NEW VERSIONS OF OLD FLOW VISUALIZATION SYSTEMS

Walton L. Howes
NASA Lewis Research Center
Cleveland, Ohio 44135

Large Aperture Interferometer Using Local Reference Beam

The Mach-Zehnder interferometer is limited in size by the difficulty and cost of making large splitter plates. Alternatives still require a reference beam which circumvents the test section and is subject to differential vibrations. These problems can be overcome by means of a small, modified Mach-Zehnder interferometer placed in series with a much larger schlieren optical system spanning the test section (figs. 1 and 2). In one arm of the interferometer, light from the schlieren is focused through a pinhole and recollimating lens to produce a reference beam which interferes with the remaining object beam from the other arm. Sample interferograms from a lens schlieren and mirror schlieren are shown in figure 3. Because the object and reference beams are separated only over a small interval following the test section, differential vibrations should be greatly reduced.

Rainbow Schlieren

Color schlieren has technical, as well as aesthetic, advantages over black-and-white schlieren. Maximum advantage of color as an additional degree of freedom can be achieved by replacing the neutral filter (e.g., knife edge) with a radial-rainbow filter having a transparent center and opaque surround. Such filters are easily made photographically on color film. Since each color is associated with a specific amount of refraction, quantitative evaluation of certain refractive-index fields becomes possible using very simple equations derived from ray trace theory. Figure 4 shows a rainbow schlieren of an acetylene flame, and figure 5 shows the evaluated refractive-index distribution. Root-mean-square refractive-index fluctuations in homogeneous, isotropic turbulence have also been determined using the rainbow schlieren, since these fluctuations determine the root-mean-square refraction, which is indicated by the overall color of the image.

Further details on the local-reference-beam interferometer and rainbow schlieren are contained in two reports being processed for publication.

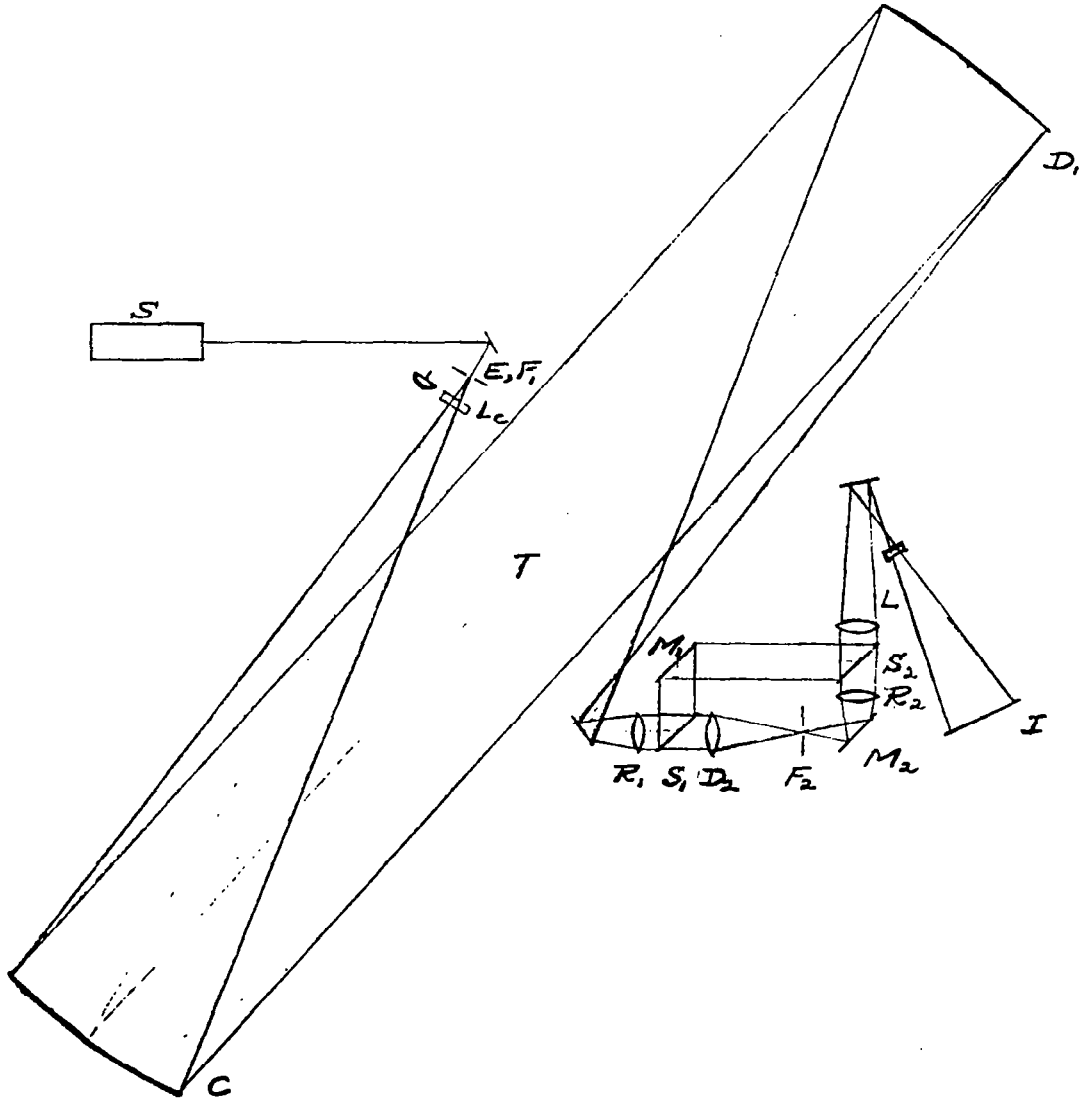


Figure 1.- Schematic of local-reference-beam interferometer coupled with schlieren optics.

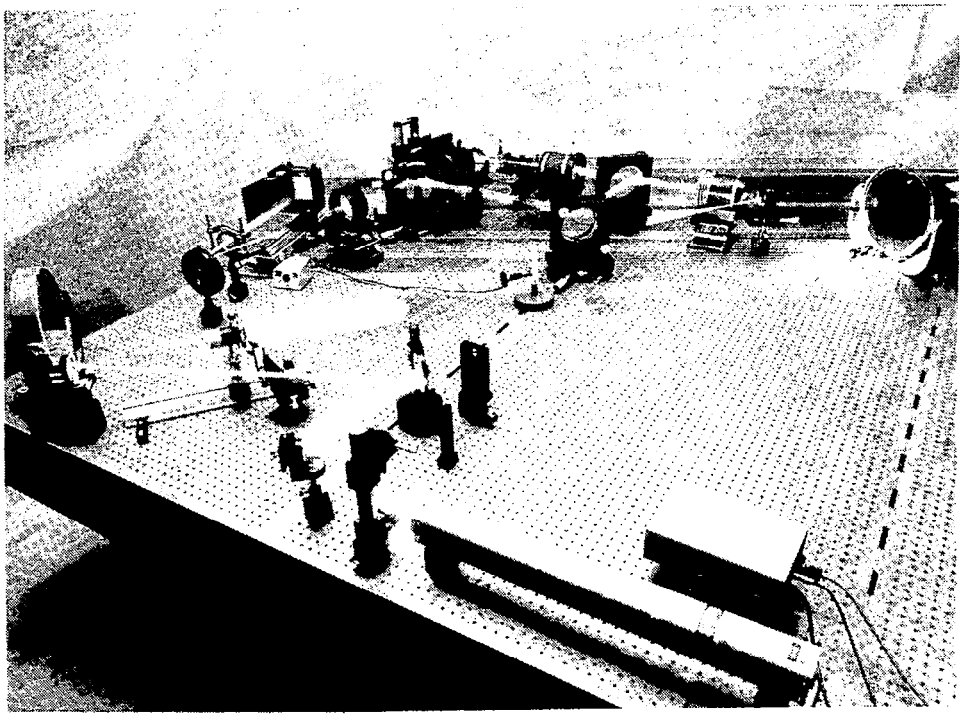
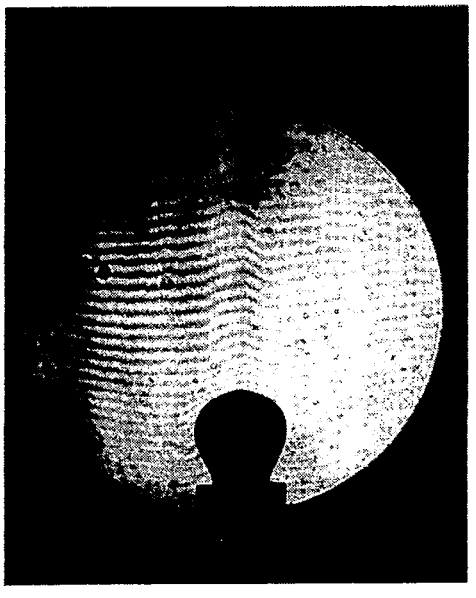


Figure 2.- Local-reference-beam interferometer coupled with mirror schlieren.



(a) 5-in. diam. lenses

(b) 12-in. diam. mirrors

Figure 3.- Interferograms obtained using local-reference-beam interferometer.

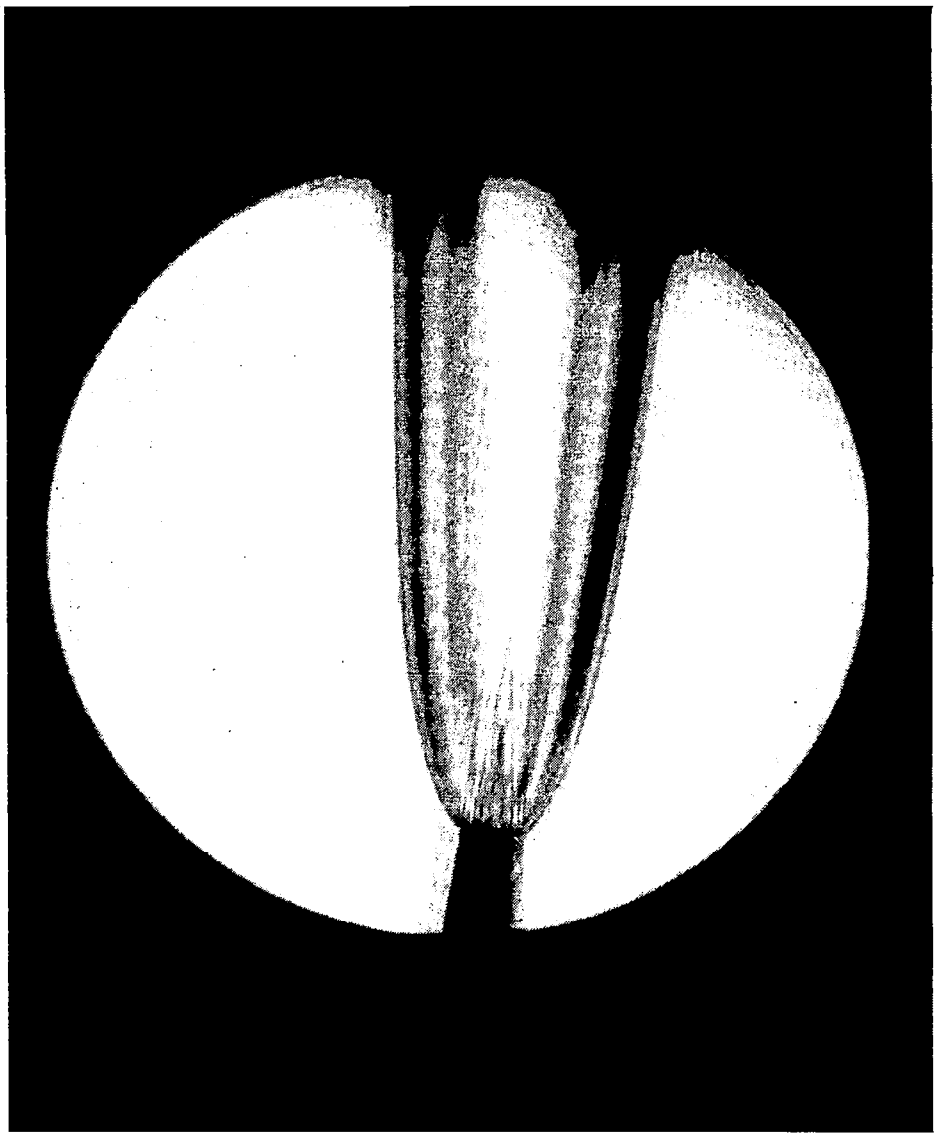


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Figure 4.- Rainbow schlieren of acetylene flame.

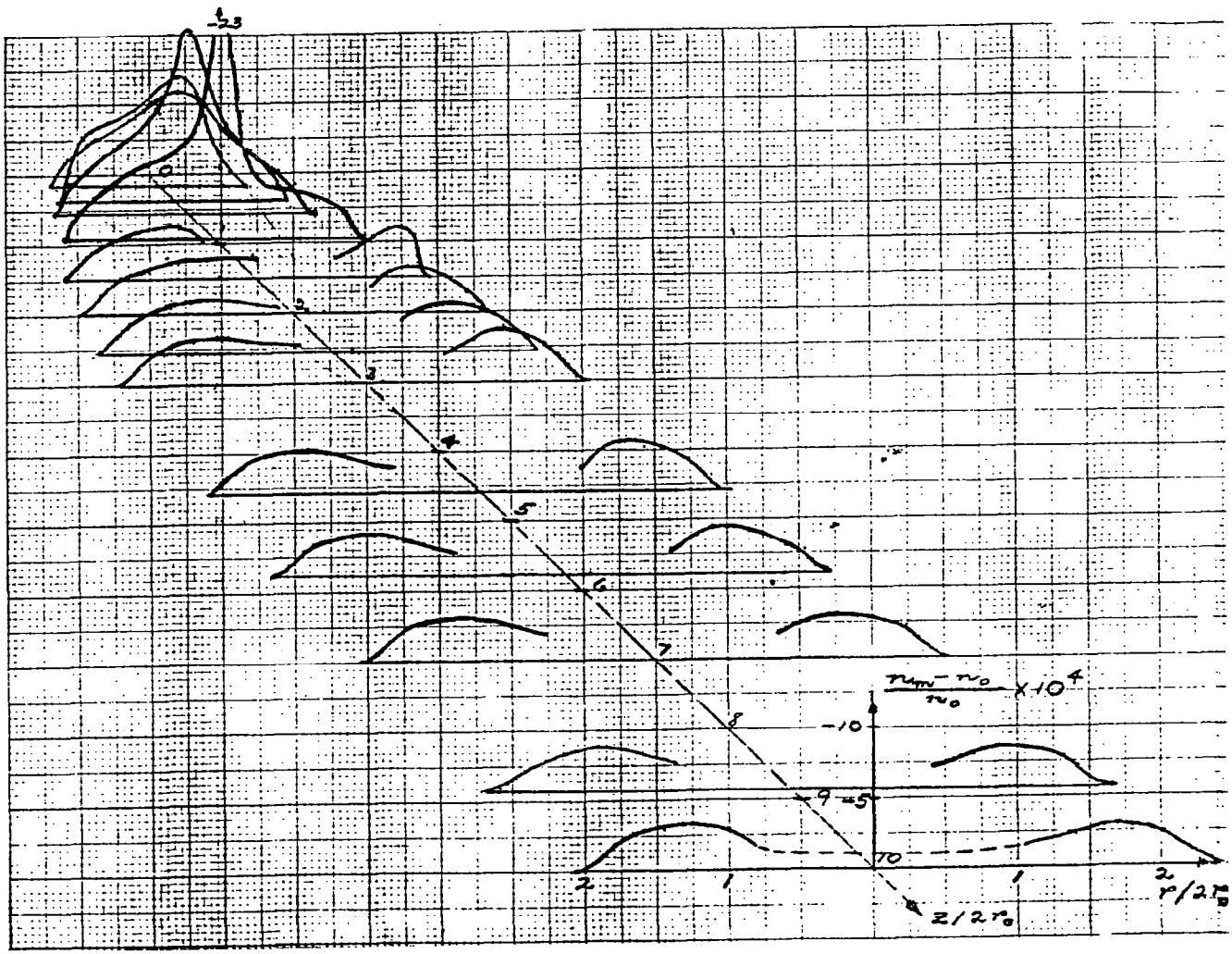

Figure 5.- Relative-refractive-index change $(n_m - n_o)/n_o$ above acetylene flame as determined using rainbow schlieren. Z, height; r_o, nozzle radius.