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A SPECIAL CASE OF CALCULATION OF OPTICAL SYSTEM FOR A COLLIMATOR WITH AN ANFOCAL ACHROMATIC COLLIMATOR

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Abstract. In connection with the development of collimator for the needs of the defense, the research on mirror-lens objectives is being enhanced, especially objectives with an afocal achromatic compensator, located in parallel shaft of light with a reflector in the form of a flat plane.

Key words: mirror-lens objective, afocal achromatic compensator

In connection with the development of collimators for the needs of the defense [1…5], the research on designing mirror-lens objectives has been broadened. On the basis of Methods for research of an optical system for Stand-collimator 9В852У/CU-01 [6], a special case has been researched at which $r_4 =$. The system is transformed into mirror-lens objective with counter-reflector in the form of a flat mirror and an achromatic afocal compensator in a parallel beam of rays (fig. 1 and fig. 2).

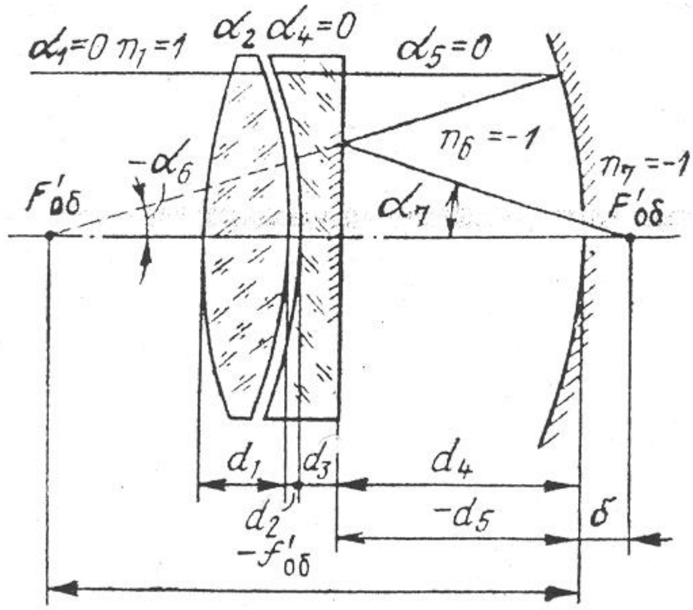

Fig. 1. Optical scheme of mirror-lens objective with an afocal achromatic compensator, located in a parallel beam of rays with counter-reflector in the form of a flat plane, put on the last plane of the compensator

Because $r_4 =$, and the compensator is afocal, so $\alpha_1 = \alpha_4 = \alpha_5 = 0$. From Fig. 2 we can see that:

(1) $$r_5 = 2f'_{об},$$

(2) $$2r_6 = r_4 = \propto.$$

From the similarity of the triangles $N_5F'_{об}O_5$ и $N_6F'_{об}P$ we can write the following:

(3) $$\frac{h_5}{f'_{об}} = \frac{h_6}{f'_{об} - d_4},$$

(4) $$d_4 = f'_{об} - \frac{h_6 f'_{об}}{h_5}.$$

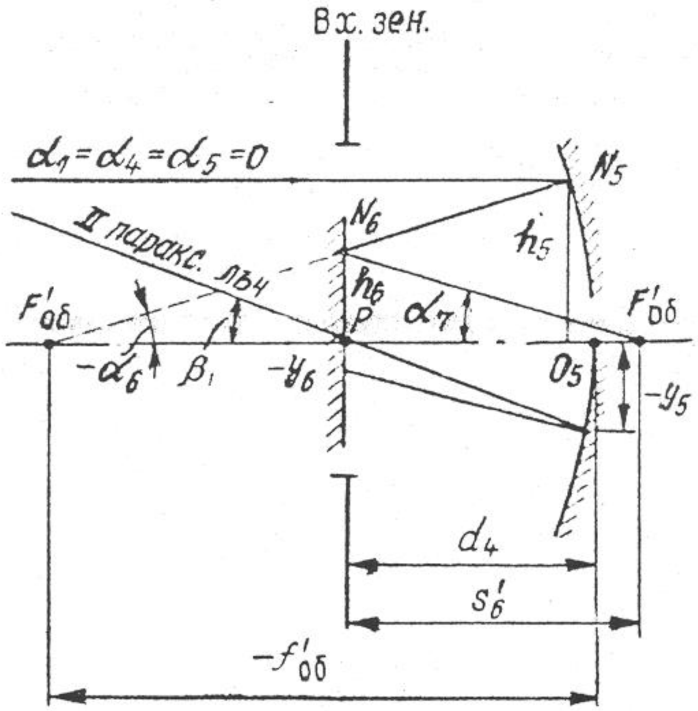

Fig. 2. Optical scheme of mirror-lens objective with an afocal achromatic compensator, located in a parallel beam of rays with counter-reflector in the form of a flat mirror

In rationing conditions $h_5 = f'_{об} = 1, h_6 = k, d_4 = 1 - k,$ the values of $S_{1огл}$ and $s_{2огл}$ are defined [7]. Because the counter-reflector itself is a flat mirror, and $P_6 = 0, W_6 = 0$, so

(5)
$$S_{1огл} = \sum_{v=5}^{6} h_v P_v = P_5 = -\frac{\alpha_6^3}{4} = \frac{1}{4}$$

(6)
$$S_{2огл} = \sum_{v=5}^{6} y_v P_v - I \sum_{v=5}^{6} W_v = y_5 P_5 + в_5 = -d_4 \frac{1}{4} + \frac{1}{2} = \frac{k+1}{4}$$

(7)
$$P_{ком} = -S_{1огл} = -0{,}25$$

(8)
$$W_{ком} = -S_{2огл} = -0{,}25 y_5 - 0{,}5 = 0{,}25 d_4 - 0{,}5$$

Considering that $\alpha_1 = \alpha_4 = \alpha_5 = 0$, we get

(9)
$$P_{ком} = \frac{\alpha_3 \alpha_2 n}{(n-1)^2}\left[\alpha_2 (n+2) - \alpha_3 (2n+1)\right]$$

(10) $$W_{ком} = \frac{n+1}{1-n}\alpha_2\alpha_3.$$

From (10) we define

(11) $$\alpha_2 = \frac{n+1}{1-n}\frac{W_{ком}}{\alpha_3}.$$

If we substitute the expression (11) into (10), after the transformation we get:

(12) $$(1+2n)\alpha_3^2 - \left(\frac{n^2-1}{n}\right)\frac{P_{ком}}{W_{ком}}\alpha_3 + (n+2)\frac{n-1}{n+1}W_{ком} = 0\,.$$

If we determine

$$1+2n = A,$$
$$-\frac{n^2-1}{n}\frac{P_{ком}}{W_{ком}} = B,$$
$$(n+2)\frac{n-1}{n+1}W_{ком} = C,$$

equation (12) can be written as this:

$$A\alpha_3^2 - B\alpha_3 + C = 0\,.$$

By means of solving the quadratic equation, the angle $\alpha_3$is defined. The order of calculation continues similarly to the Methods of calculation [6], which has been designed for Stand-collimator 9B852У/CU-01.

In conclusion we can say that the implemented Methods for calculation of a Stand-collimator 9B852У/CU-01 has been further developed and calculation of optical system for a collimator with afocal chromatic compensator has been ensured.

References:

[1]. Getsov P., St. Stoyanov, P. Boyanov, Zhekov Zh., Primary Processing of Signals in an Optical Manufacturing. Journal Scientific and Applied Research. Vol. 8, 2015, p. 10-15.

[2]. Stoyanov St., P. Boyanov, Zh. Zhekov, Implementation of Factor Analysis in the Optical Manufacturing, Journal Scientific and Applied Research. Vol. 8, 2015, p. 16-20.

[3]. Zhekov Zh., A. Antonov, P. Boyanov, Zh. Zhekov, Method for Identification of Signals, Journal Scientific and Applied Research. Vol. 5, 2014, p. 108-112.

[4]. Zhekov Zh., Optical Methods and Means for Discovery of Distant Objects from the Board of Space Aircraft, University Press Episkop K. Preslavski, Shumen, 2006, 308 p.

[5]. Zhekov Zh., Optical Systems for Observation of Distant Objects, University Press Episkop K. Preslavski, Shumen, 2007, 251 p.

[6]. Zhekov Zh. Satellite Ecological Monitoring of the Environment, Konstantin Preslavski University Press. Shumen, 2014, 293 p.

[7]. Zhekov Zh. Satellite Monitoring of the Atmosphere, Konstantin Preslavski University Press. Shumen, 2014, 165 p.