PUBLISHED
MAY 4, 1943.
BY A. P. C.

A. H. J. DE L. SAINT GENIES

COLOUR FILMS

Filed June 10, 1940

Serial No.
339,812

2 Sheets-Sheet 1

Fig. 1.

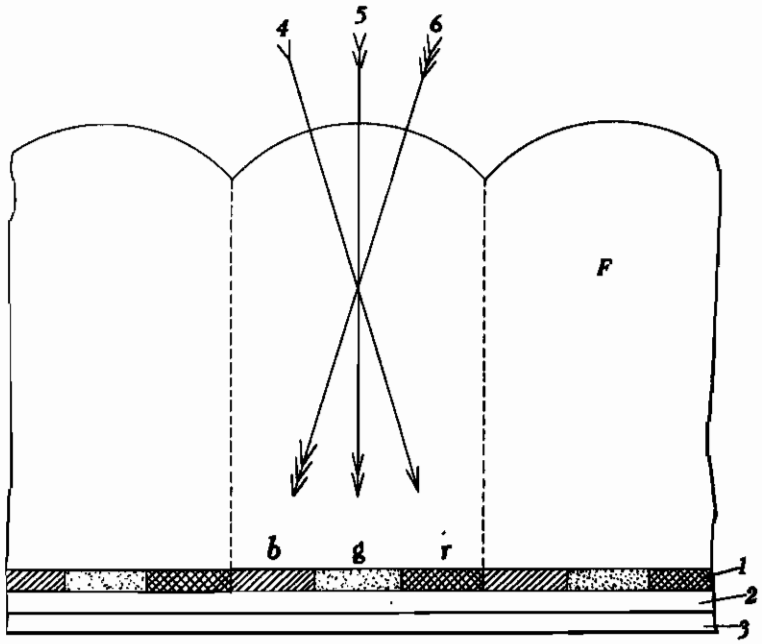

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Fig. 2.

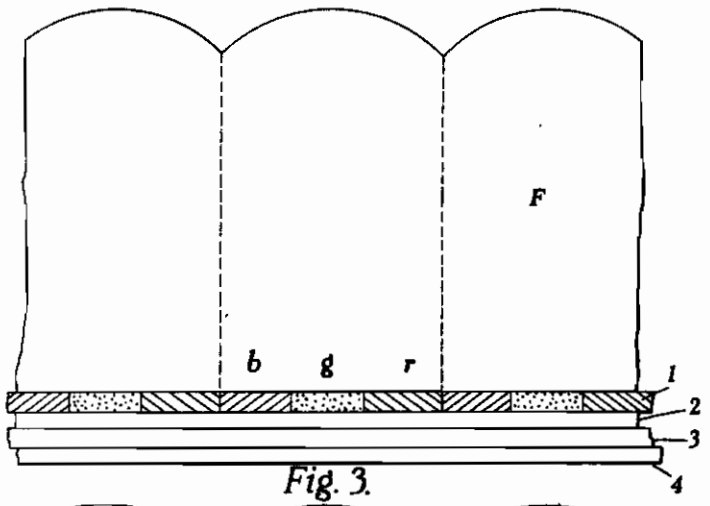
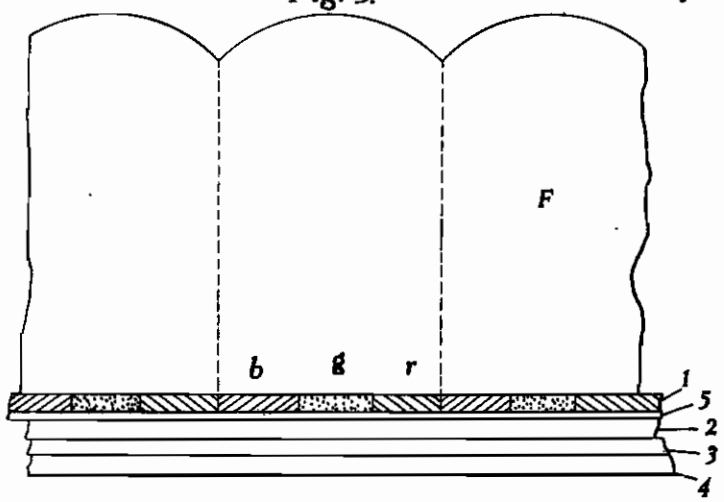


Fig. 3.



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ALIEN PROPERTY CUSTODIAN

COLOUR FILMS

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Application filed June 10, 1940

This is a continuation-in-part of my application Serial No. 263,996 filed 24th March 1939 for "Colour films".

This invention relates to colour films having lenticulations destined to allow of the separate recording of the separation monochromes and having a plurality of superposed sensitised layers in which these successive recordings are effected. The invention relates particularly to a novel arrangement of such films and to modes of operation which enable superposed images to be obtained in the said layers, these images being preferably coloured by the method of subtractive synthesis.

In accordance with the invention the film comprises a translucent lenticular support on the smooth face of which there are provided, in the course of manufacture, for example, a plurality of sensitised emulsions of different kinds which are in every case only capable of recording distinct images by any known method, for example by rendering these layers sensitive to different regions of the spectrum. The first of these layers in contact with the support is preferably transparent; after recording in this first layer, with the aid of radiations which do not affect the succeeding layers, a primary negative image for example, complete and consisting in the usual manner of a plurality of primary black and white juxtaposed monochromes, the monochrome images that have been successively recorded are selectively illuminated, by virtue of the optical properties of the lenticulation by corresponding radiations in each of the superposed layers, starting from the outermost layer, i. e. that furthest removed from the support, and proceeding systematically towards the lowermost layer.

According to one embodiment a lenticular film is obtained bearing black and white primary monochrome images juxtaposed in known manner in the single emulsion layer of any suitable composition, which alone is normally attached to the lenticular support; and the treatment of this film is finished in the conventional manner by washing and drying after fixing. On this film, which presents positive or negative images as required, there are adjoined, in accordance with any known technique, the multiple sensitised layers in which the chromogenic treatments are to take place, proceeding in every case in the stated order from the outermost towards the innermost layer.

By virtue of the application of the means according to the invention it becomes possible:

1. To separate, in time, the operations for recording the secondary monochrome images and the operations for their development; this result is obtained by the particular orientation, in respect of each of these images, of the beams recording these monochromes through the lenticulations and the primary images, without sacrifice of registration, the latter having been obtained originally by development of the complete primary image;

2. To separate strictly, in space, the secondary monochromes by distributing them between the adjacent layers of emulsion; this separation is obtained by the sensitisation of these layers for distinct spectral zones;

3. To avoid all projection of a secondary monochrome image, developed and possibly coloured on another layer. This result is due to the application of the means stipulated under 1 and 2 above, in the order from the outermost layer to the innermost layer in contact with the cellulosic support;

4. By securing these three results, to adjust with ease the contrast factor requisite to each monochrome image;

5. To reduce cost to the minimum compatible with the desired quality of the result, owing to the easy manufacturing of the film and the use of as small a number of well-known chemical treatment steps as possible.

In the accompanying drawings:

Figure 1 represents in magnified cross-section one type of film which may be used in carrying the invention into effect,

Figure 2 represents in magnified cross-section a further type of film, and

Figure 3 represents in magnified cross-section a modification of the type of film shown in Figure 2.

First example

Figure 1 of the accompanying drawings represents an embodiment of a film adapted in manufacture to carry on one of its faces for example three emulsion layers sensitised to distinct zones of the spectrum comprising visible or invisible radiations, this film being provided with lenticulations on the other face prior to the recording of the complete primary image.

It is assumed that the emulsion of layer **1** in immediate contact with the support **F** is sufficiently transparent to allow the two other layers **2** and **3** to be exposed by light traversing layer **1**.

Layer **1**, sensitive only to red rays for example, is first imprinted by itself by means of such rays passing through the lenticulations, with the aid of a suitable optical system in a well established known manner, with a view to being able to develop in this layer **1** a complete primary image composed for example of the three black and white monochrome line negatives *b*, *g*, *r*, reproducing the monochrome of an original.

Since the two other layers **2** and **3** are not sensitive to the radiation which has just been used, these layers are not affected by the above operations.

Prior to any fixation, one of the secondary positive monochromes is then recorded in the

layer 3. This monochrome is derived from the primary image with the aid of beams of rays of any desired orientation and corresponding to the zone of the spectrum for which this layer 3 is sensitized; these beams are directed by the lenticulations onto the selected primary monochrome only.

The subsequent procedure may then, for example, be as follows:

It is assumed that there may be used colour developers such as are at present known, capable of developing the three layers each in a predetermined colour. If layer 3 is sensitive to blue for example, it is imprinted by blue light, directed for example as indicated by the arrow 4, to traverse the primary monochrome corresponding in the figure of the drawing to the red monochrome *r*. In this way there is obtained a positive image which is developed in bluish green complementary to the red of the image in layer 1, in an appropriate colour developer. Generally speaking a certain amount of reduced silver remains mixed with the revealed colouring matter.

In the layer 2 sensitive for example to green there is imprinted, by green rays directed as indicated by the arrow 6, the positive monochrome *b* corresponding for example to blue and destined to come out in the yellow complementary to this blue; this layer 2 is then developed so as to reveal a yellow positive.

Finally, in layer 1, with the aid of red rays directed as indicated by the arrow 5, an image is recorded in the remaining portion of the halide in this layer, corresponding only to the last monochrome not yet reproduced, and destined to appear in the purple complementary to the green of *g*; development is therefore then effected in purple.

It will be understood that this successive development may be very exactly adjusted as to density and as regards contrast factor, as well as in respect of the degree of diffusion in the colouring matter in each layer, this diffusion being sufficient to eliminate all trace of the microscopic line structure of each image, since it is desired preferably to obtain a result by subtractive synthesis.

When all these operations have been carried out the next step is to dissolve the reduced silver present in the secondary images, as well as that to be eliminated from the entire primary silver image, and any unexposed silver halide that may still be present in the different layers is likewise dissolved out.

Second example

If the three layers are superposed on the layer containing the primary silver images of the lenticular film, they may only comprise one layer of silver chloride (or silver chloro-bromide) adjacent the other two layers or positioned in between the two other layers of silver bromide. If these three layers are sensitised in respect of absolutely separate zones of the spectrum, and if the chloride layer is the first or second counting from the outside, the outermost layer is first exposed for imprinting thereon one of the secondary monochrome images, by rays corresponding to its sensitisation, these rays traversing the lenticulations of the support and one of the primary monochrome silver images juxtaposed in the layer initially attached to the lenticular support; the second layer contacting therewith is then likewise exposed for the recording therein of another of the secondary monochrome images; the chloride layer is then developed using a colour developer having a low reduction potential and of a nature to develop only the secondary image of this layer. Thereafter, preferably with the aid of colour developer, the latent secondary image in the bromide layer contacting therewith is developed. It then merely remains to expose the last bromide layer, which is in contact with that initially carrying the primary images by the rays for which it has been sensitised, in order to record therein the third secondary monochrome image, and then to develop this latter in colours.

If this third layer is the chloride layer, the procedure will be to expose and treat selectively the outermost layer, then to expose the other two layers and to treat them selectively as has just been described in the preceding instance, by virtue of the fact that they are composed of different halides allowing of the employment of developers having different reduction potentials.

Finally, the reduced silver and the halide remaining in all the layers is dissolved out.

In the two cases under consideration it will be understood that all requisite washing operations are carried out between the different treating steps, as also adequate drying or appropriate wiping of the lenticular face of the film to ensure the obtaining of the successive imprinting of the secondary images by means of the various appropriately directed beams.

It then remains to wash and dry the film and to obliterate the lenticulations, for instance by varnishing, these lenticulations having ceased to be useful for colour projection which may be effected in any type of projector without the necessity for special measures or precautions.

It will be understood that it is possible, without departing from the spirit of the invention and while using the technique described in the first example to superpose four emulsion layers instead of merely three. One of these layers may then preferably be rendered sensitive to an invisible region of the light spectrum. Under these conditions the layer 1 may only contain the complete primary image and may not be made use of to carry one of the secondary colour images.

Referring to Figure 2, in their order, from the support 2 outwards, the emulsion layers are denoted by 1, 2, 3 and 4, as in the case of the examples previously given. Layer 1 and layers 3 and 4 are silver chloride layers, the first preferably highly transparent, and layer 2 is a silver bromide layer.

Layer 1 is sensitive to blue only, and is also tinted with yellow colouring matter which absorbs blue rays, the colouring matter used for this purpose being soluble in water in known manner.

If layers 3 and 4 are respectively sensitive, for example to green in the case of layer 3 and to red in the case of layer 4, layer 2 being, like layer 1, sensitive to blue only, it will be understood that it is possible first to record a complete primary image in layer 1, by blue light, for example by copying a lenticular original bearing, in conventional manner, its three monochrome components recorded black and white. The elementary monochrome components are denoted by *b*, *g* and *r* in the drawing.

This first layer 1 is developed but not fixed. The colouring matter in this layer disappears in the course of this first development or in the course of the washing which preferably follows the developing. Then, with the aid of red rays suitably directed, one of the monochrome com-

ponents, developed in the layer 1, is recorded in the red-sensitive layer 4, and preferably treated with chromogenic developer. An exposure of layer 3 is then similarly effected with green light, and another of the monochrome components of layer 1 is developed and given its appropriate colouration.

The operations performed thus far require merely that the spectral sensitisation of layer 4 be resistant to the development of layer 1, and that the corresponding sensitisation of layer 3 be likewise resistant to the chromogenic development of layer 4.

When this point has been reached, ammonia is used to dissolve the chloride present in the layers 1, 3 and 4.

All that remains to be done then is to record, develop and colour the last uncopled monochrome component of the layer 1, in the bromide layer 2 which is the only one that is still sensitive to blue. After this, the halide and reduced silver present in all the images is dissolved out.

In view of the fact that the developer used to develop the image in layer 1 may not, without inconvenient effects on the other layers, contain a halide solvent which favours, in known manner, the contrast between the microscopic images, it will be of advantage to impregnate this first layer completely with yellow colouring matter. Indeed the presence of such colouring matter in layer 1 permits of the recording and developing of very well separated microscopic images on the surface of this layer.

The lenticular film illustrated in Fig. 3 differs from that of Fig. 2 in that the layer 1, instead of being tinted with yellow colouring matter, is separated from the remaining layers by a thin layer of yellow varnish or the like 5 which absorbs blue rays, and which disappears in the course of the first development or the following washing operation.

A lenticular film having three or four layers may be similarly provided, to suit the method of exposure adopted. It is necessary, in the first place, that layer 1 be a panchromatic bromide layer and separated from the succeeding layers by an opaque varnish which strictly masks the other layers during the exposure of the first. This opaque varnish is composed for example of two colouring substances each of which absorbs one half of the visible spectrum. It is also sufficient that the sensitising agents for this layer 1, and this opaque varnish, be soluble in water in known manner.

The procedure may be as follows: after exposure with filter in conventional manner, the black and white images are developed in the first layer, without fixing. The opaque varnish disappears in the course of this treatment. The two outermost layers, being as described above chloride layers sensitised respectively to red and green, are exposed in succession, with the use of appropriate radiations, and coloured. They are then passed through ammonia to dissolve out the residual halide and metallic silver from the various images.

In a further embodiment, the three layers are assumed to be superposed on the single layer of a lenticular film after completion of the treatment of this layer producing the primary black and white images.

These three layers may be moride or chloride layers, as desired, and the first, attached in contact with the silver layer of this film, is sensitive to blue only and is tinted yellow or separated from the two others by yellow varnish soluble in hyposulphite for example.

The two other layers are again sensitive, respectively, to green and red.

The first step is again, to record and colour the outermost layer with the aid of appropriately coloured and directed rays, in accordance with the technique described in the specification of the parent patent; the intermediate layer is then likewise treated, the recorded monochrome component being developed in colours. Finally, the last layer (in contact with the layer originally forming a unit with the supporting film) is similarly treated beneath blue radiations to which it is sensitised, and it is then coloured.

In conclusion, the yellow varnish, the residual halide, and the reduced silver are dissolved out of the various layers, for example, with the aid of Farmer's solution.

In any case, the final step is to efface the lenticulations, by the application of heat, or by means of appropriate varnish.

Finally, it will be understood that one or several of the layers may have been prepared in known manner with products capable of producing colouring matter when brought into contact with reduced silver, or may be prepared with dyes capable of being destroyed by contact with reduced silver and proportionately to the quantity of such reduced silver, in the course of the successive treatment steps to which the secondary images are subjected. When it is a case of destroying colouring matter, the complete primary image in the layer 1 must of course be obtained as a positive.

As regards the sound track, various modes of operation may be adopted of which the following is given by way of example only:

The sound track is directly produced in the layer carrying the primary images, preferably prior to the superposition of the other layers thereon. In this case, disappearance of the sound track is prevented on the final dissolution of all the silver images, for example by protecting it by means of varnish, and if desired by limiting the breadth of the superposed layers of the emulsion destined to carry the secondary images over to the dimension of the primary images.

The layers thus superposed may then be given the total breadth of the primary images including the sound track, without protecting with the aid of varnish the sound track thus initially recorded, in the form of a positive or negative as the case may be, in the first layer, provided that the sound track be imprinted in one or more of the layers superposed in contact therewith, with a view to developing the same in such one or more of the three colours as may be made convenient for the method of projection used.

After completion of the described procedure, the silver sound track is dissolved along with the silver images in all emulsion layers, leaving merely a colour copy of the sound track in one or more of the superposed layers.

It is equally possible to imprint the sound track directly in one or more of these layers only in the course of the treatment of these secondary layers without the sound track having been initially recorded in the first layer attached to the lenticular support.

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