

PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in or relating to Optical Objectives

We, TAYLOR, TAYLOR & HOBSON LIMITED, a Company registered under the Laws of Great Britain, and ARTHUR WARMISHAM, British Subject, both of 5 104, 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:—

10 This invention relates to an optical objective for photographic or like purposes comprising four asymmetrically arranged components separated by air spaces and 15 each consisting of a simple element, the two outer components being convergent and the two inner divergent. For the most part such objectives have corrected only for apertures less than F/4 or F/4.5, but 20 in one known arrangement a higher aperture, F/3.5, has been obtained by the use of an abnormally long middle air space between the two divergent components and short outer air spaces respectively separating 25 such components from the two convergent components.

30 The present invention has for its object to provide an improved objective of this kind corrected for an aperture of not less than F/3.5 and having a wide angular field.

35 In the objective according to the present invention the radius of curvature of the front surface of the rear divergent component is at least five times that of the rear surface of that component, the middle air space being less than either of the outer air spaces and less than one-third of the sum of such outer air spaces, whilst

40 none of the air spaces exceeds .09 of the equivalent focal length of the objective. It is to be understood that the terms "front" and "rear" as used herein relate respectively to the sides of the objective nearer to and further from the 45 longer conjugate in accordance with the usual convention.

The numerical sum of the radii of curvature of the front surface of the front convergent component and the rear surface of the rear convergent component is preferably 50 greater than .70 of the equivalent focal length of the objective. Preferably also the numerical sum of the radii of curvature of the front surface of the front divergent component and the rear surface of the rear divergent component is greater 55 than .80 of the equivalent focal length of the objective.

60 Numerical data for two convenient examples of objective according to the invention, of which the first is illustrated in the accompanying drawing, are given in the following tables, in which R_1, R_2, \dots 65 indicate the radii of curvature of the individual lens surfaces counting from the front (the positive sign relating to surfaces convex towards the front and the negative sign to surfaces concave thereto), 70 D_1, D_2, \dots indicate the axial thicknesses of the individual lens elements, and S_1, S_2, S_3 indicate the axial air separations between the components. The tables also 75 give the mean refractive indices and the Abbé V numbers of the glasses used for the lens elements.

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EXAMPLE I.

	Equivalent focal length 1.000	Thickness or Separation.	Relative Aperture F/3.5.	Refractive Index n_D	Abbé V number.
5	$R_1 + .3341$	$D_1 .0680$	1,613	59.4	
	$R_2 - 2.748$	$S_1 .0515$			
10	$R_3 - .5887$	$D_2 .0134$	1,579	40.4	
	$R_4 + .7633$	$S_2 .0196$			
15	$R_5 - 16.62$	$D_3 .0134$	1,579	40.4	
	$R_6 + .3816$	$S_3 .0618$			
20	$R_7 + 1.198$	$D_4 .0587$	1,613	59.4	
	$R_8 - .4335$				

EXAMPLE II.

	Equivalent focal length 1.000	Thickness or Separation.	Relative Aperture F/3.5.	Refractive Index n_D	Abbé V number.
25	$R_1 + .3141$	$D_1 .0653$	1,613	59.4	
30	$R_2 - 3.298$	$S_1 .0495$			
	$R_3 - .6596$	$D_2 .0129$	1,653	33.6	
35	$R_4 + .7889$	$S_2 .0139$			
	$R_5 \infty$	$D_3 .0129$	1,579	40.4	
40	$R_6 + .3585$	$S_2 .0594$			
	$R_7 + 1.192$	$D_4 .0564$	1,644	48.3	
	$R_8 - .4547$				

45 It will be noticed that in both examples R_5 is considerably greater than five times R_6 and that S_2 is considerably less than S_1 or S_3 or a third of the sum of S_1 and S_3 , whilst the numerical sum of R_1 and R_3 is greater than 0.70 and that of R_2 and R_6 greater than 0.80. These examples are both corrected over a semi-angular field of 25°.

50 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:—

60 1. An optical objective for photographic or like purposes comprising four asymmetrically arranged components separated by air spaces and each consisting of a simple element, the two outer components being convergent and the two inner divergent, wherein the radius of curvature of

the front surface of the rear divergent component is at least five times that of the rear surface of that component, the middle air space being less than either of the two outer air spaces and less than one-third of the sum of such outer air spaces, whilst none of the air spaces exceed .09 of the equivalent focal length of the objective.

75 2. An optical objective as claimed in Claim 1, in which the numerical sum of the radii of curvature of the front surface of the front convergent component and the rear surface of the rear convergent component is greater than .70 of the equivalent focal length of the objective.

80 3. An optical objective as claimed in Claim 1 or Claim 2, in which the numerical sum of the radii of curvature of the front surface of the front divergent component and the rear surface of the rear

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divergent component is greater than .80 data substantially as set forth in one or
of the equivalent focal length of the ob- other of the tables herein.
jective.

4. An optical objective for photo-
5 graphic or like purposes having numerical

Dated this 30th day of May, 1941.

PULLINGER & MALET,
Agents for the Applicants.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1942.

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

