Charging apparatus for an electrostatic fluid bed powder coating system for uniformly coating a wire which is moving across the bed above the surface of fluidized powder, including a pair of elongated charging electrodes extending axially of the wire in the bed below the surface of the fluidized powder therein and a grounded control electrode located above the moving wire and having portions directly above and extending parallel to and substantially coextensive with each of the charging electrodes. The charging electrodes and control electrode portions are all located the same radial distance from the axis of the wire to be coated to form a cylindrical array having the wire to be coated as its axis.

4 Claims, 3 Drawing Figures
ELECTROSTATIC FLUID BED POWDER COATING SYSTEM

This invention relates to an electrostatic fluid bed powder coating system, and more particularly to charging apparatus for an electrostatic fluid bed powder coating system for coating wire.

One feature of the invention is that it provides an improved electrostatic fluid bed powder coating system. Another feature of the invention is that it provides charging apparatus so constructed and arranged as to provide a uniform coating of powder on an elongated workpiece, as a wire, which is moved axially across the fluid bed and above the surface of fluidized powder therein. Still further feature of the invention is that it utilizes elongated charging and control electrodes extending axially of the elongated workpiece and arranged symmetrically about its axis, all of the electrodes being radially equidistant from said axis.

Other features and advantages of the invention will be apparent from the following description and from the drawings, in which:

FIG. 1 is a transverse vertical section through a fluid bed powder coating system incorporating the invention, some of the structure being shown schematically;

FIG. 2 is a longitudinal vertical section through the system, being taken along the line 2—2 of FIG. 1, and FIG. 3 is a top plan view taken along the line 3—3 of FIG. 2.

Electrostatic fluid bed powder coating systems are well known in the art. In some arrangements, the workpiece to be coated is dipped into the fluidized powder which is charged electrostatically so that particles of the powder adhere to the workpiece, which generally is heated. In other arrangements, and particularly arrangements designed to coat elongated workpieces, as a wire of indeterminate length, the workpiece is moved horizontally across the fluid bed above the surface of fluidized powder therein. The charge imparted to the fluidized powder causes particles of the workpiece to be attracted to the workpiece, which is generally grounded. Patents illustrative of this type of electrostatic fluid bed powder coating system are Barford et al. U.S. Pat. No. 3,248,253, Point U.S. Pat. No. 3,336,903, and Beebe et al. U.S. Pat. No. 3,396,699. For a general discussion of fluid bed coating, reference may be had to Geimmer U.S. Pat. No. 2,844,489.

While, as noted above, electrostatic fluid bed powder coating systems are old, difficulties have been experienced in providing a coating of uniform thickness, particularly on wire of indeterminate length which is moved across the bed above the surface of fluidized powder therein. This invention provides improved charging apparatus resulting in more uniform powder coating on the moving wire.

Referring now more particularly to the drawings, 10 is a conventional fluidized bed container of nonconductive material having a bottom 10a opposite side walls 10b and end walls 10c. Spaced above the bottom 10a of the fluidized bed container is a porous plate 12 which, as discussed fully in Gummer U.S. Pat. No. 2,448,489 permits passage of air or other gas under pressure. Powder 14 in the container above the porous plate 12 is fluidized by the passage of the air as is fully discussed in Gummer U.S. Pat. No. 2,844,489. Fluidizing gas, which may be air, may be supplied by a conventional air compressor 16 connected by a hose 18 to the chamber 10d in the container 10 between the bottom 10a and the porous plate 12.

Apertures 19 in the end walls 10c are provided for the passage of an elongated workpiece 20 here shown as a wire of indeterminate length which is moved in the direction of the arrows (FIGS. 2 and 3) by conventional apparatus (not shown) horizontally and axially across the fluid bed above the surface of fluidized powder therein. As illustrated schematically in FIG. 2, the wire 20 is electrically grounded.

The charging apparatus comprising the invention includes one or more pairs of elongated charging electrodes in the fluid bed below the coated workpiece. The electrodes of the fluidized powder therein and a grounded control electrode located above the workpiece. These electrodes are arranged symmetrically with relation to the wire 20 in a manner to be described to provide a uniform powder coating on the wire as it moves across the fluid bed.

An outer pair of elongated charging bar electrodes 22a and 22b are positioned in the fluid bed below the surface of the fluidized powder therein. They are supported in the bed by insulating supports 23. The electrodes 22a and 22b are formed of electrically conducting material, preferably copper, and are round in transverse section. They preferably have rounded ends as shown in FIGS. 2 and 3. The electrodes 22a and 22b extend parallel to the axis of the wire 20 and are located symmetrically on opposite sides of the wire and are radially equidistant from the axis of the wire.

While not necessary in certain embodiments of the invention, in the embodiment illustrated, there is an inner pair of charging bar electrodes 24a and 24b in the fluid bed between and extending parallel to the outer electrodes 22a and 22b. The electrodes 24a and 24b may also be mounted on the insulating supports 23. Each inner electrode 24a and 24b is substantially the same size and shape as the outer electrodes and each inner electrode is spaced the same distance from its adjacent outer electrode as the other inner electrode is spaced from its adjacent outer electrode. The inner electrodes are located the same radial distance from the axis of the wire 20 as are the outer charging electrodes. Additional pairs of electrodes may be used if desired.

A power supply 26 has one terminal (preferably the positive terminal) grounded and the other terminal connected by a cable 28 to each of the electrodes 22a, 22b, 24a and 24b. In order to provide equal voltages on all of the charging electrodes, it is preferred that they be connected in parallel to the power supply.

A control electrode of smaller diameter than the charging electrodes is located above the wire 20. The control electrode, which is grounded, may be formed of a rectangular wire 30 supported in the container 10 by insulators (not shown) and having portions 30a and 30b directly above and extending parallel to and substantially coextensive with each of the outer charging electrodes 22a and 22b. The electrode 30 is supported on the walls of cabinet 10 by brackets 31. Separate grounded wire portions 30a, 30b may be used if desired. The portions 30a and 30b of the control electrode are located the same radial distance from the axis of the wire 20 as are the charging electrodes 22a, 22b, 24a and 24b. The arrangement thus provides a charging system in which the charging electrodes and control electrodes are arranged in a cylindrical manner with the wire to be coated as the axis of the cylinder.
The number of electrodes needed, their size, spacing and other values in the system, are determined by a number of parameters. These parameters include the diameter, electrical conductivity and the rate of movement of the wire 20 to be coated; the type of powder to be applied, and the charging voltage which is used. In one system which has been devised, the wire 20 was copper wire having a diameter of 0.098 inches and was moving across the bed at a speed of ten feet per minute. The coating material 14 was an epoxy powder which was coated on the wire 20 to a thickness of 0.008 inches. The power supply 26 provided 25 kilovolts (negative). The dimensions of the parts of the charging system were as follows:

a. Diameter of charging electrodes 22a, 22b, 24a and 24b — 0.5 inches

b. Length of charging electrodes 22a, 22b, 24a and 24b — 24 inches
c. Radial distance between wire 20 and electrodes 22, 24 and 30 — 4.5 inches
d. Distance between outer electrodes 22a and 22b — 6 inches
e. Angle included between radial lines drawn between electrode 22a and wire 20 and electrode 24a and wire 20 — 18°
f. Diameter of control electrode 30 — 0.036 inches
g. Vertical distance between electrodes 22a, 22b and the surface of fluidized powder 14 — 0.5 inches.

The system described above provided a powder coating of uniform thickness of 0.008 inches on the wire 20. After application of the powder, the wire may pass through an oven where the wire is heated and the coating is fused thereon as described in Beebe et al. U.S. Pat. No. 3,396,699.

While I have shown and described one embodiment of my invention, it is capable of various modifications. Changes, therefore, may be made in the construction and arrangement without departing from the spirit and scope of the invention as set forth in the appended claims.

What is claimed is as follows:

1. In an electrostatic fluid bed powder coating system having a powder fluidizing bed, a source of fluidizing gas therefor, and means for moving an elongated workpiece horizontally and axially across said bed above the surface of fluidized powder therein, charging apparatus comprising:
   a. a voltage source;
   b. a pair of elongated charging electrodes in said bed below the surface of the fluidized powder therein, said electrodes extending parallel to the axis of said workpiece and being located symmetrically on opposite sides of said axis and radially equidistant therefrom;
   c. means connecting said electrodes to said voltage source;
   d. a control electrode located above said workpiece and having portions directly above and extending parallel to and substantially coextensive with each of said charging electrodes, said portions being located the same radial distance from the axis of said workpiece as are said charging electrodes;
   e. means connecting said control electrode portions and said workpiece to a voltage different from that of the charging electrodes.

2. In an electrostatic fluid bed powder coating system having a powder fluidizing bed, a source of fluidizing gas therefor, and means for moving a wire horizontally and axially across said bed above the surface of fluidized powder therein, charging apparatus comprising:
   a. a voltage source;
   b. a pair of similar elongated charging bar electrodes in said bed below the surface of the fluidized powder therein, said electrodes being round in transverse section and having rounded ends, and said electrodes extending parallel to the axis of said wire and being located symmetrically on opposite sides of said wire and radially equidistant from the axis thereof;
   c. means connecting said electrodes to said voltage source;
   d. a control electrode of smaller diameter than said charging electrodes located above said wire and having portions directly above and extending parallel to and substantially coextensive with each of said charging electrodes, said portions being located the same radial distance from the axis of said wire as are said charging electrodes;
   e. and means connecting said control electrode portions and said wire to ground.

3. In an electrostatic fluid bed powder coating system having a powder fluidizing bed, a source of fluidizing gas therefor, and means for moving an elongated workpiece horizontally and axially across said bed above the surface of fluidized powder therein, charging apparatus comprising:
   a. a voltage source;
   b. an outer pair of elongated charging electrodes in said bed below the surface of the fluidized powder therein, said electrodes extending parallel to the axis of said workpiece and being located symmetrically on opposite sides of said axis and radially equidistant therefrom;
   c. an inner pair of elongated charging electrodes in said bed between and extending parallel to said outer electrodes, each one of said inner electrodes being spaced the same distance from its adjacent outer electrode as the other inner electrode is spaced from its adjacent outer electrode, said inner electrodes being located the same radial distance from the axis of said workpiece as are said outer charging electrodes;
   d. means connecting said outer and inner electrodes to said voltage source;
   e. a control electrode located above said workpiece and having portions directly above and extending parallel to and substantially coextensive with each of said outer charging electrodes, said portions being located the same radial distance from the axis of said workpiece as are said outer charging electrodes;
   f. and means connecting said control electrode portions and said workpiece to a voltage different from that of the charging electrodes.

4. In an electrostatic fluid bed powder coating system having a powder fluidizing bed, a source of fluidizing gas therefor, and means for moving a wire horizontally and axially across said bed above the surface of fluidized powder therein, charging apparatus comprising:
   a. a voltage source;
   b. an outer pair of elongated charging bar electrodes in said bed below the surface of the fluidized powder therein, said electrodes being round in transverse section and having rounded ends, and said ele-
trodes extending parallel to the axis of said wire and being located symmetrically on opposite sides of said wire and radially equidistant from the axis thereof;
an inner pair of elongated charging bar electrodes in said bed between and extending parallel to said outer electrodes, each inner electrode being substantially the same size and shape as said outer electrodes and each being spaced the same distance from its adjacent outer electrode as the other inner electrode is spaced from its adjacent outer electrode, and said inner electrodes being located the same radial distance from the axis of said wire as are the outer charging electrodes; means connecting said inner and outer electrodes to said voltage source; a control electrode of smaller diameter than said charging electrodes located above said wire and having portions directly above and extending parallel to and substantially coextensive with each of said outer charging electrodes, said portions being located the same radial distance from the axis of said wire as are said outer charging electrodes; and means connecting said control electrode portions and said wire to ground.

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