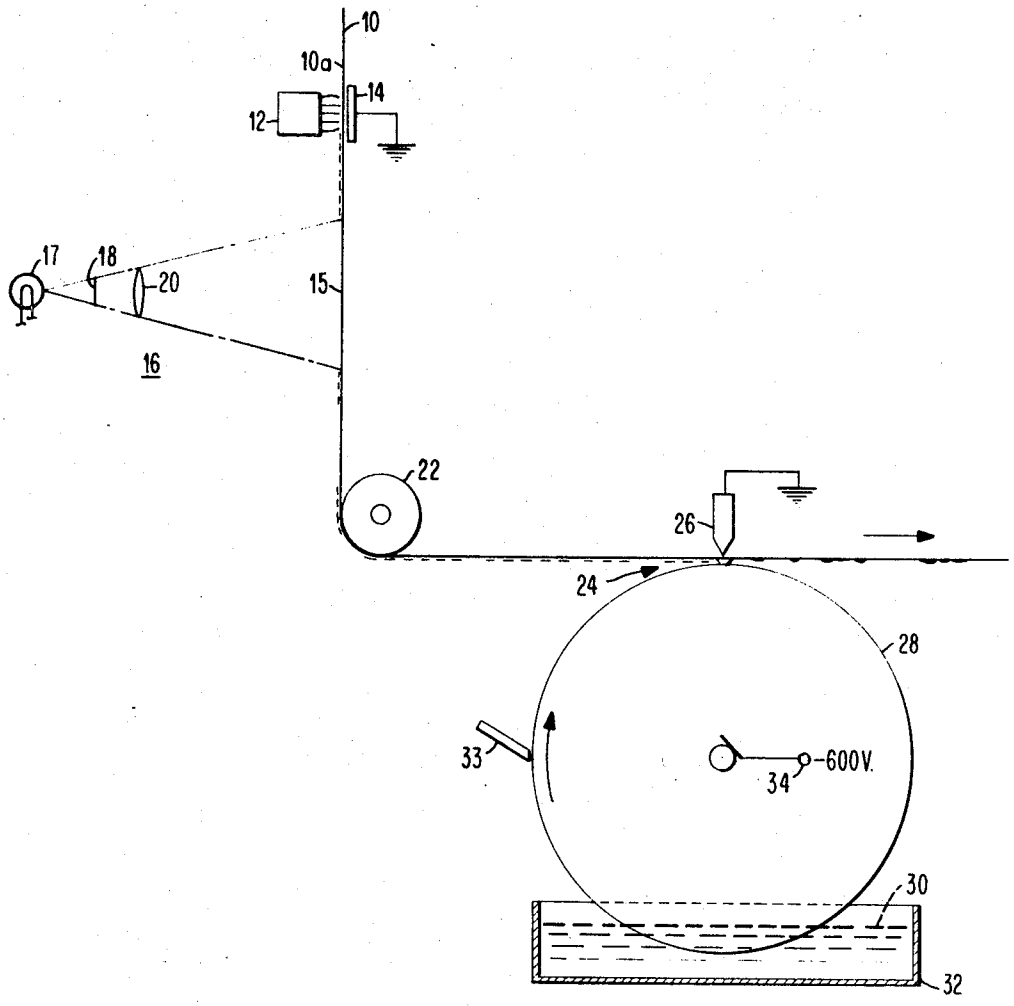
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PRINTING BY ELECTRICAL ATTRACTION OF INKS

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PRINTING BY ELECTRICAL ATTRACTION OF INKS

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ABSTRACT OF THE DISCLOSURE

Printing is effected by first placing an electric charge over the coated surface of a zinc oxide coated web of paper. This charge is neutralized in selected image areas by a projected light image. The web is then passed between a ground electrode and a smooth ink bearing conductive drum charged to a potential on the order of that of the unneutralized portions. Liquid ink from the drum is bodily attracted from the drum to the neutralized image areas in an unsupported column.

Generally stated, it is an object of this invention to provide for an improved method of attraction for liquid ink printing.

More specifically it is an object of this invention to provide for using electrical attraction for attracting a liquid ink to the surface of a coated web.

Another object of the invention is to provide for placing an electrostatic charge on the coated surface of a web, neutralizing the charge in an image area, and then utilizing a relatively high voltage to provide a potential difference between the image area and an ink-bearing drum sufficient for attracting a liquid ink bodily to the neutralized area.

Yet another object of this invention is to provide for using a water soluble acid or basic dyestuff as a self-fixing ink in an electrical printing process.

Still another object of the invention is to provide for using a photo-sensitive material coated paper as a base in a printing process and for electrically attracting a liquid ink to the coated surface of the paper in predetermined pattern areas.

It is also an object of the invention to provide for placing an electric charge on the zinc oxide coated surface of a web, removing the charge from an image area of the coating and using an electrical potential for attracting a liquid water soluble dyestuff ink to the image area.

Another important object of the invention is to provide for placing negative electric charge on the zinc oxide coated surface of a paper web, neutralizing the charge in discrete image areas by exposing such areas to selected light images, and attracting a self-fixing water soluble acid or basic dyestuff ink to the neutralized areas from a negatively charged ink drum.

Yet another important object of this invention is to provide in printing processes for establishing an image area on the surface of a coated web having a different surface charge than the surrounding area, and using an ink drum connected to a source of potential of a value sufficient to establish a field for raising an unsupported column of liquid ink to the surface of the web in the shape of the image.

Another important object of the invention is to provide for using in a printing process water soluble ink solutions which are attracted to the coated surface of a web by an electrical image field.

In accordance with a preferred embodiment of the invention, electrostatic charge is placed on the coated surface of a zinc oxide coated web of paper. The charge is

neutralized in selected image areas by projecting an image thereon by means of a beam of light passing through an image-bearing mask. The web is thereupon passed between a ground electrode and an ink-bearing drum charged to a potential on the order of the remaining surface charge. The liquid ink is attracted bodily across the gap between the drum and web in the image neutralized areas to provide well-defined character images with extremely low background effect.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawing.

In the drawing:

The single figure is a schematic diagram of apparatus for printing on a coated web according to a preferred embodiment of the invention.

Referring to the drawing, the reference numeral **10** denotes generally a web of coated paper having for example a zinc oxide coating **10***a* on one side. The web **10** is passed between a 3-wire corona unit **12** positioned on the coated front side of the web in conjunction with a ground plate **14** on the back side of the web for placing an electrical charge on the coated surface **10***a*. The web **10** is then passed through the projection area **15** of a projection system **16** comprising a lamp **17**, an image-bearing mask **18** and a lens **20** for projecting onto the coated and changed surface of the web the image or images of characters which are to be printed on the web. This neutralizes the charge on the coated surface in the image area. The web **10** is then passed around a roller **22** and through an air gap **24** between a ground electrode **26** and ink-bearing drum **28** which dips into an ink supply **30** contained in a tray **32**. A doctor blade **33** is spaced from the drum to establish the desired ink film thickness as the drum rotates. The drum **28** is conductive and is connected to a source of potential at terminal **34** so as to provide an electric field in the air gap **24** corresponding to the character image of the particular neutralized area on the web **10**. This field provides for raising the ink bodily from the surface of the drum **28** in an unsupported column having the shape of the neutralized image area to form ink images on the coated surface of the web **10** corresponding to the neutralized image areas. Ink rupture results from the tensile forces set up as the ink drum and paper diverge.

In practice, a web of zinc oxide coated electrophotographic paper **10** (Bruning No. 32–1555—Premium Copy) has been used with a standard 3-wire corona unit having three 3-mil wires spaced approximately one-fourth of an inch from the web and charged to a potential on the order of −5,000 volts. The lamp **17** comprised a type 1531A General Radio Stroboscopic Flash Unit. The ground electrode **26** had a 60 degree included angle with a 10-mil flat surface at the apex, and with an ink film on the order of .0015 inch thick the air gap **24** was on the order of .0032 inch. With −600 volts applied to the ink drum **28** of stainless steel, paper speed was six inches per second. The air gap through which the liquid ink jumps may be as high as .0032 inch. By varying experimental conditions printing speeds up to 60 inches per second were obtainable.

Using a zinc oxide coated paper, either acid or basic dyestuffs provides an excellent ink in a water solution. Examples are:

Dye	Color index	Name
Acid green	25	Alizarine Light Green GSN (Sandoz).
Acid blue	(1)	Lanasyn Brilliant Blue GL (Sandoz).
Basic blue	9	Methylene Blue Lot 24 (Du Pont).
Basic violet	3	Crystal Violet extra pure lot 182 (Du Pont)

[1] Similar to C. I. Acid Blue 127.

A 1% solution of any of the above in water provides, because of the amphoteric nature of the zinc oxide, a self-fixing action without the use of resin binders.

Most of the copying has been accomplished with a zinc oxide coated paper using negatives as the projection medium. However, positives can be used for copying, merely by electrically grounding the ink drum or by putting a potential on the drum opposite to that on the paper.

In line with the use of coated papers, an electrostatic charge image can be written on dielectric materials or paper coated with a dielectric material, thus rendering the process useful for straight output printing. Images in general would no longer be produced by way of a projected image but would be produced by means of conductive rubber rollers containing raised characters for printing standard forms, or matrix type of write-heads applying electric pulses for printing variable information.

By using a non-absorbent photo-conductor such as selenium, or a zinc cadmium sulfide coating, the deposited ink could then be transferred from the web to ordinary paper. This essentially is an off-set technique which permits the use of ordinary paper and the re-use of the conductor web.

Instead of using an acid or basic dyestuff and a water solution as the ink, carbon black ink has been used which is essentially a colloidal suspension of 35% by weight of carbon black of a particle size 28 mu in water of which 61 grams were diluted to 1000 millimeters with demineralized water. While this ink is satisfactory on ordinary paper, on coated paper it tends to smear when used by itself since there is little or no soaking of the ink into the paper. The addition of a resin binder such as polyvinyl alcohol can be added to remedy this situation. Approximately .25% of Du Pont "Evanol" 51–05 would be satisfactory. Nonpolar liquids such as toluene or nitrile silicone could be used, but they do not jump the gap as rapidly as the water based solutions. Also their response times are affected somewhat by relative humidity unless polarizing particles such as colloids are used.

From the above description and the accompanying drawing, it will be seen that water soluble inks utilizing acid or basic dyestuffs may be readily attracted electrically to a selectivity charged coated web for providing clearly defined printed character images. The use of a resin binder is avoided when zinc oxide coated paper is used with these dyes as they tenaciously cling to the paper due presumably to the amphoteric nature of the zinc oxide, and produce image fixation without the use of resin binders.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A method of printing comprising the steps of,

producing an electric charge on predetermined areas of the coated surface of a web prior to development, and

then attracting ink as an unsupported column to uncharged portions of the coated surface by transversing the web between a ground electrode and in spaced relation relative to a smooth ink-coated conductive drum rotating in the same direction as the web so as to provide a predetermined gap between the drum and the coated surface, said drum being connected to a potential source having a potential such as to provide a potential difference between the drum and said uncharged portions of the coated surface to attract ink from the drum thereto across said gap.

2. A method of printing as defined in claim 1 characterized by the web comprising a photo-sensitive coated paper.

3. A method of printing as defined in claim 2 characterized by the photosensitive coating comprising a zinc oxide coating.

4. A method of printing as defined in claim 1 characterized by initially placing a substantially uniform charge on the coated surface and the charge in the image area being neutralized by projecting a light image on selected portions of the charged surface.

5. A method of printing as defined in claim 1 characterized by the coated surface of the paper and the ink-coated drum having an air gap on the order of .0030 inch across which the ink is bodily attracted.

6. A method of printing as defined in claim 1 characterized by the ink being a water-based solution.

7. A method of printing as defined in claim 1 characterized by the ink comprising a colloidal suspension of carbon black in water.

8. A method of printing as defined in claim 1 characterized by the ink comprising a solution in water of a dyestuff.

9. A method of printing as defined in claim 1 characterized by the ink comprising a water-based acid or basic dyestuff.

10. A method of printing as defined in claim 1 characterized by the attraction of an unsupported column of a water-based ink to a latent image area on a hydrophobic substrate.

11. A method of printing as defined in claim 1 characterized by the coated surface of the web being amphoteric in nature so that either acid or basic dye inks can be used and the reaction therebetween obviates the necessity for a resin binder.

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