PATENT SPECIFICATION

PROVISIONAL SPECIFICATION

Improvements in or relating to Optical Objectives

We, TAYLOR, TAYLOR & HOBSON LIMITED, a Company registered under the Laws of Great Britain, ARTHUR WARMISHAM, British Subject, and CHARLES GORRIE WYNNE, British Subject, all of 104, Stoughton Street, Leicester, do hereby declare the nature of this invention to be as follows:—

This invention relates to an optical objective for photographic or other purposes of the kind corrected for spherical and chromatic aberrations, coma, astigmatism, field curvature and distortion, and comprising two divergent components located between two simple convergent components and each consisting of a divergent element compounded with a convergent element.

In the objective according to the invention the material used for one of the convergent elements has mean refractive index between 1.65 and 1.75 and Abbé V number between 34.0 and 27.0, whilst the materials used for the other three convergent elements have mean refractive index between 1.70 and 1.80 and Abbé V number greater than 50.0 and preferably less than 58.0. For example one of the convergent elements may be made of a dense flint glass and the other three of magnesium oxide crystal in the form known as β-magnesium oxide. Preferably it is the front convergent element which is made of the material having relatively low Abbé V number, whilst the other three may all be made of the same material having the relatively high Abbé V number. The divergent elements may be made of dense flint glass. It is to be understood that the term "front" as herein used refers to the side of the objective nearer to the longer conjugate in accordance with the usual convention.

The radii of curvature of the contact surfaces in the two compound divergent components are preferably greater than 1.5 times the equivalent focal length of the objective. Such contact surfaces may be cemented in the usual way, but are preferably left uncemented, and it is not essential to the invention that the two engaging surfaces should have exactly the same radius of curvature.

Numerical data for a preferred example of objective according to the invention are given in the following table, in which R_1 R_2 . . . . . . represent the radii of curvature of the individual surfaces (the positive sign indicating that the surface is convex to the front and the negative sign that it is concave thereto), D_1 D_2 . . . . . represent the axial thicknesses of the individual elements, and S_1 S_2 S_3 represent the axial air separations between the components. The table also gives the mean refractive index for the D-line and the Abbé V number of each of the materials used for the elements.

| Equivalent focal length 1.000 | | Relative aperture F/2. | |
Radius	Thickness or Air Separation	Refractive Index n_D	Abbé V Number
R₁ + .7120	D₁ .0671	1.6973	30.5
R₂ + 1.845	S₁ .0045		
R₃ + .3656	D₂ .0943	1.7378	53.5
R₄ + 1.917	D₃ .0195	1.6746	32.3
R₅ + .2644	S₂ .1534		
R₆ − .3350	D₄ .0192	1.6746	32.3
R₇ − 2.915	D₅ .1404	1.7378	53.5
R₈ − .4601	S₃ .0048		
R₉ ∞	D₆ .0335	1.7378	53.5
R₁₀ − .8870			

Dated this 6th day of October, 1942.

PULLINGER & MALET,
Agents for the Applicants.

COMPLETE SPECIFICATION

Improvements in or relating to Optical Objectives

We, TAYLOR, TAYLOR & HOBSON LIMITED, a Company registered under the Laws of Great Britain, ARTHUR WARMISHAM, British Subject, and CHARLES GORRIE WYNNE, British Subject, all 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 or other purposes of the kind corrected for spherical and chromatic aberrations, coma, astigmatism, field curvature and distortion, and comprising two divergent components located between two simple convergent components and each consisting of a divergent element compounded with a convergent element.

In the objective according to the invention the material used for one of the convergent elements has mean refractive index between 1.65 and 1.75 and Abbé V number between 34.0 and 27.0, whilst the materials used for the other three convergent elements have mean refractive index between 1.70 and 1.80 and Abbé V number greater than 50.0 and preferably less than 58.0. For example one of the convergent elements may be made of a dense flint glass and the other three of magnesium oxide crystal in the form known as β-magnesium oxide. Preferably it is the front convergent element which is made of the material having relatively low Abbé V number, whilst the other three may all be made of the same material having the relatively high Abbé V number. The divergent elements may be made of dense flint glass. It is to be understood that the term " front " as herein used refers to the side of the objective nearer to the longer conjugate in accordance with the usual convention.

The radii of curvature of the contact surfaces in the two compound divergent components are preferably greater than 1.5 times the equivalent focal length of the objective. Such contact surfaces may be cemented in the usual way, but are preferably left uncemented, and it is not essential to the invention that the two engaging surfaces should have exactly the same radius of curvature.

The accompanying drawing illustrates a preferred example of objective according to the invention, for which numerical data are given in the following table, in which R₁ R₂ . . . . . . represent the radii of curvature of the individual surfaces

(the positive sign indicating that the surface is convex to the front and the negative sign that it is concave thereto), D_1 D_2 ..... represent the axial thicknesses of the individual elements, and

S_1 S_2 S_3 represent the axial air separations between the components. The table also gives the mean refractive index for the D-line and the Abbé V number of each of the materials used for the elements.

Equivalent focal length 1.000 Relative aperture F/2.

Radius		Thickness or Air Separation		Refractive Index n_D	Abbé V Number
R_1 +	.7120				
R_2 +	1.845	D_1	.0671	1.6973	30.5
R_3 +	.3656	S_1	.0045		
R_4 +_	1.917	D_2	.0943	1.7378	53.5
R_5 +_	.2644	D_3	.0195	1.6746	32.3
R_6 −	.3350	S_2	.1534		
R_7 −	2.915	D_4	.0192	1.6746	32.3
R_8 −	.4601	D_5	.1404	1.7378	53.5
R_9 ∞		S_3	.0048		
R_{10} −	.8870	D_6	.0335	1.7378	53.5

In this example magnesium oxide crystal is used for the convergent second, fifth and sixth elements and a dense flint glass for the convergent front element, whilst the divergent third and fourth elements are made of another dense flint glass. The contact surfaces R_4 and R_7 in the two divergent components are preferably both left uncemented.

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:—

1. An optical objective corrected for spherical and chromatic aberrations, coma, astigmatism, field curvature and distortion, and comprising two divergent components located between two simple convergent components and each consisting of a divergent element compounded with a convergent element, wherein the material used for one of the convergent elements has mean refractive index between 1.65 and 1.75 and Abbé V number between 34.0 and 27.0, whilst the materials used for the other three convergent elements have mean refractive index between 1.70 and 1.80 and Abbé V number greater than 50.0.

2. An optical objective as claimed in Claim 1, in which the Abbé V numbers of the materials used for the said other three convergent elements are less than 58.0.

3. An optical objective as claimed in Claim 2, in which one of the convergent elements is made of a dense flint glass and the other three are made of magnesium oxide crystal in the form known as β-magnesium oxide.

4. An optical objective as claimed in Claim 1 or Claim 2 or Claim 3, in which the front convergent element is made of the material having the relatively low Abbé V number and the other three convergent elements are all made of the same material having the relatively high Abbé V number.

5. An optical objective as claimed in any one of Claims 1 to 4, in which a dense flint glass is used for the divergent elements.

6. An optical objective as claimed in any one of Claims 1 to 5, in which the radii of curvature of the contact surfaces in the two compound divergent components are greater than 1.5 times the equivalent focal length of the objective.

7. An optical objective as claimed in any one of Claims 1 to 6, in which the contact surfaces in the two compound divergent elements are left uncemented.

8. An optical objective having numerical data substantially in accordance with the table herein set forth.

Dated this 5th day of October, 1943.
PULLINGER & MALET,
Agents for the Applicants.