In variant two the starting system was of arbitrarily accepted powers of particular elements, the other (fixed) parameters being identical with those of the standard system.

In variant three the quality of the standard system has been improved after a short correction, resulting in a merit function twice less than the original one.

The programme may be easily generalized by introducing some additional parameters (for instance lens radia or other shape parameters) and adding some other conditions to the merit function (for instance, including the estimation of the geometrical aberrations) to make it more useful for further correction. Also, there exists a possibility of introducing the expression characterizing systems of variable magnification. When computing system of these types the advantage of automizing the lay-out calculation may by succesfully exploited.

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Application of the Higher Order Aberration to the Optical System Calculation

Wave aberrations are a basis for a number of image quality criteria. One of the estimation methods of the wave aberrations exploits an existing dependence between transversal aberrations and wave aberrations. Practical realisation of the method consists in expressing the coefficients of the wave function development into series by the transversal aberration coefficients. It is convenient to use the expressions for the transversal aberrations in the form given by H. A. Buchdahl [1] and the developement of the wave function as proposed by Nijboer [2]. Clearly, the accuracy of the calculations depends on the aberration order. Juan L. Rayces and Hsiao-Hung Hsieh [3] gave a relation between the Nijboer coefficients and those due to Buchdahl, taking account of contributions to the aberrations of third order and fifth order, only (first and second order due to Buchdahl). As for many systems such an accuracy is insufficient, the formulas for Nijboer coefficients taking account of the contributions coming from the seventh order terms, in addition to the lover order terms, have been derived in the following form

$$-RN_{20}=\frac{2\sigma_3+\sigma_4}{2}H^2+\frac{\mu_{10}+\mu_{11}}{4}H^4+\frac{\tau_{18}+\tau_{19}}{4}H^6$$

$$-RN_{22}=\frac{\sigma_3}{2}H^2+\frac{\mu_{10}-\mu_{11}}{4}H^4+\frac{\tau_{18}-\tau_{19}}{4}H^6$$

$$-RN_{31}=\sigma_2 H+\frac{\mu_7}{2}H^3+\frac{\tau_{15}+\tau_{16}+\tau_{17}}{4}H^5$$

$$-RN_{33}=\frac{\mu_8-\mu_9}{6}H^3+\frac{2\tau_{15}+2\tau_{16}-3\tau_{17}}{24}H^5$$

$$-RN_{40}=\frac{\sigma_1}{4}+\frac{\mu_4}{4}H^2+\frac{8\tau_{11}+3\tau_{12}-3\tau_{14}}{23}H^4$$

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$$-RN_{42} = \frac{\mu_6}{4} H^2 + \frac{\tau_{11}+\tau_{14}}{8} H^4$$

$$-RN_{44} = \frac{\tau_{12}-\tau_{14}}{32} H$$

$$-RN_{51} = \frac{\mu_3}{2} H + \frac{2\tau_7+2\tau_8+5\tau_9+7\tau_{10}}{20} H^3$$

$$-RN_{53} = \frac{2\tau_7+2\tau_8-5\tau_9-3\tau_{10}}{20} H^3$$

$$-RN_{60} = \frac{\mu_1}{6} - \frac{\tau_4-3\tau_5-2\tau_6}{12} H^2$$

$$-RN_{62} = \frac{\tau_4-\tau_5}{4} H^2$$

$$-RN_{71} = \frac{\tau_3}{3} H$$

$$-RN_{80} = \frac{\tau_1}{8}$$

where
R — reference sphere radius,
N_{nm} — Nijboer coefficients,
σ_i — Buchdahl coefficients of the first order,
μ_i — Buchdahl coefficients of the second order,
τ_i — Buchdahl coefficients of the third order.

The derived relations have been varyfied by calculating a triplet as an example, its parameters being given in table. The results of the calculations have been presented in Figs. 1a, 1b, 1c. The line··· denotes the wave aberrations obtained from the transversal aberrations of the third order, the line ·—·—·— denotes the aberrations obtained from the coefficients of the third and fifth order, the line ··—··—··—··—·· denotes the results obtained by superponing the third order terms with those of the fifth order and seventh order, the line ———— denotes the aberrations obtained from the trigonometric calculations. At the present time an analysis of optical systems with respect to the seventh order aberrations is being under study. The detailed results will be published later.

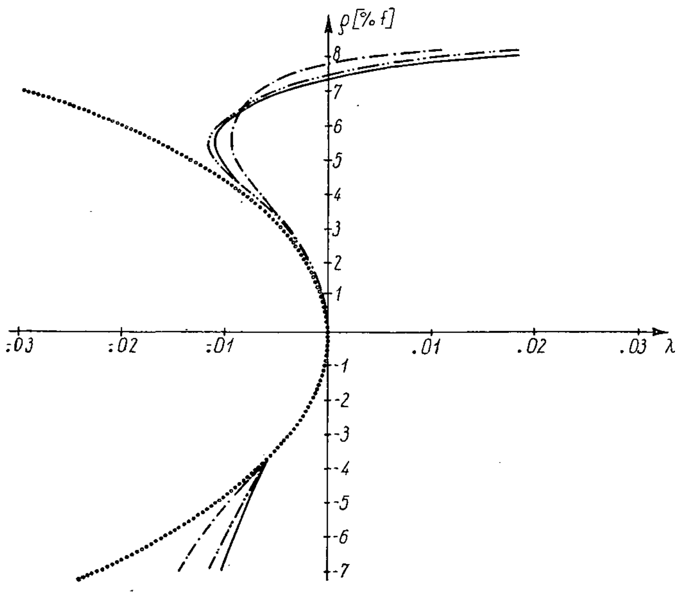

Fig. 1b. The graphs of the wave aberration for the field angle 6°

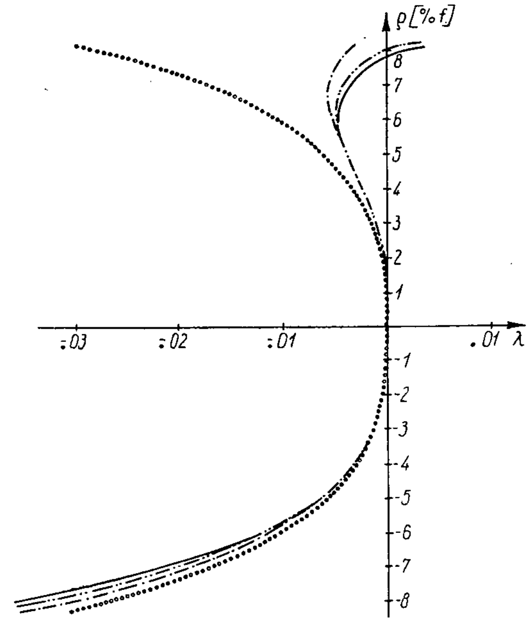

Fig. 1c. The graphs of the wave aberration for the field angle 12°

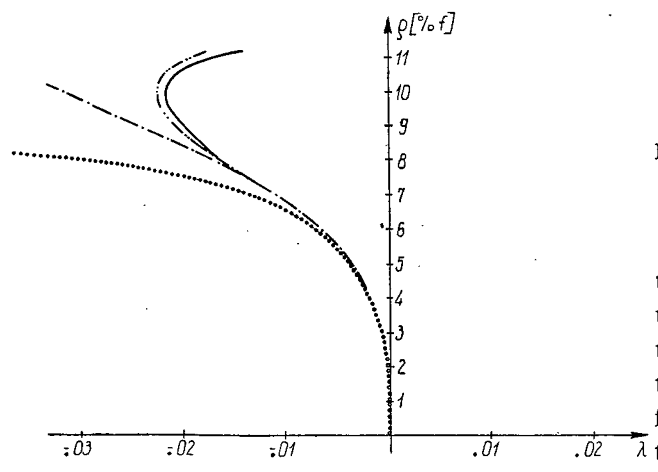

Fig. 1a. The graphs of the wave aberration for the field angle 0°

r_i	−.2073	−1.3264	−.6079	.1954	3.2181	−.6844
N_i	1	1.6162	1	1.5725	1	1.6162
d_i	.0403	.01685	.0096	.1387	.0313	

Entrance pupil position $p = .1134$.

References

[1] Buchdahl H. A., *Optical Aberration Coefficients* (1954), Oxford Press University.

[2] Nijboer B. R. A., *Thesis University of Groningen* (1942).

[3] Rayces, Juan L., Hsiao Chung-Hsieh, Annual Meeting of the O. S. A. 1970.

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On the Correction of Pancratic Systems

Pancratic systems are often composed of not too thick lenses. Their focal lengths and their separations result from the conditions of the stabilisation of the image and entrance pupil position. If the apertures and fields in which the variable part of the system works are not too great, these systems possess mainly the third order aberrations. For the correction of these systems the method of "main parameters" with some modifications, has proved to be useful.

The following symbols are now introduced

$S_1 \ldots\ldots S_5$ — Seidel's coefficients,

A, B — parameters of spherical aberration and coma,

P, W — main parameters determining the spherical aberration and coma, the focal length being reduced to unity, the object lying for each component in infinity, the entrance pupil in the component plane,

h, α — heights and angles of the aperture ray,

y, β — heights and angles of the principal ray,

$J = \alpha y - \beta h$ — Lagrange — Helmholtz invariant,

f — focal length of the lens components.

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Among the parameters A, B and the main parameters P, W there occur approximate relationships

$$A = \frac{h^3}{f^3}P + \frac{4\alpha h^2}{f^2}W + \alpha\frac{h}{f}(5.4\alpha - \alpha')$$

$$B = \frac{h^2}{f^2}W + \frac{2.7\alpha h}{f}.$$

These relationships are valid with sufficient accuracy if the magnifications of several components are less than the unity. For magnifying components these formulae lose their usefulness, since their accuracy deteriorates. In these cases one can introduce "reversed" parameters $\overleftarrow{P}$ and $\overleftarrow{W}$, determining the spherical aberration and coma, the image lying for each component in infinity. Among the parameters A and B and the reversed parameters $\overleftarrow{P}$ and $\overleftarrow{W}$ there occur approximate relationships

$$A = \frac{h^3}{f^3}\overleftarrow{P} - 4\alpha'\frac{h^2}{f^2}\overleftarrow{W} + \alpha'\frac{h}{f}(5.4\alpha' - \alpha)$$

$$B = -\frac{h^2}{f^2}\overleftarrow{W} + 2.7\frac{\alpha' h}{f}.$$