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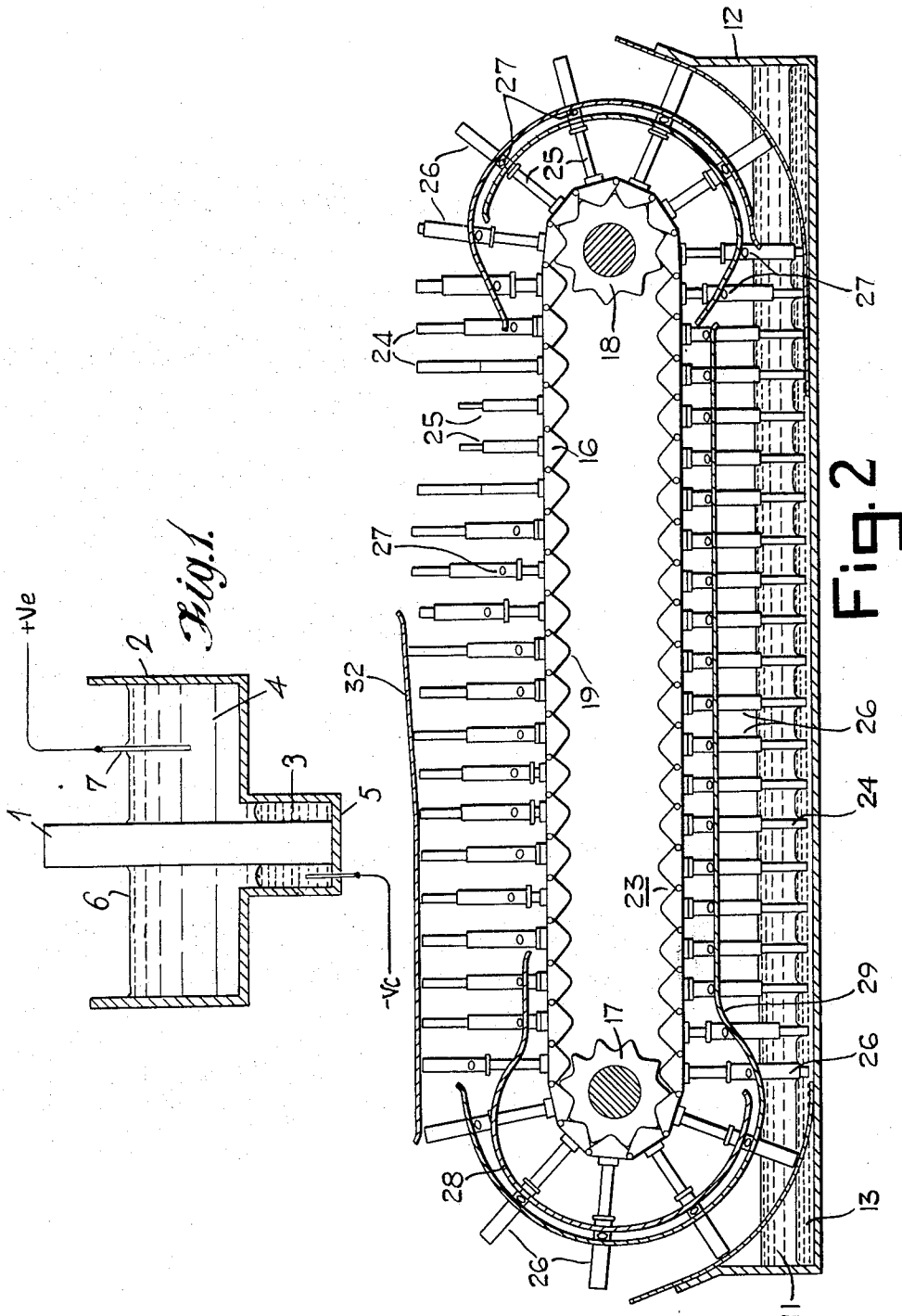
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3,254,004

PROCESS OF AND APPARATUS FOR ELECTROPHORETICALLY COATING
A SELECTED PORTION OF AN ELECTRICALLY CONDUCTING MEMBER

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2 Sheets-Sheet 1



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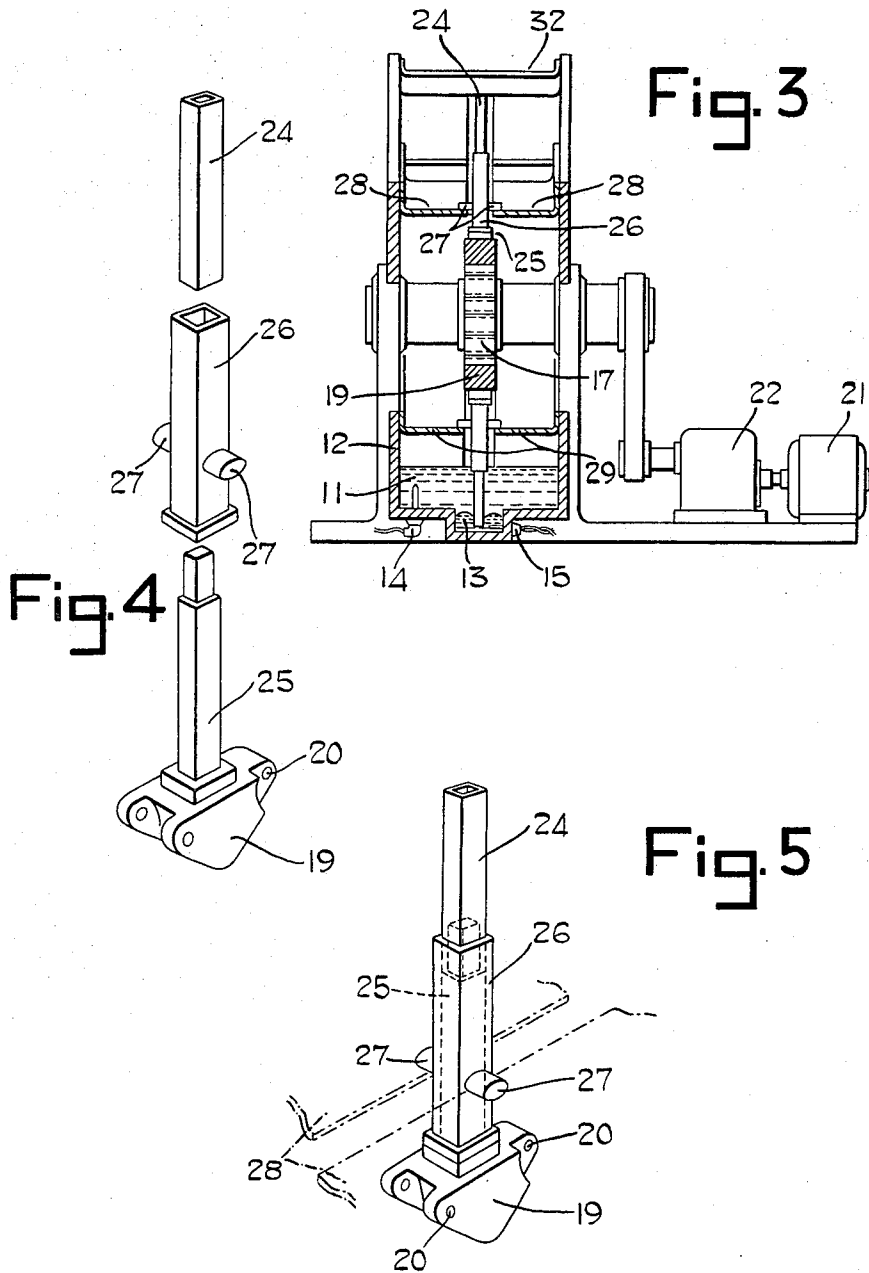
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PROCESS OF AND APPARATUS FOR ELECTROPHORETICALLY COATING A SELECTED PORTION OF AN ELECTRICALLY CONDUCTING MEMBER

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7 Claims. (Cl. 204—15)

This invention relates to a process for coating, by electrophoresis, a selected portion of an electrically conducting member with a finely divided material.

The invention is particularly, but not exclusively, applicable to the coating of tubular members with a material capable of conversion to a thermionically emissive material to form indirectly heated cathodes.

An indirectly heated cathode for a thermionic valve may comprise a tubular member, coated externally with thermionically emissive material and having a heater located within the member. For convenience in the manufacture of the valve and to enable terminal wires to be connected electrically to the end portions of the tubular members, it is usually necessary to restrict the thermionically emissive material to the central region of the member.

In a known process for applying material capable of conversion to thermionically emissive material to a tubular member, one or more members are mounted in a jig which masks their end portions, and the material, in the form of a slurry, is sprayed onto the member(s). The jig prevents the material from being sprayed onto the end portions of the member(s).

To ensure uniform and predictable operation of the cathodes, it is necessary to apply the material evenly over the whole unmasked surface of the member. It is particularly difficult to spray material onto adjacent portions of members located side by side in the jig, and unless the mask is in close contact with the entire periphery of the member, a ragged edge is formed between the sprayed and nonsprayed portions of the members.

The application of a coating of a finely divided material to an electrically conducting member by the process of electrophoresis is known. In this process the member to be coated is immersed in a suspension containing the finely divided coating material and a substance which provides the particles of coating material with an electric charge, such that when a potential of the correct polarity is applied between the member to be coated and an electrode dipping in the suspension, the coating material is deposited on the member in the form of a uniform layer. Any part of the member on which the coating is not required has to be masked, and if the member is hollow, care has to be taken to prevent a coating from being formed on the inside surface of the member.

An object of the present invention is to provide a process whereby a coating of material may be applied, by electrophoresis, to a selected portion of an electrically conducting member.

A further object of the invention is to provide apparatus by which a coating may be applied to a plurality of electrically conducting members simultaneously.

According to one aspect of the present invention in a process for coating at least one electrically conducting member with a finely divided material by immersing said member(s) in an electrophoretic suspension of the material and applying a potential between the member(s) and an electrode in contact with the suspension, a selected portion of the member is prevented from being coated with

the material by immersing said portion in a body of mercury which is itself immersed in the suspension.

According to a further aspect of the invention in a process for electrophoretically coating at least one contacting member in the form of a rod or tube, with a finely divided material by immersing said member(s) in an electrophoretic suspension of the material and applying a potential between the member(s) and an electrode in contact with the suspension, a selected end portion of the member is prevented from being coated with the material by immersing said end portion in a body of mercury which is itself immersed in the suspension, the depth of the suspension above the surface of the mercury being such as to effect coating of the whole or a part of the remainder of the member(s).

The process is conveniently carried out by cataphoresis and in this process a positive electrical potential is applied to an electrode dipped into the suspension of coating material and a negative potential is applied to the conducting member to be coated. The negative potential is preferably applied to the conducting member(s) by means of an electrode which is in contact with the layer of mercury.

Apparatus by which the coating may be applied simultaneously to a plurality of electrically conducting members in the form of a rod or tube comprises an open vessel adapted to contain the electrophoretic coating suspension with a layer of mercury in contact with the suspension, and means by which said members are supported in said vessel such that the end portion upon which a coating is not required is immersed in said mercury.

In order that the invention may be more readily understood it will now be described by way of example, with reference to the accompanying drawings in which:

FIG. 1 shows in diagrammatic form apparatus used in the performance of the invention.

FIG. 2 is a longitudinal section through apparatus by which a plurality of members in the form of tubes may be coated simultaneously in accordance with one embodiment of the invention.

FIG. 3 is an end elevation partly in section of the apparatus shown in FIG. 2; and

FIGS. 4 and 5 show in greater detail a portion of the apparatus illustrated in FIGS. 2 and 3.

Referring to FIG. 1 reference numeral 1 denotes an electrically conducting member, conveniently of tubular form, located in an open vessel 2 formed of electrically insulating material. The vessel contains a body of mercury 3 in contact with a cataphoretic suspension 4. The mercury may be contained in a recess 5 which is in the base of the vessel 2. The conducting member 1 is conveniently placed in the vessel 2 with one end in the recess 5 such that the longitudinal axis of the member is arranged substantially perpendicular to the surface 6 of the cataphoretic suspension 4.

A positive electrical potential is applied to an electrode 7 which dips into the suspension 4, and a negative potential is applied to the conducting member 1. The negative potential may be applied to the conducting member 1 by means of a further electrode in contact with the mercury 3. The coating material contained in the suspension is deposited on the portion of the conducting member which is in contact with the suspension and the portion of the member located beneath the surface of the mercury layer is not coated.

The depth of the mercury body 3 and the depth to which the member is inserted therein, defines the extent of the end portion of the member which is to be devoid of an applied coating. Similarly the depth of the suspension 4 is arranged so that the portion of the member which is to be coated is immersed in the suspension. If both end portions of the member are to remain uncoated, one portion is dipped into the mercury and the

other is arranged to extend above the surface 6 of the suspension.

To prevent the end portion of the conducting member, which is to remain uncoated, from coming into contact with the electrophoretic suspension, it is preferable that the member is inserted into the vessel and the end portion is immersed beneath the surface of the mercury before the suspension is added. Similarly it is convenient to empty the suspension from the vessel before the coated conducting member is removed. If the conducting member is of tubular form and a coating is not required on the inner surface of the member, the above mentioned procedure is particularly necessary.

Apparatus by which a plurality of electrically conducting members in the form of tubes may be electrophoretically coated simultaneously in accordance with one embodiment of the invention is shown in FIGS. 2 and 3. The electrophoretic suspension 11 is contained within a shallow open vessel 12 formed of electrically insulating material. The bottom of the vessel is covered with a layer of mercury 13 which is immersed in the suspension; an electrode 14 extends through the wall of the vessel into contact with the suspension and a further electrode 15 extends through the wall of the vessel into contact with the layer of mercury. The electrically conducting members upon which a coating is to be applied are supported, by means to be described in more detail later, on a flexible band 16 which is supported on guide members 17 and 18, one of which is located adjacent each end of the vessel, such that the band extends substantially parallel to the surface of the suspension in the vessel. The band 16 comprises a plurality of interlocking plates 19 hinged together by means of pins (not shown) which extend through openings 20 formed in overlapping portions of adjacent plates. The guide members 17 and 18 are in the form of sprockets one of which is driven by means of an electric motor 21 through a suitable gear box 22 and the rotation of the sprocket causes the band to travel with its lower portion 23 located above and substantially parallel to the surface of the suspension in the vessel.

Referring particularly to FIGS. 4 and 5, the plates 19 are each provided with a support post 25 which extends outwardly from and substantially normal to the plane of the plates 19. The outer end portion of the support posts 25 has reduced dimensions such that the tubes to be coated 24 may be placed over the end portion of the posts and is held firmly in position. The support post and the plates 19 are formed from a material which is not affected by the electrophoretic suspension, nylon having proved satisfactory.

As the sprocket 18 is rotated the tubes mounted on the support post dip into the electrophoretic suspension and remain immersed therein as they travel along the path of the lower part of the band 16. The depth of the mercury layer 13 is arranged such that the end portion of the tubes upon which a coating is not required is immersed in the mercury as it passes through the vessel. Similarly the depth of the electrophoretic suspension is arranged such that only the portion of the tube upon which a coating is required is immersed in the suspension. The speed of travel of the band and the magnitude of the potential applied to the electrodes 14 and 15 are adjusted such that during the interval of time in which the tubes are immersed in the suspension a coating of the required thickness is applied.

The end portion of each tube which is immersed in the mercury as it travels through the vessel has to be protected as the tube is inserted into and removed from the vessel or the end portion of the tube will come into contact with the suspension before it is immersed in the mercury. To overcome this difficulty a sleeve 26 also conveniently of nylon and having internal dimensions slightly larger than the outer dimensions of the support

post and tube is placed over each post. As the tube is immersed and removed from the suspension a sleeve is caused to slide along the support post and cover the tube but when the tube is immersed in the suspension the sleeve is withdrawn so that the portion of the tube to be coated is exposed. The movement of the sleeve is conveniently brought about by providing the sleeve with a projection 27 which engages with positioning strips located at each end of the vessel. Referring again to FIG. 2 and assuming that the sprocket is rotated in a direction such that the upper portion of the band is travelling in an anti-clockwise direction, as the tubes approach the sprocket 17 a positioning member 28 engages with the projection 27 on the sleeves and cause them to cover the tube. The tube is kept in a covered position until it is totally immersed in the suspension and then a further positioning strip 29 engages with the projection on the sleeve and slides the sleeve away from the tube. As the tubes approach the other end of the vessel they are covered by the sleeves in a manner similar to that described above before being removed from the vessel.

The coated tubes are removed from the support posts and the tubes to be coated positioned on the support posts as the posts pass along the upper portion of the band and to ensure that the tubes are correctly positioned on their respective support posts a vibrating guide 32 is provided and as the posts pass beneath the guide the tubes come into contact with the vibrating guide and are firmly attached to the support posts.

What we claim is:

1. A process for electrophoretically coating a portion of an electrically conducting member with a finely divided material comprising immersing said portion of the member in an electrophoretic suspension of the material which has a body of mercury immersed therein and an electrode in contact with the suspension, with a portion of the member which is required to remain uncoated being immersed in the body of mercury, and applying an electrical potential of the proper polarity between the body of mercury and said electrode.

2. A process for electrophoretically coating a portion of an electrically conducting member in the form of a tube with a finely divided material comprising immersing said portion of the tube in an electrophoretic suspension of the material which has a body of mercury immersed therein and an electrode in contact with the suspension, with an end portion of the tube which is required to remain uncoated being immersed in the body of mercury, and applying an electrical potential of the appropriate polarity between the body of mercury and said electrode.

3. A process for cathodically coating a portion of an electrically conducting member in the form of a tube with a finely divided material comprising immersing said portion of the tube in a cathodic suspension of the material which has a body of mercury immersed therein and an electrode in contact with the suspension, with an end portion of the tube which is required to remain uncoated being immersed in the body of mercury, and applying a negative electrical potential to the body of mercury and a positive potential to the electrode.

4. Apparatus for electrophoretically coating a portion of an electrically conducting member, comprising an open top vessel for containing an electrophoretic suspension and having a base portion, side walls extending from said base portion and a downwardly extending recess in said base portion containing a body of mercury said side walls and base portion of said vessel being formed of an electrically insulating material, means for creating an electrical potential of the appropriate polarity in the suspension, means for creating an opposite electrical potential in the body of mercury, and means for supporting the member to be coated such that different portions thereof will be suspended in the suspension and mercury respectively.

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5. Apparatus for electrophoretically coating a portion of an electrically conducting member in the form of a tube, comprising an open top vessel for containing an electrophoretic suspension, said vessel having a base portion, side walls extending from said base portion and a downwardly extending recess in said base portion supporting a body of mercury, said side walls and base portion of said vessel being formed of an electrically insulating material, an electrode adapted to make contact with said mercury, an electrode adapted to make contact with said suspension, and means for supporting the member to be coated in said suspension such that an end portion of the member extends into said mercury.

6. Apparatus for electrophoretically coating a portion of an electrically conducting member in the form of a tube, comprising an open top vessel for containing an electrophoretic suspension, said vessel having a base portion, side walls extending from said base portion and a downwardly extending recess in said portion supporting a body of mercury, said side walls and base portion of said vessel being formed of an electrically insulating material, an electrode adapted to make contact with said mercury, an electrode adapted to make contact with said suspension, and means for supporting the member to be coated in said suspension such that an end portion of the member extends into said mercury and the other end portion thereof is located above the surface of the suspension.

7. Apparatus for electrophoretically coating a portion of an electrically conducting member in the form of a

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tube, comprising an open vessel for containing an electrophoretic suspension, said vessel having a base portion, side walls extending from said base portion, and a downwardly extending recess in said base portion, a body of mercury contained in said recess for contacting said suspension, said side walls and base portion of said vessel being formed of an electrically insulated material, an electrode adapted to make contact with said mercury, an electrode adapted to make contact with said suspension, and means for supporting the member to be coated in said suspension such that an end portion of the member extends into said mercury.

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