NASA TECH BRIEF

NASA Headquarters

NASA Tech Briefs announce new technology derived from the U.S. space program. They are issued to encourage commercial application. Tech Briefs are available on a subscription basis from the National Technical Information Service, Springfield, Virginia 22151. Requests for individual copies or questions relating to the Tech Brief program may be directed to the Technology Utilization Office, NASA, Code KT, Washington, D.C. 20546.

Antiresonant Ring Interferometer for Laser Cavity Dumping, Mode Locking, and Other Applications

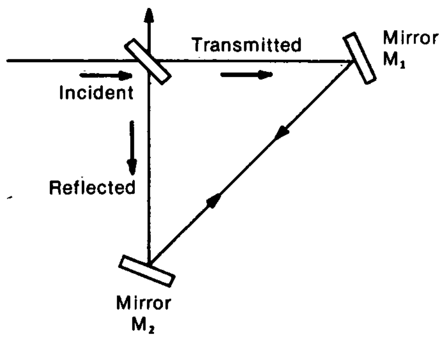

Figure 1. Antiresonant or Cyclic Ring Mirror Configuration

An antiresonant ring interferometer has been developed which has a number of applications in lasers. These include coupled laser cavities, variable laser-output coupling, intercavity harmonic-output coupling, mode locking, cavity dumping, and pulse code modulation.

The basic interferometer comprises a beam splitter and two mirrors M_1 and M_2 arranged as shown in Figure 1. A laser beam incident on the beam splitter is divided equally into reflected and transmitted components. The reflected part is incident on M_2, and the transmitted part is incident on M_1. This provides a cyclic interferometer configuration.

The antiresonant ring is particularly suitable for electro-optic laser mode locking and cavity dumping. This is done by converting electro-optic phase modulation inside the antiresonant ring into amplitude or coupling modulation. A phase modulator giving added phase modulation $\varphi(t)$ is placed inside the ring as shown in Figure 2(a). Waves moving counterclockwise around the ring are phase modulated by $\varphi(t)$ immediately before they recombine at the beam splitter. At that instant there is a time delay equal to the ring transit time T before waves with the same phase modulation traveling in the opposite direction reach the beam splitter. The recombining of immediate and delayed phase-modulated signals leads to a conversion of phase modulation into amplitude modulation or modulated coupling.

If, for example, the phase modulation $\varphi(t)$ is a step function with a short rise time compared to the transmission time T around the ring, as shown in Figure 2(b), the resulting output from the beam splitter will be a square pulse of duration T as shown in Figure 2(c). A phase step of magnitude π will dump

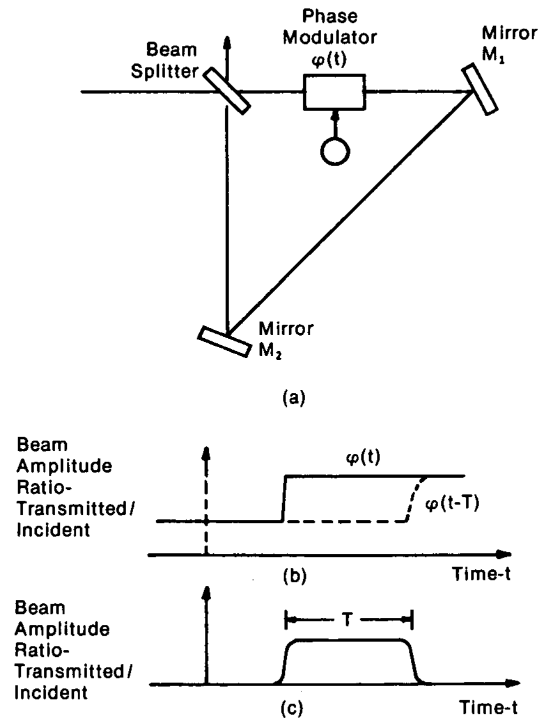

Figure 2. (a) Antiresonant Ring With Electro-Optic Phase Modulator, (b) Step Function With Short Rise Time, and (c) Output of Beam Splitter.

(continued overleaf)

all the energy stored in the ring, after which the output coupling will automatically shut itself off. If the modulator is moved away from the beam splitter toward the center of the ring, variable pulses of shorter length can be obtained. If the laser is mode locked by some other means and the phase modulator is switched while a mode-locked pulse is inside the ring, that one mode-locked pulse can easily be dumped. Repeated switching at a low modulation level, so as to accomplish only partial dumping of pulses, might be used to accomplish the pulse code modulation of a mode-locked laser.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
NASA Headquarters
Code KT
Washington, D. C. 20546
Reference: TSP75-10087

Patent status:

This invention has been patented by NASA (U.S. Patent No. 3,869,210). Inquiries concerning non-exclusive or exclusive license for its commercial development should be addressed to:

Patent Counsel
NASA Headquarters
Code GP
Washington, D. C. 20546

Source: A. E. Siegman of
Stamford University
under contract to
NASA Headquarters
(HQN-10844)