

PATENT SPECIFICATION



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261,326

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COMPLETE SPECIFICATION.

Improvements relating to Lens Systems.

I, PAUL RUDOLPH, a German citizen, of Grosssiesnitz, near Görlitz, Germany, 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:—

For optical purposes as also for photographic purposes it is still the object of manufacturers to produce and the desire of users to possess a lens system which projects an image of the greatest illumination, of the greatest sharpness whilst having an image area of large angle and free from distortion. All these conditions are demanded to the fullest extent from photographic objectives. They are however equally necessary for projection objectives, and for microscope and telescope objectives.

The problem is solved when it is possible to correct the lens system free from spherical aberrations of second order within the correction of first order for all colours and for a large relative aperture, to fulfil the sine condition, to neutralize the coma, to eliminate astigmatism over a large plane image field, to avoid distortion and to render an image free from reflections.

Solving this problem is difficult and many lens combinations have already been introduced into industry approaching this aim. However it has not yet been possible to obtain the end as in one or more respects the extreme requirements are not fulfilled.

By means of the new system herein-after described a further important advance is made. With relatively small curvatures of lenses there are obtained a large aperture, a large image field and an almost complete elimination of the second order aberrations. Small lens curvatures in proportion to the diameter guarantee security in the quality of the image and facilitate manufacture of the lenses on a commercial scale. It has

also been possible to produce the anastigmatic plane of the image field without the use of heavy barium crown glass and to use glass of which the primary features are purity and durability and which are colourless.

This improvement has been rendered possible by reason of the fact that a lens system has been chosen consisting of four or five single or cemented lenses, separated by air spaces, the air separated lenses in the series being alternately collective and dispersive lenses, at least one outer lens being collective, whilst it is necessary for the concave surface of the collective lens, next to the diaphragm and having an equivalent focus smaller than three times the equivalent focus of the complete lens system, to be turned towards the diaphragm.

For a large image area it is of importance that the lenses turn their concavity towards the diaphragm of the objective.

All the separate lenses may be simple lenses. In order however not to be restricted in the selection of durable glass materials of a perfect condition, one or more lenses are cemented, being formed of two glass materials of different dispersing power, namely collective and dispersive lenses cemented together.

Of the examples of construction No. 1 is illustrated in Figure 1 and No. 2 in Figure 2. No. 1 consists of four lenses separated by air spaces. No. 2 consists of five lenses separated by air spaces. In No. 1, the second and the fourth lens are cemented lenses in example No. 2 only the second is a cemented lens.

In the examples the reference letters correspond with those in the illustration. The dimensions are according to the scale on the drawing. B is the position of the diaphragm.

EXAMPLE 1.

The objective consists of four separated

lenses. Relative opening 1:3.2. Focal length 100.		TYPES OF GLASS.	
	Radii:	Thicknesses and Intervals.	Thicknesses and Intervals.
5	$r_1 = + 32.46$ $r_2 = + 185.5$ $r_3 = + 29.37$ $r_4 =$ $r_5 = + 18.55$	$d_1 = 3.86$ $l_1 = 0$ $d_2 = 4.17$ $d_2 = 2.01$ $b_1 = 5.41$	$L_1 = L_3 : n_D = 1.5331$ $n\bar{u} = 58.0$ $L_2 = L_5 : n_D = 1.5795$ $n\bar{u} = 53.8$ $L_2 = L_4 : n_D = 1.5749$ $n\bar{u} = 41.3$
10	$r_6 = - 77.30$ $r_7 = - 37.10$ $r_8 = - 25.35$ $r_9 =$ $r_{10} = - 32.31$	$d_3 = 2.32$ $b_2 = 1.08$ $d_4 = 6.00$ $d_4 = 14.87$	Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—
15	TYPES OF GLASS.		1. A lens system poor in aberrations of second order consisting of four or five single or cemented lenses, separated by air spaces, of which at least one outer lens has a collective power, characterised by the fact that the lenses, which are separated by the air gaps, are in succession alternately collective and dispersive lenses, whilst it is necessary for the concave surface of the collective lens next to the diaphragm and having an equivalent focus smaller than three times the equivalent focus of the complete lens system, to be turned towards the diaphragm.
	$L_1 = L_3 : n_D = 1.5331$ $n\bar{u} = 58.0$ $L_2 = L_4 : n_D = 1.5795$ $n\bar{u} = 53.8$ $L_2 = L_4 : n_D = 1.5749$ $n\bar{u} = 41.3$		2. Lens systems substantially as described in connection with the accompanying drawings.
20	EXAMPLE 2.		Dated this 14th day of September, 1926.
	Objective consisting of five separated lenses. Relative opening 1:3.2. Focal length 100.		For the Applicant:
	Radii:	Thicknesses and Intervals.	H. A. GILL & Co.,
25	$r_1 = + 32.46$ $r_2 = + 185.5$ $r_3 = + 29.37$ $r_4 =$ $r_5 = + 18.55$	$d_1 = 3.86$ $l_1 = 0$ $d_2 = 4.17$ $d_2 = 2.01$ $b_1 = 5.41$	Chartered Patent Agents,
30	$r_6 = - 77.30$ $r_7 = - 37.10$ $r_8 = - 25.66$ $r_9 = - 208.7$ $r_{10} = - 219.5$	$d_3 = 1.70$ $l_2 = 1.08$ $d_4 = 3.09$ $l_3 = 8.97$	51/52, Chancery Lane, London, W.C. 2.
35	$r_{11} = - 32.31$	$d_5 = 4.17$	

Fig. 1.

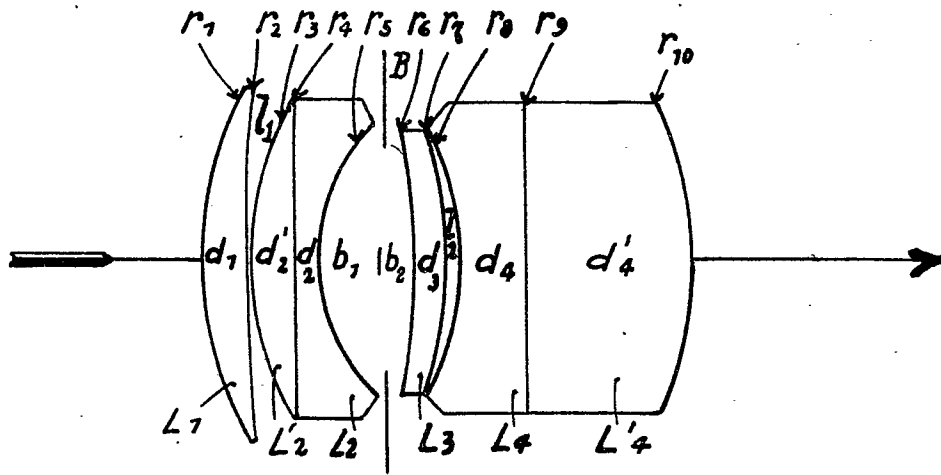
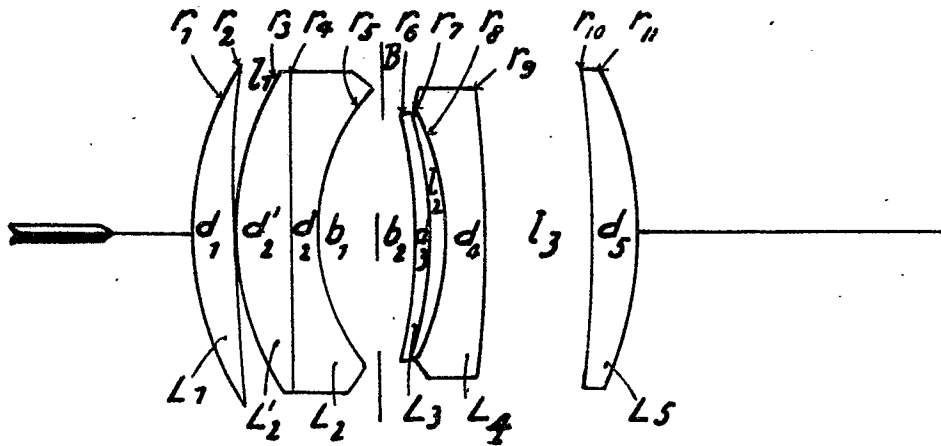


Fig. 2.



0 5 10 15 20 mm



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