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"USE OF MICROWAVE HOLOGRAPHY IN THE STUDY OF ELECTROMAGNETIC PHENOMENA"

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If our eyes were sensitive to radiation at microwave frequencies, it would be much easier to comprehend microwave phenomena. Microwave holography essentially permits this visual observation of the phenomena when the microwave fields are holographically mapped and, after suitable processing the microwave image is reconstructed at optical frequencies. Descriptions are made of two applications of the microwave holography to the studies of the microwave phenomena.

The first is a case of the study on the microwave radiator. Suppose now one looked at a microwave monopole antenna along which a sinusoidal current distribution is flowing. Would one see it as a thin filament whose intensity distribution along the antenna is modulated and looks like a corrugated sausage or would one see two bright spots located at both ends of the monopole as a simple analysis[1,2] suggests this possibility? The investigation has given the proof and settled this question.

Fig. 1 shows the arrangement for making the microwave hologram of the monopole driven from a rectangular waveguide. In ordinary two beam holography, the "object beam" is the field which has been scattered by some object onto the holographic plate, but in the present case the object beam is the field radiated by the monopole antenna onto the recording plane. A thin layer of liquid crystals was used in recording the microwave interference pattern. The microwave hologram recorded at 34.26 Gc was then reduced to approximately 1/284 of its original size. The scaled down hologram was illuminated by a He-Ne laser for optical reconstruction.[3,4]

Fig. 2 shows the optical images obtained. Fig. 2a as a photograph of the monopole. Fig. 2b, image of the microwave field distribution in the plane of the antenna. Fig. 2c, the same but in the plane away from the antenna, Fig. 2d, the same but in the far field. Thus not only the image of the field distribution in the plane of the antenna but also that of the field distribution in an arbitrary plane can be obtained by this method.

Next, if a plasma tube is used as an object of ordinary two beam microwave holography, the illumination of a laser beam onto the scaled down microwave hologram should make it possible to visualize exactly the way the microwave is scattered from the plasma tube. Even though this sounds to be an effective tool for investigating the scattering mechanism of the microwave from a plasma tube, the diffraction effects of the glass tube itself masks the scattered radiation and a scattered pattern should differ appreciably from that without the glass tube. This difficulty was overcome by a novel technique of subtractive microwave hologram by which two dissimilar microwave fields were subtracted to yield only their differences. The principle of the subtractive microwave hologram is based on the fact of the reversal of the signs of the amplitude distribution of the reconstructed image when the negative hologram (made by contact-printing the original hologram) was used for reconstructing the image.

Fig. 3 shows the results of the subtractive microwave hologram. The image of the two coins in a purse is subtracted from that of three coins. This technique was used to subtract the scattered microwave field patterns of the

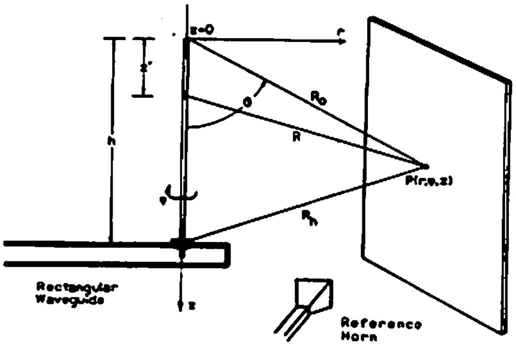


Fig. 1 Coordinates and notation for monopole antenna driven from a waveguide, where the origin is taken at the top of the antenna.

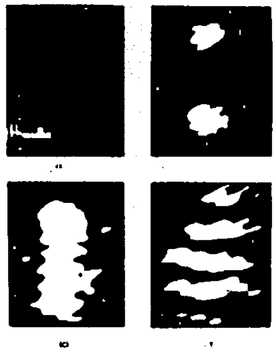
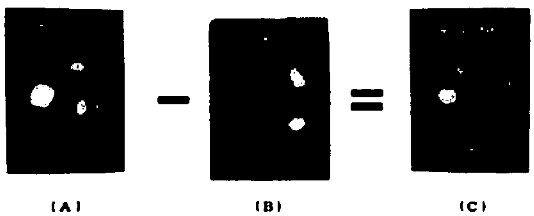


Fig. 2

(a) Photograph of the monopole
Optically reconstructed field distribution
(b) at the antenna plane.
(c) at a plane in the Fresnel region.
(d) at the Fraunhofer region.



(A) Reconstructed image of a purse with three coins
(B) Same as (A) but with two coins
(C) Reconstructed image showing coins in (B) subtracted from (A)

Fig. 3 Subtractive Microwave Holography

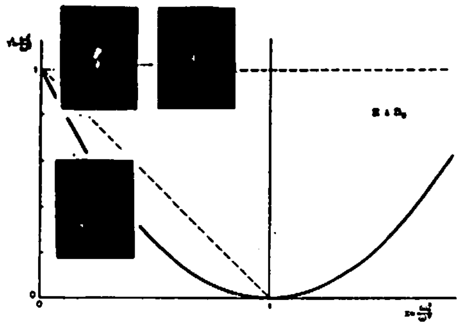


FIG 4 RECONSTRUCTED IMAGES OF MICROWAVE HOLOGRAM OF A PLASMA TUBE UNDER DIFFERENT CONDITIONS ARRANGED ON CMA DIAGRAM (NOT TO SCALE)

glass tube only from that of the glass tube and the plasma, and thus the masking effect of the glass tube was minimized.

A discharge tube of cylindrical disk shape which is basically a mercury vapour diode was placed in a dc magnetic field.

In Fig. 4 the reconstructed images of the microwave holograms of the tube are arranged on CMA diagram. The frequency of operation was the same as used for the first experiment.

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