Nov. 29, 1966 E. R. ATKINSON 3,288,059

COLOR REPRODUCTION

Filed Oct. 20, 1965

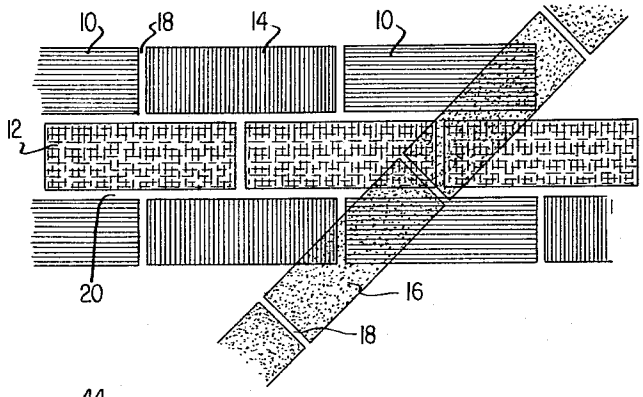


FIG. 1

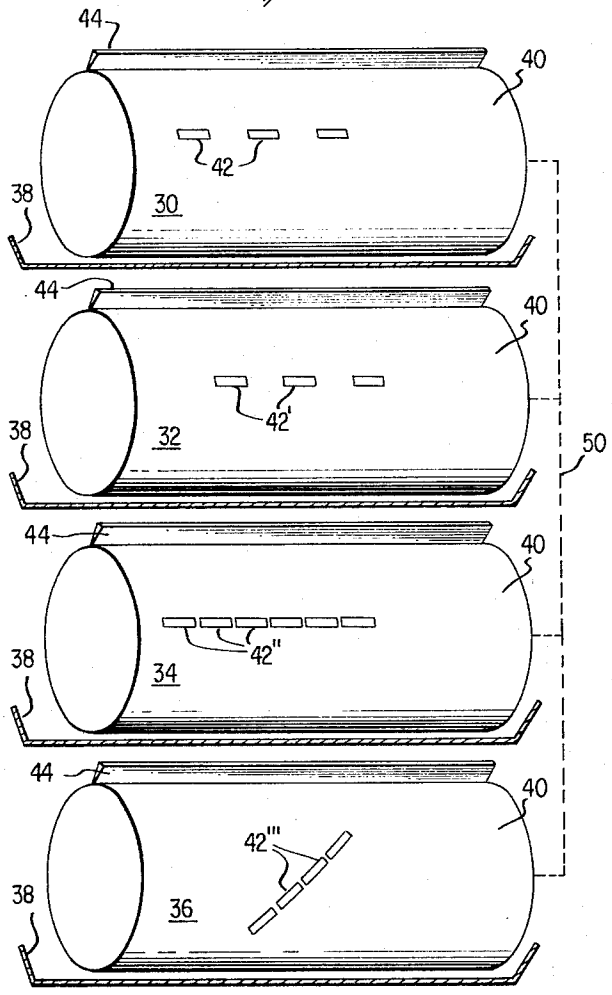


FIG. 2

FIG. 3A

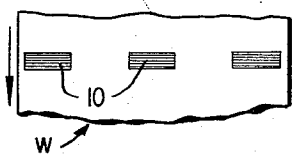


FIG. 3B

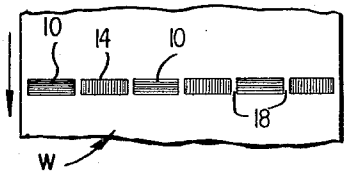


FIG. 3C

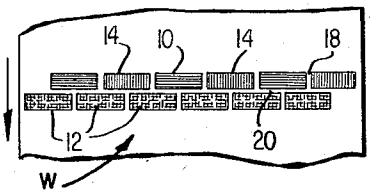
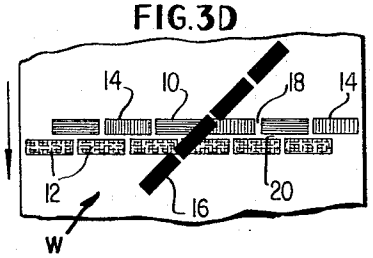


FIG. 3D



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3,288,059

Patented Nov. 29, 1966

3,288,059

COLOR REPRODUCTION

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Filed Oct. 20, 1965, Ser. No. 506,419
3 Claims. (Cl. 101—211)

This application is a continuation-in-part of my application entitled "Photographic Color Reproduction," Serial No. 329,897, filed August 28, 1964, and now abandoned.

This invention relates, in general, to color reproduction printing and more particularly, to a method of gravure or intaglio printing involving the use of a specially formed and correlated set of screen-pattern, separation printing plates, which may be readily engraved by conventional engraving apparatus.

In color reproduction printing, it is conventional to etch the printing surface of each of the correlated printing plates to provide circular or rectilinear patterns in the order of 120 wells or cells per inch or 1440 wells per square inch. Either all wells are provided with the same outline having the same surface area in which the light tones are produced by varying the depth of the wells, or alternatively, the depth of the wells remains constant and the surface area of the wells is varied. Both of these methods of achieving differences in shade or tone in color reproduction printing are quite conventional and are set forth in United States Patent 923,799 to C. W. Saalburg, issuing on June 1, 1909. Conventionally, well depth varies from 35 microns for solid colors to 2 microns for the light color tones or tints. The principal disadvantage to varying the depth of the well is that the extremely shallow wells change rapidly in volume as the printing surface wears, thus resulting in frequent and costly make overs. Further, since each of the wells is separated by a solid printing surface section known as a bridge, no ink transfer is provided from the printing plate to the paper at the areas of contact between the paper and the bridge surface. Due to the small size of the individual wells, the presence of the bridges, the wear on the plate and the shallow depth of some of the wells, and the inability of the capillary attraction to adequately remove all of the ink from the well during the process of transmitting ink from the well to the paper, pickiness or mealiness results. In this case, the ink itself acts in the nature of adhesive tending to tear during contact between the paper and the printing surface whereby only part of the ink carried by the well is transferred to the paper, while the remainder of the ink remains within the shallow, small area well, thus greatly increasing the possibility of a poor quality color reproduction due to the presence of the unwanted pickiness. Pickiness is particularly objectionable for those areas of the color image involving the yellow primary color ink.

In addition, in conventional multicolor photoengraving practice, it has been found that a color image reproduced by the superpositioning 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 ink patterns of the several screen-pattern plates and manifest themselves by the appearance of an objectionable grid pattern with a distinct geometric design, and also by actual color distortion. In multicolor photoengraving, one solution of the problem described involves 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 objectionable moire patterns.

In order to increase the reliability of the color reproduction, the yellow primary color image must be emphasized since it is highly susceptible to dilution by the presence of the other primary color image portions; that is, the blue and the red. In the past, this has been achieved principally by increasing the depth of the wells carrying the yellow ink to ensure a heavy tone yellow ink pattern.

It is, therefore, a primary object of this invention to provide a new and improved color reproduction printing method which employs a correlated set of screen-pattern, color-separation printing plates which completely eliminates objectionable mealiness or pickiness normally associated with multicolor image reproduction.

It is a further object of this invention to provide a new and improved color reproduction printing method which completely eliminates the need of angling of the screens in the production of all primary color dot screen-pattern plates whereby the primary color ink dot patterns are all printed in parallel line fashion but deposited in nonsuperimposed fashion upon the ink receiving web.

It is a further object of this invention to provide an improved method of color reproduction printing employing a correlated set of screen-pattern, color-separation printing plates which greatly reduces the number of bridge lines per unit of service area, while eliminating the objectionable in-line pattern normally produced thereby.

It is a further object of this invention to provide a new and improved color reproduction printing process producing a color image consisting of nonsuperimposed dots of the different primary colors in which the surface area of yellow ink dots is in the order of twice the surface area of either the red or the blue primary color ink dots.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawings.

In the drawings:

FIGURE 1 is a top plan view, greatly magnified, of a portion of a paper stock web after receiving a multicolor image consisting of ink dots of the primary colors and black ink dots at some angle thereto.

FIGURE 2 is a side elevational view of a preferred embodiment of the present invention showing the correlated set of screen-pattern, color-separation printing plates produced by conventional engraving means operatively positioned to provide the multicolor reproduction shown in FIGURE 1.

FIGURES 3A, 3B, 3C and 3D are plan views of the paper web showing the application of the multicolor ink dots in rectangular pattern as the paper moves sequentially with respect to the correlated set of screen-pattern, color-separation printing plates of the apparatus shown in FIGURE 2 .

In general, the method of the present invention involves the use of improved, correlated screen-pattern, color-separation printing plates with the ink receiving wells formed therein in accordance with the area to be printed and of an ink capacity in accordance with the desired tone depth to form a first series of rectilinear ink dots of alternater red and blue primary color ink, in line and at the same angle, with the dots having a ratio of width to height of at least 2 to 1 and being separated by relatively thin bridge lines. A second series of rectilinear ink dots of yellow ink is formed with the series of dots being oriented parallel to the series of the red and blue ink dots and of like configuration to the red and blue dots,

for positioning in series fashion, on either side of the series of red and blue ink dots. The primary color ink dots are then deposited in nonsuperimposed fashion on an ink receptive media, preferably with the bridge lines between dots for any given line of dots being offset with respect to the bridge lines of the next successive line of dots. Further, to modify the color tone of the color reproduction image, the volume of ink carried by each dot is preferably varied without changing the dot surface area. For four color printing, a fourth printing surface is provided in which the wells are arranged in a rectilinear pattern again having one surface dimension in the order of twice the other surface dimension but with the longitudinal axis of the line of wells being inclined with respect to the longitudinal axis of its printing plate, whereby the black ink dots formed thereby are superimposed over the ink dots formed by the primary colors during sequential contact of the web with the printing plates.

Referring to FIGURE 1, there is shown a plan view of a paper web or print stock W. The section shown in FIGURE 1 is greatly magnified with respect to that shown in FIGURES 3A, 3B, 3C and 3D. It should be remembered that there are a great number of ink dots formed within any square inch of image receiving surface and as indicated previously, in conventional practice, the ink dot pattern is normally in the order of 120 dots per inch, or 14,400 dots per square inch. In this case, the present correlated set of color-separation printing plates produce ink dots in the order of 225 dots per square inch. A series of blue ink dots **10**, yellow ink dots **12**, red ink dots **14**, and black ink dots **16** are produced. They are separated from themselves by bridge lines **18** which are transverse to the longitudinal axis of the respective dots and bridge lines **20**. Bridge lines **20** extend longitudinally between respective dot lines, such as blue dots **10** and yellow dots **12**. The bridge lines **20** lie longitudinally of the axis of the series of individual color dots, such as the yellow dots which are positioned all in a row with the exception of the narrow transverse bridge lines **18**. The red and blue ink dots are alternately disposed along a common base line and are separated by the thin transverse bridge lines **18**. In the case of the four color multicolor image reproduction systems, there is provided, in addition to the primary color ink dots, black ink dots **16** which, in the present invention, are superimposed over the spaced primary color ink dots at some angle to the longitudinal axis of the primary color dots normally 45° thereto.

It is noted that it is a principal object of this invention to provide a true color reproduction having the desired color balance. Knowing in the past that emphasis was placed on the yellow ink pattern by using excessive well depth to provide a higher than necessary yellow color tone image, the present invention advantageously uses a system of ink dot distribution which involves parallel rows of rectilinear yellow ink dots which sandwich rows of in line, alternate red and blue ink dots, thereby providing in nonsuperimposed fashion what would appear to be a solid pattern of the primary color ink dots in which the dot square area of yellow ink would be twice that of either the red or blue ink dots.

There are several dissimilarities from conventional practice which are quite obvious when viewing FIGURE 1. In order to reduce the number of areas of the image copy not receiving ink, the present system employs ink dots which are irregular rectangles, that is, they have one surface dimension which is at least twice that of the other surface dimension. For instance, in all of the dots shown in the embodiment used to produce the image of the type shown in FIGURE 1, the width of the ink dots shown is three times as large as its height. In prior practice, it is conventional to provide ink dots resulting from ink wells or cells having rectangular or round configuration, but of equal surface dimensions; that is, the wells are formed square rather than as shown.

The effect of the present arrangement is to cut in thirds the number of transverse bridge lines **18**, thus reducing greatly the areas of the image receiving medium which does not receive ink while enlarging each dot area to eliminate pickiness. Further, the present image is characterized by having primary color ink dots which are not superimposed upon each other; therefore, the red ink does not dilute the blue ink or the blue ink dilute the red, for instance, nor does the blue dilute the yellow, the yellow the blue, or the yellow and red in the same fashion. This is achieved by employing a correlated set of screen-pattern, color-separation printing plates in which there is operative alignment between the respective plates so as to deposit yellow rectangular ink dots in parallel fashion between the spaced blue ink dots **10**, the dots being separated axially of the web receiving the image by thin bridging areas or lines **20**. In addition, in an attempt to reduce the area of the paper not receiving ink due to the bridging lines between the rectangular ink wells or cells, it is noted that the horizontal bridging lines **18** between the red and blue dots and the yellow dots are not aligned, but are longitudinally displaced such that the bridging lines **18** between any two dots actually terminate adjacent the center line of the ink dot of the next succeeding line.

The production of a multicolor image in this fashion may be best appreciated by reference to FIGURES 2, 3A, 3B, 3C and 3D which show the apparatus for producing multicolor image reproduction and the sequence of printing of the multicolor image upon the web passing over the respective aligned, operatively connected printing plates. The embodiment of FIGURE 2 makes use of a correlated set of cylindrical screen-pattern, color-separation printing plates indicated at **30**, **32**, **34** and **36**; **30** being the blue printing plate, **32** the red printing plate, **34** the yellow printing plate and **36** the back printing plate. Each of the cylindrical printing plates includes a source of ink indicated by a shallow pan **38**, with the plate rotating such that its outer printing surface **40** moves into a position where it is immersed within the ink carrying pan filling the individual rectangular wells **42**, **42'**, **42''** and **42'''**. The cylinder rotates to a point where a doctor blade **44** wipes the excess ink off of the printing surface **40** with ink filling the individual wells **42** in volume depending upon the depth of the respective wells to produce the varying color tints desired.

The wells **42'** of the red printing cylinder **32** are of equal size to the wells **42** of the blue print cylinder **30** and are spaced axially a distance slightly greater than the longitudinal surface dimension of each of the wells. The wells **42'** are also positioned on plate **32** in predetermined alignment with respect to the wells **42** of the blue print plate **30** so as to produce red dots which lie on the same longitudinal axis as the ink dots produced by the blue print cylinder but separated slightly by the bridging lines **18**, as indicated in FIGURE 1.

By using rectangular wells of increased size due to the 3 to 1 width to height ratio, the horizontal or transverse bridges between adjacent rectangular wells or a line of wells, such as in the case of the yellow primary color inking plate, the relative size of the thin bridges between the wells may be actually reduced over the prior art arrangement, and in fact, bridges in the order of $\frac{3}{64}$ inch in thickness may be used satisfactorily, thus effectively producing a bridge line, on the web being printed, of like surface dimension for both the transverse bridge lines and the horizontal bridge lines. This aids in eliminating pickiness as well as providing a color reproduction print without a distracting pattern effect. This may be more readily appreciated by reference to FIGURE 3A, 3B, 3C and 3D.

Reference to FIGURES 3A, 3B, 3C and 3D of the drawings indicates the position of the ink dots as formed on web W, sequentially, as a result of movement of the

web in a direction indicated by the arrow. Thus, as web W passes in contact with the blue print cylinder **30**, a series of blue dots **10** are formed generally in a line, as indicated in FIGURE 3A. For the purpose of simplifying the explanation, only a single line of spaced blue dots are shown transferred from printing cylinder **30** to the web W. Of course, there would be transferred a great number of dots, actually hundreds per square inch. As the web moves from the blue print cylinder **30** to the red print cylinder **32**, red ink dots are formed intermediate of the blue dots and in line therewith in the manner indicated in FIGURE 3B. The blue ink dots and the red dots are separated only by thin bridging lines **18**, as best indicated in FIGURE 1. As the web moves further, yellow ink dots are transferred, from the respective wells **42″** of the yellow print cylinder **34**, the individual dots **12** being all in line, separated from themselves in a transverse direction by the thin bridging lines **18** and axially of the blue and red dots by thin bridging line **20** as indicated in FIG. 3C. It is to be noted that the transverse bridging lines **18** between the respective red and black and blue dots are not aligned with the bridging lines **18** between the adjacent yellow ink dots **12**.

As the web W moves to its final ink transfer, the black ink filling the line of ink wells **42‴** which are angled with respect to the axis of the print cylinder **36** causes a series of black ink dots to be transferred to the web, but unlike the previous ink dots, are superimposed and actually overlie the blue, red and yellow dots and may act to dilute the ink of the respective primary color dots as indicated in FIG. 3D.

It is important to note that in the photoelectric etching process the final product is a series of correlated screen-pattern, color-separation printing plates having all the dots of the same surface area but varying in depth enabling them to be rectangular in shape, separated by a bridge which create a fine bridge line which in turn enables the dot to ride on the surface wiping the top of the cylinder clean as it emerges from the ink foundation. The individual color printing plates **30**, **32**, **34** and the black dot printing plate **36** are mechanically aligned and rotate in unison to produce the desired pattern shown in FIG. 3D. Mechanical alignment is indicated schematically by the dotted line **50** in FIGURE 2. While the dots are shown having a horizontal surface dimension equal to three times the vertical dimension, other ratios above 2 to 1 may be used, always reducing the number of transverse bridges below the number required by the square or round wells of conventional process techniques. As a result of the present process, the elimination of screen angles other than for the black ink dots, provide all of the primary color dots in in-line fashion with the least moire or pattern, while the positioning of the transverse bridge lines **18** of any line of dots at the center line of the next line of dots greatly reduces the possibility of pickiness or mealiness while also contributing to reduction in noticeable pattern. While the invention is shown as applied to a system in which variation in tone is achieved by varying the depth of the individual wells **42**, **42′**, **42″**, **42‴** in respect to cylinders **30**, **32**, **34** and **36**, the effect may be achieved by maintaining constant depth of the wells, maintaining the two or three to one dimensional variations of the rectangular wells but varying the overall surface area of the individual wells depending upon the color tone desired.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. The method of producing a color reproduction image which is characterized by lack of pickiness, minimum pattern and color distortion comprising the steps of: printing a first series of alternate red and blue rectilinear ink dots, in line, and at the same angle on an ink receptive media, with said dots having a ratio of width to height of at least two to one, being separated by relatively thin bridge lines and with said red and blue dots having the same surface area, printing on said media other series of rectilinear, in line ink dots of yellow ink, parallel to and on either side of said series of red and blue dots with said yellow ink dots being of like configuration to said red and blue ink dots, with relatively thin bridge lines therebetween, and with the total surface area of the yellow ink dots being in the order of twice that of either the blue or red ink dots and controlling the tone of the ink dots by varying the volume of ink for respective dots.

2. The method as claimed in claim **1** further including the step of positioning adjacent series of rectilinear ink dots such that the bridge lines between dots for any given line of dots is offset with respect to the bridge lines for the next successive line of dots.

3. The method as claimed in claim **1** further including the step of modifying the color tone of the color reproduction image by varying the volume of ink carried by each dot without changing the dot surface area.

No references cited.

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