

July 16, 1968

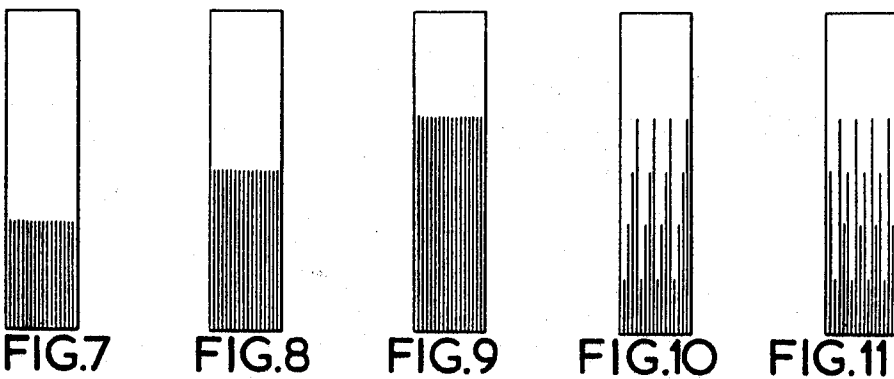
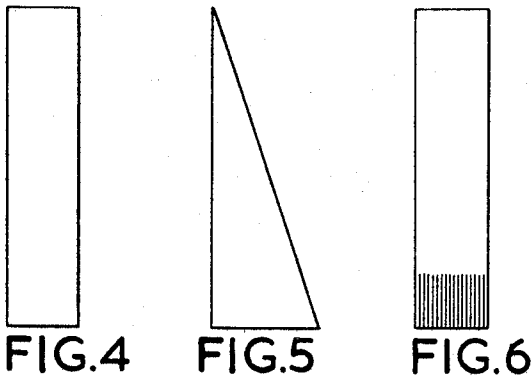
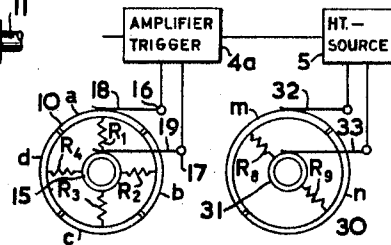
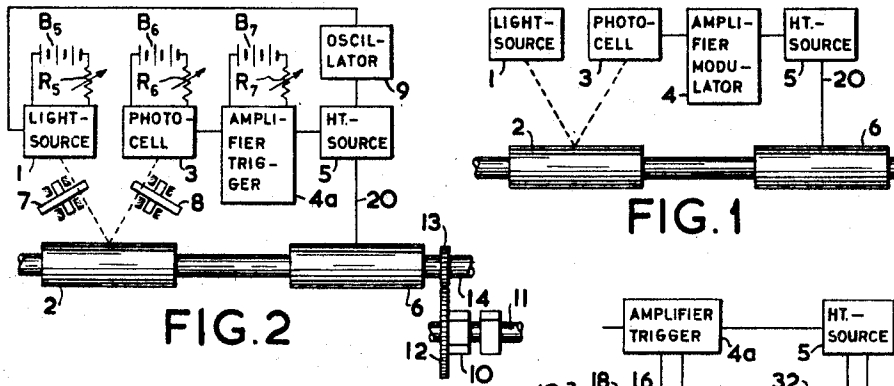
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3,393,269

METHOD AND APPARATUS FOR PRODUCING A LAMINAR PRINTING FORME

Filed April 22, 1964

2 Sheets-Sheet 1



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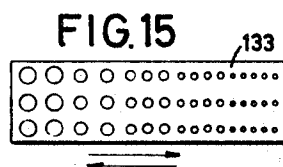
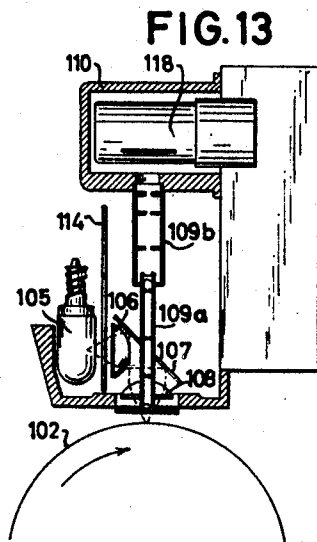
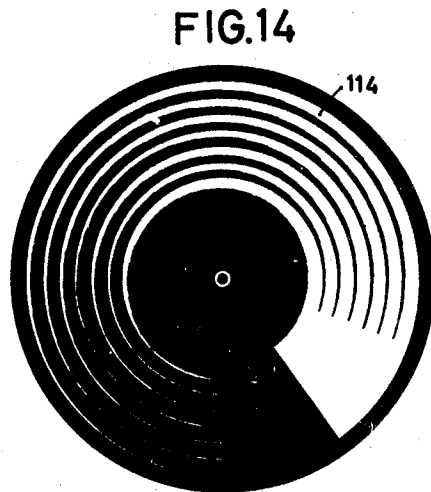
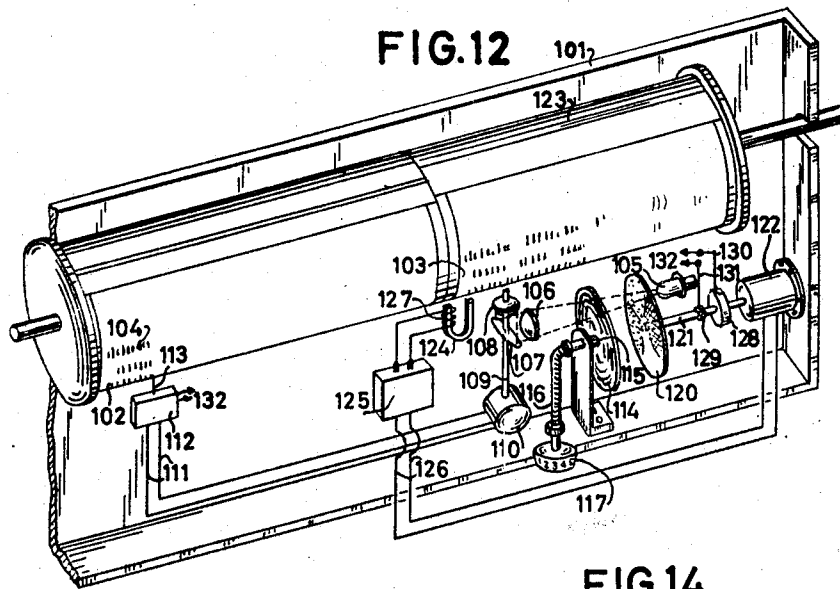
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2 Sheets-Sheet 2



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METHOD AND APPARATUS FOR PRODUCING A LAMINAR PRINTING FORME

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Filed Apr. 22, 1964, Ser. No. 361,751

20 Claims. (Cl. 178—6.6)

ABSTRACT OF THE DISCLOSURE

A method and an apparatus for the reproduction of pictures by electrically perforating a stencil in relation to the contrasting tones in an original which is to be reproduced, the invention involving the perforating of said stencil only in correspondence to all contrast tones either above or below a given grey tone in the original and varying in steps the said given grey value, the resulting stencil being adapted to produce half tone prints.

This application is a continuation-in-part application of United States patent application, Ser. No. 3,158, filed on Jan. 18, 1960.

The invention relates to a method and apparatus for producing a laminar printing forme, that is a printing forme comprising one or more laminae, and is concerned with the production of such formes in which a lamina is perforated. The lamina blank can be perforated electrically in which case it is called an electrostencil, but for off-set formes only one lamina of, say, two may be perforated.

In producing such a forme by perforation of an electrostencil the original, i.e. the object which is to be reproduced, is scanned for production of a modulated electric current which controls the application of a voltage to a stylus which effects the perforation and in which provision is made for adjusting the threshold below which no perforation takes place and above which perforation of the electrostencil is effected.

Perforation of an electrostencil blank may for instance be made in an apparatus with two synchronously running cylinders one of which carries the original and the other the stencil blank. During the rotation of the cylinders the original is scanned optically by a photocell, the output voltage of which varying in time with the changing impressions of light from the original is used in controlling a high-frequency alternating voltage which, through an amplifier, is impressed on a stylus so that local burning-through of the stencil-layer occurs when the voltage of the photocell surpasses the pre-adjusted threshold which is fixed and based upon an estimate of the contrast range of the original. The threshold may as an example be adjusted of a compensation voltage or a grid bias on an amplifier valve. In practice the threshold is not defined sharply as a point of the characteristic curve which indicates the voltage of the photocell as a function of the quantity of light received. Contrarily, a certain interval of uncertainty is found round the fixed theoretical threshold value and separating the two ranges of the characteristic curve within which ranges perforation and no perforation, respectively were attained with certainty.

Known electrostencil blanks can be divided into two main types according to the basic material on which they are built. One type, which is here called an inhomogeneous stencil blank, is built on a basic material of fibrous material, e.g. paper such as Yoshima paper. The space between the fibres is filled out by a stencil mass containing considerable quantities of electrically conductive material, e.g. carbon particles. The presence of this material gives the stencil-layer a perceptible electric conductance so, that the burning-through or the melting-away of the stencil mass can to a certain degree be controlled by

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changing the amperage this being controlled by control of the voltage applied to the stylus. The other type of stencil blank here called the homogeneous type is built on a homogeneous basic material e.g. a so-called plastic in which is likewise found a conductive material e.g. carbon but in less quantity as the intention is merely to facilitate the breakdown of the material by the electric spark.

The two types of stencil blanks, the inhomogeneous blank and the homogeneous blank have different qualities which make themselves known when it is attempted to produce half-tone pictures by these stencils. With the inhomogeneous stencil, it is possible to produce half-tone pictures by changing the burning voltage depending on the quantity of the light that is reflected every moment from the scanned original. By this arrangement greater or smaller quantities of the stencil material between the fibres are burnt away and, when imprints are produced by the stencil, a greater or smaller quantity of ink will get through the stencil. Researches have shown that the homogeneous type of stencil is ill-suited for production of half-tone pictures by the same method as that which can be used for the inhomogeneous type of stencil. The characteristic curve that indicates the area burnt through as a function of the burning voltage does not have a forme of the kind that provides proportionality over a reasonable contrast range. It is feasible to make an attempt to provide a compensation by a convenient adjustment of the characteristic curve of the amplifier receiving the signal from the photocell scanning the original, and passing the amplified signal to the stylus but such compensation involves considerable practical difficulties and further it is undesirable to make fundamental changes in the apparatus as it is preferred to enable existing apparatuses to be adjusted for the production of half-tone stencils.

It is one object of the present invention to provide an improved method by which a homogeneous blank lamina can be perforated to produce a printing forme which may be a stencil or an off-set plate.

It needs mentioning that even with a homogeneous stencil, it is possible under certain circumstances to produce imprints which simulate half-tone pictures. This applies when the original is a so-called spurious half-tone picture, i.e. a picture in which the impression of half-tones has been attained by a screen. Therefore, the greatest difficulties arise when the original exists as a real half-tone picture by which is here understood a picture the tones of which are due to a varying degree of density. If a half-tone picture is to be produced on a homogeneous stencil blank from a positive original in real half-tones, a spurious, half-tone picture must be produced first.

In practice, however, when a rather long time has lapsed the negative of the original has often been lost and therefore the original has to be photographed and a screen positive must be produced so that the method becomes troublesome and rather expensive.

The known apparatus for production of perforations in homogeneous electrostencil blanks usually comprise a control means for adjusting the threshold and this adjustment is made after an estimate of the original which is to be reproduced so that the threshold is placed conveniently between that which is to be reproduced as white and that which is to be reproduced as black. The adjustment of the threshold may for instance take place by adjustment of the bias of the grid in the first amplifier valve to which the output voltage of the photocell is led. This adjustment is carried out adequately by a potentiometer.

The apparatus is also provided with other means for adjusting the candle-power of the exciter lamps, the number of lines per cm., and the electrode voltage. This voltage is usually adjusted according to the chosen num-

ber of lines so that, practically speaking, it is inversely proportional to the number of lines.

According to the present invention a method of producing a laminar printing forme, comprises the steps of so scanning an original along a succession of scanning lines as to generate electric signals representative of the grey-values along the lines, synchronously scanning a laminar forme blank with a perforating device, applying the electric signals to cause the perforating device to perforate the blank when the grey-value in the original exceeds a given amount and, during scanning, varying the grey-value at which perforation takes place in discrete steps. The stepwise variation may be effected by hand in such a manner that the position of the threshold or given amount is changed adequately every time the stylus passes the bar that holds the ends of the stencil on to a cylinder round which the stencil lies. In order to obtain uniformity, it is desirable that a certain pre-fixed plan is followed in making the said discrete steps. It is preferred to make the said discrete steps automatically.

In an embodiment of the method according to the invention the stepwise variation occurs in a cyclically repeated permuted sequence of steps differing from the natural sequence which corresponds to a rising scale of tone values, e.g. so that four thresholds, *a*, *b*, *c*, and *d*, the natural order of which, corresponding to a rising scale of tone values, is *a*, *b*, *c*, and *d*, occur permuted, e.g., *a*, *c*, *b*, *d* or *a*, *d*, *b*, *c*, etc. The advantage of this method will be explained further in the detailed description referring to the accompanying drawings.

It is preferred that the change-over from one threshold to another should take place near the time at which the leading end of the stencil is in front of the scanning position.

It may be advantageous under certain circumstances that the voltage of the stylus should be increased on some of the steps especially on one or more of the steps on which the threshold value is within that part of the tone range which corresponds with the lightest tone. Hereby a better shading of this tone range can be obtained. The most appropriate adjustment is made based on an estimate of the original which is to be reproduced.

In order to obtain a more extensive shading, a line-screen consisting of dark parallel lines on transparent material can be inserted between the original and the light source with the lines situated substantially perpendicular to the scanning direction. Hereby the density of the screen is added to the original so that the voltage of the photocell is made larger than to the threshold voltage so that uncertainty caused by the width of the threshold is eliminated.

Advantageously, the stepwise variation of the threshold involves a cyclically repeating sequence in which some steps occur more frequently than others, e.g., so that with six different steps *a*, *b*, *c*, *d*, *e* and *f* the order will be as follows: *a*, *b*, *c*, *a*, *d*, *e*, *f*, *d*, *a* . . . etc., whereby the steps *a* and *d* are repeated more frequently than the steps *b*, *c*, *e*, and *f*.

Further according to the invention apparatus for producing a laminar printing forme, comprises means for so scanning an original along a succession of scanning lines as, in operation, to generate electric signals representative of the variations in grey-value along the lines, means adapted for synchronously scanning a laminar forme blank with a perforating device, means for applying the electric signals to cause the perforating device to perforate the blank when the grey-value in the original exceeds a given amount, and means adapted to vary in discrete steps, during scanning, the grey-value at which perforation takes place.

It is an object of the invention to provide a simple arrangement which demands but few changes in the existing apparatus and according to the invention this may be achieved by a means for automatic and recurrent stepwise change of the position of the threshold during the perforation of the stencil. Such a means, which runs syn-

chronously with the cylinders in the existing apparatus, needs so far as the electric connections are concerned only a simple connection to the existing potentiometer by which the position of the threshold is fixed.

In an appropriate embodiment of the arrangement according to the invention, the means includes a change-over mechanism, a potentiometer with fixed but preferably preadjustable taps each fixing the step in question corresponding with a certain position of the threshold and means for driving the change-over mechanism depending on the scanning movement for contacting the different taps in a predetermined sequence.

The change-over mechanism can for instance consist of a number of separate switches, e.g., micro-switches, which are operated by a rotating cam shaft but, it is preferred that the change-over mechanism should be a commutator-like contact disk divided into mutually insulated electric conductive sectors each connected with its appertaining tap and a contact brush which scans the sector. The contact disk and the contact brush are rotated one in relation to the other. In an advantageous embodiment the contact disk is fixed while the contact brush, needing only a single lead, is rotated.

In an appropriate embodiment of the arrangement according to the invention there is a further change-over mechanism which alters the voltage on the stylus stepwise every time some of the steps corresponding to different positions of the threshold are switched in. The further change-over mechanism is synchronized with the change-over mechanism which determines the position of the threshold and the stylus is kept at a fixed voltage as long as the position of the threshold is not altered. Usually the further change-over mechanism will be coupled so that the voltage on the stylus is increased in the time-intervals in which the threshold is in that end of the tone range of the picture which corresponds with the lightest tones of the picture.

The invention is explained further in the following with reference to the accompanying diagrammatic drawings, in which:

FIG. 1 shows a block diagram of the optical and electrical part of a conventional apparatus for producing grey-tone stencils on stencil blanks especially prepared for this purpose,

FIG. 2 shows a block diagram similar to that shown in FIG. 1 but illustrating the invention,

FIG. 3 shows a switching mechanism for the apparatus in FIG. 2,

FIGS. 4-11 show pictures for explaining the method for producing a picture of a grey wedge,

FIG. 12 shows schematically part of an embodiment of an apparatus according to the invention,

FIG. 13 shows an enlarged detail of the construction of an optical system for the apparatus in FIG. 12,

FIG. 14 shows an enlarged picture of an embodiment of a rotatable light dimming disc for the optical systems shown in FIGS. 13 and 14 and

FIG. 15 shows another embodiment of a light dimming member to be operated by translating movement.

In the known system suitable for producing stencils and the like from which half-tone copies can be obtained and which system is shown in FIG. 1 a ray from a light source 1 is scanning an original 2 to be reproduced which is mounted on a drum. The reflected light which is a measure of the tone-value of the scanned spot of the original is received by a photosensitive cell 3 from which is derived an electrical signal which is amplified in an amplifier 4 the output signal of which is used for modulating the output voltage of a high tension source 5 which feeds an electrode or stylus 20 for perforating a laminar forme 6. This known arrangement can be used for producing a half-tone stencil provided that the stencil layer has a sufficiently linear and sufficiently extended characteristic which means that the curve depicting the area of a hole or group of holes perforated by the current from the electrode through the stencil-layer as a function of the volt-

age of the electrode has a rectilinear part covering a substantial range of electrode voltage. The stencil produced according to this method is a real half-tone stencil in as much as the area of a hole or a group of holes corresponding to a scanned spot varies with the grey-tone value of the spots scanned in the original.

The known method is, however, not applicable in all cases for reproducing grey-tones because the characteristic curve mentioned above exists only in stencils made of certain materials having suitable properties and processed with special care to avoid differences from one batch or one stencil to the other. Such differences are detrimental because they will make a correct preadjustment of the threshold impossible. This threshold is fixed by the operator out of experience and is further based on his evaluation of the original. In principal the procedure is the same whether the operator is preparing for making tone copies or black and white copies.

The operator chooses a grey tone in the original and decides that all tones of a darker shade than that grey tone must result in the punching of holes, while all tones of a lighter shade must not or vice versa. This procedure calls for a skilled operator especially when the original is in colours. The threshold remains constant during the perforation of the complete stencil. If the properties varies from one laminar forme to the next it is obvious that the quality of the result is depending on the operator's luck in choosing the correct, threshold. It is an object of the present invention to devise a method which independently of the material of the laminar forme and the way the laminar forme is manufactured produces a laminar forme from which tone copies can be made. Since it is a fact that characteristic of the laminar forme necessary for reproduction of tone-values cannot always be obtained in a way satisfactory to permit working with varying size of holes it is the basic idea of the present invention not to rely upon the possibility of varying the area of a hole or a group of holes corresponding to a scanned spot of the original by modulating the high tension voltage on the electrode. On the contrary the invention is based upon the recognition that it is not necessary that the punched spots have areas proportional to the tone-values of the scanned spots of the original to give the impression of tones in the copy made from the stencil. It is sufficient that the number of spots of equal size within an area considerably larger than a single scanned spot, for instance a square millimetre, corresponds with the tone-value within that considerably larger area of the original.

The resolving power of the apparatus in question may for instance be 200 lines per cm. each reproduced line being composed of a row of consecutive dots or holes. Instead of varying the area of each dot or hole this invention teaches to vary the number of dots of approximately equal size in an area covered by a rather great number of consecutive lines.

How it is possible to obtain this effect is explained with reference to FIGS. 2, 3 and 4-11.

In FIG. 2 is shown a block diagram corresponding with that in FIG. 1 with the exception that the amplifier is used not for controlling the value of the voltage on the electrode but only for controlling the application of the voltage to the electrode. In other words the output of the amplifier triggers the high tension source the voltage of which may in principle remain constant. The input of the high tension source is connected to the output of an oscillator 9 which also feeds current to the light source 1.

In the following it should for the sake of simplicity be assumed that a stencil to be punched is of the homogeneous type normally used for pure black and white reproduction, and that the size of the holes punched is practically speaking independent of the value of the voltage applied to the electrode provided that this voltage exceeds the break down voltage. Further it is assumed that the threshold can be adjusted to correspond with any tone-value in the original. How this can be done in practice will

be explained later on. At this point of the description it should be sufficient to mention that if the output signal of the amplifier must exceed a certain threshold in order to effect the triggering action the adjustment of the link or bond or relationship between the tones of the original and the said threshold may be obtained by amplifying or damping the signals somewhere between the light source 1 in FIG. 2 and the output of the amplifier 4a. Whether the signals are influenced when they are still light signals or after they have been transduced into electric signals is in principle of no consequence. Both possibilities will be further explained in principle in connection with FIG. 2 where three variable resistances R_5 , R_6 and R_7 each in series with a battery B_5 , B_6 and B_7 respectively indicate schematically the possibility of influencing the characteristic of the pertaining stage in some suitable way. When adjusting the apparatus, a part of the original having a grey tone which should correspond with the threshold value is brought into the scanning field and one of the potentiometers 7, 8 or 9 is then adjusted so that a slight change in grey-value from one side to the other of the value chosen will result in a shift from an action potential to no action potential on the electrode connected to the high tension source 5. An adjustment which is analogous in principle to the electrical variation of the threshold can be obtained optically by inserting light dimming means in the path of the light rays either between the light source and the original, as symbolised by a rotatable disk 7, or between the original and the photocell, as symbolised by a rotatable disk 8. The disks 7 and 8 have different light penetration properties in different sectors. The intensity of the light signals can thus be varied with the result that the electrical signals triggering the high tension source 5 are varied accordingly.

FIGS. 2 and 3 illustrate schematically how a stepwise alteration of the characteristics of the different stages in the apparatus can be obtained. A switching mechanism comprising a commutator ring 10 is mounted on a shaft 11 together with a gear wheel 12 meshing with a gear wheel 13 mounted on the shaft 14 carrying the cylinders for the original 2 and the laminar forme 6.

The ratio between the gear wheels is in the example shown 1:4 because the commutator ring 10 has four mutually isolated conducting sectors a , b , c and d .

Between each of said conducting sectors and a conducting center-ring 15 is connected a resistance R_1 , R_2 , R_3 and R_4 respectively. The resistances are of different values. Consequently, the resistance between terminals 16 and 17 connected to brushes 18 and 19 is changing by each revolution of the shaft 14. By substituting one of the resistances R_5 , R_6 and R_7 with the sequence of changing resistances R_1 , R_2 , R_3 and R_4 a stepwise variation of the signal controlling the triggering action can be obtained. Preferably the stepwise varying resistance is used for controlling the gain of the amplifier 4a. To the man skilled in the art there are many other ways known of deriving a controlling pulse or signal for changing some characteristic in the apparatus equal to the change of a threshold. A special way will be described in connection with FIGS. 12-15. To obtain the effect aimed at either the signal or the characteristic of one or more stages can be operated upon.

With reference to FIGS. 4-11 it is now explained how the effect aimed at is obtained. When reading the following description it should be born in mind that these figures show the actual objects greatly enlarged. To permit comparison with reality it should be remembered that there may be for instance 200 lines per cm. while the pictures shown in FIGS. 7-11 have only 16 lines in all. Each vertical line, which is shown full drawn, represents a row of dots or holes having all approximately the same dimension. The holes occur because the high tension voltage applied to the electrode or stylus 20 is alternating with a suitably high-frequency derived from the oscillator 9

in FIG. 2. The maximum amplitude of the high tension remains constant in the case described.

FIG. 4 illustrates a ribbon shaped picture with tones from the lightest at the top of the picture to the darkest at the bottom. The figure is meant to show a real half-tone picture in which the degree of density is illustrated by the density of the horizontal lines in the picture which as will be seen lie more densely at the bottom than at the top. The picture may be produced by a grey wedge as is shown in FIG. 5. This figure may illustrate the degree of density as a function of the vertical position, i.e. in the direction of the ordinate so that the sloping line is a curve representing the degree of density.

If a stencil is made from an original as shown in FIG. 4, i.e. a real tone picture, using a homogeneous stencil and a fixed adjustment of the threshold near the darkest end of the picture in FIG. 4, a copy as shown in FIG. 6 will be obtained. Here it is presumed that the width of the threshold is very small so that the inked lines are practically of equal length.

If the threshold is adjusted to lie a little nearer the lighter end of the picture, an imprint such as that shown in FIG. 7 will be obtained. If the threshold is moved a little again and another stencil is made, an imprint such as that shown in FIG. 8 will be obtained and if the experiment is repeated with the threshold lying as near as possible to the lightest end a stencil which by reproduction gives a picture such as that shown in FIG. 9 will be obtained. In the figures showing the reproductions made by the stencils the inked parts are indicated by lines. The stencil does not, however, have line perforations. Each line is actually composed of a number of practically equally large points. In particular homogeneous stencils should not be made with long continuous perforations contacting each other as the stencils may then fall to pieces. The risk of this is not so great in inhomogeneous stencil provided that the fibres are not burnt away completely.

Each of the FIGURES 6 to 9 represents a reproduction of FIG. 4, but none of the reproduced pictures corresponds with reality as they are only black-white reproductions. By the method according to the present invention the four reproductions described or any number of similar reproductions can be made and the invention comprises a mixing of the different possibilities such as shown in FIG. 10.

Comparing FIG. 10 with FIGURES 6 to 9, it will be seen that the first line at the left of FIG. 10 is level with the lines of FIG. 6, equivalent to the fact that by the perforation of the stencil blank, there is used an adjustment of the threshold corresponding with the adjustment used for production of the stencil which led to the picture in FIG. 6. Likewise the second line from the left in FIG. 10 corresponds with the lines in FIG. 7, the third line in FIG. 10 with the lines in FIG. 8, and the fourth line in FIG. 10 with the lines in FIG. 9.

In the production of the stencil in FIG. 10, by the perforation of the first four lines, four mutually different separating intervals a , b , c and d are used and the sequence of the thresholds is chosen so that they correspond with the sequence of the thresholds of FIGS. 6, 7, 8, and 9, i.e. they appear in a continuously rising order.

The next four lines of FIG. 10, i.e. the lines with the numbers 5 to 8 in this figure when counting from the left, are identical with the first four lines and are found in the same order. The next four lines, i.e. the lines 9 to 12 from the left, are again a repetition of the first four lines and so on.

FIG. 10 will show that by the periodical variation of the position of the threshold is produced a picture on which a half-tone range is provided on the intermediate stage between black and white. Naturally FIG. 10 shows the proportions on a considerably enlarged scale. In practice there may be for instance a hundred lines per cm.

The fact that the position of the thresholds are altered in a continuously rising direction in FIG. 10 brings about

a distortion in the reproduction which may, however, be adjusted by changing the order in the way in which it has been done in FIG. 11 where the thresholds are found in the order c , a , d , b . A comparison between the FIGURES 10 and 11 shows the advantage of the changed order and it must still be remembered that it is an enlarged reproduction so that the improvement will turn out to be more distinct in reality.

The production of the perforations can be effected in different ways. One method can for example be that of passing the same stencil blank through the perforating apparatus four times, each time with a feed corresponding with 50 lines per cm., the first time using one position of the threshold corresponding with the one shown in FIG. 6, the second time another position corresponding with the one shown in FIG. 7, the third time a third position corresponding with the one shown in FIG. 8, and the fourth time a position corresponding with one shown in FIG. 9. On each new passing-through of the stencil care must be taken that the next line of holes is not put on top of the old line of holes, but is started one, two, or three lines to one side, so that in the finished picture there are 200 lines in all per cm. The method denoted here is the most appropriate if the production is to take place by hand, as adjustment of the apparatus is then only called for four times.

If the apparatus is adjusted automatically, it is more appropriate to work with the fine feed that gives e.g. 200 lines per cm. and then to carry out the alteration from one position of the threshold to another each time the bar fixing the ends of the stencil to the rotating cylinder of the apparatus passes the stylus.

In order to achieve a shading in the lightest parts of the picture the potential on the stylus may be increased when the threshold is adjusted to lie in the part of the tone range which corresponds with the lightest tones. With a view to this there may furthermore be used as shown in FIGS. 2 and 3, a commutator-like ring 30 which is only divided in the two sectors n and m and which has a contact brush 32 connected with the HT source and a centre-electrode 31 connected also to the HT source. Between the centre-electrode 31 and the contact-sector n there is an electric resistance R_0 and between the centre-electrode 31 and the contact-sector m there is another resistance R_0 so that two different resistances occur between the brushes 32 and 33 which resistances are used for controlling the HT source to deliver two different stylus voltages depending on the contact brush 32 being connected with one or the other of the two contact-sectors.

When the brush 18 switches in the steps a and d the brush 32 is still in contact with the segment m , as a change to the segment n is only made when the brush contacts the segments c and b .

In an arrangement in which the brushes are rotated and the commutators are stationary, synchronism may be obtained by mounting the brushes on one and the same rotating carrier driven in synchronism with the shaft of the cylinders. However, the arrangement shown in FIG. 2 is preferred.

It is the brightest parts that decide the coarseness of the picture i.e. the number of lines. As an example 200 lines per cm. correspond to a 50 line screen in four steps. Four steps corresponding to four different positions of the threshold may, however, be too little in the deep or dark tones and therefore a subdivision of two of the steps into two each is preferred, each of which steps is repeated once.

The practical design of the arrangement according to the invention can be varied in numerous ways within the scope of the invention. Thus it is possible to switch in different resistances by micro-switches operated by a cam shaft running synchronously with the shaft of the stencil cylinder. However, since such modifications are obvious to the man skilled in the art it is deemed superfluous to deal with them in detail.

FIG. 3 only serves as an illustration of the principle

and for the sake of clearness the practically most appropriate order and size of the resistances inserted have not been shown. Therefore, it must be mentioned that the repeated steps should be diametrically opposite each other and need not be similar but can be made a little different with advantage. Furthermore, it is possible instead of different resistances, to use one and the same potentiometer e.g. the already existing potentiometer of the apparatus for manual adjustment of the threshold and only connect each of the contact segments *a, b, c, d, a, e, f, d* to its fixed tap of the potentiometer and connect the then movable brush with the grid in the first amplifier valve of the amplifier which amplifies the voltage derived from the photocell.

By suitable choice of the bias in some of the steps, a shading of the darker parts of the picture can be obtained.

The change-over switch which changes the stylus voltage is shown bisected, but it can be further divided so that change-over of the stylus voltage to more than two steps is obtained.

It will be understood from the explanation given that the method according to the invention is not restricted to application in connection with homogeneous stencils but can also be used in connection with inhomogeneous stencils.

The switching mechanism shown in FIG. 3 can be designed as an attachment for an existing apparatus which needs only a few changes to adapt it to the more comprehensive use according to the invention, namely a suitable coupling with the shaft of the device and a few leads. It is obvious that the device may be built in the casing of the apparatus and that a suitable switch may be inserted in the electrical circuit in order to switch over from black-white to halftone cutting of the stencil blank.

It is obvious to the man skilled in the art that the method according to the invention can be used in connection with an apparatus in which the perforation is made mechanically by means of a stylus perforating a stencil blank since the controlling of the means for making the perforations is independent of the type of said means, provided that the value of the controlling out-put voltage is correctly adjusted.

The device described in connection with FIGS. 2 and 3 is suitably used in existing apparatuses in which the adjustment of relationship between the signal and the switching-over from a perforating voltage to a non-perforating voltage or no voltage on the electrode is obtained by electrical means. However, it is according to the invention also possible to obtain the result by optical means in which case redesign of the apparatus as described in the following with reference to FIGS. 12-15 is recommended. Even if the apparatus is used only for reproducing black-white printing formes, masters or single copies, there are advantages in using the optical adjustment according to the invention in the presetting of the threshold. Such advantages are for instance the possibility of pre-adjusting all apparatuses of a series production so that the operator does not feel any difference when changing from one apparatus to another, and the possibility of maintaining the best working conditions of light source and amplifier. Further maintenance inspection of the equipment proves to be easier.

In FIG. 12, 101 is a frame wherein a rotatable and displaceable cylinder 102 is journaled, one half of which is intended for accommodating an original 103, and the other half of which is intended for accommodating a master blank 104. The movement of the cylinder is provided by driving means, not shown, so that a helical scanning of the original can be effected by means of an optical system which is fixed in relation to the frame. The expression master blank being here used in its broadest sense and thus also including blanks to be used as single copies only.

The optical system includes an exciter lamp 105, a condensing lens 106, a mirror 107, and a condensing

lens 108 which throws a beam of light having a spot diameter of for example 0.03 mm. in the direction towards the original on the cylinder. The optical system shown is designed with a view to avoiding shadow effects as a consequence of differences of level in the surface of the original. Such level differences may, for example occur if the original is produced by gluing a number of elements to a backing of for example paper.

The light which is reflected from the original is caught by a tube 109 which extends through the centre of the mirror 107 and the condensing lens 108. The light caught is by the tube led to a light-sensitive element, for example a photocell or a photomultiplier tube which is located in a housing 110. The electric signals from the light-sensitive element are used for controlling an equipment for working the master blank 104 with a view to producing a master, for example a stencil. This is indicated by leads 111 and an apparatus 112 which amongst other things contains an amplifier and an electrode 113 to which an appropriately high perforation voltage is applied when grey-values on the original above a definitely chosen grey-value is scanned but to which no perforation voltage is applied if the scanned grey-value lies below this threshold value. The signal coming from the photosensitive element thus functions as a trigger signal which when its amplitude exceeds a definite threshold value, causes a perforation voltage to be applied to the electrode 113.

Heretofore, an adjustment of the electrical threshold has been made in the amplifier 112 so that the latter was brought into conformity with the chosen grey-value on the original. The signals supplied to the amplifier 112 through the leads 111 have consequently been uninfluenced by the adjustment of the threshold value. According to the present invention the electrical threshold value is left substantially constant and instead the values of the signals, the trigger signals, supplied through the leads 111 are altered, the altering of the signals being effected by making an alteration in the optical system, namely, so that an alteration of the intensity of the light to or from the original is taking place. According to the invention this is brought about by inserting a light-dimming member 114 at an appropriate place in the path of rays from the exciter lamp to the photosensitive element in the housing 110.

Principally, it would be possible to have a plurality of light-dimming members corresponding to the number of steps desired, so that each time a master was to be produced, an estimation of the original should be made, and it should then be determined at which threshold value a change-over between perforation and non-perforation should take place, whereafter the dimming member corresponding to this threshold value should be chosen and placed in a holder in the path of rays from the exciter lamp. However, it is more practical to leave it at one dimming member which within different areas has different dimming values. The embodiment shown in FIG. 12 has been designed in conformity therewith. The dimming disc 114 which for example may be designed as shown in FIG. 14 is mounted on a rotatable shaft 115 and by means of a flexible shaft 116 connected with an adjustment handle 117 which has a scale showing at which dimming value the handle is set. The transmission of the movement from the handle 117 to the disk 114 may be effected in any other way.

In the embodiment of the dimming disk shown in FIG. 14 there are within thirty sectors thirty different dimming values. However, any other number may be chosen. The dimming disk may for example, be a glass disk which by silk screen printing has been provided with the shown pattern in a light-impervious material which for the purpose of reducing the influence of heat may be of a light colour. The white portions in the figure represent the areas where the light unobstructed can pass through the disk. For each adjustment only

part of the disk, for example a sector of 10° , is situated in the path of rays and consequently active as a dimming member. If a curve is drawn showing the relation between the angle of rotation and the dimming value, it will exhibit a logarithmic course. By choosing a logarithmic function, proportionality will be attained between the grey-value scale and the adjustment on the handle 117.

The dimming disk may otherwise be designed in any suitable manner, for example, as a photographic film having varying degree of density, or as a solid opaque plate having perforations of varying size such as shown by way of example in FIG. 15. This plate may be used in the manner that it is pushed forwards and backwards as indicated by the two arrows so that a narrow strip transversely of its longitudinal direction is pushed into the path of rays.

FIG. 13 shows a section of the optical system. For analogue parts there are used the same reference numerals as used in FIG. 12. The cylinder 102 is indicated by parts of a circle, and an arrow shows the direction of rotation of the cylinder. The path of rays from the exciter lamp 105 is shown by dotted lines. The tube catching the light rays reflected from the original is in this example composed of two parts 109a and 109b. In the former part there is a lens at either end, and both parts are provided with inbuilt diaphragms for cutting off light having an unwanted direction. In the housing 110 provision is made for the light-sensitive element, e.g., in the form of a photomultiplier tube.

With an apparatus as described it is possible to produce a master giving half-tone impressions. This can be done by turning the handle 117 line for line during the scanning operation, alternating for example among four or five different dimming values about the preselected value. The sequence of the dimming values used may be optional. The same sequence may be repeated regularly or an irregular or random change-over may be made without any specific system. The change of the dimming disk from one step to another may be performed automatically controlled by the rotation of the cylinder, and the change can be performed line for line or, if desired, for every second line or every third line dependent on which result it is desired to attain.

In FIG. 12 there is shown an example of an embodiment of an apparatus for automatically producing half-tone masters by using two dimming members. One dimming member is the disk 114 whilst the other is a disk 120 which is mounted on a driving shaft 121 which is connected with the rotor of a motor 122 which is fixedly mounted in the frame 101. The disk 120 protrudes also into the path of rays from the lamp 105. In the example shown the dimming disk 120 has four different dimming values each lying within a sector of 90° . In this case the dimming disk, if a change-over is desired for each scanning line, is to be turned 90° when passing from one line to the subsequent line. With a view thereto, the motor 122 is arranged as a pulse motor, the driving shaft of which moves 90° each time the motor receives a pulse. Such pulses are in the example shown provided by means of a pulse generator which comprises a ferro magnetic bar 123 on the cylinder 102, a magnet 124 and an amplifier 125 which through leads 126 supplies the pulses to the motor 122.

The pulses are produced by the bar 123 altering the direction of the magnetic field of the magnet 124 so that a current is induced in a coil 127 lying around the magnet. This pulsator current is amplified in the amplifier 125 whereafter it is supplied to the motor 122. The magnet 124 is so located that the pulse is supplied when the bar 123 passes the place of scanning.

If the apparatus is of the type in which the perforation voltage is kept substantially constant during the production of a master, it may in some cases be desirable that the perforation voltage nevertheless is altered when certain grey-values in the original occur. An arrangement for

controlling the size of the perforation voltage can easily be provided in an apparatus according to the invention. In FIG. 12 there is shown an example where on the driving shaft 121 there are mounted two commutators 128 and 129 with associated brushes 130 and 131 which by leads 132 are connected with the amplifier 112. The commutator may for example be arranged with four sections each offering different resistance to an electric current. The different resistances may be inserted in a circuit in the amplifier which controls the size of the perforation voltage supplied. In the embodiment shown, synchronism between the change-over of the dimming disk 120 and change-over of the perforation voltage is ensured.

The operation of the apparatus illustrated in FIGS. 2 and 3 has been explained in detail in connection with FIGS. 4-11 but in order to permit comparison between the operation of the apparatus in which the electrical signal is influenced and the apparatus in which the optical signal is influenced a short review is given.

It is assumed that a grey-tone scale original as that symbolised by FIG. 4 is to be reproduced. The grey-tone value varies in the vertical direction of the original from a dark grey at the bottom to a light grey at the top. The original is mounted on the drum 2 in FIG. 2 and the stencil blank on the drum 6. By rotation of the drums the light-beam from the light source 1 scans the original helically and the reflected light is by means of the photocell 3 turned into an electrical signal. Assuming that the scanning is carried out line by line in the direction from the top to the bottom of the original in FIG. 4 then the light signal received by the photocell 3 will vary within any scanning line from a maximum to a minimum. When passing a certain threshold value the signal will trigger the high tension source and the electrode will receive a potential sufficiently high to result in the punching of holes in the stencil blank passing by the electrode. The threshold value will remain the same during any scanning line because the brush 18 remains in contact with one and the same commutator sector, say *a*, in FIG. 3. Before scanning of the next line takes place the brush 18 shifts from sector *a* to sector *b*, and consequently the amplifier and trigger 4a is adjusted to another threshold value so that triggering takes place at another value of the light signal whereby a result is obtained as that shown in FIGS. 10 or 11.

The operation of the apparatus shown in FIG. 12 is as to the scanning the same as that of the apparatus shown in FIG. 2. The light reflected from the original 103 passes through the tube 109 to the photocell 110 and is converted to an electrical signal controlling the application of the high tension to the electrode 113. Assuming again that the grey-tone scale in FIG. 4 is to be reproduced and is scanned from top to bottom, the triggering will take place when the reflected, increasing light signal passes a certain threshold value. There are now two ways of obtaining the effect aimed at. One is by hand and in this case the dimming disk 120 is removed or kept in a fixed position. By means of the handle 117 the dimming disk is turned a certain angle every time the bar 123 passes the optical system 108, 109, 110, so that say four different sectors are brought into the light ray one after the other. The choice of the four sectors depends on the quality of the original.

The result is, that the grey-value in the original, at which the triggering takes place varies from line to line within a range depending on the dimming values of the darkest and lightest sectors chosen.

The other way of obtaining grey-tone reproduction with the apparatus shown in FIG. 12 is to remove or to set the dimming disk 114 in a fixed position according to the quality of the original and use the disk 120 for variation. In this case the magnet 124 and coil 127 receive a pulse, when the bar 123 passes just before the scanning of a line commences. This pulse is amplified in the amplifier 125 and supplied through leads to the motor 122 which then turns the disk 90° thereby bringing another sector having

another dimming value than the retreating sector into the light ray and keeping it there through the following scanning of a line.

During the scanning of this line by the light from the lamp 132 passing through a sector of the dimming disk 105, the dimming disk 114, the lens 106, the mirror 107 and the lens 108 light is reflected from the original 103. Assuming again that the original is the grey-tone scale in FIG. 4 scanned from top to bottom the reflected light picked up by the tube 109 and photocell 110 will increase in strength and when passing a certain threshold value results in an electric pulse in leads 111 sufficiently large for triggering after amplification in the amplifier 112 the application of a high tension to the electrode 113 resulting in perforation of a row of holes of approximately constant size.

The operation described is repeated for each line, the dimming disk 114 being reset before the scanning.

If a changing of the high-tension on the electrode 113 from line to line is wanted this is obtained by means of the two commutators 128 and 129 with brushes 130 and 131 and leads 132 connected to the amplifier 125. An electric current through this system will vary with varying angular positions of the commutators owing to the prearranged difference in resistance and thus result in a signal which is used in the amplifier to switch over from one value of the high-tension to another.

As will be obvious to the man skilled in the art the dimming disk 120 need not be of the rotating type. The plate 133 in FIG. 15 has five different areas defined by the different size of the holes. It can be inserted into the light ray instead of the disk 120 and operated by a pushing mechanism (not shown), for instance a tripping delay which for each rotation of the original 103 pushes the plate one step in the longitudinal direction. When all steps have been passed the plate is retracted by a spring and the stepwise pushing begins over again.

I claim:

1. A method of producing a laminar printing forme, comprising the steps of so scanning an original along a succession of scanning lines as to generate electric signals representative of the grey-values along the lines, synchronously scanning a laminar forme blank with a perforating device, applying the electric signals to cause the perforating device to perforate the blank when the grey-value in the original exceeds a given value and, during scanning, varying in discrete steps the grey-value at which perforation takes place.

2. A method as claimed in claim 1, wherein the said variation in discrete steps occur in a cyclically repeated permutated sequence of steps differing from the natural sequence which corresponds to a rising scale of tone values.

3. A method as claimed in claim 1, wherein the stepwise variation involves a cyclically repeated sequence in which some steps occur more frequently than others.

4. A method as claimed in claim 1, wherein each discrete step is made near the times at which the leading end of the blank is in front of the scanning point.

5. A method as claimed in claim 1, wherein the voltage of the perforating device is increased in some of the steps.

6. A method as claimed in claim 1, wherein, during the production of the forme, a line screen is inserted between the original and the light with the lines situated substantially perpendicular to the scanning direction.

7. A method for producing a perforated electrostencil from a stencil blank and corresponding with a half-tone original, comprising the steps of scanning the original, deriving an electric signal from said scanning, using said electric signal for controlling the voltage on a stylus, imparting relative movement between said stylus and said stencil blank corresponding with said scanning, and varying the threshold separating the two ranges on the light intensity—stylus voltage—characteristic curve within

which perforation and no perforation respectively are made.

8. A method as claimed in claim 7, wherein the original is scanned helically.

9. A method for producing a perforated electrostencil from a stencil blank and corresponding with a half-tone original, comprising the steps of scanning the original by a light ray, deriving an electric signal which is a function of the tone value scanned, amplifying said signal, varying in a predetermined way the amplitude of said signal before amplification and using the amplified signal for controlling the perforation of the stencil blank.

10. A method for producing a perforated electrostencil from a stencil blank and corresponding with a half-tone original, comprising the steps of scanning helically by a light ray said original forming part of a cylindrical surface, deriving an electric signal which is a function of the tone-value scanned, amplifying such of said signal as exceeds a predetermined level, varying the said level stepwise in a predetermined way and using the amplified output signal for controlling the voltage on a stylus for perforating the stencil.

11. Apparatus for producing a laminar printing forme, comprising means for so scanning an original along a succession of scanning lines as, in operation, to generate electric signals representative of the grey-values along the lines, means adapted for synchronously scanning a laminar forme blank with a perforating device, means for applying the electric signals to cause the perforating device to perforate the blank when the grey-value in the original exceeds a given amount, and means adapted to vary in discrete steps, during scanning, the grey-value at which perforation takes place.

12. Apparatus for producing a laminar printing forme comprising a light source and photoelectric means for so scanning an original along a succession of scanning lines as, in operation, to generate electric signals representative of the grey-values along the lines, means adapted for synchronously scanning a laminar forme blank with a perforating stylus, means for applying a perforating voltage, which remains constant within each scanning line, to said perforating stylus, means for triggering by said electric signals the application of said perforating voltage when said electric signals pass a threshold and means for varying in discrete steps said electric signals during scanning.

13. Apparatus for producing a laminar printing forme comprising a light source and photoelectric means for so scanning an original along a succession of scanning lines as, in operation, to generate electric signals representative of the grey-values along the lines, means adapted for synchronously scanning a laminar forme blank with a perforating stylus, means for applying a perforating voltage, which remains constant within each scanning line, to said perforating stylus, means for triggering by said electric signals the application of said perforating voltage when said electric signals pass a threshold and means for varying in discrete steps said threshold during scanning.

14. Apparatus for producing a laminar printing forme comprising a light source and photoelectric means for so scanning an original along a succession of scanning lines as, in operation, to generate electric signals representative of the grey-values along the lines, means adapted for synchronously scanning a laminar forme blank with a perforating stylus, means for applying a perforating voltage, which remains constant within each scanning line, to said perforating stylus, means for triggering by said electric signals the application of said perforating voltage when said electric signals pass a threshold and means for varying in discrete steps the optical signal during scanning.

15. Apparatus as claimed in claim 14 wherein said means for varying said optical signal is a dimming disk.

16. Apparatus as claimed in claim 14 wherein said means for varying said optical signal is a dimming disk

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mounted rotatable and having different translucency within consecutive sectors which can one by one be brought into the path of said optical signal.

17. Apparatus as claimed in claim 14 wherein said means for varying said optical signal is a dimming member so arranged that the part of it which for a given adjustment is located in the path of rays, comprises a group of smaller areas which are pervious to light, and another group of areas which are less pervious to light, the two groups of areas being interdistributed.

18. Apparatus as claimed in claim 14 wherein said means for varying said optical signal is a dimming device of the screen type in which screen the screen value along the path which by adjustment of the dimming member is moved into the path of rays, as a function of the adjustment varies according to a predetermined, preferably logarithmic, function.

19. Apparatus for producing a laminar printing forme comprising a light source and photoelectric means for so scanning an original along a succession of scanning lines as, in operation, to generate electric signals representative of the grey-values along the lines, means adapted for synchronously scanning a laminar forme blank with a perforating stylus, means for applying a perforating voltage, which remains constant within each scanning line, to said perforating stylus, means for triggering by said electric signals the application of said perforating voltage when said electric signals pass a threshold and a pulse

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generator which supplies a pulse for each scanning line on the original to a change-over which controls a dimming member so that the dimming varies among a number of predetermined values in dependence on the pulses received by the change-over.

20. Apparatus for producing a laminar printing forme comprising a light source and photoelectric means for so scanning an original along a succession of scanning lines as, in operation, to generate signals representative of the variations in grey-value along the lines, means adapted for synchronously scanning a laminar forme blank with a perforating stylus, means for applying a perforating voltage, which remains constant within each scanning line, to said perforating stylus, means for triggering by said signals the application of said perforating voltage when said signals pass a threshold, means for altering in some of said discrete steps the perforating voltage from one value to another.

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