

PATENT SPECIFICATION



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PROVISIONAL SPECIFICATION

Improvements in Lenses

We, HORACE WILLIAM LEE, 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 lenses of the kind comprising a pair of collective components, enclosing a pair of compound dispersive meniscus components placed with their concave surfaces facing one another; and its object is to provide a lens having a flat field and of larger aperture than has hitherto been attained in a lens of this type.

We attain the objects of our invention by:—

(a) making the dispersive components with shallow curves but of sufficient thickness to reduce the Airy-Petzval sum to a value sufficiently low to secure flatness of field, and by

(b) making one or more of the convex

surfaces of the collective or dispersive components of conicoidal form (and preferably one or both the outer surfaces of the collective components) so as to complete the correction for spherical aberration,

It is not always necessary to make the whole of the surface conicoidal, the axial portion may be spherical and the peripheral portion a conicoid osculating the sphere at some predetermined zone.

Dated the 13th day of June, 1934.

HORACE WILLIAM LEE, KAPELLA LIMITED,

The Common Seal of Kapella Limited was hereunto affixed in the presence of:—

J. RONALD TAYLOR, Director,

G. STAFFORD, Secretary.

COMPLETE SPECIFICATION

Improvements in Lenses

We, HORACE WILLIAM LEE, 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 lenses of the kind comprising four separate components of which the two exterior components are collective and the two interior ones are dispersive menisci and have their concave exterior surfaces facing one another, and its object is to provide a lens having at the same time a flat field, of substantial angular extent, and a larger aperture than has hitherto been attained therewith.

In lenses of this kind as hitherto constructed the deep curvatures of the exterior surfaces of the components, and particularly those of the dispersive components, have limited the diameters of the components and therewith the aper-

ture of the lens, for to extend the diameters substantially would involve intersection of the surfaces and introduce objectionable zonal aberration. To avoid these difficulties, according to the invention we make the exterior surfaces of the dispersive components substantially shallower than any hitherto employed in lenses of this kind and thereby we are enabled to increase the diameters of the components without introducing serious zonal aberration, and we secure flatness of field by making the dispersive components of sufficient thickness.

As it is impossible, by the use of spherical surfaces only, to complete the correction for spherical aberration of a system so modified, we do so by making one or more of the exterior surfaces of the collective or dispersive components of conicoidal form. Preferably such form is given to one or more of the convex surfaces, and preferably to such surfaces of the collective components.

We prefer to divide the correction by

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forming two or more surfaces of the system aspherical, preferably one in each half of the system, as such treatment is more favourable for oblique pencils.

- 5 It is not always necessary to make the whole of any such surface coincoidal, the axial portion may be spherical and the peripheral portion a conicoid osculating the sphere at some predetermined zone.
- 10 The width of the outer conicoidal zone must be at least ten per cent of the diameter of the surface in order to be effective.

We shall hereafter refer to the front of the lens system as meaning that half of the lens which is situated on the side of the longer conjugate for which the lens is corrected, and we shall use the term "rear" to denote the half at the other end of the system.

In the term "conicoidal" we shall

include both surfaces which are wholly conicoidal and those which are conicoidal only as to their outer zones.

We now give data for the construction of a lens according to our invention, illustrated in the accompanying drawing. The notation is that the successive radii of curvature, counting from the front, are called $R_1, R_2,$ etc., the sign + denoting that the curve is convex toward the incident light, and - that it is concave toward the same. The axial thicknesses of the elements are denoted by $D_1, D_2,$ etc., and the separations of the components by $S_1, S_2,$ etc.

The material is defined in terms of the mean refractive index nD , as conventionally employed, followed by the type number in Messrs. Chance Brothers' optical glass catalogue. The Abbe V number also is given:—

| EXAMPLE. | | | | | | |
|----------|------------------|------------|-----------------------------|-----------|------|---------|
| | Aperture | f/1.1 | Equivalent focal length 1". | | | |
| | Radii. | Thickness. | Separation. | nD . | V. | No. |
| 45 | $R_1 + .939$ | $D_1 .12$ | | 1.6105 | 53.3 | 610,533 |
| | $R_2 + 19.34$ | | $S_1 .003$ | | | |
| 50 | $R_3 + .502$ | $D_2 .29$ | | 1.6134 | 59.3 | 613,593 |
| | $R_4 - 1.18$ | $D_3 .033$ | | 1.6504 | 33.7 | 650,337 |
| | $R_5 + .307$ | | $S_2 .23$ | | | |
| 55 | $R_6 - .390$ | $D_4 .033$ | | 1.6504 | 33.7 | 650,337 |
| | $R_7 + .600$ | $D_5 .215$ | | 1.6530 | 46.2 | 653,462 |
| 60 | $R_8 - .487$ | | $S_3 .003$ | | | |
| | $R_9 + .975$ | $D_6 .083$ | | 1.6530 | 46.2 | 653,462 |
| | $R_{10} - 1.267$ | | | | | |

65 A lens made according to the above data with all surfaces spherical is under-corrected for spherical aberration. To complete the correction we may make one or more of the surfaces wholly or partly

70 aspherical, and, for example, make the surface 10 a surface of revolution whose meridional section has the equation:—
 $y^2 = 23.132 x^2 + 2.534 x$, where x is measured from the vertex along the axis

75 away from the focal plane, and y is measured at right angles thereto. Such a lens has considerably less zonal spherical aberration than one made entirely with spherical surfaces.

80 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. A lens of the kind referred to in which the outer convex surfaces of the dispersive components have radii of curvatures at their vertices not less than 0.45 the focal length of the system, the front dispersive component has its exterior concave surface of radius of curvature not less than one-fourth and the rear dispersive component has its exterior concave surface of radius not less than one-third, the focal length of the system, and in which one or more of the exterior surfaces of the components is conicoidal.

2. A lens as claimed in Claim 1, in which neither dispersive component has a thickness less than one-fifth the focal length of the system.

3. A lens as claimed in Claim 1 or Claim 2, in which the conicoidal surface

or surfaces is or are convex.

4. A lens as claimed in any of the preceding claims, in which the conicoidal form is given to one or more convex
5 surfaces of the collective components.

5. A lens as claimed in any of the preceding claims, in which any conicoidal surface is substantially spherical as to its central area and substantially conicoidal
10 as to its peripheral zone over a width not less than one-tenth the diameter of the surface.

6. A lens constructed substantially as

described with reference to the accompanying drawing.

Dated the 14th day of June, 1935.

HORACE WILLIAM LEE,
KAPPELLA LIMITED,

The Common Seal of Kapella Limited was hereunto affixed in the presence
of:—

J. RONALD TAYLOR,
Director,

WM. TAYLOR,
Director,

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

