PATENT SPECIFICATION

411,407

Convention Date (United States): Feb. 14, 1933.

Application Date (in United Kingdom): Jan. 30, 1934. No. 3112/34.

Complete Accepted: June 7, 1934.

COMPLETE SPECIFICATION.

Improvements in or relating to the Printing of Copies from Lenticulated Film Bearing Colour Component Images.

We, KODAK LIMITED, a Company registered under the Laws of Great Britain, of Kodak House, Kingsway, London, W.C.2, (Assignees of FORDYCE TUTTLE, Citizen of the United States of America, of 343, State Street, 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 a method of and apparatus for printing from an "original" lenticulated photographic film, that is to say a film having a picture recorded thereon by colour component images, on to another lenticular film or "copy."

In the printing of colour pictures on lenticular film it has hitherto been proved difficult to obtain prints of satisfactory definition and good colour rendition due, primarily, to colour wedging and faulty colour separation. The object of the present invention is to provide an improved method and apparatus whereby printing can be effected at a one to one ratio or to produce a copy on a larger or smaller scale than that of the original without degradation of the colour values due to colour splashing and flare which may tend to occur.

To this end according to the present invention the colour component images on the original film are separately and successively illuminated and projected on to the copy so as to be separately and successively recorded in positions thereon corresponding respectively to those occupied by the colour component images on the original film.

In this way instead of printing all the colour separation or component images simultaneously they are printed separately and successively so that only that part of the light desired for printing one colour component is permitted to pass to the sensitive film or copy at a time, and the tendency for fogging and therefore degradation of the colour values in the copy are reduced.

After the colour component images have been recorded on the original film, say, through three colour filters and the original film developed, the lenticulated side of the original film may be illuminated successively from different directions corresponding respectively to the directions of the rays from the colour filters incident on the original film when exposed so that the colour component images on the original film are separately and successively illuminated, the light projected from the illuminated colour images of different colour value on to the copy being so restricted that the rays will be incident on the copy only in directions appropriate to subsequent projection of the copy through colour filters.

In the accompanying drawings—

Figure 1 illustrates diagrammatically one arrangement of apparatus according to the invention,

Figure 2 shows in perspective and on an enlarged scale the shutter diaphragm employed with the arrangement shown in Figure 1,

Figure 3 illustrates diagrammatically another form of apparatus for carrying the invention into practice and employing shutter diaphragms similar to that illustrated in Figure 2, and

Figure 4 shows an alternative form of shutter diaphragm which may be employed.

In the construction illustrated in Figure 1 the original film 10 from which a print is to be made is furnished with transverse cylindrical lenticulations 11 on one side and a developed image layer 12 comprising a plurality of minute colour separation or component images. The sensitive film 13 upon which a copy is to be made from the original film 10 similarly comprises transverse cylindrical lenticulations 14 on one side, but with an undeveloped sensitised layer 15 on the opposite side. The two films 10 and 13 are arranged one on each side of a printing objective 16 with the lenticulations 11, 13 facing towards three separate light sources 17, 18 and 19.

A masking device or shutter diaphragm 20, as clearly shown in Figure 2 and hereinafter fully described, is arranged in

front of the light sources 17, 18 and 19 whilst a similar masking device 21 is positioned within the printing objective 16. The objective 16 is shown purely diagrammatically in the drawing and will, in practice, comprise two components each having a plurality of lenses.

The two masking devices 20 and 21 are coupled together by a shaft 22 so that when the light sources 17, 18 and 19 are successively unmasked by the masking device 20 the corresponding portions of the objective 16 will be unmasked by the masking device 21. As clearly shown in Figure 2 the masking device 20 is provided with three arcuate slots R, G and B whilst the masking device 21 is similarly furnished with three arcuate slots *r*, *g* and *b*, the slots in each masking device being radially and angularly displaced so that when arranged in the optical system as shown in Figure 1 the slots R, G and B will respectively be in optical alignment with the slots *r*, *g* and *b*. The three slots, which are provided for printing the usual three colour separation or component images in succession are arranged in an angular space of 180° on each of the masking devices 20 and 21 so that both the masking devices can be rotated continuously since all three light sources 17, 18 and 19 will be masked by the masking device 20 for the time during which the films 10 and 13 are advanced, by any suitable mechanism, to bring another frame on each of the films into the printing position.

Assuming therefore that the original film 10 has been recorded so as to bear three colour component images say, red, green and blue, when the masking devices 20 and 21 are rotated to the position shown in Figure 1 the slots R and *r* will permit light to pass from the source 17 through the red colour component image on the original film 10, through the objective 16 and slot *r* on to the copy or sensitive film 13. In order that the incident light will illuminate similar areas, i.e. images of the same colour component, behind all the lenticulations 11 of the original film 10 a collimating lens 23 is arranged between the masking device 20 and the original film 10 so as to cause the light rays incident on the film 10 to be substantially parallel.

This parallel light transmitted from the lens 23 will be focussed by each cylindrical lens element 11 in a narrow band behind such element. Since in Figure 1 the slot R unmasks the light source 17 which is off the optical axis the colour component image of the original film 10 which will be illuminated will be one of the outer images i.e. the red component image. A second collimating lens 24 arranged behind the original film 10 directs the light transmitted by the illuminated colour component image towards the printing objective 16 which is now unmasked by the slot *r* in the masking device 21. The light passing through the slot *r* will be imaged by each of the cylindrical lenticulations 14 in the sensitive layer 15 of the film 13 so that a colour component image in the form of a colour band occupying one third of the area behind each lenticulation 14 will be recorded in the sensitive layer 15. In this way the red colour component image on the original film 10 is recorded in the sensitive layer 15 of the film 13 behind each lenticulation 14 in a position corresponding to that occupied by the red colour component image behind each lenticulation 11 of the original film 10. With a view to locating the colour component image bands on the film 13 so that they will occupy the correct positions relatively to the filters used in projecting the copy a suitable compensating lens 25 is arranged in front of the film 13.

After printing a colour component image, which has above been assumed to be the red component lying off the optical axis, the central colour component image, usually the green, may be printed by rotating the masking devices 20 and 21 so that the slot G will unmask the light source 18 which lies on the optical axis. The slot *g* in the masking device 21 will simultaneously unmask the central portion of the printing lens 16. The green or central component image i.e. that lying centrally behind each lens element 11 of the film 10 will now be illuminated and the slot *g* will restrict the transmission of light from the lens 16 to an area so positioned relatively to the film 13 that only those parts of the sensitive layer 15 lying immediately behind the centre of each lenticulation 14 will receive light. In this way the green colour component image of the original film 10 will be recorded on the copy 13 in positions corresponding to those of the green colour component image on the film 10. The third or blue component image on the film 10 may then be printed in a similar manner by turning the masking devices 20 and 21 so that the slot B unmasks the light source 19 whereby only the blue colour component image on the film 10 is illuminated and this colour component image recorded, through the slot *b*, on the film 13.

After printing all three colour components on one frame as above described the masking devices 20, 21 are rotated so

that all three light sources 17, 18 and 19 are masked by the unslotted portion of the masking device 20. The two films 10 and 13 are now advanced for the length of one frame so as to bring the next succeeding frame of each film into the printing position as above described.

Preferably the film advancing means is driven synchronously with the masking devices so as to provide a continuously operating mechanism for printing frame by frame. One such arrangement is illustrated in Figure 3 in which the original film 10 passes from a supply reel 30 over a guide roller 31, through gate members 32 each furnished with a window 33, and over a guide roller 34 on to a take-up reel 35. The film 13 upon which the print is to be made is drawn from a supply reel 36 over a guide roller 37, through gate members 38 each furnished with a window 39, and over a guide roller 40 to a take-up reel 41.

Each of the films 10 and 13 is advanced step by step through the corresponding gate by feed mechanism including a power shaft 42 furnished with a bevel wheel 43 meshing with a bevel wheel 44 driving a crank 45 which reciprocates a rod 46 having a pulled-down claw 47 adapted successively to engage the perforations in the film. The shaft 42 is driven through a belt and pulley 48 from an electric motor 49.

Each of the masking devices 20 and 21 is driven by gears 50, 51 and a short vertical shaft 52 driven through gears 53, 54 from the shaft 42. The two masking devices 20 and 21 are thus rotated in synchronism.

Instead of utilising three separate light sources as described with reference to Figure 1 a single lamp 7 is employed the light of which is concentrated on a ground glass 8 by a condenser 9. The ground glass 8 in this arrangement constitutes a secondary source of light which serves effectively the purpose served by the three separate sources 17, 18 and 19 included in Figure 1.

When the two films 10 and 13 have been threaded through their respective gates and attached to the take-up reels 35, 41, the motor 49 is set in operation and, whilst the two films 10 and 13 are stationary the light passing through the ground glass 8 is successively unmasked by the slots R, G and B of the masking device 20 whilst at the same time the light transmitted through the printing lens 16 is successively restricted by the slots *r*, *g* and *b* to areas the apparent positions of which corresponds respectively to the positions which will be occupied by the corresponding colour filters to be employed when projecting the copy 13. The red, green and blue colour component images on the frame of the film 10 lying opposite the apertures 33 are thus printed separately and successively on the frame of the film 13 registering with the aperture 39. As soon as these three colour component images have been printed the ground glass 8 is masked by the unslotted portion of the masking device 20 and the two films 10 and 13 are simultaneously moved forward by one frame. The sequence of operations is then repeated for the next succeeding frame of each film.

Instead of employing a rotary masking device such for example as that shown in Figure 2 a reciprocating device such, for example, as that shown in Figure 4 may be employed. The masking device shown in Figure 4 for masking, say, the light source, comprises a plate 60 furnished with three slots B, G and R arranged as shown. The plate 60 is reciprocated in guides 61 by means of a crank 62 through a connecting rod 63, the crank 62 being driven by a shaft 64 which is in turn driven, by the main shaft 42 shown in Figure 3. A second reciprocating masking device is then provided for unmasking the printing lens, the arrangement of the slots *b*, *g* and *r* of this second masking device being the reverse of that of the slots B, G and R, that is to say so that if the second masking device is viewed in the same manner as that shown in Figure 4 the slot *b* will lie to the left of and below the central slot *g* whilst the slot *r* will lie to the right of and above the central slot *g*. When two masking devices such as that shown in Figure 4 are employed means (not shown) are provided for obscuring the light source or all the light sources while the two films are advanced and while the two masking devices are returned ready for their next forward movement.

Since therefore each colour component image is printed separately the apparent angles subtended by the filter areas can be readily maintained the same for the printer as for the original film either when the printing ratio is one to one or when the print is on a scale different from that of the original. Furthermore, the aperture subtended in taking the original film is independent of that subtended in the print so that a small aperture may be used in the camera for recording the original film and the printing done with a large aperture. Again, the colour ratio can be controlled during the printing process whereby the necessity for adjustment of this ratio by cutting out some of the light during the projection of the

print is obviated.

Though the invention has been described above as applied for printing from an original film bearing transverse lenticulations on to a copy bearing similarly arranged lenticulations the invention may also be employed for printing from an original having transverse or longitudinal lenticulations on to a copy furnished with longitudinal or transverse lenticulations. It is then only necessary to arrange each masking device so that the length of each slot therein extends in a direction parallel to the lenticulations on the adjacent film.

When a reciprocating form of masking device, such for example as that shown in Figure 4 is employed, the mask will be reciprocated in a direction parallel to the lenticulations on the adjacent film whether these lenticulations are transverse or longitudinal. In any event, the proper orientation between each film and its associated masking device may be obtained by selecting either the position of the masking device or the direction of travel of the film and then adjusting either the film or the masking device to satisfy the conditions set out above.

In the arrangement above described the invention has been employed for printing at a one to one ratio. The method according to the invention may however be employed for producing a print on a scale larger or smaller than that of the original. With known methods of printing from lenticular film on to lenticular film the difficulty experienced in maintaining the apparent angles subtended by the filters the same in the print as in the original makes it impracticable to produce a satisfactory print on a scale which differs from that of the original Since however with the present invention each colour component image is printed separately and the angles of the filters in recording the original film is independent of the angles of the filter in projecting the copy, all that is necessary to produce a print on a scale larger or smaller than the original is to adjust the ratio of the object and image distances, i.e. the magnification of the rear component of the printing objective. Further, since the filter angles in recording the original film do not necessarily correspond to the angles of the filters during projection, the original film may be recorded with a lens of small aperture such, for example, as *f*.4 and to project the copy with a lens of larger aperture, say, *f*.2. This is advantageous in that whilst it is difficult to obtain lenses of short focal length and large aperture for recording purposes which will fulfil the conditions required for lenticular film, i.e. that all parts of the lens are visible from all parts of each frame on the film, it is relatively simple to obtain lenses of long focal length and larger aperture suitable for projecting purposes.

It will be understood that the arrangements described above are given by way of example only and that details may be modified. For example, though the invention has been described above as applied to the printing from lenticular film bearing three colour component images the invention is equally applicable to the printing of film bearing two or more colour separation images which may correspond to two stereoscopic views or to two separation images of a two colour process. The invention is, in fact, directed to the duplication of lenticulated film irrespective of the nature of the image or images carried by the original. Again, though the masking devices are preferably mechanically driven so as to provide continuous operation of the printer, the selective and successive masking of the light source or sources and the corresponding portions of the printing objective may be manually effected.

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 printing from an original lenticular film bearing colour component images on to another lenticular film or copy, according to which the colour component images on the original film are separately and successively illuminated and projected on to the copy so as to be separately and successively recorded in positions thereon corresponding respectively to those occupied by the colour component images on the original film.

2. The method of printing from an original lenticular film, whereon colour component images have been recorded through colour filters, on to another lenticular film or copy, according to which the lenticulated side of the original film is illuminated successively from different directions corresponding respectively to the directions of the rays from the colour filters incident on the original film when exposed so that the colour component images on the original film are separately and successively illuminated, the light projected from the illuminated colour images of different colour values on to the copy being so restricted that the rays will be incident on the copy only in directions appropriate to subsequent projection of the copy through colour filters.

3. The method of printing from an original linearly lenticular film, whereon colour component images have been recorded through colour filters, on to another linearly lenticular film or copy, which comprises arranging the two films on opposite sides of an objective with the lenticulated faces of the films facing in the same direction along the optical axis, illuminating the lenticulated side of the original film successively from different positions which correspond respectively to the apparent positions of the taking filters relatively to the original film when this was exposed in the camera so that the colour separation images on the original film are separately and successively illuminated, and restricting the projection of light from the original film during illumination of each colour component image to an area the apparent position of which relatively to the copy corresponds to the position which will be occupied by the corresponding colour filter when projecting the copy.

4. In optical apparatus for printing from an original lenticular film bearing colour component images, on to another lenticular film or copy, the combination with means for separately and successively illuminating the colour component images of the original film, of means whereby light from the original is projected on to the copy so that the colour component images are separately and successively recorded thereon in positions corresponding respectively to those occupied by the colour component images on the original film.

5. In optical apparatus for printing from an original lenticular film whereon colour component images have been recorded through colour filters, on to another lenticular film or copy, the combination with means for illuminating the original film successively from different directions corresponding respectively to the directions of the rays from the colour filters incident on the original film when exposed so that the colour component images on the original film are separately and successively illuminated, and means whereby the light projected from the illuminated colour images of different colour values on to the copy is so restricted that the rays will be incident on the copy only in directions appropriate to subsequent projection of the copy through colour filters.

6. In optical apparatus as claimed in Claim 4 or Claim 5 the combination with a source of light towards which face the lenticulated surfaces of both films, of an objective arranged between the original film and the copy, a masking device for selectively and successively unmasking part of the light passing from the light source to the original film, and a second masking device for selectively and successively unmasking the light projected from the original on to the copy.

7. Optical apparatus as claimed in Claim 6, in which the two masking devices are driven synchronously.

8. In optical apparatus for printing from an original lenticular film bearing colour component images on to another lenticular film or copy, the combination with means for separately and successively projecting the several colour component images of the original film on to the copy as claimed in Claim 6 or Claim 7, of apparatus for synchronously feeding the two films step by step through the optical axis and for operating the masking devices in synchronism with the film feeding apparatus.

9. Optical apparatus as claimed in Claim 6 or Claim 7 or Claim 8 in which means are provided whereby the picture recorded on the original film can be imaged on the desired scale on the copy.

10. Optical apparatus as claimed in Claim 6 or Claim 7 or Claim 8 or Claim 9 in which each masking device comprises a rotary slotted diaphragm.

11. Optical apparatus as claimed in Claim 6 or Claim 7 or Claim 8 or Claim 9 in which each masking device comprises a reciprocating slotted diaphragm.

12. Optical apparatus as described with reference to Figures 1 and 2, or Figures 3 and 2 or Figures 3 and 4 of the accompanying drawings.

Dated this 30th day of January, 1934.
KILBURN & STRODE,
Agents for the Applicants.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1934.

Fig. 1.

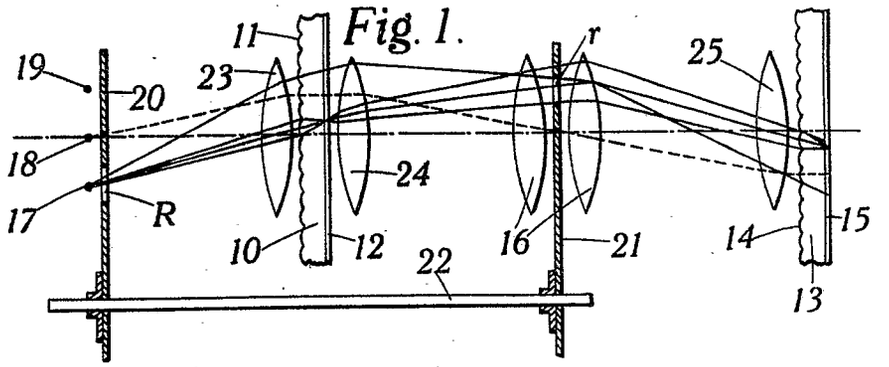


Fig. 2.

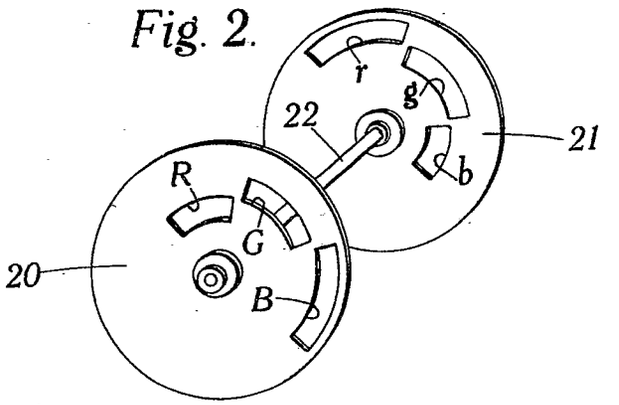


Fig. 3.

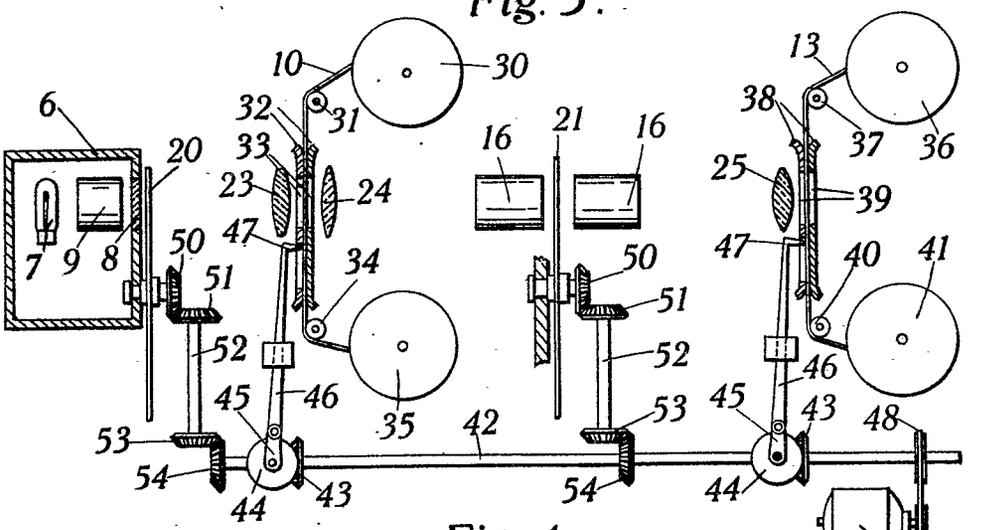
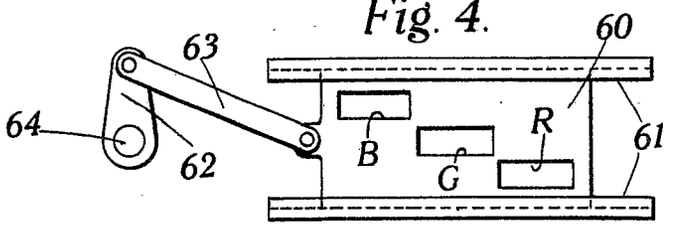


Fig. 4.



Malby & Sons, Photo-Litho.