

Oct. 26, 1937.

A. F. MESTON

2,097,233

ELECTRICAL DEPOSITION IN PATTERN FORM

Filed March 31, 1934

5 Sheets-Sheet 1

Fig. 1.

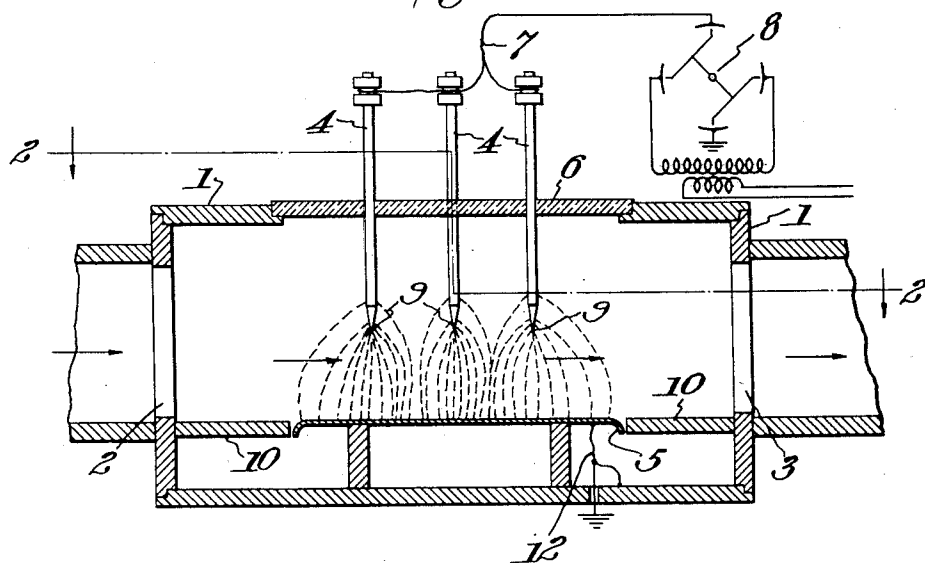
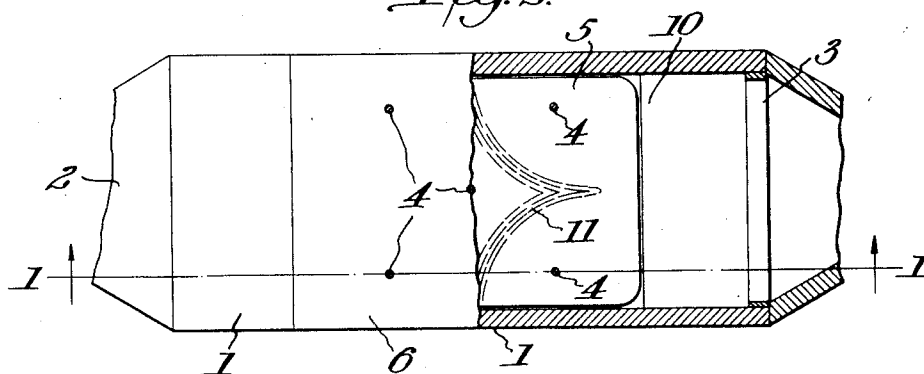


Fig. 2.



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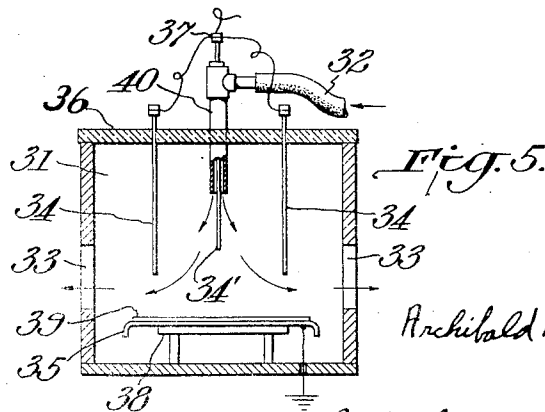
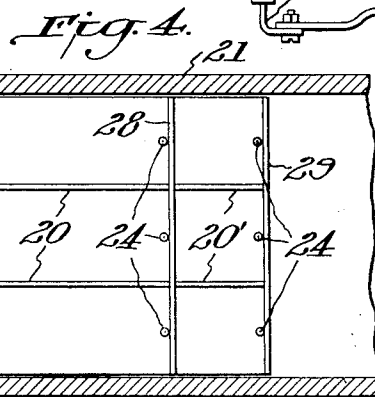
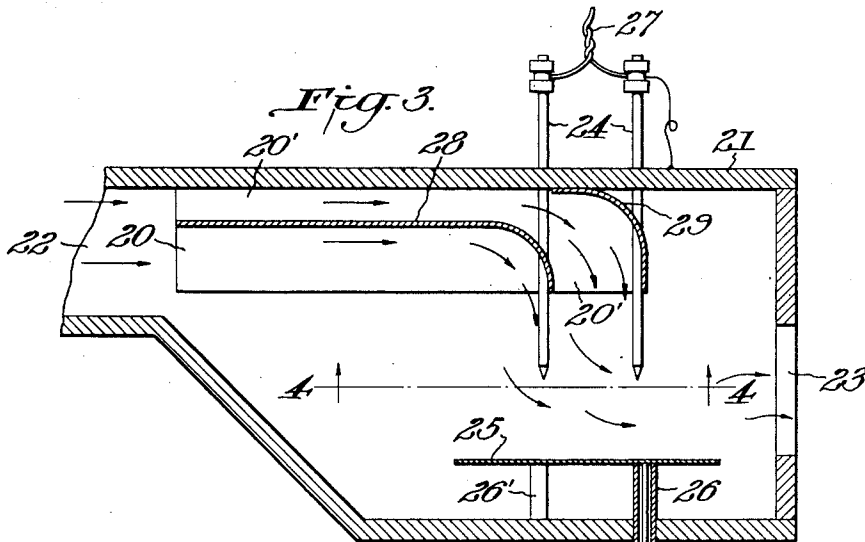
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5 Sheets-Sheet 2



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ELECTRICAL DEPOSITION IN PATTERN FORM

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Fig. 6.

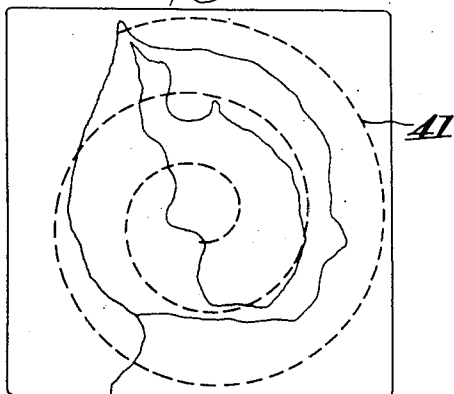


Fig. 7.

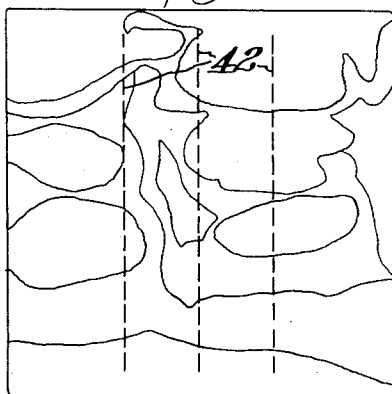


Fig. 8.

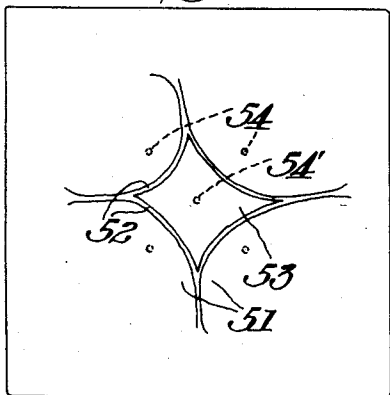


Fig. 9.

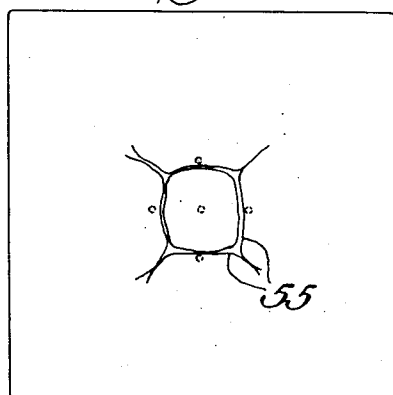


Fig. 10.

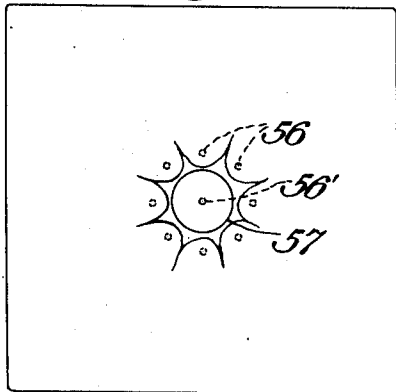
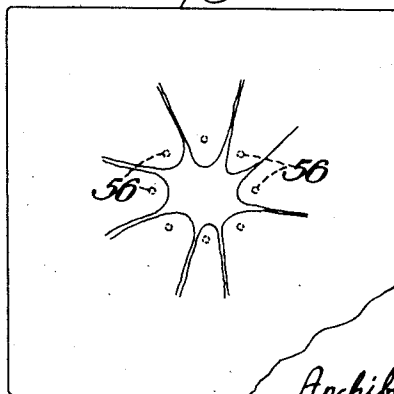


Fig. 11.



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ELECTRICAL DEPOSITION IN PATTERN FORM

Filed March 31, 1934

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Fig. 12.

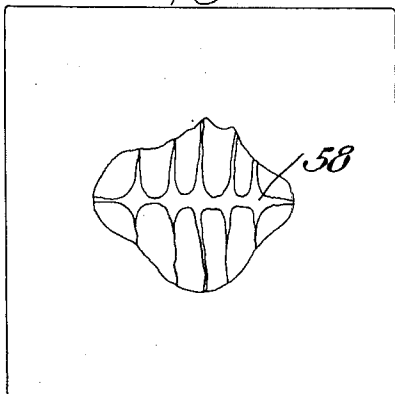


Fig. 13.

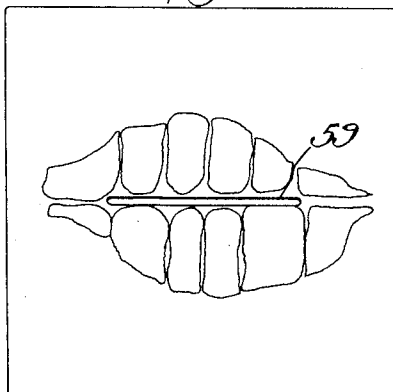


Fig. 14.

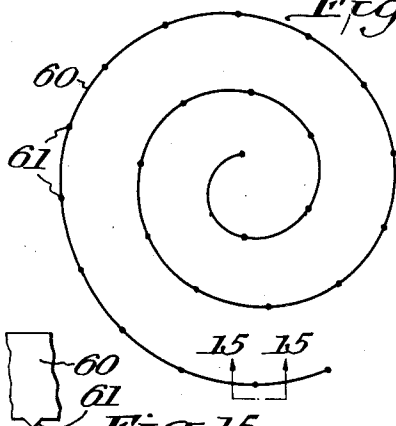


Fig. 17.

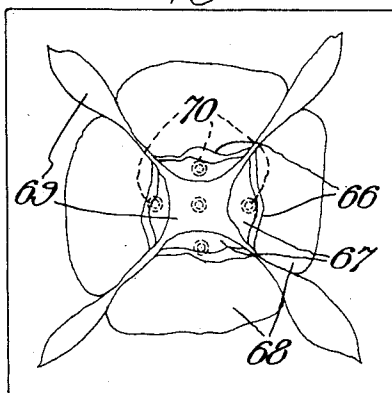


Fig. 15.

Fig. 16.

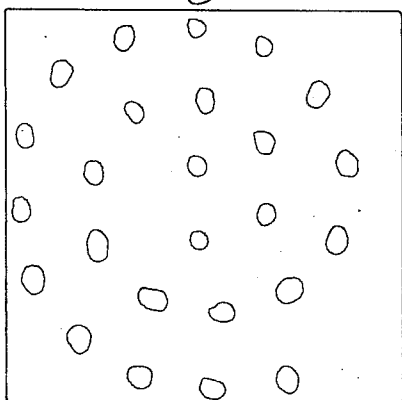


Fig. 18.

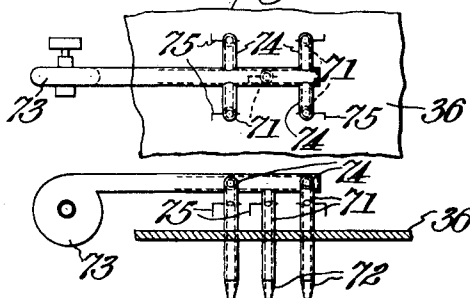


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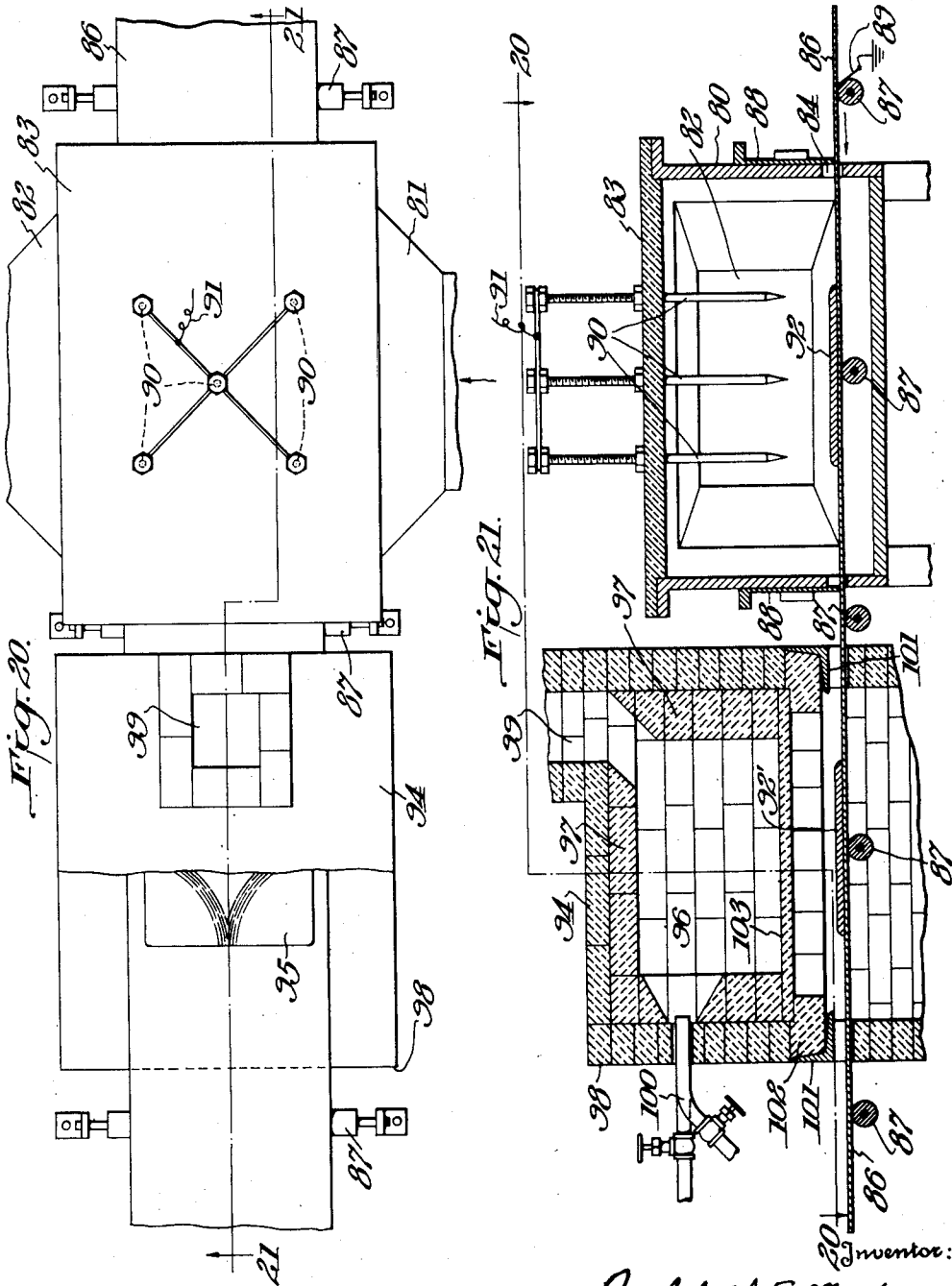
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ELECTRICAL DEPOSITION IN PATTERN FORM

Filed March 31, 1934

5 Sheets-Sheet 5



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UNITED STATES PATENT OFFICE

2,097,233

ELECTRICAL DEPOSITION IN PATTERN FORM

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Application March 31, 1934, Serial No. 718,501

10 Claims. (Cl. 41-1)

This invention has to do with the electrical deposition of comminuted material in the form of patterns. It provides apparatus for coating and/or decorating a surface with material which is conveyed to the vicinity of the surface as a finely divided suspension and is then directly deposited upon the surface in pattern form. As examples, an electric field can be used to deposit metal dusts, colored sands and enamels or dyes upon a surface in pattern form; and the material deposited can then be attached to or incorporated into the surface with adhesives or by heating or chemical action without manual arrangement.

The invention is of use in industries having problems in decorating surfaces and especially where the decorative coatings are made of materials supplied in finely divided form, such as those resulting from dry grinding, subliming, condensing or spraying operations. For instance, it permits an air floated powder immediately after leaving a classifier to be laid down in pattern form on a surface to be decorated, thus making unnecessary the collection of the powder and its incorporation into a paste or paint before deposition. It also permits surfaces of extended area to be coated in pleasing outlines without resorting to stencils or other means which require manual operation and are awkward to handle in large sizes.

It is well known that free electric charges tend to move when in an electric field, and if the charges are attached to particles which are free to move, such as dust particles suspended in air, the particles will be moved with the electric charges towards the boundaries of the electric field. The phenomenon is especially effective when the electric field is of high intensity and of constant polarity. Electric fields are commonly described in terms of so-called lines of force and accepted characteristics of these lines of force are that they leave a conductor perpendicular to the surface; that they repel one another and therefore are distributed as evenly as electrode spacings and dielectric conditions permit; and that they will not enter narrow openings between conductors, but will terminate on the surfaces adjacent such openings as is illustrated in the use of a Faraday "cage". Advantage is taken of these characteristics in the present invention. By altering the contour of the electrode boundaries, the direction and concentration of the electric lines of force can be altered. This means that the direction and velocities of charged particles moving in the

electric field are altered, making possible their deposition in patterned outline or decorative figures.

The effects resulting from changing the boundary of an electrode become very pronounced when the electrode comprises portions of great curvature, such as ridges and points which project towards the opposing electrode. When a high voltage difference is impressed across the dielectric between opposing electrodes, one or both of which have boundaries with such projecting portions, very high concentrations of lines of force exist in the vicinity of, and terminate on, the projections. If the dielectric is a gaseous fluid, the high electric stresses to which the gas is subjected in these regions will cause it to become ionized and streams of free charges (associated with ions and electrons) will move rapidly from (or to) the projections on the electrodes and set up movements in the gas known as "electric wind."

The changes that can be effected in an electric field in a gaseous dielectric in order to produce changes in the deposition of particles are, therefore: changes in the concentration and direction of the lines of force, changes which affect the production and distribution of free electric charges, and changes in gas movements due to electric wind. Of course, changes in the velocity of the gas passing through the electric field which may be brought about by the operation of a mechanical fan will also affect the deposition of particles carried into the electric field by the gas stream.

The foregoing discussion of the principles made use of in the present invention in terms of present day concepts is presented merely to assist in an understanding of the invention. The invention is not dependent, however, on any theories of operation, but involves novel, practical and useful apparatus for the deposition of materials in pattern form. The objects of the invention are set forth below, together with practical procedure for realizing these objects.

A principal object of the invention is to deposit electrically upon a surface to be coated and/or decorated with patterns or figures, particles which have been disseminated in the vicinity of the surface to be coated.

A further object of the invention is to provide means for depositing upon a surface in non-uniform but controllable manner material which has been suspended in a fluid in finely divided form without first collecting and removing the material from the fluid.

A further object is to place material in decorative outline on an extended surface without handling the material manually.

A further object is to provide for building deposits of material upon surfaces with means for controlling the outline and the depth of the deposits. Another object is to permit material to be deposited as a dry powder and in pattern form upon a surface and to be thereafter incorporated into said surface by heat and/or chemical action. Still another object is to lay down patterns upon a surface with material composed of particles having different characteristics and to shade the patterns by depositing the particles differentially.

Another object of the invention is to coat an extended surface with decorative outlines, the outlines on different portions of the surface being of equal depth by establishing an electric field essentially perpendicular to the surface to be coated and then introducing coating material in finely divided form into the electric field.

The manner of realizing the above mentioned and other objects of the invention will be made clear in the following description, reference being had to the appended drawings, of which:

Fig. 1 is a side view, in sectional elevation, on line 1—1 of Fig. 2, of apparatus for carrying out the invention;

Fig. 2 is a plan view, partly in section on line 2—2 of the apparatus shown in Fig. 1;

Fig. 3 is a side view, in sectional elevation, of apparatus for utilizing the invention in somewhat modified manner;

Fig. 4 is a fragmentary horizontal section on line 4—4 of Fig. 3;

Fig. 5 is an end view, in sectional elevation, of other apparatus useful in carrying out the invention;

Figs. 6 to 13, inclusive, illustrate patterns which have resulted from the use of the invention;

Fig. 14 is a plan view of the discharge edge comprised in the apparatus which formed the pattern shown in Fig. 16;

Fig. 15 is a side view of a fragmentary portion as taken along line 15—15 of the discharge edge shown in Fig. 14;

Figs. 16 and 17 illustrate other patterns made by use of the invention;

Fig. 18 shows in plan view the arrangement of certain details;

Fig. 19 is a side elevation of the details shown in Fig. 18;

Fig. 20 illustrates in plan view, partly in section on line 20—20 of Fig. 21, apparatus for the deposition and fusing of material in powdered form; and

Fig. 21 illustrates in sectional elevation on line 21—21 the apparatus shown in Fig. 20.

The apparatus illustrated in Figs. 1 and 2 comprises a chamber or casing 1 with fluid inlet 2 and fluid outlet 3, electrode elements 4, opposing complementary electrode member 5 and removable cover member 6. The chamber can be made of either conducting or insulating material, but it is essential that electrode elements 4 be maintained in insulated relationship to electrode 5 and an advantageous construction for providing this relationship is to make cover member 6 of insulating material and have it support elements 4. Elements 4 are usually connected to a source of electrical energy at high potential, as indicated diagrammatically at 8, by connector 7; and member 5 is usually grounded through connector 12, for example. The fluid in which the pattern forming particles are suspended is forced into

the apparatus, by means of a fan, for instance, and passes through the electric field between points 9 of elements 4 and plate electrode 5. The particles are deposited on plate 5 in pattern form, as indicated at 11, and the fluid, largely freed from suspended particles, leaves the apparatus through outlet 3. Members 10 are mainly to supply boundaries for the fluid, but can be used to influence the shape of the electric field to some degree by making them of suitable material and form.

Figs. 3 and 4 show apparatus comprising chamber 21, fluid inlet 22, fluid outlet 23, fluid directing means 20, 20', 28 and 29, discharge electrode elements 24, pattern receiving electrode 25, insulating electrode supports 26 and 26' and high potential lead 30 passing through combined support and bushing 26. In this construction it is convenient to ground the discharge elements 24, the chamber 21 and the directing means 20, 28, and 29 through connector 27, and to connect electrode 25 to a source of high potential energy (not shown) through connector 30. The outstanding characteristic of the apparatus shown in Figs. 3 and 4 is that means are provided for directing the fluid and suspended particles into the electric field in a direction more or less parallel to the lines of force. In the apparatus shown in Figs. 1 and 2 the fluid enters at right angles to the lines of force.

Fig. 5 illustrates apparatus embodying other means for bringing the fluid into the electric field in a direction parallel to the lines of force. Chamber 31 has a top 36 of insulating material through which a tube 40 projects and the particle-bearing fluid, brought to the apparatus through a tube 32, for example of rubber, which insulates it from the supply source, flows through tube 40 into the electric field between the ends of discharge electrode elements 34 and plate electrode 35. The fluid leaves the chamber through outlets 33. The desired difference in potential between the elements 34 and complementary electrode 35 is obtained similarly to the manner shown in Fig. 1, connection 37 in Fig. 5 corresponding to connection 7 in Fig. 1. Electrode 35, which is supported on stand 38, may or may not directly receive the patterned deposit. As shown, a plate 39 has been placed upon electrode 35 to receive the deposit. If this plate is conducting, the upper surface of the plate will constitute the boundary of the electric field, but if non-conducting, the upper surface of plate 35 will be the boundary or terminal of the electric field and the field will pass through plate 39. Elements 34 are held in cover 36 by a friction fit, although more positive means can be utilized, and they can be positioned to various distances above plate 35. Element 34', which is supported within tube 40, is purposely shown farther from plate 35 than members 34 because of the change in pattern that this difference in discharge distance provides.

Reference will now be made to some of the patterns illustrated and the method of making them. In this invention emphasis is laid upon concentrating portions of electric fields as by the use of discharge points and making these portions of definite concentration and outline so the patterns resulting from their use will be definite and reproducible. To illustrate this point attention is called to the results obtained when the discharge surface of electrodes is not definite. The pattern shown in Fig. 6 was made in apparatus similar to that shown in Fig. 1, but instead of using points 9 in the formation

of corona discharges, a spiral of $\frac{1}{16}$ inch diameter wire was suspended at the level of points 9—the plane of the spiral being parallel to and approximately 4" above electrode plate 5. Such a spiral is indicated with dash lines 41 on Fig. 6 as if superimposed directly above the pattern made by the discharge from the spiral. A voltage drop of 67.5 kv. was impressed intermittently across the electrodes, connections being made to a mechanical rectifier installation as shown in Fig. 1. The wire discharge electrode was made negative; the plate was grounded and positive with respect to the wire electrode. The voltage was applied intermittently because it has been found that continuous application of voltage difference does not result in an even deposition of material when the particles are floated into the field slowly, and in this instance the air, which was used as a carrier fluid, was passed through the apparatus at less than three feet per second. The material deposited had been ground to a fineness which permitted over 90 percent to pass 200 mesh. It was floated over plate 5 by the air stream and precipitated from the air upon that plate by the electric forces set up when voltage was applied. Floating the particles over the surface to be coated in this manner before applying a voltage difference makes for even deposits, especially if air velocities and voltages are not of too high values.

The higher the voltage maintained across the electrodes the more definite the outline, but it should be kept below arcing or "spark-over" values because spark-overs tend to puncture the deposited pattern and make for unsteady conditions. Regardless of potential, however, a smooth wire electrode seldom forms a definite pattern. The corona beads shift along the wire, the electric wind and ionic bombardment are not definite, either as regards position or intensity, and the pattern cannot be expected to be regular in outline even if it is more or less definite. The pattern made by the spiral of smooth wire shown in Fig. 6 is very irregular and is not generally reproducible. For some purposes, however, such informal designs are desirable.

The pattern shown in Fig. 7 was made by using three smooth $\frac{1}{16}$ inch diameter wires as discharge electrodes as indicated by 42. They were held above and parallel to receiving plate electrode 5 in the apparatus shown in Fig. 1 and were spaced $1\frac{1}{2}$ inches apart. The air used as a carrier fluid was passed through the apparatus at 23 feet per second. The voltage between wires and plate was maintained continuously, at between 65 and 75 kv., with the wires negative. Here again a very informal pattern was formed.

The pattern in Fig. 8 was made with the apparatus shown in Fig. 5. Four pointed rods 34 were symmetrically arranged around central point 34' as corners of a square having sides two inches long, as indicated by the dots 54 and 54' on the pattern. All points were four inches above plate 35, and a voltage drop of between 67 and 70 kilovolts was impressed across the electrodes. The points were grounded and the plate was connected to the high potential side of a mechanical rectifier, an insulated bushing being used in the manner shown at 26 in Fig. 3, causing 67 to 70 kilovolts to be impressed between points and plate. The material deposited was electrically collected ash from gases leaving powdered fuel burners and was exceedingly fine,

most of it passing 325 mesh. It was redispersed in air in apparatus (not shown) comprising a chamber and dispersing fan and then blown through pipe 40 which was a $\frac{3}{4}$ inch standard pipe into the electric field, below the discharge points. The distribution of particles in the pattern was unique in that the larger and darker particles, mostly carbonaceous, were found in outer portions 51, the inner region 53 was of heavy gray very evenly distributed, and the lines 52 were lighter in color and of extremely finely divided material, thinly deposited.

Fig. 9 shows a design made similarly to the design in Fig. 8, except that rods 34 were drawn up until the points were $\frac{1}{2}$ inch farther from plate 5 than was the point on rod 34'. The portions of the electric field terminating on these points now had less influence on that portion of the field terminating on the central point, on rod 34', and the lines of the pattern became concave as shown at 55.

Fig. 10 shows another pattern made with the apparatus shown in Fig. 5. The discharge electrode was made up of eight elements arranged on a circle four inches in diameter about point 34' as a center. On the pattern these are indicated at 56 and 56', respectively. The points were of negative polarity with respect to plate 35 and a voltage drop of 67 kv. was impressed across the four inch spacing between points and plate. When the points are made positive with such a set up, the voltage should be lowered to not over 50 kv. with most pattern forming materials. Positive corona gives a different and usually a much less distinct pattern.

The pattern in Fig. 11 was made similarly to the pattern in Fig. 10, except that central point 34 was entirely withdrawn resulting in the absence of circle 57.

The patterns in Figs. 12 and 13 were also made in apparatus similar to that shown in Fig. 5, but instead of pointed members 34, parallel strips projected downward from cover 36. These strips were one and one-half inches apart and along the bottom edge of each strip were six points, one inch apart. The region of light deposition is shown at 58. It is here that the effect of the mutual interference of the several portions of the electric field is readily seen. If a slot 59 is placed in the collecting plate along this interference zone, the result will be much the same, as shown in Fig. 13. Changes in the contour of the collecting plate do make some changes in the patterns formed, but in general the changes are controlled more definitely by changing the discharge elements and it is most practical to associate these elements with what has been termed the discharge electrode—the electrode that does not receive a pattern.

Figs. 14 and 15 illustrate the discharge electrode used in forming the pattern shown in Fig. 16. Spiral 60 is made of a metal strip two inches wide with points 61 spaced $1\frac{1}{2}$ inches apart projecting out $\frac{1}{4}$ inch from one edge. This electrode was held over plate electrode 5 in Fig. 1 with each point 4 inches above the plate. Different air velocities and voltages were used with somewhat different results. The pattern shown in Fig. 16 was made with an air flow of $1\frac{1}{2}$ to 2 feet per second and a voltage difference of 67.5 applied intermittently—one second on and one second off.

Fig. 17 illustrates what can be accomplished with the present invention in building patterns in prominent relief. The pattern was made with the discharge elements shown in Figs. 18 and 19.

Tubes 71 are made from $\frac{1}{8}$ inch standard pipe with the ends 72 sharpened to provide discharge edges. These edges may be nicked to give positive positions for the "corona beads" or local discharges, but the limited length of the edges on $\frac{1}{8}$ inch pipe makes this unnecessary. The gaseous medium containing suspended particles was forced to the tubes 71 by blower 73, through conduits 74 having dampers 75 for controlling the flow to each tube.

The pattern was made with the four outside tubes 71 placed with their centers on the corners of a $1\frac{1}{2}$ inch square. Their position relative to the pattern is indicated by the dotted circles 70. In this pattern in Fig. 17 portions 66 are very prominent. They really comprise ridges rising about $\frac{3}{8}$ inch above the plane of the pattern receiving plate and can be formed with sharp edges. Portions 67 are smoother with very light deposits. Portions 68 are apt to be from $\frac{3}{8}$ to $\frac{1}{2}$ inch in depth and less smooth than portions 67. Portion 69 is almost free from deposit. The changes in depth of deposit make these patterns very definite and distinctive. They are more distinctive when made with particles that differ as regards size and color and electric characteristics. The electric forces arrange the particles of different characteristics in pleasing arrangements, often with variegated effects.

It will be seen that the invention provides apparatus for the electrical deposition of particles in pattern form which includes receiving electrode means and complementary electrode means insulated from the receiving electrode means and comprising a plurality of ionizing portions positioned to define either a planar or a non-planar surface spaced from the receiving electrode means whereby topical concentration and deposition of suspended particles between the electrode means is effected when an electrical field is maintained thereacross.

Figs. 20 and 21 show apparatus that can be used to apply the present invention in commercial manner. It is particularly adapted to the decorating of metal simulated "tile" used in covering the walls, floors and ceilings of public buildings. A deposition chamber 80 with gas inlet 81 and gas outlet 82 and electrically insulated roof member 83 has an inlet 84 and outlet 85 for a conveyor flight 86. The conveyor member 86 is of heat resisting material; for instance, it may be made of links of heat resisting chrome steel alloy. It is supported upon rollers 87 and adjustable doors 88 limit the openings 84 and 85 where it passes into and out of chamber 80. The conveyor is preferably held at ground potential as indicated by grounding means 89. Projecting through roof 83 are discharge elements 90 connected to a source of high potential energy, not shown, by connector 91. Elements 90 are shown as pointed rods; for example of steel, but instead of rods, tubes as shown in Figs. 5 and 19 can be used, in which case the material for the patterns can be introduced through the tubes and gas inlet 81 can be dispensed with.

The metal blanks upon which the patterns are to be deposited are brought into chamber 80 on conveyor 86 and held under discharge elements 90 as shown at 92 while the deposition is being made. When the blank is in proper position doors 88 are closed as far as possible, preferably by automatic means (not shown), and a gas which can be air but which may be any other gas; for example, non-oxidizing gases taken from furnace 94, is introduced through inlet 81. This gas

carries in suspension the particles to be precipitated upon blank 92. The particles may be of colored sand, feldspar, kaolin, tin oxide and other metallic pigments or combinations of such materials. When the particles have floated into the space between the points of elements 90 and the blank 92, voltage is applied and the particles precipitated. For some patterns a gas velocity of 15 to 35 feet per second is set up and the voltage is maintained continuously until the pattern is of the required depth. For other patterns the particles are floated over the blank at low velocities perhaps as low as one foot per second and the voltage is applied intermittently until the pattern is of satisfactory depth and outline. In general it may be said that a pattern is formed in from ten seconds to two minutes.

If tubes are used to bring in the particles and they are projected directly towards the blank 92 the velocity of the gas leaving the tubes must be very low, preferably less than one foot per second, or else the effect of the air stream may be too large a factor as compared with the electric forces. It has been found advisable to keep the particles suspended in a gas stream moving in a closed circuit, including a fan functioning as a particle disseminator, and having the gas path through the depositing chamber 80, a shunt in parallel with this circuit being opened and closed when a pattern is to be deposited. Settling of the particles by gravity is thus minimized.

Referring again particularly to Figs. 20 and 21, a coated blank 92, after leaving chamber 80, is brought into the bottom of furnace 94 on conveyor 86 and is held in the position shown at 92' while another blank 92 is being coated in chamber 80. Furnace 94 comprises a combustion chamber 96 which includes a shell of heat refractory brick 97 inclosed in heat insulating brick 98. A burner is provided at 100 and an outlet for the gases of combustion at 99. The ends of the combustion chamber are held above conveyor 86 by steel members 101, which members are protected from intensive heat radiation by refractory brick 102. A comparatively thin plate or sheet of material having the properties of resisting disintegration at high temperatures and yet permitting heat to pass through in efficient manner is shown at 103. This sheet is placed in horizontal position above conveyor 86 and seals off combustion chamber 96 and prevents the gases circulating in that chamber from blowing against the pattern on blank 92. Sheet 103 may be made of fused silica or silicon carbide or other material which permits the heat radiating from the hot gases and carbon in chamber 96 and from the roof and walls of that chamber to be transmitted in large part to the pattern on blank 92 that is to be fused or alloyed or otherwise thermically treated.

It is to be understood that modifications can be made in the furnace if needed to effect synchronism of heat treatment with pattern forming. The furnace can be lengthened so that blank 92 will remain under heat for two or three pattern deposition periods. Or if the deposition period must be extended beyond a proper time for heat treatment, a heat resisting shield, not shown, can be placed over the blank 92 after it has been properly fused to protect it from excessive heating. Good results have been obtained by first alloying at rather high temperature, by means not shown, the surface of blanks 92 with cobalt compounds, then after cooling, as required, depositing a pattern in chamber 80 of

material that fuses at comparatively low temperature upon the alloyed surface and then fusing the pattern in furnace 94.

The manner of attaching the patterns to the surface to be decorated, just described, is only one of many methods which can be used in carrying out the invention. For instance, another manner of fixing the pattern to the surface treated is to spray the pattern with an adhesive such as a solution of shellac in alcohol, which in turn after evaporation of the alcohol can be sprayed with moisture resisting coatings.

Another method of attaching the material forming the patterns is to impregnate the material with substances which will promote chemical reactions in the materials. For instance, if plaster of Paris is laid down as a pattern, it can be hardened by subjecting the pattern to an atmosphere of high humidity or even a super-saturated atmosphere which will bring about the well known hydrating reaction in the plaster of Paris.

Pigments deposited upon porous surfaces can be impregnated with linseed oil, for instance, by spraying the under side of the material with linseed oil and allowing it to work up into the pigment by capillary action. The oil will harden by oxidation and polymerization and cohere the particles of pigment in this way.

Where the electrode and electric field are capable of forming patterns directly upon a surface, the surface itself can be coated with an adhesive before the pattern making operation is begun. In the making of some patterns, however, there is a shifting of the material after initial deposition and this cannot take place if the material is placed initially against a surface covered with an adhesive.

Numerous combinations of electrode elements can be made up which will give countless patterns of different outlines and characteristics. It is believed, however, that the foregoing description makes it readily possible for those versed in the art of electrical deposition to obtain such patterns through reasonable trials and without the need of further inventive ingenuity.

It will be understood that deposition under conditions usually found in dust removing equipment utilizing electric discharge does not furnish patterns of distinctive outline. When the electric field is maintained continuously there is selective action at the entrance of the field which usually makes the deposit heaviest at that place. A method of avoiding this difficulty as disclosed in the foregoing description comprises intermittently applying the electric field which permits the pattern forming particles to float uniformly over the surface to be coated before deposition is effected. While the voltage is temporarily reduced, the particles can be floated over very extended surfaces over which several sets of electrodes are supported, and then, upon application of a high voltage difference, one large or several smaller patterns will be deposited upon the extended surface. So, as has been previously stated, good patterns are often obtained by raising the velocity of the particle carrying fluid to comparatively high values, say from 18 to 40' per second. At this velocity the particles penetrate well into the electric field before deposition and many useful patterns are made with such velocities and the continuous application of the electric field.

It will often be found advantageous to adjust the humidity of the carrier gas in order to ob-

tain more satisfactory deposition. For example, a relative humidity of at least 50% is usually advantageous and frequently a relative humidity of over 75% is desirable.

In using tubes for the combined purpose of effecting discharges and of conducting the particles into the electric field countless different patterns can be made when the different tubes are variously spaced and the particles entering through these tubes are caused to enter at different velocities.

I claim:—

1. Apparatus for the electrical deposition of particles in pattern form comprising receiving electrode means adjacent which the pattern is to be deposited, complementary electrode means insulated from the receiving electrode means and comprising a plurality of ionizing portions adjustably positioned relative to each other and to the receiving electrode means, energizing means for maintaining a strong electric field between the receiving and the complementary electrode means, and means for bringing a suspension of particles to be deposited into the space between said electrode means.

2. In apparatus utilizing an electric field for depositing particles in pattern form, an electrode defining one boundary of the electric field, said electrode comprising a plurality of conduits for conducting suspensions of particles into the electric field having corona-forming portions adjacent the outlets thereof, said conduits and corona-forming portions being positioned to cause topical concentration of suspended particles in said field, and a complementary electrode defining the opposing boundary of the electric field.

3. In apparatus utilizing an electric field for depositing particles in pattern form, an electrode defining one boundary of the electric field, said electrode comprising a plurality of corona-forming portions positioned to cause topical concentration of suspended particles in said field, at least one of said corona-forming portions consisting of a conduit for conducting suspensions of particles into the electric field, and a complementary electrode defining the opposing boundary of the electric field.

4. In apparatus utilizing an electric field for depositing particles in pattern form, an electrode defining one boundary of the electric field, said electrode comprising a plurality of conduits having corona-forming portions adjacent the outlets thereof, said conduits and corona-forming portions being positioned to cause topical concentration of suspended particles in said field, means for passing a suspension of particles through said conduits into the electric field, and a complementary electrode defining the opposing boundary of the electric field.

5. In apparatus utilizing an electric field for depositing particles in pattern form, an electrode defining one boundary of the electric field, said electrode comprising a plurality of conduits having corona-forming portions adjacent the outlets thereof, said conduits and corona-forming portions being positioned to cause topical concentration of suspended particles in said field, means for passing a suspension of particles through said conduits into the electric field, control means to vary the flow of said suspension through the several conduits respectively, and a complementary electrode defining the opposing boundary of the electric field.

6. Apparatus for producing a patterned coating on a surface comprising means defining a

chamber, opposed electrode members in said chamber, at least one of said electrode members comprising a plurality of mutually interfering corona-forming portions positioned to cause topical concentration of suspended particles in said field, means for supporting a surface to be coated adjacent one of said electrode members, means for supplying a gaseous fluid containing suspended coating particles between said electrode members, means for impressing a high potential across said electrode members, and means for agglomerating the deposited particles.

7. Apparatus for producing a patterned coating on a surface comprising means defining a chamber, opposed electrode members in said chamber, at least one of said electrode members comprising a plurality of mutually interfering corona-forming portions positioned to cause topical concentration of suspended particles in said field, means for supporting a surface to be coated adjacent one of said electrode members, means for supplying a gaseous fluid containing suspended coating particles between said electrode members, means for impressing a high potential across said electrode members, and heating means for agglomerating the deposited particles.

8. Apparatus for the electrical deposition of particles in pattern form comprising receiving electrode means adjacent which the pattern is to be deposited, complementary electrode means insulated from the receiving electrode means and comprising a plurality of ionizing portions positioned to define a surface spaced from the receiving electrode means whereby to cause topical concentration of suspended particles between said electrode means when an electrical field is maintained thereacross, energizing means for maintaining a strong electrical field between the re-

ceiving and the complementary electrode means, and means for bringing a suspension of particles to be deposited into the space between said electrode means.

9. Apparatus for the electrical deposition of particles in pattern form comprising receiving electrode means adjacent which the pattern is to be deposited, complementary electrode means insulated from the receiving electrode means and comprising a plurality of ionizing portions positioned to define a non-planar surface spaced from the receiving electrode means whereby to cause topical concentration of suspended particles between said electrode means when an electrical field is maintained thereacross, energizing means for maintaining a strong electrical field between the receiving and the complementary electrode means, and means for bringing a suspension of particles to be deposited into the space between said electrode means.

10. Apparatus for the electrical deposition of particles in pattern form comprising receiving electrode means adjacent which the pattern is to be deposited, complementary electrode means insulated from the receiving electrode means and comprising a plurality of ionizing portions positioned to define a plane surface spaced from the receiving electrode means whereby to cause topical concentration of suspended particles between said electrode means when an electrical field is maintained thereacross, energizing means for maintaining a strong electrical field between the receiving and the complementary electrode means, and means for bringing a suspension of particles to be deposited into the space between said electrode means.

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