The object wave-front $S = S_0 \exp(i\varphi)$ is reconstructed in both its phase and amplitude by the diffracted wave (Fig. 3).

Simultaneously from (3) and (11) it can be seen that the brightness of the diffracted bundles may be regulated by using the photomaterials of different reflection index K.

The experiments performed have proved that the reflecting holograms offer great diffraction efficiency amounting to 40%. The latter depends on both the holographic relief deepness as well as the reflection coefficient of the deposited metal. The reflection coefficient may be matched to the wevelength of the light used for reconstruction.

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Andrzej Kalestyński *

Problem of the Negative in Holography

1. The Gabor holograms offered possibility of producing both positives and negatives of the diapositive holographic patterns during reconstruction. The amplitude transmittance Tra of a Gabor hologram was given by

$$Tra(x, y) = A_0^2 \pm \frac{dT}{dH} |a(x, y)|^2 \pm \frac{dT}{dH} \left\{ A_0 a^* + A_0 a \right\} \tag{1}$$

where $a(x, y) = A_0$ denotes an amplitude of a plane wave illuminating perpendicularly the object to be holographed, $a(x, y) = a_0(x, y) e^{i(x, y)}$ denotes a complex amplitude of an optical field diffracted on the object, (x, y) is the hologram plane, $\frac{dT}{dH}$ is the inclination of the transmittance-exposure characteristic of the photographical material $T = f(H)$ at the working point, where $H = I \cdot t$ and $I = I(x, y)$ is an intensity of the interference field in the hologram plane while t denotes the exposure time. The minus or plus sign of the factor $\frac{dT}{dH}$ corresponds to the negative or respectively positive developing process of the photographic material.

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The second term in formula (1) may be neglected because typically

$$|a(x, y)| \ll A_0 \tag{2}$$

for the holographic procedure, condition (2) being the consequence of the linearization of the material characteristic $T = f(H)$ in the vicinity of the working point (2).

From the formula (1) valid for Gabor holograms we obtain two values of the transmittance corresponding to the negative and the positive of the original.

2. For the Leith and Upatnicks method [3] of producing holograms by use of an offset-reference beam, for instance, $A(x, y) = A_0 e^{i2\pi\alpha y}$, where α is the spatial frequency in the hologram plane as well as for the G. Stroke method where a δ source is used, for the reference bundle producing [4] the sign of the factor dT/dH is of no importance, because the reconstructing beam, when applied to a negative hologram or to a positive one, behaves in the identical way. Another words the properties of a hologram as an operator transforming the reference beam into the image wave should be invariant with respect to the operation of the positive/negative conversion both for the amplitude transmition holograms and the phase transmition ones, as well as for the reflectance (or mixed) type holograms [5]. Nevertheless, the question may be risen if it would be possible to influence the contrast in a reconstructed image with

respect to the object by changing the visibility of the interference fringes of the registered holographic field.

3. In the paper [6] a uniform notation for transmittance (or reflectance) of the Leith-Upatnieks and Strock holograms has been proposed for both the cases of holographic inversion and the notion of "visibility of fringes on the photographic film" introduced; the latter being connected with the Michelson visibility of the photographic interference field fringes at the point $P(x, y)$ of the hologram plane

$$W_{kl}(x, y) = |\gamma| \frac{A_0 a_0(x, y)}{|A|^2 + |a|^2} = |\gamma| W_{pol}(x, y). \quad (3)$$

Then the transmittance of the hologram has the form

$$Tra = [|A|^2 + |a|^2]^{-\frac{|\gamma|}{2}} \left\{ 1 - \frac{1}{2} W_{kl} \cos[2\pi dy + \varphi(x, y)] \right\} \quad (4)$$

where γ is the so called gamma of the film, being a commonly accepted measure of the contrast reproduction ability of the photographic material, equal to the slope of the Hurter-Druffield curve $D = F(\ln H)$ in its linear region. Here, D denotes the photographic density or a magnitude taking account of the relief depth in the case of phase holograms.

The linearization condition (2) is now reduced to the form

$$W_{kl} = |\gamma| \frac{2 A_0 a_0(x, y)}{|A|^2 + |a|^2} < 1, \quad (5)$$

which can be satisfied in practice by a proper choise of the average intensities of both the reference beam I_{ref} and the object beam $I_{ob} : I_{ref} > I_{ob}$.

In the present papar a holographic procedure based of the reversed relation i. e. $I_{ref} < I_{ob}$ is examined. The linearization condition in the form (5) happens to be also fullfilled in this case, which allows to apply the well-known formulas for the hologram transmittance, for instance, the formula (4).

When changing the ratio I_{ob}/I_{ref} by a corresponding choice of the average intensity of both the reference beam and the object beam a posibility of relative increasing the visibility W_{pol} of the holographic interference pattern and consequently W_{kl} generated by the dark fragments of the illuminated holographic object with respect to the visibility W_{pol} (W_{kl}) of the bright object fragments. This procedure denotes a transition into the negative branch of the curve $W_{pol} = f\left(\frac{I_{ob}}{I_{ref}}\right)$. The point was to verify the relative contrast between the particular details of the reconstructed image may be altered in relation to the contrast of the same fragments in the object [7].

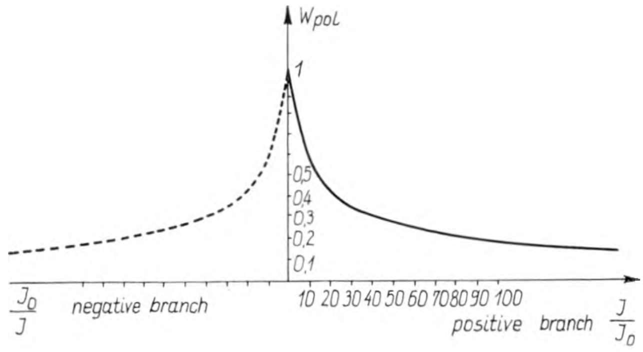

Fig. 1

Experimental examinations have been carried out for the case of the offset-reference beam holography, using the reversed relation $I_{ref} < I_{ob}$ for some special transmition tests to investigate the possibility of obtaining the said changes of contrast during the holographic reproduction. The intensity of the reference beam I_{ref} was several times smaller than that of the light transmitted through the dark parts of the test. According to (3) the visibility of the interference fringes W_{pol} corresponding to the dark parts of the holographic test is greater than the visibility of the fringes associated with the bright fragments. A difficulty of that kind of experiments consists in the fact that there appears a strong interference between the waves generated by the particular points of the object, which makes the reconstruction with weak reference fields difficult [7,8]. Our experiments have evidenced that the holographic procedure applied to the special tests with the "negative" visibility of the interference fringes does not introduce any considerable changes in the contrast in relation to the real objects during reconstruction. The only phenomenon observed was that of unregistering on the hologram any differences in contrast of the tests men-

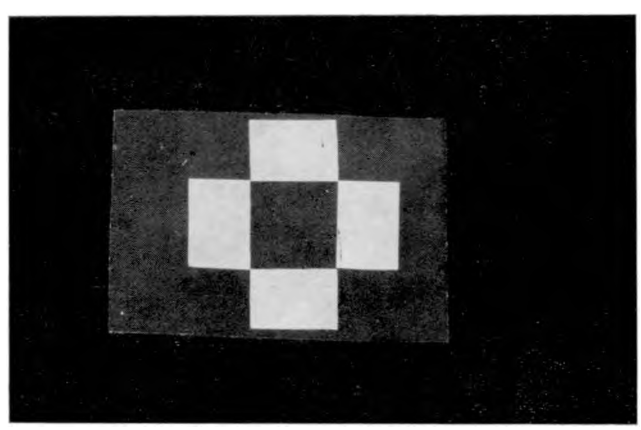

Fig. 2

tioned for the differences in the optical density ranging from 0.05 to 0.08. This phenomenon was observed for both the negative and positive branches of $W_{pol} = f(I_{ob}/I_{ref})$.

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Romuald Pawluczyk *

White Light Reconstruction of Holograms Recorded on 10E70 Photographic Plates

As is well-known, during hologram recording, there are permitted deformations of holographic systems, which will not cause shifting of the interference fringe for more than 1/4 of the distance between adjacent fringes. For the systems with "opposed beams" (Denisyuk method [1]) the mechanical stability is order of a fraction of the used light wavelength. It is very difficult to obtain such stability during the time of an exposure. Hence it is desirable to shorten the exposure time, which can be obtained when high sensitivity materials are used. The present paper describes a study of 10E70 photographic plates employment for the opposed beam holography.

These plates were provided with an anti-halo coating, so it was necessary to prepare them initially by immersing the plates for about fifteen seconds into the Agfa-Gevaert developer G3p (the plates were dried after removing from the developer), or by gentle washing the anti-halo coating in such a manner that the emulsion remained dry. Later studies showed that both methods can be employed.

For preliminary studies, the holographic system shown in Fig. 1 was used. Light beam *WL* emitted by the He-Ne laser, expanded by means of a collimator

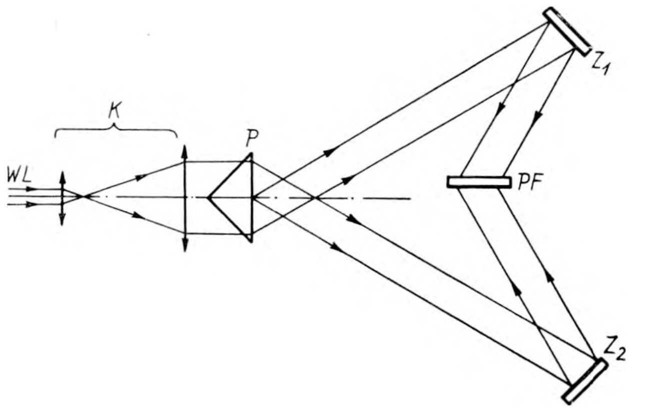

Fig. 1. "Opposed beams" holographic system. *WL* — laser beam, *K* — collimating lens, *P* — prism, Z_1 and Z_2 — auxiliary mirrors, and *PF* — photographic plate

K, was divided by means of a prism *P* into two beams. Both parallel light beams were directed by the two auxiliary mirrors Z_1 and Z_2 on to the photographic plate *PF*, the latter being processed according to producers' specification. For comparison, 8E70 photographic plates were also exposed in the same system.

Images of point light sources recorded in this way were then reconstructed by means of standard light sources, and observed in transmitted and reflected light. In transmitted light, the diffracted wave

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