COATING SURFACES EMPLOYING AN ELECTROSTATIC FIELD

Filed June 5, 1957 2 Sheets-Sheet 1

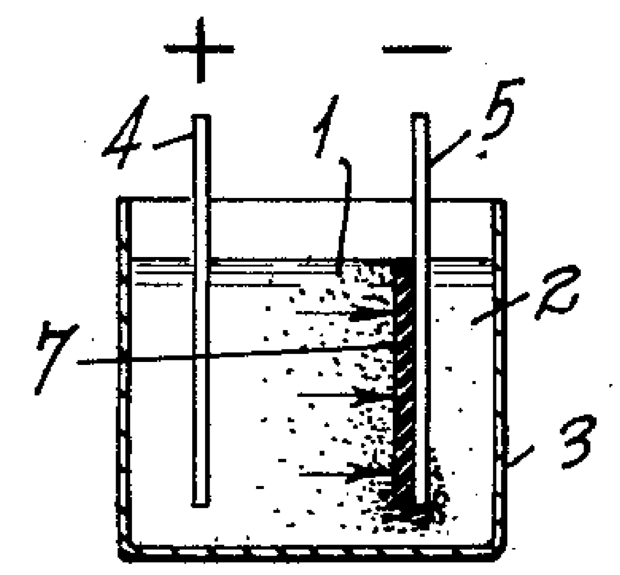

FIG. 1

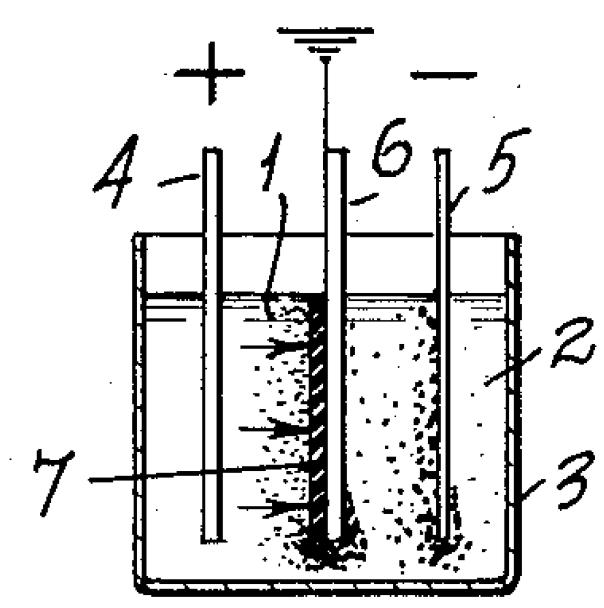

FIG. 2

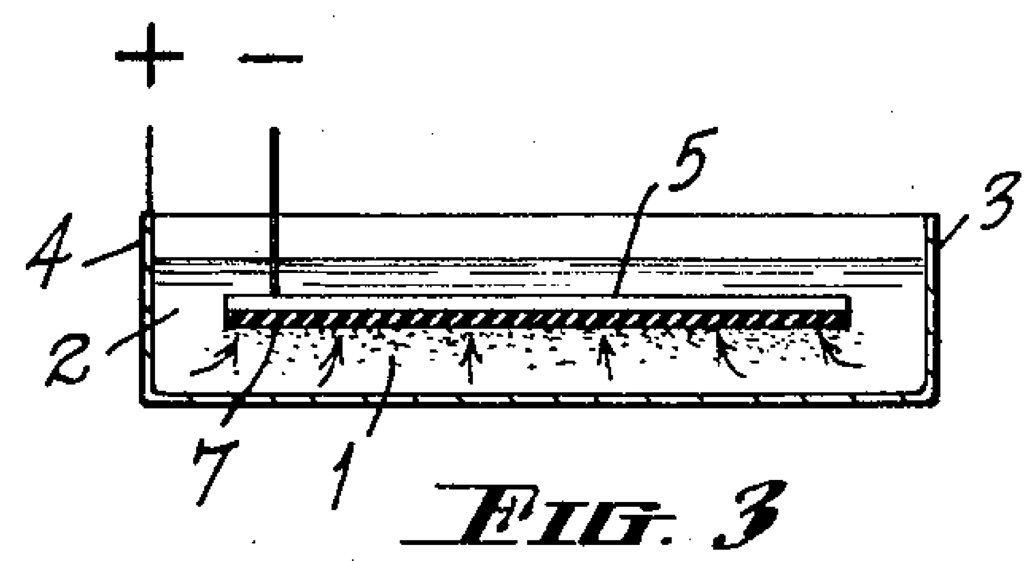

FIG. 3

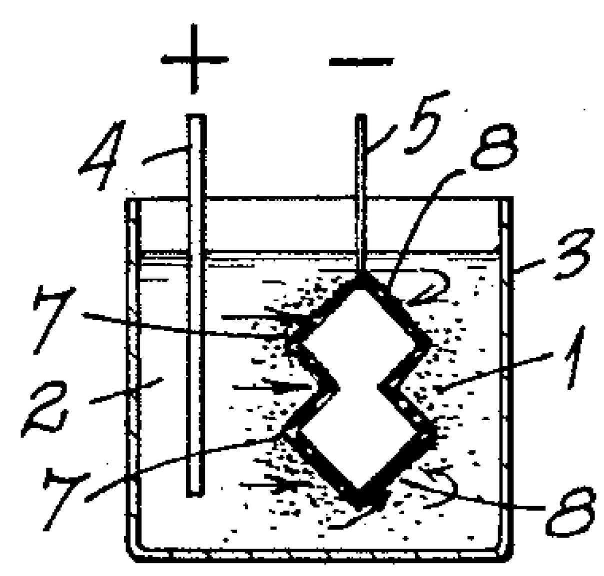

FIG. 4

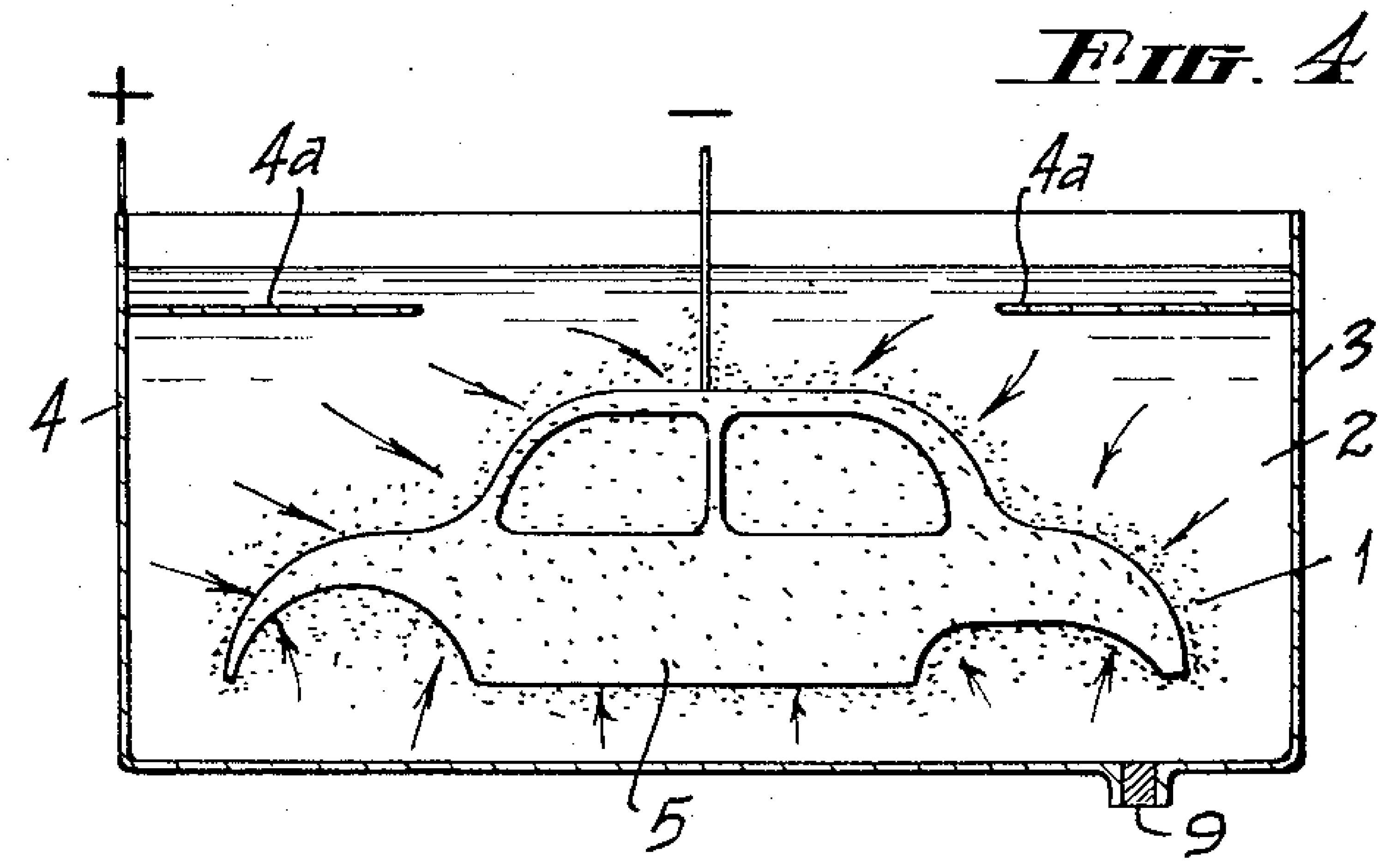

FIG. 5

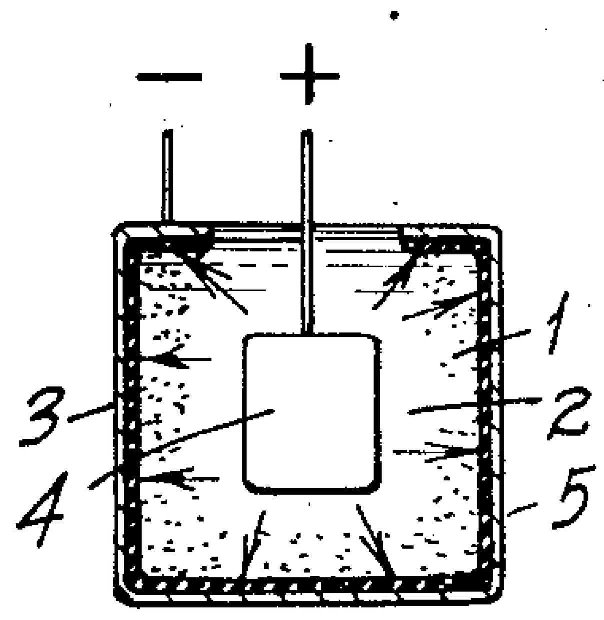

FIG. 6

COATING SURFACES EMPLOYING AN ELECTROSTATIC FIELD

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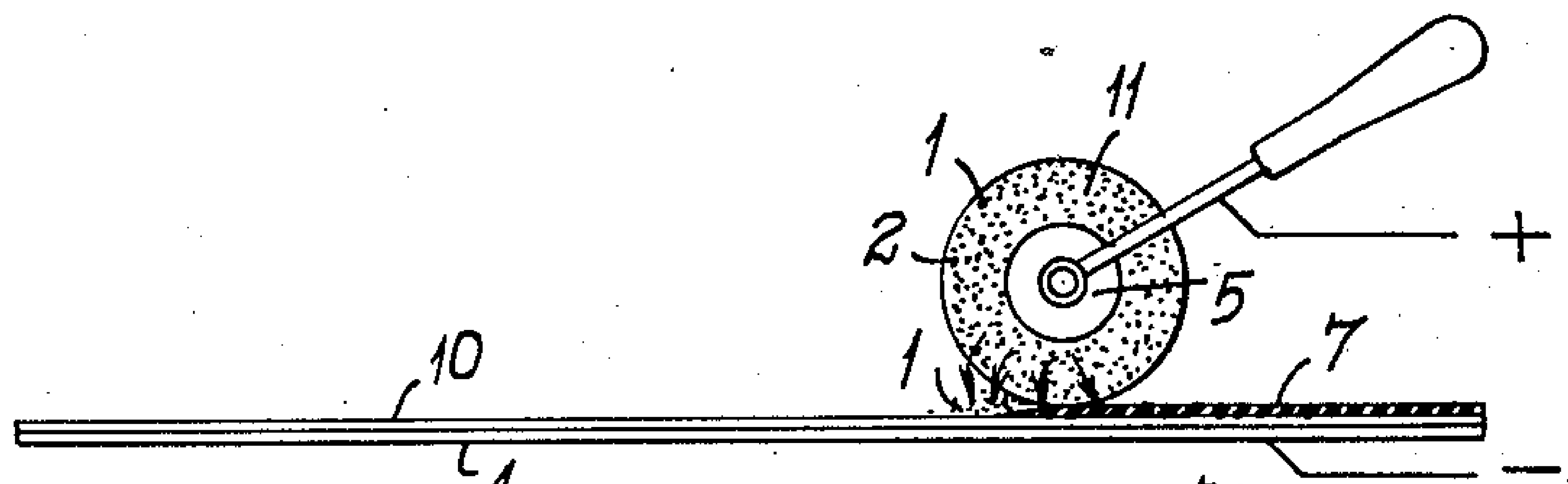

FIG. 7

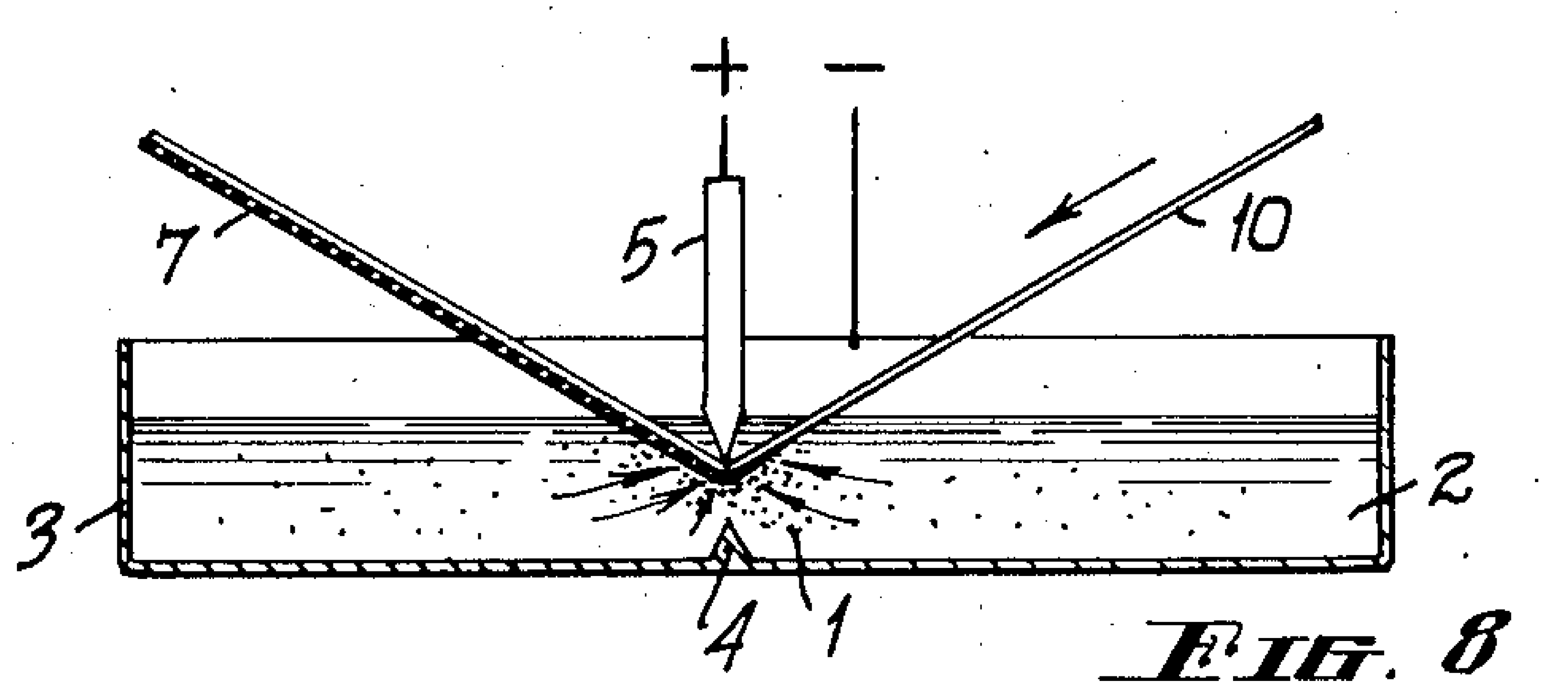

FIG. 8

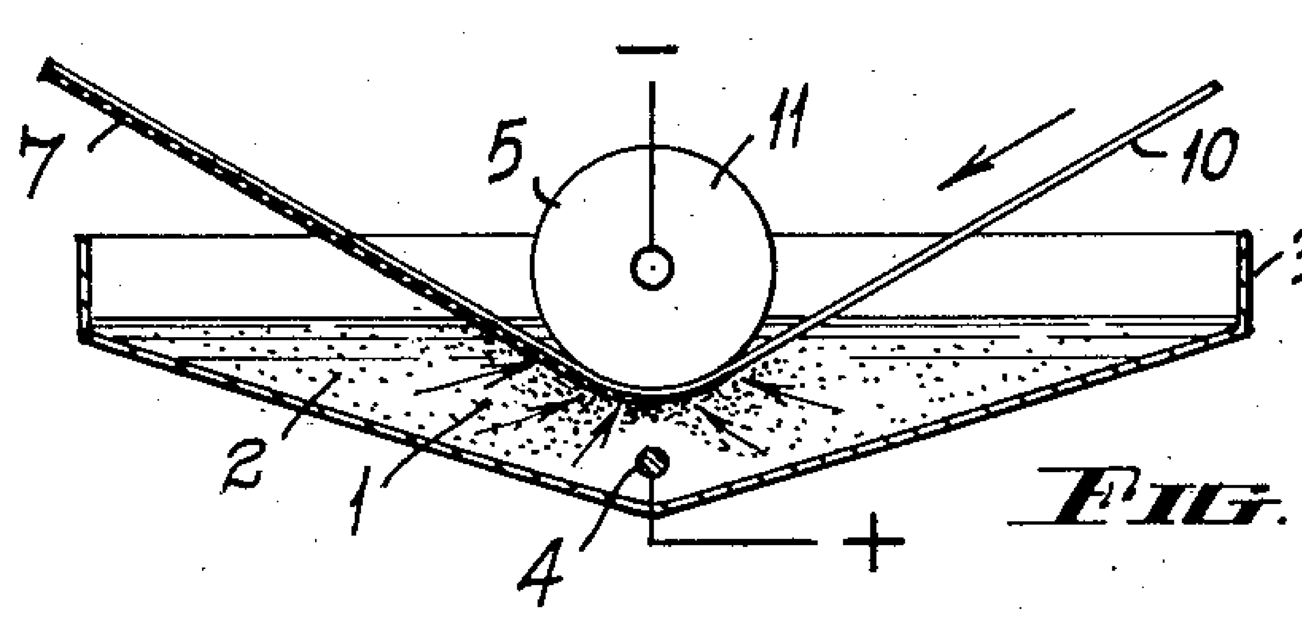

FIG. 9

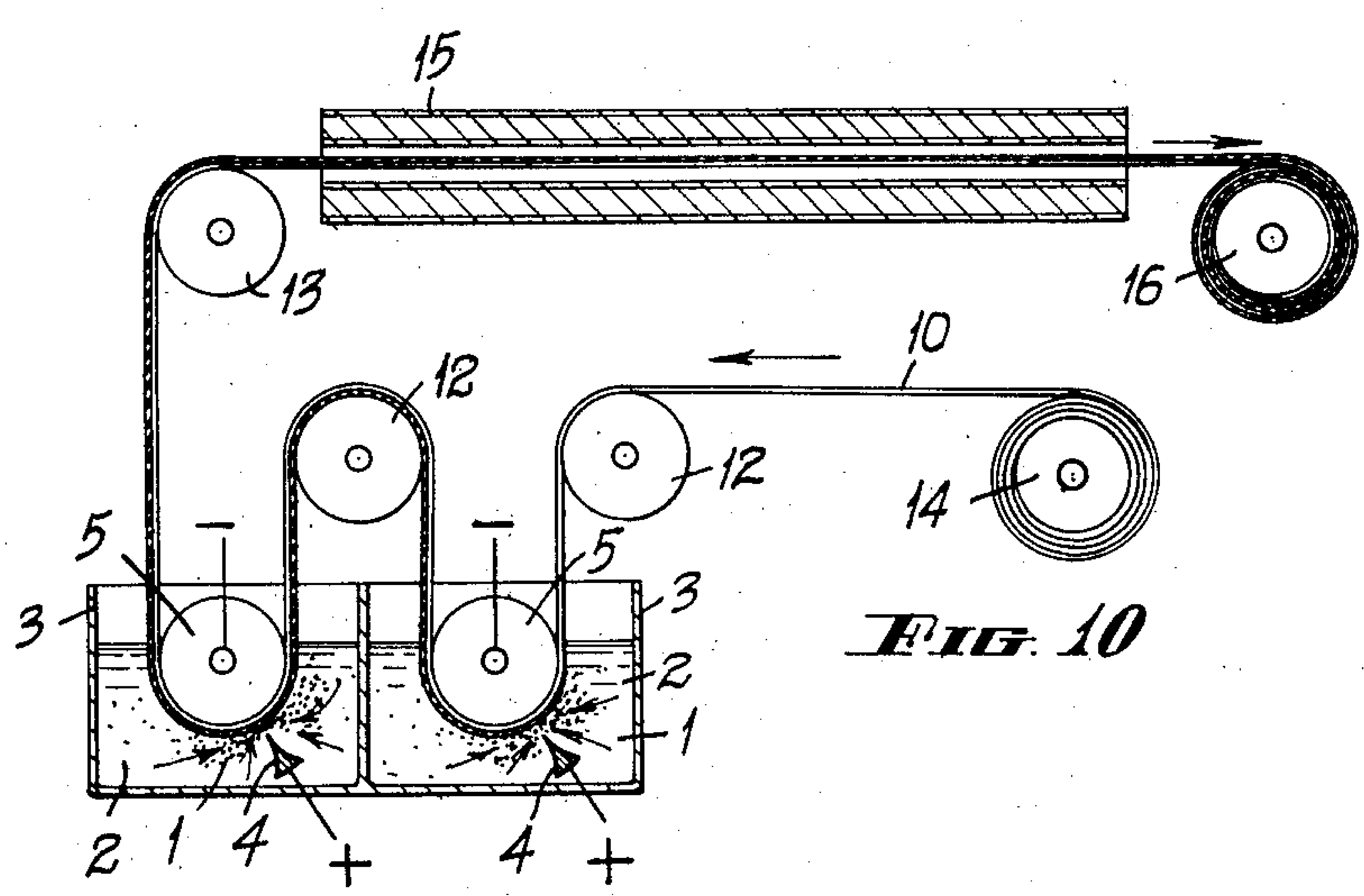

FIG. 10

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COATING SURFACES BY EMPLOYING AN ELECTROSTATIC FIELD

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Application June 5, 1957, Serial No. 663,742

Claims priority, application Australia June 14, 1956

3 Claims. (Cl. 204—181)

This invention relates to method and means for coating surfaces by electro-deposition with coating materials such as paint, paint pigments, ink, lacquer, wax resins, emulsions of various types, oils, dyes, gums, solutions and the like. Such surfaces to be coated may be those associated with objects of regular or irregular shape, and may be of conducting or non-conducting or semi-conducting material and may be of sheet form or plate form such as paper sheets or fabric sheets or plastic sheets or film.

Previously surfaces have been coated by means which include the application of paint and the like by means of brushes, knife coating devices, spray guns, air brushes, electrostatically-assisted spray guns, and by the assisted deposition of liquid paint from the air by electrostatic means. In the use of spray guns and the like, many difficulties arise in that the air operated gun is limited to a comparatively small volume of dispersion, and also causes the coating material to be dispersed in non-uniform sized particles, and in varying patterns and amounts in different areas. The difficulties encountered in this regard have given rise to an adaptation in which an electrostatic field is used to assist in distributing the particles more evenly. Further, in another adaptation an electrostatic field is used to drive liquid paint from an edge through the air on to an object to be coated.

The object of the present invention is to coat surfaces with greater uniformity than heretofore possible, and to coat with a greater variety of materials and to arrange treatment so that effective control can be exerted during treatment over the thickness and uniformity of deposition by control of the time and rate of deposition.

The invention consists in placing the material to be coated in a bath between electrodes which serve to deposit the coating material from the insulating bath on to the surface, with or without relative movement between the material and electrodes.

This invention will therefore be seen to relate to coating by electro-deposition effected in a bath of electrically insulating liquid having a dispersion of particles, colloids, emulsions, solutions, large molecules, emulsoids or gas, as opposed to the plating of articles by the prior methods of depositing through a conductive bath.

The principles underlying the invention are that when a bath of non-conducting liquid contains in it another dispersed substance which is to form the coating material, the dispersed coating substance will be moved in such a bath when there is a field through the bath.

The current consumption of this method of coating is however extremly low compared to the methods where the bath is a conductor, because there is no current flow through the bath other than the minute amount which is transferred with the moving particles as they pass through the field to the second electrode.

The actual apparatus for carrying out the invention can of course be very widely varied but may comprise a bath in which one electrode is a fixture and the other is the object or surface to be coated, or it may comprise a bath having electrodes which serve to deposit the coating material from the insulating bath on to the surface as the material moves or is disposed between the electrodes. A roller may form one of the electrodes, and the materials to be treated may pass through this bath around the roller and be coated in so doing.

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A belt or webbing can move in contact with such a roller and it can be of an insulating material or of a material which will enable it to act as an electrode, or in some cases where the coating material is to be applied to a material which can itself form an electrode, such material can simply be guided through the bath in proximity to the other electrode to effect the required coating.

It will be appreciated that the deposition depends in the first instance on the interesting phase boundary phenomena that occur when one of the phases in contact is an electrical insulator and the other consists of solid particles, colloids, liquid particles or globules, that is emulsions or emulsoids, gas pockets and the like held in suspension. In this case there is movement of the solid or liquid particles suspended in an insulating liquid when an electrical field is applied. The particles migrate either to the positive or negative electrode depending on the inherent charge of the particle. The polarity of the charges on the particles will govern the direction in which they will move, that is, to which electrode they will move when a direct current electrical field is applied. The chief action of the electrical field is in ensuring movement of the particles towards the electrode, and in producing a force which presses the particles together on the surface of the electrode.

Experiments show that when electrodes are oppositely energised, the particles immediately tend to move from the area of the one electrode into the area of the other electrode where they are available for deposition. Final adhesion of the coating is not dependent so much on the electrical field as on the adhesive properties of the coating material, that is on the properties of the pigment-oil-resin combination, for the adhesive properties of particles are functions of their surface properties, that is of the resin or oil or other surface material with which they are pre-coated, or selectively coated, or with which they are co-deposited.

It will be appreciated that the materials used for carrying out the invention can of course be very widely varied and that the coating materials used for coating can include all particles, resins, oils, waxes, dyes, gums, pigments and the like which can be dispersed in a liquid of suitably high volume resistivity. The pigments and resins and the like can be mixed in such a way as to form a paint or paste of creamy or stiff consistency, unpolymerised or partly or nearly fully polymerised and ready for dispersal in the dispersing liquid.

The dispersal into the liquid for the bath may be carried out by any of the common mixing methods such as ball milling, cone milling, mechanical agitation and the like. It is also convenient in some cases merely to stir the powders or pigments directly into the carrier liquid.

In order that the invention will be fully understood embodiments will now be described with reference to the accompanying drawings in which:

Figs. 1, 2, 3, 4, 5 and 6 show static forms of apparatus used in the process, and

Figs. 7, 8, 9 and 10 show the process applied in apparatus suitable in continuous operation, that is with moving elements.

In these figures, similar parts are given similar reference numerals.

Fig. 1 shows the simplest method of practising the invention. The particles **1**, comprising solids, emulsions, emulsoids, colloids, or large molecules are suspended, dispersed or dissolved in the liquid **2** by conventional means such as is used in paint or ink manufacture, for example milling or grinding. The liquid **2** is a liquid, or mixture of liquids, of relatively high volume resistivity, and is held in an insulating vessel **3**. The electrodes **4** and **5** are immersed in the dispersion liquid **2** at an appropriate distance from each other depending on the voltage which is subsequently applied between them, but greater than that at which arcing will occur. Such a voltage might normally be from 500 to 100,000 volts, and for 15,000 volts where the liquid is carbon tetrachloride for rapid deposition the distance would be about one inch. When the field is applied between the electrodes, the particles or droplets or molecules **1** are caused to be rejected by the electrode 4 to travel across the cell through the liquid **2** and deposit or adhere to the electrode **5** and retained on the electrode. With the above conditions a substantial coating is achieved in two seconds. Very thick deposits may be built up on the electrode **5** and retained if the field is maintained while the electrode **5** is removed from the vessel **3**.

Fig. 2 shows another embodiment of the invention in which a third member or electrode **6** is interposed between two fixed electrodes **4** and **5**, the electrode **6** being earthed through a high or low resistance. The removable member or electrode **6**, which may be a relative insulator such as a flat paper, or a conductive metal sheet, is caused to receive the coating or deposit from the bath when the electrical field is set up between the electrodes **4** and **5**. The electrode or member **6** may also be caused to retain a thick deposit if removed whilst the field is maintained.

Fig. 3 shows another embodiment of the invention in which the vessel **3** is identical with the electrode **4**, in this case for purposes of illustration a flat metal dish, but may be of other shape. The object to be coated is identical with the electrode **5**, being a flat object for the purpose of illustration. Deposition occurs primarily on the underside of the flat electrode **5**, and if the coating is itself an insulator deposition may subsequently also occur on the top of flat electrode **5**.

Fig. 4 shows an embodiment of the invention in which the object to be coated is one of irregular shape which it is desired to coat in its entirety. The object **5** is first maintained at negative polarity for a selected period and deposition occurs predominantly on those areas **7** facing the positive electrode **4** and is hindered to a certain extend in re-entrant positions and at sharp edges the deposition is greater. When the object **5** is maintained at positive polarity for a selected period, deposition occurs predominantly on those areas **8** opposite to the negative electrode **4**. After several of these slow cycles, the object is coated uniformly over the entire surface. It should be noted that the process is not designed for alternating currents of the order of fifty or more cycles per second as stringing of the particles tends to occur and deposition stops. Slow alternations of direct current of the order of one cycle per second or less than one per second are necessary, for about two to ten cycles, the uniform coating then being the result of relative potentials on varying parts of the object.

Another object identical or similar in shape to the object **5** can be substituted for the electrode **4** or be identical with the electrode **4**, enabling two objects to be coated at once. The further advantage exists in that irregularities in the object **5** will be accurately balanced by those in the similar object identical with the electrode **4** and consequently less cycling will be necessary to secure uniform overall coating.

Fig. 5 shows an embodiment of the invention in which it is desired to coat a large object of irregular shape by immersion in a vessel. The object **5**, identical with the electrode **5**, is immersed in the liquid **2** contained in the vessel **3**, which is identical with the electrode **4**. To ensure uniformity of coating it may be necessary to include removable additional electrodes **4*a***. After an operation including cycling of polarity as in Fig. 4, the liquid is drained away through outlet **9** whilst the field is maintained, or alternatively the electrodes **4*a*** are lifted away and the object removed whilst the field is maintained or if the concentration of solids and the like in the suspension is selected suitably, the field need not be maintained.

Fig. 6 shows another method for practising the invention where it is desired to coat the inside of a hollow object. The object **3** is the container for the liquid **2** and the particles **1** and is the one electrode. The electrode **4**, which may be shaped to conform with the inside of the object **3**, is immersed in the liquid **2** and held in a fixed position to prevent it moving under the influence of the electrical field which is subsequently applied between **4** and **3**. Deposition of the material occurs on the inside of the object **3** and added uniformity may be secured by cycling the polarity as in the manner of Fig. 4.

Fig. 7 shows an electrode **4** carrying the object **10** which is to be coated, and the coating substance **1** and carrier liquid **2** are carried by an absorbent roller **11** forming the other electrode **5**. This roller **11** is moved across the surface of the object **10** to be coated and discharges coating material uniformly because of the electrostatic field.

Fig. 8 shows an embodiment of the invention in which the object **10** to be coated is continuously coated whilst the object is moving. The object **10**, which may be a web of paper or a metal foil or other flexible material, is arranged to pass through the liquid **2** and between the electrodes **4** and **5**, preferably in contact with the electrode **5** as shown, and as it passes the coating **7** is caused to be deposited on it by the applied electrical field between the two electrodes **4** and **5**. The vessel **3** may be made of an insulating material, or lined with an insulating material, but is shown identical with the electrode **4**. The voltage applied between the electrodes, as in the other figures, governs the distance between the electrodes, but is commonly set at 15,000 volts and one and a quarter inches respectively.

Fig. 9 shows an embodiment of the invention in which the object **10** to be coated is once again a web which it is desired to coat continuously. For the convenient placement of the web between the electrodes and its insertion and removal from this position, it is convenient to substitute a roller **11** which is identical with the electrode **5** and similarly placed but arranged to rotate or be driven at a uniform speed. Deposition occurs in a similar way to Fig. 8 except that the electrical field is less concentrated at the base of the electrode as will be apparent from the drawing. In this case the container **3** is shown as formed of an insulating material and the electrode **4** extends across it parallel to the roller **11** which forms the other electrode **5**.

Fig. 10 shows apparatus designed to incorporate the principles set out for Figs. 8 and 9; in this case there is illustrated the roller system of Fig. 9, together with an arrangement to guide the web in and out of the bath **3**, comprising the rollers **12** and **13**. The web is fed from the feed roller **14**, over the guide rollers **12** into the baths **3** and then up and over the roller **13**, through a drying tunnel **15** and on to the finish roller **16**. It will be appreciated that this arrangement merely demonstrates the principle and that other arrangements are possible which include other web treatment rollers and positions.

It demonstrates also that multiple treatment is possible in that the object **10** passes through two separate containers **3—3**, each with its electrodes **4**, the containers **3—3** forming the other electrode **5**. The electrodes **4** could be arranged to produce lines of different colour by adjusting their width and position in relation to the object **10**, or could deposit different substances such as an adhesive and a granular material respectively or a base coat and a photo-sensitive coating respectively.

The following examples of material compositions and the liquids in which they may be dispersed will serve to illustrate the invention.

EXAMPLE 1

An enamel composition of the following proportions dispersed in the liquid toluene after compounding:

	Parts by weight
RCI 5035 toluidine red	67.00
"P–786–50 Beckosol"	134.00
Xylol	101.00

Grind in a ball mill and add:

	Parts by weight
"P–786–50 Beckosol"	429.00
Xylol	61.00
6% cobalt "Nuodex"	2.50

"Beckosol P–786–50" and "Nuodex" are trade marks respectively for epoxy ester resin and cobalt naphthenate.

EXAMPLE 2

A paint composition of the following proportions dispersed in the liquid carbon tetrachloride:

	Grams
"Rhodene L9/50" resin	100
Zinc oxide	130
Yellow litharge	20
Cobalt naphthenate (drier)	0.5
Manganese naphthenate (drier)	0.5
Toluene (carrier liquid)	100

These materials are milled together in a ball mill for eight hours. "Rhodene L9/50" is the trade mark for an alkyd resin.

After mixing the above paste is dispersed in 100 grams of a halogenated hydrocarbon such as carbon tetrachloride and becomes the material for the bath. The coating so obtained on the object after a short drying time comprises the pigments, the resins and the driers; polymerisation and hardening occurs after deposition.

EXAMPLE 3

A composition of the following proportions for dispersion in the liquid carbon tetrachloride designed to give a non-permanent coating for such purposes as carbon paper:

	Grams
"Rhodene L9/50" resin	100
Carbon black (gas black)	120
Waxoline nigrosine	20
Castor oil	20

These materials are milled together in a ball mill for four hours and then dispersed in carbon tetrachloride.

EXAMPLE 4

A composition of the following type for slow drying purposes:

	Grams
Linseed oil, boiled	25
Cadmium selenide	75
Lead naphthenate	0.5

Add 5 grams of this paste to 100 millilitres of cyclohexane (carrier) and disperse thoroughly.

EXAMPLE 5

A composition of the following proportions for dispersal in toluene and carbon tetrachloride for use in the coating of tapes for tape recorders:

	Grams
"Rhodene L9/50 resin"	100
Iron oxide	120
Cobalt naphthenate (drier)	0.5
Manganese naphthenate (drier)	0.5
Toluene (carrier liquid)	40

These materials are milled together in a ball mill for eight hours, and subsequently dispersed in a mixture of toluene and carbon tetra-chloride, containing ten percent carbon tetra-chloride by volume.

With strongly magnetic materials care must be taken to see that the magnetic fields do not act to counter the electrostatic fields.

EXAMPLE 6

A composition of the following proportions for dispersal in toluene for use in the coating of material in the form of thin transparent films:

	Parts by weight
"P–786–50 Beckosol"	429
Xylol	61
6% cobalt "Nuodex"	2.5

This material is mixed with toluene and is immediately ready for use.

EXAMPLE 7

Polystyrene, dissolved in and thinned with xylol to suitable consistency.

EXAMPLE 8

Carnauba wax or beeswax dispersed in solvent naphtha to suitable consistency.

In the foregoing examples, the function of the toluidine red, zinc oxide, yellow litharge, carbon black, waxoline nigrosine and cadmium selenide is as a colour material, while the "Beckosol," "Rhodene L9/50" are relatively permanent fixing agents. The castor oil, linseed oil and carnauba wax or beeswax are fixing agents of a less permanent type, and act also as control agents, these substances when used with the more permanent fixing agents, serving to modify the permanence of the fixing agent as well as modifying the charge of the particles. The permanent fixing agents may also modify the charge of the particles. The cobalt "Nuodex" (cobalt naphthenate), manganese naphthenate and similar substances act as driers, while the toluene, xylol and the like form the insulating liquid and suspending agent.

As stated earlier, the invention can be applied to the treatment of many materials with a large number of coating substances, but some specific examples now follow:

(*a*) *Tape for tape recorders*

The invention has application to the coating of such substances or backings as the tape used in magnetic recording machines where it is necessary to coat one side of a tape with a thin film of iron oxide or the like, the advantages of this invention in effecting such a coating being that there is a selective effect which ensures that only the particles in the bath which have the correct characteristic for deposition will be deposited, and as there is a uniform distribution of the suspended particles in the bath, there is likewise a uniform distribution on the tape, it having been shown that impurities and particles of other characteristics can be deposited on the other electrode. A composition for the dispersal material is given in Example 5 and an apparatus for continuous coating of the tape is shown in Fig. 8.

(*b*) *Coated paper for electrophotography*

In a similar way the invention has application to the coating of electrophotographic coatings on to paper or foil or fabric and the like as backings. Material suitable for the preparation of such coatings is shown in Example 2 and apparatus for coating of single sheets is shown in Figs. 1, 2 and 3; continuous coating of continuous webs can be carried out in the manner described in Figs. 8 and 9. A similar selective effect in deposition as well as the already mentioned uniformity of the coating enables a much better product to be produced for electrophotography than is obtained by any other means. Further, continuous tones are not readily obtained in electrophotography on paper produced by other means but such continuous tones are easily obtained with the electro-coated paper. Further, paper can be coated at high speed and at low cost and with simple apparatus.

(c) Coated paper for use as "carbon" paper in typing

It will be evident in (*a*) and (*b*) we have dealt only with applications where normally it is desired to produce a permanent coating which will withstand mechanical damage at least to the extent required of normal paint coating. In some instances it may be desired to utilise a coating which is not permanent but has the property of smudginess or impermanence to the desired extent, for example in the case of carbon paper for typing. To confer this property on the coating it is only necessary to stop or delay hardening on the coating composition and a typical composition is shown in Example 3. The apparatus appropriate to the manufacture of this carbon paper in continuous rolls is shown in Figs. 8 and 9.

(d) Coloured paper and coloured paper in pattern form

The invention has application to the production of high quality low cost coloured paper, foil and the like for various purposes in the printing industry, manufacture of containers, decorations and the like, by the coating of paper web of desired quality and characteristics with coloured matter of controlled thickness. A composition for use where a thick gloss finish is required is given in Example 1, also designed to give a red colour. It will be appreciated that the colours may be mixed in the base composition or in the bath itself by addition of pigments and dyestuffs at the appropriate time, mixing being assisted by the electric fields which cause deposition. This mixing can be carried out during deposition to give pattern forms. Also, the thickness of the coating may be varied by varying the time of deposition, and in the case of the continuous coater, Figs. 8 and 9, by alteration of the speed of the drive rollers, or feed or take-off rollers, Fig. 10, which alters the speed of deposition. Further this can be used to give a variation in tone or intensity of colour. It will be appreciated that by selecting the shape of roller or electrode or interposing suitable masks between the electrodes and the paper web, patterns may be formed on the paper.

(e) Coating of abrasives on to paper and other backings

The invention also has application to the coating of abrasives on to paper or other suitable backings. By substituting abrasive particles for the pigments in the Examples 1 to 5, or by including other binding agents in the mixtures, these abrasives may be coated in a similar way and the properties of the coating may be made more or less permanent by control of the binding material and its amount in relation to the quantity of abrasive and by selection of binders of suitable hardening properties. The cutting action of the abrasive material can be made more uniform than has been possible heretofore because of the inherent selective effect of the invention as regards type of material deposited and also its selective effect with respect to size of particle deposited. Further, closer packing of the fine particles is obtained than with other methods and there is order in the way the particles are deposited if the particles are of greater length in one axis than the other axis. Further, it is possible to deposit finer material in liquid suspensions than in any air suspension.

(f) Coating leather and the like

It is clear that the invention can be used also for the application of coloured or decorative or protective coatings to leather and other natural sheet material as well as to fibrous materials of artificial origin such as fabrics made from wool or cotton or silk or plastic fibres or plastic sheeting. In this case the web as coated may itself be conductive or insulating and in the latter case it may be necessary in some instances to render the back

of the material conductive or partially conductive by the application of gelatine, or silver chloride or the like prior to coating, if the electric field strength is not sufficiently high. Apparatus suitable for coating is shown in Figs. 8, 9 and 10 and materials for coating are generally similar to those already described.

(g) Pre-coating ply layers

Wastage of ply-wood is understood to be frequently caused by failure to coat the ply layers with glue and the like prior to pressing the ply layers together. Using this invention it is possible to coat the ply layers uniformly with glue and the like in a manner not heretofore possible.

(h) Anti-corrosive coatings

It will be seen that the invention can be applied in cases where the property of the coating which is required is that of protecting an underlying tough but chemically active material or material subject to corrosion. Such a situation arises in the case of boiler drums where at the present time protecting coatings are inefficiently applied by brushing on to the inside of the drum.

It is merely a matter of selecting a coating material such as a plastic or resin or pigmented resin or chemical particle or powder that is resistant to the corrosive environment to which the object is subjected, together with a suitable binding material if necessary.

This coating is applied in a manner illustrated in Fig. 6 that is by using the drum as an electrode and inserting another electrode to form the active electrodes.

(i) Welding plastics

The quantity of material deposited in our process is a function of the electric field strength at various positions on the article, and normally the distribution of the field is arranged to be uniform by positioning of the electrodes or by cycling of polarity or other means. However, where the application requires it, use may be made of naturally occurring changes in field strength and consequent changes in deposition rate, especially at edges and breaks in the continuity of materials. This is made use of in the welding of plastics, in which a conducting former of the required shape has built up around it sheets, plates or sections of plastics which will form the object except at the positions requiring welding. At these junctions of sheets or plates or the like, there will be an extremely high field strength compared with the portions of the conducting former covered by the plastic which is normally a strong dielectric material. It follows that in a deposition cell in which the former is used as an electrode there will be pronounced deposition at the joints in the plastic. If the depositing material is suitably chosen, such as a suspension of the parent plastic itself, the joint will be preferentially filled until the field strength becomes again uniform. Materials for this application can vary widely, but an example is a dispersion of methyl methacrylate resin in chloroform.

(j) Formation of plastic films

Another application of the invention relates to the deposition of plastic material such as resins for example alkyd resins on to a foil or web or other object from which it is subsequently removed to form itself a web or foil or film. The film may be made in a transparent, translucent or opaque form by the addition of suitable pigments and the like.

It will be appreciated that the film so deposited may be removed from the electrode in various ways, including in the case of a roller or plate electrode removal by peeling by means of the use of a knife or other peeling device. Further, the roller or web on which the film is deposited may be pre-treated with a material which renders it non-adherent to the deposited film although not impairing the deposition; consequently the film may be removed after deposition. An example of this is pretreatment of the web or roller or plate with a water soluble glue or dextrin or the like.

Another means whereby the film may be removable is to deposit it on a liquid surface which is identical with or connected to the depositing electrode. Such a liquid includes mercury metal, or water, or other conductive liquid.

(*k*) *Production of printing rollers and platens*

Another application of the invention utilises the ability conferred by the process to build up thick deposits by coating for longer periods up to five minutes or more with selected voltages applied between the electrodes or between one electrode and the article or work. Alternatively for continuous coating, the web may be coated a number of times or by a number of rollers or in the case of a roller coating the circumference of the roller may be continuously coated for a number of revolutions.

Taking a roller as an example, it is possible to build up a firm resin-bonded pigmented layer up to a quarter-inch thick or more, having a smooth resilient surface and character ideally suited for inking and offset rollers. It is obvious that the roller so formed may be re-worked after a period of service by machining off the top skin and re-coating by our method.

Similarly, a printing platen can be built up by coating a flat metal or other surface plate. It will be appreciated also that if the metal backing is shaped to have high or low spots or areas or lines then the coating will follow and accentuate these spots, areas or lines.

Similarly if type is first set, it is possible to coat the type-face thickly and afterwards remove the coating to form a matrix. In another adaptation, it is possible to paint a pattern on with an insulating paint and so produce a patterned coating which accentuates in relief the painted pattern.

(*l*) *Production of patterns on fibres*

In another adaptation the web which is coated may be of fabric based on wool, cotton, silk or plastic and the like and a layer of electrophotographic paint can be deposited on it. This layer can subsequently be used to photograph patterns, scenes, landscapes, portraits and the like on to the fabric and the zinc oxide or other electrophotographic pigment removed in the manner of a previous application of the present inventors.

The fabric may be of fine silk net such as is used in the manufacture of silk screens and this may be given an overall coating of electrophotographic paint which may be caused to take a pattern and in the areas unprotected by a pattern the electrophotographic pigment may be dissolved away so that the whole forms a stencil or mask in pattern form for painting purposes.

(*m*) *Production of silver halide films*

It is possible that the primary photo-chemical change in a silver halide grain itself consists simply in an internal transfer of electrons originally set free from internally absorbed metallic silver nucleii and taken up by surface silver ions which discharge to form nucleii.

Here, however, we are concerned with the electronic deposition of the silver halide in its vehicle on to a surface in a uniform manner, that is co-deposition of a silver salt with resin or the like. It will be appreciated that for development in aqueous development solutions, it is necessary for the coating to be permeable to these solutions, that is the resin content of the coating must be low enough to avoid formation of a continuous skin but high enough to bind the photochemical pigments in place. Having established the necessary permeability, development can proceed in a similar manner to that for gelatin films.

(*n*) *Fluorescent screens for X-ray and other work*

It will be appreciated that by introducing pigments of a fluorescent character, that is, fluorescent properties under the influence of light or X-rays and the like, the electro-deposited coating may be arranged to have the properties of fluorescence, permanence, and smoothness necessary for close contact and proper action on an underlying silver halide or other film when used in conjunction with the film.

(*o*) *Transfer paper for electrophotography*

Proceeding as for item (*c*) but omitting the carbon pigment, a thin sticky film, more cohesive than adhesive may be deposited on a suitable backing such as white paper suitable for transfer of developed electrostatic images. By inclusion of the usual hardeners, the permanent resin film may be used for the transfer of electrostatic images.

What we claim is:

1. A process for coating a backing with a metal oxide comprising coating the metal oxide with an alkyd resin and forming a paste thereof with a drier and a carrier liquid, dispersing the paste in a halogenated hydrocarbon liquid, establishing an electrostatic field in said liquid, and placing the backing in said field in the liquid thereby depositing the metal oxide on the backing.

2. A process as claimed in claim 1 for providing magnetic tape wherein the metal oxide is iron oxide, the drier is a naphthenate, the carrier liquid is toluene, said backing is a tape, and the liquid is carbon tetrachloride.

3. A process as claimed in claim 1 for providing photographic paper wherein the metal oxide is zinc oxide, the drier is a naphthenate, and the carrier liquid is toluene.

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