PATENT SPECIFICATION

Application Date: July 26, 1938. No. 22153/38. 517,386

Complete Specification Left: July 21, 1939.

Complete Specification Accepted: Jan. 29, 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 an optical objective for kinematograph projection or other 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 and having its shallow side turned towards the front two components, each of the four components being in the form of a simple element, i.e. consisting of a single piece of glass. It should be made clear that the side of the longer conjugate is herein regarded as the "front" of the objective in accordance with the normal convention.

In one example of objective of this kind, described in British Patent Specification No. 477,424, an aperture of F/1.4 has been obtained by employing for the divergent component glass having a mean refractive index n_D substantially greater than 1.65 and making the radius of curvature of the shallow side of the divergent component at least ten times that of the other side thereof. More usually however, objectives of this kind have been limited to apertures not greater than F/2 and have had a relatively wide angle (for example up to a semi-field of eighteen degrees) but have not been well-corrected.

The present invention has for its object to provide an objective of this kind having an aperture of, say, F/2, wherein a much higher degree of correction than hitherto, more especially in respect of curvature of field and of coma, can be obtained over a somewhat smaller angle, for example over a semi-field of about ten degrees.

In the objective according to the invention the glass of the divergent component has its mean refractive index n_D substantially greater than 1.65 and its Abbé V number substantially less than 33.5 and the air separation on the axis between the shallow side of the divergent component and the convergent component in front of it is not less than 10% of the focal length of the objective. The mean refractive indices of at least two of the three convergent components are preferably greater than 1.6. The radius of curvature of the shallow side of the divergent component is preferably not less than three times and not greater than seven times that of the other side thereof.

Numerical data for two convenient examples of objective according to the invention are given in the tables below, in which R_1 R_2 . . . . . respectively indicate the radii of curvature of the successive surfaces counting from the front (the positive sign denoting that the surface is convex towards the front and the negative sign that it is concave thereto), D_1 D_2 D_3 D_4 indicate the axial thicknesses of the individual components, and S_1 S_2 S_3 the axial air separations of the components from one another, whilst the glass of which each component is made is defined in terms of its mean refractive index n_D and its Abbé V number.

[*Price* 1/-]

EXAMPLE 1.

Equivalent Focal Length 1.00 Relative aperture F/2.

Radius.	Thickness or Separation.	Mean Refractive Index n_D.	Abbé V number.
R_1 + .7122			
	D_1 .0966	1.6128	59.2
R_2 + 1.987			
	S_1 .0074		
R_3 + .5078			
	D_2 .1031	1.6128	59.2
R_4 + 1.513			
	S_2 .1547		
R_5 − 1.318			
	D_3 .0228	1.69728	30.5
R_6 + .3242			
	S_2 .1638		
R_7 + .7407			
	D_4 .0786	1.6128	59.2
R_8 − .5296			

EXAMPLE 2.

Equivalent Focal Length 1.00 Relative aperture F/2.1.

Radius.	Thickness or Separation.	Mean Refractive Index n_D.	Abbé V number.
R_1 + .6714			
	D_1 .0913	1.6125	59.4
R_2 + 1.854			
	S_1 .0059		
R_3 + .4789			
	D_2 .0970	1.6125	59.4
R_4 + 1.426			
	S_2 .1448		
R_5 − 1.237			
	D_3 .0211	1.69728	30.5
R_6 + .3052			
	S_3 .1409		
R_7 + .6244			
	D_4 .0739	1.53019	51.1
R_8 − .4577			

In both these examples the large air separation S_2 in conjunction with a relatively high mean refractive index for the divergent component assists materially in giving good correction not only for coma and curvature of field but also for spherical aberration, and these factors are prevented from adversely affecting the chromatic correction owing to the choice of a glass for the divergent component having a relatively low Abbé V number and to the fact that this component has a power sufficient to cause a parallel beam incident on the front of the objective to diverge on emergence from this component. It will be noticed that the mean refractive indices of all three convergent components are greater than 1.6 in the first example (the same glass being used) whilst in the second example only the front two components have their indices greater than 1.6.

Dated this 26th day of July, 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 an optical objective for kinematograph projection or other 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 and having its shallow side turned towards the front two components, each of the four components being in the form of a simple element, i.e. consisting of a single piece of glass. It should be made clear that the side of the longer conjugate is herein regarded as the "front" of the objective in accordance with the normal convention.

In one example of objective of this kind, described in British Patent Specification No. 477,424, an aperture of F/1.4 has been obtained by employing for the divergent component glass having a mean refractive index n_D substantially greater than 1.65 and making the radius of curvature of the shallow side of the divergent component at least ten times that of the other side thereof. More usually, however, objectives of this kind have been limited to apertures not greater than F/2 and have had a relatively wide angle (for example up to a semi-field of eighteen degrees) but have not been well-corrected.

The present invention has for its object to provide an objective of this kind having an aperture of, say, F/2, wherein a much higher degree of correction than hitherto, more especially in respect of curvature of field and of coma, can be obtained over a somewhat smaller angle, for example over a semi-field of about ten degrees.

In the objective according to the invention the glass of the divergent component has its mean refractive index n_D substantially greater than 1.65 and its Abbé V number substantially less than 33.5 and the air separation on the axis between the shallow side of the divergent component and the convergent component in front of it is not less than 10% of the focal length of the objective. The mean refractive indices of at least two of the three convergent components are preferably greater than 1.6. The radius of curvature of the shallow side of the divergent component is preferably not less than three times and not greater than seven times that of the other side thereof.

The accompanying drawing illustrates one convenient example of objective according to the invention, of which numerical data are given in the first of the two tables below, the second table giving data for another example. In these tables R_1 R_2 . . . . . respectively indicate the radii of curvature of the successive surfaces counting from the front (the positive sign denoting that the surface is convex towards the front and the negative sign that it is concave thereto), D_1 D_2 D_3 D_4 indicate the axial thicknesses of the individual components, and S_1 S_2 S_3 the axial air separations of the components from one another, whilst the glass of which each component is made is defined in terms of its mean refractive index n_D and its Abbé number.

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EXAMPLE 2.

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R_7 + .6244			
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R_8 − .4577			

In both these examples the large air separation S_2 in conjunction with a relatively high mean refractive index for the divergent component assists materially in giving good correction not only for coma and curvature of field but also for spherical aberration, and these factors are prevented from adversely affecting the chromatic correction owing to the choice of a glass for the divergent component having a relatively low Abbé V number and to the fact that this component has a power sufficient to cause a parallel beam incident on the front of the objective to diverge on emergence from this component. It will be noticed that the mean refractive indices of all three convergent components are greater than 1.6 in the first example (the same glass being used) whilst in the second example only the front two components have their indices greater than 1.6.

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 mean refractive index n_D of the glass of the divergent component is substantially greater than 1.65 and its Abbé V number substantially less than 33.5 and the air separation on the axis between the second convergent component and the shallow side of the divergent component is not less than 10% of the focal length of the objective.

2. An optical objective as claimed in Claim 1, in which the mean refractive indices of at least two of the three convergent components are greater than 1.6.

3. An optical objective as claimed in Claim 1 or Claim 2, in which the radius of curvature of the shallow side of the divergent component is not less than three times and not greater than seven times that of the other side thereof.

4. An optical objective having numerical data substantially as set forth in one or other of the tables herein.

Dated this 21st day of July, 1939.

A. F. PULLINGER,
Agent for the Applicants.

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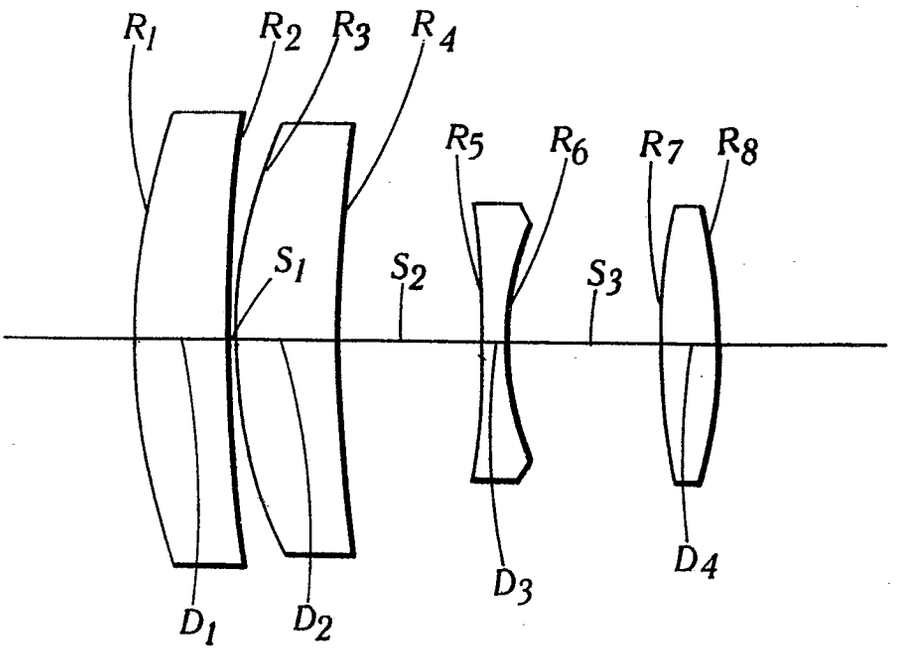

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