PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in and relating to Colour Photography

We, KODAK LIMITED, a Company registered under the Laws of Great Britain, of Kodak House, Kingsway, London, W.C.2, (Assignees of JOHN GEORGE CAPSTAFF, a British Subject, of Kodak Park, Rochester, New York, United States of America), 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:—

This invention relates to methods of and materials for colour photography and is concerned with that type of process in which the component colours are recorded as separation records in separate minute areas by employing lenticular photographic elements in which minute lenses, referred to as lenticulations, are provided on one face of the support and the colour separation records are produced, in registration with the lenticulations, in an emulsion coating on the other face of the support.

Pictures are ordinarily taken on lenticular film through a multi-colour filter associated with the objective; the coloured areas of the filter normally see the subject being photographed from different view-points and this produces defects which can only be overcome with difficulty and in a complicated and inconvenient manner.

In the present invention a multi-colour photographic record having broken-tone colour records is obtained by first producing continuous-tone colour records in the recording material and then converting each continuous-tone colour record into a broken-tone colour record. As is known, in the broken-tone colour records employed in the lenticular process, the colour separation records are present in sets of separate minute areas, each set corresponding to a lenticulation, and the areas are arranged laterally in relation to the optical axis of the photographic support. In continuous tone colour records, however, a record of each colour sensation is present in every minute area of the photographic element.

By the present invention several advantages are secured among which may be mentioned absence of the necessity of any special optical system or multi-colour filter associated with the camera and reduction of camera exposure as compared with that normally required when employing lenticular film.

The present invention makes it possible to combine the best features of both the additive and subtractive processes without the necessity of adopting their most serious weaknesses.

In accordance with one aspect of the present invention a lenticular support is provided on its plane surface with a plurality of differentially sensitized emulsions which may comprise separate layers, a single layer of mixed particles, or a combination of these, the primary sensitivity of each being for a different one of the component colours which it is desired to record. The lenticular surface is rendered optically smooth thus optically obliterating the lenticulations and the resulting film exposed through the support to an image of the subject to be recorded. After exposure and before development the lenticulations are restored and the separate areas behind each lenticulation are subjected to a selective fogging exposure so that in each area a different one of the emulsions is unaffected. Alternatively, the selective fogging exposure may be given before the camera exposure and before the lenticulations are temporarily optically obliterated. The film is then developed by a reversal process to provide a resulting film in which the colour separation images are in registration behind the lenticulations.

In the selective fogging exposure, the different areas behind each lenticulation are exposed to differently coloured light beams, each of which is minus a different one of the colours to which the different emulsions are respectively sensitive, the number of areas being the same as the number of different emulsions, whereby in each area all but one of the emulsions are re-exposed to light to which they are sensitive. Thus in a three-colour process a banded filter may be used in which the bands are respectively yellow (minus blue)

magenta (minus green) and blue green (minus red).

In accordance with another aspect of the invention, the step of temporarily optically obliterating the lenticulations may be omitted if the film is arranged during the camera exposure with its emulsion side facing the incident light. To insure the proper registration of the final images, the selective fogging exposure will, of course, be given through the support either before or after the camera exposure. While this method of practising the process of the invention is a very simple one, the spectral sensitivity of the emulsions at present available is not entirely satisfactory for the ordinary three component colours because of the requirement that the several emulsions must be selectively exposed with light incident thereon first from one side and then from the other side. This difficulty can be overcome by the employment of an infra red component in the fogging light for one at least of the fogging exposures in conjunction with a set of emulsions at least one of which is sensitive to infra-red.

Still another way is available for dispensing with the temporary optical obliteration of the lenticulations during the camera exposure if the user is willing to employ a camera objective having an aperture which meets the requirement demanded by the apertures of the film lenticulations. In this alternative the camera exposure is made through the lenticulations without any multicolour filter. Due to the absence of a multicolour filter at the camera objective, the camera exposure necessary is not increased by the presence of the lenticulations but some of the advantages of the invention are in this method lost.

If a film resulting from the process of the invention is to be employed to print in any well known manner on film other than lenticular film, the lenticulations on the original film may be made having smaller relative apertures, such as f.3.5, thereby making it practical to employ more lenses per unit area, to employ a thicker support and thereby to give the lenses on the film a greater depth of focus which improves the definition.

The invention will be best understood by reference to the following description when read in connection with the accompanying drawing in which,

Fig. 1 shows on an enlarged scale a lenticular film provided with a monopack of differently sensitized layers and a coating for optically obliterating the lenticulations;

Fig. 2, illustrates diagrammatically an arrangement for selectively fogging certain areas of the monopack layers; and

Fig. 3, illustrates the developed picture film resulting from the method of the invention.

Carrying out the invention a transparent support provided with a plurality of differentially sensitized emulsion particles or layers is exposed to a coloured image before or after which the uncoated face of the support is provided with lenticulations. These lenticulations may be embossed upon the support after the camera exposure or embossed thereon at some prior time. Due to a number of difficulties involved in embossing a support having an exposed layer thereon without damaging the latent image, it is preferred to employ a lenticular support and temporarily optically obliterates the lenticulations prior to the original exposure if such exposure is to be made through the support.

The preferred form of sensitive material is illustrated in Fig. 1, as comprising a transparent support 10 having minute lenticulations 11 on one of its faces and a plurality of differentially sensitized layers indicated as B, G and R on its other face. The lenticulations 11 are covered with a smooth layer 12 of some suitable readily removable transparent substance which preferably has a refractive index approximating the refractive index of the support 10, whereby the lenticulations 11 are optically obliterated. This temporary coating 12 may conveniently be a broken down and readily soluble gelatine or glue which may be satisfactorily removed in cold water. The exact composition of the coating 12 will, of course, vary somewhat with the nature of the support 10 and in order to secure the proper cohesion between the coating 12 and the support 10, it may be necessary, in some cases, first to apply a substratum coating thereto or to include in the gelatin solution a material having a slightly solvent action upon the support 10. A suitable substratum coating for most present day commercial film base may comprise a mixture of 30% acetone, 2% gelatin and water and applied to the film at a temperature of approximately 100° F. The above examples are given merely to indicate two satisfactory procedures and anyone skilled in the art will experience no difficulty in practising the invention by following the procedures and, of course, other well known materials may be employed for the removable layer 12.

The number of emulsion layers provided on the support 10 will depend upon

the number of component colours it is desired to record or employ in the process, but, inasmuch as it is the common practice to employ three colours, the invention will be described in detail as applied to a three-colour process. The actual colours chosen will depend upon the user and the emulsion layers are shown as being differentially sensitized to approximately the blue, green and red as indicated respectively by the reference characters B, G and R. Monopacks of this type are well known and, if desired, certain of the layers may contain dyes for screening purposes and for controlling the gammas of the respective layers as is well known. For example, the first layer B will preferably contain a yellow dye which will not transmit an appreciable amount of blue light to the layers G and R when the monopack is exposed through the support 10. Although the screening layers may comprise separate layers between the emulsion layers B, G and R, it is preferred to incorporate any such screening layers directly in the emulsions in the interest of keeping the combined thickness of the monopack layers at a minimum for purposes well known, such as reducing colour splashing and improving definition.

The film above described, is exposed through the support 10 to a coloured object which results in a latent image being present in each of the emulsion layers in accordance with the colour characteristics of said object, as is well known. The temporary layer 12 of soluble, transparent varnish is then removed as, for instance, by washing in cold water for about ten minutes if broken down gelatin has been employed for the layer 12. The film, with the lenticulations 11 restored as shown in Fig. 2, is then uniformly exposed to differently coloured light in such a manner that separate areas of the monopack emulsion are exposed to light of a single colour and the location of these separate areas is controlled by the lenticulations 11. This exposure may readily be accomplished in the ordinary manner employed for exposing lenticular film and a conventional arrangement is shown in Fig. 2 as comprising a light source 13 which illuminates the film 10 through a banded filter, each band of which transmits light minus a different one of the colours for which the emulsion layers B, G and R are sensitive, that is, a blue-green zone transmits minus red light and the light transmitted by this zone and directed to an individual area behind the lens element 11 will not expose the layer R, but will uniformly fog the blue and green layers B and G in that area. In a similar manner the magenta zone of the filter transmits minus green light which uniformly fogs the blue and red sensitive layers in another area but does not affect the green sensitive layer in that area and the yellow zone of the filter transmits minus blue light which does not affect the blue sensitive layer in a third area but uniformly fogs the green and red layers in that third area. This supplemental or printing exposure thus leaves three unfogged areas in three different layers in registration with each lenticulation 11 and upon development of the film by a reversal process the fogged areas in the different layers are completely bleached and become transparent and there remains only a positive silver image distributed in the three layers in registration with the lenticulations 11 as shown in Fig. 3. These three positive images B^1, G^1 and R^1 correspond in density to the amount of blue, green and red light in the original coloured object to which the film was exposed and since these three images are in registration with the lenticulations 11, the result is a complete lenticular colour record and it can be printed or projected in the regular manner.

It will, of course, be understood that the lenticulations 11 are very small and that what has been described as happening behind a single lenticulation happens behind all of the lenticulations. It is also to be understood that the exposing arrangement shown in Fig. 2 is diagrammatic in order to render this step of the process easily understandable and that, in practice, a conventional arrangement employing an objective lens associated with the banded filter may be used in much the same manner as it is at present used in cameras and printers for exposing lenticular film. Preferably the film will be moved non-intermittently through the printer.

If the camera exposure is to be made with the emulsion side of the film facing the incident light the emulsion layers will be arranged in a different order so that the several colours shall be properly recorded. The fogging exposure step illustrated in Fig. 2 will be accomplished in the same general way but with such changes as to insure the desired selective fogging.

If the camera exposure is made through the lenticular support and with the emulsion layers in order shown in Fig. 1 a gain in definition is secured by reason of the chromatic aberration of the lenticulations being in a favourable direction, i.e., the blue light is brought to a focus

first and the blue sensitive layer is the closest to the lenticulations. Also the scatter of wavelengths tends in the same direction as the order of the layers.

It will be evident that in the present process the colour separation in the several layers depends alone on the latent image formed as a result of sensitizing and screening and is not further complicated by the necessity of controlling the penetration of processing baths as is necessary in certain purely subtractive processes. Moreover, the emulsion layers may be much more sensitive than corresponding layers employed in films of the catalytic bleach type, i.e. films in which the layers or some of them are initially coloured with colouring matter adapted to be bleached, after exposure and development, with the catalytic aid of the silver of the image.

The invention may also be applied to the production of lenticular negatives. In this case the element, after exposure to the coloured object, is developed and fixed and the developed images reconverted to light sensitive silver salt, e.g. re-converted to silver halide. If the lenticulations have been temporarily obliterated and the exposure made through the support, they are now restored and the element subjected to fogging exposure and then redeveloped and fixed. In this case the light employed for each area is so composed as to affect one only of the emulsions in each area. Thus where three emulsions sensitized to blue, red and green are employed, a banded filter may be used, the bands of which are coloured respectively blue, red and green as in normal practice. In this modification of the invention it is necessary to select sensitizing dyes and filter dyes (if such are employed in the photographic element) which will resist the operations of development, fixing and reconversion of the developed images to light sensitive silver salt. A final separate step for removal of any such filter, e.g. with a powerful reducing agent, may be employed.

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. The method of obtaining a multicolour photographic record having broken-tone colour records which consists in first producing continuous-tone colour records constituted by light-sensitive silver salt in a photographic element having a plurality of differentially colour sensitized emulsions on one side of a single support by exposure to a coloured object and converting each continuous-tone colour record into a broken-tone colour record by exposing through lenticulations carried by the same support to fogging light passed through a banded filter each band of which permits the passage of light which can act upon one only or all but one of the emulsions.

2. The method as claimed in Claim 1 in which the differentially sensitized emulsions are in superimposed layers.

3. The method as claimed in Claim 1 or 2 in which the fogging light is passed through lenticulations formed on the face of the support opposite to that which carries the emulsions.

4. The method as claimed in claim 3 in which the lenticulations are formed on the support after exposure of the emulsions to the coloured object.

5. The method as claimed in Claim 3 in which the continuous tone colour records are produced by exposing the film to the coloured object from the side opposite to that which carries the lenticulations.

6. The method as claimed in Claim 3, in which the lenticulations are temporarily optically obliterated and the exposure to the coloured object is then made through the support.

7. The method as claimed in any of the preceding claims, in which one at least of the differentially sensitized emulsions has an additional sensitivity in the infra red region of the spectrum and the fogging is effected in such emulsion or emulsions by means of light containing an infra-red component.

8. The method as claimed in any of the preceding claims, in which the fogging exposure is effected before the exposure to the coloured object.

9. The method as claimed in Claim 6, in which the fogging exposure is effected after the exposure to the coloured object and after restoring the lenticulations.

10. The method as claimed in any of the preceding Claims in which a positive broken tone multicolour record is produced by passing the fogging light through a banded filter each band of which allows the passage of light which will affect all but one of the sensitized emulsions.

11. The method as claimed in Claim 10, in which the element has three emulsions respectively sensitive to blue, green and red and the bands of the filter are coloured respectively yellow, magenta and blue-green.

12. The method as claimed in any of claims 1 to 7 in which, for the production of a negative broken-tone multi-colour

record, the fogging exposure is effected after the continuous tone colour records produced by exposure have been developed, fixed and reconverted to light sensitive silver salt images which are still selectively colour sensitive and the fogging light is passed through a banded filter each band of which allows the passage of light which will affect one only of the sensitized emulsions.

13. A multicolour photographic film for recording continuous tone colour records comprising a transparent support records and converting them into broken tone colour records comprising a transparent support having lenticulations on one face and three differentially colour sensitized emulsions on the other face each adapted to record a different one only of the three primary colours.

14. A multicolour photographic film for recording continuous tone colour records and converting them into broken tone colour records which comprises a transparent support having on one face a plurality of differentially colour sensitized emulsions and on the other face lenticulations which are optically obliterated by a smooth layer of removable transparent material.

15. A film as claimed in Claim 14, in which the removable transparent material is broken down gelatine.

16. A film as claimed in any of Claims 14 or 15, in which the differentially sensitized emulsions are in separate layers.

17. A film as claimed in Claim 16, in which the emulsions comprise a blue sensitive emulsion next to the support and green and red sensitized emulsions over the blue sensitive emulsion, screening means being arranged in front of the green and red sensitized emulsions to absorb blue light.

18. A film as claimed in any of Claims 14 to 17, in which the colour sensitizing dyes and any filter dyes which may be present in the film are resistant to the reagents to be employed for development, fixing and reconversion of the developed images to light sensitive silver salt.

19. A lenticular colour photographic record whenever produced by the methods claimed in Claims 1 to 12.

20. A lenticular colour photographic record having on one side of the support the lenticulations and on the other side of the support a plurality of photographic layers each containing a record of one only of the colour sensations recorded.

21. A lenticular colour photographic record having the lenticulations on one side of the support and a plurality of emulsion layers on the other side of the support in which the record of one colour sensation only is present in each layer and present in the area behind each lenticulation.

22. An uncoloured lenticular colour photographic record in which the black and white images constituting the different component colour records are in separate layers.

23. The methods of and materials for producing lenticular colour photographic records, substantially as described.

Dated this 13th day of September, 1937.
W. P. THOMPSON & CO.,
12, Church Street, Liverpool, 1,
Chartered Patent Agents.

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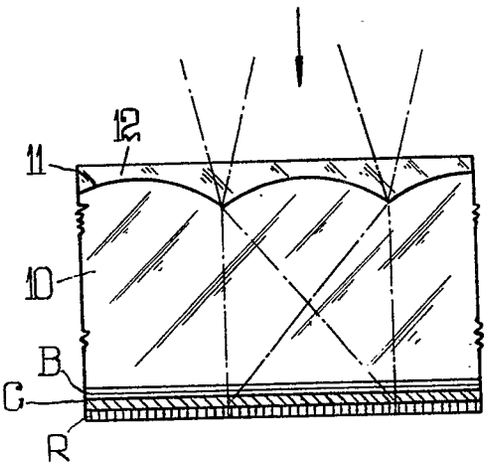

FIG. 1.

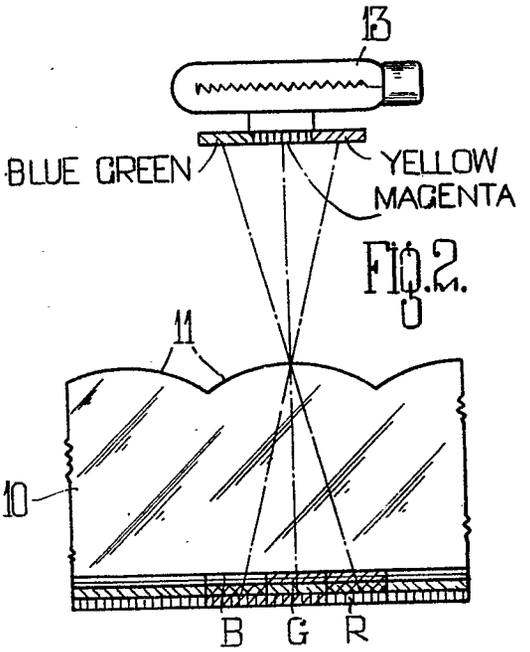

FIG. 2.

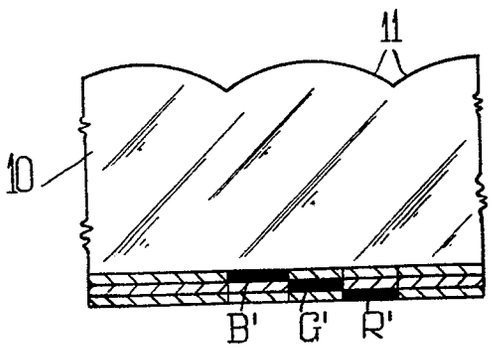

FIG. 3.

Malby & Sons, Photo-Lith.