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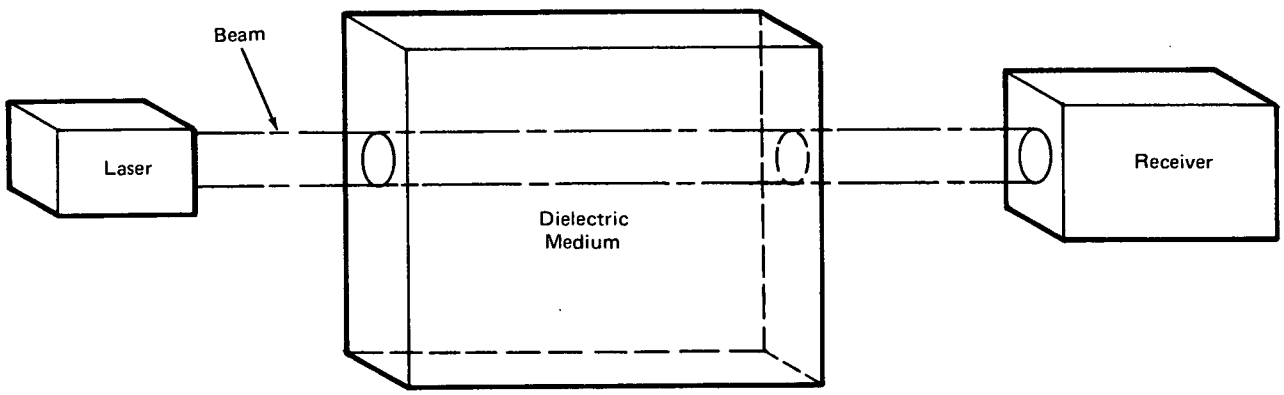
NASA TECH BRIEF

NASA Headquarters

Transmission of Optical Frequencies with Minimal Losses



The problem:

Transmission of power at optical frequencies should sustain minimal losses.

The solution:

Diffractionless dielectrics are used as efficient transmitting media between the source and receiver. In this capacity the gas-filled pipes show best results.

How it's done:

An optical beam of sufficient power is transmitted through a dielectric medium of a nonlinear refractive index. This transmitting medium may be solid, liquid, or gas with a uniform dielectric constant in the absence of an electric field. The beam of sufficient power incident on this medium increases its dielectric constant and, thus, self-generates a waveguide through the dielectric of the same diameter and shape as the beam. This effect is similar to that in fiber optics in that all the beam components are self trapped by the total internal reflection. Thus, power loss due to beam spreading between the source and receiver is minimized. The general system diagram is shown in the figure.

To establish internal reflection, the optical beam must exceed a certain critical power P_c expressed in MKS units as:

$$P_c=(1.22\lambda)^2C/64n$$

where λ is the wavelength, C is the energy flow per unit area, and n is the index of refraction due to electrostriction. Power levels produced in most laser applications are substantially above the critical levels. However, in communications, beam power may be just above the critical levels and may therefore require corrections to achieve self trapping.

Self trapping of the beam is easily induced in steel gas-filled pipes using CO_2. To produce this effect, gas pressure is set as a function of beam power: when beam power is high the pressure should be low and vice versa.

These pipes provide negligible power losses as a result of gas even at high pressures compared to those of liquid or solid dielectrics. Such gas-filled systems are self repairing in that, if gas overheats or ionizes within the beam, it is quickly replaced by the remaining gas in the system.

The developed system can be applied in power transmission, communication, bloodless surgery, machinery, etc. With this concept the laser can be placed remotely from the target area and still provide high power and small beam width.

(continued overleaf)

Note:

Requests for further information may be directed to:

Technology Utilization Officer
NASA Headquarters
Code: KT
Washington, D.C. 20546
Reference: TSP72-10389

Patent status:

This invention has been patented by NASA (U.S. Patent Nos. 3,556,634; 3,571,555; 3,575,602; and 3,606,522). Inquiries concerning non-exclusive or exclusive license for its commercial development should be addressed to:

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