

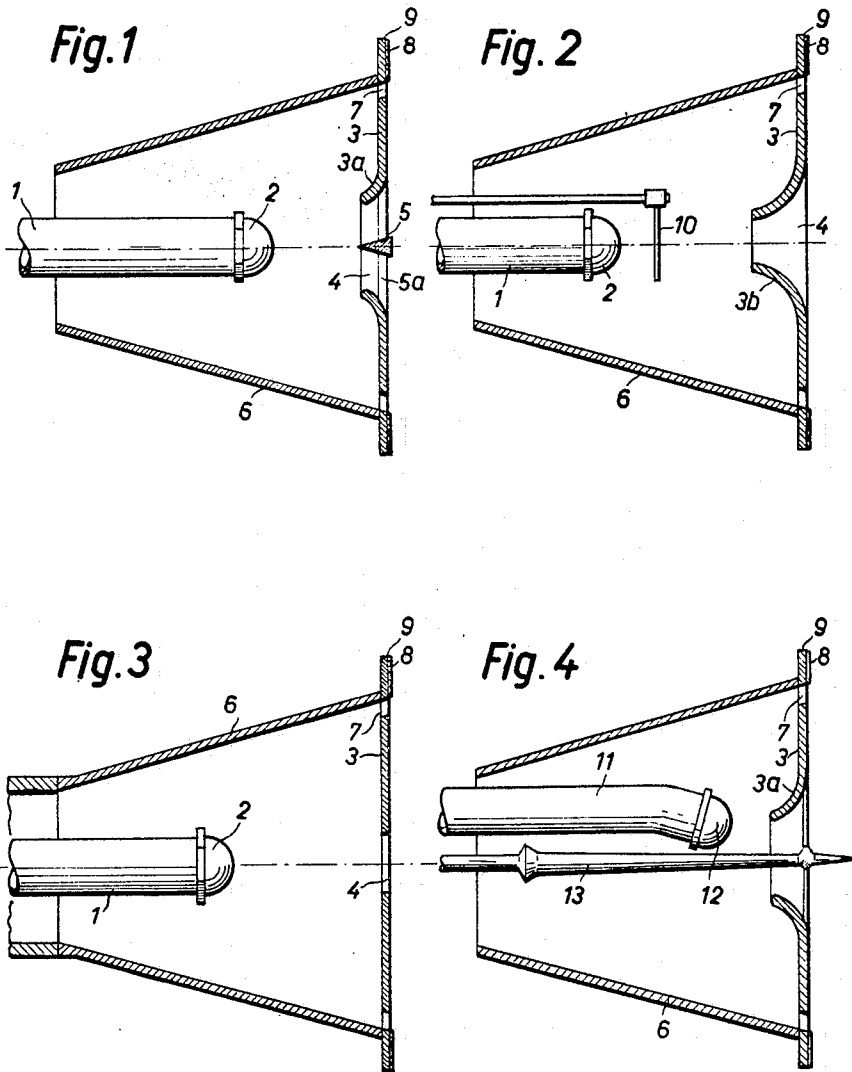
Sept. 27, 1966

K. M. OESTERLE
APPARATUS FOR THE ELECTROSTATIC PRECIPITATION
OF COATING MATERIAL

3,275,239

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3 Sheets-Sheet 1



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3 Sheets-Sheet 2

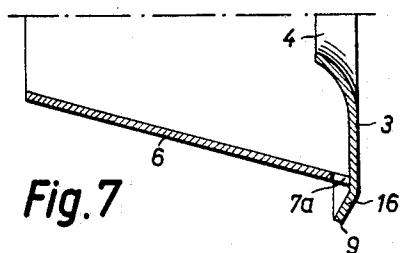


Fig. 7

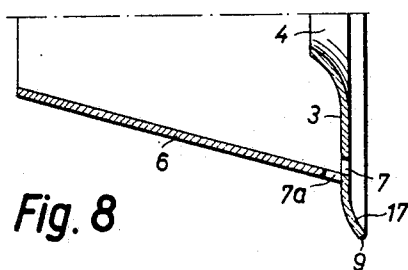


Fig. 8

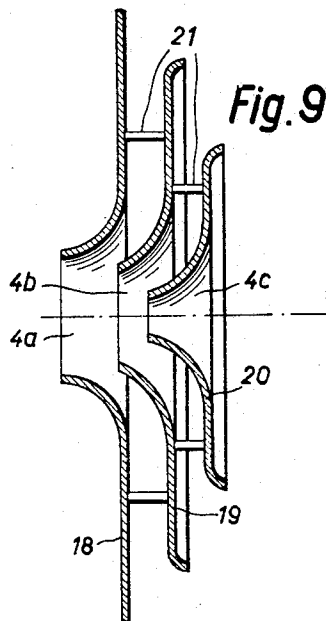


Fig. 9

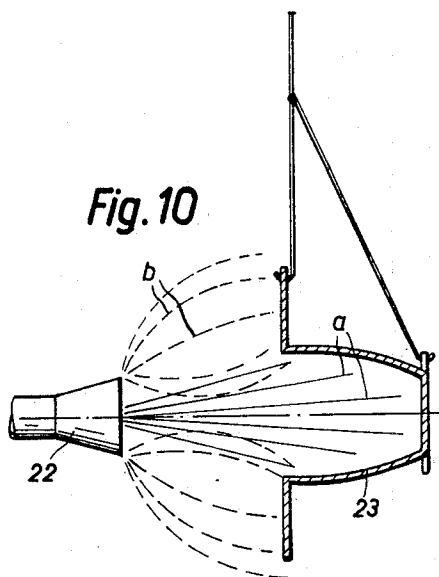


Fig. 10

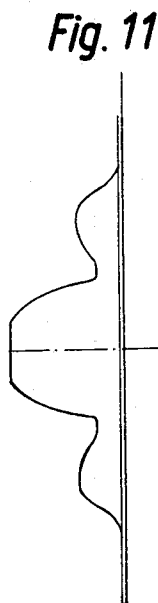


Fig. 11

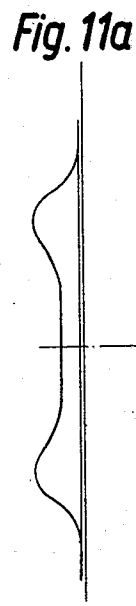


Fig. 11a

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Fig. 5

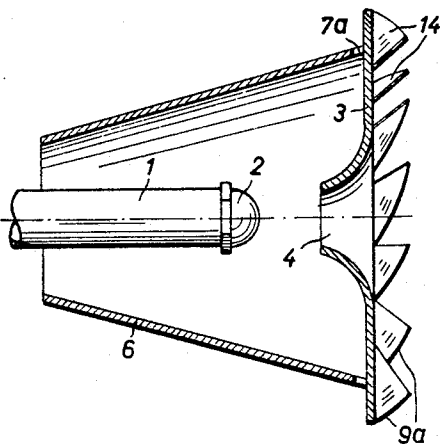


Fig. 5a

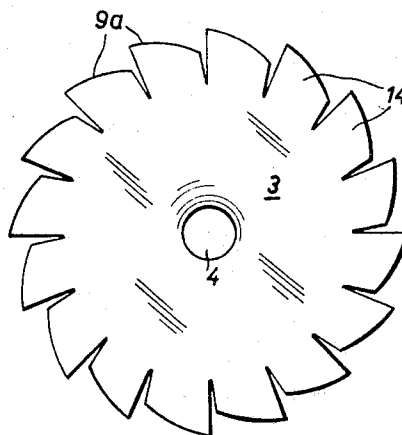


Fig. 6

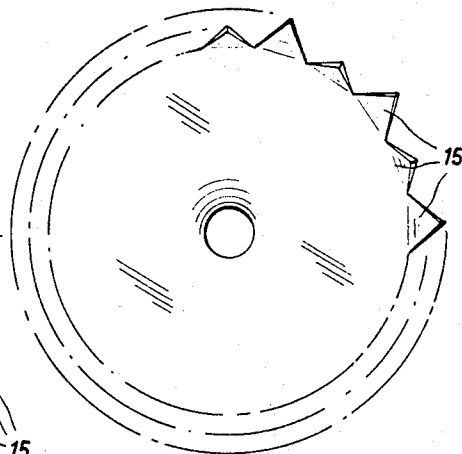
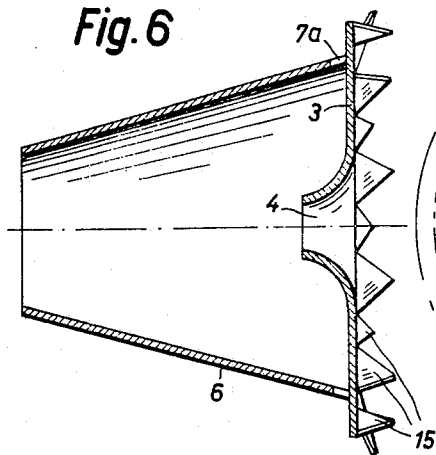


Fig. 6a

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APPARATUS FOR THE ELECTROSTATIC PRECIPITATION OF COATING MATERIAL

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10 Claims. (Cl. 239-15)

The present invention relates to apparatus for electrostatically precipitating coating material onto a base, including a spraying device and means for generating an electrostatic field between the spraying device and the base. It is known to spray liquid coating material by the combined action of mechanical and electrostatic effects and to precipitate it upon the base to be coated. The mechanical means used for this purpose are either nozzles, by means of which a jet of finely divided particles can be produced and may be directed by the influence of an electrostatic field in a manner suitable for coating the base, or rotating spray edge elements, by means of which a mist of finely distributed particles can be produced and may be directed to the base by electrostatic field action. Both known devices have advantages and drawbacks. Thus, by means of a nozzle a relatively large amount of material can be sprayed per unit of time and applied onto the object to be coated in a relatively concentrated consistency; in particular hollow bodies having larger surfaces situated approximately parallel to the direction of jet, can be satisfactorily coated by means of nozzles. Larger plane surfaces, however, can be uniformly coated only with great difficulties due to the concentrated bundling of a nozzle jet, since a directive control of the fine jet particles exhibiting relatively high kinetic energy by the electrostatic field will be possible only in a very limited degree. Moreover, when using a nozzle the discharge of material therefrom per unit of time cannot fall below a rather high minimum. Nozzles thus are less suitable for uniformly coating larger areas. Rotating spray edge elements permit to be regulated down to very small atomized quantities and produce an extremely fine mist of relatively little individual energy of motion, which mist may be easily influenced by the electrostatic field, so that especially uniform coatings will result in so far as comparatively flat base members are involved; the coating of the surfaces of hollow spaces, however, by means of such spray edge elements can be effected in sufficient thickness only with difficulty on account of the feeble particle concentration in the mist and of the low natural speed and thus the low penetrating action of the mist; the transport of particles into such hollow spaces acting as Faraday screen is in this case dependent on the electrostatic field and results seldom into a perfect coating.

The conditions mentioned above have the effect that in plants processing very different objects to be coated, various apparatus must be kept at disposal. When complicated objects having plane surfaces and hollow spaces shall be coated, devices are hitherto not known, which could at the same time meet the contradictory requirements of large-surface uniform particle distribution for plane surfaces, and of bundled depth effect for hollow spaces. The present invention first offers a solution for this problem.

To this end the apparatus according to the invention comprises a jet spraying member and at least one rotatable edge spray element positioned downstream with respect to the jet spraying member and provided with a receiving surface which confines a central opening and which is adapted to be impinged by the jet spraying member and is connected with a spray edge, means being provided for varying the ratio between the amount of coat-

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ing material delivered by the jet spraying member and impinging on the receiving surface, and the amount passing through the central opening of the edge spray element.

The apparatus according to the invention permits to perfectly and uniformly coat in one operating step articles which for example have a central deep hollow space and more or less plane marginal surfaces of large size. Dependent on the particular adjustment, it is also possible to obtain for instance a heavier coating of the surfaces of a hollow space or of the marginal surfaces; it has to be noted that the jet spraying member on the one hand delivers coating material for the hollow space surfaces in direct admission through the central opening of the edge spray element, and on the other hand indirectly supplies the edge spray element with spraying material by impinging the receiving surface of the latter which in turn sprays this material for coating the marginal surfaces of the article. In extreme cases the apparatus may also be adjusted in such a manner that all material delivered by the jet spraying member either is applied through the central opening, practically exclusively and directly to article to be coated, or arrives practically exclusively by the intermediary of the receiving surface of the spray edge element to the spraying edge thereof and from there to the article.

The present invention will now be described more fully with reference to the accompanying drawings illustrating, by way of example, several embodiments of the invention, and in which:

FIGURES 1 to 4 show in axial section each a structural example of the apparatus according to the invention,

FIGURES 5 and 5a are an axial section and an end view, respectively, of a further embodiment of the invention,

FIGURES 6 and 6a show in axial section or in end view a modification of the embodiment according to FIGURES 5 and 5a,

FIGURES 7 and 8 are axial sections, each through a modified detail of the edge spray element,

FIGURE 9 is an axial section through a combined edge spray element to be used in an apparatus according to the invention,

FIGURE 10 diagrammatically shows a side view of an apparatus according to the invention, while in operation,

FIGURE 11 indicates the distribution of a coating material obtainable upon a plane plate by an apparatus according to the invention, and

FIGURE 11a shows the distribution of coating material upon a plane plate obtainable by using only a rotating spray disc.

In the example shown in FIGURE 1 a spraying nozzle 2 is arranged on the forward end of the supply tube 1 for the liquid coating material, e.g. lacquer. Ahead of the spraying nozzle 2 and coaxially to the latter an annular disc 3 is provided, which has an inner bead edge 3a deflected towards the nozzle 2 and confining a central passage opening 4. A guide cone 5 is retained in the centre of the aperture 4 by means of radial struts 5a. A shielding cone 6 which coaxially surrounds the nozzle 2 and the adjacent end portion of the tube 1, is secured to the annular flange 3. The parts 3 and 6 are mounted for example on the tube 1 so as to be rotatable and axially movable, in a manner not shown and are operatively connected with an electric motor. Immediately ahead of the junction point of the cone 6 openings 7 are provided in the annular disc 3, while the marginal disc portion which is situated outside of these openings and radially projects beyond the

cone 6, carries at its front face remote from the cone 6 a layer 8 of electrically conducting material, which terminates in an annular spray edge 9.

When the described apparatus is in operation, a potential difference which transports the material issuing from the spraying device to the article, will be produced between the layer 8 and the article to be coated. A conical jet of particles issues from the nozzle 2 and, dependent on the axial spacing of the disc 3, passes from the nozzle 2 partly directly through the central disc aperture 4 onto the central portion, formed, e.g., by a recess, of the article, and partly to the inner surface of the rotating annular disc 3. The central cone 5 prevents the occurrence of a too concentrated jet core outside of the disc 3. The jet portion collected by the inner receiving surface of the disc 3 passes by the action of centrifugal force radially outwards, where it forms a film and is driven through the openings 7 upon the layer 8, from the spraying edge 9 of which the coating material is then sprayed away as a fine mist and delivered to the marginal section of the article by the electrostatic field generated between the layer 8 and the article. Since the nozzle jet which usually forms a hollow cone, has a predetermined opening angle, the jet portion caught by the receiving surface of the disc 3 increases with increasing distance of the disc from the nozzle and vice versa. By changing the reciprocal distance of nozzle and annular disc, the ratio between the quantity of coating material delivered by the nozzle 2 and impinging on the disc 3, and the quantity passing through the opening 4 thus may be adjusted at will.

In the example according to FIGURE 2 the annular disc 3 is provided with a somewhat larger inner bead edge 3b, but does not include any central cone 5. Furthermore, the edge spray element 3, 6 is in this case arranged so as to be axially fixed with respect to the nozzle 2. In order to be able to vary also in this embodiment the ratio between the quantities of material delivered on the receiving surface and passing through the central aperture of the annular disc 3, an adjustable hole diaphragm 10 is provided and situated in the jet zone of the nozzle 2. The general arrangement and operation, moreover, are the same as in the first described example.

The example shown in FIGURE 3 differs from that according to FIGURE 1 in that no inner bead edge is provided, and in addition by the omission of the central cone; the mode of operation of this apparatus, however, remains unchanged.

While in the examples previously described it has been assumed that the edge spray element 3, 6 is rotatable and axially movable on the coaxial supply tube 1, in the example according to FIGURE 4 the cone 6 and the disc 3 connected to it are fixed on an axial shaft 13 which is supported in overhung position by a rotary bearing in a manner not shown. The supply tube 11 is in this case introduced into the chamber formed by the shielding cone 6 in axially parallel arrangement and the nozzle 12 is slightly inclined towards the disc aperture 4. In order to be able to vary the ratio between the coating material impinging on the receiving surface 3 and that passing the central aperture of the annular disc 3, also in this embodiment of the invention the edge spray element 3, 6 is axially movable relative to the nozzle 12. In the examples described hitherto a smooth circular spray-off edge 9 has been provided. The example according to FIGURES 5, 5a (which otherwise corresponds to the construction shown in FIGURE 1) has the circumferential edge of the annular disc 3 provided with peripheral blades 14 produced by radial incisions suitably bent out of the plane of the disc. Owing to holes 7a in the cone 6, spraying material passes through the recesses in the edge of the disc upon the peripheral blades 14 and is sprayed off the circumferential edge 9a of the latter. Upon rotation of the disc 3 an

air draught is produced by the blades 14, which prevents the entry of air from the outside into the actual spraying chamber between the disc and article to be coated, said air otherwise would be able to carry lacquer mist out of the spraying chamber.

A modification of the above described example is illustrated in FIGURES 6 and 6a. The circumference of the disc is here provided with indents or teeth 15 of dissimilar length, which are bent forwardly and thus are able to exert an effect similar to the one of the aforesaid blades 14. Also in this case spraying material passes through openings 7a in the cone 6 to the rear side of the teeth 15 and is sprayed away from the edge thereof.

FIGURES 7 and 8 show two modifications of a detail of the edge spray element 6, 4. According to FIGURE 7 the outer edge 16 of the disc 3 is conically bent in backward direction and its spraying edge 9 is impinged from the rear by openings 7a in the cone 6. In contradistinction, the outer edge 17 of the disc 3 in FIG. 8 is slightly beaded in forward direction, its spraying edge 9 being impinged with spraying material, not only from the front through the disc openings 7, but also from the rear through the cone openings 7a.

It has been found, that by means of a rotating edge spray element of a predetermined size only a predetermined maximum amount of spraying can be sprayed with perfect results. Thus in many cases the capacity of the apparatus is limited by the maximum spraying-off ability of the edge spray element, while the spraying nozzle would permit a considerably larger capacity. This disadvantage may be overcome by associating two or more edge spray elements with the nozzle spraying device. FIGURE 9 shows such an edge spray member composed of three coaxial spraying discs 18, 19, 20. The three discs are firmly interconnected by means of struts 21. The discs are provided with different central apertures 4a, 4b, 4c having a diameter decreasing from the inside towards the outside. The marginal portions of the discs containing the spray edges are also differently formed. Dependent on the relative axial position between the nozzle (not shown) and the group of discs 18, 19, 20, two or all three discs will be impinged by spraying material from the nozzle and the total quantity of coating material sprayed away from the groups of discs will be correspondingly large.

FIGURE 10 diagrammatically shows a spraying device of the described type for coating an article 23 having a relatively large central recess and relatively large plane marginal surfaces. The adjustment of the spraying device is then selected so that a portion of the material fed by the spraying nozzle of the device is directly supplied to the surfaces of the article confining the recess (solid lines a), while another portion of this spraying material passes from the edge spray element under co-operation of the electrostatic field to the edge surfaces of the article (interrupted lines b). In FIGURE 11 the action of the device 22 on a plane receiving surface is illustrated; it is evident therefrom, that the proportion of the spraying material which is directly supplied from the nozzle of the device is sufficiently large for perfectly coating the relatively large surfaces of the recessed portion of the article, that, however, the proportion delivered by the edge spray element also suffices for simultaneously effecting a perfect coating of the marginal surfaces. For comparison, the result obtained by the single action of an edge spray element is illustrated in FIGURE 11a; it is easy to see from it that the impinged middle zone does not have enough material, in order to insure a perfect coating when the article has a larger central depression.

In addition to or in place of the electrostatic field generated between the layer 8 (FIGS. 1-4) of the edge spray element and the article to be coated, such a field may also be produced by means of electrodes situated outside of the spraying element, if desired by cooperation of electrodes positioned at the side of the article remote

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from the spraying device. A potential differing from the potential of the layer 8 may also be applied to the nozzle itself and the charging of the particles issuing from the nozzle may thereby be influenced. Instead of varying by means of a diaphragm or by a relative axial displacement of nozzle and edge spray element, the impingement of the edge spray element may also be changed by modifying the beam cone of the nozzle.

I claim:

1. Apparatus for electrostatic precipitation of coating material onto a base, comprising a spraying device, means for generating an electrostatic field between the spraying device and the base, said spraying device including a jet spraying member, a rotatable edge spraying element positioned downstream with respect to the jet spraying member, said edge spraying element being provided with a receiving surface adapted to be impinged by the coating material discharged from the jet spraying member, said receiving surface having a central opening and being connected with a spray edge, and means for varying the ratio between the amount of coating material delivered by the jet spraying member and impinging on the said receiving surface, and the amount passing through said central opening of the edge spray element.

2. Apparatus according to claim 1, wherein said jet spraying member is a spraying nozzle followed by an annular atomizing member having an external spray-off edge, said annular member being fastened to the larger end of a shielding cone which surrounds the nozzle in spaced relationship, and is rotatably mounted together with said shielding cone, so as to be movable about the axis of the cone, the unit formed by said annular member and said cone being provided with openings for the passage of spraying material passing from the surface of the annular member facing the nozzle to the spray-off edge formed by the outer edge of said annular member.

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3. Apparatus according to claim 2, wherein said nozzle is coaxially arranged with respect to the rotating edge spray element.

4. Apparatus according to claim 2, wherein said nozzle is arranged outside of the axis of the edge spray element carried by an axial shaft.

5. Apparatus according to claim 2, wherein said jet spraying member and said edge spray element are movable relatively to each other in the direction of the jet.

6. Apparatus according to claim 2, wherein the spray-off edge of the edge spray element is an annular edge closed in itself.

7. Apparatus according to claim 6, wherein the spray-off edge of said edge spray element is formed by the outer edges of tongues which are cut out from the circumference of this element and turned into blade-shaped form.

8. Apparatus according to claim 6, wherein the spray-off edge of said edge spray element is formed by the outer edges of pointed portions cut out from the periphery of this element.

9. Apparatus according to claim 2, wherein said nozzle is associated with it at least one annular disc acting as edge spray element and having an inner edge bent or flanged towards the nozzle.

10. Apparatus according to claim 2, wherein a plurality of rigidly interconnected parallel annular discs having different diameters and arranged coaxially to each other, are provided with central apertures of different diameters, the annular disc having the largest diameter and the largest central aperture being situated closest to said nozzle.

No references cited.

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