

PATENT SPECIFICATION

(11) 1397711

1397711

- (21) Application No. 2091/73 (22) Filed 15 Jan. 1973
 (31) Convention Application No. 282/72 (32) Filed 13 Jan. 1972 in
 (33) Austria (OE)
 (44) Complete Specification published 18 June 1975
 (51) INT CL² G02B 9/64
 (52) Index at acceptance
 G2J B7C7 B7C8



(54) PANCRATIC OBJECTIVE

(71) We, KARL VOCKENHUBER, of 118 Pötzleinsdorferstrasse, Vienna 18, Austria and RAIMUND HAUSER, of 2, Goldeggasse, Vienna 4, Austria, both Austrian Citizens, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a pancratic objective for the super-8 format with an afocal ancillary lens system of variable magnification and a basic lens of predetermined focal length, said ancillary lens system comprising a first positive member consisting of a plurality of simple lenses, followed by a second and a third negative member and finally by a fourth positive member, whereas the basic lens consists of a positive member, whereby for changing the total focal length the second negative member situated adjacent to the positive front member is movable along the optical axis and the third negative member executes the compensating movement necessary to achieve a constant image plane, whereas the fourth positive member guides the light beams diverging behind the third member through the diaphragm area in substantially axis parallel direction to the basic lens.

With usual objectives of this kind difficulties have arisen in reducing the mechanical dimensions, namely the total length, as well as the diameter of the front lens group facing the object without losing performance.

It is possible to express an objective of variable focal length by a value Z, which may be calculated from the formula

$$Z = \frac{2y}{f_{Gmin}} \cdot \frac{f_{Gmax}}{f_{Gmin}}$$

wherein 2y represents the image diagonal, f_{Gmax} the maximum and f_{Gmin} the minimum total focal length of the objective. The ratio between the maximum and the minimum total

focal length of the objective represents in known manner the factor of zooming range. Thus in order to achieve a large changing range of the reproduction scale, also the value Z must be as large as possible. With predetermined values of the zooming range factor and the minimum focal length the diameter of the front lens group is dependent on the length and this again depends to a high degree on the value of the negative focal length of the second negative member. To a certain extent the length may also be influenced by the free ratio of the focal length of the front member to the focal length of the basic objective, whereby a relatively long focal length of the basic objective results in a relatively short focal length of the front member.

In that way the distance between the infinitesimally thin lenses replacing the first and the second member may become negative. This results in the length being shortened, and to have a front member of the so-called retrofocus type, the main point of which facing the image lies outside the front member. Such front members are not only expensive to construct, but also cannot have small mechanical dimensions because of the large diameters of the beams in the diaphragm area caused by a basic objective of relatively long focal length with predetermined aperture ratio.

The aim of the invention is to produce a relatively uncomplicated pancratic objective, easy to manufacture, and which despite a slight loss of brightness towards the image margin, has relatively small mechanical dimensions and a high value Z compared to known objectives of comparable type. According to the invention this is attained in that the minimum focal length f_{Gmin} of the objective, the focal length f_{II} of the second negative, axially movable member and the three-fold length of the image plane diagonal 6y satisfy the following inequality:

$$(f_{Gmin} - f_{II}) < 6y,$$

whereby the value Z is > 4 .

In order to avoid aberrations it is advantageous to build up the positive front member, as well as the second negative member of several lenses, at the most however of four lenses. This is not contradictory to the demand for an inexpensive and uncomplicated structure, as due to the resulting distribution of the refraction powers on a number of surfaces, the particular lenses not only can have an advantageous shape so that in the front member no radius of curvature is smaller than the diameter of the respective lens, but also no axial thickness exceeds 15% of the respective diameter. This is very important with respect to a cost saving construction. Moreover these lenses may be manufactured of optical glasses, which with respect to the index of refraction and the Abbé number and consequently also with respect to cost are not excessively expensive.

It is also possible by using of the invention to produce an objective of variable focal length, by means of which objects, that are in a distance between infinity and a few millimeters in front of the front lens of the objective, can be reproduced without additional auxiliary means and showing no loss of reproduction quality. In the inventive objective reproduction scales between 1:∞ and 1:-5 are attainable by means of an additional axial displacement of a third negative member. Thus shots become possible reaching far into the macrorange, which extends as it is known between reproduction scales of 1:-10 and 1:-1.

The invention will now be described in more detail, by way of example, with reference to the accompanying drawings, in which:—

Figure 1 shows an objective set to minimum total focal length;

Figure 2 shows the objective with parts identified and at an intermediate setting; and

Figure 3 shows the objective set to maximum total focal length;

The objective is built up of a stationary member I with positive focal length f_I facing the object to be taken, a member II with negative focal length f_{II} adjacent to the member I and movable along the optical axis

for the variation of the total focal length, further of a member III with negative focal length f_{III} adjacent to the member II and movable along the optical axis for achieving a constant image plane and a stationary member IV with positive focal length f_{IV} , which collects the beams diverging behind the member III in such a way that they are guided in the diaphragm area in axis parallel direction between said member IV and a likewise stationary basic lens V with positive focal length f_V .

In the Fig. 1 the position of the member III required for macro shots is drawn in broken lines. In that way it is possible to reproduce an object of 21×28 mm situated only a few millimeters in front of the vertex of the lens facing said object in full format on the super-8 film. Moreover a short-range focus independent of the focal length up to 1 m is possible by axial displacement of the member I.

The objective shows a five-fold zooming range, as well as a minimum focal length, which is 1.2 times smaller than the diameter of the image field. In spite of the extraordinary high light intensity on the outmost image margin, the free front lens diameter is extremely small and amounts to less than the eight-fold of the value Z , whereas with comparable objectives, which are likewise developed in consideration of small dimensions, the free front lens diameter amounts to more than the twelve- or the fourteen-fold. The objective is extraordinarily well corrected over the total range of the focal length. With high contrast and resolving power the image is levelled up to the margin, achromatic, respectively orthoscopic in each setting of focal length.

In the following example the letter r means the radii of the lens surfaces, the letter d the vertex distances (i.e. lens thickness and separations), n_d the refractive indices and v_d the Abbé numbers, the numerical values of parameters r and d being based on a mean focal length $f_{GM}=1$, occurring when the negative component II reproduces at a scale of 1:1 the intermediate image of an object produced by the positive component 1.

	$r_1+6,308$	$d_1=0,07$	n_d	v_d
	$r_2+1,967$	$d_2=0,06$	1,805	/ 25,4
105	$r_3+2,082$	$d_3=0,26$	1,620	/ 60,3
	r_4 plan	$d_4=0,01$		
110	$r_5+2,341$	$d_5=0,15$	1,623	/ 58,1

			n_d	v_d
	$r_6 + 4,961$	$d_6 = 0,01$		
	$r_7 + 1,805$	$d_7 = 0,22$	1,623 / 58,1	
5	$r_8 + 12,664$			
		$d_8 = 0,04$		
		$d_8 = 0,69$	f_{Gmin}	
		$d_8 = 1,03$	f_{GM}	
			f_{Gmax}	
10	$r_9 + 5,981$	$d_9 = 0,05$	1,658 / 50,9	
	$r_{10} + 0,567$	$d_{10} = 0,16$		
	$r_{11} - 1,086$	$d_{11} = 0,05$	1,669 / 57,4	
15	$r_{12} + 0,652$	$d_{12} = 0,15$	1,805 / 25,4	
	$r_{13} + 7,039$			
		$d_{13} = 1,09$	f_{Gmin}	
		$d_{13} = 0,32$	f_{GM}	
		$d_{13} = 0,14$	f_{Gmax}	
20	$r_{14} - 0,639$	$d_{14} = 0,05$	1,624 / 47,0	
	$r_{15} - 1,288$			
		$d_{15} = 0,10$	f_{Gmin}	
		$d_{15} = 0,22$	f_{GM}	
		$d_{15} = 0,06$	f_{Gmax}	
	$r_{16} + 1,097$	$d_{16} = 0,10$	1,691 / 54,7	
30	$r_{17} - 3,661$	$d_{17} = 0,46$		
	$r_{18} + 2,052$	$d_{18} = 0,10$	1620 / 60,3	
	$r_{19} - 2,052$	$d_{19} = 0,01$		
35	$r_{20} + 0,686$	$d_{20} = 0,13$	1,717 / 48,0	
	$r_{21} + 26,527$	$d_{21} = 0,04$		
	$r_{22} - 0,848$	$d_{22} = 0,16$	1,785 / 26,1	
40	$r_{23} + 0,535$	$d_{23} = 0,18$		
	$r_{24} + 1,614$	$d_{24} = 0,19$	1,720 / 50,4	
	$r_{25} - 0,639$			
		$f_{Gmin} = 0,43$		
		$f_{GM} = 1,00$	$f_H = -0,60$	
		$f_{Gmax} = 2,03$		
50		$2y = 0,37$	$Z = 4,07$	
		aperture ratio 1:1,9		

WHAT WE CLAIM IS:—

55 1. A camera objective of variable focal length for forming an image of the super-8 format comprising

60 a positive rear member of predetermined focal length and a front member of variable magnification having a first positive front

component consisting of a plurality of simple lenses,

second and third negative components, said second component being movable along the optical axis and having a predetermined focal length f_H , whereas said third component is movable in dependence on the movement of

65

		n_d	v_d
	$r_6 + 4,961$		
	$d_6 = 0,01$		
5	$r_7 + 1,805$		
	$d_7 = 0,22$	1,623	/ 58,1
	$r_8 + 12,664$		
	$d_8 = 0,04$	f_{Gmin}	
	$d_8 = 0,69$	f_{GM}	
	$d_8 = 1,03$	f_{Gmax}	
10	$r_9 + 5,981$		
	$d_9 = 0,05$	1,658	/ 50,9
	$r_{10} + 0,567$		
	$d_{10} = 0,16$		
15	$r_{11} - 1,086$		
	$d_{11} = 0,05$	1,669	/ 57,4
	$r_{12} + 0,652$		
	$d_{12} = 0,15$	1,805	/ 25,4
	$r_{13} + 7,039$		
20	$d_{13} = 1,09$	f_{Gmin}	
	$d_{13} = 0,32$	f_{GM}	
	$d_{13} = 0,14$	f_{Gmax}	
	$r_{14} - 0,639$		
	$d_{14} = 0,05$	1,624	/ 47,0
25	$r_{15} - 1,288$		
	$d_{15} = 0,10$	f_{Gmin}	
	$d_{15} = 0,22$	f_{GM}	
	$d_{15} = 0,06$	f_{Gmax}	
	$r_{16} + 1,097$		
	$d_{16} = 0,10$	1,691	/ 54,7
30	$r_{17} - 3,661$		
	$d_{17} = 0,46$		
	$r_{18} + 2,052$		
	$d_{18} = 0,10$	1,620	/ 60,3
35	$r_{19} - 2,052$		
	$d_{19} = 0,01$		
	$r_{20} + 0,686$		
	$d_{20} = 0,13$	1,717	/ 48,0
	$r_{21} + 26,527$		
	$d_{21} = 0,04$		
40	$r_{22} - 0,848$		
	$d_{22} = 0,16$	1,785	/ 26,1
	$r_{23} + 0,535$		
	$d_{23} = 0,18$		
45	$r_{24} + 1,614$		
	$d_{24} = 0,19$	1,720	/ 50,4
	$r_{25} - 0,639$		
	$f_{Gmin} = 0,43$		
	$f_{GM} = 1,00$	$f_{II} = -0,60$	
50	$f_{Gmax} = 2,03$	$Z = 4,07$	
	$2y = 0,37$		

aperture ratio 1:1,9

WHAT WE CLAIM IS:—

55 1. A camera objective of variable focal length for forming an image of the super-8 format comprising

a positive rear member of predetermined focal length and a front member of variable magnification having a first positive front

component consisting of a plurality of simple lenses,

second and third negative components, said second component being movable along the optical axis and having a predetermined focal length f_{II} , whereas said third component is movable in dependence on the movement of

65



* C L M S *



said second component to achieve a constant image plane, and

- 5 a fourth positive component adjacent to said rear member to guide divergent light beams coming from said third component in substantially axis parallel direction towards said rear member;

- 10 a diaphragm plane being located between said front member and said rear member; the minimum focal length f_{Gmin} of the objective, the focal length f_{II} of said second component and the three-fold length $6y$ of the diagonal of said image satisfying the following inequality:

$$15 \quad (f_{Gmin} - f_{II}) < 6y,$$

- whereas the value Z calculated from the length $2y$ of said diagonal, from the minimum focal length f_{Gmin} and from the maximum focal length f_{Gmax} satisfies the following inequality:

$$20 \quad Z = \frac{2y}{f_{Gmin}} \cdot \frac{f_{Gmax}}{f_{Gmin}} > 4.$$

2. An objective of variable focal length for forming an image of an object in an image plane, said objective comprising
- 25 a positive rear member of predetermined

focal length and a front member of variable magnification having a first positive front component consisting of four simple lenses,

second and third negative components, said second component being movable along the optical axis and having a predetermined focal length f_{II} , whereas said third component is movable in dependence on the movement of said second component to achieve a constant image plane, and

a fourth positive component adjacent to said rear member to guide divergent light beams coming from said third component in substantially axis parallel direction towards said rear member;

said objective conforming substantially to the following table in which the dimensions are given proceeding from front to rear, r_1 to r_{25} designating the radii of curvature of the surfaces, d_1 to d_{24} the axial thicknesses and separations, n_d the indices of refraction and v_d the Abbé numbers, whereas f_{Gmin} , f_{GM} and f_{Gmax} are the minimum focal length, the medium focal length and the maximum focal length respectively, $2y$ is the length of the diagonal of the image frame and Z the value calculated according to the formula

$$Z = \frac{2y}{f_{Gmin}} \cdot \frac{f_{Gmax}}{f_{Gmin}}$$

		n_d	v_d
55	$r_1 + 6,308$		
	$r_2 + 1,967$	$d_1 = 0,07$	1,805 / 25,4
	$r_3 + 2,082$	$d_2 = 0,06$	
60	r_4 plan	$d_3 = 0,26$	1,620 / 60,3
	$r_5 + 2,341$	$d_4 = 0,01$	
	$r_6 + 4,961$	$d_5 = 0,15$	1,623 / 58,1
65	$r_7 + 1,805$	$d_6 = 0,01$	
	$r_8 + 12,664$	$d_7 = 0,22$	1,623 / 58,1
70		d_8 0,04 f_{Gmin} 0,69 f_{GM} 1,03 f_{Gmax}	
	$r_9 + 5,981$	$d_9 = 0,05$	1,658 / 50,9
75	$r_{10} + 0,567$	$d_{10} = 0,16$	
	$r_{11} - 1,086$	$d_{11} = 0,05$	1,669 / 57,4
	$r_{12} + 0,652$	$d_{12} = 0,15$	1,805 / 25,4
80	$r_{13} + 7,039$	d_{13} 1,09 f_{Gmin} 0,32 f_{GM} 0,14 f_{Gmax}	

		D_d	v_d
	$r_{14} - 0,639$	$d_{14} = 0,05$	$1,624 / 47,0$
	$r_{15} - 1,288$		
5		$d_{15} = 0,10$	f_{Gmin}
		$0,22$	f_{GM}
		$0,06$	f_{Gmax}
	$r_{16} + 1,097$	$d_{16} = 0,10$	$1,691 / 54,7$
10	$r_{17} - 3,661$	$d_{17} = 0,46$	
	$r_{18} + 2,052$	$d_{18} = 0,10$	$1620 / 60,3$
	$r_{19} - 2,052$	$d_{19} = 0,01$	
15	$r_{20} + 0,686$	$d_{20} = 0,13$	$1,717 / 48,0$
	$r_{21} + 26,527$	$d_{21} = 0,04$	
20	$r_{22} - 0,848$	$d_{22} = 0,16$	$1,785 / 26,1$
	$r_{23} + 0,535$	$d_{23} = 0,18$	
	$r_{24} + 1,614$	$d_{24} = 0,19$	$1,720 / 50,4$
25	$r_{25} - 0,639$		
		$f_{Gmin} = 0,43$	$f_{II} = -0,60$
		$f_{GM} = 1,00$	
30		$f_{Gmax} = 2,03$	$Z = 4,07$
		$2y = 0,37$	

aperture ratio 1:1,9

MARKS & CLERK,
Chartered Patent Agents,
57 & 58 Lincoln's Inn Fields,
London, WC2A 3LS.
Agents for the Applicant(s).

Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1975.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from
which copies may be obtained.

