PATENT SPECIFICATION

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COMPLETE SPECIFICATION.

Improvements in Photographic Apparatus.

We, TECHNICOLOR MOTION PICTURE CORPORATION, a corporation of Maine, United States of America, of 110, Brookline Avenue, Boston, Massachusetts, United States of America, assignees of JOSEPH ARTHUR BALL, a citizen of the United States of America, of 110, Brookline Avenue, Boston, aforesaid, 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:—

In certain branches of the art of photography requiring the use of short focus lenses, it is highly desirable to obtain more space between the lens and the focal plane than such lenses afford. For example, in color cinematographic cameras using prism sets for dividing the image-bearing beam into component beams with which to obtain simultaneous images representing different color aspects of the object-field, considerable space must be available for the prism set between the objective lens and the film to be exposed.

Objects of the present invention are to increase the aforesaid spacing between objective and focal plane and preferably at the same time to decrease the equivalent focal length so as to increase the depth of focus at large apertures, and to provide means for this purpose which not only avoids serious distortion but also tends to counteract the aberrations introduced by the prism set such as curvature of field.

In one aspect the invention involves the use of a positive lens and a negative lens arranged in front of the positive lens to increase the back focal length, the negative lens being substantially weaker than the positive lens, the distance between the two lenses being at least equal to the focal length of the positive lens, and the negative lens preferably being meniscus in form.

In another aspect the invention involves the use of a dispersive or negative lens located in front of the usual collecting or positive objective at a distance sufficient to reduce the equivalent focal length of the combination relatively to that of the objective lens alone. This distance should be somewhat greater than the focal length of the objective alone, as shown by the following formulæ in which f is the equivalent focal length of the combination, f^1 the focal length of the positive lens, f^{11} the focal length (virtual) of the negative lens, and D the distance between the two lenses:

$$\frac{1}{f}=\frac{1}{f^1}+\frac{1}{f^{11}}-\frac{D}{f^1 f^{11}} \text{ or } \frac{1}{f}=\frac{1}{f^1}-\frac{1}{f^{11}}+\frac{D}{f^1 f^{11}}$$

Thus if D is less than f^1 f is greater than f^1; when D equals f^1, f also equals f^1; and when D is greater than f^1, f is less than f^1.

In another aspect the invention involves a prism set or other light-dividing means, intermediate the positive lens and the local plane of the [illegible] greater than can be accommodated to the back focal length of the objective lens alone, and a negative lens disposed in front of the objective, the dispersive power of the negative lens and its spacing from the objective lens being sufficient to decrease the equivalent focal length of the lens system while increasing the back focal length sufficiently to accommodate the prism set.

In still another aspect the invention is characterized by using, as the aforesaid dispersive or negative lens, a meniscus lens having its concave side facing the objective lens, thereby minimizing distortion, particularly of the so-called barrel-shaped type. The ratio of curvature of the concave and convex faces of the meniscus lenses should be of the order of two to one.

For the purpose of illustrating the invention a typical embodiment is shown diagrammatically in the accompanying drawing in which:

Fig. 1 represents the entire system; and

Fig. 2 shows the lenses without the prisms.

In the drawings, D represents a light-dividing prism set and P and N the positive and negative lenses. While the illustrated light-dividing means is of the

[*Price* 1/-]

type disclosed in the British patent to Comstock No. 194,971 it will be understood that other types may be used according to this invention; likewise that various designs of positive and negative lenses may be used.

However, a typical combination of lenses for color cinematographic cameras comprises a fifty millimeter objective with a minus-six plus-three meniscus positioned with its concave side toward the objective at a distance from the objective of approximately four and one-half inches. With this combination the equivalent or resultant focal length is forty-three millimeters and the back focal length is forty millimeters, whereas the back focal length of the objective alone is only thirty-three millimeters. Likewise with a forty millimeter objective such a meniscus would afford a resultant focal length of thirty-two millimeters, while affording enough space for a prism set such as illustrated—which would not be available without the meniscus.

In the illustrated embodiment. which is particularly suitable for cinematographic cameras, the meniscus lens N has a diameter of two and five-eighths inches, its concave and convex faces have curvatures of plus three and minus six diopters respectively, it is chromatically corrected and it is spaced four and one-half inches from the lens P measured between lines tangent to the convex front faces of the two lenses respectively. Inasmuch as the construction of the positive lens is not novel and may be varied widely, only the front and rear faces are shown in the drawing, the peripheries of these faces being connected by broken lines to indicate an intermediate construction of any suitable composite lens type. The distance between the front and rear faces of this composite lens, measured from lines tangent to the faces respectively is one and six-thirty seconds inches. The front and rear apertures may be one inch and three-quarters of an inch respectively. As shown in Fig. 2, the back focal length of the entire system (BF) is forty millimeters and the equivalent focal length of the system (EF) is forty-three millimeters, whereas the back focal length and the equivalent focal length of the positive lens P alone (*bf* and *ef*) are thirty-three and fifty millimeters respectively. Thus the addition of the meniscus increases the back focal length seven millimeters and decreases the equivalent focal length an equivalent amount.

A secondary feature of the invention consists in that the meniscus lens counteracts the tendency of the prism set to introduce aberrations, particularly curvature of field, thereby simplifying the correction of the optical system as disclosed for example in the British patent to Comstock, No. 131,422.

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

1. A lens system for photographic use of the type having a collecting lens and a dispersing lens, characterized in that the dispersing lens is arranged in front of the collecting lens, and substantially weaker than the collecting lens, to increase the ratio between the back focal length and the equivalent focal length, thereby to increase the depth of focus and/or the covering power of the system.

2. A lens system according to claim 1 further characterized in that the distance between the two lenses is at least equal to the focal length of the collecting lens.

3. A lens system according to either of the preceding claims further characterized in that the dispersing lens is meniscus in form with its concave side toward the collecting lens.

4. A lens system according to the preceding claim further characterized in that the meniscus lens is chromatically corrected.

5. A lens system according to either of the two preceding claims further characterized in that the concave and convex faces of the meniscus lens are curved in the ratio of approximately two to one.

6. A lens system according to any of the preceding claims, further characterized by light-dividing means between the collecting lens and the image plane, said dispersing lens permitting the use of larger light-dividing means than could be accommodated to the back focal length of the collecting lens without the dispersing lens arranged as aforesaid.

7. A lens system according to claim 6, further characterized in that the light-dividing means is in the form of prisms and the lenses are correlated therewith simultaneously to produce a plurality of corrected images.

8. Photographic apparatus comprising a positive lens, light dividing prisms intermediate the positive lens and the focal plane of the lens and having dimensions greater than can be accommodated to the back focal length of the objective, and a negative lens in front of the positive lens, the power of the negative lens being less than that of the positive lens and its spacing from the objective lens being greater than the focal length of the positive lens so as to decrease the equivalent focal length of the system

without correspondingly decreasing the back focal length.

9. An optical system according to claim 8, in which the negative lens is meniscus in form, the concave and convex faces of the meniscus surfaces being curved in the ratio of approximately two to one.

10. An optical system according to claims 8 and 9, characterized in that the divided light paths in the prisms are equal in length.

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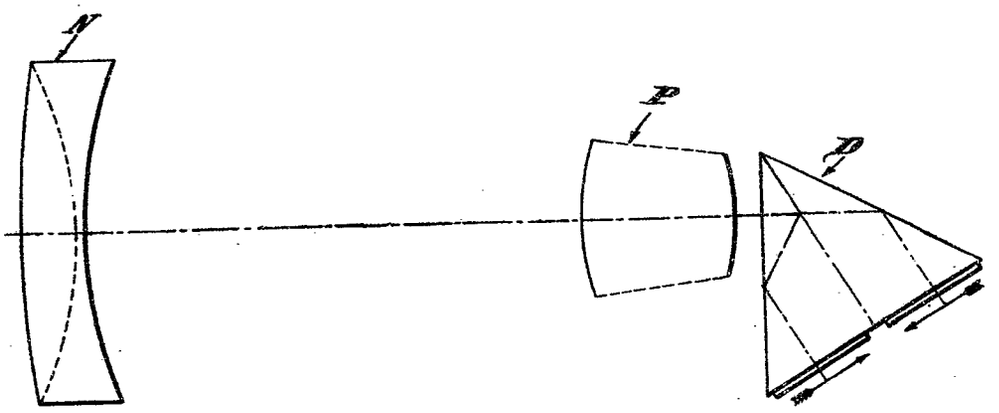

Fig. 1

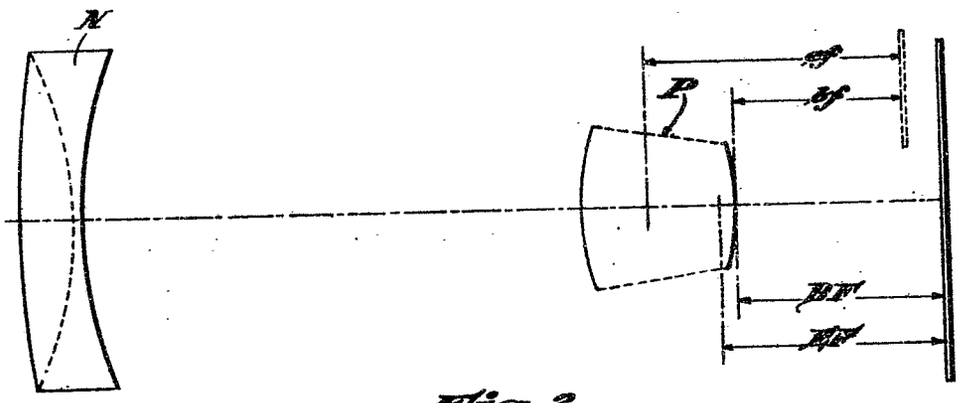

Fig. 2

Charles & Read Ltd. Photo Litho.