Sept. 27, 1932. G. HEYMER 1,879,236

PRINTING COLOR PICTURES

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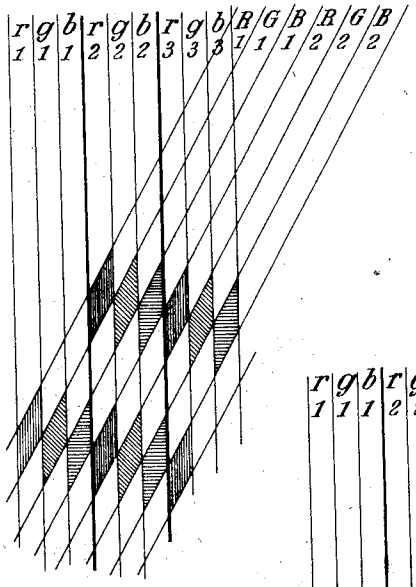


Fig. 1

Fig. 2

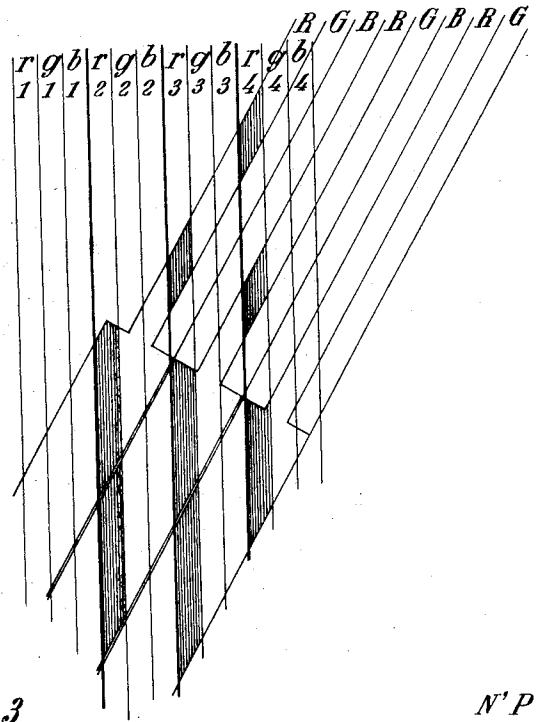
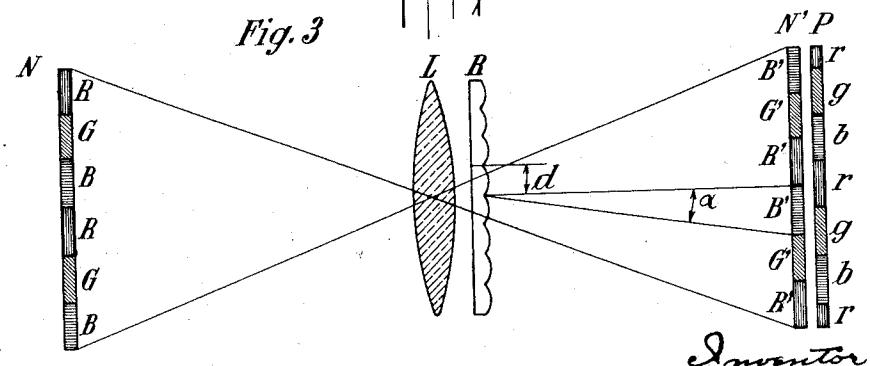


Fig. 3



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UNITED STATES PATENT OFFICE

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PRINTING COLOR PICTURES

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My present invention relates to an improvement in photographic printing and more particularly to a process of printing color pictures.

Further objects of my invention will be seen from the detailed specification following hereafter, reference being made to the accompanying drawing in which Fig. 1 shows the course of beams in a printing process generally used, and Fig. 2 the course of beams corrected according to my invention. Fig. 3 shows diagrammatically an arrangement with aid of which my new printing process may be carried out.

In color photography all methods working with color screens are associated with certain difficulties in respect of printing on light sensitive layers likewise provided with such screens. Both with irregular grained screens and with regular dotted or striated screens, especially also with the lenticular screen according to Berthon, the prints show an undesired spottiness or streakiness, generally called "moiré" effect, which is due to a sequence of areas of true and untrue reproductions of the colors or of no reproduction at all. This effect is caused by the fact that neither with the irregular grained screens nor with the regular dotted or striated screens all elements of the screen of the image to be printed coincide exactly with correspondingly colored elements of the screen of the printing layer. A perfect registration of the elements of both screens is quite impossible in the case of the irregular grained screens, and though it is theoretically possible in the case of the regular dotted or striated screens, it can likewise not be realized in practice owing to the high fineness of the screens used.

Fig. 1 illustrates the origin of this "moiré" effect or striation in the case of a picture printed on a support which is provided with a regular striated screen. In this figure R G B R G B . . . are the elements of the screen of the original formed by red, green and blue lines; *r g b r g b* . . . are the corresponding elements of the layer on which is printed. Now, only on that places where a colored ray of the original crosses an isochromatic ray of the printing layer, a correct exposure of the printing layer can be made. These places are marked in Fig. 1 by a corresponding hatching. Even when both systems of screens of the original and of the printing layer are placed completely parallel to each other and show a completely equal breadth in striation, the exposure can only be correct if, accidentally, isochromatic parts of both screens coincide completely.

To avoid this "moiré" effect various suggestions have been made according to which a certain reduction of definition is imparted to the print whereby the streakiness originating from the screen disappears. It has, for instance, been proposed to displace relatively to each other the parts of the printing device during the printing operation or to insert in the passage of the rays an opaque glass disc, a black and white line screen or an oscillating plano-parallel glass disc. In the "British Journal of Photography", 1909, col. supp., page 71/72, Farmer, for instance, described such auxiliary means as applied to grain screen plates. As far as movable parts are used in printing the processes require rather complicated devices, whereas, by insertion of a black and white screen, the light intensity in printing is strongly reduced. Moreover, it is difficult to determine exactly the diminution of definition, which is to be imparted to the print exactly, so as to obtain a maximum of an unobjectionable and uniform reproduction of color simultaneously with a minimum of reduced definition. This method of printing with a minimum of reduced definition and avoiding as much as possible the "moiré" effect is illustrated by Fig. 2. *r g b r g b* indicate again the screen of the printing layer and R G B R G B the correspondent screen of the original. If one succeeds to broaden the screen-lines of the original, for instance, by optical reproduction in such a manner that they get threefold the breadth as originally, then they cover (as seen in Fig. 2) homogeneously and exactly the whole field and then the appearance of the faults illustrated in Fig. 1 is completely avoided since the stria of the screen are uniformly illuminated in their whole ex-

tent. For sake of clarity this is illustrated in Fig. 2 only in the case of the red beams.

According to my invention an exactly determinable diminution of definition for avoiding the streakiness can be obtained by inserting in the path of the rays a lenticular screen the lens elements of which are geometrically similar to the elements of the regularly dotted or striated screen to be printed. By suitably choosing the size of the lens elements, the result can be attained that the light emanating from one part of the screen of the original is spread exclusively over a determined minimum surface of the light sensitive printing layer. It is advisable to give the lens elements of the lenticular screen to be inserted such a size and focal length that of the undeflected image produced behind each screen element of the copying layer only a limited number of interference images is produced in each interference direction.

If, for instance, a negative on a lenticular screen film having a system of parallel cylindrical lenses is to be printed on a like film having the same lenticular embossing, it is possible to obtain a perfect registration of a screen unit, that is to say, a sequence of stripes corresponding with the stripes containing the red, green and blue color records in the negative by causing a single interference picture to be produced on each side of the undeflected image and causing these interference images to appear at a distance from each other which is as great as the breadth of the stripe of the undeflected image of a color stripe of the negative. To this end a system of adjacent cylindrical lenses of a determined breadth is inserted in the passage of the rays, the said lenses running parallel to the embossing of the negative and positive film. To adjust the distance of the interference images, produced in the light sensitive layer, in the manner indicated above, the screen is inserted at such a position that the angle α under which a color stripe of the image of the negative screen is seen from the inserted screen satisfies the equation.

$$d=\frac{\lambda}{\sin \alpha},$$

λ being the wave length of the light used for printing and d the breadth of the cylindrical lenses. The focal length of the cylindrical lenses of the lenticular screen to be inserted must be chosen in such a manner that the light emanating from any point of the negative just spreads within the breadth of a screen unit, that is to say, the sequence of a red, blue and green strip.

Fig. 3 shows an arrangement for performing this printing operation. N indicates the negative bearing the screen R G B R G B . . . From this negative N a real picture N′ with the screen elements B′ G′ R′ B′ G′ R′ . . . is projected through a lens or objective L on the printing layer P bearing the screen elements *r g b r g b* . . . The screens of the negative and of the printing layer do not coincide. Now, the broadening of each stripe of the real picture N′ to reach the threefold or any other desired value, is effected according to my invention by inserting the lenticular screen R into the course of the beams. The breadth of each lens element of this screen is d. Seen from such a lens element of the inserted screen R each screen-stria of the real image N′, for instance, the part B′ appears under the angle α which is decisive in proportioning d according to the formula

$$d=\frac{\lambda}{\sin \alpha}$$

as mentioned above.

For avoiding any streakiness in printing regular screens, the elements of which consist of polygons or circles, lenticular screens are inserted in the path of the rays the lenses of which have a similar form, that is to say likewise constitute polygons or circles. The quantity of lens elements on the surface unit and the focal length of the elements are determined accordingly.

The process according to this invention can, of course also be applied to the printing of photographic images having irregular screens though it is then not possible to insert in the passage of the rays a lenticular screen which is geometrically similar to the screen of the image. It is advisable, in this case, to choose a lenticular screen, the elements of which approximately correspond as to their diameter and size, to the elements of the irregular grain screen. Prints are thus obtained which practically do not show streakiness and whose colors are the true colors.

In the above discussion it is to be understood that the particular data chosen, are by way of example. I have given statements of theory which I believe to be correct; but it is of course possible that this explanation is incomplete. At any rate, the observed facts and results are as stated and the methods as described are highly effective.

In practice it is, obviously, unnecessary to calculate in every case the diameter d of the light refracting elements of the screen inserted in the passage of the rays. It will be sufficient to have some screens with lens elements of different diameter at hand and to determine by a simple test the best kind of screen to employ with a particular negative or printing layer.

What I claim is:—

The process of printing a photographic picture having a regular screen of the group consisting of dotted and striated screens, onto a light sensitive layer provided with a like screen, which comprises inserting in the course of the light rays a lenticular screen

the lens elements of which are geometrically similar to the elements of the regular screen to be printed, and have a size and focal length so as to produce only a limited number of interference images in each interference direction of the undeflected picture arising in the printing layer behind each screen element.

In testimony whereof, I affix my signature.

GERD HEYMER.