

# PATENT SPECIFICATION



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## COMPLETE SPECIFICATION

### Improvements in Photographic and like Objectives

I, HUGH IVAN GRAMATZKI, of 30, Lahnstrasse, Berlin-Neukölln, Germany, a German citizen, 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:—

The invention relates to an optical attachment to a photographic or like objective which allows of continuously varying the size of the image of any object at constant distance, thus giving the same effect as if the picture was taken with the aid of a lens of variable focal length.

It is well known that a Galilean system giving a magnified image in one direction gives a minified one in the other direction. Reversible Galilean systems in front of taking lenses have already been used but have not so far been adapted for continuously changing the size of the image. The object of the present invention is so to re-construct the system as to render such continuous change possible.

According to the invention one of the lenses of the Galilean system is for this purpose divided up into two lenses, or both of the lenses are divided up in this manner. The lenses lying between the outer ones are made movable along the optical axis.

Figs. 1 and 2 of the accompanying drawings are sectional views of the ordinary Galilean system of lenses, one as used for magnifying and the other for minifying.

Figs. 3—8 are views showing the lens system modified according to the invention, and

Fig. 9 is an enlarged sectional view showing the improved lens system fitted in a mount.

The division of the positive lens of the Galilean system into two lenses  $L_1$ ,  $L_2$  is shown in Figs. 3 and 4. Lens  $L_1$  is negative, lens  $L_2$  is positive. The negative lens  $L_1$  has the same focal lengths as the negative lens  $L_3$ . The focal length of the positive lens  $L_2$  is calculated on the basis of the magnifying (or minifying) factor  $m$  of the Galilean system, this factor at the same time deciding the length  $a$ . By moving the lens  $L_2$  along the optical axis

until it comes in contact with the lens  $L_3$  the Galilean system is continuously changed from one magnifying  $m$ -times into the minifying by  $l:m$ .

In Figs. 5 and 6 the division of the negative lens into two lenses  $L_2$ ,  $L_3$  is shown. On the basis of similar considerations the distance  $a$  and the focal length of the lens  $L_2$  is determined dependent on the factor  $m$ , the focal lengths of the positive lenses  $L_1$  and  $L_3$  being made equal.

Figs. 7 and 8 lastly show the division of both lenses into couples  $L_1$ ,  $L_2$  and  $L_3$ ,  $L_4$ . The focal lengths of the lenses  $L_2$  and  $L_3$  are equal but of different sign so that they will combine (Fig. 8), to form a plane parallel glass plate. The system acts in this position as a magnifying one whereas it acts as a minifying one in the position of Fig. 7. The focal lengths of the lenses  $L_2$  and  $L_3$  are determined according to the magnifying factor  $m$  of the system and the focal length  $f_1$  of  $L_1$ .

The focal length  $f_4$  of  $L_4$  is simply  $= \frac{m}{l} f_1$ .

To reduce distortion the outer lenses are given the form of meniscus lenses (Fig. 9). Both lenses are fixed in a tube A. The movable intermediate lens is located in a ring B, which slides in the tube A. The lens  $L_2$  is moved with the aid of a ring C, connected by screws with the ring B, slots E being provided in which the screws slide.

The radii and thickness of the lenses in this case are:—

$$r_1 + 150.77 \quad d_1 \quad 7.1 \quad 90$$

$$r_2 + 54.00$$

$$r_3 + 64.16$$

$$d_2 \quad 9.6 \quad 95$$

$$r_4 - 258.7$$

$$r_5 + 172.6$$

$$d_3 \quad 2.8$$

$$r_6 + 55.0$$

$$l + 95.5$$

$$m^2 = 2$$

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The speed of the lens remains constant during the movement of the middle lens and the variation of the size of the image occurs without any change of the

luminosity of the picture.

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:—

1. An optical attachment to a photographic or like objective comprising a Galilean system of lenses divided so as to present a central lens or combination of

lenses which is movable along the optical axis relative to the outer lenses.

2. A lens system constructed as hereinbefore described with reference to Fig. 9 of the accompanying drawings.

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Dated the 4th day of November, 1935,  
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Registered Patent Agents.

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

