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# United States Patent [19]

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Isaacson et al.

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- [54] **MULTIFOCAL DIFFRACTIVE OPTHALMIC LENS AND METHOD OF MANUFACTURE**
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- [58] Field of Search ..... **351/160 H, 160 R, 161, 351/162; 604/294; 623/6; 156/73.1; 219/121.6; 359/565**

4,828,558 5/1989 Kelman ..... 623/6  
 4,846,833 7/1989 Cumming ..... 623/6

### FOREIGN PATENT DOCUMENTS

43640 1/1982 European Pat. Off. .  
 1154360 6/1969 United Kingdom .  
 2171106 8/1986 United Kingdom .

### OTHER PUBLICATIONS

O. Wichterle, "Hydrogels," *Encyclopedia of Polymer Science and Technology*, vol. 15, 1971, pp. 273-291.  
 Wichterle et al., "Hydrophilic Gels for Biological Use," *Nature*, 185:117-118, 1960.  
 Ratner et al., "Synthetic Hydrogels for Biomedical Applications," *Hydrogels for Medical and Related Applications*, Am. Chem. Soc., Wash, D.C., 1976, pp. 1-35.  
 R. A. Clarke, "Ultrasonic Assembly," *Modern Plastics Encyclopedia*, 1980-81, pp. 447-451.  
 Jordan et al., "Kinoform Lenses," Aug. 1970, *Applied Optics*, pp. 1883-1887.

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[56] **References Cited**  
**U.S. PATENT DOCUMENTS**

3,630,200	12/1971	Higuchi	128/260
4,210,391	7/1990	Cohen	351/161
4,338,005	7/1982	Cohen	351/161
4,340,283	7/1982	Cohen	351/161
4,575,372	3/1986	Gundersen	623/6
4,618,649	10/1986	Ofstead	525/60
4,637,697	1/1987	Freeman	351/161
4,641,934	2/1987	Freeman	351/159
4,642,112	2/1987	Freeman	623/6
4,655,565	4/1987	Freeman	351/159
4,664,666	5/1987	Barrett	623/6
4,685,921	8/1987	Peyman	623/6
4,685,922	8/1987	Peyman	623/6
4,693,939	9/1987	Ofstead	428/421
4,702,865	10/1987	Koziol et al.	264/17
4,704,016	11/1987	de Carle	351/161
4,731,078	3/1988	Stoy et al.	623/6
4,771,089	9/1988	Ofstead	524/41

### [57] ABSTRACT

A multifocal ophthalmic lens includes first and second lens members. Each lens member has a smooth outer surface and an inner surface with an edge about its perimeter. A multifocal diffractive zone plate on at least one of the lens members is characterized by an index of refraction. The lens members are joined at the edges by ultrasonic welding to form a cavity adjacent the diffractive zone plate. The cavity is filled with a liquid medication having an index of refraction which is different than the index of refraction of the diffractive zone plate. A hole through one of the lens members functions as a fluid transport mechanism to permit transfer of the medication between the cavity and eye.

35 Claims, 4 Drawing Sheets

