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# United States Patent [19]

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Doiron et al.

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- [54] **CONTINUOUS GRADIENT CYLINDRICAL DIFFUSION TIP FOR OPTICAL FIBERS AND METHOD FOR MAKING**
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- [51] Int. Cl.<sup>5</sup> ..... **A61B 17/36**
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- [58] Field of Search ..... **606/2, 3, 4, 7-16; 128/395-398; 385/115-119**

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[57] **ABSTRACT**

A cylindrical diffuser tip for use with an optical fiber is described. The diffuser tip comprises a silicone core containing scattering centers embedded therein abutted to the terminus of the conventional optical core of an optical fiber, and an outer protective plastic tube to provide controlled stiffness or rigidity to the silicone diffuser tip while maintaining a flexibility comparable to that of the optical fiber. The scattering centers embedded in the silicone core are distributed to provide a gradient that increases continuously in a direction perpendicular from the terminus face of the optical fiber. The tip provides a substantially uniform distribution of radiance along its length and is particularly useful for laser radiation treatment of tumors. The stiffness of the diffuser tip can be varied by choosing a protective tube of varying wall thickness and durometer. The diffuser tip is useful for providing uniform cylindrical illumination of target tissue in remote areas of the body and is particularly useful in such areas as Photodynamic Therapy of tumors, phototherapy of atheromas and hyperthermia.

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

|           |        |                |           |
|-----------|--------|----------------|-----------|
| 4,336,809 | 6/1982 | Clark          | 606/3 X   |
| 4,660,925 | 4/1987 | McCaughan, Jr. | 606/15 X  |
| 4,693,556 | 9/1987 | McCaughan, Jr. | 606/15 X  |
| 4,733,929 | 3/1988 | Brown          | 385/115 X |
| 4,852,567 | 8/1989 | Sinofsky       | 606/3     |
| 4,860,743 | 8/1989 | Abela          | 606/7     |
| 4,921,327 | 5/1990 | Zito           | 606/3 X   |

**5 Claims, 4 Drawing Sheets**

