[Second Edition.]

PATENT SPECIFICATION

247,168

Convention Date (France): Feb. 7, 1925.

Application Date (in United Kingdom): Jan. 19, 1926. No. 1552/26.

Complete Accepted: Feb. 3, 1927.

COMPLETE SPECIFICATION.

Improvements in or relating to Photographic Objectives.

We, SOCIETE MONDIALE DU FILM EN COULEURS KELLER-DORIAN, of 42, rue d'Enghien, Paris, France, a Société Anonyme organized under the laws of France, 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 processes for colour photography based on the use of sensitized films embossed on their unsensitized side with a lenticular, spherical or cylindrical system are difficult to carry into practice. These difficulties arise from the fact that the various cells of the film work under dissimilar optical conditions according as they are positioned on the axis of the lens or at the edge of the field.

Endeavours have already been made to overcome the said difficulties in connection with picture-taking by placing a collimating lens very closely to the film to be exposed, the said lens having its focus in the vicinity of that of the objective. A device having the above features does not unfailingly correct the aforementioned defects since in order to obtain proper and unfailing correction the lens must form with the objective a perfect optical structure.

This invention comprises a photographic objective the pupil of emergence of which is at infinity or at least at a very great distance in front of the sensitized layer of a photographic plate so that the images of the colour selecting filters, or of any other screens that may have to be placed in the diaphragm be independent, as to their effects, of the focal length of the objectives.

The invention will be more clearly understood with the aid of the examples illustrated in the accompanying drawings in which

Figure 1 shows the path of the light rays in the hitherto known picture-taking device without a collimating lens and emphasises the difference in optical operation of the marginal and of the central lenticular elements.

Figure 2 shows the fault occurring when printing diapositives or transparencies.

Figures 3, 4 and 5 show optical structures according to the invention.

In order to review in detail the conditions to be fulfilled by the optical combinations according to the invention and with a view to emphasise their importance, the disadvantages of the device at present in use are first to be described, with reference to Figure 1. In the said figure, D denotes the diaphragm of the objective, where the colour-selecting filter is located.

P^1 is the image of the said diaphragm, as seen through the optical structure at the rear of the diaphragm, that is to say that P^1 is what is known as the pupil of emergence. The embossed sensitive film is shown, considerably enlarged, at L S. L is the lenticular face. S is the sensitized surface.

Under good picture-taking conditions each lenticular element projects on the surface S an extremely reduced image of the selecting filter positioned at D.

It is most essential for preserving the purity of the colours that the images be quite sharp in order that the partitioning lines photographed at S may outline as boldly as possible the various zones of colour.

It will now be seen from Figure 1 that while this condition is practically fulfilled as regards the lenticular elements situated in the vicinity of the axis, as at L, such is not the case as regards the marginal elements, as L^1, L^2, which form considerably displaced images of the filter.

The lack of sharpness of the marginal secondary filters resulting from such dis-

placement is compensated for neither when the subsequent operations of positive printing are proceeded with nor on projection. On the contrary, each optical re-taking of the images increases the deficiency in sharpness so that ultimately the said deficiency is increased fourfold on projection. This partly accounts for the lack of purity in marginal colours which spoils colour projections made by this process.

There are further serious disadvantages arising also from the difference in optical working of the marginal and of the central lenticular elements, these disadvantages being as follows:

Let V (green) be the central zone of the filter positioned at D and R (red) another zone. These two zones are reproduced at V^1 and R^1 respectively behind the central lenticular element L and at V^1_1 and R^1_1 behind the marginal lenticular element L_1. In order that the reconstitution of colours be exact, all the zones V^1, V^1_1 . . . . and R^1, R^1_1 . . . . must be represented on projection by images well superimposed at a single point V or R. This implies that the pupil of incidence of the projecting objective must be at the same distance from the film as the distance at which the pupil of emergence was from the picture-taking objective. In practice the focal length of projecting objectives used must be about the same as that of the picture-taking objective. This requirement is generally incompatible with the distance at which the projection screens stand in halls, and with the size of such screens.

Another difficulty arising from the same cause is the necessity for perfect centering of the photographic plate on the axis of the projecting objective. A displacement of the centre of the plate in its plane relatively to the optical axis displaces by as much the coloured images relatively to the selector film of projection and involves a diffusion of colours.

When transparencies are printed by contact, Figure 2 shows that the images V^1 R^1 of the filter on the original film are reproduced at V^{11} R^{11} correctly as regards the central elements and incorrectly as regards the marginal elements.

If copying is done in the dark room and with unit magnification the diaphragm must occupy the same position as to distance and have the same angular extent relatively to the two films as on picture-taking. This requirement leads to the use of objectives working for the same field with considerable aperture ratios which are twice those of picture-taking objectives; whence imperfect copies.

The invention is based on the principle of designing the optical structure so that the pupil of emergence of the optical combination where the last image of the colour filter is placed, should be removed to infinity, or at any rate far back in front of the film so that all the difficulties pertaining to the position of the filter as to distance are removed, the remaining matters to be dealt with being those of angles, the solution of which as to geometrical optics then becomes quite easy.

Objectives meeting this requirement in a simple way may be obtained by starting from known constructions and by placing in the vicinity of their focal plane a lens C acting as a collimator the focal length of which is such that the pupil of emergence of the original objective is in the focal foreplane of lens C. The shape of this lens depends upon the requirement of reducing to a minimum the distortion thereby introduced into the image.

The other aberrations introduced, such as spherical aberration, coma, astigmatism and curvature of the field are compensated for by the introduction of opposite residual aberrations into the original objective.

For instance, the collimating lens introduces a forward curvature of the image substantially equal to ϕ/η, ϕ denoting its power and the index of refraction of the material of which it is made.

The objective is therefore designed so as to produce a backward curvature of image equal to $\phi\eta$ and also a slight overcorrection of spherical and chromatic aberrations.

The following objectives are given as examples of embodiments of the invention.

For picture taking, anastigmat objectives (Figure 3) constituted by three thin separated components and by a collimating lens located in the vicinity of the focal plane. Experts in the art are aware that in the case of anastigmat objectives the curvature of the image is equal to Petzval's sum $P = -\sum\frac{\phi}{\eta}$ and that in designing these objectives in view of increasing the sharpness of the marginal images, P is given a negative value suited to the extent of the field to be represented; when designing an objective of this kind to be provided with a pupil collimating lens, the residual value ascribed to P is therefore to be increased to the extent $-\phi\eta$.

For copying purposes:

a) Symmetrical objectives (Figure 4) each half of which is constituted by two

separate optical components O and C, O^1 and C^1. The elements O and O^1 act as the objective proper while the elements C and C^1 act as a collimating lens for the diaphragms located at D at a suitable mid-distance between the systems O and O^1.

b) Asymmetrical objectives for transforming a non-collimated film into a collimated film when copying. Such objectives are produced by combining (Figure 5) as ordinary picture-taking objective O (as used for the first filming) with the rear half O^1 C^1 of the previously described copying objective so that the diaphragm D of this second part coincides as to position with the pupil of entrance of the objective used for picture taking.

The result aimed at may also be obtained by placing the collimating lenses considerably forward of the focal plane. These lenses are then of valuable assistance in causing convergence of the system. This is particularly useful in the case of wide aperture objectives as those required to copy films in the dark room.

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 photographic objective the pupil of emergence of which is at infinity or at least at a very great distance in front of the sensitized layer of a photographic plate so that the images of the colour selecting filters, or of any other screens that may have to be placed in the diaphragm be independent, as to their effects, of the focal length of the objectives.

2. The application of such objectives to colour photography by the method of sensitized layers carried on a lenticular support comprising microscopic elements.

3. Devices to adapt the same to the construction of kinematographic picture-taking, copying and projecting objectives.

4. The photographic objective substantially as described with reference to the accompanying drawings.

Dated this 19th day of January, 1926.

SOCIETE MONDIALE DU FILM EN COULEURS KELLER-DORIAN.
Per Boult, Wade & Tennant,
111 & 112, Hatton Garden, London, E.C. 1,
Chartered Patent Agents.

Abingdon : Printed for His Majesty's Stationery Office, by Burgess & Son.
[Wt. 123A.—50/11/1931.]

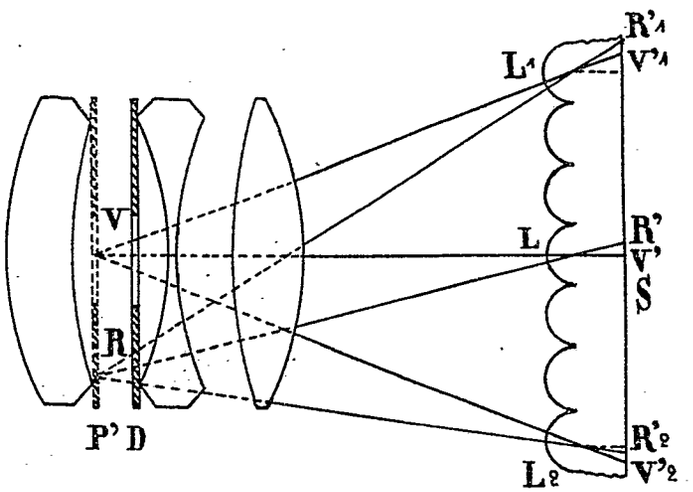


Fig.1

Fig.4

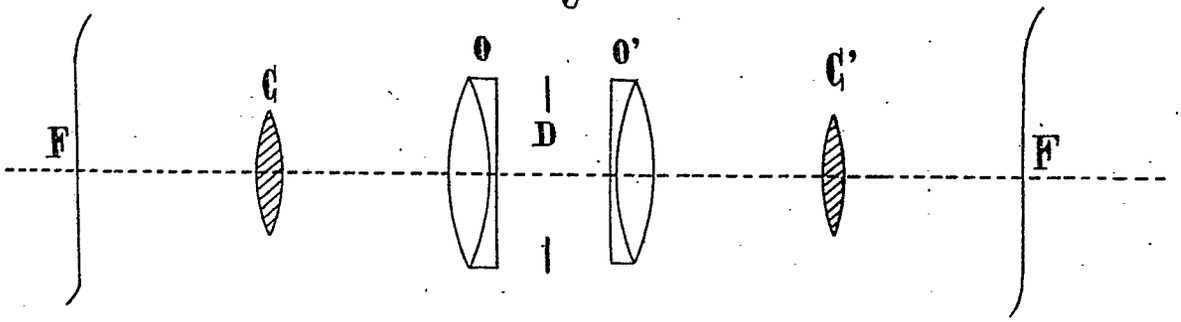
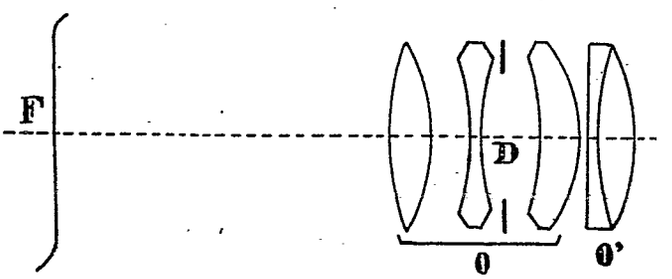
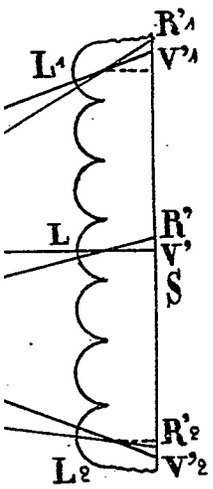


Fig.5





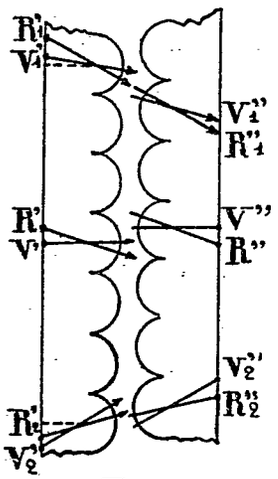
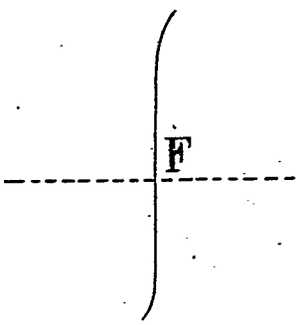


Fig.2

Fig.3



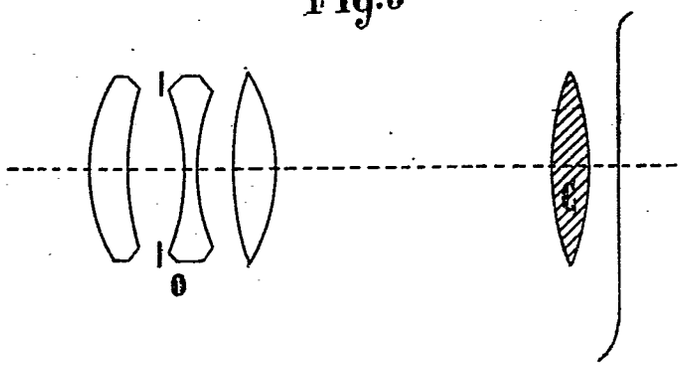
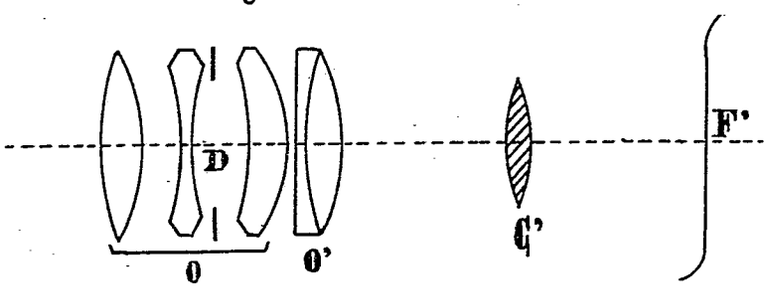


Fig.5



Charles & Read Ltd. Photo Litho

2nd Edition

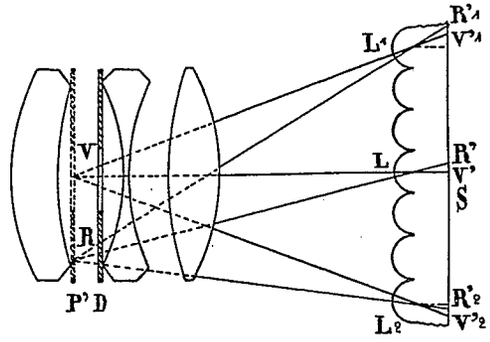


Fig.1

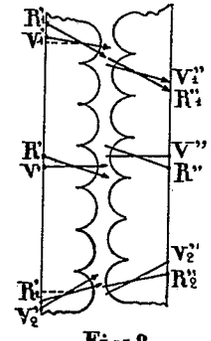


Fig.2

Fig.4

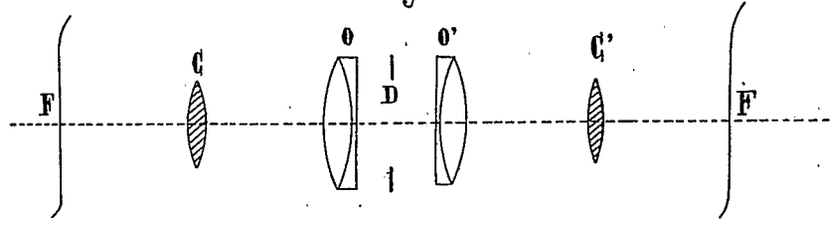


Fig.3

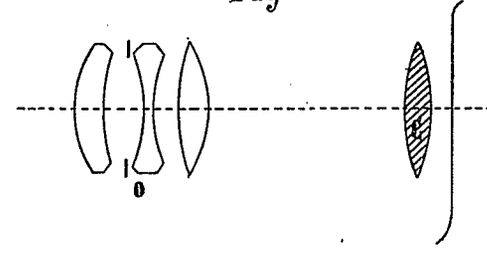


Fig.5