APPLICATION OF FOURIER TRANSFORM AT ACCURATE MEASURING OF REGULAR LINEAR FORMATIONS.

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1. Introduction. The optical diffraction represents relatively extended, well-known but practically little used sphere of optics, suitable for various metrological applications.

The report refers to one possible sphere of application for accurate measuring of regural or linear formations.

2. Diffraction and space filtration of optical image. When the system of Cartesain co-ordinates is introduced and plane x, y is the object plane, then in plane X, Y (axes correspond to exes x and y) we can investigate diffraction states (Fig.1). Let us choose a case of less used arrangement which, however, is from practical view suitable for realization of Frankhofer diffraction. The collimated beam is focussed by optical system O_1 into focus F. If a transparent or quasi-transparent object is located in plane x, y, than is valid, that complex amplitude G(x,y) of wave in focus plane is the Fourier transform of lightwave complex amplitude g(x,y) in plane x, y and has form

$$G(x,y) = A_1 \iint_S g(x,y)\, e^{-i\frac{2\pi}{\lambda d}(X_x + Y_y)}\, dx\, dy \qquad (1)$$

where S is integration area, quantity A_1 is so called complex coeficient of shape.

The complex amplitude of lightwave in object plane is given by type of object, in case of unidimensional structure of screen type (Fig.2) is in form

$$g(x,y) = \sum_{m=-n}^{n} \mathrm{rect}\, \frac{x - mb}{a} \qquad (2)$$

where a is and interval of pulse function, b is the period of pulse function series and integration interval c = 2 mb for m as positive integer. The complex amplitude in focus plane can be then defined as follows:

$$G(\mu) = \sum_{N=-\infty}^{\infty} G_N(\mu)\ ;\ \mu = \frac{X}{\lambda d} \qquad (3)$$

where any function $G_N(\mu)$ shows energically in focus plane as intensity, correspondent to individual spectral amplitudes in points $N\mu_0$, where $\mu_0 = \frac{1}{b}$. The resultant intensity is then in plane X, Y in form

$$I = I_0 \left(\frac{\sin \frac{\pi}{\lambda d} a X}{\frac{\pi}{\lambda d} a X} \right)^2 \sum_{N=-\infty}^{\infty} \left[\frac{\sin \frac{\pi}{\lambda d} c\,(X - NX_0)}{\frac{\pi}{\lambda d} c\,(X - NX_0)} \right]^2 \qquad (4)$$

where $X_0 = \lambda d / b$,

what is graphically illustrated in Fig. 3.

The plane X, Y is convenient for optical filtration of diffracted image with use of suitable type of space filter. By utilization of additional optical system O_2 we get in focus plane of optical system O_1 after filtration an inverted Fourier transform $g_1(x)$, that is identical with primary amplitude function in plane x,y. However, the whole spectrum don't pass in real conditions throug aperture of optical system, so that function $g_1(x)$ contains only the passing spectral components.

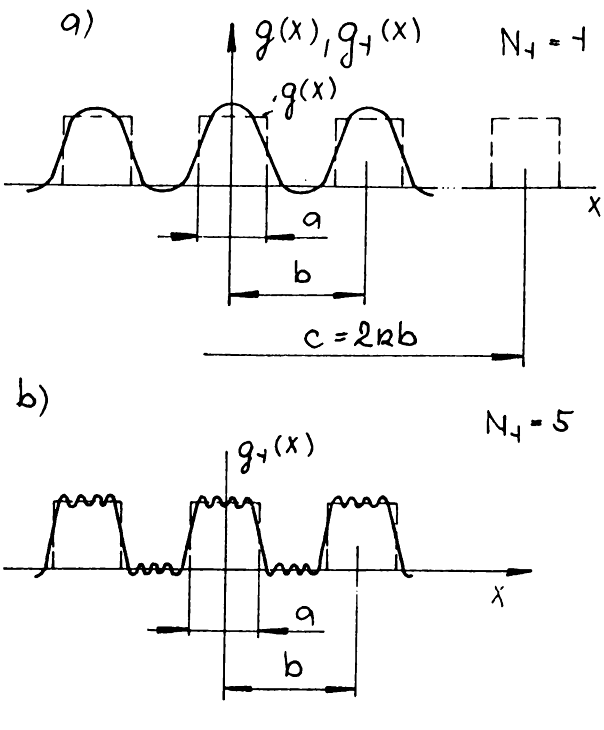

Fig . 2

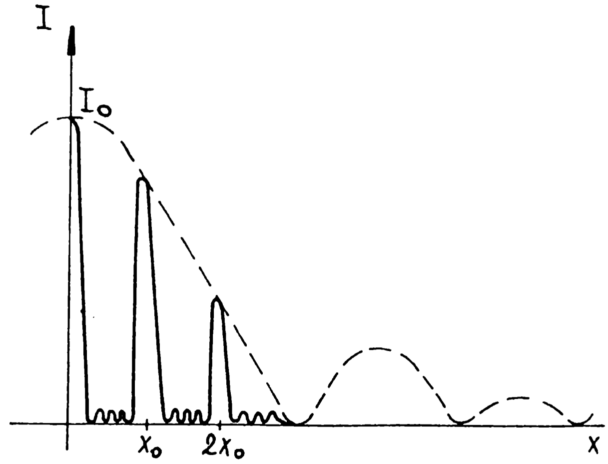

Fig . 3

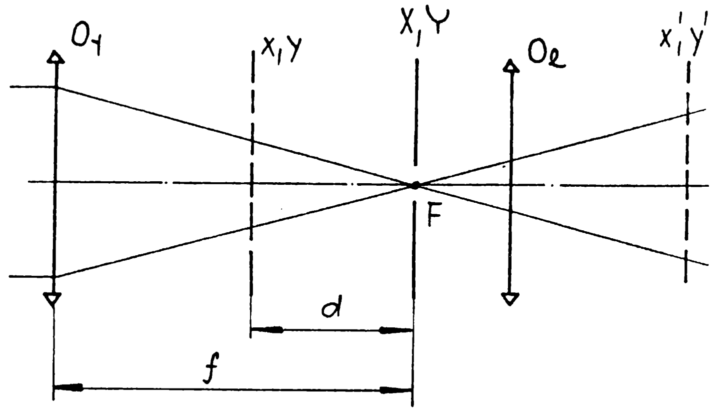

Fig. 1

In accordance with the number N_1 of passed spectral components is the function $g_1(x)$ more or less similar to function $g(x)$. The form of function $g_1(x)$ is for $N_1=1$ illustrated in Fig 2a, for $N_1=5$ then in Fig. 2b. The more spectral components pass through optical system O_2, the more similar is function $g_1(x)$ to $g(x)$. Detected intensity

$$J(x) = / g_1 (x) /^2 \tag{5}$$

then corresponds to image of measured object.

3. <u>Conclusion</u>. The principle of application of Fourier transform in convergent beam, that could be followed by optical spatial filtration, represents a convenient tool for contactless accurate measuring of linear formations in relatively broad spectrum of dimensions. They were developed e. g. accurate meter of industrial screen dimensions (will be introduced in discussion); the process can be mechanized into high degree with use of computing technique.