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[54] **ULTRAVIOLET LUMINESCENT RETROREFLECTIVE SHEETING**

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[58] **Field of Search** 428/141, 143, 428/156, 195, 201, 203, 204, 207, 325, 913, 166, 178; 359/529, 530, 531, 532, 533, 534, 536; 40/612, 442, 542, 543, 582; 250/461.1, 486.1

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,830,682	8/1974	Rowland	161/2
4,025,674	5/1977	Mizuochi	428/29
4,250,646	2/1981	Trachtenberg	40/582
4,424,449	1/1984	O'Brill	250/461.1
4,555,161	11/1985	Rowland	350/103
4,653,864	3/1987	Miyata	350/105
4,656,072	4/1987	Coburn, Jr. et al.	428/40
4,952,023	8/1990	Bradshaw et al.	350/102
5,009,019	4/1991	Erlendsson et al.	40/541
5,050,327	9/1991	Woltman	40/582
5,085,918	2/1992	Rajan et al.	428/195
5,223,977	6/1993	Bennett	359/530
5,229,882	7/1993	Rowland	359/530
5,237,448	8/1993	Spencer et al.	119/792
5,272,562	12/1993	Coderre	359/529
5,414,947	5/1995	Hjaltason	40/615
5,478,628	12/1995	Billingsley et al.	428/171
5,516,227	5/1996	Kozak et al.	404/9

FOREIGN PATENT DOCUMENTS

50-47591	4/1975	Japan .
51-144198	12/1976	Japan .
57-133004	8/1982	Japan .
60-194405	10/1985	Japan .
5173008	7/1993	Japan .
643819	2/1994	Japan .
6250006	9/1994	Japan .
9314422	7/1993	WIPO .

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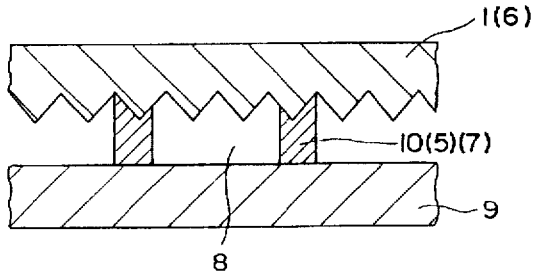
[57] **ABSTRACT**

Ultraviolet luminescent retroreflective sheeting includes a retroreflective portion containing retroreflective elements and an ultraviolet luminescent portion to facilitate nighttime viewing by persons not located at or near a source of light being retroreflected by the retroreflective portion. At least part of the ultraviolet luminescent portion is provided as the bonding lines for bonding the transparent cover sheet to the support sheet to form a series of sealed cells in which the retroreflective elements, which may be of the encapsulated lens-type or the encapsulated cube-corner-type, are disposed. The ultraviolet luminescenct portion includes fluorescent agent which emits light when irradiation by ultraviolet irradiation. The ultraviolet luminescent retroreflective sheeting may be used in a display device, such as a roadside sign, in combination with a source of ultraviolet radiation means which may be formed integrally with the sheeting or spaced therefrom and which will, in operation, emit ultraviolet rays in the direction of the retroreflective sheeting.

24 Claims, 4 Drawing Sheets