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ALTERNATE METHODS FOR PRODUCING TRANSITION FIBERS.(U)
AUG 76 G ACHUTARAMAYYA, W D SCOTT N00123-76-C-1451

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Two new methods of producing transition waveguide structures for coupling stripe geometry double hetrostructure lasers to single mode fibers were evaluated. The first involved producing an elliptical cross section air core in a glass fiber. This air core was to be rounded by local heating and subsequently filled with a liquid to form a waveguide. Elliptical cores were successfully produced, however, when the rounding operation was attempted the cores collapsed. A second experiment involved flattening a conventional round cross section fiber

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to achieve an elliptical core cross section. This technique has been used to produce fiber cores that are 19 x 7 micrometers from 12.5 micrometer round core fibers.

ABSTRACT

Two new methods of producing transition waveguide structures for coupling stripe geometry double hetrostructure lasers to single mode fibers were evaluated. The first involved producing an elliptical cross section air core in a glass fiber. This air core was to be rounded by local heating and subsequently filled with a liquid to form a waveguide. Elliptical cores were successfully produced, however, when the rounding operation was attempted the cores collapsed. A second experiment involved flattening a conventional round cross section fiber to achieve an elliptical core cross section. This technique has been used to produce fiber cores that are 19 x 7 micrometers from 12.5 micrometer round core fibers.

INTRODUCTION

Transition structures developed under a previous contract sponsored by the Naval Electronics Laboratories Center and Defense Advanced Research Projects Agency, have been used to couple light from a rectangular source to a round waveguide. These structures were fabricated by pulling a glass preform into a rectangular fiber then rounding the fiber by local heating. Suitable choices of materials and physical demensions allow efficient coupling to the output aperture of a double hetrostructure laser and at the rounded end of good geometrical match to typical single mode fibers. Details of the construction of such transition fibers are contained in references 1-6.

At the suggestion of Dr. D. J. Albares of NELC (Code 2500). Two new construction methods for producing transitions have been evaluated. They involve (1) construction of a hollow transition fiber which can be filled with liquid of an appropriate refractive index and (2) production of a transition by simply flattening a conventional round fiber.

LIQUID CORE FIBERS

The procedure shown in Fig. 1 was followed in an attempt to produce an elliptical to round transition in core cross section of a hollow core fiber. A flattened glass capillary tube approximately 1 mm in diameter is produced in step 1. The flattened portion of this capillary is placed between glass plates which are then fused together to form a preform for pulling. Step 3 shows the pulling process which results in a fiber with an elliptical hole in the center. We investigated the possibility of rounding this core by local heating of the outside of the cladding; before rounding occurred the fiber core was observed to collapse. Figure 2 shows a cross section of the flattened capillary tube and Fig. 3 the drawn fiber before the final heating process. Beside the elliptical core is a bubble produced by an air inclusion in the fused preform.

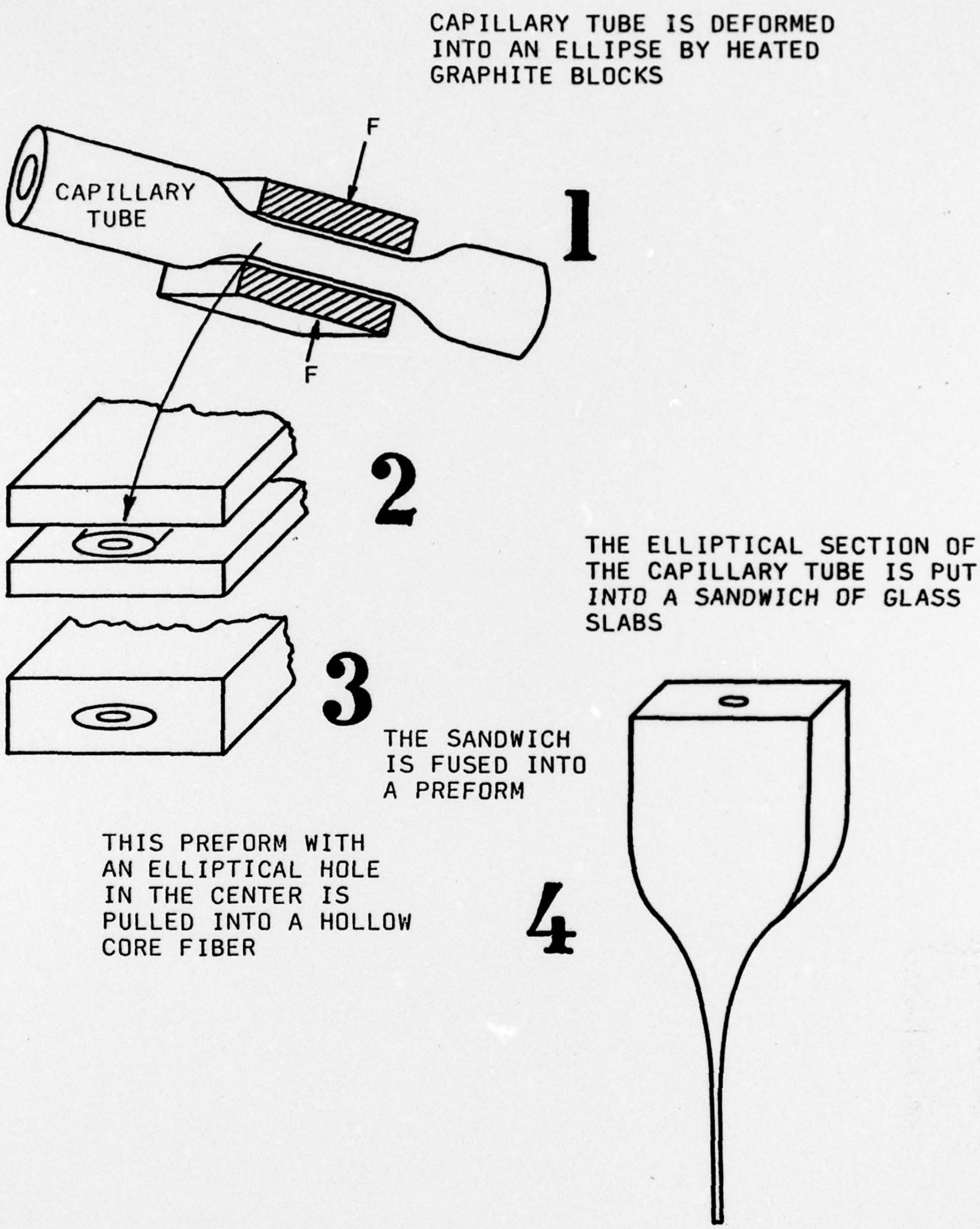

FIGURE 1

Construction of a fiber with an elliptical hole in the center.

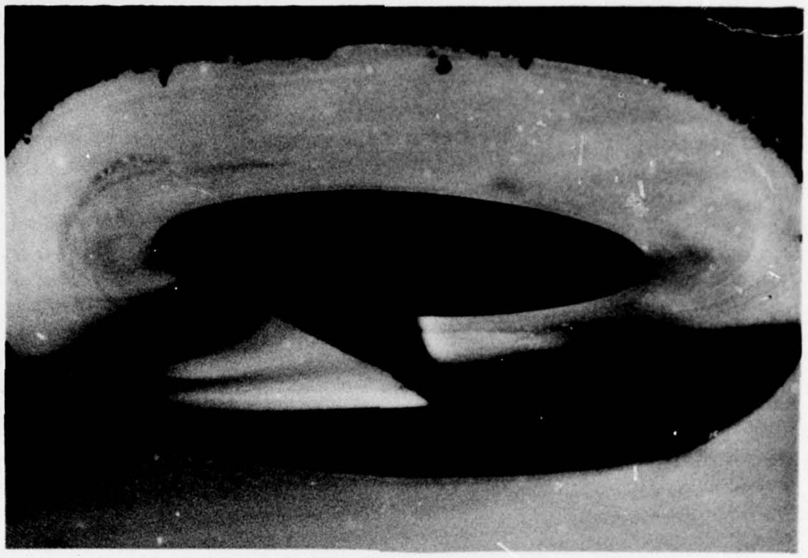

FIGURE 2

Cross section of a capillary tube which has been flattened, as in step 1 of Fig. 1. The inside demensions of the tube are 236 x 981 μm.

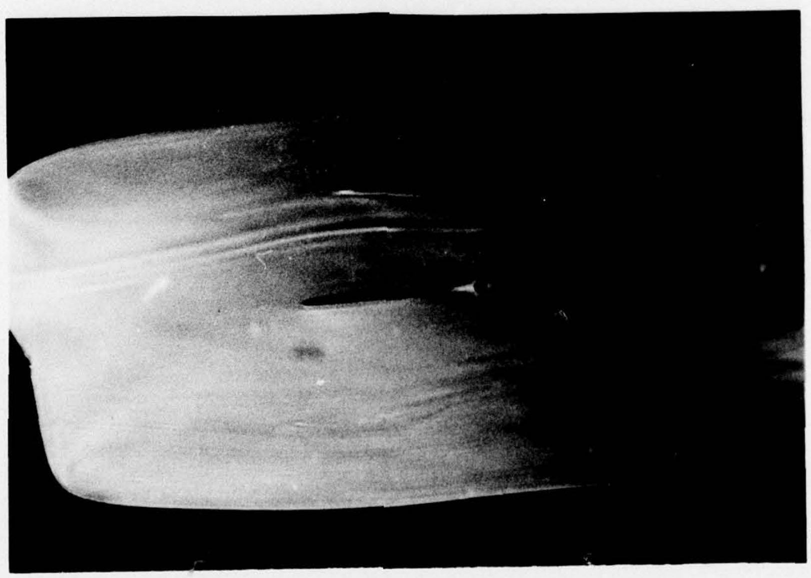

FIGURE 3

Drawn elliptical core fiber, after step 4 of Fig. 1. The elliptical core in this fiber is 8 x 218 μm. Beside the core is a small bubble which was caused by air trapped in the preform fusing process.

TRANSITION FIBERS PRODUCED BY FLATTENING ROUND FIBERS

A second method was investigated for producing transition structures. It involved simply flattening existing round fibers with heated graphite tongs to produce an elliptical core cross section. This procedure is illustrated in Fig. 4 and results of pressing a 12.5 μm core (Fig. 5) are shown in Fig. 6. The 12.5 μm diameter core becomes a 19 x 7.5 μm ellipse.

For smaller cores, in the 3-6 μm range, less flattening would probably be experienced, however, this could be offset by placing the fiber core away from the center of the cladding shown in Fig. 7. The results shown in Figs. 5 and 6 indicate that it is possible to achieve some flattening of a fiber core by pressing the outside of the cladding. Practical coupling structures however, require smaller core diameters for the round cross section and more ellipticity when the fiber is flattened. A typical round core diameter should be approximately 5 μm and the elliptical section about 2 x 11 μm.

CONCLUSIONS

Liquid core transitions produced by flattening a hollow elliptical fiber core do not appear to be practical since the core collapses when it is heated in the rounding process. It does however, appear practical to produce transition structures by flattening conventional round core fibers with heated graphite blocks to produce an elliptical core cross section. If this technique can be refined to produce high efficiency coupling it may be possible to apply the flattening process directly to prepare the ends of single mode fibers.

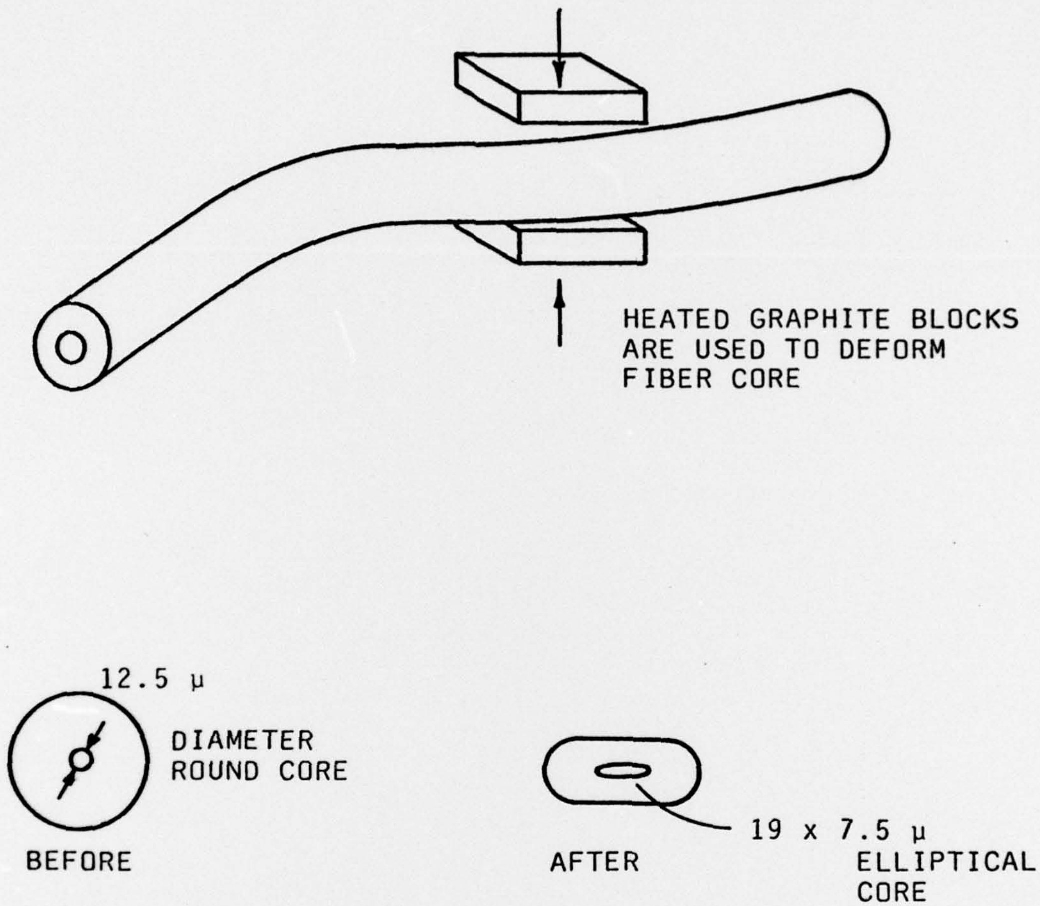

FIGURE 4

Flattening of fiber core by pressing the outside of the fiber.

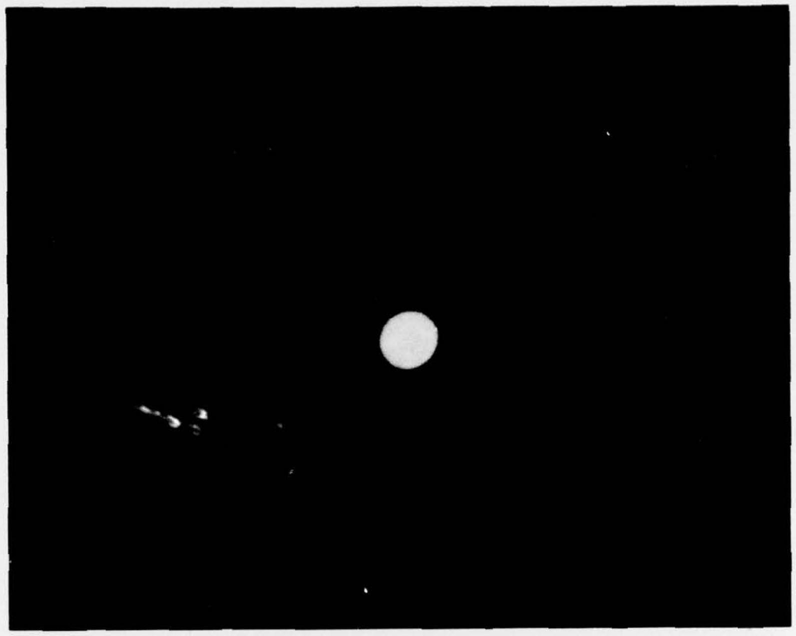

FIGURE 5

Round core of a conventional fiber before pressing. The core diameter is 12.5 μm.

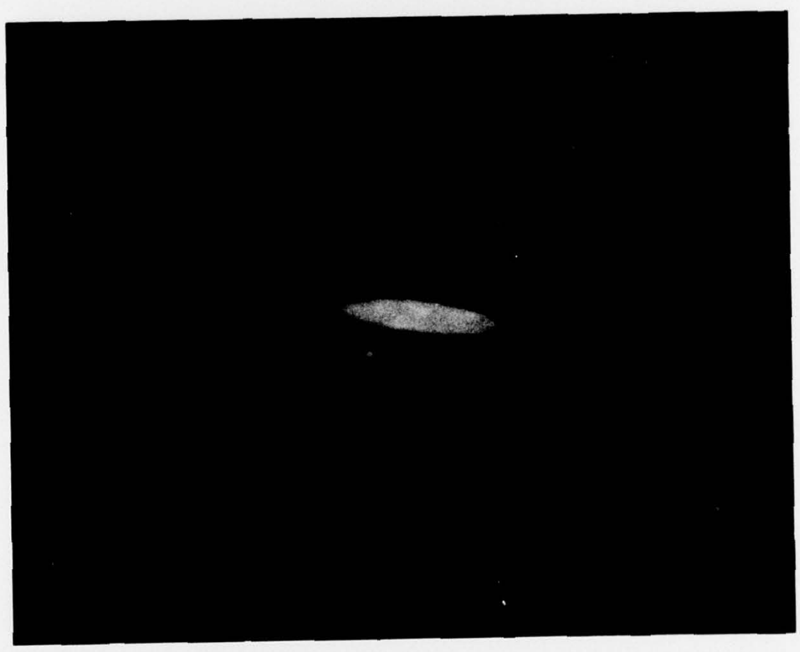

FIGURE 6

The same core as shown in Fig. 5 after pressing the cladding. This elliptical core is 19 x 7.5 μm.

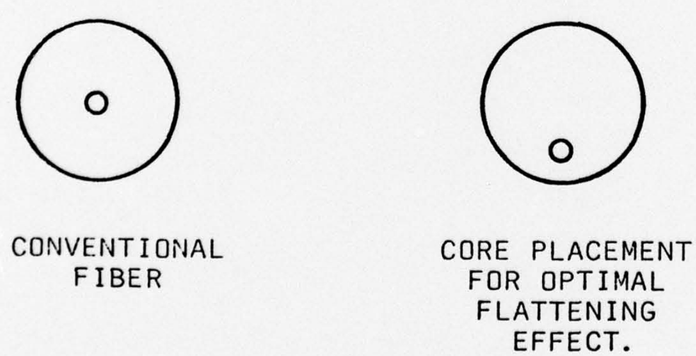

FIGURE 7

Geometry for improving core flattening characteristics.

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