

[54] **ELECTRODE CONFIGURATION FOR
ELECTROLYTIC PRINTING**

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[58] Field of Search ... **346/74 E, 74 ES, 74 CH, 74 S,
346/74 SB, 74 SC, 139 C; 204/2, 15, 224**

[56] **References Cited**

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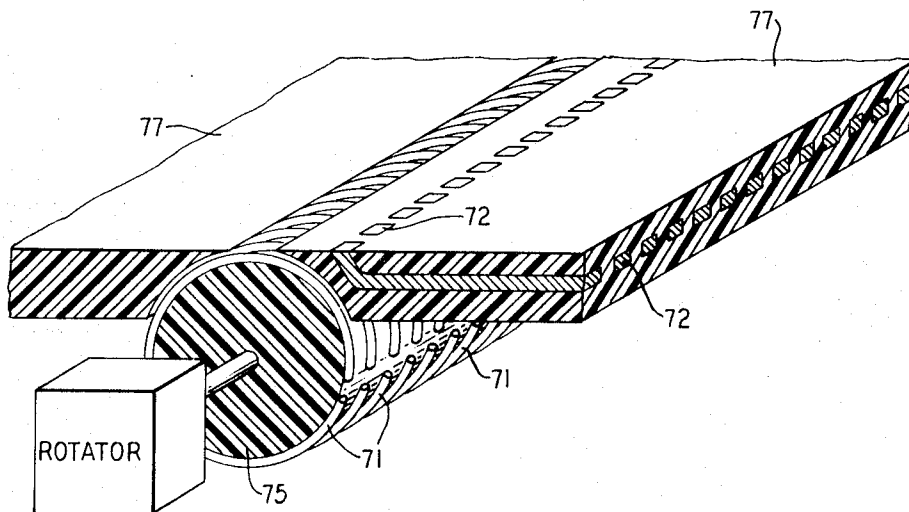
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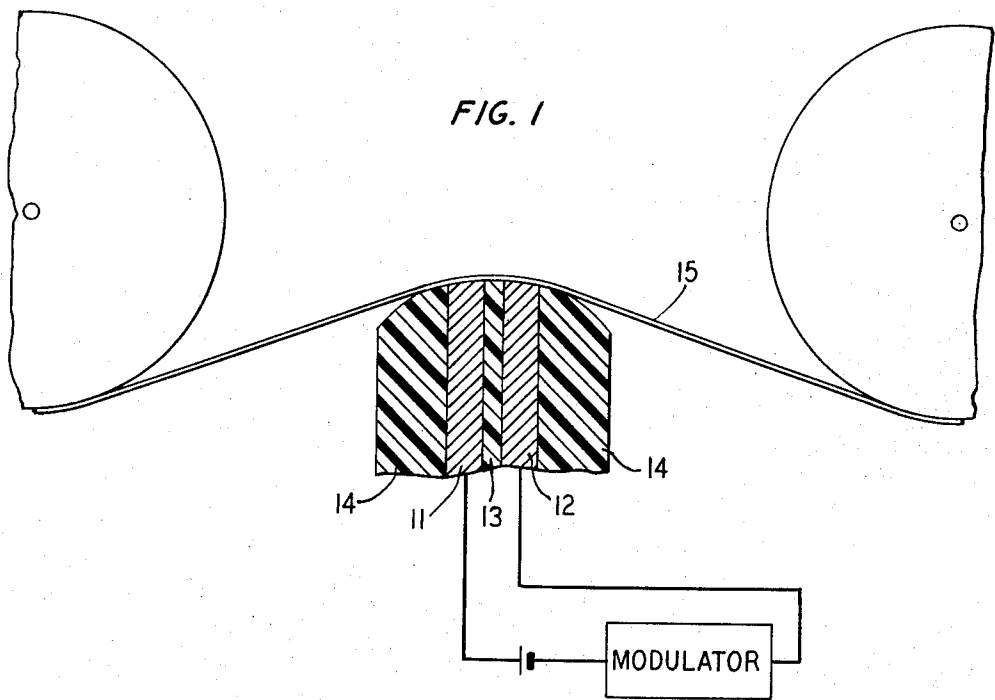
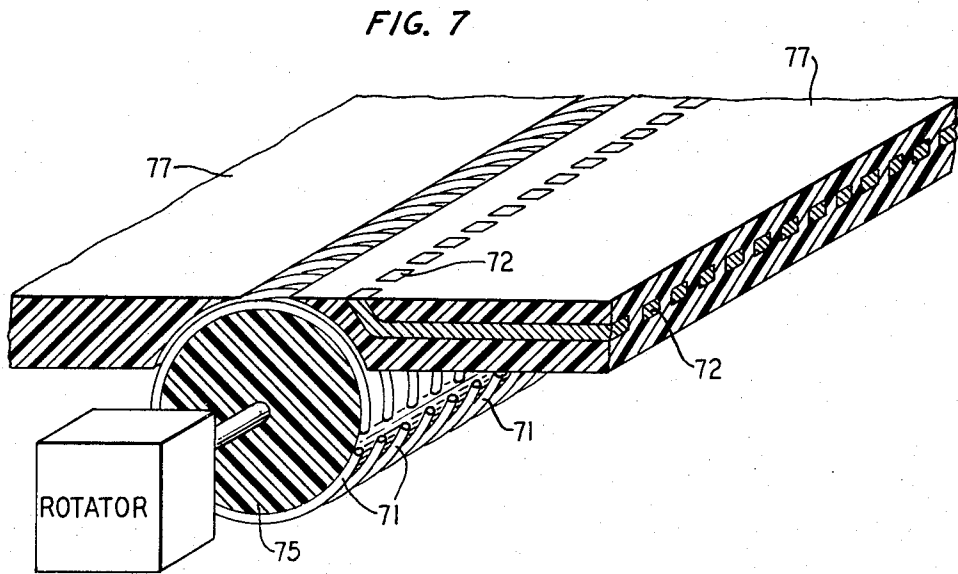
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[57] **ABSTRACT**

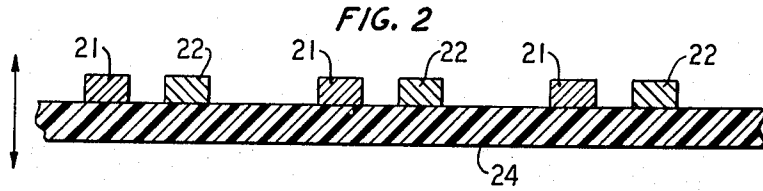
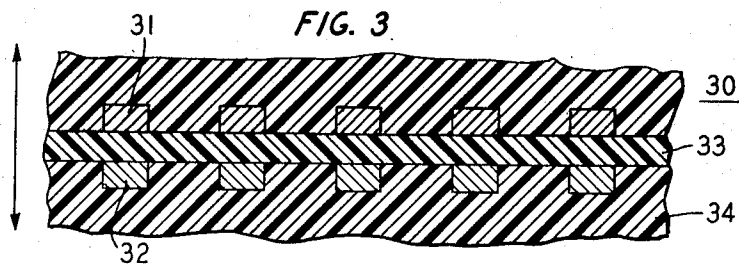
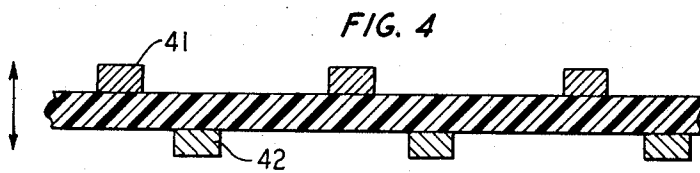
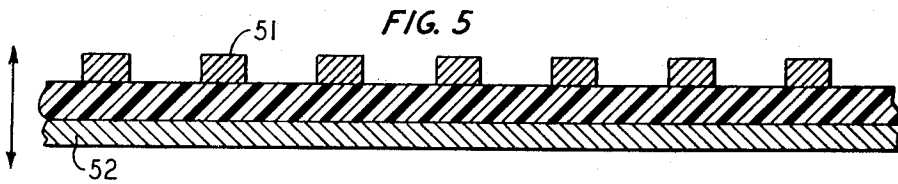
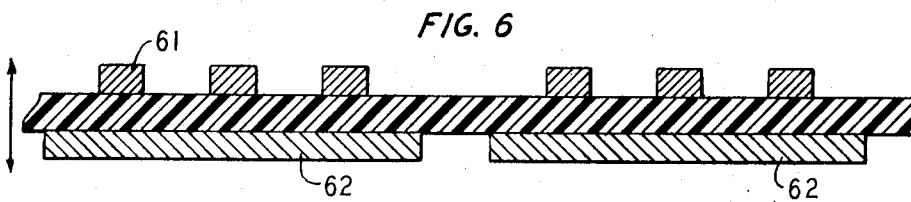
To make possible high-speed electrolytic printing, an electrode arrangement is necessary which will permit the recording sheet to be transported past the writing electrodes at rates greater than 1-inch per second. The disclosed arrangement places a linear array of electrode pairs across the width of the recording sheet with the anode and the cathode electrodes of each pair on the same side of the recording sheet and without a backing plate or roller on the other side. In addition to easing the otherwise stringent mechanical tolerances on the system and the drag on the recording sheet, this arrangement eliminates printing through and could permit printing on both sides. Exemplary electrode geometries are presented, including suggested methods for the renewal of the anode.

2 Claims, 7 Drawing Figures





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ELECTRODE CONFIGURATION FOR ELECTROLYTIC PRINTING

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention pertains to high-speed electrolytic printing.

2. Prior Art

The prior art electrolytic production of prints from electric signals is exemplified by a widely used system in which an electric current is passed between a silver bar anode, extending across the paper to be printed, and a cathode in the form of a spiral bar fixed to a rotating cylinder. The electrolyte soaked paper passes between the anode and the cathode and is transported past the anode at a rate of approximately 2 inches per minute. As the paper is drawn past the anode, the point of intersection between the rotating spiral cathode and the anode passes across the paper. Modulation of the electric current causes a variation of the amount of silver deposited on the paper and a print is formed from a series of these modulated lines, much as the picture on a television screen. The speed of this process is limited by the fact that the point of intersection between the anode and cathode bars must physically move across the paper in order to produce each line, and by the fact that the paper must be compressed between the anode and cathode bar in order to maintain good electric contact. The first limitation can be overcome, as it has in an extant electrostatic printing method, by passing the paper across an array of fixed electrodes extending across the paper. These electrodes are then excited serially to produce a modulated line. However, the use of such an electrode array in the electrolytic process would make it even more difficult to transport the paper rapidly between the electrodes, imposing stringent tolerances on both the interelectrode spacings and the thickness uniformity of the paper.

SUMMARY OF THE INVENTION

The electrode configuration taught here places both the anode and cathode electrodes on the same side of the porous recording sheet and provides that the sheet be held against the electrodes by means other than the placing of solid body on the other side. This configuration greatly eases the mechanical tolerances required of the electrode array, since the slight elasticity of the recording sheet compensates for irregularities in the array. In addition, variations in sheet thickness are unimportant. This configuration permits the sheet to be transported past the electrodes at speeds greater than one inch per second and, for some ranges of design parameters, permits printing on both sides of the sheet by limiting print-through.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plain view in cross section of an exemplary electrode configuration including a representation of the recording sheet;

FIG. 2 is an end view in cross section of an exemplary electrode array in which the anode and cathode electrodes of each pair are located next to one another in the array;

FIG. 3 is an end view of an electrode array in which the anode and cathode of each electrode pair are located opposite each other;

FIG. 4 is an end view of an exemplary electrode array in which the anode and cathode electrode of each pair are opposite each other, but displaced from one another;

FIG. 5 is an end view of an exemplary electrode array in which the cathode electrodes have been joined together as a single electrode;

FIG. 6 is an end view of an exemplary electrode array in which the cathode electrodes have been joined together in more than one groups; and

FIG. 7 is a perspective view partially in cross section of an exemplary method for the renewal of the anode material.

DETAILED DESCRIPTION

1. Electrode Pairs

FIG. 1 shows an exemplary electrode structure in which a silver anode 11 is separated from a platinum cathode 12 by an insulating sheet 13, all of which are imbedded in an insulating supporting structure 14. The recording sheet 15, which is in this case paper, contains a solution of potassium nitrate and is transported in the direction indicated by the arrow past the electrode pair 11, 12. The electrical potential which must be introduced between the anode and cathode in order to produce the deposition of silver upon the paper is dependent, in part, upon the particular chemical system used and, in part, on the electrical resistance between the electrodes 11, 12 through the electrolyte moistened paper. This latter term must be taken into account when deciding the thickness of the insulating separator 13. As the thickness of the separator 13 becomes greater than the thickness of the paper 15, the electrical resistance of the conducting path between the electrodes 11, 12 increases rapidly, increasing the potential which must be applied. Since recording sheets are generally less than 0.005 inches thick, good practice would limit the thickness of the insulating separator 13 to less than 0.01 inch.

Of the several anode materials tried, silver yielded by far the best print. However, copper, gold, palladium, and nickel were also successful. For each of these metals, an appropriate electrolyte was chosen so as to minimize the redeposition of the dissolved anode material back onto the cathode. Although the above-mentioned metals proved best for their electrolytic writing properties other metals may advantageously be included as minor constituents to improve the physical or electrical properties of the anodes. Note also that, since the current flow is not through the sheet from one side to the other, the above metals are deposited mainly on the contacted side of the sheet permitting printing on both sides if a second set of electrodes, displaced from the first and on the other side of the sheet, are provided. In addition the sheet may be composed of an impervious body and a porous surface layer or layers.

2. Array

In choosing the spacing between the anodes of an array of electrode pairs, the principal consideration is acceptable print quality. It has been determined, for instance, that a line of 0.002 inch spots on 0.008 inch centers are distinguishable to the eye from a solid line

at normal viewing distances. A satisfactory print will result if the unprinted distance between the modulated lines is less than 0.01 inch.

FIGS. 2-6 show end views of several exemplary electrode configurations. The direction of motion of the recording sheet is indicated by the arrow. In FIG. 2 the electrode pairs 21, 22 are arrayed side by side on an insulating sheet 24 and are separated by the air or some other insulating material 23. In FIG. 3, the anode 31 and cathode 32 electrodes are on opposite sides of the insulating sheet 33, which is similarly either surrounded by air or an insulating support material 34. FIG. 4 shows the electrode pairs 41, 42 laterally displaced with a possible view to minimizing the replating of the dissolved anode 41 material onto the cathode 42. The external circuitry can make the cathodes of the array electrically independent. Alternatively, they can be electrically common or, as indicated in FIG. 5, can be merged into a single cathode electrode 52. In some cases, it may be advantageous to form groups of electrode pairs by merging groups of cathodes 62 as in FIG. 6. Another alternative, providing advantage in some situations, is the merging of the anode electrodes in which case 52 and 62 of FIGS. 5 and 6 would be biased anodically.

In order to make an electrolytic printing system practical, it is necessary to provide for the renewal of the anode which is continuously losing material during the writing process. Among the many methods possible is the simple grinding-down of the end of the structure 30 — such as illustrated in FIG. 3 — in order to expose new material. Alternately, new anode material may be replated on the existing anode surface by, if for instance the anode is composed of silver, imposing a reverse bias on the writing electrodes while in contact with a silver plating solution (for example while a sheet impregnated with a silver plating solution is passed across the array).

FIG. 7 shows an exemplary electrode configuration in which the anodes 71 are formed from, for example, silver wire wrapped continuously around a mandrel 75. The wire 71 is the slit along the length of the mandrel 75 and the resulting wire circles 71 are individually contacted. Electrolytic printing takes place only where the wires are exposed by an insulating mask 77. In order to renew the anodes, the mandrel 75 is simply rotated exposing fresh silver wire.

In the absence of a solid body, in the nature of a pressure plate, on the other side of the recording sheet, means is necessary to hold the sheet in electrical contact with the electrodes. The following are offered as exemplary of the many possible means; maintenance of the sheet in tension in such a manner as to hold the sheet against the electrodes; provision of an air stream directed against the noncontacted side of the sheet; and the provision of a partial vacuum at the contacted side

of the sheet. The first of these means and any sheet transport means may necessitate the placing of rollers or other solid bodies on the other side of the sheet. In order to maintain the advantages taught here it is necessary that these solid bodies be positioned away from the electrodes 11, 12 and their support structure 13, 14, (see FIG. 1 for example) by at least several times the thickness of the recording sheet.

I claim

1. Apparatus for electrolytic printing comprising means for the electrolytic deposition of particles of a metal on a porous recording sheet permeated with an electrolyte by the introduction of metal ions into the recording sheet where they are subsequently precipitated as metal particles in the deposition region, which means comprises transportation means necessary to provide relative motion between the said recording sheet and an array comprising a first portion and a second portion each portion containing at least one electrode pair CHARACTERIZED IN THAT each said electrode pair consists of an anode, incorporating the said metal, and a cathode located adjacent to the said anode on the same side of the said recording sheet as the said anode and IN THAT the said first portion is the only solid body in contact with either side of the said recording sheet in the said deposition region whereby printing is accomplished on one side of the said recording sheet and the said second portion is displaced from the said first portion in the direction of transportation of the said recording sheet and disposed on the opposite side of the said recording sheet from the said first portion whereby printing is accomplished on the opposite side of the recording sheet.

2. Apparatus for electrolytic printing comprising means for the electrolytic deposition of particles of a metal on a porous recording sheet permeated with an electrolyte by the electrolytic introduction of metal ions into the recording sheet where they are subsequently precipitated, as metal particles in the deposition region which means comprises transportation means necessary to provide relative motion between the said recording sheet and an electrode pair CHARACTERIZED IN THAT the said electrode pair consists of an anode, incorporating the said metal, and a cathode located adjacent to the said anode on the same side of the said recording sheet as the said anode, and the said anode and the said cathode are the only solid bodies in contact with either side of the said recording sheet in the said deposition region and comprising means for renewing the anodes of the array comprising wires of the material composing the said anodes fixed to a curved surface adjacent to an aperture in an insulating mask and rotation means for imparting a rotation to the curved surface in order to bring a fresh portion of the said wire to the said aperture.

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