

## PATENT SPECIFICATION

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## COMPLETE SPECIFICATION

## Improved Photographic Lens System

We, ERNST LEITZ G.M.B.H., of Wetzlar, Germany, a German Company, 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 invention relates to rapid photographic lens systems which constitute a variation of the Gauss type of lens system.

A type of lens system is already known in which two collecting members separated by air gaps and each consisting of one lens enclose two dispersing meniscus members also separated from each other and from the collecting lenses by air gaps. The meniscus members are each cemented from two lenses. The system has eight air-exposed surfaces, the first four being convex towards the object side. If this type is to be developed for maximum rapidity with simultaneous good correction of all image errors, one of the collecting members must be subdivided into two collecting members. Thereby, a lens system with ten air-exposed surfaces is obtained.

It is an object of the present invention to avoid the disadvantages resulting from an increased number of air-exposed surfaces and yet not to surrender the advantages associated therewith for the correction. To achieve this the present invention consists in a photographic lens system wherein two collecting members separated by air gaps enclose two dispersing meniscus members also separated from each other and from the collecting members by air gaps, the concave surfaces of the dispersing members facing each other and at least the dispersing member on the image side containing a cemented surface, and both the collecting members being biconvex, characterised by the feature that the collecting member on the object side contains a cemented surface which is concave towards the object side and is so highly dispersing that a light pencil arriving parallel to the axis of the system is over-corrected with regard to its intersection distance in relation to the paraxial ray after the refraction at the first and second surfaces.

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Thereby, such a distribution of the aberrations to the individual surfaces is obtained that systems of this type with eight air-exposed surfaces still combine a greater rapidity than hitherto with a favourable position of the astigmatic image surfaces, small spherical zone and relatively great distance of the focus on the image side from the last refractive surface. The "astigmatic image surfaces" are the surfaces on which the sagittal and tangential image points lie respectively. The more these surfaces approximate to the focal plane of the optical system, the better is the system astigmatically corrected. The "spherical zone" of a corrected system is that zone at which the spherical correction is substantially worse than it is in the centre and margin of the image field. The meniscus member on the object side and the collecting member on the image side may each consist of a simple lens.

An embodiment of the invention is illustrated diagrammatically, by way of example, in the accompanying drawing.

The system illustrated comprises a collecting member on the object side consisting of two lenses  $L_1$  and  $L_2$  cemented together. The collecting member has, beginning from the object side, an air-exposed surface  $r_1$ , which is convex towards the object, a cemented surface  $r_2$  concave towards the object, and a second air-exposed surface  $r_3$  concave towards the object. The thickness of the lens  $L_1$  is  $d_1$  and that of the lens  $L_2$  is  $d_2$ .

The said collecting member is followed by a meniscus member  $L_3$  having two air-exposed surfaces  $r_4$  and  $r_5$ . The separation of the lens  $L_2$  from the meniscus member  $L_3$  is  $A_1$ , the thickness of the meniscus member  $L_3$  being  $d_3$ .

A second meniscus member follows, consisting of two lenses  $L_4$  and  $L_5$  cemented together. This second meniscus member has two air-exposed surfaces  $r_6$  and  $r_7$  and a cemented surface  $r_7$ . The separation of the first meniscus member  $L_3$  from the second meniscus member is  $A_2$ , the thickness of the lens  $L_4$  being  $d_4$  and that of the lens  $L_5$  being  $d_5$ .

At the separation  $A_3$  from the lens  $L_5$ , a

collecting member  $L_c$  is arranged having two air-exposed surfaces  $r_9$  and  $r_{10}$ , its thickness being  $d_c$ .

Thus, the system has ten refracting surfaces, eight of which are air-exposed.

The specification of this lens system having the refractive power one is given in the following table.

In column 4 of the table, the material is defined by its means refractive index,

denoted by  $n$ . The Abbé number  $V$  is also given.  $A, B, \Gamma, P, \square$ , are the Seidel partial coefficients, their totals being indicated by  $S_I, S_{II}, S_{III}, S_{IV},$  and  $S_V$  respectively.

It will be appreciated from columns 6 to 10, that the system is precorrected to such an extent that only small variations of the constructional elements are needed to correct it finely.

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TABLE

	1) Surface	2) Curvature of refract- ing surface	3) Thicknesses and separations	4) Medium between surfaces		5) Refractive power of surface
25				$n$	$V$	
	$r_1$	+1.000		1.565	56	+0.36
	$r_2$	-1.722	$d_1=0.165$			-0.13
30	$r_3$	-0.432	$d_2=0.035$	1.673	32	+0.43
	$r_4$	+3.025	$A_1=0.002$	Air		+0.83
	$r_5$	+4.455	$d_3=0.172$	1.626	34	-0.95
35	$r_6$	-3.214	$A_2=0.262$	Air		-0.84
	$r_7$	+0.581	$d_4=0.052$	1.596	39	+0.01
40	$r_8$	-2.580	$d_5=0.124$	1.620	60	+0.75
	$r_9$	+0.381	$A_3=0.002$	Air		-0.09
	$r_{10}$	-1.156	$d_c=0.083$	1.620	60	+0.63
						Total: +1.00

SEIDEL PARTIAL COEFFICIENTS

	6) A	7) B	8) $\Gamma$	9) P	10) $\square$
	+0.23	+0.23	+0.23	+0.37	+0.59
	-0.82	+0.19	-0.04	-0.07	+0.03
50	+0.55	-0.48	+0.42	+0.17	-0.52
	+1.11	+0.71	+0.45	+1.16	+1.03
	-1.53	-1.39	-1.26	-1.72	-2.70
	-1.97	-0.40	-0.08	-1.20	-0.26
	+0.00	+0.01	+0.04	+0.01	+0.14
55	+1.46	+0.75	+0.39	+0.99	+0.71
	-0.01	+0.04	-0.25	+0.15	+0.60
	+1.14	+0.51	+0.22	+0.44	+0.30
	$S_I$	$S_{II}$	$S_{III}$	$S_{IV}$	$S_V$
Totals:	+0.16	+0.17	+0.12	+0.29	-0.08

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

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1. Photographic lens system, wherein two collecting members separated by air gaps enclose two dispersing meniscus members also separated from each other and from the collecting members by their gaps, the concave surfaces of the dispersing members facing each other and at least the dispersing member on the image side containing a cemented surface, and both the collecting members being biconvex, characterised by the feature that the col-

lecting member on the object side contains a cemented surface which is concave towards the object side and is so highly dispersing that a light pencil arriving parallel to the axis of the system is over-corrected with regard to its intersection distance in relation to the paraxial ray after the refraction at the first and second surfaces.

2. Photographic lens system substantially as hereinbefore described with reference to the accompanying drawing.

Dated this 9th day of June, 1937.

BARON & WARREN,  
231, Strand, London, W.C.2,  
Chartered Patent Agents.

[This Drawing is a full-size reproduction of the Original.]

