PATENT SPECIFICATION

Application Date: Aug. 2, 1939. No. 22410/39. 532,950

Complete Specification Left: June 19, 1940.

Complete Specification Accepted: Feb. 4, 1941.

PROVISIONAL 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 104, Stoughton Street, Leicester, do hereby declare the nature of this invention to be as follows:—

This invention relates to an anastigmatically corrected objective for photographic or projection or like purposes, of the kind comprising three axially aligned components, each consisting of a simple element, the middle component being dispersive and the two outer components collective.

Attempts to design an objective of this kind with a high aperture, say F/2.5, have hitherto resulted in an objective having rather heavy residual zonal spherical aberration, thereby restricting their use to short focal lengths of 1½ inches or less.

The present invention has for its object to provide an objective of this kind in which the same high aperture can be obtained with considerably improved zonal sperical aberration correction, or alternatively in which a still higher aperture can be obtained with the same degree of residual zonal spherical aberration.

In the objective according to the invention one of the collective components is made of a glass having a mean refractive index higher than 1.75 and preferably higher than 1.8. Various examples of glass having such high refractive index are given in British Patent Specification No. 462,304, such glass having as its main constituents oxides of elements such as tungsten, tantalum, lanthanum, thorium, yttrium, zirconium, hafnium and columbium.

The sum of the numerical values of the radii of curvature of the front surface of the front component and the rear surface of the rear component lies between .85 and 1.3 times the equivalent focal length of the objective.

It is to be understood that the term "front" as herein used refers to the side of the objective nearer to the longer conjugate and the term "rear" to that nearer the shorter conjugate.

The use of the high index glass is preferably confined to one only of the components, the other two components being made of glasses within the more usual range, that is having refractive indices less than 1.7. When the rear component has the high index, the axial air separation between the middle and rear components is preferably less than forty per cent. of that between the front and middle components. When the front component has the high index, the axial air separation between the front and middle components is preferably less than fifty per cent. of that between the middle and rear components. In either case the axial air separation between the high index component and the middle component is preferably less than one tenth and greater than one fiftieth of the equivalent focal length of the objective.

Numerical data of three convenient practical examples of objective according to the invention are given in the following tables, in which the radii of curvature of the individual surfaces are designated by R_1 R_2 . . . . . counting from the front, the positive sign indicating that the surface is convex towards the front and the negative sign that it is concave thereto, whilst the thicknesses of the individual elements along the axis are designated by D_1 D_2 D_3 and the axial air spaces between the components by S_1 S_2. The tables also give the mean refractive indices and the Abbé V numbers of the glasses used for the individual elements.

[Price 1/-]

Price 2s. 8d.

EXAMPLE I.

Equivalent focal length 1.000			Relative aperture F/2.5
Radius	Thickness or Separation	Refractive Index n_D	Abbé V number
R_1 + .3460			
	D_1 .109	1.574	57.5
R_2 ∞			
	S_1 .110		
R_3 − .6443			
	D_2 .031	1.697	30.7
R_4 + .3571			
	S_2 .110		
R_5 + 1.205			
	D_3 .085	1.901	42.5
R_6 − .7364			

EXAMPLE II.

Equivalent focal length 1.000			Relative aperture F/2.2
Radius	Thickness or Separation	Refractive Index n_D	Abbé V number
R_1 + .6761			
	D_1 .186	1.901	42.5
R_2 − 1.754			
	S_1 .065		
R_3 − .5435			
	D_2 .052	1.697	30.7
R_4 + .4273			
	S_2 .170		
R_5 + 2.222			
	D_3 .125	1.613	59.3
R_6 − .4273			

EXAMPLE III.

Equivalent focal length 1.000			Relative aperture F/2.7
Radius	Thickness or Separation	Refractive Index n_D	Abbé V number
R_1 + .5255			
	D_1 .065	1.613	59.3
R_2 + 3.559			
	S_1 .243		
R_3 − .4272			
	D_2 .017	1.697	30.7
R_4 + .5051			
	S_2 .061		
R_5 + 1.335			
	D_3 .087	1.901	42.5
R_6 − .4522			

As will be seen, the first and third examples employ the high index glass in the rear component, and both give good zonal spherical aberration correction, that in Example III which has a low rear air separation being exceptionally good whilst in Example II, which has a high index front component and a low front air separation, the improvement in zonal spherical aberration correction is sacrificed in order to obtain a higher aperture.

The sum of the numerical values of the two outermost radii is in Example I 1.0824, in Example II 1.1034 and in Example III .9777.

Dated this 2nd day of August, 1939.
A. F. PULLINGER,
Agent 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, and ARTHUR WARMISHAM, British Subject, 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 anastigmatically corrected objective for photographic or projection or like purposes of the kind comprising three axially aligned components, each consisting of a simple element, the middle component being dispersive and the two outer components collective.

Attempts to design an objective of this kind with a high aperture, say F/2.5, have hitherto resulted in an objective having rather heavy residual zonal spherical aberration, thereby restricting their use to short focal lengths of $1\frac{1}{2}$ inches or less.

The present invention has for its object to provide an objective of this kind in which the same high aperture can be obtained with considerably improved zonal spherical aberration correction, or alternatively in which a still higher aperture can be obtained with the same degree of residual zonal spherical aberration.

In the objective according to the invention one of the collective components is made of a glass having a mean refractive index higher than 1.75 and preferably higher than 1.8, at least one of the other two components being made of glass having a mean refractive index less than 1.7. Various examples of glass having refractive index higher than 1.75 are given in British Patent Specification No. 462,304, such glass having as its main constituents oxides of elements such as tungsten, tantalum, lanthanum, thorium, yttrium, zirconium, hafnium and columbium.

The sum of the numerical values of the radii of curvature of the front surface the front component and the rear surface of the rear component lies between .85 and 1.3 times the equivalent focal length of the objective.

It is to be understood that the term "front" as herein used refers to the side of the objective nearer to the longer conjugate and the term "rear" to that nearer the shorter conjugate.

When the rear component has the high index, the axial air separation between the middle and rear components is preferably less than forty per cent. of that between the front and middle components. When the front component has the high index, the axial air separation between the front and middle components is preferably less than fifty per cent. of that between the middle and rear components. In either case the axial air separation between the high index component and the middle component is preferably less than one tenth and greater than one fiftieth of the equivalent focal length of the objective.

Numerical data of three convenient practical examples of an objective according to the invention (of which the first is illustrated in the accompanying drawing) are given in the following tables, in which the radii of curvature of the individual surfaces are designated by R_1 R_2 . . . . . counting from the front, the positive sign indicating that he surface is convex towards the front and the negative sign that it is concave thereto, whilst the thicknesses of the individual elements along the axis are designated by D_1 D_2 D_3 and the axial air spaces between the components by S_1 S_2. The tables also give the mean refractive indices and the Abbé V numbers of the glasses used for the individual elements.

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The sum of the numerical values of the two outermost radii is in Example I 1.0824, in Example II 1.1034 and in Example III .9777.

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 of the kind described, in which one of the collective components is made of a glass having a mean refractive index higher than 1.75 and preferably higher than 1.8, at least one of the other two components being made of a glass having a mean refractive index less than 1.7.

2. An objective as claimed in Claim 1, in which the sum of the numerical values of the radii of curvature of the front surface of the front component and of the rear surface of the rear component lies between .85 and 1.3 times the equivalent focal length of the objective.

3. An objective as claimed in Claim 2, in which the high index glass is used for the rear component and the axial air separation between the middle and rear components is less than forty per cent. of the axial air separation between the front and middle components.

4. An objective as claimed in Claim 2, in which the high index glass is used for the front component and the axial air separation between the front and middle components is less than fifty per cent. of the axial air separation between the middle and rear components.

5. An objective as claimed in Claim 2, or Claim 3, or Claim 4, in which the axial air separation between the high index component and the middle component is less than one tenth and greater than one fiftieth of the equivalent focal length of the objective.

6. An optical objective having numerical data substantially as set forth in any one of the tables herein.

Dated this 19th day of June, 1940.
PULLINGER & MALET-VEALE,
Agents for the Applicants.

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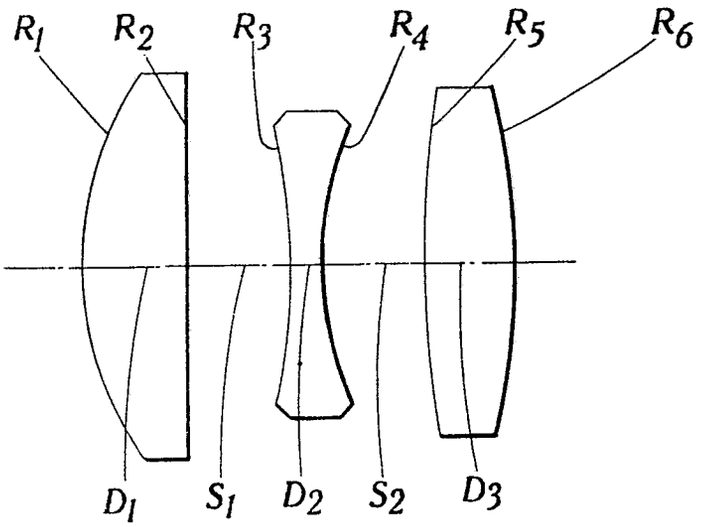

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