

# PATENT SPECIFICATION

258,092

Application Date: Sept. 26, 1925, No. 24,003/25.

" " June 12, 1926. " 14,813/26.

One Complete Left: June 25, 1926.

Complete Accepted: Sept. 16, 1926.



## PROVISIONAL SPECIFICATION.

No. 24,003, A.D. 1925.

### Improvements in Lens Systems.

We, ARTHUR WARMISHAM, a British subject, and KAPELLA LIMITED, a British company, both of 104, Stoughton Street, Leicester, do hereby declare the nature of this invention to be as follows:—

This invention relates to photographic and projection objectives and its aim is to provide such objectives corrected for the various aberrations throughout a useful field and having a larger working aperture than hitherto obtained.

According to our invention, we achieve this aim by using a novel modification of the Petzval type of objective, our novel modification consisting in dividing the front convergent member, that is the member adjacent to the longer conjugate for which the system is corrected, into two convergent members of which at least one is compound, and both are meniscus shaped and present their concave faces toward the rear combination.

By the use of our modification in its simplest form, that is in which one of the front convergent members is simple and the other compound, it is possible so to distribute the residual zonal spherical aberration as to enable correction to be obtained at an aperture F/1.5 of substantially the same quality as is yielded by known constructions of the Petzval type at an aperture F/2.0.

Dated the 25th day of September, 1925.

ARTHUR WARMISHAM,  
KAPELLA LIMITED,

The common seal of Kapella Limited was hereunto affixed in the presence of:—

WM. TAYLOR,  
A. WARMISHAM,

T. E. HUDSON,

Directors.

Secretary

## PROVISIONAL SPECIFICATION.

No. 14,813, A.D. 1926.

### Improvements in Lens Systems.

We, ARTHUR WARMISHAM, a British subject, and KAPELLA LIMITED, a British company, both of 104, Stoughton Street, Leicester, do hereby declare the nature of this invention to be as follows:—

This invention relates to photographic and projection objectives and its aim is to provide such objectives corrected for the various aberrations throughout a

useful field and having a larger working aperture than hitherto obtained.

The invention is a development of that described in our Provisional Application No. 24,003/25, such modification having for its aim the provision of an objective of larger working aperture than hitherto obtained.

According to this invention, we achieve this aim by dividing the con-

vergent component of the rear member of the known Petzval construction into two convergent members.

This invention makes it possible to produce an objective with substantially increased working aperture. Used in combination with a divided front convergent member as described in Provisional Application No. 24,003/25, it enables us to produce an objective of extraordinary rapidity.

Dated the 11th day of June, 1926.

ARTHUR WARMISHAM,  
KAPELLA LIMITED,

The common seal of Kapella Limited was hereunto affixed in the presence of:—

C. STAFFORD,

A. WARMISHAM,

Directors,

T. E. HUDSON,

Secretary.

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## COMPLETE SPECIFICATION.

### Improvements in Lens Systems.

We, ARTHUR WARMISHAM, a British subject, and KAPELLA LIMITED, a British company, 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 photographic and projection objectives and its aim is to provide such objectives corrected for the various aberrations throughout a useful field and having a larger working aperture than hitherto obtained.

According to the invention we achieve this aim by a novel modification of the Petzval type of objective, our novel modification consisting in dividing one or both of the convergent members into two convergent members whereby the residual zonal spherical aberration is so reduced as to enable us to produce objectives of relative aperture  $F/1.5$  while maintaining a sufficiently good state of correction of the zonal spherical aberration to give definition comparable with that given by the conventional Petzval objectives having about two-thirds of this effective diameter.

Throughout the following specification we define the front member as that adjacent to the longer conjugate for which the objective is corrected, and the back member that adjacent to the shorter conjugate.

In the known Petzval objective as illustrated in Fig. 1, the front member is convergent and compound, and at the back there is one divergent and one convergent member, usually both simple.

Now according to the invention, a considerable reduction of the residual zonal spherical aberration and a corresponding increase in effective working aperture in such objectives may be obtained by division of the front convergent member into two convergent members as illustrated in Figs. 2, 3 and 4 of the accompanying drawings.

In Fig. 2 is depicted the simplest form of such division, the front system comprising a simple meniscus-shaped convergent member followed by a compound meniscus-shaped convergent member.

Fig. 3 shows a variant of the construction illustrated in Fig. 2, in which the compound convergent meniscus precedes the simple convergent meniscus.

Fig. 4 shows a further development which is more advantageous, though more complex, than either of the constructions illustrated in Figs. 2 and 3. In the development of the invention as illustrated in Fig. 4, both the front convergent meniscus members are compound.

According to the invention in constructions as illustrated in Figs. 2, 3 and 4 comprising two convergent meniscus front members, both the menisci preferably present their concave curvatures toward the back.

Extended investigations have shown that we may alternatively divide the back convergent member, and compared with division of the front convergent member, this is almost as favourable for reduction of the zonal spherical aberration and slightly more favourable for improvement of the field.

Fig. 5 illustrates the simplest embodiment of this modification, in which the front member is substantially of the form as in the Petzval objective, and both the back convergent members, preferably made of crown glass of high refractive index, present their deeper curvatures toward the front.

We may further reduce residual zonal spherical aberration by employing a front member divided in the manner explained in combination with a back system having its convergent member divided.

In Fig. 6 we illustrate a typical development of the invention combining the features as illustrated in Figs. 3 and 5.

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Other obvious extensions can be arrived at by combining a back system of the form illustrated in Fig. 5 with a front system of the form illustrated in Fig. 2, or alternatively in Fig. 4.

We further illustrate our invention by two numerical examples of objectives of large relative aperture constructed according to the invention. The notation of the examples is that the successive radii of curvature, counting from

the front, are called  $R_1, R_2$ , etc., and the sign + denotes that the curve is convex toward the front, and - that it is concave toward the front. The axial distances between the surfaces  $R_1$  and  $R_2$  are denoted by  $D_{12}$  and so on. The material is defined in terms of the mean refractive index  $n_D$  and the mean dispersive power  $V$ , as conventionally employed, and further by the type-number in Messrs. Chance Brothers' optical glass catalogue.

EXAMPLE I. E.F.L. 1.094 RELATIVE APERTURE F/1.5.  
Chance Brothers'  
 $n_D$   $V$  Catalogue Number

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$R_1 + .883$					
$R_2 + 1.454$	$D_{12}$	.082	1.5735	57.7	9002
$R_3 + .793$	$D_{23}$	.002		Air.	
$R_4 - .793$	$D_{34}$	.210	1.5290	51.6	7863
$R_5 + 1.775$	$D_{45}$	.032	1.6513	33.5	5093
$R_6 + .734$	$D_{56}$	.326		Air.	
$R_7 + .471$	$D_{67}$	.047	1.6513	33.5	5093
$R_8 + .661$	$D_{78}$	.047		Air.	
$R_9 - 2.54$	$D_{89}$	.107	1.6130	56.3	2065

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EXAMPLE II. E.F.L. 1.084 RELATIVE APERTURE F/1.5.

$R_1 + 1.0103$					
$R_2 + 1.938$	$D_{12}$	.082	1.5736	57.7	9002
$R_3 + .7143$	$D_{23}$	.002		Air.	
$R_4 - 1.1905$	$D_{34}$	.210	1.5290	51.6	7863
$R_5 + 2.0000$	$D_{45}$	.032	1.6512	33.5	5093
$R_6 + 1.1693$	$D_{56}$	.326		Air.	
$R_7 + .4711$	$D_{67}$	.047	1.6512	33.5	5093
$R_8 + .6250$	$D_{78}$	.047		Air.	
$R_9 + 2.1190$	$D_{89}$	.080	1.6129	59.3	4873
$R_{10} + .5910$	$D_{9-10}$	.000		Air.	
$R_{11} + 1.3330$	$D_{10-11}$	.080	1.6129	59.3	4873

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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 Petzval type for photographic, projection or the like purposes, in which one of the convergent members is replaced by two convergent members substantially as and for the purpose described.

2. A lens as claimed in Claim 1 in which the other convergent member is replaced by two convergent members substantially as and for the purpose described.

3. A lens as claimed in Claim 1 in which the back convergent member is simple and the two front convergent members are meniscus-shaped and present their concave curvatures toward the back members, one or both of said front members being compounded, substantially as illustrated by reference to any of the drawings Nos. 2, 3 and 4, or to Example No. I.

4. A lens as claimed in Claim 1 in which the front convergent member is single and the two back convergent members present their deeper curves toward the front member, substantially as illustrated by reference to the drawing No. 5.

5. A lens as claimed in Claim 2 in which the two front convergent members are meniscus-shaped and present their concave curvatures toward the back members and the two back convergent members present their deeper curvatures toward the front members substantially as illustrated with reference to drawings Nos. 5 and 6 and to Example II.

Dated the 24th day of June, 1926.

ARTHUR WARMISHAM,  
KAPELLA LIMITED,  
The common seal of Kapella Limited was hereunto affixed in the presence of:—  
WM. TAYLOR,  
C. STAFFORD,  
T. E. HUDSON,  
Directors,  
Secretary.

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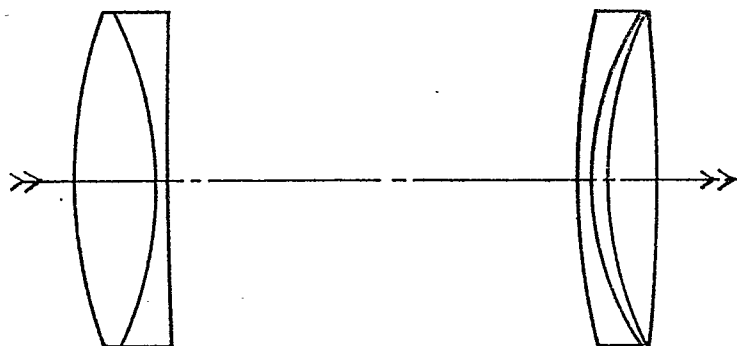


FIG. 1.

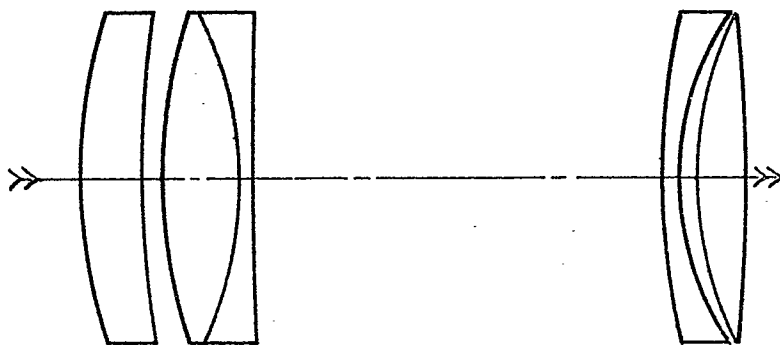


FIG. 2.

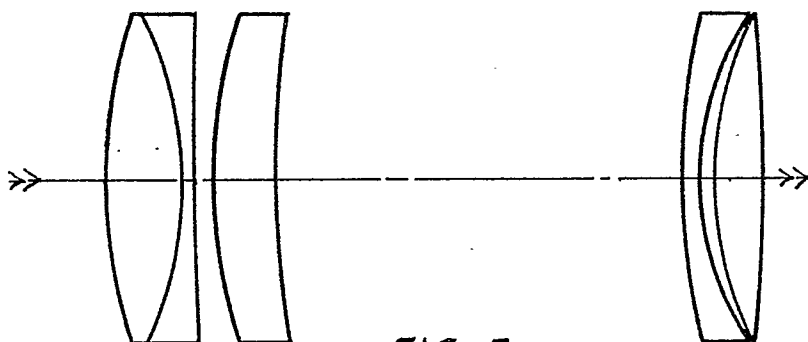


FIG. 3.

*[This Drawing is a reproduction of the Original on a reduced scale.]*



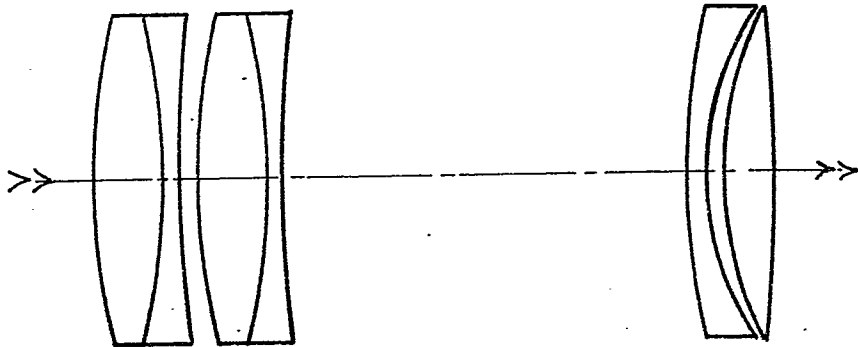


FIG. 4.

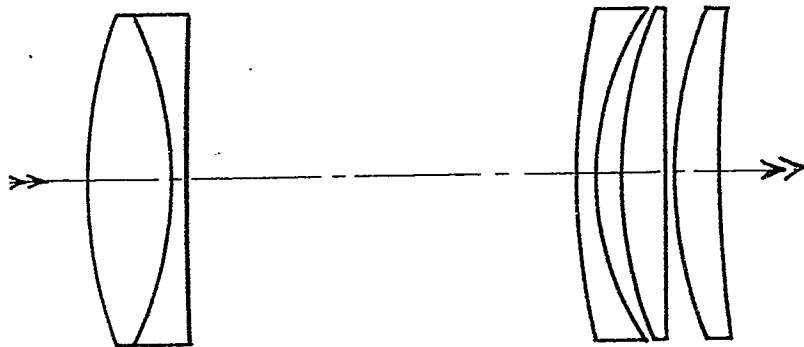


FIG. 5.

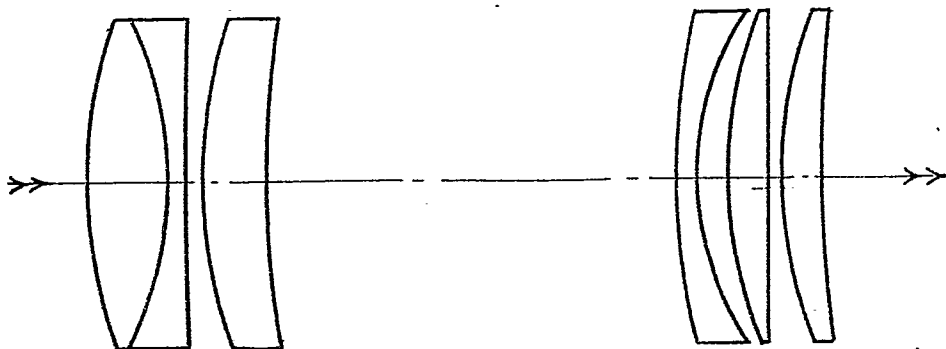


FIG. 6.

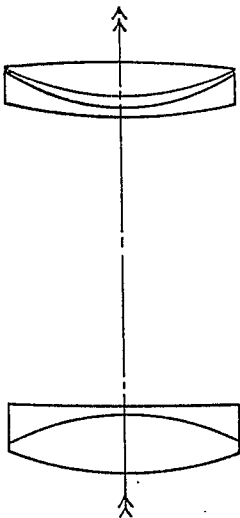


FIG. 1.

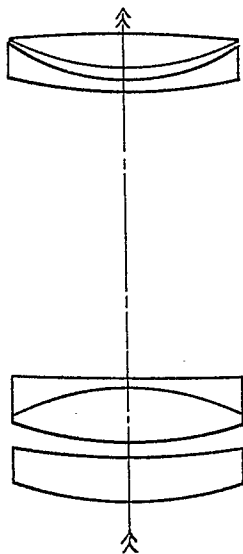


FIG. 2.

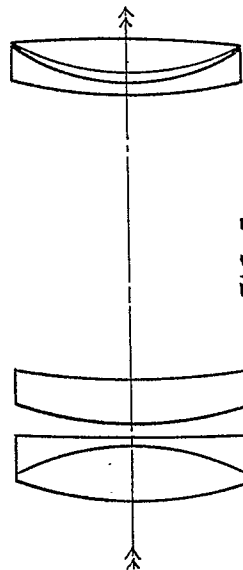


FIG. 3.

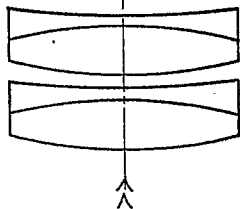


FIG. 4.

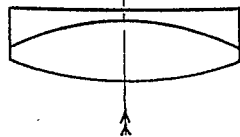


FIG. 5.

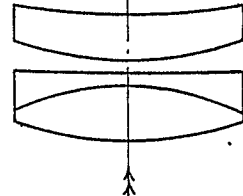


FIG. 6.

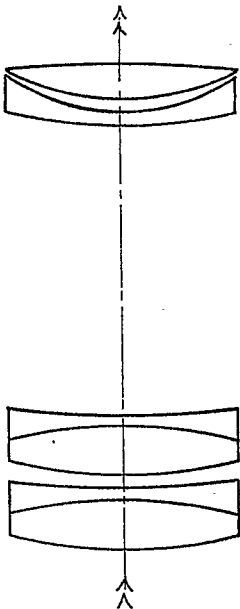


FIG. 4.

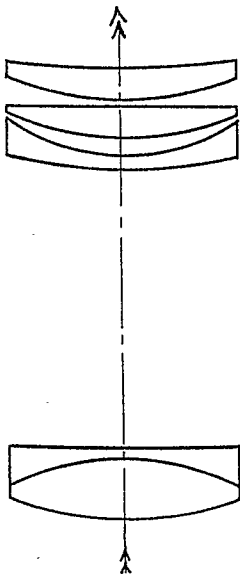


FIG. 5.

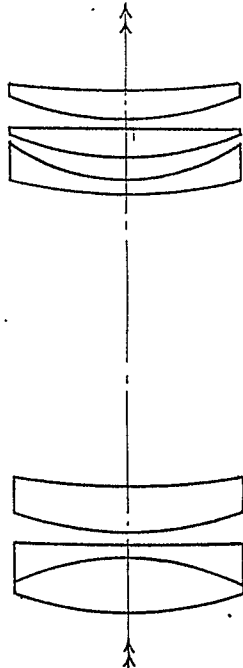


FIG. 6.

[This Drawing is a reproduction of the Original on a reduced scale.]