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Studies on the Holography by He-Ne Gas Laser

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The present paper deals with the confirmation of the holographical method, with some contributions to the technique. The holography consists of making the interference fringe pattern (hologram) and the wavefront reconstruction using a laser. The principal technique of holography was developed by D. Gabor (1948) and is based on the theory of two-beam method with the wedge (1963, Leith-Upatnieks). In the present experiment an optical system resembling the Mach-Zehnder interferometer type was employed instead of the wedge. The process of making the hologram and wavefront reconstruction corresponds to the optical modulation and the detection, respectively.

As the light source, a He-Ne gas laser (wave length 6328 Å) with several millimeter in diameter was used. The beam was enlarged to parallel beams, several cm in diameter. In this case, in order not to disturb the wavefront, it was indispensable that a single mode was selected so that the light intensity became uniform. To obtain exactly parallel beams a condenser lens with a short focus and a large collimeter lens with a large radius of curvature should be used.

When the reference beam was deviated through a very small angle θ and was superimposed on the diffraction pattern, we were able to make the fine-structure of the interference fringe which embodied in the spatial frequency. The number of fringes were ten to fifty in a millimeter, and the wavefront reconstruction was clearly made.

For reconstruction, the hologram was placed in a collimated beam of monochromatic light of the laser. The fringe described above, corresponding to the spatial frequency, caused the hologram to act like a diffraction grating producing a pair of the first order diffracted waves. One of these produced a real image, displaced to an off-axis position.

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