Oct. 30, 1956 J. A. BOYAJEAN 2,768,577

MULTI-COLOR-SEPARATION PRINTING PLATES

Filed March 31, 1953 2 Sheets-Sheet 1

FIG.1a

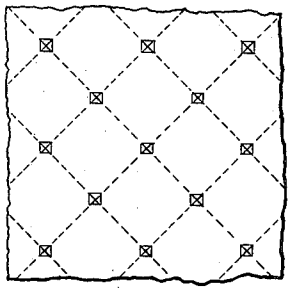


FIG.2a

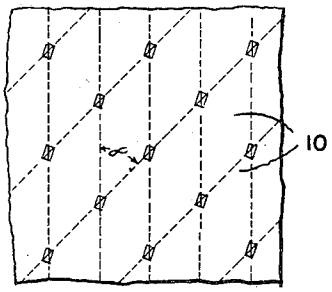


FIG.1b

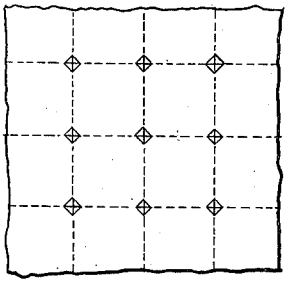


FIG.2b

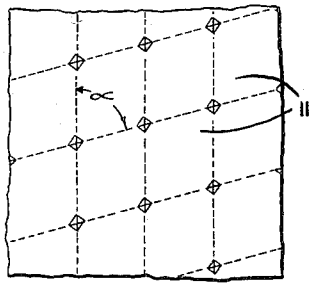


FIG.1c

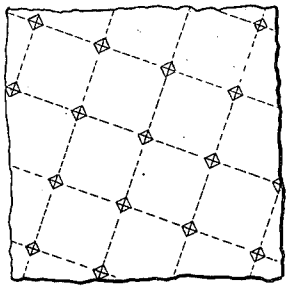


FIG.2c

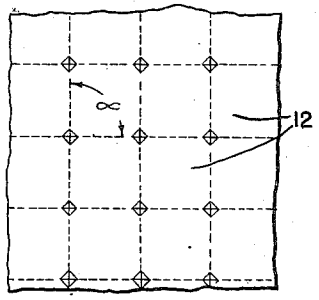


FIG.1d

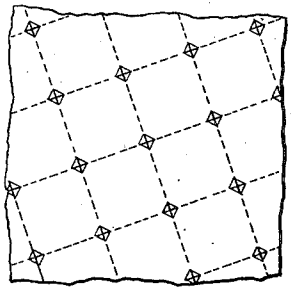
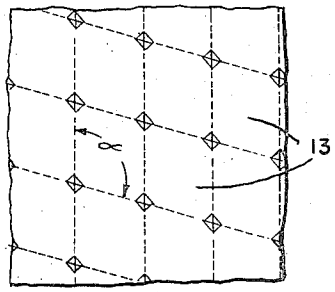


FIG.2d



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MULTI-COLOR-SEPARATION PRINTING PLATES

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FIG.3a

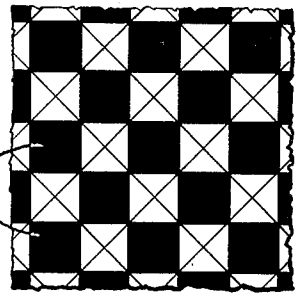


FIG.3d

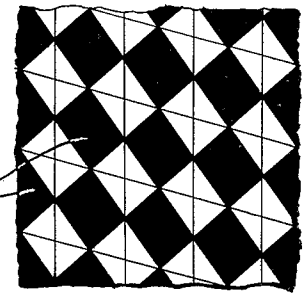


FIG.3b

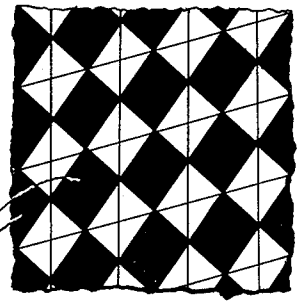


FIG.4a

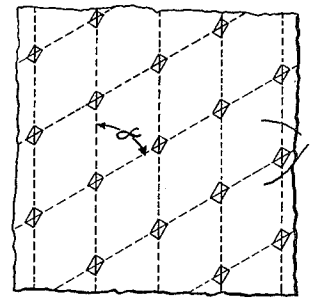


FIG.3c

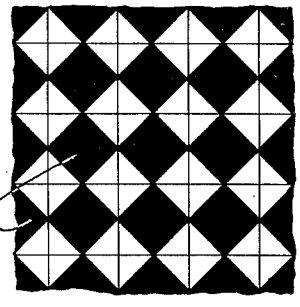
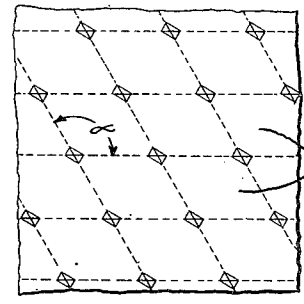


FIG. 4b



United States Patent Office 2,768,577 Patented Oct. 30, 1956

2,768,577

MULTI-COLOR-SEPARATION PRINTING PLATES

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Application March 31, 1953, Serial No. 345,953

7 Claims. (Cl. 101—401)

This invention relates to screen-pattern multi-color-separation printing plates and to a method of multi-color reproduction and particularly to such plates suitable for engraving by apparatus of the type described and claimed in applicant's Patent No. 2,575,546, entitled "Machine for Producing Screened Relief Pattern Plates."

Heretofore in conventional multi-color photoengraving practice, it has been found that a color image reproduced by the superimposition of imprints from a plurality of screen-pattern color-separation plates often is impaired by objectionable interference or moire patterns. These patterns result from the impracticability of similarly precisely registering the corresponding dot patterns of the several screen-pattern plates and manifest themselves both by the appearance of an objectionable grid pattern with a distinct geometric design and also by actual color distortion.

In multi-color photoengraving, one solution of the problem described has involved the exposure of each of the color-separation plates to light reflected from a specially prepared black-and-white separation plate with a conventional photoengraver's screen interposed to produce the desired screen effect in the image. The screens are rotated through different angles relative to a horizontal base line for the several exposures so that the lines of the screen-patterns fall at different angles relative to such a base line. A group of color-separation plates so formed is capable of printing a color reproduction with a minimum of the objectionable moire patterns described.

However, plates of the type just described cannot readily be formed on the photoelectric engraving apparatus of the type described in aforesaid Patent No. 2,575,546, except by relatively rotating the image being scanned and the plate being engraved during the engraving process. It is not only difficult to secure the image to its supporting cylinder with the various relative orientations required but, for any given apparatus, the maximum size of a plate that may be engraved is reduced in accordance with the reduction in size of a rectangle inscribed within another rectangle and oriented at the various angles required. Such an arrangement has additional disadvantages in requiring subsequent trimming of the engraving plate, with resulting wastage, and a lengthening of the required engraving time. A further drawback results from the dissimilarly oriented stretch imparted to the plates by the clamping action of the supporting cylinder.

It is an object of the present invention, therefore, to provide a new and improved correlated set of screen-pattern color-separation printing plates which can readily be engraved by photoelectric engraving apparatus of the type described in aforesaid Patent No. 2,575,546 and which are effective to reproduce multi-color images without objectionable interference or moire patterns.

In accordance with the invention, there is provided a correlated set of three or more screen-pattern color-

separation printing plates each comprising a regular pattern of elementary deformations, the centers of adjacent deformations of each of the plates lying at the apices of a series of parallelograms with the sides of the parallelograms of different ones of a plurality of the plates forming different corresponding angles therebetween, thereby substantially to reduce moire patterns in a resulting multi-color reproduction. The term "adjacent deformations" is used herein and in the appended claims to refer to deformations which are adjacent along a given "line" of the screen pattern or to nearest deformations lying on adjacent lines of such pattern.

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawings, while its scope will be pointed out in the appended claims.

Referring now to the drawings:

Figs. 1*a*–1*d*, inclusive, are idealized representations of individual screen-pattern color-separation plates formed with conventional photoengraver's screens oriented at different angles for different colors;

Figs. 2*a*–2*d*, inclusive, are idealized representations of individual screen-pattern color-separation plates engraved by apparatus of the type described in said Patent No. 2,575,546 and embodying the present invention;

Figs. 3*a*–3*d*, inclusive, are fragmentary details of printing plates of the type represented in Figs. 2*a*–2*d*, inclusive, respectively, illustrating the preferred form of the individual engraved impressions; while

Figs. 4*a* and 4*b* are similar representations of a modified form of color-separation plates suitable for use in place of those represented by Figs. 2*b* and 2*d*, respectively.

Referring now more particularly to Figs. 1*a*–1*d*, inclusive, there are represented in idealized form color-separation plates produced by conventional photoengraving methods with the engraver's screens rotated at different angles for the different colors. For example, Fig. 1*a* may represent the black-and-white plate, Fig. 1*b* the yellow plate, Fig. 1*c* the blue plate, and Fig. 1*d* the red plate. For simplicity, the engraved deformations are shown as square and of minimum depth and area, which would represent in the black-and-white the darkest shade value and in the other plates maximum color saturation, although it will be understood that the configuration of the deformations will depend on the shape of the engraving stylus and its orientation relative to the direction of scanning.

It is seen that in the plate of Fig. 1*a*, the centers of adjacent deformations lie at the apices of a series of parallelograms, specifically squares, with the sides thereof both making an angle of 45° to a horizontal reference base line. In the plate of Fig. 1*b*, the screen pattern is similar but the sides of the series of squares are parallel to and at 90° to the horizontal base line. In the plate of Fig. 1*c*, the sides of the squares of the screen-pattern form angles of 75° and 165° to the horizontal base line, while in the plate of Fig. 1*d* the sides of the squares of the screen-pattern form angles of 15° and 105° to the horizontal base line.

While it is not practicable to illustrate a resulting multi-color image reproduced by plates having screen-pattern configurations of Figs. 1*a*–1*d*, inclusive, experience has shown that, if proper angles of rotation are chosen, such a multi-color reproduced image is free to a maximum degree from noticeable interference or moire patterns. However, the plates of Figs. 1*a*–1*d*, inclusive, are not readily producible on a photoelectric engraving apparatus of the type described in said Patent No. 2,575,546 without relative angular displacement of the image and

the plate during engraving. Without such angular displacement, it becomes necessary in changing from a plate of one color to another to change a large number of the operating elements of the machine; for example, the relative speed of the screen generator stator 40*b*, the number of teeth of the screen generator 40, and the relative speed of rotation of the cylinder shafts 14*a*, 14*b* and the speed of their lateral travel. If such changes were made between the engraving of successive color-separation plates, the engraving process would be considerably complicated. In addition, construction of the photoelectric engraver to permit the required adjustments or replacement of elements make its considerably more complicated. On the other hand, if the color-separation plates of Figs. 1*a*–1*d*, inclusive, are formed by progressively relatively rotating the image and the plate during scanning, the disadvantages previously mentioned arise.

Referring now to Figs. 2*a*–2*d*, inclusive, of the drawings, there are illustrated a correlated set of screen-pattern color-separation engraving plates embodying the present invention. As in the plates of Figs. 1*a*–1*d*, inclusive, the plates of Figs. 2*a*–2*d*, inclusive, are idealized to show rectangular engraving deformations of minimum depth. Each of the plates of Figs. 2*a*–2*d*, inclusive, comprises a regular screen-pattern of elementary deformations, the centers of adjacent deformations of each of the plates lying at the apices of a series of parallelograms, such as the parallelograms 10, 10 of Fig. 2*a*; 11, 11 of Fig. 2*b*; 12, 12 of Fig. 2*c*; and 13, 13 of Fig. 2*d*. The sides of the parallelograms of the several plates form different corresponding angles therebetween, that is, the parallelograms may be said to be collapsed like a scissors rather than being bodily rotated as in the plates of Figs. 1*a*–1*d*, inclusive. For example, in the plate of Fig. 2*a*, the angle α between the sides of the parallelogram 10 is equal to 45°; in the plate of Fig. 2*b*, the angle α is equal to 75°; in the plate of Fig. 2*c*, the angle α is equal to 90°; while in the plate of Fig. 2*d*, the angle α is equal to 105°.

It will be noted that in the plates of Figs. 2*a*–2*d*, inclusive, the separations of the centers of the deformations in a direction parallel to a reference base line, that is, the horizontal width of the parallelograms varies progressively from plate-to-plate as sine α. In order to maintain the number of deformations per unit area constant for all plates, so that all plates have the same resolution, the separations of the centers of the deformations in a direction normal to the horizontal base line of each plate, that is, the length of the vertical side of each parallelogram, are varied from plate-to-plate as $1/\sin \alpha$. With such a pattern, the resolutions of the several plates are equal, although in the plates of Figs. 2*a*, 2*b*, and 2*d* the horizontal and vertical resolutions are not precisely equal to each other.

The plates of Figs. 2*a*–2*d*, inclusive, may readily be formed by the apparatus of said Patent No. 2,575,546 by making the following adjustments:

(1) Adjustment of the rate of carriage travel by interchanging certain of the driving gears, such as the gears 48, 49. The speed ratio from plate-to-plate should be varied inversely with the desired horizontal separation of the vertical lines of deformations, that is, the speed ratio should very as $1/\sin \alpha$.

(2) Adjustment of the screen frequency either by adjustment of the speed of rotation of rotor 40*a* of the screen generator by insertion of a variable-speed drive between the shaft 14*a* and the rotor 40*a* or by replacement of the screen generator 40 during the engraving of each plate with a generator having a different number of teeth. In either case, the screen frequency should be varied as $\sin \alpha$.

(3) Progressive adjustment of the speed of rotation of the screen generator stator 40*b*, which can be effected simply by replacing the pulley 41 by a pulley of a slightly different size. This has the effect of progressively shifting the deformations in the direction of scanning from plate-to-plate. For example, in forming the plate of Fig. 2*a*, the stator 40*b* may be rotated by one-half of the angular distance of one tooth and one space for each revolution of the rotor 40*a*; in forming the plate of Fig. 2*b*, it may be rotated one-quarter of such angular distance; in forming the plate of Fig. 2*c*, it may be held stationary; while in forming the plate of Fig. 2*d*, it may be rotated three-quarter of such angular distance per revolution of the rotor 40*a*, or one-quarter of such angular distance per revolution but in the reverse direction.

It will be understood that plates of Figs. 2*a*–2*d*, inclusive, may be formed on a single engraving machine of the type described in aforesaid Patent 2,575,546 by making the adjustments described between the engraving of successive plates.

Figs. 2*a*–2*d*, inclusive, may also represent a set of color-separation imprints, except that in this instance the dots represent printing "islands" rather than depressions and the imprints represent highlight portions of a reproduced image, so that Figs. 2*b*, 2*c*, and 2*d* represent portions of the image of minimum color saturation. It is possible to form the color-separation plates of Figs. 2*a*–2*d*, inclusive, by the conventional photoengraving method by interposing during the exposure of the several color-separation plates engraver's screens of the same general configuration as the screen patterns shown in the figures. Further, as described above, plates for printing images as represented by Figs. 2*a*–2*d*, inclusive, may be readily formed by the photoelectric engraving apparatus of said Patent 2,575,546.

Irrespective of the manner in which printing plates are formed, in making a multi-color image reproduction comprising the superimposition of a series of imprints, as represented by Figs. 2*a*–2*d*, inclusive, there may be made in any desired sequence first a black-and-white or brightness imprint, as represented by Fig. 2*a*, having a screen pattern consisting of dots forming a series of parallelograms 10. There is then superimposed upon the imprint of Fig. 2*a* the imprints representeds by Figs. 2*b*, 2*c*, and 2*d*, each of which is a color-separation imprint of a different color and each having a screen pattern consisting of dots forming a different series of parallelograms, such as the parallelograms 11, 12, and 13 of Figs. 2*b*, 2*c*, and 2*d*, respectively. As described above, it will be noted that the sides of the parallelograms of the imprints of Figs. 2*a*–2*d*, inclusive, form different corresponding angles therebetween, the angles varying progressively from 45° to 105°. It is also noted that the separations of the dots in a direction parallel to a reference base line of each imprint varies as sine α from imprint to imprint, the separation of the dots in a direction normal to the horizontal base line varies as $1/\sin \alpha$ from imprint to imprint, and each of the imprints consists of an equal number of dots per unit area. As described above, a color image formed by the superimposition of the imprints of Figs. 2*a*–2*d*, inclusive, is substantially free of undesirable interference and moire patterns.

Referring now more particularly to Figs. 3*a*–3*d*, inclusive, of the drawings, there are represented idealized printing patterns formed by the use of pyramidal engraving stylus in the engraving machine adjusted to make color-separation plates having an orientation and separation between adjacent deformations corresponding to the patterns of Figs. 2*a*–2*d*, respectively, and representing an image area of medium tone value or color saturation. In Figs. 3*a*–3*d*, inclusive, the shaded areas 16—19, inclusive, respectively, represent the actual printing surface islands, while the intervening parallelograms with diagonals drawn in represent individual deformations made by the pyramidal stylus in the engraving plate. The printing patterns of Figs. 3*a* and 3*c* are formed by the use of a pyramidal stylus of square cross section while those of Figs. 3*b* and 3*d* are formed by the use of a pyramidal stylus whose cross section is a parallelogram.

It is seen that the elemental printing surfaces of the plates of Figs. 3*a*–3*d*, inclusive, have the same area and that there are the same number of surfaces per unit area of the image, but that the centers of adjacent deformations lie at the apices of a series of parallelograms with the sides of the parallelograms of different ones of the plates forming different corresponding angles therebetween, thereby substantially to reduce the moire patterns in a resulting multicolor reproduction, as described above.

In Figs. 4*a* and 4*b* are represented screen-pattern color-separation plates which may be substituted for certain of the plates of Figs. 2*a*–2*d*, inclusive, for example, those of Figs. 2*b* and 2*d*. In the plates of Figs. 4*a* and 4*b* the deformations form a series of parallelograms 14 and 15, respectively, the sides of which form an angle of 60° to each other, but those of Fig. 4*b* being rotated through 90° relative to those of Fig. 4*a*. The plate of Fig. 4*a* may readily be formed on the machine of Patent 2,575,546 in the same manner as the plates of any of Figs. 2*a*–2*d*, inclusive. The plate of Fig. 4*b* may be formed either by relatively rotating the image being scanned 90° during engraving or, alternatively, it may be formed by changing the speed of rotation of the screen generator stator **40***b* and simultaneously adjusting the relative speed of rotation of the shafts **14***a* and **14***b* and the lateral advance of the scanning carriages **22** and **30**, as by changing the ratio of the gearing **46—49**, inclusive. In the plates of Figs. 4*a* and 4*b* the series of parallelograms formed by the deformations have different configurations relative to a horizontal base line and thus contribute to the elimination of intefering moire patterns in the same manner as the plates of Figs. 2*a*–2*d*, inclusive, described above.

While there have been described what are at present considered to be the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A correlated set of three or more screen-pattern color-separation printing plates each comprising a homogeneous pattern of elementary deformations, the centers of adjacent deformations of each of said plates lying at the apices of a series of parallelograms with the sides of said parallelograms of different ones of a plurality of said plates forming different corresponding angles therebetween, thereby substantially to reduce moire patterns in a resulting multi-color reproduction.

2. A correlated set of three or more screen-pattern color-separation printing plates each comprising a homogeneous pattern of elementary deformations, the centers of adjacent deformations of each of said plates lying at the apices of a series of parallelograms with the sides of said parallelograms of different ones of a plurality of said plates forming different corresponding angles α therebetween, the separations of said centers of said deformations in a direction parallel to a reference base line of each plate varying from plate to plate as sine α, thereby substantially to reduce moire patterns in a resulting multi-color reproduction.

3. A correlated set of three or more screen-pattern color-separation printing plates each comprising a homogeneous pattern of elementary deformations, the centers of adjacent deformations of each of said plates lying at the apices of a series of parallelograms with the sides of said parallelograms of different ones of a plurality of said plates forming different corresponding angles α therebetween, the separations of said centers of said deformations in a direction parallel to a reference base line of each plate varying from plate to plate as sine α and the separations of said centers of said deformations in a direction normal to said base line of each plate varying from plate to plate as $1/s$ in α, thereby substantially to reduce moire patterns in a resulting multi-color reproduction.

4. A correlated set of three or more screen-pattern color-separation printing plates each comprising a homogeneous pattern of elementary deformations, the centers of deformations of each plate lying in a series of parallel lines with said deformations of successive lines being progressively shifted from plate to plate in the direction of said lines, thereby substantially to reduce moire patterns in a resulting multi-color reproduction.

5. A correlated set of three or more screen-pattern color-separation printing plates each comprising a homogeneous pattern of elementary deformations, the centers of adjacent deformations of each of said plates lying at the apices of a series of parallelograms with the sides of said parallelograms of different ones of a plurality of said plates forming different corresponding angles therebetween, each of said plates having substantially the same number of deformations per unit area, thereby substantially to reduce moire patterns in a resulting multi-color reproduction.

6. A correlated set of four screen-pattern color-separation printing plates each comprising a homogeneous pattern of elementary deformations, the centers of adjacent deformations of each of said plates lying at the apices of a series of parallelograms with the sides of said parallelograms of different ones of a plurality of said plates forming corresponding angles therebetween of 45°, 75°, 90°, and 105°, thereby substantially to reduce moire patterns in a resulting multi-color reproduction.

7. A correlated set of three or more screen-pattern color-separation printing plates each comprising a homogeneous pattern of elementary deformations, the centers of adjacent deformations of each of said plates lying at the apices of a series of parallelograms with the sides of said parallelograms of different ones of a plurality of said plates forming different corresponding angles α therebetween, the separations of said centers of said deformations in a direction normal to a reference base line of each plate varying from plate to plate as $1/\sin \alpha$, thereby substantially to reduce moire patterns in a resulting multi-color reproduction.

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