NOTE.—*The application for a Patent has become void.*
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PATENT SPECIFICATION

Convention Date (France): Dec. 4, 1922. **207,837**

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Complete not Accepted.

COMPLETE SPECIFICATION.

Improvements in Engraved Dies Intended to Emboss Microscopic Lenticular Nets on Photographic Films.

We, KELLER-DORIAN AND Co., of 42, rue d/Enghien, Paris, France, a French company, 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:—

Hitherto the microscopic lenticular screens intended for colour photography and kinematography comprised at most 400 lenticular elements per square millimeter and even, speaking generally a substantially smaller number, (about 225) corresponding to well defined technical results.

The object of the invention is to provide for an increase in the number of lenticular elements to over 500 and even over 1000 per square millimeter as will be hereinafter described, which increase bears new results and allows films according to the invention to be used in circumstances in which films fitted with known and relatively less fine screens could not be used.

A brief comparison of the operation of the known screens with 225 lenticular elements per square millimeter and of the new screen having 520 such elements per square millimeter shows the high importance of the latter and the simplifications their use involves in general photographic and kinematographic art.

The type of screen comprising 225 lenticular elements per square millimeter is made to meet, when applied to common films, (which are usually found in the trade and have a thickness of 12 to 13 hundredths of a millimeter) the following optical requirement, *viz.:* to produce by refraction of the ocular disc of a photographic objective in which the aperture f. 2.5 such an image that the latter's diameter exactly coincides, on the sensitive layer, with the diameter of the microscopic lens it is produced by. Theoretically the whole of the sensitive surface is thus utilised. Calculation demonstrates that with a medium having a refractive index analogous to that of celluloid, (with a suitable curvature of the microscopic surfaces impressed on the emulsion support or backing having a thickness of $^{12}/_{1000}$th of a millimeter), the result aimed at is obtained when the diameter of each lens is substantially $^{1}/_{15}$th of a millimeter and corresponds therefore to 225 lenses per millimeter of area.

This type of screen necessitates accurate evenness in the thickness of the support as well as a perfectly accurate regularity of the impressions on the surface of the photographic support. The least difference involves variations in the image formation plane as well as in the dimensions of the images, and such variations, the extent of which is furthermore functional of the refractive index, involve substantial losses in vividness of colour or in the luminosity of the image.

Considering now what occurs in the case of screens with 500 and more lenticular elements per square millimeter, we find that a new phenomenon, namely: diffraction, has preponderant effect in the formation of microscopic images in the ocular disc of the objective. Each lenticular element still gives an image by

[*Price* 1/-]

simple refraction but it operates furthermore in the manner of a pinhole or stenope and the image given by it from the ocular disc of the objective is characterised by a substantially constant clearness in all the planes, and by uniformly increasing size according to the distance of the plane considered and independently of the refractive index. Should such a number of lenticular elements per square millimeter be selected, that the diameter of each of them correspond to the diameter of the diffraction image which would be given by the said lenticular element from the ocular disc of an objective and according to the plane of the sensitive emulsion of the film considered, it will be apparent that it is possible, as in the case of a screen with 225 lenticular elements per square millimeter, to emboss or impress the whole of the sensitive layer at the rear of the said elements. Moreover, owing to the abovementioned physical reasons, the size of the said images and consequently the perfection of the colour images, will be much less affected by variations in the thickness of the support and the differences in curvature of the lenticular elements than were those of images obtained on screens with 225 lenticular elements per square millimeter. The type of screen which most approximates best theoretical conditions comprises 625 elements per square millimeter, but the diffraction phenomenon which characterises it shows this phenomenon under a definitely utilisable form fairly below this number and considerably above it (1000 and more).

The foregoing numerical values are moreover functional of the thickness of the photographic films provided with lenticular screens, as has already been stated; the average value of the number of lenticular elements described to the typical or standard screen corresponding to a given thickness of the emulsion support must vary inversely to the square of the said thickness in order to remain in the conditions of best utilisation of the sensitive surface. If, for instance, the film is $^6/_{100}$ths instead of normally $^{12}/_{100}$th of a millimeter thick, the standard screen must not have 625 but $\frac{625 \times 12^2}{6^2}$ or 2500 elements per square millimeter. This figure may vary within wide limits and still give good practical photographic results.

Similarly the size of the lenticular elements and therefore their number varies according to the absolute aperture of the photographic objectives utilised, the lenticular elements having to be the finer for one and the same film thickness the smaller the aperture the unitarian number of elements in the standard screens having to remain proportional to the ratio of the square of the relative aperture.

The use of lenticular screens operating as above has a further great advantage over simple refraction screens. All those screens comprise microscopic lenticular elements the diameter of which is functional of their number per unit area, and is of the same order of magnitude as the definition of the projection objectives, that is $^1/_{25}$th of a linear millimeter and less. The result is that the images recorded on those screens do not allow their reticular texture to be felt on being projected, and owing to the same reason, such images can be reproduced by projection, either on the same or on a modified scale, without their screens becoming visible or producing moires or waterings, a defect which can be eliminated on screens having 225 lenticular elements per square millimeter only by means of elaborate and complicated optical devices or film crossings involving most complex apparatus.

It will be seen from the foregoing that it is highly advantageous in most cases to raise the number of lenticular elements from 500 to 2000 and more per square millimeter on dies for embossing microscopic lenticular screens on photographic films.

The invention is therefore characterised by the fact that a diffraction effect is produced by increasing the number of lenticular elements per square millimeter. The real characteristic of the invention is the working of the film by diffraction effect and, as will be readily grasped, (while conducive to results inferior to those achieved by increasing the number of lenticular elements but yet very valuable) the same diffraction effect can be obtained even by using screens with 225 lenticular elements per square millimeter by providing the support with an opaque screen limiting the diameter of each element in view of reducing it sufficiently to produce the contemplated diffraction effect.

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:—

Our invention consists in increasing to beyond 500 and even 1000 lenticular elements per square millimeter the number of such elements provided on dies intended to emboss microscopic lenticular screens on photographic films, according as films of standard thickness or thinner films are used and according as objectives in which the ratio of aperture is equal to or different from 2.5 are used, for the purpose of causing the said screen to operate by diffraction, owing to the minuteness of their lenticular elements as well as by refraction owing to the curvature of the said elements. In the case of films of a thickness other than $^{12}/_{100}$ths of a millimeter, varying the number of lenticular elements per square millimeter proportionately to the inverse ratio of the square of the thickness of the film. Varying the number of said elements according to the ratio of the square of the aperture of the objectives used. The invention has as a consequence to allow a greater latitude in gauging and impressing the support; the screen is invisible when the images are projected or reproduced, owing to the use of microscopic lenticular elements the diameter of which is of the same order of magnitude as the definition of the photographic objectives. The invention is further characterised by the combination with a relatively restricted number of lenticular elements of an opaque screen limiting the diameter of each element in view of reducing the said diameter sufficiently to produce the desired effect of diffraction.

Dated this 4th day of December, 1923.

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