PATENT SPECIFICATION

418,040

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Complete Accepted: Oct. 17, 1934.

COMPLETE SPECIFICATION.

Improvements in Projecting Multi-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:—

This invention is an improvement in or a modification of that described in Specification No. 383,795.

That specification relates to a method of projecting without a multi-colour filter multi-colour pictures recorded on lenticular films, in which there is interposed near the gate aperture in the normal path of the beams of light a light-dispersing optical element which may consist of a direct-vision prism or a number of narrow prisms such as are shown in Fig. 3 of Specification No. 24,276 of 1914; this element decomposes the light into its spectral colours and, when viewed from the plane of the film, makes the source of light appear as a spectrum in the plane which would be occupied by the multi-colour filter, if that were used, and in dimensions that correspond with those of the multi-colour filter. In the process of that invention, the decomposition of the light into its spectral colours is produced essentially by the light-dispersing action of the prism or prisms. In realising the process, parts are required which, due to their dimensions, cannot be applied without altering the usual projectors.

The present invention relates to a method wherein this drawback is overcome by using for the decomposition of the light into its spectral colours, instead of a direct-vision prism or series of prisms producing spectra merely by dispersion, a prism grating consisting of a number of minute prisms arranged side by side so as to form a grid and of such small dimensions (for instance, having sides less than a micron in length) that they produce spectra by interference.

It is known that for decomposing light into its spectral colours by interference, there can be used a diffraction grating which, compared with the prism, has the advantage of a greater dispersion and of a more uniform distribution of the various wave lengths. For the purpose in question it is of great importance that in decomposing the white light into various colours any loss of light should be avoided as far as possible. Such loss of light, however, occurs to a particularly large extent with the usual diffraction gratings. Therefore, it is but an insignificant progress to use, instead of the three-colour filter hitherto employed, a diffraction grating which, though adaptable more conveniently, has not a materially higher transparency to light. With such diffraction gratings the losses of light are due to the fact that a very large, theoretically infinite number of spectra is produced, of which but a single one can be utilised so that the loss of light may be very considerable.

According to this invention there may be produced a single interference spectrum and the light available so directed that, when viewing it from the plane of the film, it appears to emanate from a single spectrum. By the use of a prism grating in accordance with the invention, the light is refracted at a number of juxtaposed places which are all illuminated by the same source of light, and it becomes possible to resolve the whole energy into a spectrum of a definite order. For this purpose, the angle of refraction and the index of refraction of the prisms are so chosen that the image of the source of light or of the slot is projected at the place where the spectrum of the desired order is formed. By this means a spectrum of a very high brightness is obtained.

The choice of the angle of refraction and index of refraction for the aforesaid purpose is governed by the formula

$$\frac{N\lambda}{bn-\sqrt{b^2-N^2\lambda}} = \tan \varepsilon,$$

wherein b is the grating constant (that is, the breadth of a prism of the grating),

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ϵ is the angle of refraction of the prism,

N is the number of the order of the spectrum desired

n is the refractive index of the prism material and

λ is the wave length of the light.

If the ratio $\frac{\text{apparent distance of the filter}}{\text{apparent breadth of the filter}}$ is represented by G then, for instance, for the value G=3.5, there would be used for projection a prism grating, for example, for which the following values apply:—

$\lambda = 5500$ Å

$n = 1.6$

$N = 2$, $b = 2\mu$ and $\epsilon = 33°$,

and for G=2.3,

$N = 1$, $b = 0.9\mu$ and $\epsilon = 24°$.

Prism gratings suitable for use in the invention can be supplied by Adam Hilger, Limited, of London.

Like the light-dispersing optical element used in the process of Specification No. 383,795, the prism grating used in the present invention is arranged in close proximity to the gate of a projection apparatus. The only alternation necessary in the apparatus in this case is a slight lateral displacement of the source of light, or a slight turning of the plane of the gate.

When the refracting angles of the prisms are not too large (their magnitude depends on the order of the spectrum used), it may even be feasible to dispense with alteration of the usual projector, if during the printing operation or, when using a film which is to be reversed, during the operation of taking the picture, the rays directed to the middle of the green portion of the spectrum or of the filter are so laterally displaced by a slight lateral displacement of the diaphragm used in printing or of the filter used in taking the picture, that the lateral displacement of the rays corresponds with the deviation from the optical axis required during the operation of projecting the picture.

The object of this invention will be more fully understood from the following description of the accompanying drawings, in which Figs. 1—5 illustrate the formation of spectra by means of a diffraction grating and a prism grating respectively and Fig. 6 illustrates the arrangement of a prism grating in the projection of a lenticular film in accordance with the invention.

Fig. 1 shows the normal course of the light rays emanating from a slot Sp or a source of light, which rays are rendered parallel by a lens L_1 and convergent by a lens L_2 so as to form an image of the slot Sp at Sp^1.

Fig. 2 shows the formation of the grid spectra by using a diffraction grating g which is composed of alternating transparent and opaque stripes. There is first formed the non-deflected picture of the slot at Sp^1, which shows no decomposition into the spectral colours and has the maximum brightness. On the right and on the left of this non-deflected image of the slot there are formed the interference spectra of the first order (1, 1), the second order (2, 2), and so on. The diminution of the brightness of these spectra from the middle of the row towards its ends may be represented by the intensity curve at the bottom of Fig. 2, in which the ordinate I represents brightness.

Fig. 3 represents in another way the decrease in brightness of the spectra of a higher order. The light falling parallel on a slot G of the grating g of Fig. 3 (only one slot being shown) is decomposed at the edges of each slot by diffraction in such a manner that the slot seems to be the starting point of a new spherical wave. The distribution of the brightness is indicated in the intensity curve at the bottom of Fig. 3, in which O represents the middle of the slot. Quite similar to that curve is the distribution of the brightness in the different diffraction spectra.

If, however, as represented at P in Fig. 4 on an exaggerated scale, prisms take the place of the slots, the whole light is guided in a definite direction, whereby losses of light are avoided. Thus it is possible (see Fig. 5) to guide the whole light to the point where the spectrum of the first order 1 is projected. The distribution of the brightness then corresponds with the curve at the bottom of Fig. 5. The same effect, that is the concentration of the whole energy in a single spectrum may, of course, also be observed, if there is not projected a "real" spectrum, as has been supposed in the accompanying drawings to facilitate representation, but if the eye or the measuring instruments are placed immediately behind the diffraction grating or the slot grating, just as a spectrum is also visible when a prism is held immediately before the eye without using a reproducing system. In the case of Fig. 5, that is to say when using a prism grating, a single spectrum of great brightness is visible in a direction that deviates from the perpendicular to the grating. In place of the eye there may now be used a film bearing microscopic lenticular lens elements. For this film the virtual image of the spectrum takes the place of a filter situated in the same line of view.

The use of a prism grating according to this invention involves the advantage as compared with the use of a dispersing prism as described in specification No. 383,795, that the breadth of the different colour zones does not increase from red to blue, but that all colours are uniformly distributed, so that the three main colours, red, green and blue, occupy nearly the same breadth, as is always the case with grating spectra. When adopting this principle for recording pictures there is obtained the advantage that the faults of reproduction are diminished owing to the absence of masses of glass of a considerable thickness.

Fig. 6 represents the use of a prism grating during the projection of a lenticular film. In this Fig, H is the concave mirror of the usual reflector arc lamp, which takes the place of the slot of Fig. 5. B is the arc of the arc lamp which illuminates the mirror. The picture of the crater is projected near the gate F. Behind the gate, the lenticular film L is placed with its lenticular side facing the source of light. The prism grating P is arranged near the gate F. Furthermore, for laterally displacing the source of light there may be mounted lenses R near the grid, by which the direction of incidence of the rays may be altered as required. With the same object in view prisms, too, may be laid over the grating. The picture of the lenticular film is projected on the screen by means of the objective O.

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 modification of the method of and apparatus for projecting multi-colour pictures recorded on lenticular films, described in Specification No. 383,795, wherein the light-dispersing optical element is a prism grating which produces spectra by interference.

2. A modification as claimed in claim 1, wherein the angle of refraction and the refractive index of the prisms constituting the grating are such that the whole of the light available is concentrated in a single spectrum of the desired order.

3. A modification as claimed in claim 1 or 2, wherein near the prism grating or near the lenticular film, there is arranged at least one lens or prism which alters the angle of incidence of the light.

4. A method of projecting multi-colour pictures recorded on lenticular films, substantially as herein described with reference to Fig. 6 of the accompanying drawings.

Dated this 31st day of July, 1933.

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30, Southampton Buildings, London, W.C.2,
Agents for the Applicants.

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Fig. 1

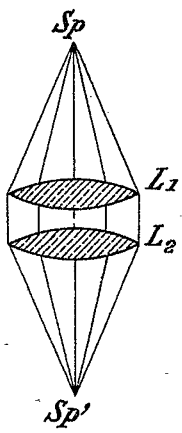

Fig. 2

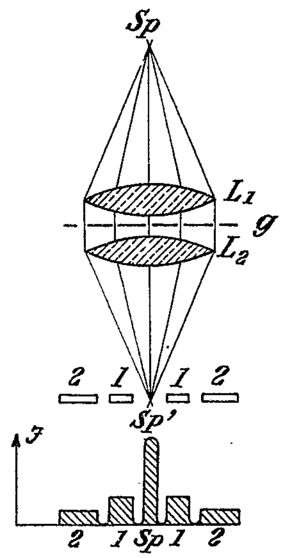

Fig. 3

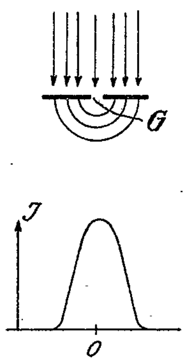

Fig. 5

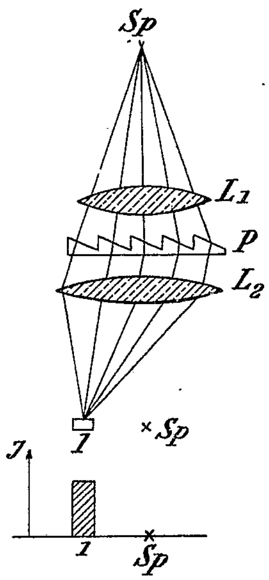

Fig. 4

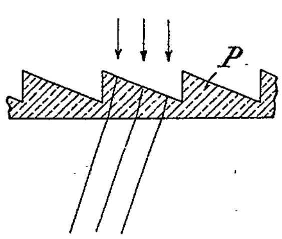

Fig. 6