# PATENT SPECIFICATION

Application Date : Sept. 22. 1919 No. 23,286/19. **155,640**

Complete Accepted : Dec. 22, 1920.

## COMPLETE SPECIFICATION.

### Improvements in Lenses.

We, TAYLOR, TAYLOR & HOBSON LIMITED, of Stoughton Street Works, Leicester, Opticians, and HORACE WILLIAM LEE, B.A., of the same address, Optician, 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 improved triplet anastigmat lens comprising three single lens-components, of at least two different dispersions, each of which components has a refractive index for the D-line greater than 1.61, where the middle dispersive lens is placed symmetrically, or approximately symmetrically (to within 10%), between the outer, double convex lenses, the combination having an aperture-ratio of at least 13.

It is well-known that the symmetrical form offers considerable advantages in the correction of distortion, coma and chromatic difference of magnification. In fact these aberrations are automatically corrected in a symmetrical lens working at unit magnification. A photographic objective however is usually used at magnifications varying from zero to unity, so that the best result is obtained by correcting the lens at some magnification less than unity. This leads to some slight departure from the strictly symmetrical form. In the lenses to which the present invention relates, the separations and lens thicknesses are practically equal (within 10%), but the lens curves in front of the mid point of the system, *i.e.* nearer the object, are shallower than those behind, but the difference in the powers of corresponding surfaces is no more than 25% of the power of the complete system. A better correction is thus obtained by slight departure from strict symmetry, without losing the advantages of symmetry.

Previously lenses of this type have been made of three glasses, in which the positive lenses are of crown glass, of high $n_D$ and low dispersion, combined with flint glass of lower $n_D$ and higher dispersion as described in the Specification of Letters Patent No. 15,107 of 1895, in which the aperture ratio did not exceed $f/6.5$; also, in the case of a lens with aperture $f/4$ as described in the Specification of Letters Patent No. 22,607 of 1893, in which the positive lens consists of crown glass of low refractive index, combined with flint glass of higher refractive index; also, in the case of a similar lens with aperture $f/6$, as described in the Specification of Letters Patent No. 4714 of 1911. Also in the lens described in the Specification of Letters Patent No. 2619 of 1911, where the mid lens is not placed symmetrically with regard to the outer lens, and these outer lenses are not double convex but plano-convex and meniscus respectively. Furthermore, in the first two cases it was stipulated that the coma ("diaphragm corrections") should be removed in all these lenses simultaneously.

Calculation has shown that this last condition is not necessary to the correct performance of a lens as a whole, and moreover, that to obtain a large aperture-ratio it is necessary to use glasses of high refractive index for both positive and negative lenses. In a lens thus formed, the flatness of field is obtained by the use of highly refractive glass for the crown, and freedom from spherical aberration by the use of highly refractive flint.

Two numerical examples of lenses made according to the improved construction of

[*Price* 1/-]

Price 3s. 6d.

Price 4s 6d.

the present invention, will now be described with reference respectively to Figure 1 and Figure 2 of the accompanying drawings; the letters PM. and C. referring to the catalogues of Parra-Mantor's and Chance respectively.

## Example I (Figure 1).

Equivalent focal length 1 unit; the radii *etc.* being expressed in the same units. Aperture ratio F/3. Flat field of view 45°.

| Radii | Thicknesses | Diameters | $n_D$ | Nu-value |
|---|---|---|---|---|
| $r_1$ + .4013<br>$r_2$ − 5.370 | $d_1$ .06 | .34 | 1.613 | 58. 5 PM.6540 |
| Separation | $s_1$ .10 | | 1. | |
| $r_3$ − .4702<br>$r_4$ + .4001 | $d_2$ .01 | .3 | 1.621 | 36. 2 C. 361 |
| Separation | $s_2$ .1076 | | 1. | |
| $r_5$ +2.345<br>$r_6$ − .3794 | $d_3$ .06 | .3 | 1.613 | 58. 5 PM.6540 |

## Example II (Figure 2).

Equivalent focal length 1 unit. Aperture ratio F/3. Flat field of view 35°.

| Radii | Thicknesses | Diameters | $n_D$ | Nu-value |
|---|---|---|---|---|
| $r_1$ + .4156<br>$r_2$ − 4.64 | $d_1$ .06 | .34 | 1.613 | 58. 5 PM.6540 |
| Separation | $s_1$ .13 | | 1. | |
| $r_3$ − .4266<br>$r_4$ + .3603 | $d_2$ .01 | .3 | 1.621 | 36. 2 C. 361 |
| Separation | $s_2$ .121 | | 1. | |
| $r_5$ +1.8138<br>$r_6$ − .3546 | $d_3$ .06 | .3 | 1.613 | 58. 5 PM.6540 |

Having now particularly described and ascertained the nature of our said invention and the manner in which the same is to be performed, we declare that what we claim is:—

1. An astigmat lens comprising three single lens-components, of at least two different dispensions, each of which components has a refractive index for the D-line greater than 1.61, where the middle dispersive lens is placed symmetrically, or approximately symmetrically (to within 10%), between the outer, double convex lenses, the combination having an aperture-ratio of at least $f/3$, substantially as described.

2. An astigmat triplet lens formed according to the constructional data hereinbefore set forth with reference respectively to Example I or to Example II.

Dated this 22nd day of September, 1919.

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

Fig. 1.

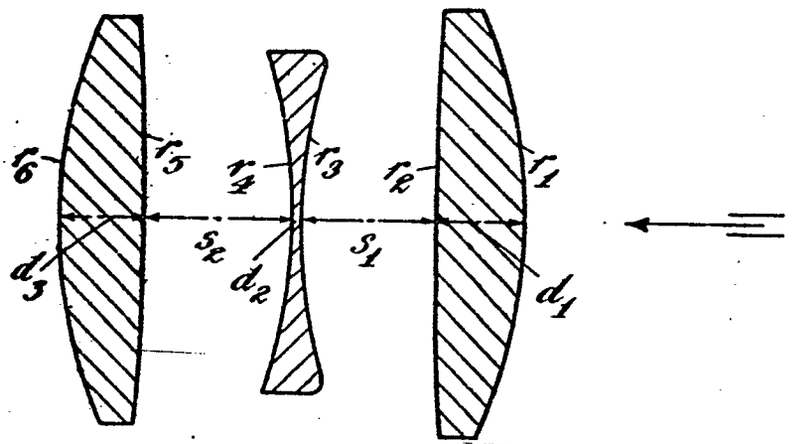
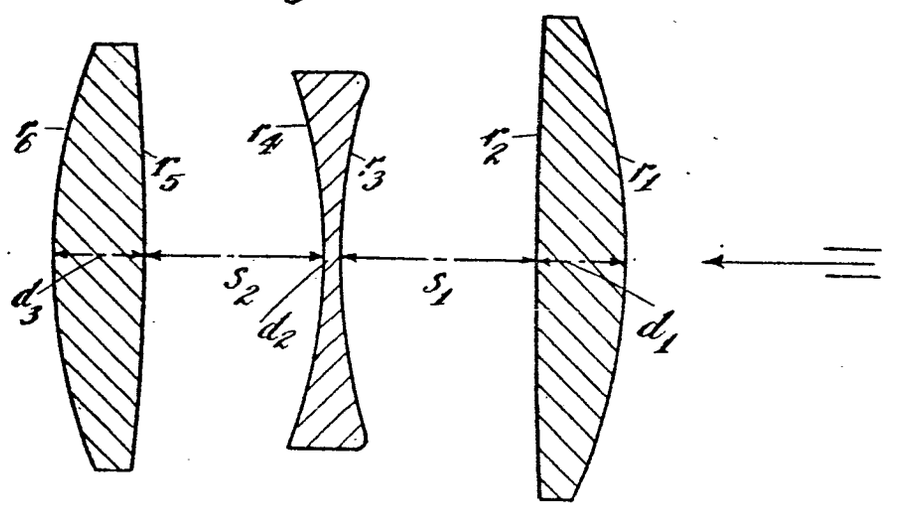



Fig. 2.




Malby & Sons, Photo-Litho.