

N<sup>o</sup> 29,637



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PROVISIONAL SPECIFICATION.

**Improvements in Lenses for use in Photography and Projection,  
or the like.**

We, JOHN STUART, Managing Director of Ross Limited, and JOHN WILLIAM HASSELKUS, Engineer, both of 3, North Side, Clapham Common, in the County of London, do hereby declare the nature of this invention to be as follows:—

5 This invention has for its object to provide an improved objective having large relative aperture, which can be used for photography and projection, or the like, and which is distinguished from lenses such as are described in the Specifications of Letters Patent 22,607 A.D. 1893, 15,107 A.D. 1895; and 13,061 A.D. 1902, by perfect correction for spherical aberration, in particular the smallness of zonal aberration which has hitherto presented one of the greatest  
10 difficulties in astigmatically corrected lens systems.

This result is obtained according to this invention by constructing a lens combination of two dissimilar ends separated by the diaphragm, the front combination consisting of a convex-plano, or double-, convex lens separated by an air space from a double concave lens, the air space being in the form of a positive  
15 lens, or meniscus; and the back combination consisting of three lenses cemented together the first lens being a double-concave, or plano-concave lens of low refraction, the second lens being a meniscus lens of medium refraction and the third lens being a double convex lens of high refraction.

20 The gradual increase in the refractive indices in the lenses of the back combination enables the curvatures and thicknesses of the lenses to be so arranged and determined that the spherical, astigmatical, comatical, and zonal, aberrations, become a minimum for this type of lens.

Objectives made according to this invention are chromatically corrected.

Dated the 23rd day of December, 1913.

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JOHNSONS & WILLCOX,  
47, Lincoln's Inn Fields, London, W.C.,  
Agents.

COMPLETE SPECIFICATION.

**Improvements in Lenses for use in Photography and Projection,  
or the like.**

We, JOHN STUART, Managing Director of Ross Limited, and JOHN WILLIAM HASSELKUS, Engineer, both of 3, North Side, Clapham Common, in the County of London, do hereby declare the nature of this invention, and in what manner

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the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention has for its object to provide an improved objective having large relative aperture, which can be used for photography and projection, or the like, and which is distinguished from lenses such as are described in the Specifications of Letters Patent 22,607 A.D. 1893, 15,107 A.D. 1895, and 13,061 A.D. 1902, by perfect correction for spherical aberration, in particular the smallness of zonal aberration which has hitherto presented one of the greatest difficulties in astigmatically corrected lens systems.

The result is obtained, according to this invention, by constructing a lens combination of two dissimilar ends separated by the diaphragm, the front combination consisting of a plano convex-lens, (or it may be a double-convex lens) separated by an air space from a double concave lens, the air space being in the form of a positive lens, (a meniscus when the first named lens is double-convex) and the back-combination consisting of three lenses, cemented together, the first lens being a double-concave, or plano-concave, lens of low refraction, the second lens being a meniscus lens of medium refraction and the third lens being a double convex lens of high refraction.

The gradual increase in the refractive indices in the lenses of the back combination enables the curvatures and thicknesses of the lenses to be so arranged and determined that the spherical, astigmatical, comatical, and zonal, aberrations become a minimum for this type of lens.

Objectives made according to this invention are chromatically corrected,

An example of the improved objective is illustrated in the accompanying drawing of which the following are the particular details.

The objective illustrated is corrected for all errors for the relative aperture of  $f/4.5$ .

The following data apply to an objective of an equivalent focus of 100m/m. The glasses are characterised by their refractive index  $N_D$  and the index  $N_g^1$  for the H $\gamma$  line of the hydrogen spectrum.

Radii of:—

$R_1 = +$	23.6
$R_2 =$	$\infty$
$R_3 = -$	64.2
$R_4 = +$	22.7
$R_5 = -$	232.0
$R_6 = +$	17.6
$R_7 = +$	31.8
$R_8 = -$	39.5

Thicknesses and distances at:—

$d_1 =$	3.7
$d_2 =$	3.9
$d_3 =$	1.2
$d_4 =$	4.9
$d_5 =$	1.8
$d_6 =$	1.9
$d_7 =$	3.7.

Glasses.

	$N_D$	$N_g^1$
Lens 1.	1.5725	1.5852
Lens 2.	1.5784	1.5965
Lens 3.	1.5199	1.5320
Lens 4.	1.5394	1.5509
Lens 5.	1.6120	1.6258.

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. In an objective having large relative aperture and consisting of a lens combination of two dissimilar ends, or groups, with a diaphragm between, making the back combination, or group, of three cemented lenses with refractive indices increasing towards the rear lens (away from the diaphragm) and having two collective cemented surfaces the difference of refractive indices  $N_D$  on the

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first cemented surface being between 0'01 and 0'03, and the difference on the second cemented surface being between 0'07 and 0'09 both cemented surfaces being convex towards the diaphragm.

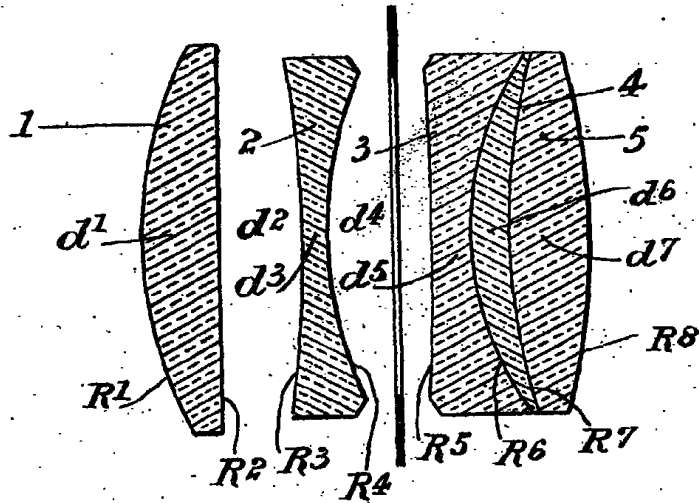
- 5 2. A spherically, chromatically and astigmatically corrected objective consist-  
ing of five lenses arranged in two combinations, or groups, with a diaphragm  
between them, the front combination or group consisting of two lenses with an  
air space between them, having the form of a positive lens, and the other com-  
bination, or group consisting of three lenses with refractive indices increasing  
10 towards the rear lens (away from the diaphragm) and having two collective  
cemented surfaces the difference of refractive indices  $N_D$  on the first cemented  
surface being between 0'01 and 0'03 and the difference on the second cemented  
surface being between 0'07 and 0'09, both cemented surfaces being convex  
towards the diaphragm.

Dated this 23rd day of June, 1914.

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Agents.

[This Drawing is a full-size reproduction of the Original.]



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