

COPY

PATENT SPECIFICATION



Application Date: May 14, 1931. No. 13,941/32.

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PROVISIONAL SPECIFICATION.

Communicated by ARTHUR WARMISHAM, of 1625, Hinman Avenue, Evanston, Illinois, United States of America (a British Subject).

Zonal Spherical Aberration Correction of Photographic Lenses.

We, KAPELLA LIMITED, a British Company, of 104, Stoughton Street, Leicester, do hereby declare the nature of this invention to be as follows:—

5 This invention relates to photographic lenses and has for its object to provide lenses which have relatively greater depth of focus behind the plane of a principal object focussed, than they have in front of such plane.

15 In the normal use of a photographic lens, the lens is focussed on the principal plane of interest of the scene to be photographed. It is very seldom that there is much, if any, interest in front of the principal plane of interest, while there is nearly always some interest in the background. The present invention is directed to securing improved definition of objects in the background.

20 Photographic lenses as hitherto constructed have usually had spherical surfaces and have been characterized by spherical under-correction of the middle zones of the lens accompanied by marginal over-correction. The depth of field is accordingly distributed on both sides of the principal focal plane, but on account of the above distribution of the spherical correction, the depth of focus in front of the principal focal plane is substantially greater than that behind said plane.

Now according to the present invention, we invert the usual distribution of spherical correction in such lenses by forming one or more of their surfaces as aspherical surfaces in such a way that the middle zones are over-corrected, the marginal zones under-corrected, and thereby the depth of focus behind the focal plane is made substantially greater than that in front of said plane.

Our invention contemplates the use of aspherical surfaces for the construction of lenses having the aforesaid inversion of the usual distribution of spherical correction. We assume an objective having only spherical surfaces, and computed to give substantial over-correction of spherical aberration, and this we invert by applying to one or more selected surfaces such predetermined deformation as will produce the above-mentioned zonal correction.

Dated the 11th day of May, 1932.

KAPELLA LIMITED,

The Common Seal of Kapella Limited was hereunto affixed in the presence of:—

WM. TAYLOR,

Director,

G. STAFFORD,

Secretary

COMPLETE SPECIFICATION.

Zonal Spherical Aberration Correction of Photographic Lenses.

55 We, KAPELLA LIMITED, a British Company, of 104, Stoughton Street, Leicester, 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:—

60 This invention relates to photographic lenses and has for its object to provide lenses which have relatively greater depth of focus behind the plane of a principal

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object focussed, than they have in front of such plane.

In the normal use of a photographic lens, the lens is focussed on the principal plane of interest of the scene to be photographed. It is very seldom that there is much, if any, interest in front of the principal plane of interest, while there is nearly always some interest in the background. The present invention is directed to securing improved definition

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of objects in the background.

Photographic lenses as hitherto constructed have usually had spherical surfaces and been characterised by spherical under-correction of the middle zones of the lens (those intermediate between its axis and its marginal zones) accompanied by over-correction of the marginal zones. The effect is that when any lens is focussed on a principal object in a scene comprising objects both nearer and further away, the depth of focus of the lens enables it to define objects both nearer and farther within limits which, however, somewhat favour the nearer objects. And when such a lens, after being focussed with a large aperture, is stopped down before exposure of the film, it still further favours the nearer objects. Now according to the present invention, we invert the usual distribution of spherical correction in such lenses by making one or more of their surfaces as aspheric surfaces of such form that the middle zones are over-corrected, the marginal zones are under-corrected, and thereby the limits of depth of focus are made to favour objects behind the principal object focussed, at the expense of those in front. And this is especially the case when the lens, after being used with a large aperture for focussing the principal object, is stopped down for the exposure. In practice we prefer to compute an objective with spherical surfaces so

as to have substantial over-correction of spherical aberration in all zones, and then to apply to one or more selected surfaces of the lens such aspheric deformation as will invert the correction of the marginal zones. This we generally accomplish by removing from the marginal zones of such surface or surfaces, material increasing in amount regularly from zero toward the edge of the lens.

A lens embodying this invention is described by the following specification and accompanying drawing, the surfaces R_1 and R_6 being both aspheric, but as their departure from spherical form is small, this cannot be made apparent in the drawing.

We now give data for the construction of the example illustrated in the accompanying drawing. The notation is that the successive radii of curvature, counting from the front, are called R_1, R_2 , etc., the sign + denoting that the curve is convex toward the incident light, and - that it is concave toward the same. The axial thicknesses of the elements are denoted by D_1, D_2 , etc., and the separations of the members by S_1, S_2 , etc.

The material is defined in terms of the mean refractive index n_D , as conventionally employed, followed by the type number in Messrs. Chance Brothers' optical glass catalogue. The Abbe V number also is given.

EQUIVALENT FOCAL LENGTH 3".

	Radii	Thickness	Separation.	n_D	V	No.
75	$R_1 +2.02$					
	$R_2 +12.55$	$D_1 .236$		1.5731	57.3	9002
	$R_3 +1.12$		$S_1 .039$			
	$R_4 +7.9$	$D_2 .290$		1.6135	59.4	3465
80	$R_5 +.723$	$D_3 .121$		1.6134	37.0	4743
	$R_6 -.79$		$S_2 .531$			
85	$R_7 \infty$	$D_4 .119$		1.5795	40.4	407
	$R_8 -1.063$	$D_5 .290$				3465
	$R_9 +51.5$		$S_3 .039$			
90	$R_{10} -1.97$	$D_6 .242$				3465

The above data are for a lens as made originally with spherical surfaces, and, in that condition, the over-correction of the extreme marginal zone for an aper-

ture of F/2, is 0.098 inch, and at an inner zone, corresponding to the limit of an aperture of F/2.83, the over-correction is 0.0287 inch.

- To invert this over-correction we then remove from the marginal zones of the surfaces R_5 and R_6 , for example by grinding and polishing, commencing at a zone corresponding to an aperture of about $F/3.5$, material the amount of which increases regularly from zero toward the edge of the lens, where it should be about 400 wave-lengths of sodium light.
- 10 Although we have described a lens made originally with spherical surfaces, some of which are subsequently deformed, we do not limit ourselves to such method of production.
- 15 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:—
- 20 1. A photographic lens, spherically over-corrected in its middle zones, which is undercorrected in its marginal zones by making one or more of its surfaces aspheric.
- 25 2. A photographic lens having an aspheric surface as and for the purpose claimed in claim 1, in which the aspheric surface is formed initially as a spherical surface and is finally deformed by removing, from its marginal zones, material the amount of which increases regularly from zero toward the edge of the lens.
- 30 3. A photographic lens substantially as described and illustrated herein.

Dated the 11th day of May, 1933.

KAPELLA LIMITED,

The Common Seal of Kapella Limited was hereunto affixed in the presence of:—

WM. TAYLOR,

Director,

G. STAFFORD,

Secretary,

[This Drawing is a reproduction of the Original on a reduced scale.]

