PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in or relating to Photographic Objectives

I, ALBRECHT WILHELM TRONNIER, of 50*a*, Salinenstrasse, Bad Kreuznach, Rhineland, Germany, a German citizen, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The present invention relates to a further development of the Taylor Triplet type of photographic objective described in my copending application No. 23829/36 (Serial No. 476,348) wherein a simple, uncemented, and essentially unsymmetrical dispersing lens is preceded by two air spaced collective members whereas on the other side only one collective member is disposed which is provided with at least one collective, cemented surface. These new objectives therefore contain four air spaced members comprising at least five components and at a relative aperture of more than f 3.5 provide excellent zonal correction over an image field extent of over 30° and up to 60° and without necessitating for such high total efficiency the use of extremely curved surfaces or the traversing of particularly long paths of glass. In the present specification the terms "surface extent" and "rest effect" and other terms and symbols have their usual meaning as employed in this art and as used in the said co-pending application.

The present invention permits of an appreciable decrease in the constructional length of the new objective, accompanied by such correction of aberrational errors that within the aforesaid image field the positional aberrations of the sagittal and meridional image surfaces, i.e. their distances from the ideal image plane are kept below about $\frac{3}{4}$ per cent. of the focal length, accompanied by such correction of spherical aberrations that their greatest zonal longitudinal error remains below about $\frac{3}{8}$ per cent. of the focal length. By fully retaining these error limits, already defined in the said co-pending application, the constructional length may, in accordance with the present invention, be maintained below $\frac{3}{8}$ of the focal length of the objective by virtue of the herein claimed novel distribution of the refractive effect among the two collective lenses which precede the isolated dispersing lens, the characteristic of the invention being that the rest effect $\bar{\phi}^1{}_{V\,I}$ viz: the algebraic sum of all the surface effects of this first member, i.e. of the front lens (I) preceding the inner collective member (II) on the side of longer conjugate distance, is greater than 50 per cent. of the rest effect $\bar{\phi}^1{}_{V\,II}$, viz.: the alebraic sum of all the surface effects of both of these front collective members of the objective taken in the direction as used for photographic exposing.

The accompanying drawing shows an objective made according to the invention for a focal length of 100 millimeters. The indicia correspond to the embodiment given in the table of constants and have the same significance as those of the said co-pending application. Since the two front collective members consist of uncemented single lenses, the radius of the rear surface of the front lens (I) is indicated by R 2, the corresponding radius of the collective member (II) adjacent the dispersive inner member (III) is indicated by R 4, so that the following relations hold:

$$\bar{\phi}^1{}_{V\,I} = \bar{\phi}^1{}_{V\,2} = \bar{\phi}_{F\,1} + \bar{\phi}_{F\,2} \quad \text{and} \quad \bar{\phi}^1{}_{V\,II} = \bar{\phi}^1{}_{V\,4} = \sum_{1}^{4} \bar{\phi}_F$$

The focal length of the numerical embodiment given is equal to unity. The distance of the Gauss image plane from the image vertex of the last lens is designated by $p^1{}_0$. The refractive indices given correspond to the yellow ray whereas the colour dispersion is designated by the Abbe number ν.

Relative aperture f 2.9 $p^1_0 = .8186$

R1 = + .4323

$d1 = .05717$ $n1 = 1.5890$ $\nu 1 = 61.2$

R2 = − 12.234

$\Delta 1 = .00407$ air

R3 = + .5424

$d2 = .04070$ $n2 = 1.6375$ $\nu 2 = 56.1$

R4 = + .8521

$\Delta 2 = .04884$ air

R5 = − .7238

$d3 = .01647$ $n3 = 1.6045$ $\nu 3 = 37.8$

R6 = + .3293

$\Delta 3 = .08178$ air diaphragm space

R7 = − 2.0391

$d4 = .02849$ $n4 = 1.5145$ $\nu 4 = 54.7$

R8 = + .3905

$d5 = .07442$ $n5 = 1.6025$ $\nu 5 = 59.5$

R9 = − .3935

From the embodiment given the following values are obtained:

ν	Height of Incidence. $n\nu$	Surface Effect. $\bar{\phi}_{F\nu}$
1. Surface	1.00 00 00	+1.36 25 84
2. Surface	.95 09 76	+ .04 57 83
3. Surface	.94 52 44	×1.11 08 90
4. Surface	.88 26 32	− .66 03 20
5. Surface	.79 18 47	− .66 12 96
6. Surface	.77 95 51	−1.43 11 93
7. Surface	.79 86 52	− .20 15 09
8. Surface	.80 68 36	+ .18 18 20
9. Surface	.81 85 96	+1.25 32 41

ν	Rest Effect $\bar{\phi}_{V\nu}$	Rest Effect $\bar{\phi}^1{}_{V\nu}$
1. Surface	± .00 00	+1.36 25 84
2. Surface	+1.36 25 84	+1.40 83 67
3. Surface	+1.40 83 67	+2.51 92 57
4. Surface	+2.51 92 57	+1.85 89 37
5. Surface	+1.85 89 37	+1.19 76 41
6. Surface	+1.19 76 41	− .23 35 52
7. Surface	− .23 35 52	− .43 50 61
8. Surface	− .43 50 61	− .25 32 41
9. Surface	− .25 32 41	+1.00 00

Corresponding to the principles set forth in the said co-pending application it follows from the embodiment given that the surface effect of the collective cemented surface in the positive outer member (IV) $\bar{\phi}_{F_8} = +.181820$, and the rest effect $\bar{\phi}^1{}_{V_{III}}$ (which can also be represented as $\bar{\phi}^1{}_{V_6}) = -.233\ 552$, and it is clear that .181820 is greater than .233552 : 4, The rest effect $\bar{\phi}^1{}_{V_{II}}$ (which can also be represented as $\bar{\phi}^1{}_{V_4}) = 1.858937$, the surface effect of the inner surface (R5) of the dispersing member (III) facing both of these collective members is $\bar{\phi}_{F_5} = -.661296$, and finally the surface effect of the outer surface (R9) of the cemented collective lens (IV) facing the side associated with the shorter conjugate distance is $\bar{\phi}_{F_9} = +1.253241$. Thus for the two other ratios specified in the said co-pending application: $\bar{\phi}_{F_5} : \bar{\phi}_{F_9} = 661296 : 1.253241 = 527670$ numerical value

$$\bar{\phi}^1{}_{V_4} : \bar{\phi}_{F_9} = 1.858937 : 1.253241 = 1.483307$$

Hence .527670 lies between the value 1/3 and 1, while 1.483307 lies between the values 2/3 and 2.

Furthermore, according to the present invention the rest effect $\bar{\phi}^1{}_{V_I}$ or $\bar{\phi}^1{}_{V_2} = +1.408367$, the rest effect $\bar{\phi}^1{}_{V_{II}}$ or $\bar{\phi}^1{}_{V_4} = +1.858937$, and, as claimed, 1.408367

is greater than 50 per cent. of 1.858937.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

Photographic objective consisting of four air-spaced members in which a simple, uncemented, and essentially unsymmetrical dispersing lens is preceded by two air-spaced collective members on the longer conjugate side, whereas on the shorter conjugate side only one collective member is disposed which, in the case of the present type of developed triplet comprises at least one, collective, cemented surface, the objective having the refractive effect distributed among the two air-spaced members on the longer conjugate side so that the rest effect $\bar{\phi}^1{}_{v_I}$ viz.: the algebraic sum of all the surface effects of the front lens (1) is greater than 50% of the rest effect $\bar{\phi}_{v_{II}}$, viz.: the algebraic sum of all the surface effects (considered in the direction of photographic exposure) of these two front collective members (I and II) of the objective.

Dated this 31st day of August, 1936.

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Fig. 1

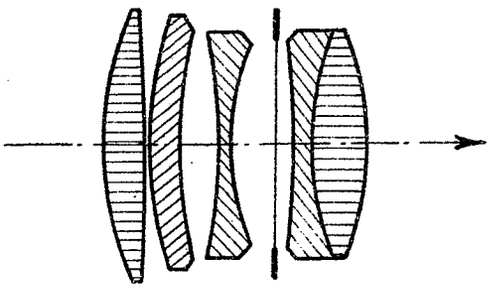
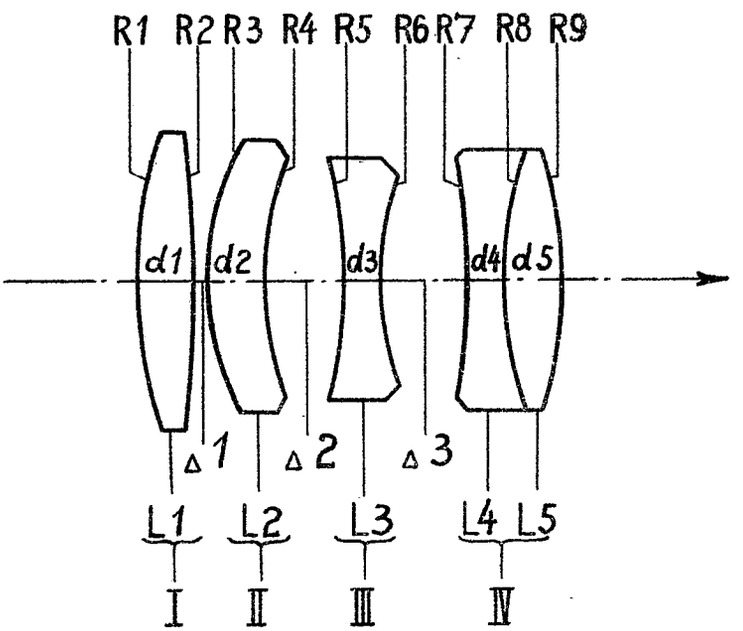


Fig. 2



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