

April 1, 1969

D. J. KYTE

3,436,472

SCREENED PHOTO REPRODUCTION

Filed Sept. 16, 1965

Sheet 1 of 4

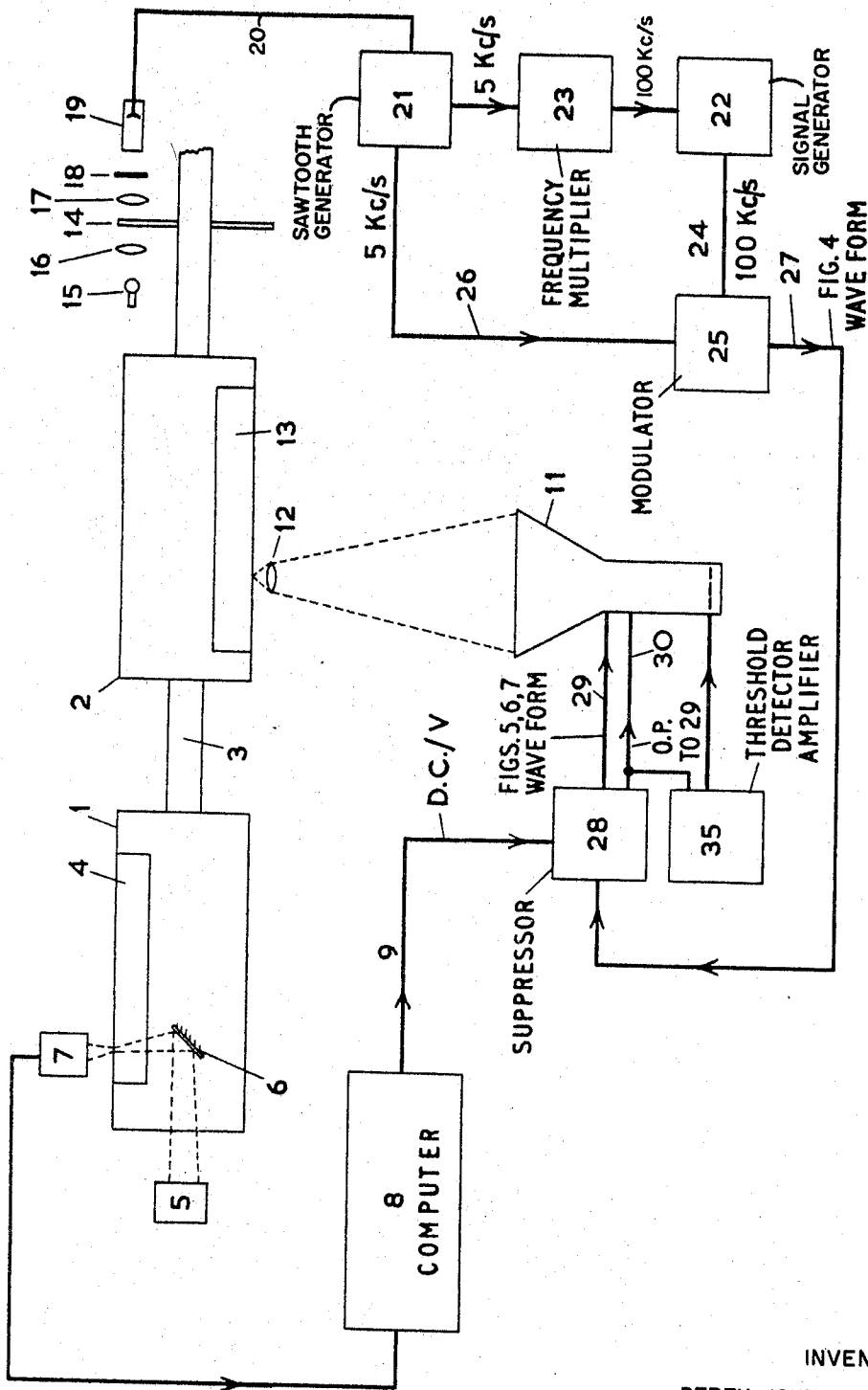


FIG. 1

INVENTOR
DEREK JOHN KYTE

April 1, 1969

D. J. KYTE

3,436,472

SCREENED PHOTO REPRODUCTION

Filed Sept. 16, 1965

Sheet 2 of 4

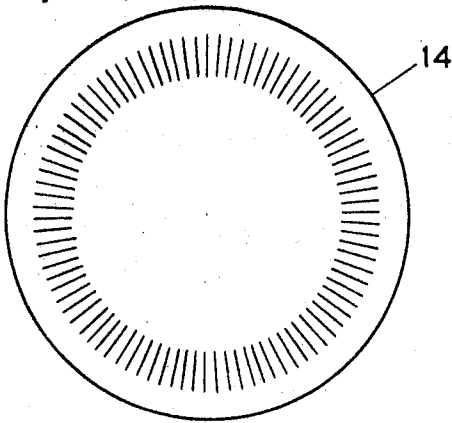


FIG. 2

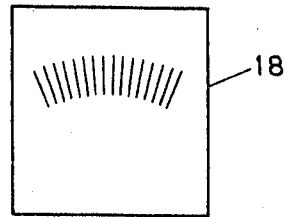


FIG. 3

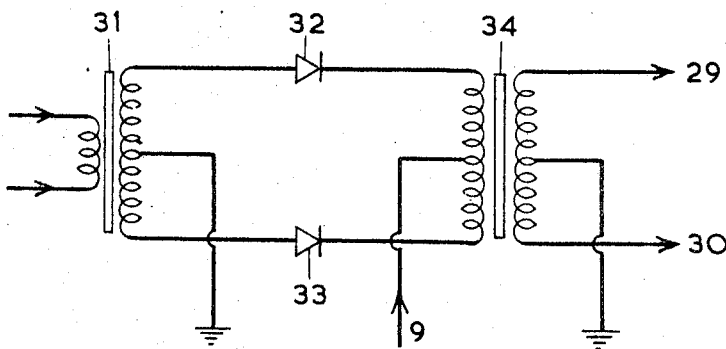


FIG. 8

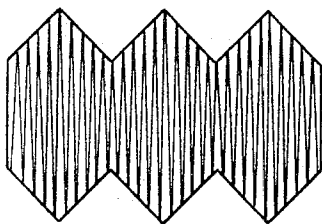


FIG. 4



FIG. 5

INVENTOR
DEREK JOHN KYTE

April 1, 1969

D. J. KYTE

3,436,472

SCREENED PHOTO REPRODUCTION

Filed Sept. 16, 1965

Sheet 3 of 4

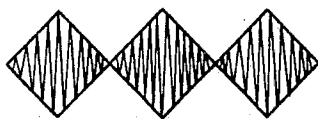


FIG. 6

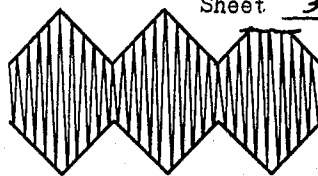


FIG. 7

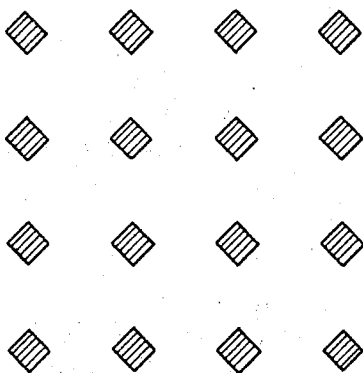


FIG. 9

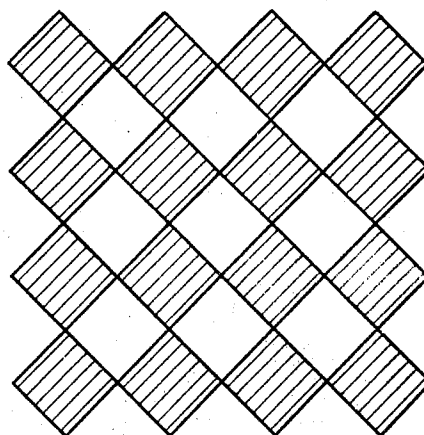


FIG. 10

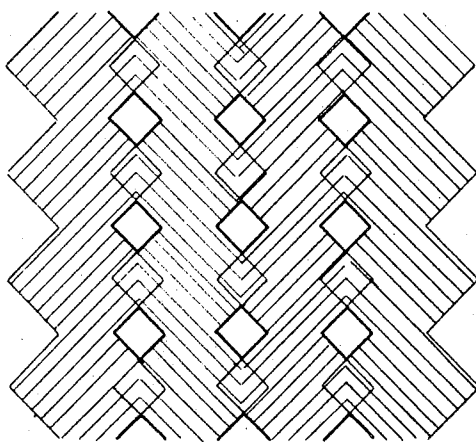


FIG. 11

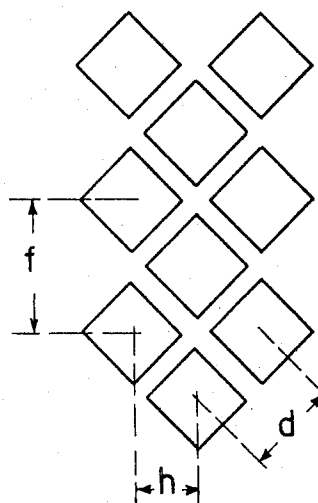


FIG. 16

INVENTOR
DEREK JOHN KYTE

April 1, 1969

D. J. KYTE

3,436,472

SCREENED PHOTO REPRODUCTION

Filed Sept. 16, 1965

Sheet 4 of 4

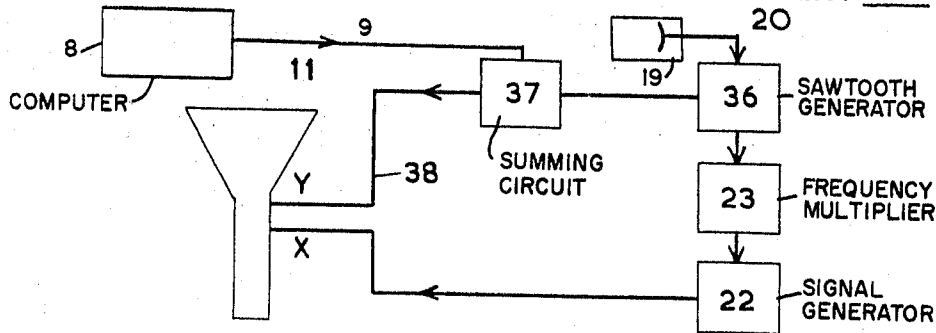


FIG. 12

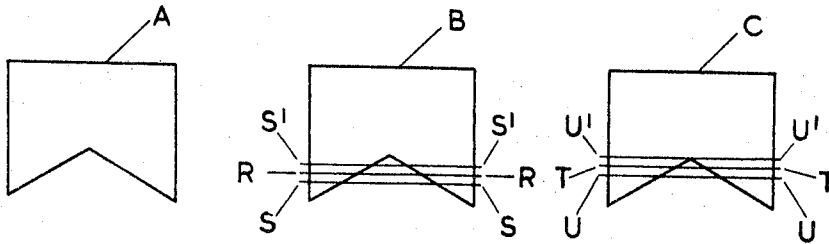


FIG. 13



FIG. 14

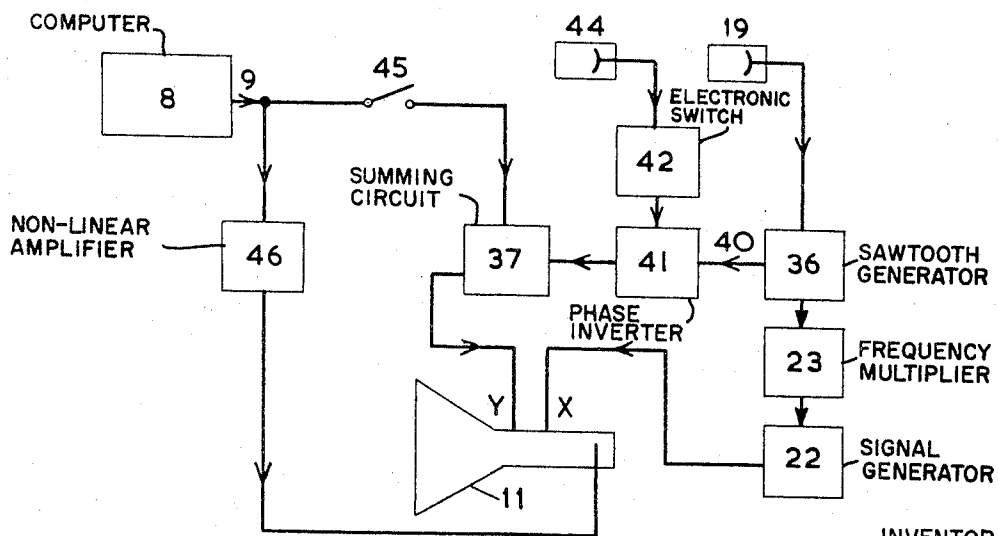


FIG. 15

INVENTOR
DEREK JOHN KYTE

1

2

3,436,472

SCREENED PHOTO REPRODUCTION

Derek J. Kyte, 117 Valley Road, Chorleywood,
Hertfordshire, England

Filed Sept. 16, 1965, Ser. No. 487,876

Claims priority, application Great Britain, Sept. 23, 1964,
38,781/64

Int. Cl. H04n 5/84, 7/00

U.S. Cl. 178—6.7

15 Claims

ABSTRACT OF THE DISCLOSURE

A photograph or the like to be made into a printing plate is put on a revolving drum and scanned to produce electrical signals representing a photograph. The electrical signals are fed through a computer to perform any required corrective or revisions in the reproduction ultimately produced. Electrical timing pulses are derived from the same rotating element carrying the drum. These pulses and the signal from the computer are sent to a suppressor connected to a cathode ray tube, the suppressor serving to divide the picture signals into dots as determined by the pulses. The dot illumination of the cathode ray tube is reproduced on a photo sensitive plate also drum mounted on the same rotating elements of the first drum. The size and density of the dots can be adjusted.

This invention relates to methods and means for producing screened photographic reproductions.

In the photo-chemical production of printing plates from monochrome or coloured originals, it is normally necessary to include at some stage the process of screening. The object of this process is to produce a photographic reproduction in which the image is broken up into a regular array of discrete areas known as "dots." In the type of screening used for letterpress and lithographic printing, it is customary for the individual dots to be of constant optical density but for their size to vary according to the optical density of the corresponding part of the original picture. For conventional photogravure printing, on the other hand, the dots are usually of constant size but of varying optical density. In some processes for gravure printing, however, both size and optical density of the dots change according to the optical density of the original.

In color reproduction photography alters the tonal values of the various colors to varying degrees, and for hi-fidelity reproduction of original color photographs it is necessary to split elemental areas of color thereon into, for example, the red, blue and yellow constituents, to perform a complex procedure of intensity modulation of each constituent and to recombine the resulting color intensities.

This is done by scanning the original, raster fashion, with a spot of light from a cathode ray tube, for instance; by splitting the resultant beam from each elemental area into the elemental colors; by translating the successive intensities of each elemental beam into a corresponding series of electrical signals; by modulating the signals according to predetermined criteria; and by using each resulting series of electrical signals to modulate a light beam moved raster fashion over a light-sensitive surface to recreate the original with its colors adjusted to give the appeal to the eye much nearer to that of the object or scene originally photographed than was given by the original photograph itself.

Such modifications of colored photographs are usually prepared by wrapping the original, and the sensitive film around ganged, cylinders which are rotated at high speed

while flying light spots are directed thereat for "reading" and reproduction.

It is not easy to apply a physical screen to a film wrapped around a cylinder and it is the object of the invention to simulate physical screening electrically.

It will be seen that whereas in continuous reproduction, the cathode ray tube moves its light spot in a single raster for recreation of the whole "picture," the beam being variably modulated throughout its movement, it is now necessary for the tube to generate a raster for each individual pattern so that the speed of operation of the cathode ray tube is hundreds of times faster for the present electrically screened technique than for continuous reproduction.

In the existing types of cathode ray tubes, the patterns must be generated in a size very much greater than the patterns to be created on the reproduction surface so that the patterns are passed through optical reduction means. However, with developments in cathode ray tubes and in other means for generating flying light spots, reduction means may become unnecessary, and it is within the scope of the invention to generate patterns of the size required for reproduction and to apply such patterns direct onto the film.

The patterns vary in size; and in light areas will be very small and relatively widely spaced, whereas in darker areas the patterns will overlap.

The invention will now be described with reference to embodiments shown in the attached drawings, in which:

FIG. 1 shows diagrammatically a rotating drum scanner associated with screening and exposure means incorporating the invention. This embodiment is suitable for exposing screened reproductions for letterpress and lithographic printing.

FIG. 2 shows a timing disc suitable for attachment to the shaft of the exposing drum of FIG. 1.

FIG. 3 shows the aperture plate associated with the timing disc of FIG. 2.

FIGS. 4-7 show examples of output waveforms from the modulator circuit 25 in FIG. 1.

FIG. 8 shows a suitable suppressor circuit for the embodiment shown in FIG. 1.

FIGS. 9, 10 and 11 show examples of exposed dot patterns.

FIG. 12 shows another embodiment of the invention.

FIG. 13 shows the shape of the cathode ray tube mask associated with the embodiment of FIG. 12.

FIG. 14 shows the assymetric output waveform of a sawtooth generator 36 in FIG. 12.

FIG. 15 shows a further embodiment suitable for producing "gravure" screens, while

FIG. 16 shows a portion of a photogravure screen.

Referring now to FIG. 1, two rotating drums 1 and 2 are coupled together and are driven by shaft 3. Drum 1 is transparent and has wrapped round it a transparent monochrome or coloured original 4. An illumination system 5 projects a small spot of light onto the transparency via a mirror 6 within the drum 2. The transmitted light is picked up by scanning system 7, which incorporates optical means for directing all or part of the light onto one or more photocells. Where coloured originals are to be scanned, then the scanning system 7 will usually incorporate colour filters or prismatic means for directing the blue part of the visible spectrum onto one photocell, the green part onto another, and the red part onto a third.

The electrical signals from the photocells within the scanning system 7 are fed to a computer 8 comprising circuits well known in the art for performing any or all of the functions of contrast alteration, tonal correction, colour masking, under-colour removal, black separation or unsharp masking.

It will be understood that the aforesaid tonal correction circuits within the computer will include means for delivering an output voltage suitable for controlling the screening device to be described. Since, in general, the output voltage will not be linearly related to the photocell signal, such circuits will contain non-linear elements such as crystal diodes or non-linear resistors connected in ways well known in the art.

The output of the computer on conductor 9, therefore, will represent some function of the optical density of the original, and is preferably in the form of a varying D.C. signal. This output is fed to a suppressor circuit 28 whose function in the control of an exposure cathode ray tube 11 is explained below.

An image of part of the face of the cathode ray tube 11 is directed by lens 12, preferably much reduced, onto a sheet of unexposed film 13 wrapped round the exposing drum 2. A reduction of between 50 and 100 times is found satisfactory.

During the scanning process, the two drums 1, 2 rotate in synchronism whilst the scanning system 7, the illumination system 5 and the exposing system comprising cathode ray tube 11 and lens 12 move relative to the drums in a direction parallel to the longitudinal axis. It is immaterial whether the scanning system 7, the illumination system 5 and the exposing system 11 and 12 actually move, or whether the drums themselves move along axially while they rotate.

In order to provide equal spacing of the exposed dots round the circumference of the exposing drum, it is necessary to provide means for synchronizing the pattern generator with the rotation of the drum. In the preferred embodiment of the invention, a partly transparent timing disc 14 is firmly attached to the shaft 3. This disc is shown in more detail in FIG. 2, and carries one or more circular tracks concentric with the axis, each track containing a large number of alternately opaque and transparent slits of equal width. The total number of transparent slits is preferably equal to the number of dots which would correspond to a complete circumference of the drum. Thus if the drum circumference is 15 inches, and the required screen pitch is 100 dots per inch, the timing disc track will contain 1500 slits.

Referring again to FIG. 1, a portion of one or more of the concentric tracks on the disc 14 is illuminated by means of lamp 15 and lens 16. Part of the emergent light is collected by a further lens 17, which focusses an image of parts of the concentric timing tracks on aperture plate 18. The latter is shown in more detail in FIG. 3 and consists of an opaque plate carrying one or more circular track segments of alternate transparent and opaque lines corresponding with those on the timing disc 14.

The aperture plate 18 is so disposed that the images of the lines on the tracks of disc 14 focussed upon it by the lens 17 exactly coincide with the lines within the corresponding segment as many times per revolution as there are transparent lines around the timing disc. As the latter rotates, therefore, light emerges from the aperture plate with periodic increase and decrease in intensity. This emergent light falls on a photocell 19 from which, during rotation of the timing disc, a series of electrical pulses are delivered along conductor 20 to a sawtooth generator 21 forming part of the circuits for generating the required pattern on the cathode ray tube. The use of a transparent timing disc is not an essential feature of the invention. Instead, a magnetic disc on which timing pulses have previously been recorded may be used in conjunction with a reading head. Alternatively, a phonic wheel may be employed, or any means for deriving a series of electrical pulses at a frequency corresponding to the rotational speed of the drum.

The low frequency sawtooth generator 21 generates a constant amplitude sawtooth waveform of a frequency determined by the synchronizing pulses received from photocell 19 along conductor 20. For a drum peripheral

speed of 50 inches per second and a screen pitch 100 dots per inch, this generator would produce a frequency of 5 kc./s.

A further generator 22 produces a constant amplitude waveform which is preferably, but not essentially, of approximate to sawtooth form. The frequency of this waveform has to be appreciably higher than that produced by generator 21. A suitable ratio of frequencies is 20:1. It is also preferable, but again not essential, that the frequency of generator 22 should be an even harmonic of that of generator 21. In practice, this is best achieved by frequency-multiplying the output of the generator 21 in circuit 23 and applying the output to synchronize generator 22.

The high frequency output of generator 22 is fed along conductor 24 to a modulator circuit 25 where it is amplitude-modulated to a depth of preferably 50% by the low frequency sawtooth fed in via conductor 26 from generator 21. The output of the modulator 25 appears on conductor 27 and is of the form shown in FIG. 4. This amplitude-modulated signal is fed via conductor 27 to a suppressor circuit 28, which is also supplied with a varying D.C. voltage along conductor 9 from the scanning computer 8. The purpose of the suppressor circuit is to allow only those parts of the input waveform on conductor 27 which are greater in amplitude than the amplitude of the incoming D.C. voltage on conductor 9 to pass to the output conductors 29 and 30. The waveform appearing on conductor 29 is shown in FIGS. 5, 6, 7 for the three cases of high, medium and low values of the input D.C. voltage. The waveform on conductor 30 is exactly similar to that on conductor 29 with the exception that it is opposite in phase.

A suitable type of suppressor circuit for use at 28, FIG. 1, is shown in part in FIG. 8. The amplitude modulated input waveform is applied to the primary of transformer 31. The opposite phase signals appearing on the outer ends of the split-phase secondary winding are applied to two diodes 32 and 33, which are biased in the reverse direction by the incoming D.C. signal on conductor 9, it being assumed in the diagram that this D.C. voltage is of positive polarity. The diodes 32 and 33 only conduct when the amplitude of alternate half-cycles of the high frequency component of the waveform delivered by transformer 31 exceed the aforesaid D.C. bias voltage.

During conduction, the signals passing diodes 32 and 33 are recombined in transformer 34 which has a split-phase secondary winding giving two out-of-phase outputs on conductors 29 and 30. These conductors are led directly or via further amplifying circuits to one pair of deflecting plates, or a magnetic deflecting coil, on cathode ray tube 11. One of the output leads from suppressor circuit 28 is also taken to an amplifier and trigger circuit 35. The purpose of this circuit is to deliver a positive D.C. voltage to the grid of the cathode ray tube as long as the output of the suppressor circuit exceeds a small threshold value. The cathode bias of the cathode ray tube is so adjusted that in the absence of a positive voltage on the grid, the light spot on the tube face is extinguished. Only when the suppressor circuit 28 delivers sufficient output, therefore, will the light spot be visible.

Operational output from suppressor circuit 28 will cause the light spot to describe a series of oscillatory movements along one line, the amplitude of the oscillatory movement increasing and decreasing at a regular frequency determined by the output of the sawtooth generator 21. The cathode ray tube is so disposed that the image of these linear movements of the light spot formed on the film 13 by the lens 12 is parallel with the axis of the rotating drum 2.

During rotation of the drum, the film is exposed to the

5

image of the moving light spot. The exposed images will have a form similar to any one of those shown in FIGS. 5, 6, 7 since the moving film gives a "time axis." In practice, since the light spot on the tube is not made very small, the successive exposures of the high frequency component of the light spot movement overlap. The exposed images are therefore of substantially constant density but each has a shape similar to the envelope of one of the waveforms shown in FIGS. 5, 6, 7.

It was stated earlier that the number of timing pulses produced by the timing disc for one complete drum revolution should be equal to the number of screen dots required round the circumference of the drum. The number of these dots per inch is the screen pitch. In order to obtain a symmetrical array of screen dots in two dimensions, it is also necessary that the movement of the exposing light source relative to the drum should be equal to the reciprocal of the screen pitch. Thus if the latter is 100 dots per inch, the relative movement between the exposing light spot and the drum for one revolution of the latter should be equal to $\frac{1}{100}$ part of an inch. In order to obtain screen dots of any size, it is also necessary for the maximum width of the exposed image, which will usually correspond to the lowest D.C. signal on conductor 9, to be at least twice, and preferably slightly more than twice, the distance between dots (i.e. for 100 screen pitch, the maximum size of the exposed image should be slightly greater than $\frac{1}{50}$ part of an inch).

Under the above circumstances, successive lines of exposed images will produce a range of exposed dots of varying sizes according to the D.C. output signal from the computer 8. FIGS. 9, 10, 11 show three examples of exposed dot patterns for four drum revolutions, i.e. four successive rows of exposed dots. In FIG. 9 it is assumed that the D.C. output from the computer 8 is a constant high value. The exposed dots are small separated squares and correspond to the "highlight" dots of conventionally produced screened reproduction.

In FIG. 10 the D.C. output is lower than in FIG. 9 and successive rows of dots just touch, producing a chequerboard pattern of so-called "middle ton" dots.

In FIG. 11 the D.C. output is lower still so that successive rows of exposures overlap. Most of the film is now exposed but there are left behind small squares of unexposed film. These form the "Shadow" dots of the screening process and are shown surrounded by bold lines in FIG. 11.

The doubly exposed regions will have a density slightly higher than that of the singly exposed regions. This density difference is small, however, because the type of film used for screening ("lith" type emulsion) has a very flat relationship between exposure and density once a certain exposure has been exceeded.

If, during scanning, the D.C. output voltage of the computer varies as some function of the optical density of the original, then the exposed screened reproduction will have dot sizes which also vary as the optical density of the said original. The range of dot sizes obtained may be varied as required by adjusting the maximum and/or minimum values of the D.C. output voltage from computer 8. Moreover, by suitable modifications to the circuits of the computer, the output voltage may be made to vary as some inverse function of the optical density of the original. In this case, the exposed screened reproduction will represent a negative reproduction of the original. Such screened reproductions are of a form suitable for letterpress and lithographic printing since the dot size, but not the dot density, varies with the optical density of the original.

FIG. 12 shows part of a further embodiment of the invention in which the electronic circuits have been simplified.

The pulses from photocell 19 are produced by a timing disc as before. These pulses are fed via conductor 20 to

6

a sawtooth generator 36 which generates an asymmetrical sawtooth waveform, the purpose of which will be explained below. As before, the high frequency sawtooth generator 22 generates a symmetrical sawtooth waveform at a frequency much higher than that of generator 36 under control of frequency multiplier 23. The constant amplitude output of the generator 22 is fed directly to the X set of deflector plates, or to the X deflection coil of cathode ray tube 11. The asymmetrical sawtooth output of generator 36 is fed to a summing circuit 37 where it is added to the varying positive D.C. voltage from computer 8 fed in via conductor 9. The output of summing circuit 37 is fed along conductor 38 to one of the Y deflector plates, or to the Y deflector coil of cathode ray tube 11.

On the face of the cathode ray tube 11 is mounted a thin opaque mask having triangular cut-out as shown at A in FIG. 13. This mask is so disposed that the Y direction of the tube is parallel with a line passing through the apex of the cut-out triangle and bisecting it. Thus the X direction is horizontal in FIG. 13 and the Y direction vertical.

Since the output of the high frequency sawtooth generator 22 is applied to the X plates, the light spot on the cathode ray tube is continuously tracing a line in the X or horizontal direction. The mask on the face of the tube is so disposed that in the absence of any Y deflection, or with some pre-determined fixed voltage applied to the Y plates, the line of light occupies some such position as that of the line marked R—R in B, FIG. 13. Moreover, the cathode ray tube is so disposed that the image of this line formed on the film by lens 12, FIG. 1, is parallel with the axis of the rotating drum.

If the output of the sawtooth generator 36 is now applied to the Y plates, it being assumed for the moment that the output of the computer on conductor 9 is zero, then the line of light will move periodically up and down in the Y direction. Because of the shape of the mask on the tube face, the horizontal width of the line of light visible through the mask, and of the reduced image formed on the film, will also vary periodically. Under these conditions, with zero computer output, the amplitude of the Y deflection will normally be such that the peak excursion towards the apex of the triangle is approximately 50% of the distance between the rest position of the line and aforesaid apex. Thus the line of light will move periodically between such extremes as lines S—S; S'—S'; at B in FIG. 13.

If the velocity of the vertical movement of the line of light is the same in the upward and downward directions, the exposed images on the moving film will not be symmetrical. This is because in the upward direction, for example, the image on the film will be moving in the same direction as the direction of rotation of the drum, whilst in the downward direction, the image will be moving in the opposite direction. Thus in one case the relative velocity between the image and the film is less than, and in the other case greater than the mean velocity of the drum. To compensate for this effect, it is necessary to apply an asymmetric sawtooth waveform to the Y plates so that the line of light is made to move, for example, faster in the downward direction and slower in the upward direction: this is the reason for making generator 36 asymmetric.

Simple mathematical calculation shows, for example, that with a triangular mask having an included angle of approximately 144° , the velocity in the Y direction should be twice as much upwards as downwards. The sawtooth waveform required to achieve this is illustrated in FIG. 14 and it will be seen that its rise and fall times are related in the ratio 2:1.

Assuming that generator 36 produces the required waveform for symmetrical exposure, and again assuming that the output of the computer is zero, the periodic movement of the line of light between such lines as S—S and

S¹—S¹ at B in FIG. 13 will result in the exposure on the film of a pattern such as that illustrated in FIG. 4. Successive lines of such exposures, corresponding to several revolutions of the drum, will result in a completely exposed film. If now the computer produces a small D.C. output voltage on conductor 9, this will be added to the sawtooth waveform and will cause the mean value of the Y deflection to shift towards the apex of the triangular mask. Thus the exposed image will correspond to that shown in FIG. 7 and several lines of such exposures will give a series of small non-exposed squares, known as shadow dots, as in FIG. 11.

Further increase in the computer output will cause the mean Y deflection to move to some such line as T—T, at C in FIG. 13, with corresponding upward and downward excursions U¹—U¹ and U—U. The resultant exposed image will be shown in FIG. 6 and several such exposed lines will give "middle tone" dots as in FIG. 10. Still further increase in computer output will cause the mean Y deflection to rise higher relative to the mask. The exposed dots then become smaller as illustrated in FIG. 9, which shows what are called "highlight dots."

It will be understood that the particular advantages of this embodiment are that the modulating circuits and trigger circuits associated with the previously described embodiment are dispensed with.

As is the case of FIG. 1, this embodiment is suitable for the exposure of screened reproductions for the making of letterpress or lithographic plates.

Another embodiment of the invention, the essential parts of which are shown in FIG. 15, is suitable for producing screened reproductions for the making of printing plates or cylinders for photogravure printing. In this case, successive lines of exposed dots are required to be "interlaced" as shown, for example, in FIG. 16. The simplest way to achieve this is to alter the phase of the low frequency sawtooth generator 36 in FIG. 12 by 180° for every complete rotation of the drum. In the preferred embodiment shown in FIG. 15, the output of the low frequency sawtooth generator 36 is applied to a phase inverting stage 41 along conductor 40. The phase inverting stage either inverts the phase of the incoming signal or leave the phase unaltered according to the condition of an electronic switch circuit 42, which is triggered alternately into its "on" or "off" condition by a pulse received along conductor 43 for every rotation of the drum. The required pulse may be generated by any convenient means such as by a cam-operated contact, by magnetic means, or by the addition of a further concentric timing track consisting of a single radial transparent slit both in the timing disc 14, FIG. 2, and in the plate 18, FIG. 3, together with a further photocell 44, FIG. 15. It is preferable for the phasing pulse to be delivered during the period when the exposure image falls in the gap between the two ends of the film wrapped round the exposing drum.

Referring to FIG. 16, it is customary to define the fineness of a gravure screen as the number of dots per inch along any line parallel to the edges of the squares. The reciprocal of this number may be referred to as the dot interval and is marked as dimension d in FIG. 16. From simple geometrical considerations, it is clear that the distance p between successive rows of exposed dots is not equal to the dot interval as defined above but is related to it by the equation:

$$p = \frac{\sqrt{2}}{2} d$$

Also, the distance f between successive dots along a line of exposed dots is not equal to either p or d , but is related to both by the equation:

$$f = 2p = d\sqrt{2}$$

Thus, to produce a gravure screen of interval d , it is

necessary that the relative axial movement between the exposing image and the rotating drum should be $d\sqrt{2}/2$ for every revolution of the drum, and that the number of timing pulses per revolution produced by a timing disc as described, or other means, should be

$$2d \frac{1}{d\sqrt{2}}$$

Referring again to FIG. 15, the output of the computer 8 on conductor 9 is assumed to be a positive D.C. signal which increases in amplitude as the required dots decrease in size and/or optical density. Conductor 9 is led to the cathode of cathode ray tube 11 via a suitable non-linear amplifier 46, and also to the summing circuit 37 via switch 45.

With switch 45 open, the only effect of the computer output is to alter the brightness of the line of light on the face of the tube. Because of the combined action of the asymmetric sawtooth delivered by generator 36 to the Y plates and the high frequency sawtooth delivered by generator 22 to the X plates, the horizontal line of light on the tube face will be periodically varying in width as described previously. The mean value of the asymmetrical waveform and its amplitude are so adjusted that successive lines of exposed dots have the form shown in FIG. 16. Throughout the reproduction, these dots will remain constant in size but because of the connection between computer 8 and the cathode of the cathode ray tube 11, their optical density will vary according to some function of the optical density of the scanned original. The resultant screened reproduction will then be suitable for conventional photogravure printing. The purpose of non-linear amplifier 46 is to modify the output of the computer 8 so that the resultant modulation of the light intensity is of suitable form to produce the required final relationship between the optical density of the exposed dots and that of the original.

Then switch 45 in FIG. 15 is closed, the size of the exposed dots as well as their optical density varies according to the computer output. The means by which the size is altered are exactly as described previously with reference to the embodiment shown in FIG. 12. However, in this case the mean position of the line of light with reference to the mask is so adjusted that with very low or zero computer output, the exposed dots are close to one another but not overlapping, as shown in FIG. 16. Increase in computer output then reduces the dot size and at the same time reduces the exposed dot density.

Such a screened reproduction is suitable for the so-called "invert dot" or "halftone" gravure methods of printing.

Although the method by which the invention can be used to produce gravure type screens has been described with reference to the second embodiment shown in FIG. 12, it will be understood that the first embodiment shown in FIG. 1 can be similarly modified for this purpose although it involves greater complexity of the electronic circuits.

What I claim is:

1. Equipment for photographic reproduction comprising a flying light spot device capable of generating a light spot raster, mounting means for a photo-sensitive reproduction surface, means for relatively moving the photo-sensitive reproduction surface and said flying light spot device, means whereby reproduction on a surface is screened and electrical apparatus for applying electrical control signals to the flying light spot device so that said device generates a succession of identical raster patterns which are basically identical, and means for modulating such control signals in response to a train of picture signals derived from an "original" so that the actual patterns applied to a surface vary, the speed of generation of such patterns being such that they are applied to a sur-

face in an array similar to the dot formation of a physically screened reproduction.

2. Equipment as claimed in claim 1 comprising optical reproduction means for focusing successive patterns on a photosensitive reproduction surface on said mounting.

3. Equipment for screened photographic reproduction as claimed in claim 1 which comprises a rotatable scanning drum, electrical time signal generating means including a timing disc on the drum shaft, and electrical pattern-control signal generating means which forms a part of said electrical control circuits and to which said time signal generating means is connected.

4. Equipment for screened photographic reproduction as claimed in claim 3 and comprising an asymmetric low frequency saw-tooth generator, and a symmetrical high frequency saw-tooth generator, both synchronized by said timing disc, a summation circuit fed both by said low frequency generator and by said computer, connections from said high frequency generator output and from said summation circuit output to respective controls of said flying light spot device, and a mask with a triangular cut-out on the front of the beam tube positioned so as to suppress parts of the pattern generated by the tube according to the size and position of the pattern on the tube screen.

5. Equipment for screened photographic reproduction as claimed in claim 3 and comprising an asymmetric low frequency saw-tooth generator and a symmetrical high frequency saw-tooth generator, both synchronized by time pulse generating means controlled by said drum, photoelectrical means for scanning an original, a phase inverter controlled by said time-pulse generating means for phase inversion at the beginning of each reproduction raster line, and connections from said high frequency output and from said low frequency output via said phase inverter to respective controls of said flying light spot device, and a mask with a triangular cut-out on the front of the beam tube positioned so as to suppress parts of the pattern generated by the tube according to the size and position of the pattern on the tube screen.

6. Equipment for screened photographic reproduction as claimed in claim 5 wherein a non-linear amplifier is connected between the computer and said flying light spot device and is so designed that the resultant variation in light and density in the flying light spot device produces variations in optical density of the exposed dots related in a predetermined manner to the sequence of optical densities on the screened original.

7. Equipment for screened photographic reproduction as claimed in claim 6 and comprising a summation circuit between said low frequency generator and the respective beam deflection means, and a connection to said summation circuit via which said electrical control signals are added to said low frequency signal, and comprising an on-off switch in the connection to said summation circuit.

8. Equipment for screened photographic reproduction as claimed in claim 1 wherein said electrical control circuits include wave-form generating and modulating means which is controlled by said time signal generating means and which generates a high frequency wave-form partially amplitude-modulated at low frequency so as to have mirror saw-tooth envelopes, and connections from said wave-form means to the control circuits of the flying light spot device.

9. Equipment for screened photographic reproduction as claimed in claim 8 comprising photo-electrical means

for scanning an original so as to generate a plurality of electrical signal trains corresponding to individual color constituents of said original, a computer to which said signal trains are applied, and which performs the conventional corrections to said signals and applies the corrected signals to said electrical control circuit for pattern control, and comprising a compressor circuit to which said amplitude-modulated wave-form is applied, which also receives the computer output, which is arranged to suppress positive and negative portions of an incoming wave-form from zero amplitude up to the amplitude of the computer output whereby the amplitude of the wave-form at the opposed saw-tooth troughs is reduced or is eliminated to leave diamond-shaped pulses varying in size according to the extent of suppression, and the output of which is connected to the controls of the flying light spot device.

10. Equipment for screened photographic reproduction as claimed in claim 9 wherein said suppressor circuit incorporates phase reversal means and separate outputs opposite in phase connected to the control circuits of the flying light spot device.

11. Equipment for screened photographic reproduction as claimed in claim 9 wherein an output of said suppressor circuit is also connected to a threshold detector which suppresses the beam when the suppressor output is below a predetermined threshold amplitude.

12. Equipment for screened photographic reproduction as claimed in claim 9 wherein said suppressor circuit comprises a transformer with split-phase secondary windings to the primary of which the incoming wave-form is connected, and comprises two diodes respectively connected to the outer ends of the secondary windings and respectively biased on opposite directions by an incoming D.C. signal from the computer, whereby the diodes only conduct while the amplitudes of alternate half-cycles of the high frequency component of the wave-form delivered by the transformer exceed the D.C. bias voltage.

13. Equipment for screened photographic reproduction as claimed in claim 1 and comprising means for adjusting the voltage range of said electrical control signals.

14. Equipment for screened photographic reproduction as claimed in claim 1 suitable for producing screened photographic reproductions for the making of letterpress or lithographic plates in which the dots are applied in coordinate array.

15. Equipment for screened photographic reproduction as claimed in claim 1 suitable for producing screened photographic reproductions for the making of printing plates or the like for photogravure printing in which the dots are interlaced.

References Cited

UNITED STATES PATENTS

2,510,200	6/1950	Thompson	178—6.6
2,681,382	6/1954	Hilburn	178—6.7
2,816,955	12/1957	Foll	178—7.4
2,862,051	11/1958	Marzan, et al.	178—6.7
3,108,248	10/1963	Alexander et al.	340—15.5
3,299,434	1/1967	McNaney	346—110

ROBERT L. GRIFFIN, *Primary Examiner*.

RICHARD K. ECKERT, JR., *Assistant Examiner*.

U.S. Cl. X.R.

178—6.8