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COMPLETE SPECIFICATION.

Improvements in the Production of Photographic Colour Pictures.

We, I. G. FARBENINDUSTRIE AKTIENGESELLSCHAFT, a Joint Stock Company organised according to the laws of Germany, of Frankfurt a/Main, Germany, 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 the process according to Berthon's Specification No. 10,611 of 1909 for preparing motion pictures in natural colours there is used a multicolour filter composed in its usual form of three parallel strips dyed in the fundamental colours red, green and blue, and a penchromatic photographic material, the support of which is embossed on its back, which faces the objective during the exposure with microscopic refracting cylindrical lenses. Another known form of three-colour filter comprises four parallel strips of which the two outer strips have the same colour. The strips formed by the cylindrical lens elements run parallel to the longitudinal direction of the filter strips of the multicolour filter placed in the plane of the diaphragm of the objective.

The present invention has for its object a process of producing photographic pictures reproducible in natural colours, on films bearing microscopic refracting lens elements while observing the above-mentioned conditions, and a multi-colour filter suited for the execution of this process. In the following description the invention is exemplified by a multicolour filter in the usual three fundamental colours red-green-blue; it is, however, not limited thereto, but may also be applied to processes in which colour pictures are produced with the aid of multi-colour filters of only two or more than three fundamental colours.

According to this invention the width of a series of colour strips in the colours red-green-blue of the filter has relation to the diameter of the single element of the lenticular embossing of the film.

Each lens element produces in the photographic layer a real image of the multi-colour filter. The size of these filter images depends upon certain conditions. In theory an unobjectionable reproduction is best obtained by arranging that the filter images produced in the light-sensitive layer by the adjacent lens elements just touch at their edges. This condition is fulfilled if the width of the filter images, having the form of strips, is equal in the direction at right angles to their length to the diameter of the cylindrical lenses in a direction at right angles to the focal line. If the images are larger than the diameter of the lenses, the two marginal strips of two adjacent filter images would overlap, so that, for instance, in the case of the usual sequence of colours in a filter, viz. the succession red-green-blue, a bluish-red coloured marginal zone would be produced, rendering the exact reproduction of the actual colours impossible. If the filter images are to be adjusted so that they do not overlap each other, the following equation must be fulfilled:

$$\frac{d}{f} = \frac{D}{F}$$

In this equation d is the diameter of the cylindrical lenses in a direction at right angles to the focal line; f is the focal length of the lens elements or the thickness of the support, which is equal to this focal length; D is the width of the multicolour filter or of its virtual image in a direction at right angles to the length of the strips, and F is the distance of the multi-colour filter or of its virtual image from the plane of the lenticular screen. Hence follows the equation:

$$D = \frac{F}{f} \cdot d$$

Therefore, according to this invention, the width of a series of colour zones in the colours red-green-blue of the filter is so selected that the optical image of the said series of colour zones projected by a lens element has just the diameter of this lens element. The result attained in the first place is that the filter images projected by the several cylindrical lenses touch one another, that is to say they cover the whole surface of the film throughout. In this case, the longitudinal extension of the filter strips may be chosen at will.

When working according to the hitherto known processes the utilisable aperture would, especially if objectives of large aperture are used, not totally be covered by the filter thus constructed, but would have to be obturated, with exception of the multi-colour filter, in order to exclude false light. It has now been found that these portions of the light which would wholly be lost may also be utilised by repeating incompletely the series of the colour strips in the succession of colours red-green-blue in the same sequence and breadth of the zones, in such a way that adjoining both margins of the original series, there is an incomplete repetition of this series, or several repetitions of this series of which the outermost repetition is incomplete. If the succession of the colour zones from left to right be, for instance, blue-green-red, then it is continued according to this feature of the invention from the red strip in the succession blue-green-red-blue-green-red etc. and on the other margin from the blue strip in the order red-green-blue-red-green-blue, etc. The number of repetitions of the series of colour zones is determined by the dimensions of the view-taking objective used in each case. In general, the repetition is continued up to the edge of the utilisable aperture of the objective, but is is likewise possible to discontinue the repetition so that a small part of the aperture remains uncovered by the light filter. As already indicated, the multi-colour filter does not comprise on each side of the middle series a whole-number multiple of the simple succession of the colour strips, and in the above-mentioned Example, for instance, the outer strip on the left is either a green or red one and that on the right is either a blue or green one. Consequently, in the case of the simplest form of execution a filter consisting of, for instance, three fundamental colours, comprises five zones in the succession blue-red-green-blue-red.

The working method of the new process will now be illustrated by a three-colour filter having one incomplete repetition of a series of the colour zones on each side. In this case the image of the middle group of strips in the colours red-green-blue produced by a lens element of the film, is of width equal to the diameter of the lens element. On the left and right there follow directly the images of the middle group projected by the two adjacent lens elements. Superimposed upon the image of the middle group of strips projected by the middle lens there is moreover produced by the right lens element the image of the right incomplete group of strips of the filter, and by the left lens element the image of the left incomplete groups of strips of the filter, the images produced by the three juxtaposed lens elements being in strict coincidence.

In general, by the new arrangement of the filter strips the ratio of the total permeability of all filter strips of a fundamental colour to the permeability of the total filter surface of the other fundamental colours will be changed in comparison with the ratio of permeability of the corresponding simple multi-colour filter. In order to obtain the best ratio of permeabilities ascertained for the emulsion to be used, the colour zones may be shortened in their longitudinal direction and thus the proportion of the coloured surface be modified. It is however likewise possible to alter the permeability of the colour surfaces. In this case it is advantageous to increase the permeability of that colour which covers the smallest surface in the filter and to choose as the colour to occupy the smallest surface that colour the permeability of which can be increased with the smallest reduction of its spectral properties.

In the case of the three-colour filter the colours red and blue are best suited to this end. It is therefore recommended to adopt for a filter consisting of five zones of three fundamental colours the colour succession green-blue-red-green-blue or green-red-blue-green-red, since in the case of red and blue a brightening is possible, in comparison with the three-colour filter hitherto used, by reducing the dyestuff concentration without production of any essential deterioration of the colour selection. For daylight exposures the middle zone is preferably given a blue colour and for Nitra-light exposures a red colour.

In general the filter zones of the same fundamental colours will have exactly the same spectral permeability. But there exists the possibility of imparting to the zones of the same kind, i.e. having the same coloration, while preserving their fundamental colour, a different spectral permeability so that by the combination of two colour strips which are unsuitable by themselves an improved selection of colours may be attained.

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 process of producing colour-record pictures on films having cylindrical lenticular embossings, wherein there is used a multi-colour filter comprising a middle group of colour strips in two or more fundamental colours and, adjoining each

margin of the middle group, an incomplete repetition of this group in the same range of colours, or several repetitions of this group of which the outermost repetition is incomplete, and wherein the width of the middle group of filter strips is so related to the lenticular embossings of the film that the image of the middle group projected by each lenticular element has the diameter of a lenticular element.

2. A process of producing colour-record pictures on films having lenticular embossings as referred to in claim 1, wherein the filter strips of the same fundamental colour are given a different spectral permeability.

3. A process of producing colour-record pictures on films having lenticular embossings as referred to in claims 1 and 2, by using a multi-colour filter in which the colours covering a comparatively small surface of the filter are photographically adapted to those of larger areas by increasing their permeability.

4. A process of producing colour-record pictures on films having lenticular embossings as referred to in claim 3 by using a multi-colour filter in which the colour which occupies the smallest surface is that colour whose permeability can be increased with the smallest deterioration of its spectral properties.

5. A three-colour filter for the process referred to in claims 1, 2 and 3, consisting of five colour zones the marginal zone of which on one side has the same fundamental colour as the last strip but one of the marginal zone on the other side, but, if desired, a different spectral permeability.

6. A three-colour filter as referred to in claim 5, in which the middle zone is coloured either blue or red.

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