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(54) **Multicolor electrocoagulation printing method and apparatus**

Mehrfarben -Elektrokoagulationsdruckverfahren und Vorrichtung

Procédé et appareil d'impression par électrocoagulation multicolore

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention pertains to improvements in the field of dynamic printing. More particularly, the invention relates to an improved multicolor electrocoagulation printing method and apparatus.

[0002] In US Patent N° 5,538,601 of July 23, 1996, the inventor has described a multicolor electrocoagulation printing method and apparatus in which use is made of a single positive electrolytically inert electrode in the form of a revolving cylinder having a passivated surface onto which dots of colored, coagulated colloid representative of an image are produced. These dots of colored, coagulated colloid are thereafter contacted with a substrate such as paper to cause transfer of the colored, coagulated colloid onto the substrate and thereby imprint the substrate with the image. As explained in this patent, the positive electrode is coated with a dispersion containing an olefinic substance and a metal oxide prior to electrical energization of the negative electrodes in order to weaken the adherence of the dots of coagulated colloid to the positive electrode and also to prevent an uncontrolled corrosion of the positive electrode. In addition, gas generated as a result of electrolysis upon energizing the negative electrodes is consumed by reaction with the olefinic substance so that there is no gas accumulation between the negative and positive electrodes.

[0003] The electrocoagulation printing ink which is injected into the gap defined between the positive and negative electrodes consists essentially of a liquid colloidal dispersion containing an electrolytically coagulable colloid, a dispersing medium, a soluble electrolyte and a coloring agent. Where the coloring agent used is a pigment, a dispersing agent is added for uniformly dispersing the pigment into the ink. After coagulation of the colloid, any remaining non-coagulated colloid is removed from the surface of the positive electrode, for example, by scraping the surface with a soft rubber squeegee, so as to fully uncover the colored, coagulated colloid which is thereafter transferred onto the substrate. The surface of the positive electrode is thereafter cleaned by means of a plurality of rotating brushes and a cleaning liquid to remove any residual coagulated colloid adhered to the surface of the positive electrode.

[0004] In order to provide a polychromic image, the negative electrodes, the positive electrode coating device, ink injector, rubber squeegee and positive electrode cleaning device are arranged to define a printing unit and several printing units each using a coloring agent of different color are disposed around the positive cylindrical electrode to produce several differently colored images of coagulated colloid which are transferred at respective transfer stations from the positive electrode active surface onto the substrate in superimposed relation to provide the desired polychromic image. The substrate which is in the form of a continuous web is partially wrapped around the positive electrode and passed through the respective transfer stations for being imprinted with the differently colored images in superimposed relation.

[0005] Since the paper web is brought into contact with the dots of colored, coagulated colloid produced by each printing unit, by the positive cylindrical electrode upon rotation thereof and pressed against the positive electrode active surface by pressure rollers for being imprinted with differently colored images of coagulated colloid, the web is often displaced between the positive electrode and the pressure rollers in a direction parallel to the longitudinal axis of the positive electrode. Accordingly, it is difficult to provide a polychromic image in which the differently colored images are perfectly superimposed.

SUMMARY OF THE INVENTION

[0006] It is therefore an object of the present invention to overcome the above drawback and to provide an improved multicolor electrocoagulation printing method and apparatus capable of providing a polychromic image of high definition.

[0007] According to one aspect of the invention, there is provided a multicolor electrocoagulation printing method comprising the steps of:

a) providing a positive electrolytically inert electrode having a continuous passivated surface moving at substantially constant speed along a predetermined path, the passivated surface defining a positive electrode active surface;

b) forming on the positive electrode active surface a plurality of dots of colored, coagulated colloid representative of a desired image, by electrocoagulation of an electrolytically coagulable colloid present in an electrocoagulation printing ink comprising a liquid colloidal dispersion containing the electrolytically coagulable colloid, a dispersing medium, a soluble electrolyte and a coloring agent ;

c) bringing an endless non-extendable belt moving at substantially the same speed as the positive electrode and having on one side thereof a colloid retaining surface adapted to releasably retain dots of electrocoagulated colloid, into contact with the positive electrode active surface to cause transfer of the dots of colored, coagulated colloid from the positive electrode active surface onto the colloid retaining surface of the belt and to thereby imprint the colloid retaining surface with the image.

d) repeating steps (b) and (c) several times to define a corresponding number of printing stages arranged at predetermined locations along the aforesaid path and each using a coloring agent of different color, and to thereby produce several differently colored images of coagulated colloid which are

transferred at respective transfer positions onto the colloid retaining surface in superimposed relation to provide a polychromic image; and

e) bringing a substrate into contact with the colloid retaining surface of the belt to cause transfer of the polychromic image from the colloid retaining surface onto the substrate and to thereby imprint the substrate with said polychromic image.

[0008] The present invention also provides, in a further aspect thereof, an apparatus for carrying out a method as defined above. The apparatus of the invention comprises:

- a positive electrolytically inert electrode having a continuous passivated surface defining a positive electrode active surface;
- means for moving the positive electrode active surface at a substantially constant speed along a predetermined path;
- an endless non-extendable belt having on one side thereof a colloid retaining surface adapted to releasably retain dots of electrocoagulated colloid;
- means for moving the belt at substantially the same speed as the positive electrode;
- a plurality of printing units arranged at predetermined locations along the path, each printing unit comprising:

    - means for forming on the positive electrode active surface a plurality of dots of colored, coagulated colloid representative of a desired image, by electrocoagulation of an electrolytically coagulable colloid present in an electrocoagulation printing ink comprising a liquid colloidal dispersion containing the electrolytically coagulable colloid, a dispersing medium, a soluble electrolyte and a coloring agent, and
    - means for bringing the belt into contact with the positive electrode active surface at a respective transfer station to cause transfer of the dots of colored, coagulated colloid from the positive electrode active surface onto the colloid retaining surface of the belt and to imprint the colloid retaining surface with the image,

      thereby producing several differently colored images of coagulated colloid which are transferred at the respective transfer stations onto the colloid retaining surface in superimposed relation to provide a polychromic image; and
    - means for bringing a substrate into contact with the colloid retaining surface of the belt to cause transfer of the polychromic image from the colloid retaining surface onto the substrate and to thereby imprint the substrate with the polychromic image.

[0009] The inventor has found quite unexpectedly that by utilizing an endless non-extendable belt having a colloid retaining surface such as a porous surface on which dots of colored, coagulated colloid can be transferred and by moving such a belt independently of the positive electrode, from one printing unit to another, so that the colloid retaining surface of the belt contacts the colored, coagulated colloid in sequence, it is possible to significantly improve the registration of the differently colored images upon their transfer onto the colloid retaining surface of the belt, thereby providing a polychromic image of high definition which can thereafter be transferred onto the paper web or other substrate. For example, use can be made of a belt comprising a plastic material having a porous coating of silica.

[0010] The positive electrode used can be in the form of a moving endless belt as described in the inventor's US Patent No. 4,661,222, or in the form of a revolving cylinder as described in the inventor's US Patent No. 4,895,629 or in the aforementioned US Patent No. 5,538,601.

[0011] In later case, the printing units are arranged around the positive cylindrical electrode. Preferably the positive electrode active surface and the ink are maintained at a temperature of about 35-60°C, preferably 40°C, to increase the viscosity of the coagulated colloid in step (b) so that the dots of colored, coagulated colloid remain coherent during their transfer in step (c), thereby enhancing transfer of the colored, coagulated colloid onto the substrate. For example, the positive electrode active surface can be heated at the desired temperature and the ink applied on the heated electrode surface to cause a transfer of heat therefrom to the ink.

[0012] When use is made of a positive electrode of cylindrical configuration rotating at substantially constant speed about its central longitudinal axis, step (b) of the above electrocoagulation printing method is carried out by:

i) providing a plurality of negative electrolytically inert electrodes electrically insulated from one another and arranged in rectilinear alignment to define a series of corresponding negative electrode active surfaces disposed in a plane parallel to the longitudinal axis of the positive electrode and spaced from the positive electrode active surface by a constant predetermined gap, the negative electrodes being spaced from one another by a distance at least equal to the electrode gap;

ii) coating the positive electrode active surface with an oily material to form on the surface micro-droplets of olefinic substance containing the metal oxide;

iii) filling the electrode gap with the aforesaid electrocoagulation printing ink;

iv) electrically energizing selected ones of the negative electrodes to cause point-by-point selective coagulation and adherence of the colloid onto the olefin and metal oxide-coated positive electrode ac-

tive surface opposite the electrode active surfaces of the energized negative electrodes while the positive electrode is rotating, thereby forming the dots of colored, coagulated colloid; and

v) removing any remaining non-coagulated colloid from the positive electrode active surface.

[0013] As explained in US Patent No. 4,895, 629, spacing of the negative electrodes from one another by a distance which is equal to or greater than the electrode gap prevents the negative electrodes from undergoing edge corrosion. On the other hand, coating of the positive electrode with an oily material prior to electrical energization of the negative electrodes weakens the adherence of the dots of coagulated colloid to the positive electrode and also prevents an uncontrolled corrosion of the positive electrode. In addition, in case of the oily material being an olefinic substance, gas generated as a result of electrolysis upon energizing the negative electrodes is consumed by reaction with the olefinic substance so that there is no gas accumulation between the negative and positive electrodes.

[0014] Examples of suitable electrolytically inert metals from which the positive and negative electrodes can be made are stainless steel, platinum, chromium, nickel and aluminum. The positive electrode is preferably made of stainless steel, aluminum or tin so that upon electrical energization of the negative electrodes, dissolution of the passive oxide film on such an electrode generates trivalent ions which then initiate coagulation of the colloid.

[0015] The gap which is defined between the positive and negative electrodes can range from about 50 μm to about 100 μm, the smaller the electrode gap the sharper are the dots of coagulated colloid produced. Where the electrode gap is of the order of 50 μm, the negative electrodes are preferably spaced from one another by a distance of about 75 μm.

[0016] For the oily material which may be used to coat the surface of the positive electrode in the step (b) ii), it is preferred to use olefic substances. Examples of suitable olefinic substances include unsaturated fatty acids such as arachidonic acid, linoleic acid, linolenic acid, oleic acid and palmitoleic acid and unsaturated vegetable oils such as corn oil, linseed oil, olive oil, peanut oil, soybean oil and sunflower oil. A particularly preferred olefinic substance is advantageously applied onto the positive electrode active surface in the form of an oily dispersion containing the metal oxide as dispersed phase. Examples of suitable metal oxides include aluminum oxide, ceric oxide, chromium oxide, cupric oxide, iron oxide, magnesium oxide, manganese oxide, titanium dioxide and zinc oxide; chromium oxide is the preferred metal oxide. Depending on the type of metal oxide used, the amount of metal oxide may range from about 15 to about 40% by weight, based on the total weight of the dispersion. In case of using an oily dispersion, a particularly preferred dispersion contains about 75 % by weight of oleic acid or linoleic acid and about 25 % by weight of chromium oxide. Operating at a temperature of about 35-60°C enables one to lower the concentration of metal oxide in the oily dispersion and thus to reduce wear of the positive electrode active surface.

[0017] The oily dispersion containing the olefinic substance is advantageously applied onto the positive electrode active surface by providing a distribution roller extending parallel to the positive cylindrical electrode and having a peripheral coating comprising an oxide ceramic material, applying the oily dispersion onto the ceramic coating to form on a surface thereof a film of the oily dispersion uniformly covering the surface of the ceramic coating, the film of oily dispersion breaking down into micro-droplets having substantially uniform size and distribution, and transferring the micro-droplets from the ceramic coating onto the positive electrode active surface. As explained in the inventor's US Patent No. 5,449,392 of September 12, 1995, the use of a distribution roller having a ceramic coating comprising an oxide ceramic material enables one to form on a surface of such a coating a film of the oily dispersion which uniformly covers the surface of the ceramic coating and thereafter breaks down into micro-droplets having substantially uniform size and distribution. The micro-droplets formed on the surface of the ceramic coating and transferred onto the positive electrode active surface generally have a size ranging from about 1 to about 5 μm.

[0018] A particularly preferred oxide ceramic material forming the aforesaid ceramic coating comprises a fused mixture alumina and titania. Such a mixture may comprise about 60 to about 90 weight % of alumina and about 10 to 40 weight % of titania.

[0019] According to a preferred embodiment of the invention, the oily dispersion is applied onto the ceramic coating by disposing an applicator roller parallel to the distribution roller and in pressure contact engagement therewith to form a first nip, and rotating the applicator roller and the distribution roller in register while feeding the oily dispersion into the first nip, whereby the oily dispersion upon passing through the first nip forms a film uniformly covering the surface of the ceramic coating. The micro-droplets are advantageously transferred from the distribution roller to the positive electrode by disposing a transfer roller parallel to the distribution roller and in contact engagement therewith to form a second nip, positioning the transfer roller in pressure contact engagement with the positive electrode to form a third nip, and rotating the transfer roller and the positive electrode in register for transferring the micro-droplets from the distribution roller to the transfer roller at the second nip and thereafter transferring the micro-droplets from the transfer roller to the positive electrode at the third nip. Such an arrangement of rollers is described in the aforementioned US Patent No. 5,449,392.

[0020] Preferably, the applicator roller and the transfer roller are each provided with a peripheral covering

of a resilient material which is resistant to attack by the olefinic substance, such as a synthetic rubber material. For example, use can be made of a polyurethane having a Shore A hardness of about 50 to about 70 in the case of the applicator roller, or a Shore A hardness of about 60 to about 80 in the case of the transfer roller.

[0021] The oily material-coated positive active surface is preferably polished to increase the adherence of the micro-droplets onto the positive electrode active surface, prior to step (b) (iii). For example, use can be made of a rotating brush provided with a plurality of radially extending bristles made of horsehair and having extremities contacting the surface of the positive electrode. The friction caused by the bristles contacting the surface upon rotation of the brush has been found to increase the adherence of the micro-droplets onto the positive electrode active surface.

[0022] Where the positive cylindrical electrode extends vertically, step (b) (iii) of the above electrocoagulation printing method is advantageously carried out by continuously discharging the ink onto the positive electrode active surface from a fluid discharge means disposed adjacent the electrode gap at a predetermined height relative to the positive electrode and allowing the ink to flow downwardly along the positive electrode active surface, the ink being thus carried by the positive electrode upon rotation thereof to the electrode gap to fill same. Preferably, excess ink flowing downwardly off the positive electrode active surface is collected and the collected ink is recirculated back to the fluid discharge means.

[0023] The colloid generally used is a linear colloid of high molecular weight, that is, one having a weight average molecular weight between about 10,000 and about 1,000,000, preferably between 100,000 and 600,000. Examples of suitable colloids include natural polymers such as albumin, gelatin, casein and agar, and synthetic polymers such as polyacrylic acid, polyacrylamide and polyvinyl alcohol. A particularly preferred colloid is an anionic copolymer of acrylamide and acrylic acid having a weight average molecular weight of about 250,000 and sold by Cyanamid Inc. under the trade mark ACCOSTRENGTH 86. The colloid is preferably used in an amount of about 6.5 to about 12% by weight, and more preferably in an amount of about 7% by weight, based on the total weight of the colloidal dispersion. Water is preferably used as the medium for dispersing the colloid to provide the desired colloidal dispersion.

[0024] The ink also contains a soluble electrolyte and a coloring agent. Preferred electrolytes include alkali metal halides and alkaline earth metal halides, such as lithium chloride, sodium chloride, potassium chloride and calcium chloride. Potassium chloride is particularly preferred. When operating at a temperature of about 35-60°C, the electrolyte is preferably used in an amount of about 4.5 to about 10% by weight, based on the total weight of the dispersion. The coloring agent can be a dye or a pigment. Examples of suitable dyes which may be used to color the colloid are the water soluble dyes available from HOECHST such a Duasyn Acid Black for coloring in black and Duasyn Acid Blue for coloring in cyan, or those available from RIEDEL-DEHAEN such as Anti-Halo Dye Blue T. Pina for coloring in cyan, Anti-Halo Dye AC Magenta Extra V01 Pina for coloring in magenta and Anti-Halo Dye Oxonol Yellow N. Pina for coloring in yellow. When using a pigment as a coloring agent, use can be made of the pigments which are available from CABOT CORP. such as Carbon Black Monarch® 120 for coloring in black, or those available from HOECHST such as Hostaperm Blue B2G or B3G for coloring in cyan, Permanent Rubine F6B or L6B for coloring in magenta and Permanent Yellow DGR or DHG for coloring in yellow. A dispersing agent is added for uniformly dispersing the pigment into the ink. Examples of suitable dispersing agents include the anionic dispersing agent sold by Boehme Filatex Canada Inc. under the trade mark CLOSPERSE 25000. The pigment is preferably used in an amount of about 6.5 to about 15% by weight, and the dispersing agent in an amount of about 0.1 to about 0.1% by weight, based on the total weight of the ink.

[0025] After coagulation of the colloid, any remaining non-coagulated colloid is removed from the positive electrode active surface, for example, by scraping the surface with a soft rubber squeegee, so as to fully uncover the colored, coagulated colloid. Preferably, the non-coagulated colloid thus removed is collected and mixed with the collected ink, and the collected non-coagulated colloid in admixture with the collected ink is recirculated back to the aforesaid fluid discharge means.

[0026] The optical density of the dots of colored, coagulated colloid may be varied by varying the voltage and/or pulse duration of the pulse-modulated signals applied to the negative electrodes.

[0027] According to a preferred embodiment, step (c) is preferably carried out by providing at each transfer position a pressure roller extending parallel to the positive cylindrical electrode and pressed thereagainst to form a nip and permit the pressure roller to be driven by the positive electrode upon rotation thereof, and passing the belt through the nip.

[0028] Preferably, there are at least two printing stages each including one pressure roller. The pressure rollers are arranged in pairs with the pressure rollers of each pair being diametrically opposed to one another.

[0029] Preferably, the pressure roller is provided with a peripheral covering of a synthetic rubber material such as a polyurethane having a Shore A hardness of about 95. A polyurethane covering with such a hardness has been found to further improve transfer of the colored, coagulated colloid from the positive electrode active surface onto the colloid retaining surface of the belt. The pressure exerted between the positive electrode and the pressure roller preferably ranges from about 50 to about 100 kg/cm^2.

[0030] After step (c), the positive electrode active surface is generally cleaned to remove therefrom any remaining coagulated colloid. According to a preferred embodiment, the positive electrode is rotatable in a predetermined direction and any remaining coagulated colloid is removed from the positive electrode active surface by providing an elongated rotatable brush extending parallel to the longitudinal axis of the positive electrode, the brush being provided with a plurality of radially extending bristles made of horsehair and having extremities contacting the positive electrode active surface, rotating the brush in a direction opposite to the direction of rotation of the positive electrode so as to cause the bristles to frictionally engage the positive electrode active surface, and directing jets of cleaning liquid under pressure against the positive electrode active surface, from either side of the brush. In such an embodiment, the positive electrode active surface and the ink are preferably maintained at a temperature of about 35-60°C by heating the cleaning liquid to thereby heat the positive electrode active surface upon contacting same and applying the ink on the heated electrode surface to cause a transfer of heat therefrom to the ink.

[0031] Preferably, the electrocoagulation printing ink contains water as the dispersing medium and the dots of differently colored, coagulated colloid representative of the polychromic image are moistened between steps (d) and (e) so that the polychromic image is substantially completely transferred onto the substrate in step (e).

[0032] According to another preferred embodiment, the substrate is in the form of a continuous web and step (e) is carried out by providing a support roller and a pressure roller extending parallel to the support roller and pressed thereagainst to form a nip through which the belt is passed, the support roller and pressure roller being driven by the belt upon movement thereof, and guiding the web so as to pass through the nip between the pressure roller and the colloid retaining surface of the belt for imprinting the web with the polychromic image. Preferably, the belt with the colloid retaining surface thereof imprinted with the polychromic image is guided so as to travel along a path extending in a plane intersecting the longitudinal axis of the positive electrode at right angles, thereby exposing the colloid retaining surface to permit contacting thereof by the web. Preferably, the longitudinal axis of the positive electrode extends vertically. The belt is guided so as to travel along a horizontal path with the colloid retaining surface facing downwardly, the support roller and pressure roller having rotation axes disposed in a plane extending perpendicular to the horizontal path.

[0033] After step (e), the colloid retaining surface of the belt is generally cleaned to remove therefrom any remaining coagulated colloid. According to a preferred embodiment, any remaining coagulated colloid is removed from the colloid retaining surface of the belt by providing at least one elongated rotatable brush disposed on the one side of the belt and at least one support roller extending parallel to the brush and disposed on the opposite side of the belt, the brush and support roller having rotation axes disposed in a plane extending perpendicular to the belt, the brush being provided with a plurality of radially extending bristles made of horsehair and having extremities contacting the colloid retaining surface, rotating the brush in a direction opposite to the direction of movement of the belt so as to cause the bristles to frictionally engage the colloid retaining surface while supporting the belt with the support roller, directing jets of cleaning liquid under pressure against the colloid retaining surface from either side of the brush and removing the cleaning liquid with any dislodged coagulated colloid from the colloid retaining surface.

[0034] The invention enables one to significantly improve the registration of the differently colored images of coagulated colloid upon their transfer onto the colloid retaining surface of the belt, thereby providing a polychromic image of high definition which is thereafter transferred onto a paper web or other substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] Further features and advantages of the invention will become more readily apparent from the following description of a preferred embodiment as illustrated by way of examples in the accompanying drawings, in which:

Figure 1 is a schematic top plan view of a multicolor electrocoagulation printing apparatus according to a preferred embodiment of the invention;
Figure 2 is a fragmentary sectional view thereof, showing one of the printing units;
Figure 3 is a fragmentary longitudinal view of one of the printing heads used for electrocoagulation of the colloid; and
Figure 4 is a fragmentary schematic perspective view of the apparatus illustrated in Fig. 1, showing the image wetting device, image transfer device and belt cleaning device.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0036] Referring first to Fig. 1, there is illustrated a multicolor electrocoagulation printing apparatus comprising a central positive electrode 20 in the form of a revolving cylinder and four identical printing units 22 arranged around the cylindrical electrode 20. In the embodiment shown, the first printing unit 22A at the left of the figure is adapted to print in yellow color, the second printing unit 22B in magenta color, the third printing unit 22C in cyan color and the fourth printing unit 22D in black color. The cylindrical electrode 20 extends vertically and has a shaft 24 which is driven by a motor (not shown) for rotating the electrode about a vertical axis coincident with the shaft 24. An endless non-extendable belt 26 having a colloid retaining surface such as a po-

rous surface 28 (best shown in Fig. 4) on one side thereof is displaced to the printing units for imprinting the colloid retaining surface 28 with differently colored images which are transferred at respective transfer stations onto the surface 28 in superimposed relation to provide a polychromic image. The belt 26 is driven at the same speed as the electrode 20 by means of three pairs of sprockets 30 (only three sprockets shown) having teeth 32 engaging two series of longitudinally spaced perforations 34 formed in the belt 26 adjacent the edges thereof, the sprockets 30 of each pair being keyed to a respective shaft 36 which is mechanically to the shaft 24 of the electrode 20. The belt 26 is retained in engagement with the sprockets 30 by arcuate guide members 38. The apparatus further includes a moistening device 40 for moistening any dried dots of colored, coagulated colloid on the surface 28 of the belt 26 and representative of the polychromic image, a transfer device for transferring the polychromic image from the surface 28 of the belt 26 onto a paper web 44 fed from a feed roller 46 and cleaning device 48 for cleaning the surface 28 of the belt 26.

[0037] As best shown in Fig. 2, the printing units 22 each comprise a cleaning device 50 for cleaning the surface 52 of the positive electrode 20, a positive electrode coating device 54 for coating the surface 52 with an olefinic substance and a metal oxide, a polishing brush 56 for polishing the olefin and metal oxide-coated surface 52, a device 58 for discharging an electrocoagulation printing ink onto the surface 52, a printing head 60 provided with negative electrodes 62 for electrocoagulating the colloid contained in the ink to form on the positive electrode surface 52 dots of colored, coagulated colloid representative of a desired image and a soft rubber squeegee 64 for removing any remaining non-coagulated colloid from the surface 52. Each printing unit 22 further includes a pressure roller 66 for bringing the belt 26 into contact with the positive electrode surface 52 to cause transfer of the dots of colored, coagulated colloid from the surface 52 onto the colloid retaining surface 28 of the belt 26 and to thereby imprint the web with the image. As shown in Fig. 1, the provision of two pairs of diametrically opposed pressure rollers 66 arranged about the cylindrical electrode 20 prevents the electrode 20 from flexing since the forces exerted by the rollers 66 of each pair cancel each other out.

[0038] The positive electrode cleaning devices 50 each comprise a rotating brush 68 and two high pressure water injectors 70 arranged in a housing 72. Each brush 68 rotates in a counterclockwise manner and is provided with a plurality of radially extending bristles 74 which are made of horsehair and have extremities contacting the surface 52. Any coagulated colloid remaining on the surface 52 after transfer of the dots of colored, coagulated colloid at the transfer station of a preceding printing unit is thus removed by the brush 68 and washed away, by the powerful jets of water produced by the injectors 70.

[0039] The positive electrode coating devices 54 each comprise a vertically extending distribution roller 76, an applicator roller 78 extending parallel to the distribution roller 76 and in pressure contact engagement therewith to form a nip 80, and a transfer roller 82 extending parallel to the roller 76 and in contact engagement therewith to form a nip 84. The transfer roller 82 is in pressure contact engagement with the positive electrode 20 to form a nip 86 and permit the roller 82 to be driven by the positive electrode 20 upon rotation thereof. Each coating device 54 further includes a feeding device 88 for supplying to the applicator roller 78 the olefinic substance in the form of an oily dispersion containing the metal oxide as dispersed phase.

[0040] The distribution roller 76 has a solid core 90 of metal provided with a peripheral coating 92 of oxide ceramic material. A pair of stub shafts 94 (only one shown) integral with the core 90 extends outwardly from the extremities of the roller 76. The applicator roller 78 and transfer roller 82 also have a solid core 96 of metal, but are provided with a peripheral covering 98 of polyurethane. The rollers 76 and 78 are rotated in register by means of a motor (not shown) driving the shaft 94 of the distribution roller 76. The drive from the motor rotates the distribution roller 76 in a counterclockwise manner, which in turn transmits a clockwise rotation to the applicator roller 78.

[0041] The feeding device 88 is adapted to discharge the oily dispersion onto the applicator roller 78 at an upper portion thereof. The dispersion then flows downwardly under gravity along the roller 78 and is carried to the nip 80 by the roller 78 during rotation thereof. The dispersion upon passing through the nip 80 forms a film uniformly covering the surface of the ceramic coating 90 of the distribution roller 76, the film breaking down into micro-droplets containing the olefinic substance in admixture with the metal oxide and having substantially uniform size and distribution. The micro-droplets formed on the roller 76 are carried by the latter to the nip 84 where they are transferred onto the transfer roller 82. The micro-droplets are then carried by the roller 82 to the nip 86 where they are transferred onto the positive electrode 20.

[0042] The polishing brushes 56 used for polishing the olefin and metal oxide-coated surface 52 of the positive electrode 20 are similar to the brushes 68, each brush 56 rotating in a counterclockwise manner and being provided with a plurality of radially extending bristles 74 made of horsehair and having extremities contacting the surface 52. The friction caused by the bristles 74 contacting the surface 52 upon rotation of the brush 56 has been found to increase the adherence of the micro-droplets of olefinic substance containing the metal oxide onto the positive electrode surface 52.

[0043] As shown in Fig. 3, each printing head 60 comprises a cylindrical body 100 with the negative electrodes 62 being electrically insulated from one another and arranged in rectilinear alignment along the length

of the body 100 to define a series of corresponding negative electrode active surfaces 102. The printing head 60 is positioned relative to the positive electrode 20 such that the surfaces 102 of the negative electrodes 62 are disposed in a plane parallel to the central longitudinal axis of the electrode 20 and are spaced from the positive electrode surface 52 by a constant predetermined gap 104. The electrodes 62 are also spaced from one another by a distance at least equal to the electrode gap 104 to prevent edge corrosion of the negative electrodes.

[0044] The device 58 which is used to fill the electrode gap 104 with an electrocoagulation printing ink consisting of a colloidal dispersion containing an electrolytically coagulable colloid, a dispersing medium, a soluble electrolyte and a coloring agent is disposed adjacent the electrode gap 104 and is adapted to discharge the ink onto the positive electrode surface 52 at a predetermined height relative to the positive electrode 20. As the ink is being discharged from the device 58 onto the positive electrode surface 52, it flows downwardly along the surface 52 and is carried by the positive electrode 20 upon rotation thereof to the electrode gap 104 to fill same.

[0045] Electrical energizing of selected ones of the negative electrodes 62 causes point-by-point selective coagulation and adherence of the colloid onto the olefin and metal oxide-coated surface 52 of the positive electrode 20 opposite the electrode active surfaces 102 of the energized negative electrodes 62 while the electrode 20 is rotating, thereby forming a series of corresponding dots of colored, coagulated colloid representative of a desired image. After electrocoagulation of the colloid, any remaining non-coagulated colloid is removed from the positive electrode surface 52 by the squeegee 64 so as to fully uncover the dots of colored, coagulated colloid adhered on the surface 52.

[0046] The optical density of the dots of colored, coagulated colloid may be varied by varying the voltage and/or pulse duration of the pulse-modulated signals applied to the negative electrodes 62. Synchronization of the data furnished to the printing heads 60 is ensured by proper electronic circuitry (not shown).

[0047] The pressure rollers 66 which serve to bring the belt 26 into contact with the positive electrode active surface 52 at the respective transfer stations are each urged against the positive electrode 20 to form a nip 106 through which the belt 26 is passed and permit the rollers 66 to be driven by the positive electrode 20 upon rotation thereof. As the surface 28 of the belt 26 is contacted with the dots of colored, coagulated colloid on the surface 52, the colored, coagulated colloid is transferred from the surface 52 onto the surface 28 to thereby imprint same with the image. The differently colored images produced by the printing units 22A, 22B, 22C and 22D are thus transferred onto the surface 28 of the belt 26 in superimposed relation to provide a polychromic image 108 (shown in Fig. 4).

[0048] The polychromic images 108 are then conveyed by the belt 26 to the moistening device 40 which comprises a plurality of spray nozzles 110 arranged in a housing 112. An aqueous solution containing a surfactant is sprayed by the nozzles 110 onto the surface 28 of the belt 26 in order to moisten any dried dots of colored, coagulated colloid representative of the images 108, thereby ensuring that the polychromic images 108 are substantially completely transferred from the surface 28 onto the paper web 44 by the transfer device 42.

[0049] As shown in Fig. 4, the transfer device 42 comprises a pair of inclined turn bars 114, 114' and a pair of guide rollers 116, 116' disposed relative to one another for guiding the belt 26 so that it travels along a horizontal path with the surface 28 facing downwardly, thereby exposing the surface 28 to permit contacting thereof by the paper web 44. The device further includes a support roller 118 and a pressure roller 120 extending parallel to the roller 118 and pressed thereagainst to form a nip 122 through which the belt 26 is passed and to permit the rollers 118, 120 to be driven by the belt 26 upon movement thereof. The rotation axes of the support roller 118 and pressure roller 120 are disposed in a plane which extends perpendicular to the horizontal path along which the belt 26 travels. The paper web 44 is guided by a pair of guide rollers 124, 124' so as to pass through the nip 122 between the pressure roller 120 and the surface 28 of the belt 26, for being imprinted with the polychromic images 108 which are transferred from the surface 28 onto the web 44. The paper web 44 imprinted with the images 108 is then taken up by a collect roller 126.

[0050] After the polychromic images 108 have been transferred from the surface 28 of the belt 26 onto the paper web 44, the belt 26 is sent to the cleaning device 48 for removing any remaining coagulated colloid from the surface 28. The cleaning device 48 comprises two rotating brushes 128, three high pressure water injectors 130 (shown in Fig. 1) and a rubber squeegee 132 disposed on one side of the belt 26, as well as three support rollers 134 disposed on the other side of the belt, all being arranged in a housing 136. Each brush 128 rotates in a clockwise manner and is provided with a plurality of radially extending bristles 74 which are made of horsehair and have extremities contacting the surface 28 of the belt 26. Any coagulated colloid remaining on the surface 28 is thus removed by the brushes 128 and washed away by the powerful jets of water produced by the injectors 130.

Claims

1. A multicolor electrocoagulation printing method comprising the steps of:

a) providing a positive electrolytically inert electrode having a continuous passivated surface

moving at substantially constant speed along a predetermined path, said passivated surface defining a positive electrode active surface;

b) forming on said positive electrode active surface a plurality of dots of colored, coagulated colloid representative of a desired image, by electrocoagulation of an electrolytically coagulable colloid present in an electrocoagulation printing ink comprising a liquid colloidal dispersion containing said electrolytically coagulable colloid, a dispersing medium, a soluble electrolyte and a coloring agent;

c) bringing an endless non-extendable belt moving at substantially the same speed as said positive electrode and having on one side thereof a colloid retaining surface adapted to releasably retain dots of electrocoagulation colloid, into contact with said positive electrode active surface to cause transfer of the dots of colored, coagulated colloid from the positive electrode active surface onto the colloid retaining surface of said belt and to thereby imprint said colloid retaining surface with the image;

d) repeating steps (b) and (c) several times to define a corresponding number of printing stages arranged at predetermined locations along said path and each using a coloring agent of different color, and to thereby produce several differently colored images of coagulated colloid which are transferred at respective transfer positions onto said colloid retaining surface in superimposed relation to provide a polychromic image; and

e) bringing a substrate into contact with the colloid retaining surface of said belt to cause transfer of the polychromic image from said colloid retaining surface onto said substrate and to thereby imprint said substrate with said polychromic image.

2. A method as claimed in claim 1, wherein said substrate is in the form of a continuous web and wherein step (e) is carried out by providing a support roller and a pressure roller extending parallel to said support roller and pressed thereagainst to form a nip through which said belt is passed, said support roller and pressure roller being driven by said belt upon movement thereof, and guiding said web so as to pass through said nip between said pressure roller and the colloid retaining surface of said belt for imprinting said web with said polychromic image.

3. A multicolor electrocoagulation printing apparatus comprising:

- a positive electrolytically inert electrode having a continuous passivated surface defining a positive electrode active surface;
- means for moving said positive electrode active surface at a substantially constant speed along a predetermined path;
- an endless non-extendable belt having on one side thereof a colloid retaining surface adapted to releasably retain dots of electrocoagulated colloid;
- means for moving said belt at substantially the same speed as said positive electrode;
- a plurality of printing units arranged at predetermined locations along said path, each printing unit comprising:
  - means for forming on said positive electrode active surface a plurality of dots of colored, coagulated colloid representative of a desired image, by electrocoagulation of an electrolytically coagulable colloid present in an electrocoagulation printing ink comprising a liquid colloidal dispersion containing said electrolytically coagulable colloid, a dispersing medium, a soluble electrolyte and a coloring agent, and
  - means for bringing said belt into contact with said positive electrode active surface at a respective transfer station to cause transfer of the dots of colored, coagulated colloid from the positive electrode active surface onto the colloid retaining surface of said belt and to imprint said colloid retaining surface with the image, thereby producing several differently colored images of coagulated colloid which are transferred at said respective transfer stations onto said colloid retaining surface in superimposed relation to provide a polychromic image; and
  - means for bringing a substrate into contact with the colloid retaining surface of said belt to cause transfer of the polychromic image from said colloid retaining surface onto said substrate and to thereby imprint said substrate with said polychromic image.

4. An apparatus as claimed in claim 3, wherein said positive electrode is a cylindrical electrode having a central longitudinal axis and wherein said means for moving said positive electrode active surface includes means for rotating said positive cylindrical electrode about said longitudinal axis, said printing units being arranged around said positive cylindrical electrode.

5. An apparatus as in claim 3 or 4, wherein said means for forming said dots of colored, coagulated colloid comprises:

- a plurality of negative electrolytically inert electrodes electrically insulated from one another and arranged in rectilinear alignment to define a series of corresponding negative electrode active surfaces disposed in a plane parallel to the longitudinal axis of said positive electrode and spaced from the positive electrode active surface by a constant predetermined gap, said negative electrodes being spaced from one another by a distance at least equal to said electrode gap;
- means for coating the positive electrode active surface with an olefinic substance and a metal oxide to form on said surface micro-droplets of olefinic substance containing the metal oxide;
- means for filling said electrode gap with said electrocoagulation printing ink;
- means for electrically energizing selected ones of said negative electrodes to cause point-by-point selective coagulation and adherence of the colloid onto the olefin and metal oxide-coated positive electrode active surface opposite the electrode active surfaces of said energized negative electrodes while said positive electrode is rotating, thereby forming said dots of colored, coagulated colloid; and
- means for removing any remaining non-coagulated colloid from said positive electrode active surface.

6. An apparatus as in one of claims 3, 4 or 5, wherein said means for bringing said belt into contact with said positive electrode active surface at said respective transfer station comprises a pressure roller extending parallel to said positive electrode and pressed thereagainst to form a nip through which said belt is passed and to permit said pressure roller to be driven by said positive electrode upon rotation thereof.

7. An apparatus as in one of claims 3, 4, 5 or 6, wherein each said printing unit further includes means for removing any remaining coagulated colloid from said positive electrode active surface after transfer of said dots of colored, coagulated colloid onto the porous surface of said belt.

8. An apparatus as in one of claims 3, 4, 5, 6 or 7, wherein said dispersing medium is water and wherein said apparatus further includes means for moistening the dots of differently colored, coagulated colloid representative of said polychromic image after transfer onto the colloid retaining surface of said belt so as to permit said polychromic image to be substantially completely transferred onto said substrate.

9. An apparatus as in one of claims 3, 4, 5, 6, 7 or 8, wherein said substrate is in the form of continuous web and wherein said means for bringing the web into contact with the colloid retaining surface of said belt comprises a support roller and a pressure roller extending parallel to said support roller and a pressed thereagainst to form a nip through which said belt is passed and to permit said support roller and pressure roller to be driven by said belt upon movement thereof, and web guide means for guiding said web so as to pass through said nip between said pressure roller and the porous surface of said belt for imprinting said web with said polychromic image.

10. An apparatus as in one of claims 3, 4, 5, 6, 7, 8 or 9, further including means for removing any remaining coagulated colloid from the colloid retaining surface of said belt after transfer of said polychromic image onto said substrate.

11. An apparatus as in one of claims 3, 4, 5, 6, 7, 8, 9 or 10, wherein said colloid retaining surface is a porous surface of silica thereon.

Patentansprüche

1. Vielfarben-Elektrokoagulations-Druckverfahren, umfassend die Schritte, daß man

(a) eine positive, elektrolytisch inerte Elektrode bereitstellt, die eine kontinuierliche, passivierte und sich mit im wesentlichen konstanter Geschwindigkeit über einen vorbestimmten Weg bewegende Oberfläche aufweist, wobei die passivierte Oberfläche eine aktive Oberfläche der positiven Elektrode definiert;
(b) auf der aktiven Oberfläche der positiven Elektrode durch Elektrokoagulation eines elektrolytisch koagulierbaren Kolloids, das in einer Elektrokoagulations-Druckfarbe zugegen ist, die eine flüssige kolloidale Dispersion umfaßt, die das elektrolytisch koagulierbare Kolloid, ein dispergierendes Medium, einen löslichen Elektrolyten und ein Färbemittel enthält, eine Vielzahl von Punkten eines farbigen, koagulierten Kolloids bildet, die für ein gewünschtes Bild stehen;
(c) ein endloses, nicht-dehnbares Band, das sich mit im wesentlichen derselben Geschwindigkeit bewegt wie die positive Elektrode und das auf einer seiner Seiten eine ein Kolloid haltende Oberfläche aufweist, die Punkte eines Elektrokoagulations-Kolloids freisetzbar halten kann, in Kontakt mit der aktiven Oberfläche der positiven Elektrode bringt und so eine Übertragung der Punkte aus dem gefärbten, koagulierten Kolloid von der aktiven Oberfläche der po-

sitiven Elektrode auf die ein Kolloid haltende Oberfläche des Bandes bewirkt und dadurch die ein Kolloid haltende Oberfläche mit dem Bild bedruckt;

(d) die Schritte (b) und (c) einige Male wiederholt und so eine entsprechende Zahl von Druckstufen definiert, die an vorbestimmten Stellen über den Weg angeordnet sind und von denen jede Gebrauch von einem Färbemittel unterschiedlicher Farbe macht, und damit einige unterschiedlich gefärbte Bilder aus koaguliertem Kolloid herstellt, die an jeweiligen Übertragungsstellen in übereinander angeordneter Beziehung zueinander auf die ein Kolloid haltende Oberfläche übertragen werden, wodurch ein polychromes (vielfarbiges) Bild geschaffen wird; und

(e) ein Substrat in Kontakt mit der ein Kolloid haltenden Oberfläche des Bandes bringt und so eine Übertragung des polychromen (vielfarbigen) Bildes von der ein Kolloid haltenden Oberfläche auf das Substrat bewirkt und dabei das Substrat mit dem polychromen (vielfarbigen) Bild bedruckt.

2. Verfahren nach Anspruch 1, worin das Substrat in Form eines kontinuierlichen Gewebes vorliegt und worin Schritt (e) in der Weise durchgeführt wird, daß man eine Trägerwalze und eine Andruckwalze, die sich parallel zu der Trägerwalze erstreckt und gegen diese gedrückt wird und dabei einen Spalt bildet, durch den das Band hindurchgeführt wird, bereitstellt, wobei die Trägerwalze und die Andruckwalze durch das Band bei dessen Bewegung angetrieben werden, und worin man das Gewebe so führt, daß es durch den Spalt zwischen der Andruckwalze und der ein Kolloid haltenden Oberfläche des Bandes hindurchtritt und dabei das Gewebe mit dem polychromen (vielfarbigen) Bild bedruckt.

3. Vielfarben-Elektrokoagulations-Druckvorrichtung, umfassend

- eine positive, elektrolytisch inerte Elektrode, die eine kontinuierliche passivierte Oberfläche aufweist, die eine aktive Oberfläche der positiven Elektrode definiert;
- Einrichtungen zum Bewegen der aktiven Oberfläche der positiven Elektrode mit einer im wesentlichen konstanten Geschwindigkeit über einen vorbestimmten Weg;
- ein endloses, nicht dehnbares Band, das auf einer seiner Seiten eine ein Kolloid haltende Oberfläche aufweist, die freisetzbar Punkte eines elektrokoagulierten Kolloids halten kann;
- Einrichtungen zum Bewegen des Bandes mit im wesentlichen derselben Geschwindigkeit wie die positive Elektrode;
- eine Vielzahl von Druckeinheiten, die an vorbestimmten Stellen im Bereich des Weges angeordnet sind, wobei jede Druckeinheit umfaßt

  - Einrichtungen zum Ausbilden einer Vielzahl von Punkten aus einem gefärbten, koagulierten Kolloid, die für ein gewünschtes Bild stehen, auf der aktiven Oberfläche der positiven Elektrode durch Elektrokoagulation eines elektrolytisch koagulierbaren Kolloids, das in einer Elektrokoagulations-Druckfarbe zugegen ist, die eine flüssige kolloidale Dispersion umfaßt, die das elektrolytisch koagulierbare Kolloid, ein dispergierendes Medium, einen löslichen Elektrolyten und ein Färbemittel enthält; und
  - Einrichtungen, um das Band mit der aktiven Oberfläche der positiven Elektrode an einer jeweiligen Übertragungsstation in Kontakt zu bringen und so eine Übertragung der Punkte aus einem gefärbten, koagulierten Kolloid von der aktiven Oberfläche der positiven Elektrode auf die ein Kolloid haltende Oberfläche des Bandes zu bewirken und so die ein Kolloid haltende Oberfläche mit dem Bild zu bedrukken und damit einige unterschiedlich gefärbte Bilder aus koaguliertem Kolloid zu erzeugen, die an den jeweiligen Übertragungsstationen auf die ein Kolloid haltende Oberfläche in übereinander angeordneter Beziehung zueinander übertragen werden, wodurch ein polychromes (vielfarbiges) Bild geschaffen wird; und
  - Einrichtungen zum In-Kontakt-Bringen eines Substrats mit der ein Kolloid haltenden Oberfläche des Bandes unter Bewirken einer Übertragung des polychromen (vielfarbigen) Bildes von der ein Kolloid haltenden Oberfläche auf das Substrat und dadurch Bedrucken des Substrats mit dem polychromen (vielfarbigen) Bild.

4. Vorrichtung nach Anspruch 3, worin die positive Elektrode eine zylindrische Elektrode mit einer zentralen Längsachse ist und worin die Einrichtung zum Bewegen der aktiven Oberfläche der positiven Elektrode Einrichtungen zum Drehen der positiven zylindrischen Elektrode um die Längsachse einschließt, wobei die Druckeinheiten um die positive zylindrische Elektrode herum angeordnet sind.

5. Vorrichtung nach Anspruch 3 oder Anspruch 4, worin die Einrichtung zum Ausbilden der Punkte aus gefärbtem, koaguliertem Kolloid umfaßt:

- eine Mehrheit von negativen, elektrolytisch in-

erten Elektroden, die gegeneinander elektrisch isoliert sind und in geradliniger Anordnung angeordnet sind und so eine Reihe von entsprechenden aktiven Oberflächen von negativen Elektroden definieren, die in einer Ebene parallel zur Längsachse der positiven Elektrode angeordnet und von der aktiven Oberfläche der positiven Elektrode um einen konstanten vorbestimmten Abstand beabstandet sind, wobei die negativen Elektroden voneinander mit einem Abstand beabstandet sind, der wenigstens gleich dem Elektrodenabstand ist;

- Einrichtungen zum Beschichten der aktiven Oberfläche der positiven Elektrode mit einer olefinischen Substanz und einem Metalloxid unter Bildung von Mikrotröpfchen von olefinischer Substanz, die das Metalloxid enthalten, auf der Oberfläche;
- Einrichtungen zum Auffüllen des Elektrodenabstandes mit der Elektrokoagulations-Druckfarbe;
- Einrichtungen zum Zuführen elektrischer Energie zu ausgewählten negativen Elektroden unter Bewirken einer Punkt für Punkt erfolgenden, selektiven Koagulation und eines Haftens des Kolloids auf der mit dem Olefin und dem Metalloxid beschichteten aktiven Oberfläche der positiven Elektrode, die gegenüber den aktiven Elektrodenoberflächen der mit Energie beaufschlagten negativen Elektroden angeordnet ist, wobei sich die positive Elektrode dreht, wodurch Punkte aus gefärbtem koaguliertem Kolloid gebildet werden; und
- Einrichtungen zum Entfernen von zurückgebliebenem, nicht koaguliertem Kolloid von der aktiven Oberfläche der positiven Elektrode.

6. Vorrichtung nach einem der Ansprüche 3, 4 oder 5, worin die Einrichtung zum In-Kontakt-Bringen des Bandes mit der aktiven Oberfläche der positiven Elektrode an der jeweiligen Übertragungsstation eine Andruckwalze umfaßt, die sich parallel zu der positiven Elektrode erstreckt und gegen diese gedrückt wird, wodurch ein Spalt gebildet wird, durch den das Band geführt wird, und wodurch ermöglicht wird, daß die Andruckwalze durch die positive Elektrode bei deren Umdrehen angetrieben wird.

7. Vorrichtung nach einem der Ansprüche 3, 4, 5 oder 6, worin jede Druckeinheit weiter Einrichtungen zum Entfernen von zurückgebliebenem koaguliertem Kolloid von der aktiven Oberfläche der positiven Elektrode nach einem Übertragen der Punkte aus gefärbtem, koaguliertem Kolloid auf die poröse Oberfläche des Bandes einschließt.

8. Vorrichtung nach einem der Ansprüche 3, 4, 5, 6 oder 7, worin das dispergierende Medium Wasser ist und worin die Vorrichtung weiter Einrichtungen zum Befeuchten der Punkte aus verschieden gefärbtem, koaguliertem Kolloid, die für das polychrome (vielfarbige) Bild stehen, nach Übertragung auf die ein Kolloid haltende Oberfläche des Bandes einschließt, wodurch es ermöglicht wird, daß das polychrome (vielfarbige) Bild im wesentlichen vollständig auf das Substrat übertragen wird.

9. Vorrichtung nach einem der Ansprüche 3, 4, 5, 6, 7 oder 8, worin das Substrat in Form eines kontinuierlichen Gewebes vorliegt und worin die Einrichtung zum In-Kontakt-Bringen des Gewebes mit der ein Kolloid haltenden Oberfläche des Bandes eine Trägerwalze und eine Andruckwalze, die sich parallel zu der Trägerwalze erstreckt und gegen diese gedrückt wird, wodurch ein Spalt gebildet wird, durch den das Band hindurchgeführt wird, und ermöglicht wird, daß die Trägerwalze und die Andruckwalze durch das Band bei dessen Bewegung angetrieben werden, und Gewebe-Leit-Einrichtungen zum Leiten des Gewebes unter Hindurchtreten durch den Spalt zwischen der Andruckwalze und der porösen Oberfläche des Bandes unter Bedrukken des Gewebes mit dem polychromen (vielfarbigen) Bild umfaßt.

10. Vorrichtung nach einem der Ansprüche 3, 4, 5, 6, 7, 8 oder 9, welche weiter Einrichtungen zum Entfernen von zurückgebliebenem koaguliertem Kolloid von der ein Kolloid haltenden Oberfläche des Bandes nach der Übertragung des ploychromen (vielfarbigen) Bildes auf das Substrat umfaßt.

11. Vorrichtung nach einem der Ansprüche 3, 4, 5, 6, 7, 8, 9 oder 10, worein die ein Kolloid haltende Oberfläche eine poröse Oberfläche aus Siliciumoxid darauf ist.

Revendications

1. Procédé d'impression multicolore par électrocoagulation comprenant les étapes consistant à :

a)fournir une électrode inerte électrolytiquement positive présentant une surface passivée continue, se déplaçant à une vitesse essentiellement constante le long d'un trajet prédéterminé, ladite surface passivée définissant une surface active d'électrode positive ;

b)former sur ladite surface active d'électrode positive une pluralité de points de colloïde coagulé, coloré, représentatifs d'une image souhaitée, par électrocoagulation d'un colloïde qui peut coaguler électrolytiquement, présent dans une encre d'impression par électrocoagulation

comprenant une dispersion colloïdale liquide, contenant ledit colloïde qui peut coaguler électrolytiquement, un milieu de dispersion, un électrolyte soluble et un colorant ;

c)amener une courroie non extensible sans fin se déplaçant à une vitesse essentiellement identique à celle de ladite électrode positive et présentant sur un côté de celle-ci une surface retenant le colloïde adaptée de façon à retenir et à pouvoir relâcher les points de colloïde électrocoagulé, au contact de ladite surface active d'électrode positive de façon à provoquer le transfert des points de colloïde coagulé, coloré de la surface active d'électrode positive à la surface retenant le colloïde de ladite courroie et d'imprimer ainsi l'image sur ladite surface retenant le colloïde ;

d) répéter les étapes (b) et (c) plusieurs fois afin de définir un nombre correspondant de stades d'impression agencés en des endroits prédéterminés le long dudit trajet, et chacun utilisant un colorant de couleur différente, et afin de produire ainsi plusieurs images différemment colorées de colloïde coagulé qui sont transférées en des positions de transfert respectives sur ladite surface retenant le colloïde, superposées les unes aux autres, afin de fournir une image polychrome ; et

e)amener un substrat au contact de la surface retenant le colloïde de ladite courroie afin de provoquer le transfert de l'image polychrome de ladite surface retenant le colloïde sur ledit substrat et afin d'imprimer ainsi ladite image polychrome sur ledit substrat.

2. Procédé selon la revendication 1, dans lequel ledit substrat est de la forme d'une bande continue et dans lequel l'étape (e) est effectuée en fournissant un rouleau de support et un rouleau presseur s'étendant parallèlement audit rouleau de support et pressé contre celui-ci afin de former une ligne de contact à travers laquelle ladite courroie passe, lesdits rouleau de support et rouleau de pression étant entraînés par ladite courroie au moment du mouvement de celle-ci, et en guidant ladite bande de sorte qu'elle passe à travers ladite ligne de contact entre ledit rouleau presseur et la surface retenant le colloïde de ladite courroie afin d'imprimer ladite image polychrome sur ladite bande.

3. Appareil d'impression multicolore par électrocoagulation comprenant :

- une électrode inerte électrolytiquement positive présentant une surface passivée continue définissant une surface active d'électrode positive ;
- un moyen de déplacement de ladite surface active d'électrode positive à une vitesse essentiellement constante le long d'un trajet prédéterminé ;
- une courroie non extensible sans fin présentant sur un côté de celle-ci une surface retenant le colloïde adaptée de façon à retenir et pouvoir relâcher les points de colloïde électrocoagulé ;
- un moyen de déplacement de ladite courroie à une vitesse essentiellement identique à celle de l'électrode positive ;
- une pluralité d'unités d'impression agencées en des endroits prédéterminés le long dudit trajet, chaque unité d'impression comprenant :
  - un moyen de formation sur ladite surface active d'électrode positive d'une pluralité de points de colloïde coagulé, coloré, représentatifs d'une image souhaitée, par électrocoagulation d'un colloïde qui peut coaguler électrolytiquement, présent dans une encre d'impression par électrocoagulation, comprenant une dispersion colloïdale liquide contenant ledit colloïde qui peut coaguler électrolytiquement, un milieu de dispersion, un électrolyte soluble et un colorant, et
  - un moyen pour amener ladite courroie au contact de ladite surface active d'électrode positive en une position de transfert respective afin de provoquer le transfert des points de colloide coagulé, coloré, de la surface active d'électrode positive à la surface retenant le colloïde de ladite courroie et afin d'imprimer l'image sur ladite surface retenant le colloïde, produisant ainsi plusieurs images différemment colorées de colloïde coagulé qui sont transférées dans lesdites positions de transfert respectives, sur la surface retenant le colloïde, superposées les unes aux autres, afin de fournir une image polychrome ; et
  - un moyen pour amener un substrat au contact de la surface retenant le colloïde de ladite courroie afin de provoquer le transfert de l'image polychrome de ladite surface retenant le colloïde sur ledit substrat et afin d'imprimer ainsi ladite image polychrome sur ledit substrat.

4. Appareil selon la revendication 3, dans lequel ladite électrode positive est une électrode cylindrique présentant un axe longitudinal central et dans lequel ledit moyen de déplacement de ladite surface active d'électrode positive inclut un moyen de rotation de ladite électrode cylindrique positive autour dudit axe longitudinal, lesdites unités d'impression étant agencées autour de l'électrode cylindrique positive.

5. Appareil selon la revendication 3 ou 4, dans lequel ledit moyen de formation desdits points de colloïde coagulé, coloré, comprend :

- une pluralité d'électrodes inertes électrolytiquement négatives, isolées électriquement les unes des autres et agencées en alignement rectiligne afin de définir une série de surfaces actives d'électrodes négatives correspondantes, disposées dans un plan parallèle à l'axe longitudinal de ladite électrode positive et espacées de la surface active d'électrode positive par un espace prédéterminé constant, lesdites électrodes négatives étant espacées les unes des autres par une distance au moins égale audit espace entre les électrodes ;

- un moyen de revêtement de la surface active d'électrode positive avec une substance oléfinique et un oxyde métallique afin de former sur ladite surface des micro-gouttelettes de substance oléfinique contenant l'oxyde métallique ;

- un moyen pour remplir ledit espace entre les électrode avec ladite encre d'impression par électrocoagulation ;

- un moyen d'excitation électrique des électrodes choisies parmi lesdites électrodes négatives afin de provoquer la coagulation sélective point par point et l'adhérence du colloïde sur la surface active d'électrode positive revêtue d'oléfine et d'oxyde métallique, faisant face aux surfaces actives d'électrodes desdites électrodes négatives excitées, tandis que l'électrode positive est en rotation, formant ainsi des points de colloïde coagulé, coloré ; et

- un moyen pour ôter tout colloïde non coagulé restant de ladite surface active d'électrode positive.

6. Appareil selon l'une des revendication 3, 4 ou 5, dans lequel ledit moyen pour amener ladite courroie au contact de ladite surface active d'électrode positive dans ladite position de transfert comprend un rouleau presseur s'étendant parallèlement à ladite électrode positive et pressé contre celle-ci pour former une ligne de contact à travers laquelle ladite courroie passe et afin de permettre audit rouleau presseur d'être entraîné par ladite électrode positive au moment de la rotation de celle-ci.

7. Appareil selon l'une des revendications 3, 4, 5 ou 6, dans lequel chaque dite unité d'impression inclut en outre un moyen pour ôter tout colloïde coagulé restant de ladite surface active d'électrode positive à la suite du transfert des dits points de colloïde coagulé, coloré sur la surface poreuse de ladite courroie.

8. Appareil selon l'une des revendication 3, 4, 5, 6 ou 7, dans lequel le milieu de dispersion est de l'eau et dans lequel ledit appareil inclut en outre un moyen d'humidification des points de colloïde coagulé, coloré différemment représentatifs de ladite image polychrome, à la suite du transfert sur la surface retenant le colloïde de ladite courroie afin de permettre lé transfert essentiellement complet de ladite image polychrome sur ledit substrat.

9. Appareil selon l'une des revendication 3, 4, 5, 6, 7 ou 8, dans lequel ledit substrat est de la forme d'une bande continue et dans lequel ledit moyen d'amener la bande au contact de la surface retenant le colloïde de ladite courroie comprend un rouleau de support et un rouleau presseur s'étendant parallèlement audit rouleau de support et pressé contre celui-ci pour former une ligne de contact à travers laquelle la courroie passe et afin de permettre audit rouleau de support et au rouleau presseur d'être entraînés par ladite courroie au moment du mouvement de celle-ci, et un moyen de guidage de la bande afin de guider la bande de sorte qu'elle passe à travers ladite ligne de contact entre le rouleau presseur et la surface poreuse de ladite courroie afin d'imprimer ladite image polychrome sur ladite bande.

10. Appareil selon l'une des revendications 3, 4, 5, 6, 7, 8 ou 9, incluant en outre un moyen pour ôter tout colloïde coagulé restant de la surface retenant le colloïde de ladite courroie après le transfert de ladite image polychrome sur ledit substrat.

11. Appareil selon l'une des revendications 3, 4, 5, 6, 7, 8, 9 ou 10, dans lequel ladite surface retenant le colloïde est une surface poreuse de silice sur celle-ci.

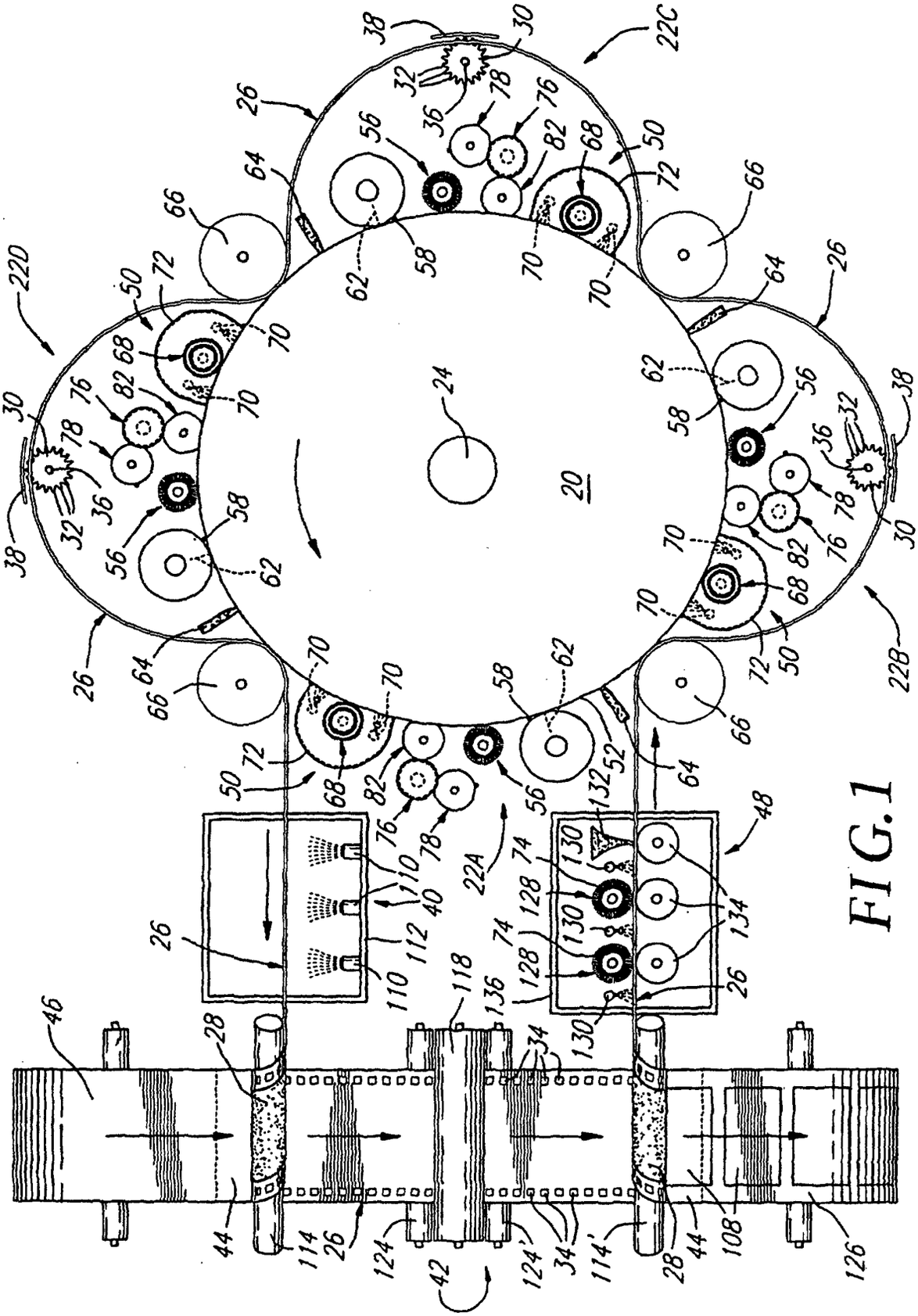
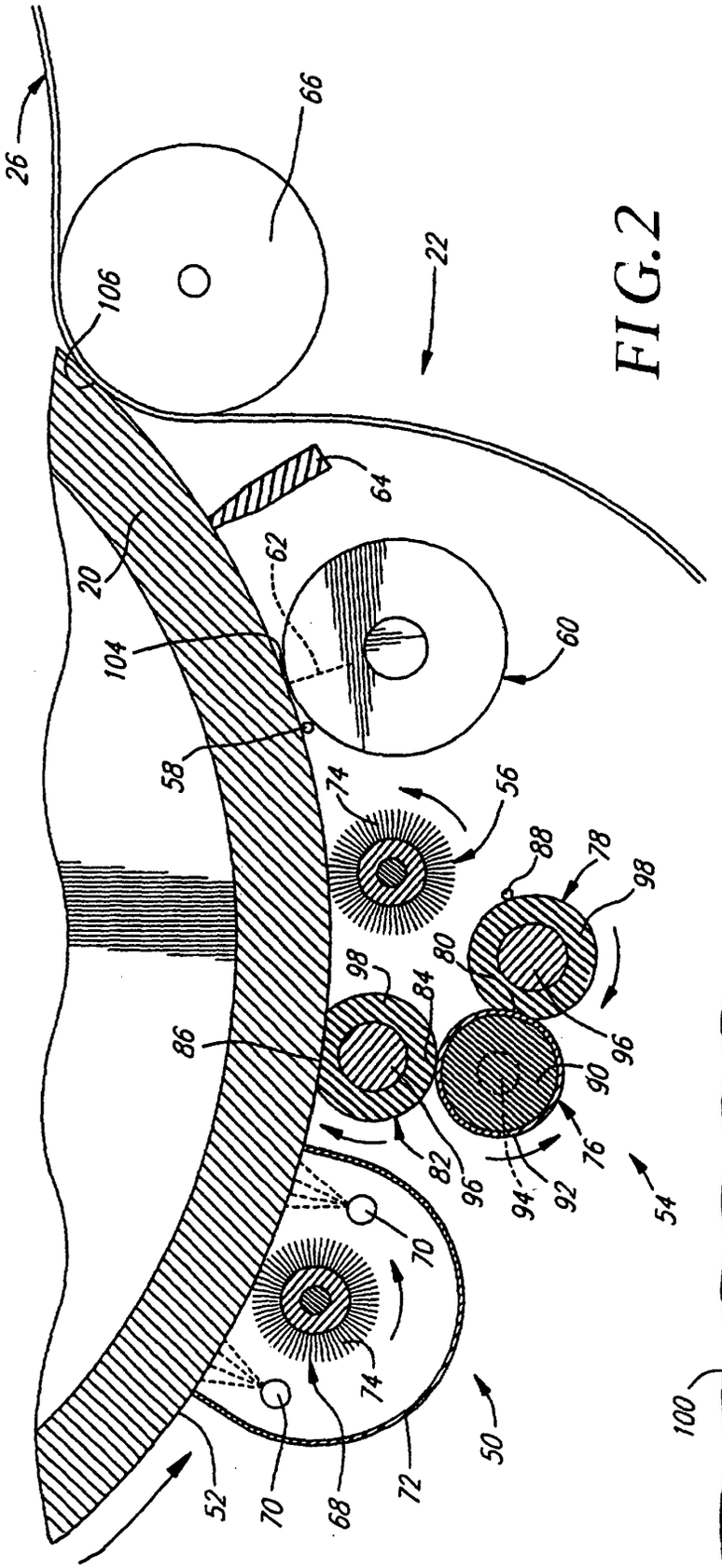


FIG. 1


26
66
106
22
64
62
20
104
60
58
74
56
88
78
98
80
98
84
86
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82
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96
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92
54
70
74
50
52
70
68
72

FIG.2

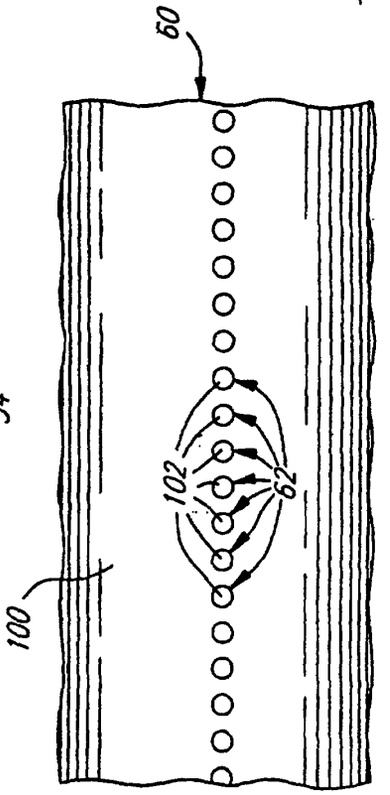
60
102
62
100

FIG.3

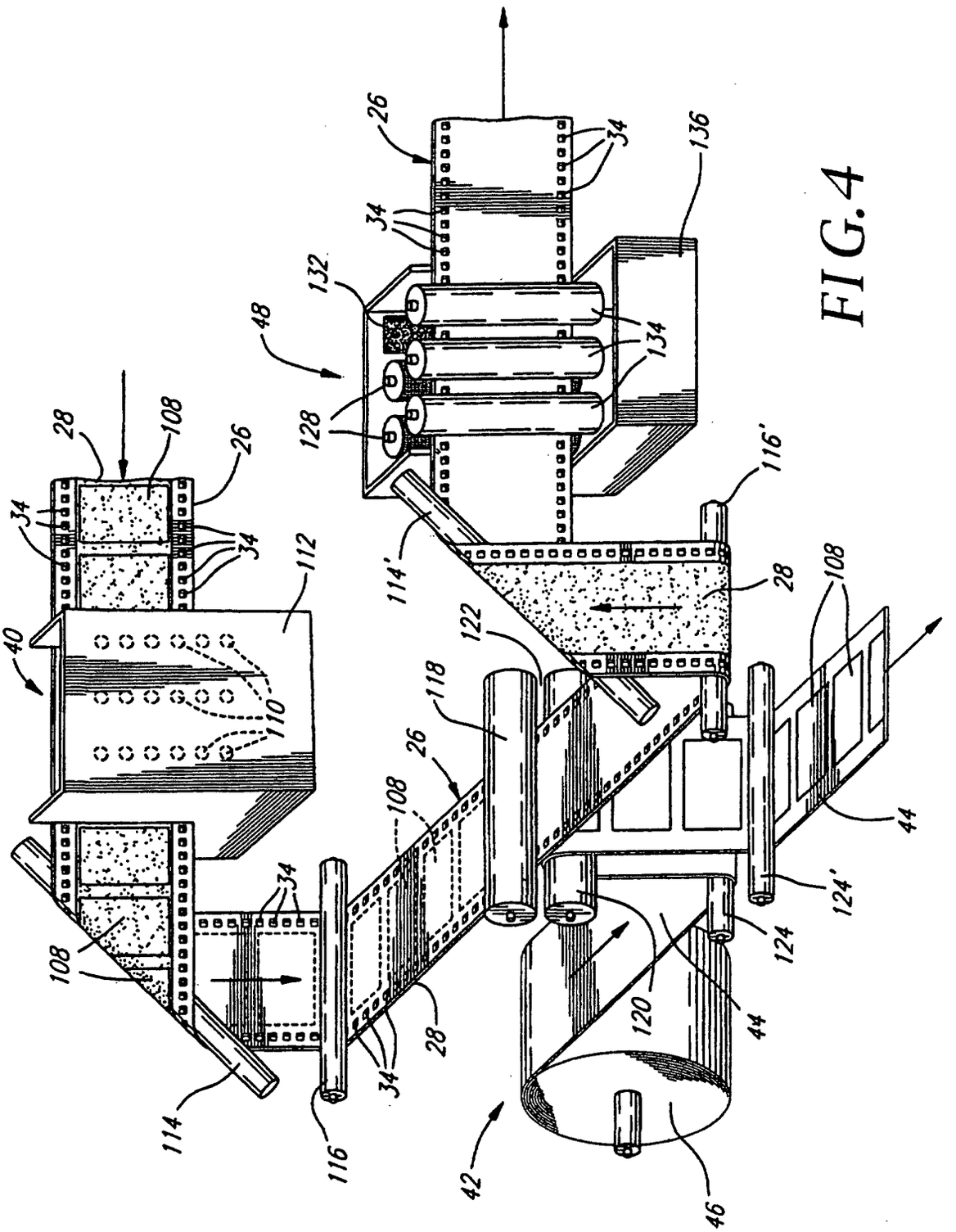
26
34
136
34
132
48
134
128
28
108
26
34
34
112
116'
114'
28
108
40
122
118
110
26
108
44
34
124'
124
108
28
120
44
34
114
116
42
46

FIG.4