May 12, 1964 M. L. SCOTT 3,132,946

CONTACT SCREENS FOR PHOTOGRAVURE

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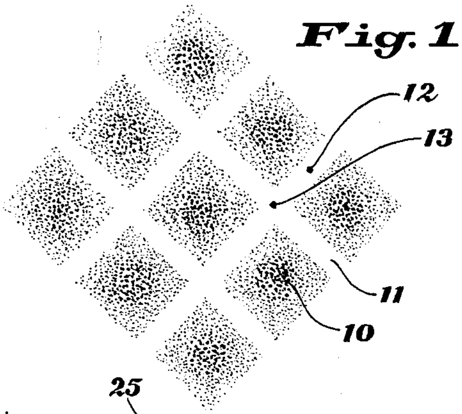
Fig. 1

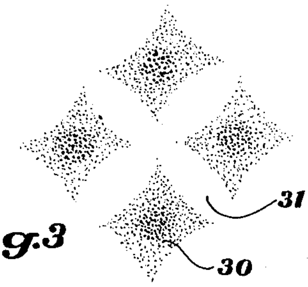
Fig. 3

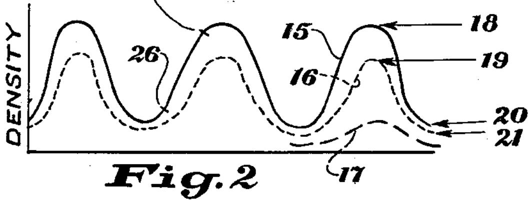
Fig. 2

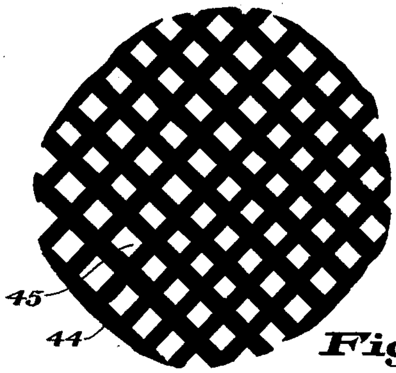
Fig. 6

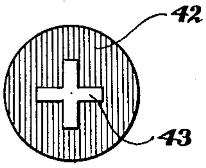
Fig. 5

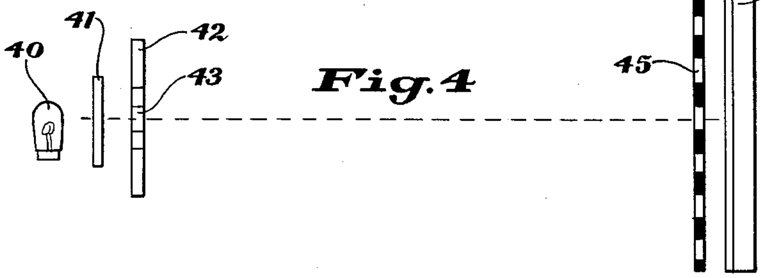
Fig. 4

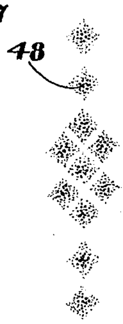
Fig. 7

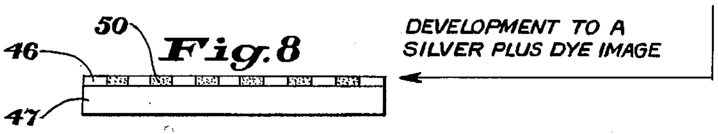
Fig. 8

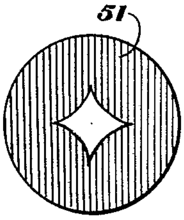
Fig. 9

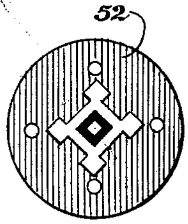
Fig. 10

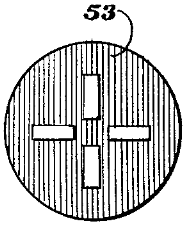
Fig. 11

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CONTACT SCREENS FOR PHOTOGRAVURE

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This invention relates to contact screens for the production of dot negatives to be used in photogravure. It relates particularly to halftone contact screens for the production of variable area, variable depth dots in the ultimate printing plate made from the negative. Such processes are sometimes called inverted halftone as distinguished from those gravure processes in which only the depth of the printing dot is varied.

Some gravure processes in common use employ the so-called "lateral" dot rather than the checkerboard pattern of dots commonly found in photolithography and the like. The lateral dot includes a relatively narrow square grid of effectively clear or effectively opaque lines. The area inside each square of the grid is uniform density in some gravure processes and is non-uniform in various ways in other processes. In common with gravure processes in general, the present invention relates to a contact screen having a "lateral dot" pattern.

The object of the present invention is to provide a contact screen capable of producing a halftone negative or positive which when used in gravure processes will result in an extremely high quality reproduction. This problem is complex and many systems which have been proposed to solve it are also complex. One object of the present invention is to provide a simple screen which is easy to manufacture uniformly and reliably.

U.S. Patents 2,292,313 and 2,304,988, both to Yule, and U.S. 2,311,071 Murray describe contact screens in which the density is provided by a highly transparent dye and in which contrast is controlled by varying the color of the printing light passing through the screen.

Another object of the present invention is to obtain all of the advantages of the Murray screen plus the lateral dot form and the density distribution within each dot necessary for high quality photogravure. The main discovery involved in the present invention is that certain percentages of silver (or other metal) combined with dye give exactly the density distribution and the resultant effect necessary to produce highest quality in photogravure processes. The amount of silver is small compared to the amount of dye but the total density range is, of course, higher than that of the dye alone. Nevertheless the quality is equal to that obtainable with dye screens as far as resolution is concerned and better than with the dye screens, with respect to tone reproduction. It is particularly important in gravure processes to have a high density range in each dot since only a portion of this range is used. This point will be discussed in more detail in connection with the drawings.

According to the invention a contact gravure screen is made up on a transparent support such as glass or plastic by distributing in a transparent layer on the support, grains of metal such as silver and a substantially transparent dye, both being distributed in the same uniformly undulating pattern of halftone lateral dots. If D max. is the density at the point of maximum density and D min. is the density at the point of minimum density, the amount of silver present must be such that the range between D max. and D min. is between 0.15 and 0.70 greater than the same range for the dye alone. Silver is conveniently deposited by a photographic process and the dye is produced by color photographic methods.

In the preferred embodiment D min. for silver alone is between 0.05 and 0.3 and for dye alone is between 0.15 and 0.9 and is greater than that for the silver alone. The total D min. is about .20 and 1.20. If it were obtainable in practice, the D min. could theoretically be as low as zero.

D max. in the preferred embodiment is between 0.45 and 0.75 for the silver alone between 1.55 and 2.75 for the dye alone. Thus the total D max. lies between 2.0 and 3.5. The density for the dye is read through a complementary filter; for example, magenta dyes are commonly used in contact screens and in this case the density is read on a microdensitometer through a green filter such as a Wratten 61 filter. The presence of the filter does not affect the measurement of the silver density. In each case the filter is present and is allowed for in all of the density measurements.

Usually the highest values of D max. are accompanied by the highest values of D min. but the lower values of D max. may have any value of D min. The grid of the lateral dot is effectively uniform at the D min. value. In practice it is not quite uniform, but the variations do not have any effect since sufficient exposure is always given to print to a maximum through the grid lines. Since the grid lines always print black, one never gets a 100% clear dot. The maximum clear dot may be only a 40 or 50% one in gravure. Similarly at the other end of the scale one never produces a pin-point clear dot. About a 10% dot is used for the highlight dot. Thus one does not utilize the density of the contact screen dot all the way up to D max. thereof. The working range ends a little below D max. in order to leave the 10% dot. The working range is usually between 0.70 and 1.3, an optimum quality range being about 1.1 in density units. The working range is always less than the total range.

The method of manufacturing screens according to the present invention is quite simple. It is similar to that described in the Murray patent mentioned above, except for three things. First the exposure, specifically the distribution of light in each dot area is such that a lateral dot rather than a checkerboard dot results. Secondly the right amount of silver halide is used in the emulsion and the right amount exposure is given to obtain the amount of silver needed (within a fairly wide range) in the end product. Thirdly the silver is not bleached out as it is in the manufacture of Murray's dye screens.

Since only a relatively small amount of silver is required and since there is an adequate amount in all medium contrast, fine grain photographic films, there is no problem at this end of the scale. Similarly, there is no problem producing a small enough deposit of silver since this is controlled by the exposure and, as in any photographic process, the exposure is selected to give the density specified. Medium contrast ortho films producing a gamma of about 2 are sometimes known as commercial type films. With such films, for example 15 seconds' exposure by a standard ultra-violet lamp (a General Electric H4 lamp with a Corning UV filter), at 90 inches from the film (with a standard ruled 1:1 halftone screen at halftone distance in front of the film) gives a proper latent density. After such exposure the layer is color developed except that the silver bleaching step is omitted. Thus the screen contains an undulating pattern consisting of both dye and silver.

To produce the lateral dot shape, the exposure is made through a crossed slit aperture located immediately in front of the exposing lamp. The crossed slit aperture may take any of the usual forms employed in making gravure negatives through ruled screens. The term "crossed slit" is used herein as generic to the simple cross and to those modifications in which the center of the cross is made larger or smaller or in which the cross is made to appear as an exaggerated pin cushion.

The ruled halftone screen is commonly a 1:1 screen, but again other rulings have been found useful such as a screen in which the width of the openings is three times the width of the rulings. Some gravure screens have grids which provide pin cushion rather than square shape dots. The present invention can be employed in such systems, but with the present invention, the need for such refinements seems hardly necessary and accordingly the preferred embodiment of the invention has dots which are more or less square lateral dots and may even be slightly "rounded off."

The operation of the invention and the advantages thereof will be fully understood from the following description when read in connection with the accompanying drawing in which:

FIG. 1 illustrates the appearance of a greatly enlarged section of the screen according to the present invention.

FIG. 2 is a graph of the density distribution across three dots of the screen shown in FIG. 1.

FIG. 3 is similar to FIG. 1 and illustrates a slight modification thereof.

FIG. 4 schematically illustrates the method of manufacture of screens according to the present invention.

FIG. 5 is a front view of the aperture mask used in FIG. 4.

FIG. 6 is a front view of the ruled halftone screen used in FIG. 4.

FIG. 7 schematically illustrates the distribution of the exposing light at the sensitive film in FIG. 4.

FIG. 8 schematically shows a cross section of a screen according to the present invention.

FIGS. 9, 10 and 11 show alternative forms of aperture useful in the manufacture of such screens.

In FIG. 1, nine lateral dots of a contact screen according to the invention are shown with the centers of the dots at 10 and the grid separating the lateral dots shown at 11. This is a so-called positive screen and the grid 11 is effectively clear or uniform at D min. but actually the density at the point 12 between two adjacent dots is a little higher than the density at the corners 13 of the dots. Effectively they are the same density, however, since when exposures are made through the screen, sufficient exposure is given to expose fully through the area 12 as well as through the areas 13.

In FIG. 2 the undulating curve 15 illustrates the density distribution diagonally across three of the lateral dots of FIG. 1. This density is made up of the dye density represented by the curve 16 and the silver density represented for one of the dots by curve 17. That is, the curve 15 is the sum of the curves 16 and 17. Densities add linearly. In the examples shown the curve 16 is about three times the height of the curve 17. D max. 18 for each dot is the sum of D max. 19 for the dye alone and D max. for the silver. The density due to the silver is shown either by the curve 17 or by the differences between the curves 15 and 16, i.e., the differences between the point 18 and the point 19 for the center of the dot.

Similarly D min. 20 for the whole dot is made up of D min. 21 for the dye alone and D min. for the silver which is the difference in density between the points 20 and 21. It should be noted that the present invention does not involve an absolutely clear grid. The screen has sufficient density range between D max. at 18 and D min. at 20 that the whole of the range need not be, and is not, used in actual practice. The points 25 and 26 represent the working range of the screen. When the exposure is sufficient to produce an image through the point 25, only a small clear dot is left unexposed in the negative being made through the screen. This clear dot becomes a highlight dot in the ultimate positive. It is about a 10% dot. Similarly there is always sufficient exposure through the screen to produce a latent image at the point 26. Thus the clear dot in the negative resulting from low exposure is never larger than the square. This may be only a 40% dot. The part of the dot between the points 25 and 26 is the part which affects the tone reproduction of the system. Highlights are controlled by the part just below the point 25 and the shadow dot quality is controlled by the parts just above the point 26 on the curve 15. The highlight dot corresponding to the point 25 is not only small in area but is shallow on the printing plate whereas the shadow dot corresponding to the point 26 is large in area and quite deep, to provide more ink when printing therefrom.

FIG. 3 is similar to FIG. 1 except that the "squareness" of the lateral dots has been exaggerated as shown at 30 to form a pincushion. That is, contours of uniform density are pincushion in shape. The resulting grid 31 is a series of bi-convex areas linked together. The pincushion dot is useful in those gravure processes in which the etching of the gravure cells in the plate tends to cut through the side walls in the shadow dots. This is not part of the present invention but is shown merely to illustrate that the present invention can be used with this added feature if desired. In practice it does not seem necessary to have this added feature, however.

In FIG. 4 light from an ultra violet lamp 40 (General Electric H–4 Mercury Lamp) through an ultra violet filter 41 and an aperture 43 in a stop mask 42 is used to expose a photographic film through a ruled halftone screen 44 having square holes 45 therein. The light strikes a sensitive emulsion 46 of a medium high contrast film carried on a transparent support 47. The aperture mask 42 is illustrated in FIG. 5 and the ruled screen 44, the ruling being diagonal with respect to the cross slit 43 of the aperture 42, is shown in FIG. 6.

Due to diffraction the light behind each hole 45 in the screen tends to be circular. However, the crossed slit aperture 43 overcomes this to the extent that the distribution of light at the emulsion 46 takes the form of the lateral dot pattern 48 as illustrated in FIG. 7.

The screen 44 is located at halftone distance from the emulsion 46. Halftone distance is well known and depends on the fineness of the screen and the distance of the aperture 43 from the screen. For example with a 133-line screen and with the aperture 43 at a distance of 90 inches from the emulsion layer 46, normal halftone separation between the screen 44 and the emulsion layer 46 is about 0.28 inch. In this case the cross slits in the mask 43 are each about 2¼ inches long and may be ¼ inch wide, preferably with an enlarged center area and tapering to a point at the ends as discussed in connection with FIG. 10 below. With a finer ruling the separation of screen and film would be slightly less and the aperture 43 would stay about the same size and about the same distance from the film. Larger apertures could be used farther away, but 90 inches appears to be adequate, whereas closer distances result in less uniformity of exposure and the disadvantage of the corners of the film being exposed too obliquely through the screen. The exposed film is then processed to a negative silver image and by a suitable color forming developer (containing a coupler agent and a dye forming coupler) the processing produces a halftone screen as shown in FIG. 8 containing both silver grains and the dye. The centers (D max.) of the dots are shown at 50. The amount of silver deposited is controlled by the exposure given in FIG. 4 as in any photographic process. In the particular example given, an exposure of 15 seconds is proper. This results in a low density silver image, but quite a high density dye image, the total density being effective as a screen as discussed in connection with FIG. 2.

The simple crossed slits 43 shown in FIG. 5 can be replaced by a pin-cushion aperture as in the mask 51 of FIG. 9 or by a more complex arrangement of slits as in the mask 52 of FIG. 10. In the latter case the center of the aperture is enlarged and the ends of the slits are extended by small holes which are shown circular in shape but which could be almost any shape. In FIG. 11 the crossed slits are opaque at the center and thus actually consist of four slits but this is just another modified form of crossed slit aperture.

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 within the spirit and scope of the invention as described hereinabove and as defined by the appended claims.

I claim:

1. A gravure contact screen comprising a transparent support sheet and on a surface thereof a transparent layer containing grains of silver and a substantially transparent dye both distributed in the same uniform undulating pattern of lateral dots with an effectively clear grid, said dots having a D min. for the combination of silver grains and dye not greater than 1.2 the difference between D min. and D max. for said combination being between 0.15 and 0.70 greater than the difference between D min. and D max. for the dye alone, where D min. and D max. are the optical density of the areas of the pattern having respectively the minimum density and the maximum density, measured by light of wavelengths which are absorbed by the dye, as well as by the silver grains.

2. A gravure contact screen according to claim 1 in which D min. for the silver alone is between .05 and .3 and for the dye alone measured through a complementary filter is between .15 and .9.

3. A gravure contact screen according to claim 1 in which D max. for the silver alone is between 0.45 and 0.75 and D max. for the dye alone measured through a complementary filter is between 1.55 and 2.75.

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