

PATENT SPECIFICATION

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323,138



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PROVISIONAL SPECIFICATION.

Improvements in and relating to Objectives suitable for Photographic Purposes.

We, JOHN WILLIAM HASSELKUS and GEORGE ARTHUR RICHMOND, both British subjects, both of Optical Works, Clapham Common, London, S.W. 4, do hereby declare the nature of this invention to be follows:—

The invention relates to objectives suitable for photographic purposes, a special object being to provide such an objective having an exceptionally large aperture, a large field and a high degree of correction.

In carrying the invention into effect according to one form, the objective consists of six co-axial lenses of the general character to be described, namely, a negative doublet and a single lens on each side of the diaphragm.

Taking the combination of lenses on one side of the diaphragm, by way of example, the doublet consists of a negative meniscus and a positive meniscus cemented together, the power of the cemented surfaces being collective in effect, while in addition the negative meniscus is disposed nearer the diaphragm and with its concavity directed thereto.

On the side of the doublet remote from the diaphragm is disposed with an intervening air space a single collective lens having surfaces of different radii, the surface with the greater radius being adjacent to the doublet.

According to the present invention, the

negative element of the meniscus, e.g., of flint glass, has a higher refractive index than the collective element, e.g., of crown glass, the refractive index of which may be the same as that of the single lens.

In the case of small-aperture objectives, a good correction for coma can be obtained by an arrangement of lenses as described symmetrical about the diaphragm even though the object and image distances are unequal.

To obtain comparable results, however, with a large aperture, a considerable deviation from symmetry must be made.

Thus, for example, in a specific case, the focal length of the front combination is approximately double that of the back combination, while the focal length of the front negative doublet is approximately half that of the back negative doublet.

By virtue of such a dissimilarity in the powers, an objective can be obtained well corrected for spherical aberration, astigmatism and coma, with a field of 50° and the extremely large aperture of F/1.9.

Although a particular combination of lenses has been described by way of illustrating the nature of the invention, it will be understood that the scope of the latter is wide enough to include similar combinations of optically equivalent lenses.

Dated this 28th day of January, 1929.
MARKS & CLERK.

COMPLETE SPECIFICATION.

Improvements in and relating to Objectives suitable for Photographic Purposes.

We, JOHN WILLIAM HASSELKUS and GEORGE ARTHUR RICHMOND, both British subjects, both of Optical Works, Clapham Common, London, S.W. 4, 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:—

The invention relates to objectives suitable for photographic purposes and [Price ~~is~~]

particularly to the kind having front and back combinations of lenses each consisting of a negative doublet and a single lens.

A main object of the present invention is to provide an improved objective of the kind indicated having an exceptionally large aperture, a relatively large angle of view and a high degree of correction.

With such an object:—

The present invention consists in an

objective of the kind indicated, having front and back combinations of lenses each comprising a negative doublet composed of a negative meniscus lens and a positive meniscus lens, the negative meniscus being of a higher refractive index than the collective meniscus and disposed nearer the diaphragm with its concavity directed thereto and comprising also a single collective lens disposed with an intervening air space on the side of the doublet remote from the diaphragm, and having surfaces of different radii, the surface with the greater radius being adjacent to the doublet.

The invention also consists in the improved objectives hereinafter described or indicated.

In carrying the invention into effect according to one form as shown in the accompanying diagrammatic Figure, the objective consists of six co-axial lenses I, II, III, IV, V, VI, arranged three on each side of the diaphragm, A, i.e., the single lens, I, and the negative doublet, II, III, are arranged on one side and the negative doublet, IV, V, and the single lens, VI, on the other.

Taking, by way of example, the combination of lenses on the left-hand side (front) of the diaphragm, as shown in the Figure, the doublet consists of a negative meniscus, III, and a positive meniscus, II, cemented together, the power of the cemented surfaces being collective in effect, while in addition the negative meniscus, III, is disposed nearer the diaphragm than the positive meniscus, II, and with its concavity directed towards the diaphragm.

On the side of the doublet remote from the diaphragm is disposed with an intervening air space, S_1 , a single collective lens, I, having surfaces of different radii, R_1 , R_2 , the surface, R_2 , with the greater radii being adjacent to the doublet.

The combination on the right-hand side (back) of the diaphragm is similar as regards the general arrangement of the lenses.

According to the present invention, the refractive index of the negative element of the meniscus, III or IV, e.g., of flint glass, is at least three units of the second decimal place higher than the refractive index of the collective element, II or V, e.g., of crown glass, while the refractive index of the single lens, I or VI, may be the same as that of the positive meniscus, II or V.

In the case of small-aperture objectives, a good correction for coma can be obtained by an arrangement of lenses as described symmetrical about the diaphragm even though the object and image distances are

unequal.

To obtain comparable results, however, with a large aperture, a considerable deviation from symmetry must be made.

Thus, for example, in the specific example, particulars of which are given below, the focal length (+198 mm.) of the front combination of three lenses is approximately double that (+111 mm.) of the corresponding back combination, while the focal length (-243 mm.) of the front negative doublet is approximately half that (-483 mm.) of the back negative doublet.

The following tables give particulars of one specific form of objective having a focal length of 100 units; the thicknesses, separation of the component lenses and radii of the surfaces being denoted in the tables by the corresponding reference letters in the Figure, while the types of glass for the different lenses are characterised by the refractive indices, N_d and N_g , for the helium and mercury lines respectively.

Radii of Surfaces.	Thickness and Separations.	
$R_1 = +64.75$	$d_1 = 7.90$	
$R_2 = +289.15$	$S_1 = 1.32$	95
$R_3 = +37.65$	$d_2 = 6.21$	
$R_4 = +64.75$	$d_3 = 5.88$	
$R_5 = +27.60$	$b_1 = 7.98$	
$R_6 = -26.85$	$b_2 = 7.98$	
$R_7 = -64.75$	$d_4 = 5.08$	100
$R_8 = -33.00$	$d_5 = 6.59$	
$R_9 = +564.75$	$S_2 = 1.32$	
$R_{10} = -75.50$	$d_6 = 9.03$	

GLASSES.

	N_d	N_g	
I, II, V, VI,	1.61217	1.62522	105
III, IV	1.65336	1.67860	

By virtue of such a dissimilarity in the powers, an objective can be obtained well corrected for spherical, zonal, chromatic and comatic aberrations, with a field of 50° and the extremely large aperture of $F/1.9$.

Although a particular combination of lenses has been described by way of illustrating the nature of the invention, it will be understood that the scope of the latter is wide enough to include similar combinations of optically equivalent lenses.

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 objective of the kind indicated, having front and back combinations of lenses each comprising a negative doublet composed of a negative meniscus lens and a positive meniscus lens, the negative meniscus being of a higher refractive

index than the collective meniscus and disposed nearer the diaphragm with its concavity directed thereto and comprising also a single collective lens disposed with
5 an intervening air space on the side of the doublet remote from the diaphragm, and having surfaces of different radii, the surface with the greater radius being adjacent to the doublet, substantially as
10 described.

2. An objective as claimed in Claim 1, in which the refractive index of the negative meniscus lens is at least three units of the second decimal place higher than
15 the refractive index of the positive

meniscus lens, substantially as described.

3. An objective as claimed in Claims 1 or 2, in which the focal length of the front combination is approximately double that of the back combination, while the focal length of the front negative doublet is approximately half that of the back negative doublet, substantially as
20 described.

4. Improved objectives substantially as hereinbefore described with reference to the accompanying drawings.
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Dated this 23rd day of October, 1929.
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[This Drawing is a full-size reproduction of the Original.]

