Optical alignment procedure for an unstable resonator high-power laser

John G. Ackenhusen and Duncan G. Steel

Department of Nuclear Engineering, The University of Michigan, Ann Arbor, Michigan 48109

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A method for aligning the optics of a pulsed high-power positive branch unstable resonator is described. The procedure relies on the distribution of the output beam and is thus independent of a separate alignment laser, allowing systematic and rapid adjustment.

Previous techniques[1,2] for alignment of a positive branch unstable resonator laser cavity have required use of an autocollimator and/or a helium–neon alignment laser, and have required that the alignment laser beam be accurately positioned along the cavity axis. The alignment method set forth in this communication allows for inaccuracy in alignment laser positioning, as final adjustments use the image of the unstable resonator beam formed by firing the laser at thermally sensitive paper.

The laser used in developing this technique had two micrometer adjustments on each of the rear and front mirrors, which allowed orthogonal deflection of the mirrors, vertically and horizontally. The laser was first approximately aligned by the standard technique[1,2] of using a coaxial beam from a helium–neon alignment laser entering the cavity through a small aperture in the center of the primary mirror.

Refinement to this adjustment resulted from study of a burn spot image of the output beam on thermally sensitive paper. Best alignment required that the shadow in the burn spot cast by the secondary mirror be symmetrically placed ($h_1 = h_2$ and $v_1 = v_2$ in Fig. 1). The shadow was positioned by fine adjustment of the micrometers controlling the secondary mirror; for example, vertical offset of the shadow required correction by vertical micrometer adjustment.

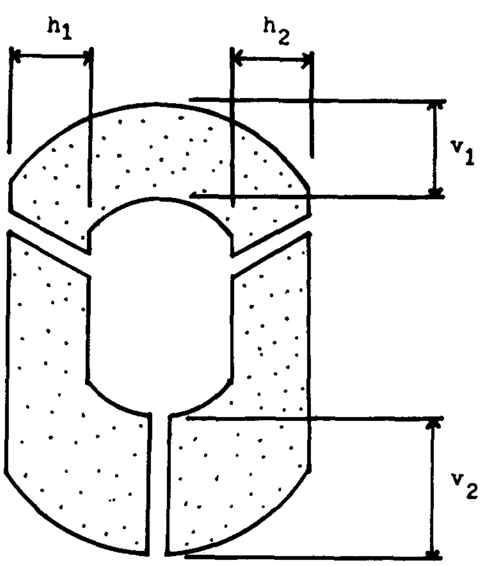

FIG. 1. Burn spot produced on thermally sensitive paper. The shadow of the front mirror appears high in the beam, indicating need for vertical fine adjustment of front mirror.

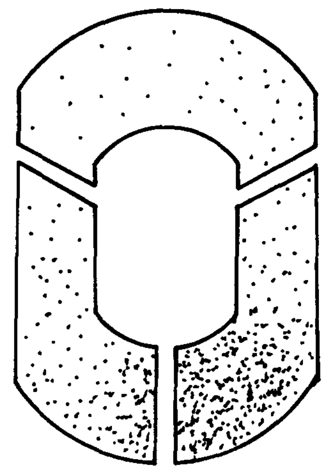

FIG. 2. Burn spot is distributed downward and slightly to the right, specifying need for vertical and slight horizontal alignment of rear mirror.

After final alignment of the secondary mirror, the primary mirror was adjusted to achieve uniform illumination of the burn spot. As with the secondary mirror, the distribution of energy followed the positioning of the primary mirror, so that to correct the case of energy distributed toward the bottom of the beam and slightly to the right (Fig. 2), the rear mirror was tilted vertically and slightly horizontally by the micrometers. Final alignment of the rear mirror was occasionally aided by monitoring the total beam energy with a pyroelectric detector.

This alignment technique was developed with a Lumonics model No. TEA-601A CO_2 TEA laser. The method allowed attainment of maximum beam output more rapidly than previous trial-and-error techniques.

[1] H. Granek and A. J. Morency, Appl. Opt. **13**, 368 (1974).
[2] Lumonics Research Ltd., Kanata, Ont., Canada, Operating and Maintenance Manual for Series 600A High Energy Pulsed TEA CO_2 Laser System," 4.4 (1975).

