Dec. 30, 1930. W. MERTE 1,786,916
OBJECTIVE CORRECTED SPHERICALLY, CHROMATICALLY, ASTIGMATICALLY, AND FOR COMA
Filed Sept. 7, 1928

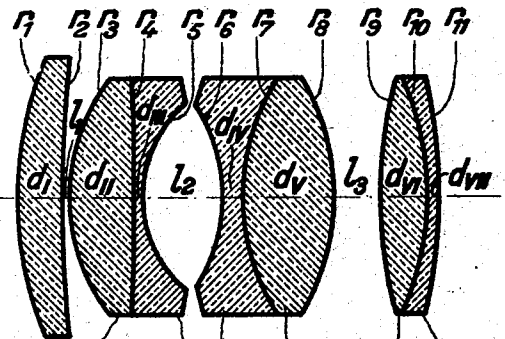
T2305

Focal length: 100

Fig. 1

Radii:

r_1 = + 86.19
r_2 = + 331.04
r_3 = + 46.35
r_4 = − 1118.78
r_5 = + 29.19
r_6 = − 39.81
r_7 = + 52.10
r_8 = − 55.00
r_9 = + 109.69
r_{10} = − 68.20
r_{11} = − 124.13



Thicknesses and distances:

d_I = 11.10
l_1 = 1.70
d_{II} = 16.07
d_{III} = 2.22
l_2 = 19.58
d_{IV} = 5.23
d_V = 22.20
l_3 = 11.74
d_{VI} = 11.62
d_{VII} = 2.74

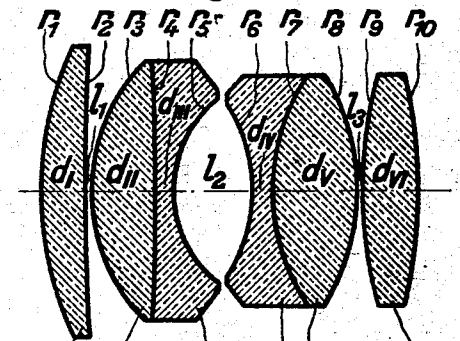
Kinds of glass:

	I	II	III	IV	V	VI	VII
n_d	1.64238	1.62377	1.56926	1.64579	1.64238	1.64238	1.67292
ν =	48.0	53.0	42.5	34.0	48.0	48.0	32.2

Fig. 2

Radii:

r_1 = + 83.6
r_2 = + 321.0
r_3 = + 44.8
r_4 = − 1150.0
r_5 = + 28.3
r_6 = − 38.5
r_7 = + 50.5
r_8 = − 53.2
r_9 = + 106.0
r_{10} = − 120.0



Thicknesses and distances:

d_I = 10.75
l_1 = 1.65
d_{II} = 15.55
d_{III} = 5.05
l_2 = 18.9
d_{IV} = 5.05
d_V = 21.22
l_3 = 0.97
d_{VI} = 13.9

Kinds of glass:

	I	II	III	IV	V	VI
n_d	1.64238	1.62306	1.57566	1.67270	1.64238	1.64238
ν =	48.0	56.9	41.2	32.2	48.0	48.0

Focal length: 100

Inventor:
Willy Merté

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UNITED STATES PATENT OFFICE

WILLY MERTÉ, OF JENA, GERMANY, ASSIGNOR TO THE FIRM OF CARL ZEISS, OF JENA, GERMANY

OBJECTIVE CORRECTED SPHERICALLY, CHROMATICALLY, ASTIGMATICALLY, AND FOR COMA

Application filed September 7, 1928, Serial No. 304,470, and in Germany September 29, 1927.

The present invention relates to photographic objectives consisting of four lenses, separated by air, of which the two outer ones are collective and the two inner ones dispersive and distinctly menisci, their concave surfaces facing each other.

According to the present invention it is possible to obtain objectives with unusually large aperture, affording the utmost sharpness and brilliancy of the images produced, by making distinctly biconvex that one of the two collective lenses facing the image, and by so choosing the proportion in which, in the other collective lens, the curvature radius of the strongest curved boundary surface stands to the curvature radius of the other boundary surface, that it is algebraically larger than the corresponding proportion of the collective lens facing the image.

As distinctly biconvex and distinctly meniscal one intends to designate in this case such lenses in which, according to the absolute amount, the one radius is at most the centuple of the other.

In order to eliminate certain definite remaining aberrations in the objectives corresponding to the invention a part of the four lenses or also all four of them may be subdivided into several members cemented to each other.

In the annexed drawing Figs. 1 and 2 each show an example of the invention in a longitudinal section.

The two objectives shown in the drawing and further explained in the subjoined tables are destined for use at a relative aperture of 1:1.4. At this large aperture the spherical aberrations of the two objectives are very slight. In the objective shown in Fig. 1, e. g. the maximum of the spherical aberrations for the D: line only amounts to one thousandth of the focal length, whereby the correction of the oblique pencils is carried out quite satisfactorily. The values given hereafter relate to a focal length of the objectives of 100 units.

Example 1 (Fig. 1)

Radii	Thicknesses and distances
r_1=+ 86.19	d_I=11.10
r_2=+ 331.04	l_1= 1.70
r_3=+ 46.35	d_{II}=16.07
r_4=−1118.78	d_{III}= 2.22
r_5=+ 29.19	l_2=19.58
r_6=− 39.81	d_{IV}= 5.23
r_7=+ 52.10	d_V=22.20
r_8=− 55.00	l_3=11.74
r_9=+ 109.69	d_{VI}=11.62
r_{10}=− 68.20	d_{VII}= 2.74
r_{11}=− 124.13	

KINDS OF GLASS

Lens	n_d	ν
I	1.64238	48.0
II	1.62377	53.0
III	1.56926	42.5
IV	1.64579	34.0
V	1.64238	48.0
VI	1.64238	48.0
VII	1.67292	32.2

Example 2 (Fig. 2)

Radii	Thicknesses and distances
r_1=+ 83.6	d_I=10.75
r_2=+ 321.0	l_1= 1.65
r_3=+ 44.8	d_{II}=15.55
r_4=−1150	d_{III}= 5.05
r_5=+ 28.3	l_2=18.9
r_6=− 38.5	d_{IV}= 5.05
r_7=+ 50.5	d_V=21.22
r_8=− 53.2	l_3= 0.97
r_9=+ 106.0	d_{VI}=13.9
r_{10}=− 120.0	

KINDS OF GLASS

Lens	n_d	ν
I	1.64238	48.0
II	1.62306	56.9
III	1.57566	41.2
IV	1.67270	32.2
V	1.64238	48.0
VI	1.64238	48.0

I claim:

1. Photographic objective corrected spherically, chromatically, astigmatically and for coma, consisting of four lenses separated by air, of which the two outer ones are collective, while the two inner ones are dispersive and distinctly menisci whose concave surfaces face each other, of the two collective lenses the one facing the image being distinctly biconvex and the proportion in which, in the other collective lens, the curvature radius of the strongest curved boundary surface stands to the curvature radius of the other boundary surface, being algebraically larger than the corresponding proportion of the collecting lens facing the image.

2. An objective comprising four components separated by air spaces, the two outer components being collective, the two inner components being dispersive, each of said inner components comprising two elements, the inner elements of the inner components having concave surfaces which face each other and provide an intermediate air lens, said front component being distinctly meniscus, both the surfaces of said rear component being convex.

3. Photographic objective corrected spherically, chromatically, astigmatically and for coma, consisting of four lenses separated by air, of which the two outer ones are collective, while the two inner ones are dispersive and distinctly menisci whose concave surfaces face each other, of the two collective lenses the one facing the image being distinctly biconvex and the other collective lens being a meniscus, the proportion in which, in this collective lens, the curvature radius of the strongest curved boundary surface stands to the curvature radius of the other boundary surface, being algebraically larger than the corresponding proportion of the collecting lens facing the image.

4. Photographic objective corrected spherically, chromatically, astigmatically and for coma, consisting of four lenses separated by air, of which the two outer ones are collective, while the two inner ones are dispersive and distinctly menisci whose concave surfaces face each other, of the two collective lenses the one facing the image being distinctly biconvex and the curvature radius of the one boundary surface of this lens, according to the absolute values, being not larger than twice the curvature radius of the other boundary line of this lens, the proportion in which, in the other collective lens, the curvature radius of the strongest curved boundary surface stands to the curvature radius of the other boundary surface, being algebraically larger than the corresponding proportion of the collecting lens facing the image.

5. Photographic objective corrected spherically, chromatically, astigmatically and for coma, consisting of four lenses separated by air, of which the two outer ones are collective, while the two inner ones are dispersive and distinctly menisci whose concave surfaces face each other, the curvature radius of one of these two concave surfaces, according to its absolute value, being at least 10% larger than the curvature radius of the other of these two concave surfaces, of the two collective lenses the one facing the image being distinctly biconvex and the proportion in which, in the other collective lens, the curvature radius of the strongest curved boundary surface stands to the curvature radius of the other boundary surface, being algebraically larger than the corresponding proportion of the collecting lens facing the image.

6. Photographic objective corrected spherically, chromatically, astigmatically and for coma, consisting of four lenses separated by air, of which the two outer ones are collective, while the two inner ones are dispersive and distinctly menisci whose concave surfaces face each other, of the two collective lenses the one facing the image being distinctly biconvex, the refractive indices pertaining to the D-line of the members contained in this lens amounting to at least 1.61, and the proportion in which, in the other collective lens, the curvature radius of the strongest curved boundary surface stands to the curvature radius of the other boundary surface, being algebraically larger than the corresponding proportion of the collecting lens facing the image.

WILLY MERTÉ.