PATENT SPECIFICATION

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Complete Specification Accepted: June 24, 1940.

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 optical objectives, for photographic or projection or like purposes, of the kind comprising two compound dispersive meniscus components with their concave surfaces facing one another, disposed between a front collective component and a pair of rear collective components, the three collective components preferably all being simple elements. 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 two separate rear collective components in such an objective enables substantial flatness of field to be obtained over, say, 40° with good correction for spherical aberration for apertures up to F/1.4.

The present invention has for its object to provide an improved objective of this kind with still better correction for spherical aberration and curvature of field.

In the objective according to this invention the refractive indices of the glasses used for the front element of the front compound dispersive component and the rear element of the rear compound dispersive component and also for the front member of the pair of rear collective components are each greater than 1.63, and the two rear collective components each have their shallower surfaces facing the front.

Conveniently the power of the rear collective component is made not less than 40 per cent. of the power of the whole objective, or in other words the focal length of such component should not exceed $2\frac{1}{2}$ times the equivalent focal length of the whole objective. The power of such component should preferably be less than about 70% of that of the whole objective. The shallower surface of this component may be convex or concave towards the front, and its radius is preferably greater than three times the equivalent focal length of the whole objective.

Numerical data for one convenient example of objective according to the invention are given in the table below. In this table, the radii of curvature of the successive surfaces are designated by R_1 R_2 . . . . counting from the front, the positive sign signifying that the surface is convex to the front and the negative sign that it is concave thereto; the thicknesses of the individual elements along the axis are designated by D_1 D_2 . . . . and the axial air gaps by S_1 S_2 . . . . The table also gives the refractive indices for the **D**-line and the Abbé V numbers for the glasses of which the individual elements are made. In this example the equivalent focal length is taken as 1.000, and the numerical aperture is F/1.4.

[*Price* 1/-]

Radius	Thickness or Air Separation	Refractive Index n_D	Abbé V Number
R_1 + .8438			
	D_1 .1335	1.613	59.4
R_2 +11.92			
	S_1 .0020		
R_3 + .3866			
	D_2 .1671	1.644	48.3
R_4 − 9.890			
	D_3 .0277	1.675	32.3
R_5 + .2656			
	S_2 .2027		
R_6 − .3446			
	D_4 .0277	1.580	40.4
R_7 + .5495			
	D_5 .1662	1.644	48.3
R_8 − .5495			
	S_3 .0020		
R_9 ∞			
	D_6 .0574	1.644	48.3
R_{10} − 1.123			
	S_4 .0020		
R_{11} + 8.241			
	D_7 .0494	1.613	59.4
R_{12} − 1.364			

In this example it will be noticed that the second, fifth and sixth elements are all made of the same glass having a refractive index 1.644. The radius of the shallower surface R_{11} of the rear component is over eight times the equivalent focal length of the whole objective and the power of this component is 52½ per cent. of that of the whole objective. This example has a substantially flat field of about 46° with very good correction.

Dated this 17th day of December, 1938.

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 optical objectives, for photographic or projection or like purposes, of the kind comprising two compound dispersive meniscus components with their concave surfaces facing one another, disposed between a front collective component and a pair of rear collective components, the three collective components preferably all being simple elements. 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 two separate rear collective components in such an objective enables substantial flatness of field to be obtained over, say, 40° with good correction for spherical aberration for apertures up to F/1.4.

The present invention has for its object to provide an improved objective of this kind with still better correction for spherical aberration and curvature of field.

In the objective according to this invention the refractive indices of the glasses used for the front element of the front compound dispersive component and the rear element of the rear compound dispersive component and also for the front member of the pair of rear collective components are each greater than 1.63, and the two rear collective components each have their shallower surfaces facing the front.

Conveniently the power of the rear collective component is made not less than 40 per cent. of the power of the whole objective, or in other words the focal length of such component should not exceed 2½ times the equivalent focal length of the whole objective. The power of such component should preferably be less

than about 70% of that of the whole objective. The shallower surface of this component may be convex or concave towards the front, and its radius is preferably greater than three times the equivalent focal length of the whole objective.

One convenient example of objective according to the invention is shown in the accompanying drawing, and numerical data therefor are given in the table below. In this table, the radii of curvature of the successive surfaces are designated by R_1 R_2 .... counting from the front, the positive sign signifying that the surface is convex to the front and the negative sign that it is concave thereto; the thicknesses of the individual elements along the axis are designated by D_1 D_2 .... and the axial air gaps by S_1 S_2 .... The table also gives the refractive indices for the D-line and the Abbé V numbers for the glasses of which the individual elements are made. In this example the equivalent focal length is taken as 1.000, and the numerical aperture is F/1.4.

Radius	Thickness or Air Separation	Refractive Index n_D	Abbé V Number
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R_6 − .3446			
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In this example it will be noticed that the second, fifth and sixth elements are all made of the same glass having a refractive index 1.644. The radius of the shallower surface R_{11} of the rear component is over eight times the equivalent focal length of the whole objective and the power of this component is 52½ per cent. of that of the whole objective. This example has a substantially flat field of about 46° with very good correction.

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 the refractive indices of the glasses used for the front element of the front compound dispersive component, for the rear element of the rear compound dispersive component and for the front member of the pair of rear collective components are greater than 1.63, and the two rear collective components each have their shallower surfaces facing the front.

2. An optical objective as claimed in Claim 1, in which the power of the rear collective component is not less than 40 per cent., and preferably not greater than 70 per cent., of the power of the whole objective.

3. An optical objective as claimed in Claim 1 or Claim 2, in which the radius of the shallower surface of the rear collective component is greater than three times the equivalent focal length of the whole objective.

4. An optical objective substantially as shown in the accompanying drawing.

Dated this 13th day of December, 1939.

PULLINGER & MALET VEALE,
Agents for the Applicants.

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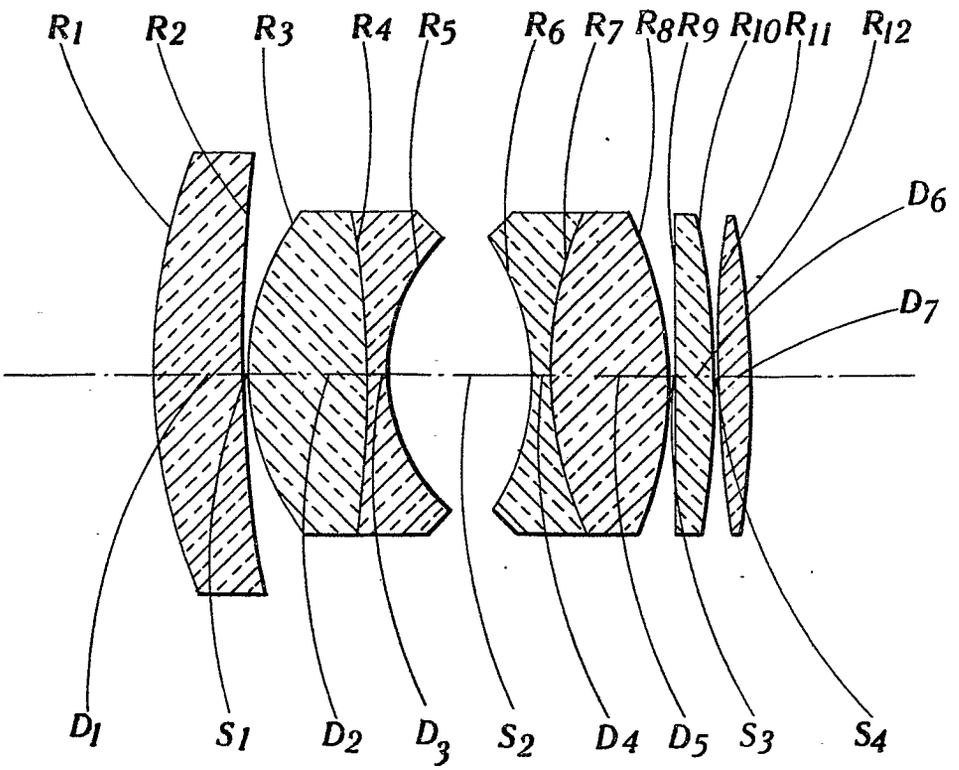

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