Dec. 8, 1970 W. W. PENDLETON ET AL 3,546,017
ELECTRODEPOSITION OF PARTICULATE COATING MATERIAL
Filed Nov. 7, 1967

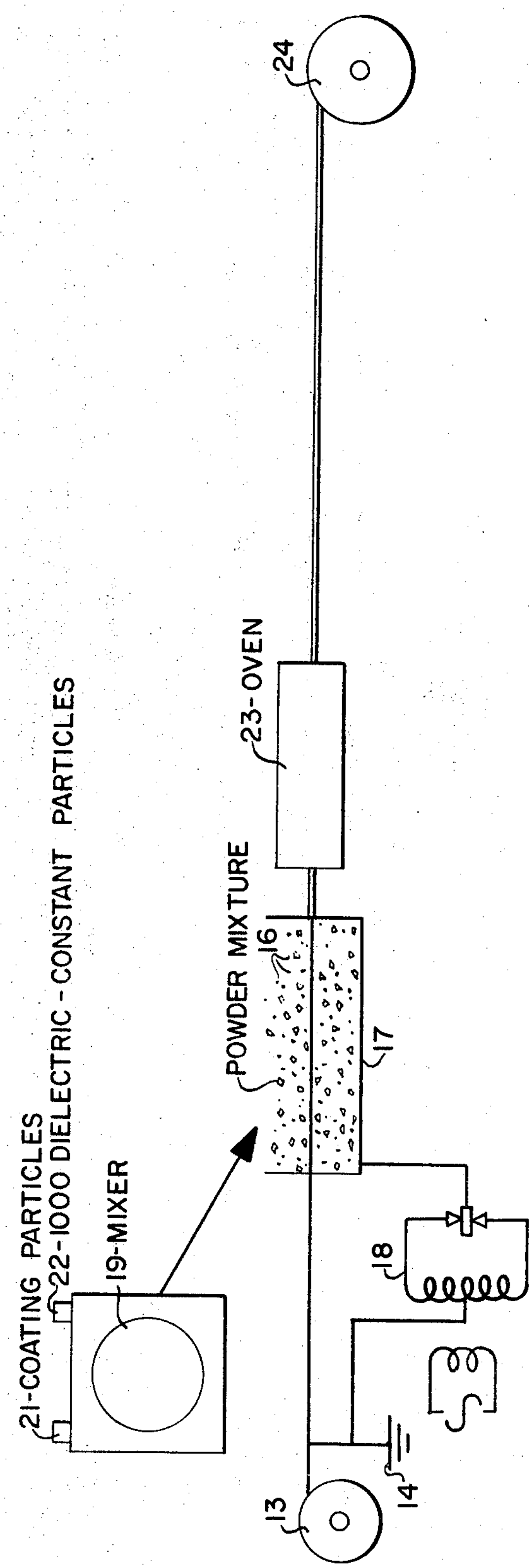

Fig. 2

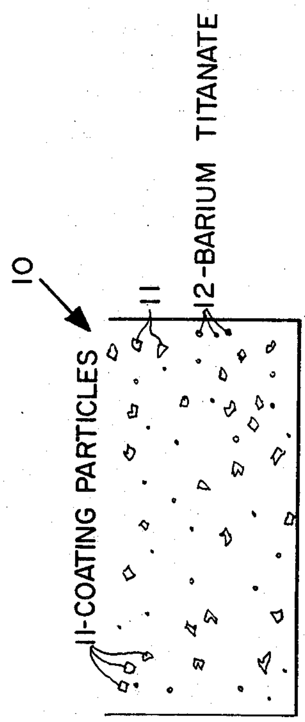

Fig. 1

INVENTORS
W. W. PENDLETON
W. W. ULMER
BY
V. F. Volk
THEIR AGENT

United States Patent Office

3,546,017
Patented Dec. 8, 1970

1

3,546,017

ELECTRODEPOSITION OF PARTICULATE COATING MATERIAL

Wesley W. Pendleton and William W. Ulmer, Muskegon, Mich., assignors to Anaconda Wire and Cable Company, a corporation of Delaware

Filed Nov. 7, 1967, Ser. No. 681,198
Int. Cl. H01b *3/00;* B44d *1/094*
U.S. Cl. 117—232 10 Claims

ABSTRACT OF THE DISCLOSURE

Dielectric particles for electrostatic deposition are mixed with a small proportion of barium titanate or other high-dielectric-constant particles to increase the rate and efficiency of a coating process.

BACKGROUND OF THE INVENTION

This invention relates to the coating of surfaces and particularly to the continuous coating of elongated conductors by electrostatic deposition. In application Ser. No. 588,511, now patent 3,396,699, an improvement is described in apparatus for electrostatically coating a continuous conductor passing through a cloud of particles above a fluid bed, and coating apparatus is commercially available in several varieties that operate on principles of electrostatics. In such apparatus an electrical potential, usually in the range of 30,000–100,000 volts, is impressed between the object to be coated and an electrode spaced from the object. The coating particles are introduced between the electrode and the object and may become charged either by contact with the electrode, other charged particles, or the ionized air.

In the commercial use of electrostatic coating methods, including the practice of xerographic printing, it is, of course, desirable to apply a given thickness of coating in as short a time as possible. The rate of application increases with an increased potential difference but a higher potential requires greater spacing of the electrode from the object being coated, and, where the particles are charged by contact with the electrode, a higher potential will then mean that the particles must travel a longer path.

It is not always possible to place the article being coated symmetrically with respect the electrode and it has been considered an advantage of the electrostatic method of coating that the particles will deposit around corners onto surfaces that are not in direct line with the particle supply source. This is particularly true in the case where a moving wire or strip is being coated in a cloud of particles above a fluid bed. In the commercial application of this method, however, the far surfaces have not always been uniformly coated when speeds were increased to those speeds wherein the near surfaces received a sufficient coating.

We seek therefore by our invention to obtain electrostatic depositions in shorter times.

We seek further, by our invention, to obtain coatings at lower potentials.

We seek, further, by our invention, to obtain more uniform electrostatically deposited coatings.

SUMMARY

In a process for coating a surface by means of electrostatically charged particles, particularly particles having a dielectric constant under 10, we have invented the improvement of mixing among these particles a small percentage of a, preferably much finer, particulate material, such, by preference, as barium titanate, having a dielectric constant, at the temperature of deposition, of at least 1500. Our invention has particular application to the deposition of an organic resin, such as one comprising an epoxy, upon a continuously advancing conductor, such as a wire, and the subsequent fusing of the resin on the conductor.

2

Our invention comprises also the powdered mixture, for deposition, of particles of a coating material, and a small weight percentage of a substance, such as barium titanate, with a dielectric constant in excess of 1500. The barium titanate or other high-dielectric-constant substance is preferably substantially finer than the coating material. In certain preferred embodiments the coating material of our mixture comprises an organic resin such as an epoxy.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 represents a container of the mixture of our invention with the particle sizes very much enlarged.

FIG. 2 shows a scheme of the process of our invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1 a mixture, indicated generally by the numeral 10, has been prepared for coating the surface of an object such as an electrical wire strip that is passed continuously adjacent to an electrostatically charged supply of said particles. This mixture comprises a large plurality of particles **11** of an epoxy resin of a type known for electrical insulation coating or the constituents of such a resin.

A suitable epoxy resin comprises about 77.31 parts of Epi Rez #530 C, 9.59 parts Epi Rez #540, .23 part of hexamethylene tetramine, 10.5 parts of trimellitic anhydride and .87 part of powdered silica (Cab-o-Sil, supplied by Godfrey L. Cabot, Inc.). Epi Rez is supplied by the Celanese Plastics Company. Although we have described a mixture where the particles **11** comprise epoxy, other resins suitable for electrodeposition may be used, of which polyolefins, polyesters, polyacrylics, polyvinyls, polyamids, polyimids are listed by way of example. The dielectric constant of these materials is preferably lower than 4 and invariably lower than 10. Inorganic glasses and ceramics or blends thereof, that will be fused on a coated object can also comprise the particles **11** within the scope of our invention as can pigment particles which are known for use in the practice of xerography.

In the preferred example the epoxy particles **11** had the following mesh analyses—on 170 mesh, 9.2%; on 200 mesh, 28.9%; on 230 mesh, 23.6%; on 270 mesh, 13.4%; on 325 mesh, 13.2%; on 400 mesh, 6.7%; through 400 mesh, 5%. Generally we favor a particle size for the coating material from .5–3.5 mils in diameter.

Interspersed uniformly among the particles **11** are particles **12** of barium titanate to the amount of about 1% of the weight of the particles **11**. Barium titanate has a dielectric constant at room temperature of 1740 and a low dissipation factor (0.63%) which is advantageous in an electrical insulation. We prefer that the particle size of the barium titanate should be much finer than the size of the particles **11** and all of it is passed through 400 mesh. Consequently, although the weight of the barium titanate added is relatively small the number of particles in the blend are sufficient to effect its behavior in an electric field. It is preferred to have the high-dielectric-constant powder in a particle size from .01 to .05 mil. We prefer that the $BaTiO_3$ be from 0.5–1.5% of the weight of the particles **11** but weights from .1 to 5% may be used with advantageous effect depending on the relative particle sizes and selection of high-dielectric-constant material.

Other high-dielectric-constant materials that can be used in the practice of our invention include combinations of barium titanate and strontium titanate of which the compound with a barium:strontium ratio of 79:21 has a dielectric constant of 8700, that with a barium:strontium ratio of 71:29 has a dielectric constant of 2990 and that with a barium:strontium ratio of 90:10 has a dielectric constant of 1310. The dissipation factor of the 79:21 barium strontium compound is high, 2.30%, but, because the quantity of the compound that will finally be fused into the insulation is low, the high dissipation factor will not be objectionable for many electrical insulation applications, and of course, will be no hindrance at all for non-electrical coatings. Ferrites are known with dielectric constants as high as 680,000 and these too are useful in the practice of our invention although their cost, at present, is high for many commercial applications.

It is noteworthy, however, that when TiO_2, which has a dielectric constant of 100, was employed in the same manner as the $BaTiO_3$ to improve powder deposition no improvement was observed.

In FIG. 2, in a preferred method of our invention, a reel of rectangular magnet wire conductor **13**, grounded at **14** is continuously advanced through a cloud **16** of electrostatically charged particles maintained by known methods around the conductor. A suitable method employs a fluid bed as hereinabove cited. A high potential is maintained on a plate **17** by means of a transformer-rectifier **18** or other suitable means in a known manner. Instead of the plate **17** the high potential might be applied to the nozzle of a powder spray unit of which several types are commercially available. The cloud **16** is supplied from a mixer **19** which may also advantageously comprise a pulverizer, into which are paid the coating particles **21** and a small proportion of high-dielectric-constant particles **22**. In an oven **23** the coating is fused on the conductor which is then cooled and taken up on a reel **24**.

When an epoxy resin was deposited on a copper strand passing through an electrified particle cloud at the rate of 30 ft./min. with an electrostatic potential of 100 kv., the wall thickness of insulation deposited was 2.0 to 2.4 mils. When .79% of barium titanate was added to an essentially similar epoxy powder the same rate of deposition was obtained at only 50 kv. potential and at 100 kv. the deposition was 4–5 mils. (In this experiment .21% of strontium titanate was also added but since the dielectric constant of this material is only 234 the barium titanate accounts for the improved deposition). When 2.5% of barium titanate was included (with no strontium titanate) a deposition of 6–7 mils was obtained at only 85 kv. at 36 ft./min.

We have invented a new and useful process and product of which the above description has been exemplary rather than definitive and for which we desire an award of Letters Patent.

We claim:

1. The process of coating an electrically conducting surface comprising the steps of:

(A) blending a mixture of electrostatically chargeable,

heat fusible, coating powder having a dielectric constant lower than 10, and from 0.1 to 5% of the weight of said powder, of particles of a material having a dielectric constant of at least 1500 at the temperature of deposition,

(B) electrostatically charging said mixture,

(C) electrically grounding said surface,

(D) introducing said mixture adjacent to said surface whereby said mixture is transferred to said surface by reason of said charges, and

(E) heating said surface thereby fusing said heat fusible particles thereto.

2. The process of claim **1** wherein said particles comprise barium titanate.

3. The process of claim **1** wherein said heat fusible particles comprise an organic resin.

4. The process of claim **2** wherein said heat fusible particles comprise an organic resin.

5. The process of claim **1** wherein said particles are substantially finer in size than said powder.

6. The process of claim **2** wherein said barium titanate is substantially finer in size than said powder.

7. The process of insulating a conductor comprising the steps of:

(A) applying a high electric potential between said conductor and an electrode spaced therefrom,

(B) blending a mixture of particles of a dielectric organic resin and 0.1% to 5% of the weight of said particles of particles of a material having a dielectric constant of at least 1500.

(C) introducing said mixture between said conductor and said electrode thereby depositing said particles of resin and said material upon said conductor, and

(D) fusing said resin particles upon the surface of said conductor.

8. The process of claim **7** wherein said conductor comprises a continuously advancing wire.

9. The process of claim **7** wherein said material comprises barium titanate.

10. The process of claim **7** wherein said resin comprises an epoxy.

References Cited

UNITED STATES PATENTS

2,919,247	12/1959	Allen	252—62.1
3,203,821	8/1965	Domin	117—17
3,239,465	3/1966	Rheinfrank	117—17.5
3,342,621	9/1967	Point et al.	117—17

FOREIGN PATENTS

3,563,663	12/1961	Japan	117—17

WILLIAM D. MARTIN, Primary Examiner

R. M. SPEER, Assistant Examiner

U.S. Cl. X.R.

117—17, 21, 224

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,546,017 Dated 12/8/70

Inventor(s) Wesley W. Pendleton and William W. Ulmer

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 47, after "respect" insert --to--.

Column 2, line 64, for "effect" read --affect--.

Claim 7, column 4, line 30, after 1500 change the period to a comma.

SIGNED AND
SEALED
MAR 29 1971

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, J
Commissioner of Patent