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Carley

[11] **3,800,699**

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[54] **FOUNTAIN SOLUTION IMAGE APPARATUS FOR ELECTRONIC LITHOGRAPHY**

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[21] Appl. No.: **337,124**

Related U.S. Application Data

[62] Division of Ser. No. 46,935, June 17, 1970, Pat. No. 3,741,118.

[52] **U.S. Cl.** **101/147,** 101/451, 346/140

[51] **Int. Cl.** **B41l 25/12,** B41l 25/06

[58] **Field of Search** 101/147, 132.5, 366, 451, 101/452; 346/140

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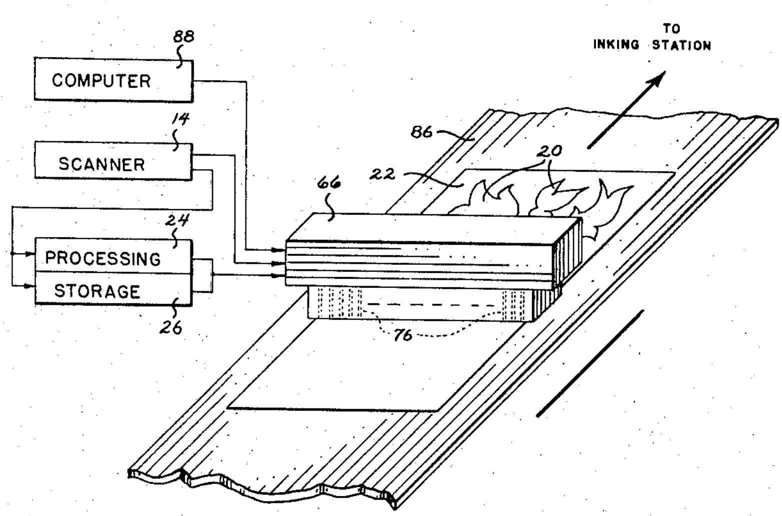
Primary Examiner—Clyde I. Coughenour
Attorney, Agent, or Firm—Chittick, Thompson & Pfund

[57] **ABSTRACT**

A method and apparatus for printing an image in scanned electronic form on an ink receiving surface using ordinary printer's ink. The method and apparatus employ quasi-lithographic techniques and equipment, but unlike conventional lithography, the method does not require the preparation, prior to the printing process, of a lithographic plate containing in permanent form the image to be printed. The scanned electronic image is used to form a fountain solution image on a lithographically blank plate by the selective deposition and/or removal of the fountain solution from the plate. Lithographic ink is applied to the fountain solution imaged plate and then transferred to an ink receiving surface, such as paper or an offset blanket. Thereafter, the lithographically blank plate is cleaned and ready for the formation of the same or a different fountain solution image.

1 Claim, 12 Drawing Figures



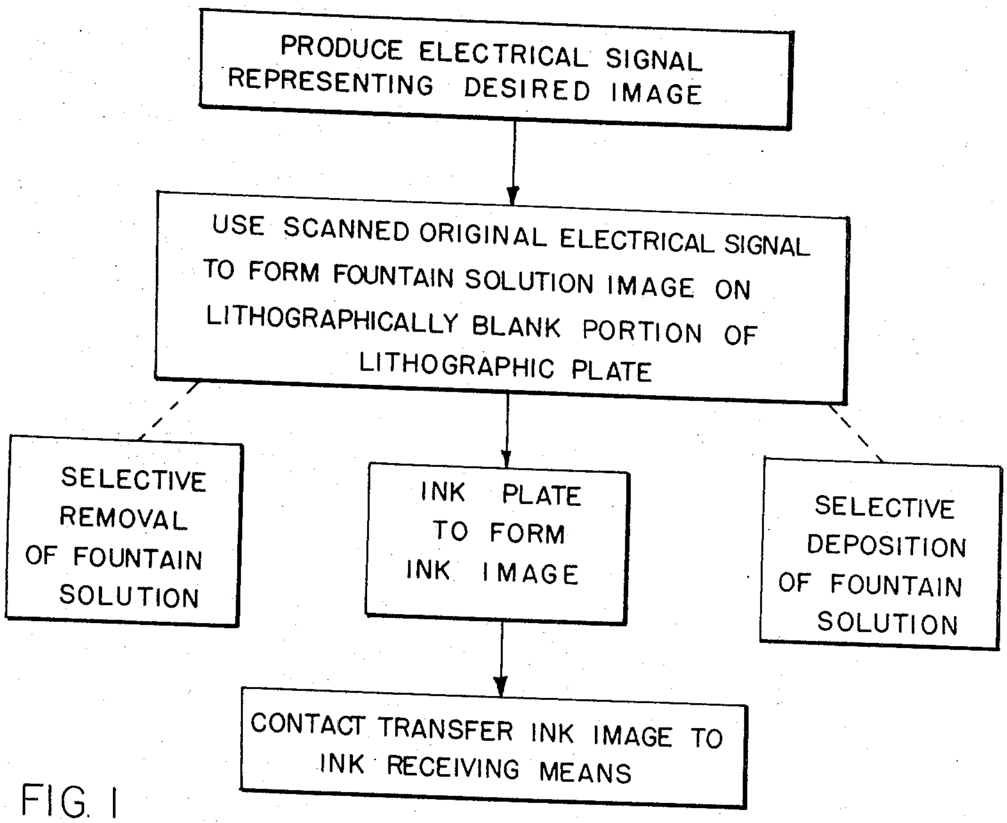

PRODUCE ELECTRICAL SIGNAL REPRESENTING DESIRED IMAGE
USE SCANNED ORIGINAL ELECTRICAL SIGNAL TO FORM FOUNTAIN SOLUTION IMAGE ON LITHOGRAPHICALLY BLANK PORTION OF LITHOGRAPHIC PLATE
SELECTIVE REMOVAL OF FOUNTAIN SOLUTION
INK PLATE TO FORM INK IMAGE
SELECTIVE DEPOSITION OF FOUNTAIN SOLUTION
CONTACT TRANSFER INK IMAGE TO INK RECEIVING MEANS

FIG. 1

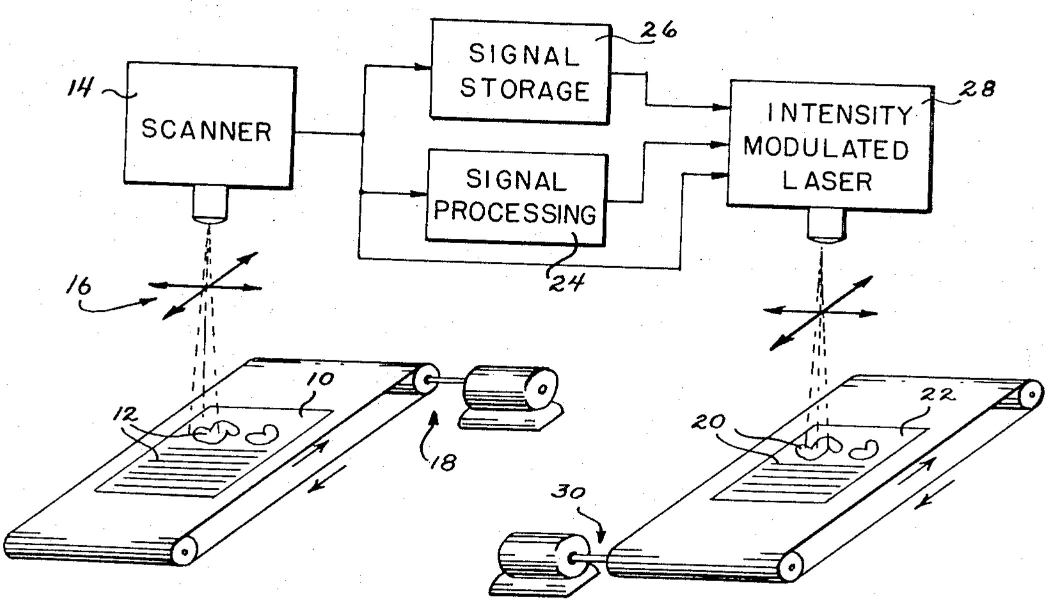

SCANNER
14
SIGNAL STORAGE
26
SIGNAL PROCESSING
24
INTENSITY MODULATED LASER
28
16
10
12
18
20
22
30

FIG. 2

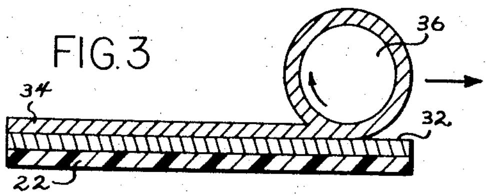


FIG. 3

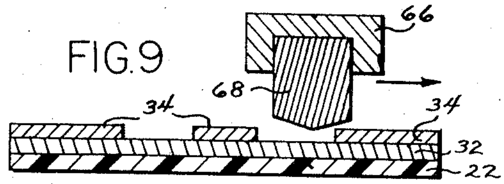


FIG. 9

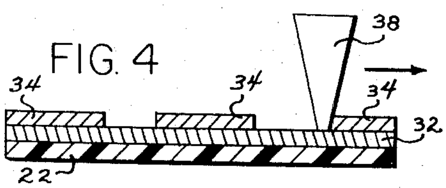


FIG. 4

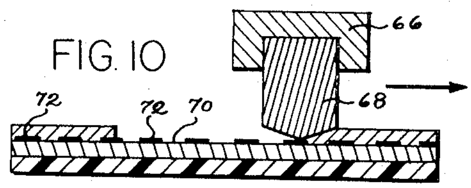


FIG. 10

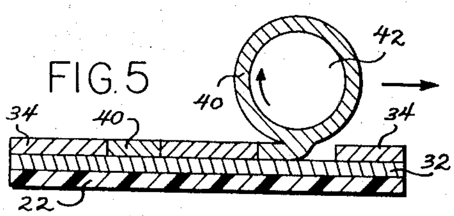


FIG. 5

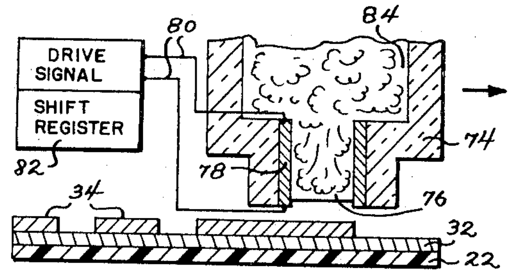


FIG. 11

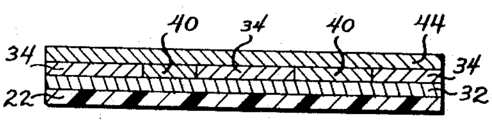


FIG. 6

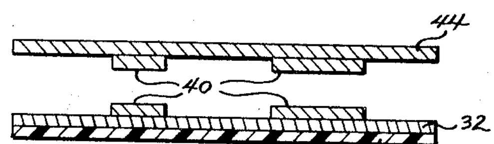


FIG. 7

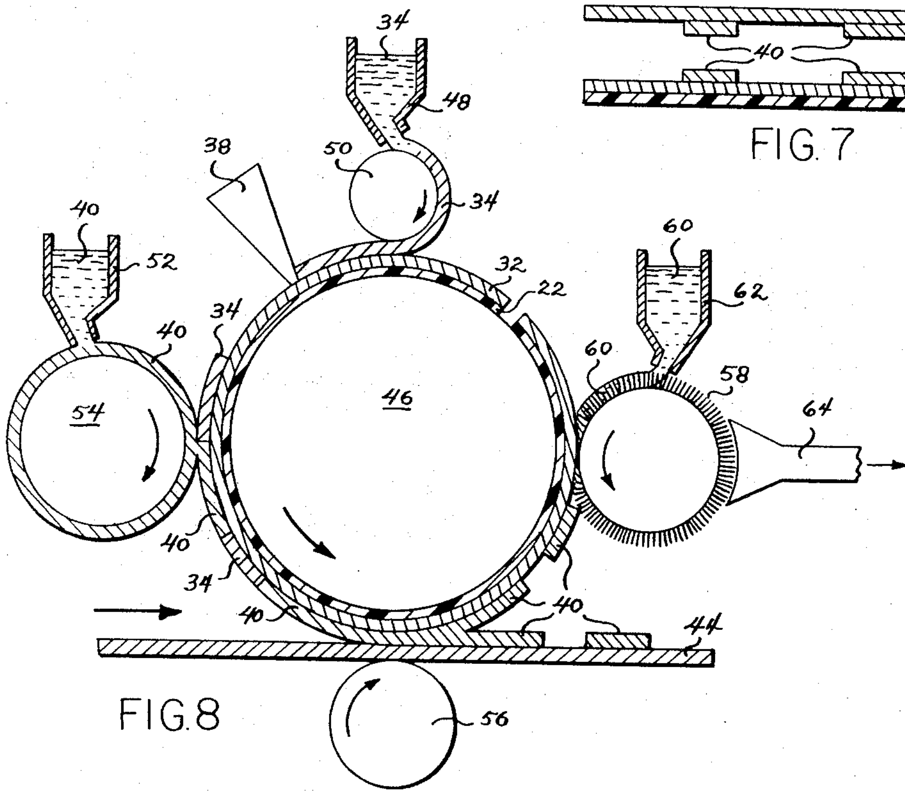


FIG. 8

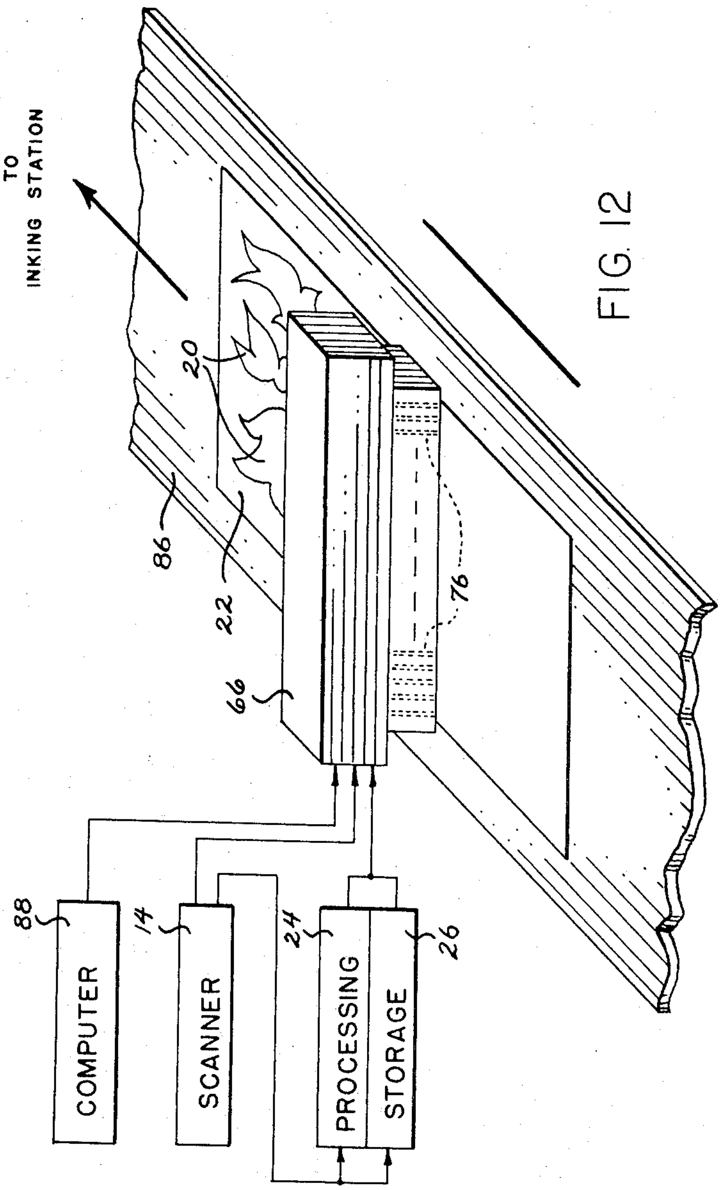

TO INKING STATION
20
22
86
66
76
88
COMPUTER
14
SCANNER
24
PROCESSING
STORAGE
26

FIG 12

FOUNTAIN SOLUTION IMAGE APPARATUS FOR ELECTRONIC LITHOGRAPHY

This is a division of application Ser. No. 46,935, filed June 17, 1970, now U.S. Pat. No. 3,741,118.

BACKGROUND OF THE INVENTION

The present invention relates to printing in general, and more particularly, to a method and apparatus for electronic printing.

The printing industry today utilizes a number of printing techniques, the major types of which include lithography, letterpress, and intaglio. Lithography is a technique which employs a plate on which the areas corresponding to the inked section of the image are hydrophobic, whereas the other areas are hydrophilic. Neither area is significantly raised or indented with respect to the other. An aqueous-based "fountain solution" is applied to the plate. The fountain solution adheres to the hydrophilic areas only. An oil-base ink is then applied to the plate. The ink is repelled by the fountain solution and adheres only to the hydrophobic areas of the plate. The lithographic plate is then brought into contact with paper on which the ink image is printed (direct Lithography) or with a resilient rubber blanket which in turn prints on paper (offset lithography).

The second technique, letterpress, utilizes a plate on which areas corresponding to the inked section of the image are raised. When ink is applied to the plate, the ink adheres to the raised portions only. When paper is brought into contact with the type (plate), the ink adheres to it in the pattern of the raised portion. This technique is currently used for printing many newspapers and magazines.

The third major type of printing, intaglio, employs a plate on which areas corresponding to the inked section of the image are indented. When ink is applied to the plate, the ink remains in the indented portions only. When paper is brought into contact with the plate, the ink is absorbed by it in the pattern of the indented portion.

The three major processes described above all require that a plate be prepared prior to the printing process which contains in some permanent form the image to be printed. In practice, such plates are used on presses, repeatedly, so as rapidly to produce many copies of the same original. However, it is not possible to introduce a new original without interrupting the printing process to change a plate. This is not only costly but time consuming.

Recent advances in technology have produced a number of other "printing" techniques. Of interest are the various electro-static processes including xerographic copying which uses techniques not involving a permanent plate, but instead creates a charged pattern on a photoconductor such as, zinc oxide or selenium to which a powdered ink selectively adheres. The photoconductor is either on an intermediary, e.g., drum, or the paper itself. In the latter case, a costly and undesirable special paper is involved. In both cases, the toner or electrostatic ink is much more expensive than printer's ink, and in the former case, a fragile, costly and gradually deteriorating photo conducting drum is required. In general, the quality is noticeably inferior to printing and for photographic work is unacceptable.

Photography or chemical imaging is a technique whose variations involve light-sensitive chemical reactions, heat-sensitive chemical reactions, possible intermediary images, developing reagents, chemical image transfers, etc. The disadvantages of photographic printing are that the per-print cost is high and the processes are generally slow and inconvenient. However, quality is quite high.

Other techniques include facsimile, thermal-wax transfer systems, rupturable ink containing globules, and a wax vaporization transfer process. The wax transfer process is illustrated in British Pat. Nos. 943,401, 943,402 and 943,403.

All of the systems described above have certain advantages and disadvantages. Generally speaking, when the reproduced image quality is high, the cost per-print is correspondingly high and the process may not have the desired speed. On the other hand, the speed can be increased and cost reduced with concomitant sacrifice in image quality.

It is accordingly, a general object of this present invention to provide a method and apparatus for printing an image at high speeds with high quality at a low cost.

It is a specific object of the invention to provide a method and apparatus for printing a visible image from an image in scanned electronic form.

It is another object of the invention to provide a method and apparatus for printing which utilizes a number of conventional lithographic printing techniques and lithographic equipment.

It is still another object of the invention to provide a method and apparatus for printing which employs a re-usable image receiving and transferring member.

It is a further object of the present invention to provide a re-usable image receiving and transferring member which can receive and transfer the same or different images.

BRIEF SUMMARY OF THE INVENTION

The present invention produces a copy which is similar to a lithographically printed copy and uses many of the component parts of a lithographic press, but eliminates the need for preparation prior to the printing process of a plate containing the image to be printed in permanent form. The image is supplied to the printing unit in scanned electronic form, i.e., a television signal. The signal can be generated either directly by electronic equipment such as a computer or video tape, or by a camera using electronic or mechanical scanning, with a without image storage and with a scanned or unscanned light source.

The scanned electronic signal is used to form a "fountain solution" image on a lithographically blank portion of a lithographic plate. The term "lithographically blank," refers to a lithographic plate which would print blank on an ordinary lithographic press. The entire surface of the lithographically blank portion of the plate is hydrophilic. A water or aqueous-based fountain solution image is formed on electronically selected areas of the lithographically blank portion of the plate. The fountain solution image corresponds to the desired image, but in complementary form. The formation of the fountain solution image is produced by the selective removal of the fountain solution from the lithographically blank portion of the lithographic plate or by the selective deposition of the fountain solution on the lithographically blank portion.

The fountain-solution-imaged-plate is then exposed to a lithographic ink which adheres only to the dry areas of the plate. The ink forms an ink image which is a complement of the fountain solution image. The inked plate image is then brought into contact with an ink receiving means such as, for example, paper, tinfoil, or an intermediary offset blanket. The excess ink subsequently cleaned from the plate (and blanket, if used) by a cleaning mechanism leaving the plate completely blank and dry.

Since no permanent lithographic image was formed on the plate, the lithographically blank portions of the plate can be re-imaged with a fountain solution and the process repeated as often as desired. The re-imaging of the lithographic plate can be used to produce multiple copies of a single original or copies of different originals or electronically created images.

The objects and features of the present invention will best be understood from a detailed description of the preferred embodiments thereof, selected for purposes of illustration, and shown in the accompanying drawings in which:

FIG. 1 is a block flow diagram illustrating the steps of the printing process after conversion of the original into a scanned electronic signal;

FIG. 2 is a diagrammatic view and partial schematic showing a representative scanning and imaging system;

FIG. 3 is a sectional side view illustrating the application of a fountain solution to the hydrophilic surface of the lithographically blank plate;

FIG. 4 is a sectional side view illustrating the selective removal of the fountain solution by vaporization produced by an intensity modulated laser beam;

FIG. 5 is a sectional view depicting the application of ink to the areas where the fountain solution has been selectively removed;

FIG. 6 is a sectional side view showing an ink receiving means, such as paper, in contact with the wetted and inked surface of the lithographic plate;

FIG. 7 is a sectional side view similar to FIG. 6 showing the ink image on the ink receiving means after removal of the means from contact with the lithographic plate;

FIG. 8 is a diagrammatic and sectional side view of a modified lithographic press which simultaneously and repeatedly performs the functions illustrated in FIGS. 3–7;

FIG. 9 is a sectional side view of an alternative embodiment providing for the selective removal of the fountain solution by means of an electrode;

FIG. 10 is a view similar to the view shown in FIG. 9 showing the lithographic plate having a special surface in the form of a checkerboard anodic coating;

FIG. 11 is a sectional side view illustrating the selective deposition of the fountain solution on the lithographically blank portion of the lithographic plate; and,

FIG. 12 is a view in partial block and diagrammatic form depicting the printing head which is used to selectively deposit the fountain solution on the lithographic plate.

Turning now to the drawings, and particularly to FIG. 1 thereof, there is shown in block form a flow chart illustrating the steps of the electronic lithographic process of the present invention. It has already been mentioned that the image to be printed is supplied in scanned electronic form to the printing unit, described below in detail.

In general, the parameters of the scanned electronic signal, such as frame-rate, number of lines, etc., differ markedly from a standard television signal and the signal is non-interlaced. The source of television signal does not comprise part of the invention. The signal can be generated in a number of ways, either directly by electronic equipment, such as a computer, or from video-tape or by a camera using electronic or mechanical scanning, with or without image storage, i.e., integration, and with a scanned or unscanned light source. The color or black and white camera can be an integral part of the printing unit or separate from it. Conventional camera technology and electronic signal generation and processing is employed and need not be described in detail. It is sufficient to note that some of the currently available camera techniques which can be employed to produce the scanned electronic signal include: image orithicon, videcon, flying-spot scanner, rotating mirrors, rotating prism, scanned laser light source and dichroic mirror color separation. The "television" or signal parameters are selected for the speed, aspect ratio and resolution desired. Compared to standard 525 line television signals, representative values for printing three 8 ½ × 11 inch copies per second at 150-screen resolution are: frame rate, one tenth; resolved elements, ten times; and bandwidth, the same.

In the case of color printing, the colors in the original are separated and matrixed electronically and, if desired, delayed, to produce separate television signals for each color ink used in the printing process. In addition, non-linearities in the printing process may require gray-scale (gamma) correction in the television signal before it is fed to the printing unit.

The scanned electronic image signal generated by any of the means described above is used to form a fountain solution image on a lithographic plate having at least a portion thereof which is lithographically blank. A lithographically "blank" plate is a plate which will print blank pages on an ordinary lithographic press. The lithographically blank portion of the plate has a surface which is entirely hydrophilic. A fountain solution is made to adhere to electronically selected areas of the lithographically blank lithographic plate in response to the scanned electrical signal representing the desired image. As will be described in greater detail below, the formation of the fountain solution image is done by either depositing the fountain solution on selected areas of the lithographically blank portion or by first coating the entire plate with the fountain solution and then selectively removing some of the fountain solution.

The term "fountain solution" refers to a liquid usually comprising water, which renders a plate surface non-receptive to ink. The terms "oil based ink," "hydrophilic plate," and "aqueous solution" should be considered special cases of the functional terms "lithographic ink," "lithographically blank plate," and "fountain solution." In present lithographic practice, the fountain solution comprises water plus various additives, notably alcohol. The selective deposition or removal of the fountain solution is obtained in the present invention by selective condensation or vaporization. Therefore, only the volatile components (including water) of the fountain solution will be imaged. The fountain solution additives do not, per se, form a part of the invention and it should be emphasized that pure water or even salt water will work in the lithographic process.

The now fountain-solution-imaged lithographic plate is contacted with a lithographic (e.g., oil-based) ink which adheres only to the dry areas of the plate. The lithographic ink forms an ink image on the plate which is the complement of the fountain solution image. The application of the lithographic ink to the lithographic plate is done by using conventional lithographic techniques and equipment. The inked lithographic plate is then brought into contact with an ink receiving means, such as paper or a lithographic blanket. The ink is then transferred by contact onto the paper either directly of via an intermediary blanket, onto which the ink image is printed.

After cleaning, the lithographic plate is ready for another fountain solution imaging process. It will be appreciated at this point in the description of the invention that the lithographically blank portion of the lithographic plate permits the repeated formation of fountain solution images on the plate. The fountain solution images can be the same or different depending upon the type of printing desired. If multiple copies of a single image are desired, the same fountain solution image will be formed on the lithographic plate. On the other hand, if copies of different images are required, then the fountain solution image will be different for each different image.

The term "plate" as used herein should be construed broadly to include planar as well as curved plates which can be either rigid or resilient. In the case of offset lithography, the plate preferably should be curved and rigid to facilitate use in conventional lithographic presses. However, for direct lithography, a resilient plate is preferred. Turing now to FIG. 2, there is shown in diagrammatic and partial block diagram form a representative system for obtaining the scanned electronic signal and using the signal to form a fountain solution image on a lithographically blank lithographic plate. An original 10 containing image information 12 is black-and-white, color, gray-scale, and/or continuous tone is positioned for scanning beneath a scanner 14. The scanning operation can be fully optical with no movement of the original as indicated by the crossed arrows 16, or the original can be moved past the scanner by means of a transport system 18 to provide vertical scanning. The scanner 14 produces an electronic signal representing the image information 12 on the original. This electronic signal can be used directly to control the formation of a fountain solution image 20 on a lithographically blank plate 22 or the electronic signal can be processed to manipulate the image or stored for subsequent usage. Manipulations include transmission, storage, collating, masking, mixing, negative, contrast enhancement, color correction, and other specialized alterations such as sequence numbering of printed forms. The manipulations of the electronic signal are performed by conventional and well-known signal processing circuits or computer indicated by the reference numeral 24. The storage of the electronic signal can be on tape, discs, and other conventional signal storing means, all of which are indicated generally by the reference numeral 26.

Given the scanned or otherwise generated electronic signal representing the imaged original 10, in one embodiment of the invention, the electronic signal is used to modulate the beam of light emitted by a laser 28. The laser beam impinges upon the lithographically blank lithographic plate 22 which has been previously coated with a thin layer of a fountain solution. As the laser beam scans across the fountain solution coated plate, the fountain solution is vaporized from the plate to form the desired fountain solution image. Horizontal scanning of the laser beam can be provided by a number of conventional means including rapidly rotating optics (not shown) which moves the laser beam across the plate. The corresponding vertical scanning can also be accomplished opto-mechanically, but the preferred method is to use the mechanical motion provided by a suitable transport system indicated generally in FIG. 2 by the reference numeral 30. In practice, the mechanical motion of the lithographic plate on the lithographic press can be used to provide the requisite vertical scanning of the plate.

The scanned television signal modulates the laser beam by modulating the intensity of the beam, the size of the light spot at the plate or by varying the scan velocity of the beam. The energy in the light spot is absorbed by the plate's surface which is colored to absorb the laser light. The plate surface then supplies heat-of-vaporization to the fountain solution which is in thermal contact with it.

The scanned electronic signal produces a laser beam intensity or spot size corresponding to the amount of ink desired at that point in the image. With the laser "full on" all of the fountain solution will be evaporated and a maximum amount of ink will be deposited on the plate. The corresponding spot on the ink receiving means, e.g., paper, will be "black", i.e., inked. With the laser "full off" the corresponding spot on the paper is left white because none of the fountain solution was evaporated. A whole range of half-tones can be achieved by in between modulation of the laser. For additional fidelity, size modulated half-tone dots can be formed in the horizontal dimension by means of a mode-locked laser or other optical means. The image is differentiated in the vertical dimension by the scanning lines.

The operation of the laser embodiment of the present invention can best be understood by referring to the sequential steps illustrated in FIGS. 3–7. The lithographically blank plate 22 whose top surface 32 is everywhere hydrophilic is coated with a fountain solution 34 by means of a dampener roller 36. The modulated laser beam laser 28 is depicted diagrammatically in FIG. 4 and identified by the reference numeral 38. The beam selectively evaporates the fountain solution 34 in the form of the desired image. After formation of the fountain solution image by selective vaporization, the fountain solution-imaged lithographic plate is coated with a lithographic ink 40 by means of an ink form roller 42. The ink adheres only to those areas where the fountain solution has been removed as shown in FIG. 5.

FIG. 6 depicts an ink receiving means 44, such as a sheet of paper or an offset blanket, in contact with the ink 40 and fountain solution 34. FIG. 5 illustrates the paper or blanket 44 after it has been removed from contact with the inked lithographic plate. The ink 40 adheres to the ink receiving means 44 in the form of the desired image. Some ink remains behind on the lithographic plate while the fountain solution evaporates or is absorbed by the paper.

FIG. 8 illustrates how the complete electronic lithographic process can be performed on a repeating basis. The lithographic plate **22** is mounted on a conventional plate cylinder **46.** The fountain solution **34** is applied to the plate surface **32** in the manner of existing lithographic presses. This is represented in a simplified form in FIG. 8 by a fountain solution reservoir **48** which feeds the fountain solution **34** onto a roller **50** which in turn applied the fountain solution to the hydrophilic surface **32** of the lithographic plate **22.**

The modulated laser beam **38** selectively removes the fountain solution **34** to form the desired image. The lithographic ink **40** passes from an ink reservoir **52** onto an ink application form roller **54,** again, illustrated in simplified form, and then onto the areas of the plate surfaces **32** where the fountain solution was removed by the laser beam. The ink receiving means **44,** such as paper, is pressed against the lithographic plate by means of an impression cylinder **56.** Some of the ink adheres to the paper, and the fountain solution evaporates. The remainder of the ink is cleaned off the plate surface **32** by means of a suitable cleaning system, one such system, shown in simplified form comprises one or more rotary cleaning brushes **58.** A suitable cleaning solvent **60** passes from reservoir **62** onto the cleaning brushes **58** to facilitate ink removal. The cleaning solvent **60** and ink **40** are both removed from the brushes by a solvent recirculation system **64.**

The preceding description has referred to the use of a laser beam to selectively evaporate the fountain solution from the desired areas on the lithographically blank lithographic plate. It will be appreciated while UV, visible or IR light can be used to vaporize the fountain solution, visible light is preferred.

The process described in connection with FIG. 8 illustrates the use of the present invention in direct lithography. In offset lithography, a blanket cylinder (not shown) is positioned between the plate cylinder **46** and the impression cylinder **56** with the ink receiving means **44** passing between the impression cylinder and the blanket. A cleaning system (not shown) is used to clean the blanket.

The selective removal of the fountain solution to form a fountain solution image on the lithographically blank lithographic plate can be accomplished in a variety of ways. FIG. 9 depicts an alternative method for selective removal of the fountain solution. Again, a layer of fountain solution is first applied to the lithographic plate and then selectively removed. In this case, a "head" **66** is used to remove the fountain solution. The "head" **66** rides hydroynamically/aerodynamically on the surface of the fountain solution not touching the plate itself. The head **66** contains a plurality of electrodes **68**; one of which is shown in FIG. 9. A separate electrode **68** is employed for each resolution element across the horizontal dimension of the image.

The surface of the lithographic plate is made of conducting material such as grained aluminum. An iterated circuit, such as a shift register (not shown) applies the scanned electronic signal to the electrodes and performs the horizontal de-scanning function. The fountain solution is selectively vaporized by the ohmic heating produced by electrical current flow through the solution. The intensity of the current is varied according to the amount of fountain solution to be removed, i.e., the amount of ink required at each point.

A similar system is illustrated in FIG. **10** except that for the surface **32** of the lithographic plate **22** is no longer made entirely of a conducting material. Instead, it comprises an alternating pattern of conducting and non-conducting material, **70** and **72** respectively, arranged in "checkerboard" fashion. The side of one "square" on the "checkerboard" is less than one resolution element. Such a surface can be prepared as follows. A standard "checkerboard" printing screen (photographic negative) is photographically reduced to the appropriate size. Using the resulting reduced screen, photo-resist is applied to an aluminum plate in the reduced "checkerboard" pattern. The plate is then anodized; the photo-resist will insure that only the area not covered by the photo-resist will be anodized. The photo-resist is then removed with acetone. The resulting plate is selectively anodized in a fine checkerboard pattern. The anodic coating is not only an electrical insulator, but furthermore, it is also raised above the aluminum itself. The head **66** moves over the plate selectively evaporating the fountain solution by passing current through the solution as described above. However, in this case, the head **66** rides directly on the raised squares **72** of the anodic coating, rather than hydrodynamically/aerodynamically on the fountain solution itself.

Another variation in the geometry of the electrodes and lithographic plate be accomplished by placing the electrodes in electrical contact as well as physical contact with the plate. The surface of the plate comprises an electrically resistive, lithographic substance coated on a grounded conductor. The necessary heat in generated in the surface of the plate as the current passes into it. The fountain solution is in turn heated selectively by thermal conduction from the underlying plate. Unlike the examples discussed in connection with FIGS. **9** and **10,** no current is conducted by the fountain solution itself. In all these configurations, the current can be applied in short pulses to create vertical half-tone dots, while the horizontal dots are created by the discrete nature of the electrodes.

Turning now to FIG. **11,** there is shown a steam-water head version of the present invention. The selective deposition of a fountain solution on the lithographically blank lithographic plate can be accomplished by converting the fountain solution into steam and then condensing the steam on the selected areas of the lithographic plate. Alternatively, water can be directly applied to the selected areas. Looking at FIG. **12,** the lithographic plate **22** starts out dry and a long narrow head **66** applies water to it in the form of the desired fountain solution image. The head **66** comprises an electrical and thermal insulator **74,** such as glass, containing a row of tiny capillaries or passageways **76,** one of which is shown in FIG. **11.** There is capillary or passageway **76** for each horizontal resolution element. Preferably, the thickness of the insulator substantially is the same as the depth of the capillaries **66** and many times the capillary diameter. For purposes of illustration and clarity the respective dimensions of the capillary diameter and the thickness of the insulator have not been drawn to scale in FIG. **11.** The inside of each capillary **76** is plated with a thin-film resistive material **78,** such as metal. By means of tiny wires **80,** each capillary's plating is connected to an iterated electronic circuit, such as a shift register **82**. The shift register passes current through the lining of the capillaries and performs the horizontal de-scanning function. The vertical scanning function is provided by the mechanical motion of the plate on the press. Here, as before, the terms "horizontal" and "vertical" refer to television terminology and not necessarily to the actual orientation of the image.

On one side of the head **66** is a sealed vessel **84** containing saturated steam and water at a fixed pressure above atmospheric. The steam escapes through the capillaries and condenses on the lithographic plate to form the fountain solution image. The steam is replenished by a servo-mechanism (not shown) which applies heat to the water in the vessel. The steam discharging end of each capillary is positioned very close to, but not necessarily touching, the rapidly moving lithographic plate. Before encountering the head **66**, the dry lithographic plate is at a known temperature below 100° C.

A current passing through each capillary lining **78** generates heat according to the scanned television signal, as sampled for that capillary. The heat is carried away by the high velocity steam, increasing its temperature. Two effects cause the amount of steam hitting the plate to be less the hotter the steam temperature. First the steam's viscosity increases with temperature causing the volume passing through the capillary to decrease. Second, the steam expands causing the mass for a given volume to decrease. The combined effect is, very roughly, a T^{-2} temperature dependence. By this mechanism, the amount of steam condensing on the "black" image areas is substantially less than on "white" image areas. The temperature of the lithographic plate is selected to just barely re-evaporate all the water from the purest black areas, leaving varying amounts in other areas. This re-evaporation takes place between the steam head and the ink form roller (not shown in FIG. **11**). A third effect at this point, augments the viscosity and gas-law effects: in the darker areas the hottor steam releases more heat on condensing and thereby promotes the re-evaporation in those areas.

Instead of using steam, cold water can be passed through the capillaries **76** and be selectively heated by the electric current passing through the capillary lining **78**. Hotter water, having a markedly lower viscosity will flow more freely than the cold water. The viscosity of the water is 1.79 at freezing; 1.00 at room temperature, and 0.28 at boiling (centipoise) with a continuous range in between. The density change is slight. Flow in a capillary is inverse to viscosity giving a flow range of 6.2 to 1, which is roughly the same as obtainable for the previously described steam system. The water is applied to the plate either by spraying it on, vaporizing it and spraying it on, or "wiping" it on. The capillary employed is much, e.g., tenfold, smaller than for the steam situation.

Another variation for the head configuration shown in FIG. **11** is to pass hot water through the capillary **76** and selectively vaporize the water by heat. The steam will constrict the flow because of its radically lower density, in spite of its lower viscosity. The term "hot" refers to water temperature near 100°C. The steam produced is also near 100°C. The viscosity of the water at 100°C is 0.2828cp, for steam 0.125, a ratio of 22 to 1 favoring steam by volume. However, the densities (at 100°C) favor water by 1600 to 1, or a net of 70 to 1 more flow for water. The advantages of utilizing the hot water system for selectively forming the fountain solution image include: constant temperature, no signal heat loss, no thermal time delay in the capillary, much less signal heat required, excellent extinction ratio (70 to 1) and no need for "re-evaporation" from the plate.

Referring now to FIG. **12**, there is shown in diagrammatic and partial block form the previously described printing head **66** and the major associated electronic circuitry. For purposes of illustration, the printing head **66** is shown in FIG. **12** with capillaries **76**. However, it should be understood that the electrode version of the head described in connection with FIGS. **9** and **10** can be substituted, in which case a dampener system is used.

Printing head **66** is positioned over a plate transport system, indicated representationally by a moving web **86**. The lithographically blank lithographic plate **22** is carried by the web **86** beneath the printing head thereby providing vertical scanning of the image. Horizontal scanning of the image is obtained by sequentially energizing the capillaires **76** (or electrodes) in response to the scanned electronic signal representing the desired image.

It will be appreciated that the present invention permits the formation of the fountain solution image **20**, either by selective removal or deposition of the fountain solution, directly from an electrical representation of the fountain solution image without any intermediary image means. This situation is illustrated in FIG. **12** by the direct connection of a computer **88** to the printing head **66**. Of course, it is also possible to work from an original image by converting the original image into a scanned electronic signal by means of a suitable scanner **14**, as previously described. Again, no intermediary image is required between the television signal and the fountain solution image.

After formation of the fountain solution image **20** by selective deposition or removal, the fountain solution imaged lithographic plate passes to an inking station as indicated by the arrow in FIG. **12**. In practice, it is desirable to structure printing and inking stations to conform to conventional lithographic equipment. Therefor, looking back at FIG. **8**, the printing head **66** is positioned at and substituted for the laser beam **38**. With this configuration, multiple copies of the same image (either an original image or an electronic, e.g., computer generated image) can be produced rapidly and inexpensively. Single copies also can be produced from different images, either originals or electronically generated. Furthermore, with multiple printing heads and inking stations, multiple colors, including black, can be printed on the same ink receiving means.

The present invention lends itself to repetitive printing jobs in which one or more informational elements are changed in each print. For instance, "form letters" have the same body material but different addresses. The "body" of the letter preferably is permanently formed on a lithographic plate in the conventional manner. However, the addressee portion of the plate is lithographically blank so that a separate and different fountain solution image can be formed for each addressee. It is also possible, but not as desirable, to form the entire letter including the body and addressee each time by the selective fountain solution deposition or removal techniques of the present invention.

Having described in detail a number of embodiments of the invention, it will be appreciated that various modifications can be employed to achieve the desired selective deposition and/or removal of the fountain solution form the lithographically blank portion of the lithographic plate. For example, intense non-laser light can be used to vaporize the fountain solution in response to an electronic signal representing the desired image.

Other modifications can also be used, such as various types of fountain solutions, including non-aqueous solutions which can be selectively deposited or removed from a lithographically blank lithographic plate.

What I claim and desire to secure by Letters Patent of the United States is:

1. Apparatus for applying a fountain solution image

to a lithographic plate comprising:

1. a printing head comprising:
   a. means containing a vaporized or liquid fountain solution,
   b. a plurality of spaced fountain solution dispensing passageways fluidly coupled to said fountain solution containing means,
   c. selectively energizable electrical means in each passageway for supplying heat to the fountain solution passing through selected dispensing passageways
2. means positioning a lithographic plate in predetermined spaced relation with respect to the dispensing passageways of said printing head; and,
3. means producing relative movement between said lithographic plate and said printing head.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,800,699 Dated April 2, 1974

Inventor(s) Adam Loran Carley

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 52, "a" should be -- or --;

Column 5, line 17, "of" should be -- or --;

Column 5, line 44, "is" should be -- in --;

Column 7, line 18, "surfaces" should be -- surface --;

Column 8, line 35, "in" first occurance, should be -- is --;

Signed and sealed this 24th day of September 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

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