

PATENT SPECIFICATION (11)

1 335 071

DRAWINGS ATTACHED



- (21) Application No. 17148/71 (22) Filed 26 May 1971
 (31) Convention Application No. 893 (32) Filed 31 July 1970 in
 (33) Hungary (HU)
 (44) Complete Specification published 24 Oct. 1973
 (51) International Classification B05B 5/02
 (52) Index at acceptance

B2F 12A 2H 2R 2T 4A4A 4A4Y 5D4A 5D5A 5D5C2C
 5D5C2X

(54) PROCESS AND APPARATUS FOR ELECTROSTATICALLY SPRAYING COLORANTS, POWDERS AND FIBROUS MATERIALS

(71) We, HAJTOMU ES FELVONOGYAR, of 98, Fehérvári ut, Budapest XI., Hungary, a body corporate duly organised under the laws of Hungary, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a process and an apparatus for electrostatically spraying colorants, powders, or fibrous materials, in which the material to be sprayed is charged by electrostatic means and is subsequently deposited on an article charged with an opposite electrostatic charge.

Processes and apparatus for coating articles with corrosion-protective or decorative surface coatings or for applying a coloured layer using this principle are already known. For charging the material to be sprayed use is made of an electrode that is connected with a source of A.C. having a voltage of 50 to 150 kV by means of a metal or semi-conductor connection. This electrode causes the material to be charged either by direct contact or via the agency of ionised layers of air.

It is well-known that the magnitude of the electrostatic field formable on electrical conductors, or in their immediate vicinity, is inversely proportional to the size of the radii of curvature of the charged surfaces, so that very strong fields of force arise along sharp edges or pointed tips for a given voltage, which enable the resulting charge to be increased appreciably. Thus, it is already known that a satisfactory electrostatic charge can be applied to the material to be sprayed by using charging electrodes constructed with metal tips or knife-edges if the article to be sprayed or coated is located relatively close to the article arranged to form a counterelectrode, so that a strong field of force can be developed. Spraying apparatus has therefore already been provided in which electrodes in the

form of ionisation needles or rings with sharp edges have been incorporated in the spray head.

For reasons of safety during working it is absolutely essential that the high tension source should possess a small short-circuit current and its maximum value has in certain countries been laid down to be about 200 milliamperes. However, even with such a small current it is very important that the electrostatic charge located in the spraying apparatus should not discharge without damping. For this reason an induction resistance of several megohms has been provided.

Spray apparatus is also known in which the electrostatic charge is transferred to the material to be sprayed by means of a metal electrode arranged in the interior of the spraying head. If this electrode is placed as far as possible into the interior in the spraying head and it is provided with adequate insulation, then this known apparatus is truly proof against sparking. However, such apparatus has the defect that, as a rule, it does not charge the material highly enough to achieve a uniformly satisfactory coating. With this apparatus a sufficient charge is generated only in the centre, but not in the outer regions, of the spray cone.

The present invention therefore has as its aim the provision of a process and apparatus for electrostatically spraying colouring agents, powders, or fibrous materials in which, while using lower applied voltages than in any known process or apparatus, substantially uniform charging of the material and hence the maximum homogeneity of coating is obtained.

According to one aspect of this invention, there is provided a process for electrostatically spraying a workpiece, comprising electrostatically charging the material to be sprayed by passing it through a feed passage (at least) a part of which is formed between the electrodes of a capacitor spaced

[Price 25p]

by a relatively small distance apart, the electrodes being connected to the opposite poles of a high tension D.C. supply, one of the electrodes having a dielectric on its side facing the other electrode which latter is charged to a potential different from that of the workpiece and is spaced farther from the outlet end of said passage than said one electrode, and causing the charged material to be sprayed from said outlet end towards the workpiece.

While according to the hitherto known processes the field of force for the charging of the material to be sprayed is formed by the electrode in the spraying head and the article to be sprayed serving as the counterelectrode, which as a rule are spaced about 15 to 50 cm away from one another, in the process according to the invention a field of force used to charge the material to be sprayed is formed between two facing electrodes or plates of an electric capacitor, spaced apart by a relatively small distance, i.e. a few millimetres or a few tenths of a millimetre from one another, between which the material to be sprayed is led before entering the spraying head. For a smaller applied voltage, this field of force between these closely spaced capacitor electrodes is substantially greater than the field of force formed in the known processes having the electrode in the spraying head and the article to be sprayed as the counterelectrode, so that the charging of the material to be sprayed that is led between the two electrodes of the capacitor in the process according to the invention is considerably stronger and also more uniform. This charging is independent of the distance between the spraying head and the article to be sprayed and hence also independent of whether the article to be sprayed has a planar or uneven surface, e.g. one with projecting pointed ends, which in the known process tend to gather an accumulation of the material being sprayed.

In the known processes using a charging electrode in the spraying head in the shape of a pointed tip or edge, an average field strength of 3 to 5 kV/cm was obtained in the case where the applied voltage was about 80 kV and the article to be sprayed was substantially planar and spaced typically 20 cm away from the charging electrode. By means of an appropriate construction of the charging electrode, e.g. by means of a further sharpening or pointing, a deformation of this field of force, and, consequently, to the accompaniment of luminescence and corona discharges, a field strength of about 30 to 50 kV/cm has been achieved.

By contrast, in the process according to the invention, with the material passing through a capacitor before being sprayed,

the two capacitor electrodes, spaced by a distance of a few millimetres or tenths of millimetre, ensure an entirely adequate field strength of 30 to 50 kV/cm even when the applied voltage is only 15 to 20 kV and, in addition, afford an exceptionally uniform charging of the material being sprayed.

The invention also provides an electrostatic spraying apparatus comprising a spraying head, a feed passage for feeding the material to be sprayed to the spraying head, two electrodes in or forming part of said passage and, spaced apart by a relatively small distance, one of the electrodes being provided with a covering of dielectric on its side facing the other electrode which latter is spaced farther from the spraying head than the said one electrode, the arrangement being such that, in operation, the electrodes are connected to opposite poles of a high tension D.C. supply with said other electrode being charged to a potential different from that of the workpiece, whereby the two electrodes function as a capacitor and charge the said material.

As has already been described above, the distance between the two capacitor electrodes inside the feed passage leading to the spraying head need not amount to more than a few millimetres or tenths of a millimetre.

Both electrodes may be arranged in the interior of the spraying apparatus and may be insulated with respect to the external surface of the apparatus, preferably by means of an insulating layer that is proof against the operating conditions and by employing an appropriate insulation spacing, in order to make the apparatus substantially completely proof against sparks and accidents. As has already been stated, as a result of the closely spaced-together electrodes it is possible to operate the apparatus at a considerably lower voltage than is the case for known apparatus; this leads not only to a saving in power consumption but also to a further reduction in accident risks.

In a preferred embodiment the two electrodes may be formed from concentric tubes fitted inside one another, the feed passage for the material to be sprayed being located between these tubes which are separated by a dielectric. This passage may be cylindrical or helical in shape. If it is of helical construction it is suitably formed by a helical groove located in the dielectric.

In known spray apparatus it was possible, fundamentally, to obtain a maximum rate of spraying of 200 to 600 grammes of material a minute using electrodes with sharp annular edges, needle tips, or by indirect ionisation charging and having the electrodes arranged in the centre of the spraying head. On increasing the throughput of material the latter's relative charge, of

course, diminishes. The minimum charge that can be used for spraying is 0.7 micro-coulombs per gramme of material. With conventional spraying apparatus this minimum charge is reached at the aforementioned maximum spraying rate.

By contrast, using the process and apparatus according to the invention, the substantially longer path along which the material is charged enables this figure to be increased considerably, i.e. charging of a desired amount of material can be obtained without leading to a too-small relative charge. This feature is of very great importance in constructing modern high performance spraying apparatus.

The invention may be used advantageously not only for hand spray apparatus, but also for all larger scale spraying and coating apparatus using the principle of electrostatic charging.

The invention will now be described, by way of example only, with reference to the accompanying diagrammatic drawing, in which:

Fig. 1 illustrates the basic principle of the process according to this invention;

Fig. 2 shows a preferred embodiment of the apparatus serving to carry out the process according to the invention, shown in longitudinal section, and

Fig. 3 shows a further embodiment of the apparatus, also in longitudinal section.

Referring to the drawing, wherein like or functionally equivalent parts are designated with like reference numbers, the basic principle is illustrated in Fig. 1, wherein a capacitor is formed by two closely spaced together, mutually facing rib-shaped or strip electrodes 1 and 4, the electrode 1 being connected with a D.C. high tension source 2 of, typically, 20 kV via an insulated cable 3, the other pole of the high tension source being earthed. It should be understood that inspraying technology by "electrode" is meant a metallic body which may not be in physical contact with the material to be sprayed, but which plays a role in forming the electric field in which the material to be sprayed is electrostatically charged. Hereinafter, the electrode 1 will be referred to as the charging electrode and the electrode 4 as the counterelectrode, in view of the fact that the former is connected to the D.C. high tension source 2 while the latter is earthed. The counterelectrode 4 is also earthed and is covered with a suitable dielectric 5 on the side thereof facing the charging electrode 1; in this way, a feed passage for the material 8 to be sprayed is formed between the dielectric 5 and the charging electrode 1, which material is fed, in use, to the feed passage by a feed tube 7. An end piece 6, not connected to the current source, adjoins the downstream end

of this passage and together with the opposite end of the dielectric 5, which extends downstream of the counterelectrode 4, forms a mouth 9 for the material 8 to be sprayed.

During its travel between the two electrodes 1, 4, the material to be sprayed is kept out of contact with the counterelectrode 4 by the dielectric 5 and is charged by the strong field of force formed between the two electrodes, so that at the mouth 9 it traverses a spraying space 10 to become deposited on an article 11 to be sprayed, which article 11 is arranged to be at the same potential as the counterelectrode 4 and, for reasons of safety, may be earthed.

The charging electrode 1 terminates at a greater distance from the outlet end 9 of the feed channel at the spray head than the counterelectrode 4. This greater spacing effects a separation of the material particles of the material to be sprayed in the force field between the two electrodes, before they could give up their charge again at the charging electrode 1, because the electrostatic attractive force of the counterelectrode 4 is still effective between the end of charging electrode 1 and the spray head, whereby to prevent the discharge of the charged material particles before flowing past the downstream end of the dielectric 5.

In Fig. 2, the spraying and charging elements of the spraying apparatus are shown in section in diagrammatic form. In this embodiment, two electrodes 1 and 4 forming a capacitor are constructed as concentric tubes arranged one within the other with a dielectric member 5 located between them. A helical groove 8, connected with a material feed channel 7, is constructed in the body of the dielectric member 5 and represents the material feed passage leading to the spraying head. The outer, charging electrode 1 is connected by an insulated cable 3 with a D.C. high tension source 2 having its other pole earthed, while the inner, counter-electrode 4 is also earthed.

The downstream end of the charging electrode 1 adjoins a nozzle-shaped spraying head 6 through which the material to be sprayed is emitted after being charged inside the helical groove of the dielectric member 5 by the field of force formed therein between the electrodes 1 and 4.

The outer, charging electrode 1 is spacedly surrounded by a housing 12 made of insulating material with which the charging electrode 1 forms an annular compressed air channel having an air inlet 13 and an annular gap 14 around the outside of the spraying head 6. Through this gap a current of air introduced into the air inlet 13 can be made to emerge from the housing at the edge of the spraying head 6 to intensify the spraying of the

material emerging from the mouth 9 of the spraying head 6.

The material to be sprayed moving through the feed passage 7 under pressure travels along a relatively long, spiral path between the two concentric electrodes 1, 4 lying within one another and with a strong field of force between them to reach the exit from the mouth 9. This ensures an exceptionally uniform and extremely strong charging of the material before spraying takes place, so that after leaving the apparatus it can deposit in a uniformly thick layer on the article to be sprayed or coated.

If the pressure of the material streaming to the spraying head 6 is adequate and the mouth 9 in the spraying head is appropriately small, then the material is atomised on leaving the spraying head. If the material feed to the spraying head is under relatively low pressure, then the atomising is effected by the compressed air emerging from the housing through the annular gap 14 on the spraying head periphery.

In the hand atomiser shown in section in Fig. 3 the material to be charged and atomised streams in operation to a feed passage 8 via a duct 17 and an intermediate channel 7. A valve 19, operable by a trigger 20, is arranged between the duct 17 and the adjoining channel 7. In this apparatus the atomising air is in use fed to a tube 13 via a tube 16, a valve 18, likewise operated by the trigger 20, being arranged between the two tubes.

During operation of the apparatus the communication between the channels 7 and 17 and the tubes 13 and 16, respectively, is established by pressing the trigger 20, resulting in the spraying material entering the channel 17 and reaching the feed passage 8 via the intermediate channel 7. The feed passage 8 is surrounded by a dielectric 5 arranged inside a tubular counter-electrode 4 earthed via an earthed handle 15. The second, cylindrical charging electrode 1 is located in the portion of the feed passage 8 adjacent the spraying head 6 and is connected via an insulated cable 3 to a D.C. high tension source 2 whose other pole is earthed. A strong field of force is in use formed between the charging electrode 1 and the outer counter-electrode 4, which causes the material to be sprayed streaming along the passage 8 to the spraying head to be uniformly charged.

Following the electrostatic charging, the material reaching the spraying head 6 is atomised at the mouth 9 of the head 6 either by the pressure of the material itself or by compressed air that is led to an annular gap 14 extending around the spraying head 6 via the tubes 16 and 13 and an adjoining annular channel 21. The annular channel 21 and the exit gap 14 are formed

by a cylindrical housing 12 surrounding the counterelectrode 4 in a spaced-apart manner. In operation, the electrostatically charged material atomised in this way streams across a spraying space 10 to the article 11 that is at the same potential as the counter-electrode 4, the article not being shown in Fig. 3, and deposits on it a uniform and dense coating.

In Figs. 2 and 3 also, the charging electrode 1 is constructed to be effectively shorter than the counterelectrode 4; in other words, in those embodiments also the charging electrode 1 terminates at a greater distance from the outlet end 9 of the feed channel at the spray head than the counter-electrode 4, so as to allow the electrostatic attraction of the latter to remain effective at least as long as the charged particles of the material to be sprayed have separated from the charging electrode 1. This greater spacing of the charging electrode 1 from the outlet end of the feed channel in the spray head means greater operational safety by reducing the risk of sparking.

WHAT WE CLAIM IS:—

1. A process for electrostatically spraying a workpiece, comprising electrostatically charging the material to be sprayed by passing it through a feed passage (at least) a part of which is formed between the electrodes of a capacitor spaced by a relatively small distance apart, the electrodes being connected to the opposite poles of a high tension D.C. supply, one of the electrodes having a dielectric on its side facing the other electrode which latter is charged to a potential different from that of the workpiece and is spaced farther from the outlet end of said passage than said one electrode, and causing the charged material to be sprayed from said outlet end towards the workpiece.

2. A process as claimed in claim 1 substantially as hereinbefore described with reference to and as shown in the accompanying drawing.

3. Electrostatic spraying apparatus comprising a spraying head, a feed passage for feeding the material to be sprayed to the spraying head, two electrodes in or forming part of said passage and spaced apart by a relatively small distance, one of the electrodes being provided with a covering of dielectric on its side facing the other electrode which latter is spaced farther from the spraying head than the said one electrode, the arrangement being such that, in operation, the electrodes are connected to opposite poles of a high tension D.C. supply with said other electrode being charged to a potential different from that of the workpiece, whereby the two electrodes function as a capacitor and charge the said material.

material emerging from the mouth 9 of the spraying head 6.

The material to be sprayed moving through the feed passage 7 under pressure travels along a relatively long, spiral path between the two concentric electrodes 1, 4 lying within one another and with a strong field of force between them to reach the exit from the mouth 9. This ensures an exceptionally uniform and extremely strong charging of the material before spraying takes place, so that after leaving the apparatus it can deposit in a uniformly thick layer on the article to be sprayed or coated.

If the pressure of the material streaming to the spraying head 6 is adequate and the mouth 9 in the spraying head is appropriately small, then the material is atomised on leaving the spraying head. If the material feed to the spraying head is under relatively low pressure, then the atomising is effected by the compressed air emerging from the housing through the annular gap 14 on the spraying head periphery.

In the hand atomiser shown in section in Fig. 3 the material to be charged and atomised streams in operation to a feed passage 8 via a duct 17 and an intermediate channel 7. A valve 19, operable by a trigger 20, is arranged between the duct 17 and the adjoining channel 7. In this apparatus the atomising air is in use fed to a tube 13 via a tube 16, a valve 18, likewise operated by the trigger 20, being arranged between the two tubes.

During operation of the apparatus the communication between the channels 7 and 17 and the tubes 13 and 16, respectively, is established by pressing the trigger 20, resulting in the spraying material entering the channel 17 and reaching the feed passage 8 via the intermediate channel 7. The feed passage 8 is surrounded by a dielectric 5 arranged inside a tubular counter-electrode 4 earthed via an earthed handle 15. The second, cylindrical charging electrode 1 is located in the portion of the feed passage 8 adjacent the spraying head 6 and is connected via an insulated cable 3 to a D.C. high tension source 2 whose other pole is earthed. A strong field of force is in use formed between the charging electrode 1 and the outer counter-electrode 4, which causes the material to be sprayed streaming along the passage 8 to the spraying head to be uniformly charged.

Following the electrostatic charging, the material reaching the spraying head 6 is atomised at the mouth 9 of the head 6 either by the pressure of the material itself or by compressed air that is led to an annular gap 14 extending around the spraying head 6 via the tubes 16 and 13 and an adjoining annular channel 21. The annular channel 21 and the exit gap 14 are formed

by a cylindrical housing 12 surrounding the counterelectrode 4 in a spaced-apart manner. In operation, the electrostatically charged material atomised in this way streams across a spraying space 10 to the article 11 that is at the same potential as the counter-electrode 4, the article not being shown in Fig. 3, and deposits on it a uniform and dense coating.

In Figs. 2 and 3 also, the charging electrode 1 is constructed to be effectively shorter than the counterelectrode 4; in other words, in those embodiments also the charging electrode 1 terminates at a greater distance from the outlet end 9 of the feed channel at the spray head than the counter-electrode 4, so as to allow the electrostatic attraction of the latter to remain effective at least as long as the charged particles of the material to be sprayed have separated from the charging electrode 1. This greater spacing of the charging electrode 1 from the outlet end of the feed channel in the spray head means greater operational safety by reducing the risk of sparking.

WHAT WE CLAIM IS:—

1. A process for electrostatically spraying a workpiece, comprising electrostatically charging the material to be sprayed by passing it through a feed passage (at least) a part of which is formed between the electrodes of a capacitor spaced by a relatively small distance apart, the electrodes being connected to the opposite poles of a high tension D.C. supply, one of the electrodes having a dielectric on its side facing the other electrode which latter is charged to a potential different from that of the workpiece and is spaced farther from the outlet end of said passage than said one electrode, and causing the charged material to be sprayed from said outlet end towards the workpiece.

2. A process as claimed in claim 1 substantially as hereinbefore described with reference to and as shown in the accompanying drawing.

3. Electrostatic spraying apparatus comprising a spraying head, a feed passage for feeding the material to be sprayed to the spraying head, two electrodes in or forming part of said passage and spaced apart by a relatively small distance, one of the electrodes being provided with a covering of dielectric on its side facing the other electrode which latter is spaced farther from the spraying head than the said one electrode, the arrangement being such that, in operation, the electrodes are connected to opposite poles of a high tension D.C. supply with said other electrode being charged to a potential different from that of the workpiece, whereby the two electrodes function as a capacitor and charge the said material.



4. Apparatus as claimed in claim 3 in which the two electrodes are constituted by concentric tubes positioned one inside the other, the annular gap between the dielectric covering of one tube and the inner wall of the other tube constituting the feed passage.
5. Apparatus as claimed in claim 4, in which the feed passage is cylindrical.
6. Apparatus as claimed in claim 4, in which the feed passage is helical, there being a helical groove in the face of the dielectric turned towards the said other tube.
7. Apparatus as claimed in any one of claims 3 to 6, in which the two said electrodes are insulated with respect to the external surfaces of the apparatus.
8. Apparatus as claimed in any one of claims 3 to 7 in which a compressed air passage is connected to the spraying head adjacent to the outlet end of the feed passage.
9. Apparatus as claimed in claim 3 substantially as hereinbefore described with reference to and as shown in Fig. 1, Fig. 2 or Fig. 3 of the accompanying drawing.
10. An article electrostatically sprayed by the process claimed in claim 1 or claim 2, or by the apparatus claimed in any one of claims 3 to 9.

T. Z. GOLD & CO.,
Agents for the Applicants,
Chartered Patent Agents,
Staple Inn Buildings North,
High Holborn,
London, WC1V 7QB,
and
15, Lymington Road,
London, NW6 1HX.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1973.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.



* C L M S *