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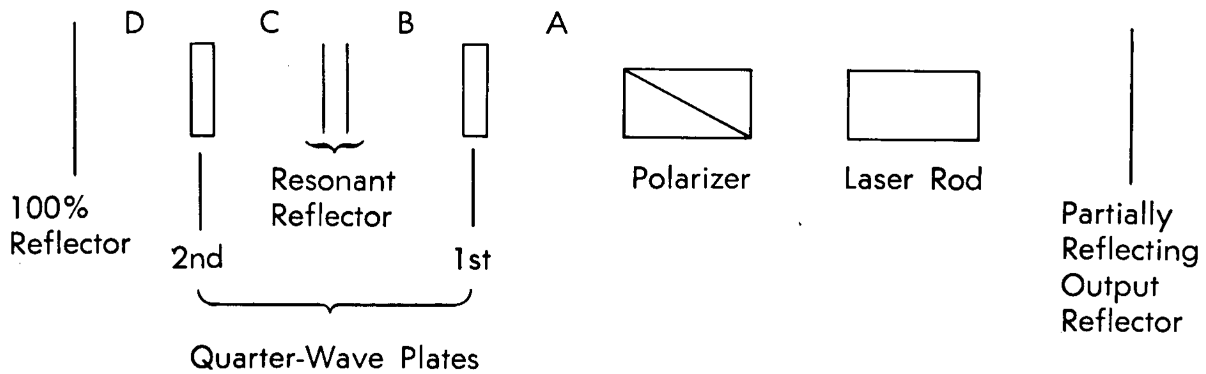
Improving Laser Beam Coherence: A Concept

Light emitted by a laser is not strictly monochromatic, for it actually consists of a narrow band of closely-spaced wavelengths. For certain applications, such as the production of holographic images with greater scene depth, it is desirable that the band of frequencies represented by the closely-spaced wavelengths be reduced even further to a single frequency or, in some special cases, to a few selected frequencies.



In some techniques, the extent of narrowing of the frequency band depends on the thickness of a dielectric parallel plate (resonant reflector) which is used as the output reflector. Reflectivity is sufficient to permit lasing only at frequencies such that odd multiples of quarter wavelengths are equal to the optical thickness of the reflector; at even multiples of quarter wavelengths, reflectivity is zero and lasing does not occur. Thus, the thickness of the reflector determines the comb of permitted frequencies, but the teeth of the comb are not narrow enough for the desired holographic images.

It is proposed that the desired comb could be obtained with a double-surfaced resonant reflector (Fabry-Perot interferometer) by using the arrangement depicted in the diagram. Light from the laser rod propagating to the left is linearly polarized and passes into region A; then, passing through the first quarter-wave plate, it is circularly polarized in region B. Light reflected from the resonant reflector is returned, traveling to the right in region B with the opposite sense of circular polarization. After passing through the quarter-wave plate, it is made into linearly polarized light in region A with a direction perpendicular to the original polarization and thereby rejected by the polarizer. To this point, the system behaves like the one-way polarizers used on readout devices to reject reflected incident light.

Light at a frequency which can pass through the resonant reflector into region C is still circularly polarized, and then is made linearly polarized in region D by the second quarter-wave plate. After reflection and a second pass through the second quarter-wave plate, it is rendered circular of the same sense as before, passes through the double-surface resonant reflector and the first quarter-wave plate, and emerges

(continued overleaf)

into region A as linearly polarized light in the pass direction of the polarizer. The polarization elements thus permit reflection for only the narrow frequency intervals which have high transmission through the resonant reflector.

The surfaces of the double-resonant reflector are coated with a dielectric material for high reflectivity, thus creating very narrow pass bands as is the case with a Fabry-Perot interferometer. The thickness of the reflector, i.e., distance between reflecting surfaces, determines the spacing of the comb frequencies. If single-frequency performance from the laser is desired, then the spacing should be such that only one tooth of the comb will fall within the natural line width. When two or more simultaneous frequencies are needed, a thicker spacing is used so that two or more teeth of the comb fall within the natural line width.

The configuration described is adaptable to operation with a Kerr or Pockel cell for Q-switching. For example, the quarter-wave plate nearest the 100% reflector is replaced by the Kerr cell; application of voltage to the cell makes it into a quarter-wave plate, and absence of voltage makes the Kerr cell operate without birefringence so that all reflection is stopped.

Notes:

1. The following documentation may be obtained from:

   National Technical Information Service
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.95)

   Reference:
   NASA CR-114274 (N71-17271),
   Holographic Instrumentation Studies.

2. No additional documentation is available. Specific questions, however, may be directed to:
   Technology Utilization Officer
   Ames Research Center
   Moffett Field, California 94035
   Reference: B71-10527

Patent status:

No patent action is contemplated by NASA.

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