Aug. 23, 1932. H. R. HARVEY 1,872,943

HALFTONE PROCESS AND TYPE

Filed Aug. 2, 1930

Fig. 1.

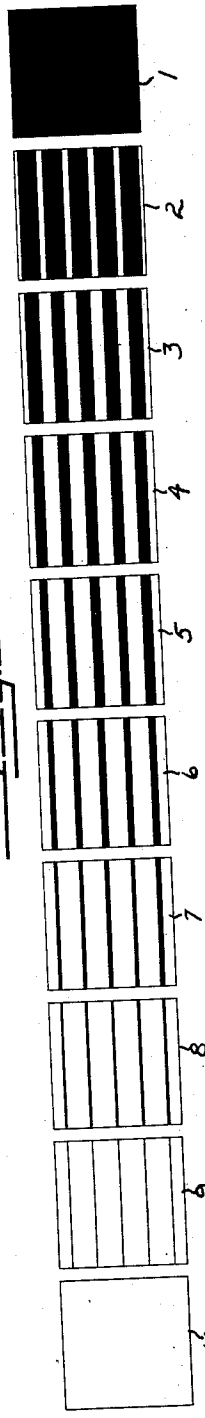


Fig. 2.

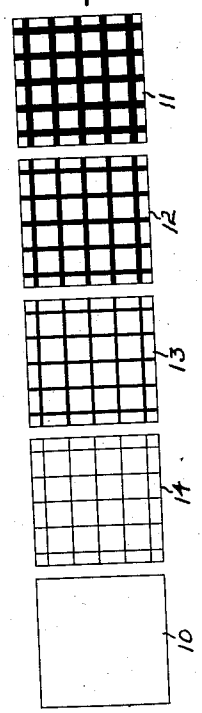


Fig. 3.

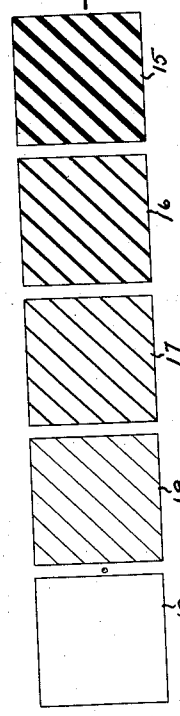


Fig. 4.

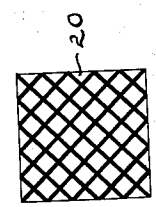
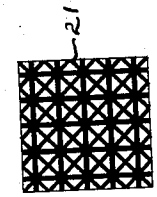


Fig. 5.



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UNITED STATES PATENT OFFICE

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HALFTONE PROCESS AND TYPE

Application filed August 2, 1930. Serial No. 472,551.

My invention relates to the reproduction of pictures, and particularly to a method for printing half-tone reproductions of large size, for billboard and similar uses.

Among the objects of my invention are: first, to provide an inexpensive method for making large size half-tone picture reproductions; second, to provide a method of half-tone picture reproduction which does not involve photo-engraving; third, to provide a method of half-tone picture reproduction by movable type; fourth, to provide a reproduction method which is applicable either to black and white or to three or four color reproductions; fifth, to provide a type font which will give apparently uniform gradations of shading or color with a limited number of characters; and sixth, to provide a type font for color reproduction of pictures which, when overprinted in the requisite colors, will form a uniformly shaded pattern, which is indistinguishable from a solid tone at a very short distance from the picture.

Other objects of my invention will be apparent or will be specifically pointed out in the description forming a part of this specification, but I do not limit myself to the embodiment of my invention herein described, as various forms may be adopted within the scope of the claims.

Referring to the drawing:

Figure 1 is a representation of the printing pattern of ten characters in a font of type, the characters being graded in density between maximum and minimum printing surface, and adapted to half-tone reproduction in one or two colors.

Figure 2 is a representation showing the pattern produced when the characters of Figure 1 are overprinted at right angles, as, for example, in two-color work.

Figure 3 is a representation showing the printing patterns of a second font of characters having a different type of shading, which may be used in adding a third and fourth color in reproducing a picture by my process.

Figure 4 shows the pattern resulting from overprinting the characters of Figure 3 in two directions; and

Figure 5 shows the pattern resulting from a combination of the characters, adding the effects of Figures 2 and 4, as is produced in four-color reproduction.

Reproduction of pictures in half tone, i. e., reproduction showing gradation of shading between black or maximum pigmentation and white or zero pigmentation, is usually accomplished by a photo-engraving process. In this process, the degrees of light and shade are represented by uniformly spaced dots of larger or smaller size, the spacing being so close that, at a greater or less distance, depending on the size of the dots, the eye ceases to resolve the dots as separate points and shows the reproduction as uniformly shaded.

The preparation of the half-tone plates is a complicated, technical process and, in large sizes, a very expensive one. For this reason, half-tone reproductions in the large size required for billboard displays and the like, is very rarely resorted to, ordinary billboard pictures being lithographic reproductions of line or wash drawings. For satisfactory reproduction in full color, a large number of lithographic printings must be resorted to, which makes even this latter process an expensive one.

In accordance with my invention, the reproduction is printed from movable type, eliminating either the production of a half-tone plate of large size, or the multiple lithographic printing required by the older processes. Full color reproduction by my process may be made with not more than four printings, and black-and-white or equivalent reproductions, in full half tones, may be made with a single printing.

In general terms, my method comprises analyzing the picture to be reproduced into uniform elementary areas, selecting type whose mean density corresponds with the mean density of the elementary areas and setting them up to form a printing surface from which reproductions may be made by any of the ordinary letter-press processes. The selection and setting of the type characters used may either be done manually, or, preferably, by the mechanical method set

forth in the co-pending application of Harvey and Gary, Serial No. 489,831, filed October 20, 1930. The characters used derive their printing density from alternate areas of maximum and minimum density—"black-and-white"—preferably formed as parallel lines. A limited number of characters, varying in printing area by systematic gradations, preferably logarithmic, are used. Where the reproduction is to be made in color, a succession of characters is used for each color whereon the lines of the printing patterns run in a different direction from those of the other colors. Thus, by making the lines by one color run vertical, another horizontal, and the third and fourth diagonally at 45° on each side of the vertical, a full color reproduction may be made using not more than twenty characters in all.

Describing my invention in detail, the picture to be reproduced, usually in the form of a photographic negative or positive, is first divided into uniform square elementary areas. The preferred method of thus analyzing the picture is by scanning it systematically with an aperture through which light is directed which falls upon a photo-electric cell, the latter operating through a system of relays, which correspond in number to the number of characters used, to select characters whose mean printing density corresponds with that of the areas scanned.

The apparatus for making this selection is described in the co-pending application above referred to, but is not shown in the present application as the selection may be made by eye and the type may be set up by hand.

A preferred form of character is shown in Figure 1, wherein the reference characters 1 to 10 inclusive show the printing patterns of a set of characters grading from a solid color to zero, representing an em space in the ordinary type font. The printing surfaces of the characters from 2 to 9 inclusive are formed of parallel lines, similarly arranged in the successive characters, and varying in width by systematic gradations. These gradations may, if desired, be uniform, but I have found that a better effect is produced if the gradations are made in accordance with a logarithmic law.

This law may be stated thus: Let A represent the total area of the type face, A_p the printing surface, i. e., that portion of the area of the type face which actually contacts with the paper in printing, n the number of characters in the sequence, and a the number of the particular character in the sequence. Then

$$A_p = A\left(\log_n \frac{n}{a}\right).$$

Thus, if five lines comprise the printing pattern of each character, as in the case shown, the width of each line is equal to one-fifth of the width of the type face multiplied by the quantity in the parenthesis in the above formula. This holds true for any number of characters in sequence, but I have found that from seven to ten characters are adequate for almost all types of work.

In the example shown in the drawing, ten characters are used, and "a", the number of the character in the succession, is the reference number in Figure 1. The width of the lines forming the printing surface are then in the following ratios:

a	A_p	
1	1.00	(solid color)
2	.70	
3	.525	
4	.40	
5	.30	
6	.22	
7	.155	
8	.10	
9	.045	
10	0.00	(em space)

For printing in two colors, no additional characters need be used, since the characters are square and need only be turned at right angles to produce a cross pattern as is shown in Figure 2, the characters shading from dark to light as shown by the reference characters 11, 12, 13 and 14.

Where more than two colors are used, it is preferable that still another direction of shading be adopted, a second succession of characters being provided as indicated by the reference characters 15, 16, 17, 18 and 19 in Figure 3. This succession also grades from maximum to zero as in the first example given, but only a portion of the succession is shown.

This second succession of characters also provides for two colors of printing, by rotating the characters at 90° and overprinting as shown in Figure 4, reference character 20.

Since it is desirable, for color work, that the four characters used to overprint a single area should combine in a regular, uniform pattern, the diagonal lines used in the second succession of characters are preferably spaced more closely in the ratio of

$$1/\sqrt{2},$$

and are made narrower in the same proportion. The pattern 21 thus produced by four printings with characters of the same density is shown in Figure 5. A similar pattern of larger size is formed if the diagonal lines are made wider and are spaced in the ratio of

$$\sqrt{2}/1$$

as referred to the lines in the horizontal characters. The choice of either of these arrangements is optional.

It will be understood that the overprinting of four characters of the same density in different colors will be relatively rare, and

is shown merely for convenience in the drawing. In practice the overprinted characters may be any one in the different successions.

In color reproduction work, the usual three or four reproductions are made through color filters of red, yellow, and blue, the fourth color being a black and white reproduction made without a filter. Each of the four pictures is analyzed separately, and the corresponding type are set up by hand, or by type-setting machine as the case may be. A satisfactory size of type for billboard work has been found to be 6 point, although larger or smaller faces may be used if deemed advisable. The pictures thus formed may be printed direct from the type, by stereotype, or by any other process satisfactory in letter-press work.

It is to be noted, that whereas the usual half-tone picture is formed from dots of varying size, the picture produced by my process is resolved into elements of uniform size but of varying density. The variation of printing density in these elements is accomplished by dividing the elementary areas into sub-areas whose printing and non-printing surfaces are of varying size. In the last analysis, both the old process and my process rely upon different proportions of pigmented and non-pigmented areas to produce gradations in shading, but in my process the subdivision is carried one step further than in the customary method. This produces a picture which does not resolve itself into an undistinguishable mass of dots when viewed from ordinary distances, and at the same time one which does not require an excessively fine analysis, which would not be warranted for the type of work for which it is designed.

In the automatic method of selection, the movable type which comprise the printing surface may be set by a monotype or other satisfactory type-setting machine at a cost which is but a small fraction of that of preparing photo-engraved plates, and printing surfaces may be prepared in sizes which would be impossible in photo-engraving. As compared with lithography, my invention provides a method of preparing large pictures in half tone and in full color, with a much smaller number of printings and with improved effect.

While I have referred to characters whose printing patterns are composed of parallel, straight lines, it is obvious that other patterns, such as stipples, or curved or waved lines may be used. The form shown is preferred, however, as the types are simplest to cut, and are more rugged, than those embodying more complex patterns.

I claim:

1. A type font for reproducing pictures in half tone comprising a succession of characters, whose printing surfaces vary by logarithmic gradations.

2. A type font for reproducing pictures in half tone comprising a succession of characters, whose printing surfaces comprise parallel lines extending across the face of the type, the width of said lines varying in successive characters by systematic gradations.

3. A type font for reproducing pictures in half tone comprising a succession of characters, whose printing surfaces comprise parallel lines extending across the face of the type, the width of said lines on each character being proportional to the logarithm of the reciprocal of its number in the succession.

4. A type font for reproducing pictures in half tone comprising a succession of characters, the printing surface of each character being proportional to the logarithm of the reciprocal of its number in the succession.

5. A type font for reproducing pictures in colored half tone comprising a succession of characters whose printing surfaces comprise parallel lines whose widths in successive characters vary by systematic gradations, and a second succession of corresponding characters whose printing surfaces comprise parallel lines arranged at an oblique angle as referred to the lines on said first succession.

6. A type font for reproducing pictures in colored half tone comprising a succession of characters whose printing surfaces comprise parallel lines whose widths in successive characters vary by systematic gradations, and a second succession of corresponding characters whose printing surfaces comprise parallel lines arranged diagonally with respect to the lines on said first succession, the lines on said successions being in the ratio of

$$1/\sqrt{2}$$

in width and spacing.

7. A method of half-tone reproduction of pictures which comprises resolving the picture to be reproduced into elementary areas of uniform size, and reproducing each of said areas as uniform in mean density throughout its extent, said areas being divided into sub-areas of alternate light and dark coloration to produce said mean density.

8. A type font for reproducing pictures in half tone comprising a succession of characters, the printing surface of any character being expressed by the equation

$$A_p = A\left(\log_n \frac{n}{a}\right);$$

where A_p is the printing surface of the character, A is the total area of the type face, n is the total number of characters, and a is the number of the character in the succession.

9. The method of two or three color picture reproduction from movable type comprising a limited number of characters of different printing surfaces which comprises the steps of analyzing the picture to be reproduced into elementary areas, selecting characters

of type whose printing surfaces correspond with the mean density of one color in said elementary areas, setting said type to correspond with the distribution of said color in the picture, selecting characters of different configuration whose printing surfaces correspond with the mean density of a second color in said elementary areas, setting said second mentioned characters to correspond with the distribution of said second color in the picture, and printing said picture with the set type in the appropriate colors successively.

10. The method of half-tone picture reproduction with movable type comprising a limited number of characters which comprises analyzing the picture to be reproduced into elementary areas, selecting characters whose printing surfaces correspond with the mean density of said areas, setting said type to correspond in arrangement with said areas, inking the entire surface of the set type substantially uniformly, and printing the picture with the set type, whereby said type determine both the form and density of the figures of the completed print.

11. A font of type for producing half-tone prints in color comprising a succession of characters whose printing surfaces vary by systematic gradations between zero and a maximum, and a second succession of characters of different conformation and varying by like gradations.

In testimony whereof, I have hereunto set my hand.

HENRY R. HARVEY.