[Second Edition.]

PATENT SPECIFICATION

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COMPLETE SPECIFICATION.

Improvements in Lenses for Photography and the like.

We, TAYLOR, TAYLOR & HOBSON LTD., a British Company, and HORACE WILLIAM LEE, a British subject, both of Stoughton Street Works, Leicester, in the County of Leicester, England, 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 extremely wide aperture lens for photography, kinematography, micrography, and for all purposes for which a lens yielding an extended flat field at a large aperture is required.

The accompanying drawings shew in central section different combinations of lenses.

It is well-known that the type of lens known as the Gauss lens (Fig. 1) is particularly favourable for reducing the so-called spherical zones and is used therefore as a wide aperture telescope objective. Such a type of lens is well adapted for photography by proper choice of glass and of lens curves and thicknesses, whereby the field is flattened consistently with the correction of spherical and chromatic aberration. By the combination of two such lenses (Figure 2) a photographic objective is obtained corrected also for coma and for distortion.

A modification of this type of lens is described in the Specification of Letters Patent No. 27,635 of 1896 in which either or both of the single meniscus lenses (collective or dispersive) is replaced by a pair of lenses cemented together, of equal or nearly equal refractive index and different dispersions, the object being to achromatise the combination. The complete lens in the example there given had an aperture of F/4.

The present invention is an improvement on this type of lens whereby an aperture of F/2 is obtained, so that the rapidity is more than four times as great as that in the invention referred to. To attain this aperture great freedom from spherical zones is necessary. Exhaustive research and computation have shewn that the desired result can be obtained by the use of dense barium crown glass for the collective components. The form of the present invention is then, two meniscus collective lenses of the aforesaid dense barium crown glass the refractive index of which for the D line of the solar spectrum is not less than 1.60 containing between them two meniscus dispersive lenses. These dispersive lenses are compound and each consists of a plano, or nearly plano, concave lens of flint glass cemented to a plano, or nearly plano, convex lens of the same or similar dense barium crown to that used for the separate collective menisci; where the separating surface is plano or slightly curved in the sense of being slightly collective in effect. It is essential according to the present invention that the components of the compound menisci should differ in refractive index by an amount of at least .03 for the D line, the dispersive lenses having the lower refractive index. The respective dispersions are so chosen as to produce achromatism for the system.

To obtain freedom from coma exact symmetry must be departed from. Calculation shows that the radius of the convex surface of the front compound meniscus, *i.e.* the one facing the incident light, must be approximately 10% greater than that of the corresponding surface of the back compound meniscus; also that the back single collective lens must have its shallow surface shallower than that of the front single collective lens, and in fact it is generally flat or only slightly concave.

In the Specification of Letters Patent No. 27,635 of 1896 mentioned above, use is made of this principle of dissymmetry,

but different glasses are used, in particular, use is not made of dense barium crown glass. In the Specification of Letters Patent No. 12,420 of 1902, where again a modified type of Gauss lens is described, use is not made of the principle of dissymmetry; on the contrary, the correction for coma of one half of a symmetrical combination is claimed. Now it is well-known that if two lenses, free from coma, are combined in a symmetrical combination, such a combination will not in general be well corrected for coma, except for unit magnification. To obtain a lens system capable of yielding an aperture of F/2 a far higher correction of coma and spherical zone is necessary, which is obtained according to the present invention by the use of dense barium crown glass and the unsymmetric form of the system, as above described.

An example of a lens made according to this invention is shewn in Figure 3 of which the following are particulars.

EQUIVALENT FOCAL LENGTH 1″ APERTURE F/2 FLAT FIELD 50 DEGREES.

		n_D	V.	Chance's Cat. No.
r_1 + .6534				
	d_1 .0836	1.6118	59	4873
r_2 +3.024				
	s_1 .0139	1.		
r_3 + .4461				
	d_2 .0975	1.6118	59	4873
r_4 ∞				
	d_3 .0418	1.576	41.0	410
r_5 + .2829				
	s_2 .1393	1.		
r_6 − .2869				
	d_4 .0418	1.576	41.0	410
r_7 ∞				
	d_5 .0975	1.6118	59.0	4873
r_8 − .3879				
	s_3 .0139	1.		
r_9 ∞				
	d_6 .0836	1.6118	59	4873
r_{10} − .6884				

(All dimensions in inches).

Radii are marked + when they are convex towards the incident light, and − when they are concave towards the incident light.

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 system for photography, kinematography, micrography and the like, corrected for an aperture of, substantially, F/2, and yielding an anastigmatic flat field of 50 degrees, consisting of six constituent lenses of which two are simple meniscus collective lenses of dense barium crown glass of refractive index for the D line not less than 1.6, and having between them two compound dispersive menisci, each meniscus consisting of a plano, or nearly plano, concave lens of light flint glass cemented to a plano, or nearly plano, convex lens of barium crown glass of high refractive index, the difference between the refractive indices for the D line of the two glasses cemented together being not less than .03.

2. A lens system as claimed in Claim 1 wherein the radius of curvature of the convex surface of the front dispersive meniscus is approximately 10% greater than that of the corresponding surface of the rear dispersive meniscus, and in which the shallower surface of the back simple lens has a curvature less than that of the shallower surface of the front simple lens.

3. A lens system as claimed in Claims 1 and 2, substantially as described in the example given with reference to Figure 3.

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2nd Edition

Fig. 1.

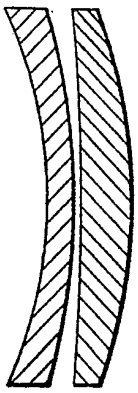


Fig. 2.

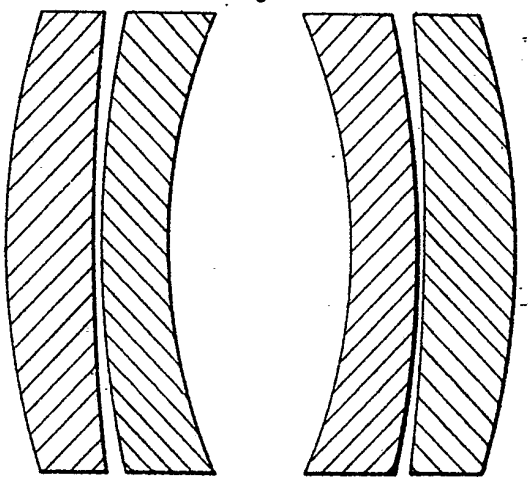
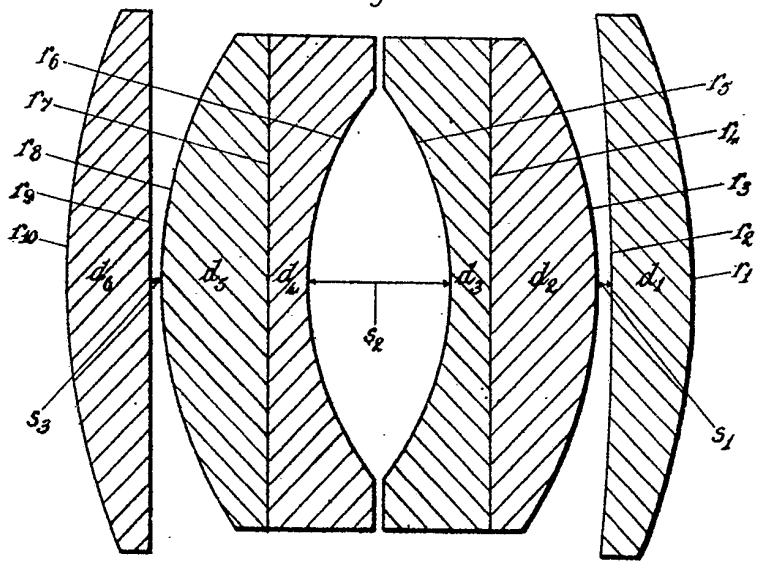


Fig. 3.



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