Oct. 5, 1965 S. W. LEVINE 3,209,687

HALF-TONE PRINTING PLATE

Original Filed Dec. 23, 1959

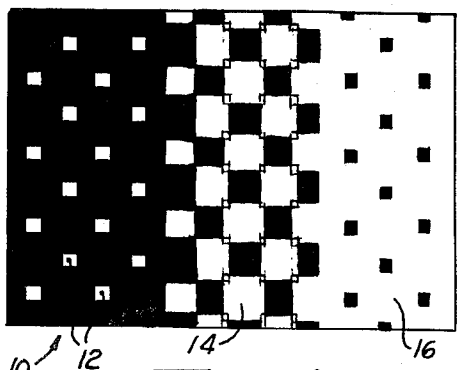


Fig. 1 PRIOR ART

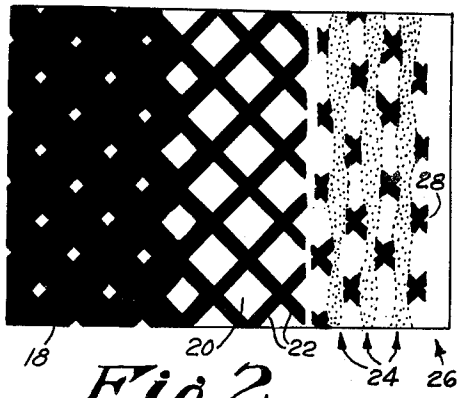


Fig. 2

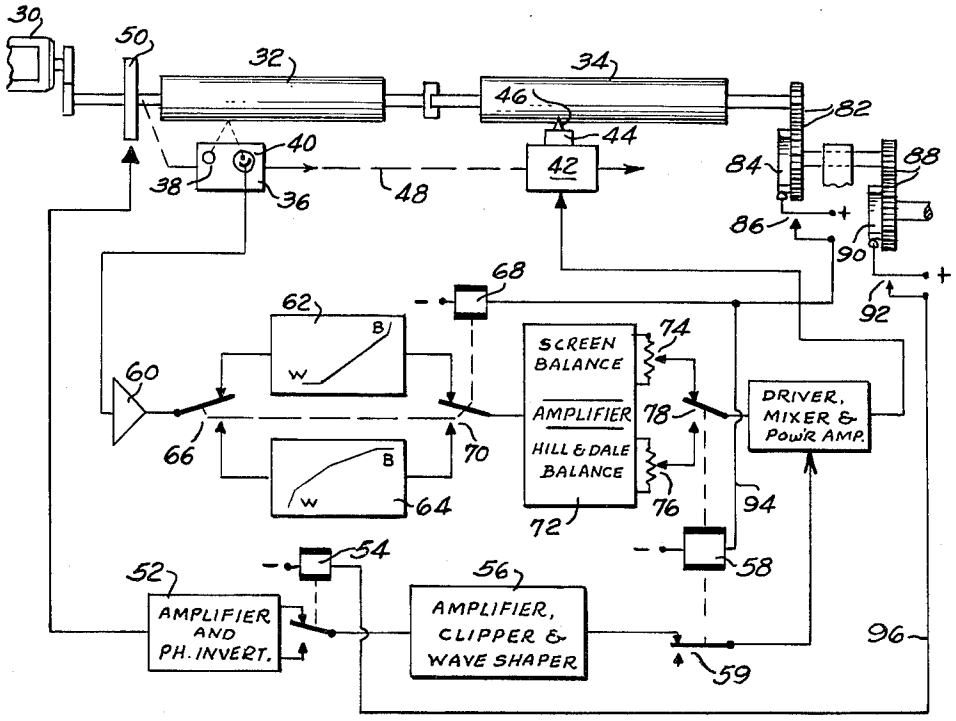


Fig. 4

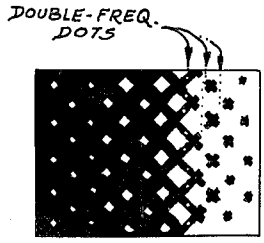


Fig. 3

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United States Patent Office 3,209,687 Patented Oct. 5, 1965

3,209,687

HALF-TONE PRINTING PLATE

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Original application Dec. 23, 1959, Ser. No. 861,625, now Patent No. 3,075,042, dated Jan. 22, 1963. Divided and this application Apr. 26, 1962, Ser. No. 195,359
3 Claims. (Cl. 101—401)

This is a division of application S.N. 861,625, filed Dec. 23, 1959, and now U.S. Patent 3,075,042, issued Jan. 22, 1963.

This invention is concerned with improvements in electronic half-tone engraving, and has for its principal object the provision of an apparatus and method, by which half-tone engraved plates of good printing and matting quality can be produced by the cold engraving of plate material in a manner generally analogous to the production of similar plates by the hot burning of plastic plate material. The invention thus provides for the provision of metal engravings, for example on magnesium or magnesium-alloy plate stock, by the electronic line scan and point-to-point engraving procedure currently in wide use by newspapers and other printing plants.

The known apparatus and techniques referred to above are best exemplified by the disclosure of U.S. Reissued Letters Patent 23,914 of December 21, 1954, to J. A. Boyajean, Jr., owned by the assignee of the present invention, utilizing the heated plate-decomposing tool therein described as the preferred plate-deforming tool, and operating upon a thin plate composed for example of a heat-decomposable material such as cellulose nitrate. Preferred forms of the latter material are disclosed in U.S. Patent No. 2,827,726, G. F. Stradar, also owned by the present assignee.

At the present time, there are three principal types of machines for the cold engraving of half-tone printing plates direct from electrical signals. In the first type (exemplified by the "Klischograph" machine of Dr. Rudolph Hell), a flat-bed machine uses a linear scan motion to produce a screened reproduction quite similar in structure to the desired conventional pattern, but it is necessary to rotate the copy and the plate at a 45 degree angle to the direction of scan, which can only be done by scanning a diagonal of the copy, rather than lines parallel to the rectangular copy edges. The size of copy (and plate) which a given machine can handle is therefore considerably reduced. In a second type (exemplified by the "Elgrama" machine of Swiss origin), a hill-and-dale type of engraving is utilized resulting in a line pattern; while theoretically this machine can scan and engrave in the directions parallel to copy edges, operators find it necessary, as a practical matter, to resort to 45 degree rotation of the copy and plate to minimize the line characteristic of the screen, and to reduce the problem of ink flow which reduces detail in the shadow areas of the plate. In a third type of machine (which has been demonstrated experimentally by Hassing), a triangular shaped dot is engraved, to circumvent the requirement for rotating the copy. The screen so produced is not conventional, in that the dots are aligned at a 60 degree angle instead of the usual 45 degrees characteristic of the standard screen; the dot shape also raises other problems.

In the engraving technique to be described herein, a somewhat unconventional dot structure is obtained, but one whose differences from the standard are visible only on microscopic examination. When a printed proof from the plate is examined visually, it appears to be entirely conventional. The copy and plate can be oriented (as on a rotary type machine) with the direction of scan parallel to an edge of the copy, yet the rows of dots line up at the desired 45 degree angle. The achievement of this angular alignment is very important, because it happens that the human eye can resolve details much better when the detail is aligned in either a horizontal or vertical direction, and resolves least when the details are aligned at the 45 degree angle. If a plate is engraved with the dots aligned vertically or horizontally, they become very apparent to the eye, which is objectionable since the entire basis for half-tone reproduction is the suppression of the effects of the individual dots in favor of the over-all impression of continuity of tones.

It is accordingly a further object of the invention to provide ways and means for accomplishing the electronic half-tone cold engraving of metal or like hard plate material, to yield in a single complete scanning operation a plate having the desired tonal range, proper dot structure and shape, and the other properties deemed requisite by those using such plates for printing operations.

It is a further object of the invention to provide ways and means for producing a cold engraved half-tone plate having the desired staggering of the dots of successive rows, without the necessity for "cocking" or the turning of the original copy and plate material at a 45 degree angle relative to the directions of scan; thereby making it possible to engrave plates of full size up to the normal limits of the engraving equipment employed.

Still another object of the invention is to provide an engraving system of the above type which can be carried out with rotary plate-handling machines such as described in the Reissue patent referred to above, with the copy and the plate oriented in the usual way, yet producing the desired diagonal or stagger pattern of dots in the finished plate. An additional object of the invention is to provide a system of this kind in which the deflection of the engraving tool employed is relatively smaller than in the case of normal hot-stylus engraving as employed heretofore with hot-stylus machinery, thereby to permit either a higher effective speed of engraving, or the production of steeper walls on the cavities in the plate material which form the dot structure. The depth of engraving for a given highlight dot size is also considerably less than that required for the cold engraving techniques as practiced in the three electronic engraving machines previously discussed.

Yet a further object of the invention is to provide such a procedure which is capable of producing a highlight dot of very minimum size as compared with prior art efforts in electronic plate engraving. Finally, it is an object of the invention to produce such a process and system which can be carried out with very simple and readily performed modifications in existing line-scan engraving equipment of the rotary cylinder type, thereby to permit a variety of different materials to be satisfactorily employed with such equipment.

Briefly to summarize the way in which the above and other objects of the invention are accomplished, it may be said that the invention utilizes a cold engraving tool shaped to engrave a cavity, in metal or like plate material, which is of diamond shape—that is, a square cavity oriented with its sides at 45 degrees to the principal scan directions. This is accomplished by a screen tone modulation of the engraving depth as carried out in the machine of the reissued patent mentioned heretofore. However, after the engraving of each complete line of such cavities in one direction of scan, the same tool is employed to produce either a variable-width engraved pattern or a double-frequency engraved pattern, which thus modifies the area lying between the successive rows of dots; but the production of the variable-width modification or the double frequency engraving is automatically re-

stricted to plate regions in which highlight tones greater than some predetermined value are to be produced. The result is a plate pattern which in all tonal respects is fully equivalent to the more conventional pattern of staggered square dots of varying size.

With the above outline of the invention in mind, the actual procedures employed, and preferred apparatus for carrying out such procedures, will best be understood from the following detailed specification of a preferred example thereof, taken in connection with the accompanying drawings, in which:

FIGURE 1 is an illustration of the cavity structure (or dot structure) of a conventional electronically engraved plate, showing a variety of tonal values in the dot pattern.

FIGURE 2 is a similar illustration of the dot structure obtained by the use of the present invention with the hill-and-dale variable width auxiliary engraving, together with an indication of the manner in which it is obtained.

FIGURE 3 is a similar illustration of the dot structure obtained by the use of the present invention utilizing the double frequency auxiliary engraving line, together with an indication of the manner in which it is obtained.

FIGURE 4 is a schematic illustration, sufficient to enable those skilled in the art to practice the invention, of a preferred form of apparatus by which the invention may be accomplished.

Referring first to FIGURE 1 of the drawings, there is illustrated the form of printing plate obtained by the use of the machine of the Boyajean patent already mentioned, said plate being obtained by controlling from point to point the depth of entry of a hot stylus into the material of a decomposable flexible plate indicated generally by numeral **10**. Such plates are printed by inking the printing surface, so the surface at the left end of FIGURE 1 corresponds to a shadow tone in the reproduction. The dot structure consists of alternately staggered rows of square indentations or cavities **12** whose area, at the printing surface, is a relatively small fraction of the total undisturbed area surrounding each dot. In the central portion of FIGURE 1, a middle-tone dot structure **14** is indicated, in which the cavity area has increased to a larger fraction, specifically to a fraction greater than one-half. This is possible because the square-topped cavities produced by the pyramidal engraving stylus point actually overlap at the printing surface, as indicated by the dash lines at the corners. Between the areas **12** and **14**, a single row of dots is shown in which the cavities just touch at their corners, producing a checkerboard pattern.

The right-hand portion of FIGURE 1 illustrates a highlight tone area **16** in which the excised cavities have become so large that only a small part of the unit area of the printing surface remains, producing a maximum highlight dot pattern. In all cases, the dots are substantially rectangular in outline, and arranged so that the nearest dots extend at a 45 degree angle to the vertical and horizontal edges of the original rectangular copy and engraving material. In effect, the arrangement of nearest dots lining up at a 45 degree angle to the horizontal and vertical makes them less easily resolved by the eye, and this is a condition that is desired.

It will be seen from the foregoing that production of such a staggered dot pattern cannot be accomplished by the engraving of continuous lines along directions parallel to the plate edges, but that such could be attempted by performing variable-width line engraving along two sets of mutually perpendicular lines cocked at 45 degrees to the plate edges; or alternatively by cocking the original copy (and the plate material) at such angle. In FIGURE 1, the scanning and engraving line direction is from top to bottom of the figure.

According to the invention, an acceptable cold-engraved dot pattern equivalent to the known FIGURE 1 pattern can be obtained, on a single pass of the plate material, which can be arranged at the normal angle with its edges parallel to the scan directions, by the use of a pyramidal

cold engraving tool which is however angled at 45 degrees so as to engrave diamond-shaped dots such as indicated in the shadow portion **18** at the left of FIGURE 2. As the penetration depth increases, the excised diamond-shaped areas become larger, as at **20**, but in this case the signal is appropriately limited to prevent the corners of these cavities from overlapping or touching. The middle tone area is thus represented by a grid of perpendicular printing-surface lines **22**, the minimum width of such lines being set by the controls of the process.

Further, according to one form of the invention, the highlight area at the right end of FIGURE 2 is obtained by removing controlled-width furrows of the connector grid lines **22** between each pair of their intersection centers from top to bottom of the plate material, being the scan direction of the process. These furrows **24** (shown stippled for clarity) are produced by the same stylus which excised the cavities in the other plate portions, the stylus having a relatively shallow included angle at its pyramidal point so that the width of the furrow is readily controlled by the penetration depth, in the manner of a hill-and-dale recording of the Philips-Miller type. The result, as indicated in FIGURE 2, is a highlight dot area **26** consisting essentially of controlled portions of the intersections only of the waffle-pattern middle tone area **20**. It will be noted that the production of a continuously varying furrow is readily accomplished by eliminating the on-off tone which characterizes the driving current of the stylus in the true dot-producing action in the shadow and middle tone regions.

In order to permit a plate as illustrated in FIGURE 2 to be produced in a single scan of the material, the variable width lines or furrows **24** are preferably produced (when required by the tones value being engraved) by the use of the engraving stylus as a continuous hill-and-dale graver upon alternate passes of the sylus along the scan lines running from top to bottom of the drawing figures. In this connection, it will be recalled that the staggering of the dot patterns of the conventional engraving in FIGURE 1 is obtained by the use of a 180 degree phase shift in the screen tone (or on-off tone) during alternate lines of scan or engraving. The same procedure is used for the dot structure of FIGURE 2, but the on-off tone is completely suppressed during the production of the variable width furrows **24**. Thus, the scan cycle is made up of a sequence of four conditions, rather than two, in regions of highlight tone production:

(1) A line of dots with the screen tone on, phased zero degrees.
(2) A line engraving with the screen tone off.
(3) A line of dots with the screen tone on, but phased 180 degrees.
(4) A line engraving with the screen tone off.

Since the furrow width, from point to point along its direction, will have to be controlled independently from the penetration of the stylus when making a purely dot pattern, alternate control channels are provided to produce the desired output signals for the control of stylus during successive lines of engraving, as will be described.

In FIGURE 3, an alternate to the technique of FIGURE 2 is pictured. In this case, the hill-and-dale auxiliary line is replaced by a line of dots formed with the stylus operating at double the frequency of the primary engraving frequency. This technique has the advantage over the hill-and-dale system in that it can engrave to a greater depth where the connectors are being removed, and thereby reduce the elevation of the remaining connector to a greater degree. This is desirable in that, if too great a pressure is used in the printing process, ink is not deposited on the shallow connectors and thereby printed. The scan cycle for producing the plate as depicted in FIGURE 3 would occur in the following sequence:

(1) A line of dots with the single frequency tone on, phased zero degrees.

(2) A line of double frequency dots with a phase shift of 90 degrees.

(3) A line of single frequency dots with the screen tone on, but phased 180 degrees with respect to the first line of single frequency dots,

(4) A line of double frequency dots with phasing at 90 degrees to the previous line of single frequency dots.

It has been found that plates engraved with this double frequency technique, when sterotyped by the newspaper process referred to as matting, produce much better reproductions than the dot structure formed by the hill-and-dale technique first described.

Experience with the cold-engraved patterns made according to the invention demonstrates that while the highlight dot is not perfectly square, it does correspond closely to a rectangular shape, occasionally somewhat elongated in the direction of scan, and with a slight dimple in each edge as indicated at **28** in FIGURE 2. However, it has been found possible to produce an effective dot size (at the printing surface) as small as 0.001 inch on the side. Moreover, the presence of the connectors or grid lines **22** in the middle tone region has been found distinctly advantageous, since their presence eliminates the so-called half-tone "break" between shadow and middle tone regions. Furthermore, the fact that the stylus penetration is never so great as to permit an overlap of the excised cavities, permits faster operation of the stylus in its reciprocating motion, and in turn permits either a faster engraving action or the production of steeper-walled cavities, both of which are desirable features.

It will be apparent to those skilled in this art that the provision of a single machine for carrying out the foregoing procedures will also make it readily possible to produce line engravings as such, by simple changes in the line advance rate and complete suppression of the on-off or screen tone. Thus, a machine can be produced which will be capable of conventional hot-burning, cold half-tone engraving, or direct line work.

FIGURE 4 of the drawings shows schematically one form of apparatus by which the novel methods may readily be practiced. The mechanical parts of the equipment are quite similar to the machine of the Boyajean reissue patent, including a drive motor **30** and gearing by which are rotated the cylinder **32** for carrying an original continuous tone image such as a news photo or the like and the cylinder **34** for carrying the plate to be engraved with a half-tone reproduction of the image. A scanner carriage **36** carries the usual focussed spot light source **38** and the photocell pickup **40**, while an engraver carriage **42** supports the usual stylus drive motor **44** operative to drive the stylus **46** toward and away from the plate surface for dot production. The two carriages are connected for concurrent axial motion (parallel to the axes of the cylinders) by a drive connection **48** from the same motor power source. Suitable guides, bearings and the like have been omitted from the drawing in the interest of simplification of the illustration. A fixed-frequency tone-wheel **50**, as described in the reissue patent, or of other known type, provides the screen signal synchronized with cylinder rotation.

In the case of double frequency engraving, the double frequency signal is readily obtained by clipping the single frequency screen signal, differentiating it, amplifying, clipping, and then wave shaping. The 90 degree phase shift is obtained by well-known techniques.

Various switching arrangements may be employed to produce the desired dot-position stagger as between successive rows of engraved dots, the arrangement illustrated including a dot or tone frequency amplifier and phase inverter **52** providing outputs which are 180 degrees apart in phase position with respect to cylinder rotation, and a relay **54** is energized and de-energized, during successive groups of two complete rotations of the cylinders, to

apply the screen tone in desired stagger phase to the amplifier, clipper and wave shaper **56**. A relay **58** controls contacts **59** to permit the tone output to be interruped entirely, during the second revolution of each such group of two revolutions, to prevent the screen tone from modulating the image signal during those revolutions in which, because of the existence of a highlight region under scanner cell **40**, a simple hill-and-dale or varying width cut is to be made.

The signals derived from scanner cell **40** are amplified by a preamplifier **60**, and during alternate single revolutions of the cylinders, are applied to alternate compensating amplifier networks **62** and **64** for independent regulation of the functional relation between the input signal and the desired depth of penetration of the stylus **46** into the material of the engraved plate on cylinder **34**. This switching is accomplished by contacts **66** operated by a relay **68**, and the outputs of the two compensating channels are likewise synchronously switched as by another contact set **70** of the same relay **68**. The respective signals are then conveyed to the balance amplifier **72** which provides a separate and independent level control for the dot and hill-and-dale operations, as by respective potentiometers **74** and **76**.

In view of the fact that the screen tone is interrupted during the hill-and-dale or variable width cut, the alternate switching of the ouput of balance amplifier **72** can readily be accomplished by a second set of contacts **78** of relay **58**.

From the description above regarding the four different conditions which will exist during the engraving of a highlight reproduction, it will have been realized that the change in phase of the screen tone applied as a modulation to the amplified output signal in final mixer amplifier **80** must take place only at the completion of two complete rotations of the cylinders, while the shift as between dot engraving and furrow engraving, when it happens, must occur after each single revolution. This can easily be provided in a number of obvious ways, including the use of two-to-one counter, or by use of stick or latch-type relays suitably triggered and released once every one or two revolutions. FIGURE 4 illustrates an arrangement in which the shaft of the cylinders drives the smaller gear of a two-to-one gear set **82**, there being a half-circular cam **84** on the larger gear, arranged to close contacts **86** during each alternate rotation of the cylinders, and open them during the intervening rotations. Additionally, the large gear of set **82** drives the small gear of a second two-to-one gear set **88**, whose larger gear also carries a half-circular cam **90** engaging switch contacts **92** to close them during two rotations of the cylinders, and to open them during the next two revolutions. Closure of contacts **86** energizes relay **68** as already described to accomplish the desired transfer as between dot engraving and hill-and-dale during alternate successive revolutions of the cylinders, at contacts **66** and **77**, and also, over a branch conductor **94**, energizes relay **58** to switch the output of amplifier **72** and to cut the tone modulation on or off at contacts **78** and **59**.

During the next group of two cylinder revolutions, exactly the same sequence occurs, but in this case the phase position of the screen tone will be reversed 180 degrees by the energization of relay **54** over conductor **96** from contacts **92**. Thus, during the production of two successive engraved lines of dots, the desired stagger of position will result, while the intervening lines of furrow-production, when called for by the highlight signals from scanner cell **40** (as modified by the characteristics of the compensating amplifiers **62** and **64** and the balance amplifier **72**), will be obtained in the desired manner. The amplifier characteristics are so chosen, as will be understood, that in no case will the engraved dot-forming cavities actually overlap, or even quite touch one another at their corners; this condition can be insured by the use of suit-

able and well-known signal shaping techniques, as indicated for the amplifiers **62** and **64**.

From the method standpoint, it is clear that an equivalent engraved plate could be obtained by the use of two complete scans, all of the dot pattern and waffle-iron grid of FIGURE 2 or FIGURE 3 being engraved during one scan, and all of the furrow production or double-frequency engraving being obtained as a second operation. However, there are manifest technical advantages in the single-operation procedure outlined, for example in reduction of the need for careful positioning of the stylus at the beginning of the second complete scan operation. Theoretically, at least, the furrowing or double-frequency operation could even be performed as a first operation, followed by the half-tone dot production, and it is at least conceivable that a skillfull operator could produce a printable plate by hand engraving according to the patterns suggested herein.

A further advantage in the line-by-line interchange of the dot and furrow (or dot and double-frequency dot) functions across the plate width is that it enables the operator to obtain a complete appraisal of the progress of the work after each line or pair of lines, for example by the use of the stroboscopic microscope described in the Boyajean patent.

While the invention has been disclosed herein in connection with a preferred procedure and apparatus, it should be understood that given the novel concept, those skilled in the art will be able to implement the same by other forms of apparatus and even by variant procedures to produce the new form of plate, and that the invention is not to be considered as restricted to the details given above, except as may be required by the scope of the appended claims.

What is claimed is:

1. A half-tone printing plate having an engraved pattern of substantially rectangular outline cavities having their boundary lines oriented at 45 degrees to the plate edges throughout its shadow and middle tone regions, and in its highlight regions a pattern of such cavities from whose boundaries at least a part of the inter-cavity connecting material is absent along lines parallel to one edge only of said plate, to provide highlight dots at the printing surface which are centered on the center-lines of said cavities that are parallel to the plate edges.

2. A half-tone printing plate having an engraved pattern of spaced aligned cavities whose outlines throughout its shadow and middle tone regions are substantially rectangular figures in the printing plane of the plate, with their edges inclined at 45 degree angles to the edges of the plate, to provide in the middle tone regions continuous cavity-bounding grid lines at the printing surface; said plate in its highlight regions having a pattern of isolated printing dots constituting the residual intersections of the grid line boundaries of such middle-tone cavities.

3. A half-tone printing plate in accordance with claim **2**, in which said highlight region printing dots are or cruciform outline.

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DAVID KLEIN, *Primary Examiner.*