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NASA TECH BRIEF

Marshall Space Flight Center

Coherence-Length Extender

The problem:

To form a hologram of a large object, the laser sources used must produce beams that are intense and have the maximum possible coherence length. In general, the available laser sources cannot provide both at the same time. Therefore, holograms of large objects have been limited by the coherence and intensity capabilities of the available laser sources.

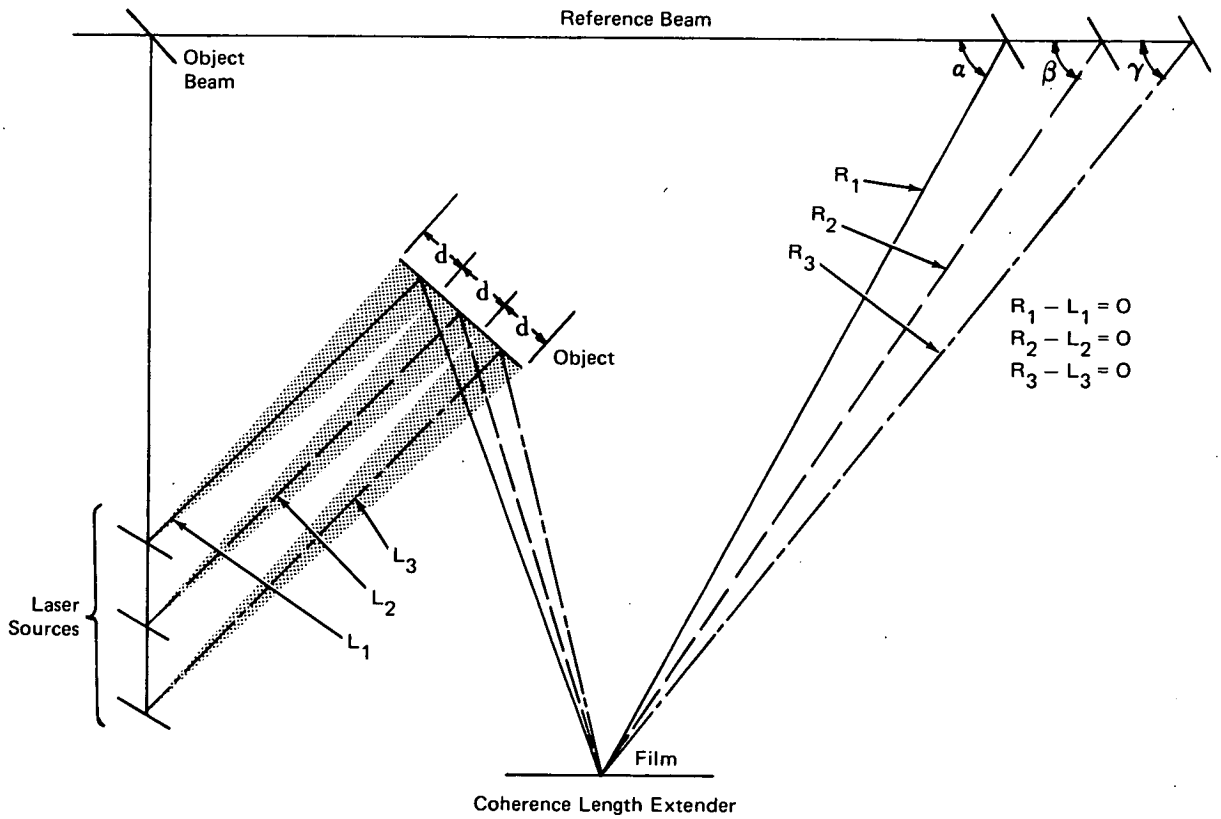
The solution:

Holograms of large objects may be formed by using several coherent low-intensity laser sources.

How it's done:

In holography, the maximum coherence length from any given laser source can be obtained by equating the lengths of the reference and object beams. The setup shown in the figure utilizes this principle with three beams. In each instance, the total length of the object beam is equal to the total length of its respective reference beam. There is sufficient overlap between the adjacent beams to produce uniform brightness over the entire object image.

The total number of object beams necessary to record the entire object is determined by the dimension



Coherence Length Extender

(continued overleaf)

of the object and the coherence length of each laser source. Here the coherence length of each source is just sufficient to record one section of the object, labeled d. As shown, three sources are necessary to record the entire object.

It is noted that each separate reference beam is incident on the film at a different angle. Therefore, on reconstruction with a single reference beam, the plate must be rotated back and forth through some small angle, δ, where

$$\delta = \alpha + \beta + \gamma$$

where α, β, and γ were the original angles associated with the three reference beams used for construction of the hologram.

If several low intensity laser sources are available, they can be applied simultaneously by a method similar to that in the figure. Each laser source is then used to establish one object beam and one reference beam whose path lengths are equal, recording a small portion of the total object. When used in this fashion, the drift between the lasers is inconsequential since the object beam from the first source interferes only with the reference beam from the second, and so on.

Note:

Requests for further information may be directed to:

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Patent status:

NASA has decided not to apply for a patent.

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