Variable Ratio Beam Splitter for Laser Applications

A rugged, versatile, highly efficient, variable ratio beam splitter employing birefringent optics can provide either widely different or precisely equal intensity ratio is equal to \( \tan^2 \alpha \), where \( \alpha \) is the angle between the polarization plane and the prism's principal axis. As the plate rotates, this intensity ratio continuously changes. For identical beam polarizations, a polarization rotator or a second half-wave plate can be added to one beam.

Because the entering beam must be collimated and monochromatic, the beam splitter is most useful with laser sources. If the beams are already polarized, the device is very efficient because its only inherent losses are caused by surface reflections and intramaterial scattering. Also, the beam splitter can be constructed of air-spaced or optically contacted components, without reflective films, making it highly resistant to high power density damage and possibly usable with Q-switched ruby lasers.

The device was employed in a less-than-optimum... (continued overleaf)
arrangement (see Fig. 2) to examine its practical usefulness. No polarizer was used, an SiO-over-coated aluminum mirror was placed in the path, and only standard precautions were taken to ensure optical surface cleanness. A PIN photodiode detector, for measuring the light intensity of each beam, was varied between 0 and $\pi/2$ rad. At the larger angle, almost all light was directed to the deflected beam.

With the arrangement in Figure 2, a beam ratio range of from $4.4 \times 10^{-4}$ to $7.4 \times 10^{3}$, over seven decades, was available. With the arrangement in Figure 1, the range was extended to beyond $2 \times 10^{8}$.

The ellipticity introduced into the laser beam by the mirror (Fig. 2) caused no appreciable difference between experimental results and expected values. In fact, for those applications involving mirror incidence angles that are non-varying as a function of time, the extra phase change may be considered a small, constant, optical path length difference which can often be ignored.

Reference:

Note:
Requests for further information may be directed to:
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No patent action is contemplated by NASA.

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