Feb. 3, 1970 R. E. MAURER 3,493,381

HALFTONE SCREENS HAVING MORE THAN ONE TYPE OF DOT

Filed Jan. 27, 1966 3 Sheets-Sheet 1

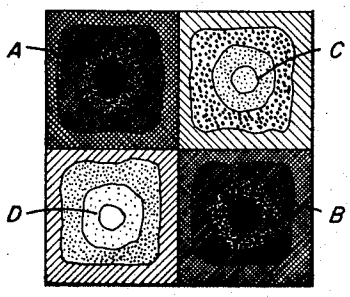


FIG. 1

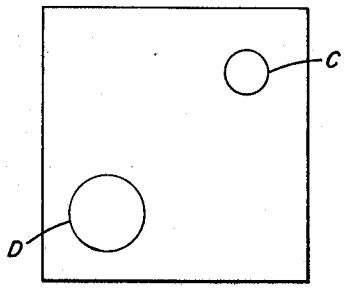


FIG. 2

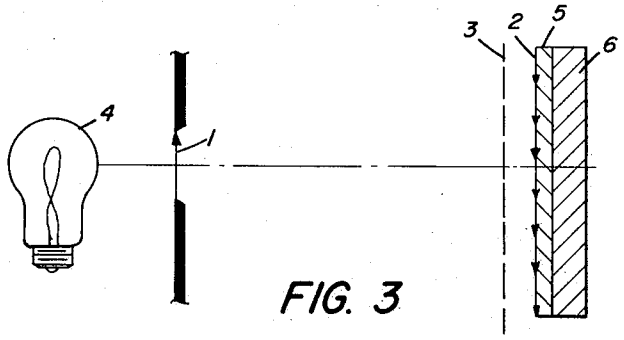


FIG. 3

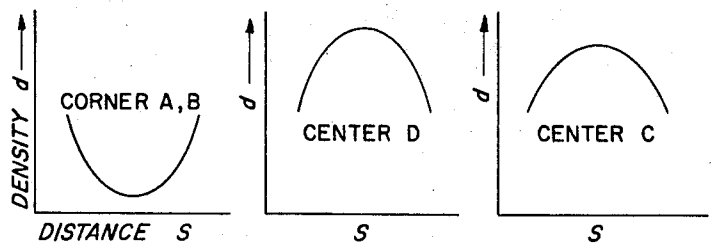


FIG. 4

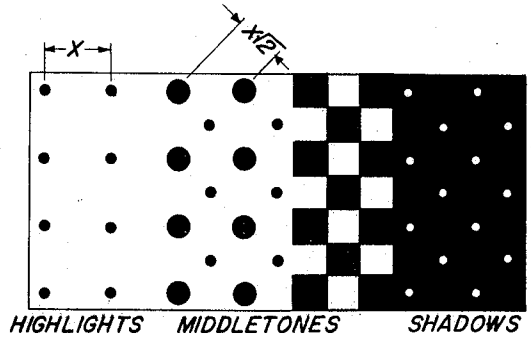


FIG. 5

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HALFTONE SCREENS HAVING MORE THAN ONE TYPE OF DOT

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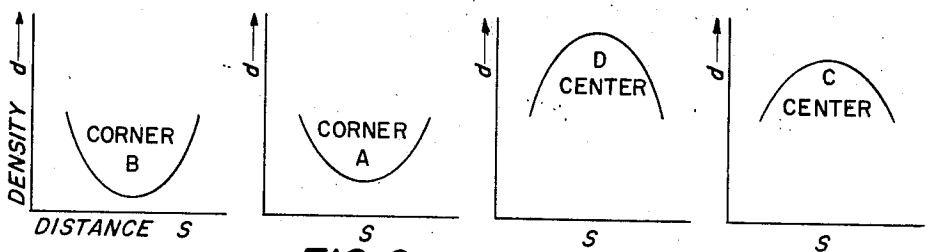


FIG. 6

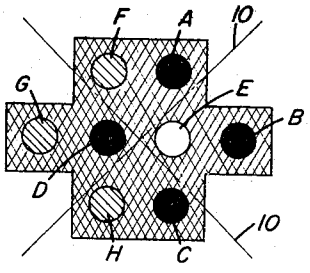


FIG. 7

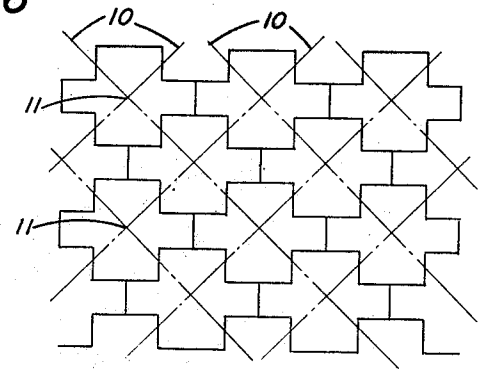


FIG. 8

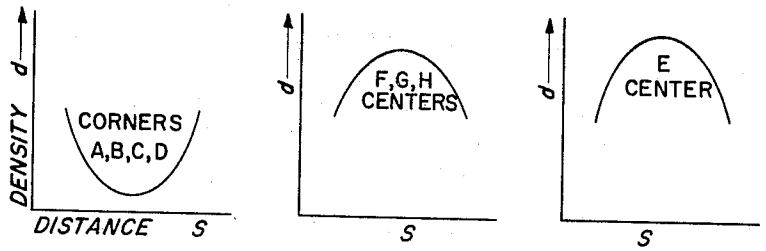


FIG. 9

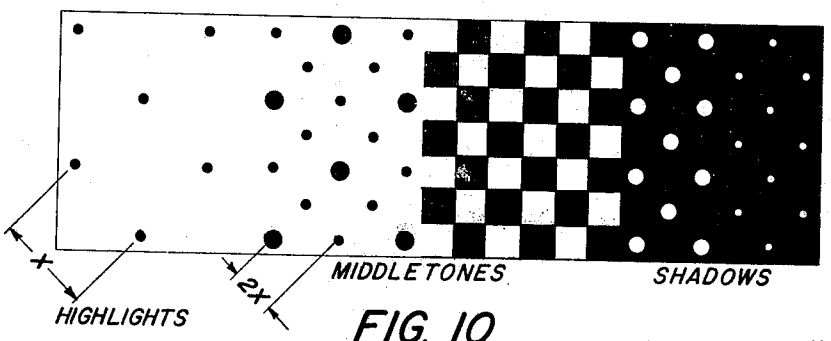


FIG. 10

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HALFTONE SCREENS HAVING MORE THAN ONE TYPE OF DOT

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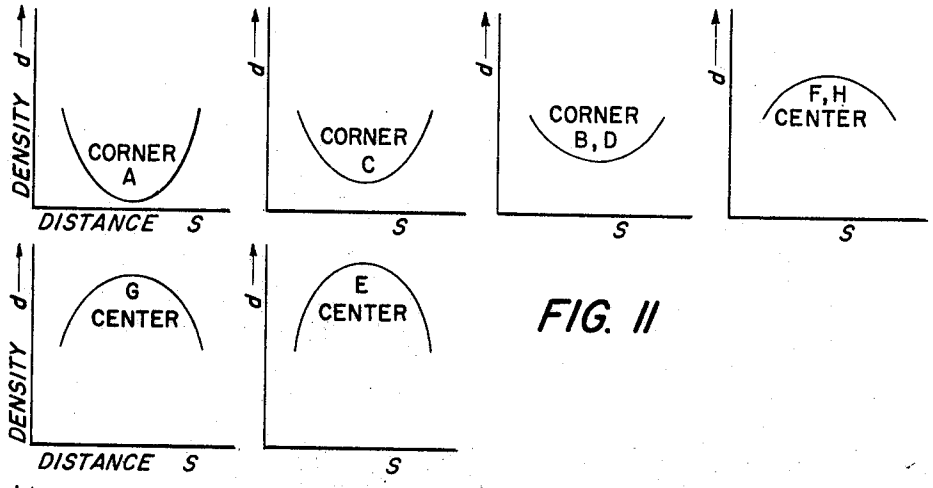


FIG. 11

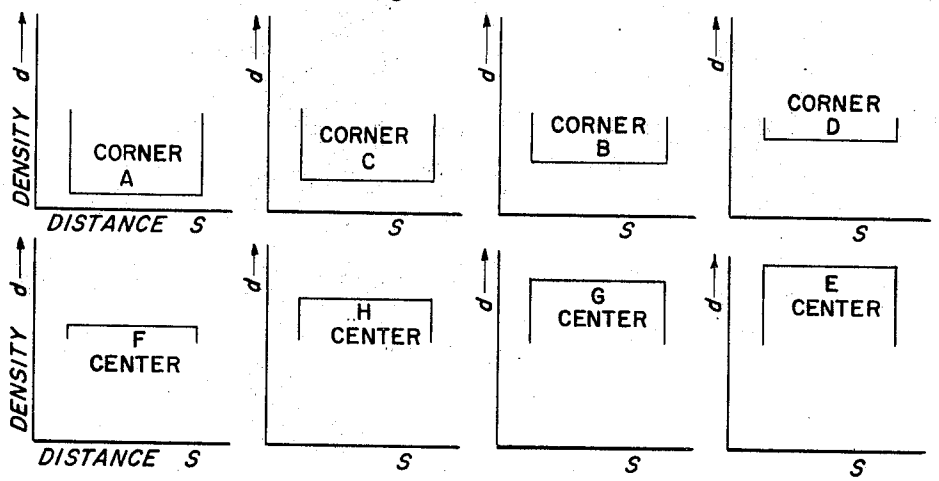


FIG. 12

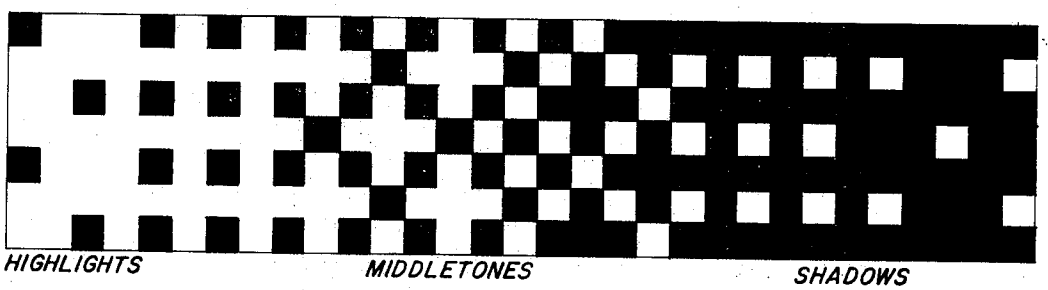


FIG. 13

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United States Patent Office

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HALFTONE SCREENS HAVING MORE THAN ONE TYPE OF DOT

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Int. Cl. G03f 5/00

U.S. Cl. 96—116 9 Claims

ABSTRACT OF THE DISCLOSURE

This invention relates to a halftone screen and a method of making the screen wherein the screen has dots that vary in size and number in the highlights, middletones and shadows.

This invention relates to graphic arts contact screens. More specifically, this invention relates to contact screens having more than one type of independently variable dot, the result of which can be a halftone print with a different ruling in the highlights, middletones and/or shadows.

Under ordinary graphic arts processes the density of halftone prints is varied from the highlights to the shadows by changing the size of the dots. At any particular density the sizes of all dots are the same, and from density to density the number of dots remains constant. Using a contact screen, this is accomplished by the density distribution of the screen. Reproduction problems in applying a contact screen to a particular process are ordinarily solved by uniformly adjusting the density distribution within each dot of the screen or by using a screen with a different ruling.

For the purposes of many printing processes, certain basic discrepancies are impossible to eliminate by use of any single dot configuration or any single screen ruling. For example, in the dry-offset process the highlight dots are disproportionately increased in size when the ink is squeezed by the printing plate as it contacts the rubber blanket. In the direct transfer gravure process the tone scale is not long enough to avoid poor rendition in either highlights or shadows. In neither of these cases has the problem been solved by a single dot configuration of a contact screen.

Several processes have attempted to increase tone reproduction by varying the number of dots as well as their size. For example, the diaphase halftone process involves moving a crossline screen for black-and-white halftones between two positions half a screen unit apart with one exposure at each position thereby doubling the number of dots in the middletones and highlights. Other methods include certain electrooptical systems; see for example, U.S. 2,294,644, Wurzburg. All of these variably ruled halftone processes are quite costly but give such improved results for particular purposes that they are often worth the extra expense.

It is an object of this invention to provide a contact screen which will correct many of the reproduction problems not correctable by uniformly changing each dot.

It is another object of this invention to provide a method of producing a halftone with more than one type of dot that is comparable in cost to ordinary halftones but has considerably more flexibility and variety of applications than previous variably ruled halftone processes.

These and other objects are accomplished by building the feature of variable ruling into a single contact screen.

Each set or type of corners or centers can be varied independently of the other type or types, thereby controlling features not easily controlled by a single dot type. For example, a single large center per unit area is replaced by two smaller centers in the same unit area which centers can be varied independently of each other. In a preferred embodiment one center fades out in the highlights giving a different ruling from the middletones.

In the drawings:

FIGS. 1, 2 and 7 are diagrams of aperture plates for making contact screens according to the invention.

FIG. 3 is a schematic diagram showing a method of making a contact screen from the aperture plates shown in FIGS. 1, 2 and 7.

FIGS. 4 and 6 are graphs of the densities of screens made from aperture plates similar to those shown in FIGS. 1 and 2.

FIG. 5 is a schematic diagram of a halftone reproduction made from a contact screen having densities as shown in FIG. 4.

FIG. 8 is a schematic diagram showing alternative imaging patterns of an aperture plate according to FIG. 7.

FIG. 9 shows a set of graphs illustrating the densities of a screen made from an aperture plate similar to the one shown in FIG. 7.

FIGS. 11 and 12 are graphs of the densities of contact screens made with various embodiments of aperture plates similar to FIG. 7.

FIGS. 10 and 13 are halftone positives made with contact screens represented by FIGS. 9 and 12 respectively.

For purposes of explaining the invention, the terms "center" and "corner" will be used to describe the subdivisions of a dot in halftone prints, halftone negatives, contact screens and aperture plates according to the result in the final halftone print. Thus, a "corner" in an aperture plate is that part of the plate which contributes to the corner in a final halftone positive. In each case it will be assumed that the contact screen is being used to make a halftone negative from a continuous tone positive and that the halftone negative is then used to make a halftone positive. Use of the invention to make contact screens for interposition between continuous tone negatives and halftone positives are, of course, equally part of the invention.

FIG. 1 illustrates an aperture plate for making a variable density contact screen according to the invention. This aperture plate represents a total of two corners and two centers. The two corners are enumerated A and B and the centers C and D.

As a practical matter the simplest form of aperture plate useful in the invention is more likely to be an opaque plate with merely openings C and D as shown in FIG. 2. In this case the spillover light from the openings as the plate is reproduced on the contact screens forms the corners corresponding to A and B. For purposes of explaining the invention it will be assumed that we are working with an aperture plate constructed according to FIG. 1.

FIG. 3 shows a method of making a contact screen from an aperture plate, a method well-known in the art. The aperture plate **1** is imaged by a light source **4** through a crossline screen **3** on photo-sensitive film **2**. The system of multiple apertures, in which two or more aperture plates are imaged at the same spot through two or more adjacent openings in the crossline screen, can also be used.

For an explanation of this method, see U.S. 2,478,443, Yule et al., particularly FIG. 3 thereof. For purposes of explaining the invention only, it will be assumed that a single aperture plate is imaged only once behind each opening in a crossline screen as shown. Although this method is generally known in the art, see Fr. 1,382,265 for more details in application.

An ordinary contact screen according to the prior art is made by using an aperture plate in which openings C and D are of the same density. If, however, center C is made slightly more dense throughout than center D, as is shown in FIG. 1, a contact screen with densities which vary or graduate from one center to another is obtained. The same result can be obtained with an aperture plate similar to FIG. 2 by making opening C smaller than opening D, as is shown in FIG. 2. Such densities are shown by three graphs in FIG. 4 in which density *d* is plotted against distance S across the corners and centers in the contact screen corresponding to A, B, C and D. Use of such a screen to make a halftone negative from which a halftone positive is made will give a halftone positive similar to that shown in FIG. 5. In FIG. 5 the centers corresponding to the lighter or wider opening D appear in the highlights while the other centers corresponding to those of opening C do not appear until the lighter middletones. This is due to the fact that the two have different peak or middle densities in the contact screen. At that point they are smaller in size. As is shown in FIG. 5, if the highlights have a ruling of X lines per inch, the middletones and shadows will have a ruling of $X\sqrt{2}$ lines per inch.

The invention may be used to vary the ruling in both the highlights and the shadows. If corner A is made slightly less dense than corner B as well as center C being slightly more dense than center D, the densities of the corners and centers in the contact screen will be as shown in FIG. 6. This will give a halftone positive having X lines per inch in the highlights and shadows and $X\sqrt{2}$ lines per inch in the middletones. Each of the two corners and of the two centers can be varied independently of the others as the application warrants. In fact, the variation does not need to affect the peak densities but can be limited to the middletones. This would give the same number of centers or corners at all times, but different sized ones at particular densities.

FIG. 7 shows an aperture plate which can be used for more complicated forms of the invention. According to FIG. 7 the corners are enumerated A, B, C and D and the centers are enumerated E, F, G and H. The contact screen can again be made as shown in FIG. 3. FIG. 8 schematically shows the resulting image arrangement on the contact screen when made through a 90° crossline screen. Lines **10** represent the center lines of the openings in the crossline screen, the middle of said openings being where they cross **11**.

With opening E as shown in FIG. 7 of less density than openings F, G and H a contact screen with densities according to those shown in the graphs in FIG. 9 is obtained. This will give a halftone positive similar to that shown in FIG. 10. If there are X lines per inch in the highlights, there will be 2X lines per inch in the middletones and shadows. This type of screen is especially useful in photoengraving where the necessity of highlight dots makes the highlights grayish. Reducing the number of dots would satisfy the necessity of some dots but reduce the grayness.

With an aperture plate as shown in FIG. 7 a large number of variations are possible. One of the more complicated embodiments is represented by the graph shown in FIG. 11. Here center E is the lightest, G the next lightest and F and H the next lightest, while the corners A, B, C and D are similarly varied. Such an aperture plate will give a contact screen which will produce a halftone positive having X lines per inch in the highlights and shadows $X\sqrt{2}$ lines per inch in the darker highlights and lighter shadows and 2X lines per inch in the middletones. This will help give generally better contrast in both highlights and shadows.

If spillover is reduced and stepped variations are used in the aperture plate, a contact screen with the densities shown in FIG. 12 can be obtained. In FIG. 12 the size of all dots are the same and the gradations of density are obtained by changing only the number of dots. Note that the number of dots is changed in the middletones without changing the ruling. This would give the halftone positive shown in FIG. 12. Such a contact screen is particularly applicable to gravure work when the dot shapes are suitable for gravure printing. A more sophisticated version of this embodiment would use this method in highlights and shadows, but vary the size of the dots in the middletones.

No attempt has been made to list all the variations and uses of this invention. For example, diamond shaped dots as shown in Fr. 1,382,265 are readily adaptable to this invention. The aperture plate shown in FIG. 12 of that patent is particularly suitable for such an adaptation. Note that it has eight dots, thereby making available a larger variety of rulings than in any of the examples explained herein.

Although the invention has been described in considerable detail with reference to certain preferred embodiments thereof, it will be understood that variations and modifications can be effected without departing from the spirit and scope of the invention as described hereinabove.

I claim:

1. A contact screen for photomechanical reproduction, comprising:

a photographic material having a repetitive pattern continuously gradating from one to the other along generally rectilinearly directed lines;

each pattern including a number of gradating areas, each of said areas being of at least one variable density and forming at least one dot having a density varying from the center outward;

whereby said areas, when said screen is illuminated with a continuous tone image, will form halftone dots on a photosensitive material in varying number and size in accordance with the tonal density of the portion of said image incident thereon.

2. A contact screen according to claim **1** wherein each of said patterns comprises at least three areas of different density.

3. A contact screen according to claim **1** wherein each of said areas has a peak of greater or lesser density and the total number of said peaks in each of said patterns is at least three.

4. A contact screen according to claim **1** wherein some of said areas in each of said patterns have a greater peak density than the rest of said areas and the ratio of the number of greater peak density areas to the number of lesser peak density areas is approximately 3:1.

5. A contact screen according to claim **1** wherein the number of halftone dots formable by some of said areas is double the number of halftone dots formable by the other areas.

6. The method of producing a contact screen for photomechanical reproduction, comprising the steps of:

imaging a pattern comprising a number of areas of different density distribution on a photographic material once behind each opening in a crossline screen; and

developing said photographic material, whereby said pattern is repetitive along generally rectilinearly directed lines and continuously gradates from one to

the other and each of said areas forms at least one dot having a density varying from the center outward.

7. The method according to claim 6 wherein said pattern comprises two transparent openings in a plate, each of said openings having a different area.

8. The method according to claim 6 wherein said pattern comprises four areas of low opaqueness in a plate, at least one of said areas transmitting more light than the others.

9. The method according to claim 6 wherein said pattern comprises four areas of high opaqueness in a plate, at least one of said areas transmitting less light than the others.

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