

## PATENT SPECIFICATION

477,424

Application Date: July 31, 1936. No. 21178/36.

Complete Specification Left: July 19, 1937.

Complete Specification Accepted: Dec. 30, 1937.



### PROVISIONAL SPECIFICATION

#### Improvements in Objectives

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

This invention relates to objectives corrected for spherical aberration, coma, astigmatism and distortion, for photography and the like, of the kind comprising a double concave unsymmetrical divergent component enclosed between two anterior convergent components and a posterior convergent component, the shallow side of the divergent component being turned toward the two anterior components; and its principal object is to extend the useful aperture of such objectives.

Objectives of the kind referred to as hitherto made have apertures limited to about F/2.

By means of the present invention we

are enabled to increase the aperture to F/1.4, and this we achieve by employing glass of refractive index  $n_D$  substantially greater than 1.65 for the divergent component if it is a simple element, or for one or more of the elements if a compound divergent component, and at the same time making the radius of the shallow side of the divergent component at least ten times the radius of its deep side.

Dated the Thirtieth day of July, 1936.

ARTHUR WARMISHAM.

KAPELLA LIMITED.

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

J. RONALD TAYLOR,

Director.

G. STAFFORD,

Secretary.

### COMPLETE SPECIFICATION

#### Improvements in Objectives

We, ARTHUR WARMISHAM, British Subject, and KAPELLA LIMITED, a Company registered under the Laws of Great Britain, both 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:—

This invention relates to an optical objective for photographic and like purposes consisting of a lens system corrected for spherical aberration, coma, astigmatism and distortion, of the kind comprising a double-concave asymmetrical divergent component disposed behind two convergent components and in front of a third convergent component, the shallow side of the divergent component being turned towards the front two components. The term "component" is used herein to indicate a lens, whether simple or compounded of two or more elements, forming a component part of a lens system, whilst the term "element" indicates a lens consisting of a single piece of glass.

Objectives of the above-mentioned kind in which each of the two convergent components between which the divergent component lies is of the compound type have been proposed in the present applicants' prior British Patent Specification No. 408,787 capable of yielding apertures up to F/1.0 but in objectives of the above kind consisting of simple elements the useful apertures have been limited to about F/2, and the present invention has for its primary object to extend the useful aperture of such simple element objectives.

To this end in an objective of the above kind according to the present invention in which each of the components consists of a simple element, glass having a mean refractive index  $n_D$  substantially greater than 1.65 is employed for the divergent component and the radius of curvature of the shallow side of the divergent component is at least ten times that of the other side thereof.

The glass used for the rear convergent component preferably has a mean refractive index  $n_D$  greater than 1.62 and an

Abbé V number less than 50. With such an arrangement it is possible to obtain an aperture of F/1.4.

5 The accompanying drawing illustrates a preferred example of objective according to the invention, for which numerical data are given below.

10 In this example the successive radii of curvature, counting from the front, are designated by  $R_1, R_2, \dots$ , the positive sign denoting that the surface is convex towards the incident light and the negative sign that it is concave thereto; the

axial thicknesses of the components are indicated by  $D_1, D_2, \dots$ ; and the axial air separations of the components from one another are indicated by  $S_1, S_2, S_3$ . The glass of which each component is made is defined in terms of the mean refractive index  $n_D$  and the Abbé V number. 15

The numerical data for this example which has a relative aperture F/1.4 and an equivalent focal length 1.02 are set out in the following table:— 20 25

	Radius.	Thickness.	Separation.	$n_D$ .	V.
	$R_1 + .940$				
		$D_1 .112$		1.61377	56.3
30	$R_2 + 3.80$		$S_1 .005$		
	$R_3 + .534$	$D_2 .300$		1.61377	56.3
	$R_4 \infty$		$S_2 .008$		
35	$R_5 - 4.176$	$D_3 .162$		1.74919	27.8
	$R_6 + .316$		$S_3 .201$		
40	$R_7 + .575$	$D_4 .089$		1.6529	46.2
	$R_8 - 1.400$				

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:— 45

1. An optical objective of the kind referred to, in which each of the components consists of a simple element and wherein glass having a mean refractive index  $n_D$  substantially greater than 1.65 is employed for the divergent component and the radius of curvature of the shallow side of the divergent component is at least

ten times that of the other side thereof. 55

2. An optical objective as claimed in Claim 1, in which the glass used for the rear convergent component has a mean refractive index  $n_D$  greater than 1.62 and an Abbé V number less than 50. 60

3. The optical objective substantially as described with reference to the accompanying drawing.

Dated this 19th day of July, 1937.  
KILBURN & STRÖDE,  
Agents for the Applicants.

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

