,132**) and provide a restoration force. The combination of the torsion hinges and the flexure hinges realizes a deflectable pixel that is operable in the linear range for a large range of address voltages. The flexure hinges also maintain a flat undeflected state when no address voltage is applied, and prevent the pixel from collapsing. The pixel may be reinforced, such as about its perimeter (**74**) to ensure mirror flatness and prevent warping, even during extreme deflections of the mirror. The pixel is electrostatically deflected by applying an address voltage to an underlying address electrode (**60,96,98**). The hexagonal mirrors (**92, 132**) allow a tightly packed mirror array, and have a closely circular surface area so as to efficiently reflect a light beam of circular cross section, such as a light beam from fiber optics.

[*] Notice: The term of this patent shall not extend beyond the expiration date of Pat. No. 5,629,794.

[21] Appl. No.: **537,179**

[22] Filed: **Sep. 29, 1995**

[51] Int. Cl.⁶ **G02B 26/00**

[52] U.S. Cl. **359/290; 359/214; 359/850**

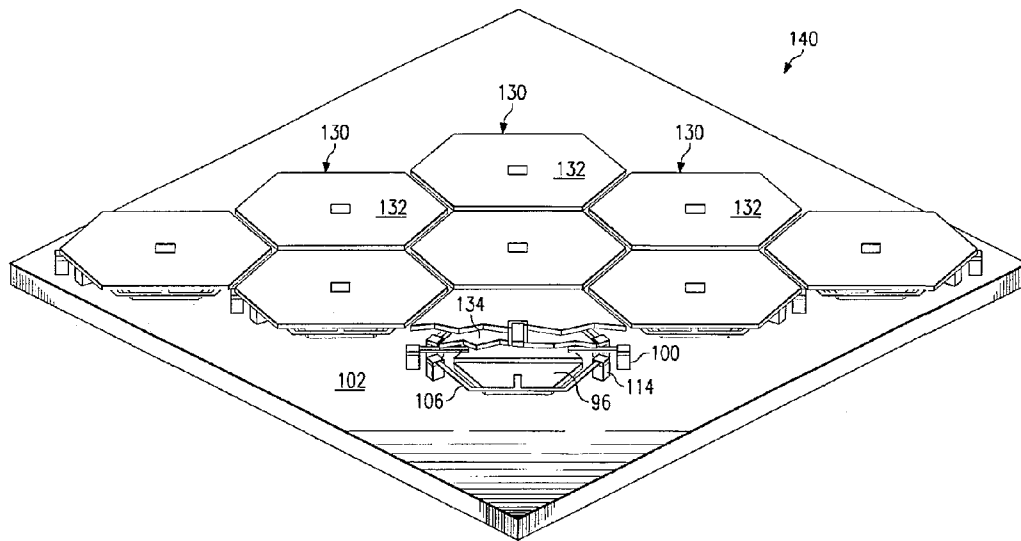
[58] Field of Search 359/290, 291, 359/212, 213, 214, 846, 847, 848, 849, 850, 851

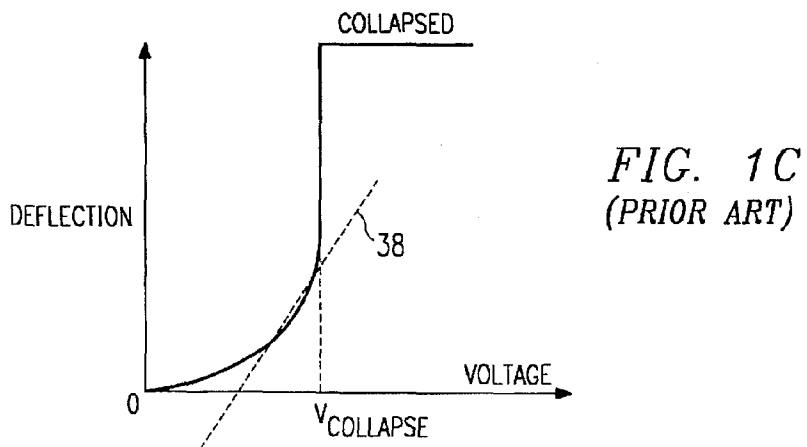
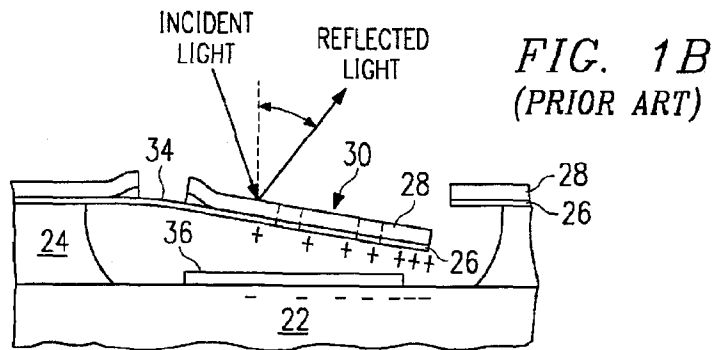
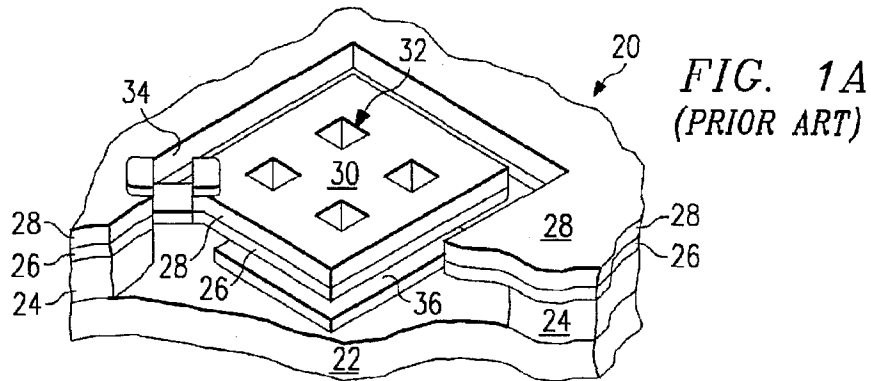
[56] **References Cited**

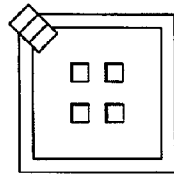
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16 Claims, 9 Drawing Sheets

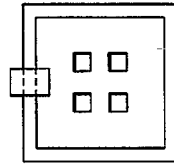






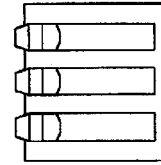
45° FLAP

FIG. 1D



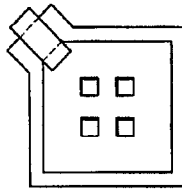
90° FLAP

FIG. 1E



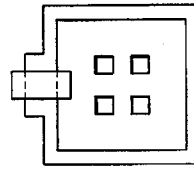
DIVING
BOARDS

FIG. 1F



45° EXTENDED
HINGE

FIG. 1G



90° EXTENDED
HINGE

FIG. 1H

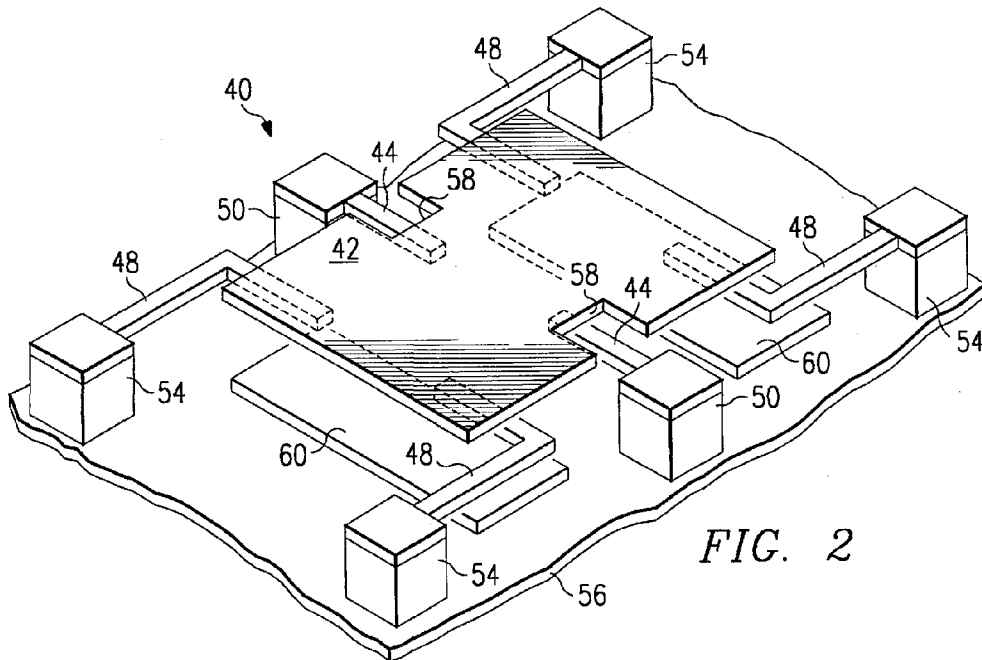


FIG. 2

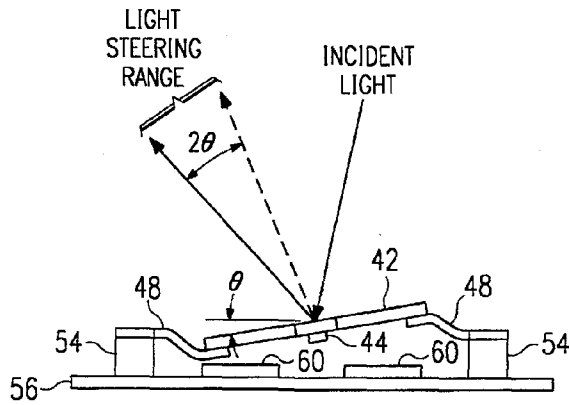


FIG. 3A

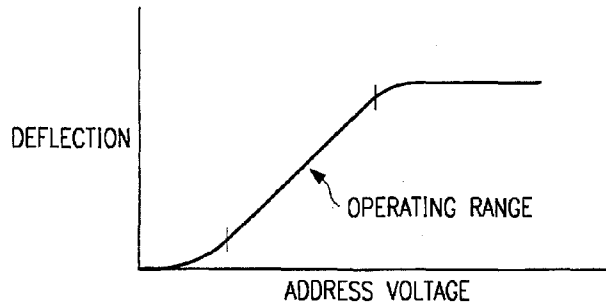


FIG. 3B

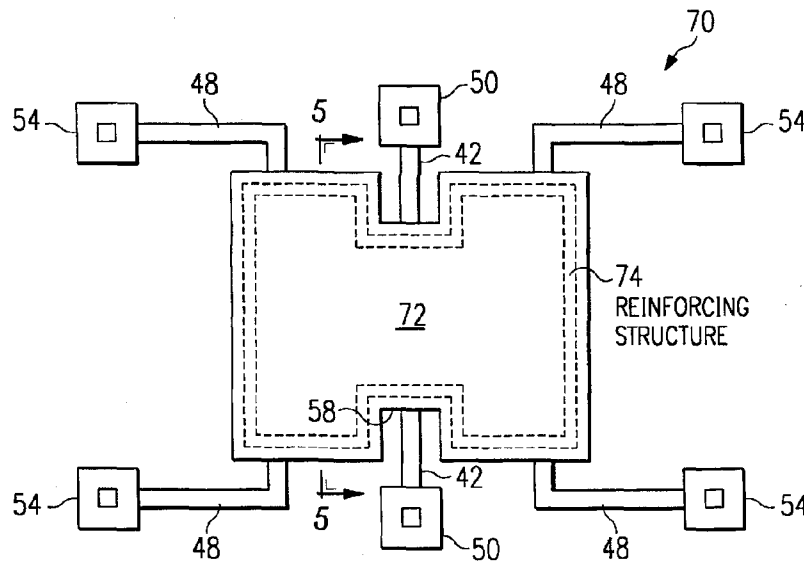


FIG. 4

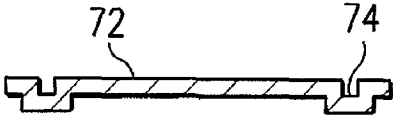


FIG. 5

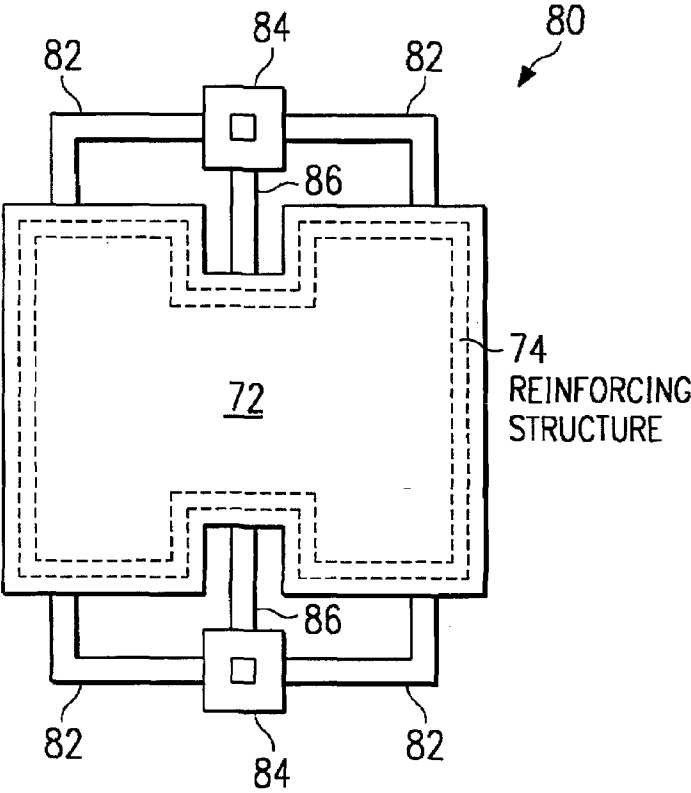


FIG. 6

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