

July 23, 1957

M. N. FREDENBURGH
CATAPHORETIC COATING MACHINE

2,800,448

Filed April 30, 1954

Fig. 1.

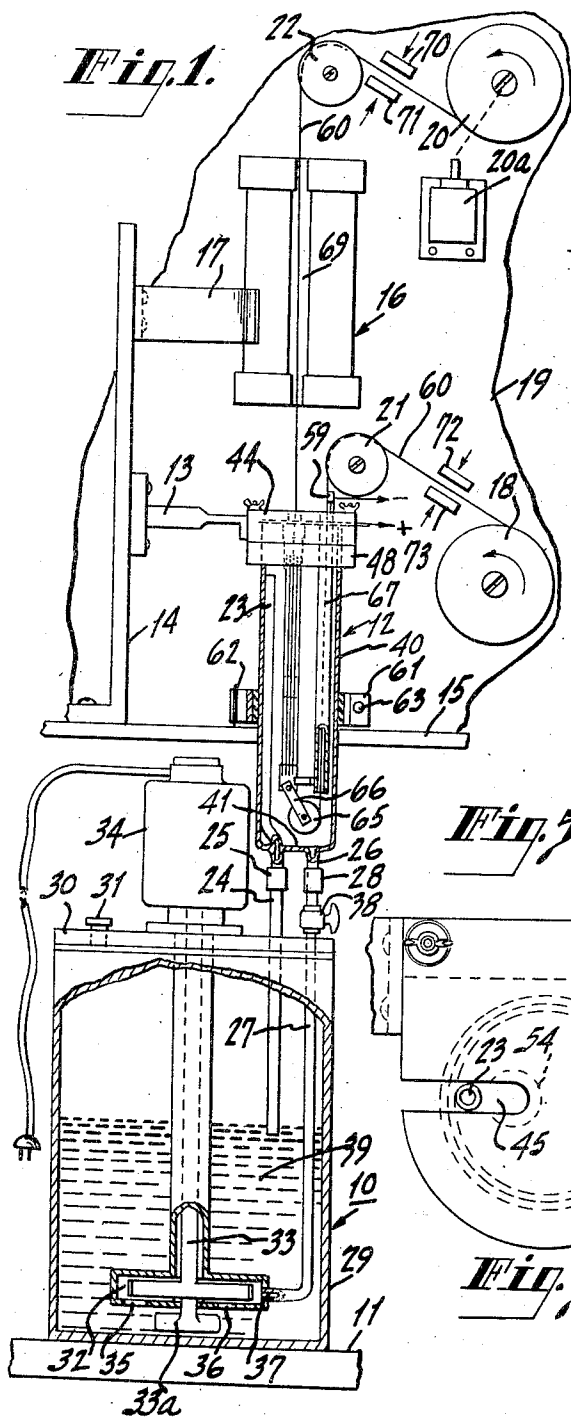


Fig. 2.

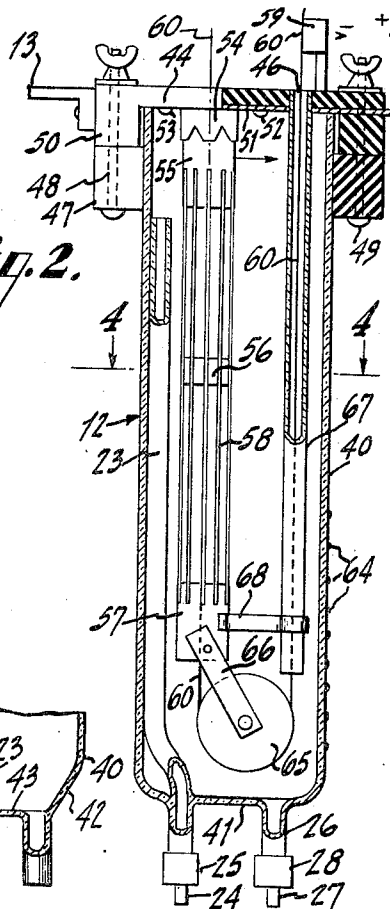


Fig. 3.

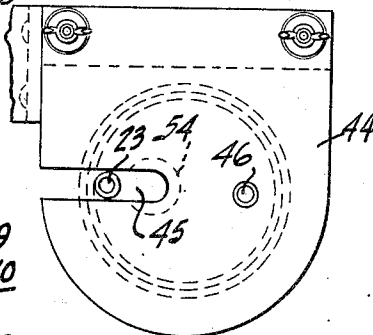
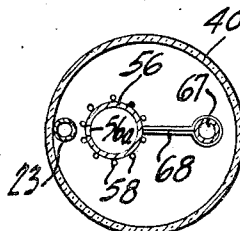


Fig. 3.

Fig. 4.



INVENTOR.
MARK N. FREDENBURGH

BY *William A. Zaleski*
ATTORNEY

1

2,800,448

CATAPHORETIC COATING MACHINE

Mark N. Fredenburgh, Summit, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application April 30, 1954, Serial No. 426,874

14 Claims. (Cl. 204—300)

The present invention relates to machines for applying coatings by electrophoresis and particularly to a cataphoretic coating machine of increased efficiency.

Cataphoretic coating machines heretofore known have included means for passing a base to be coated through a bath containing in suspension particles of a desired coating material and means for the application of an electric field adjacent the base to be coated for causing solid particles of the suspension to deposit on the base. In order to maintain a uniform suspension concentration, means have also been provided for agitation of the suspension. The aforementioned coating deposit by such machines of suspension particles on the base, however, has been characterized by relatively poor adherence and therefore means have been provided for passing the base coated as aforementioned, through a second bath containing a binder such as nitrocellulose. The resultant deposit of binder material together with the initially applied coating, was found to increase the adherence of the coating on the base. Such increased adherence is necessary in order to prevent loss of coating during spooling and subsequent handling of the coated base.

Several disadvantages result from the aforementioned requirements of known cataphoretic coating machines. One disadvantage results from the fact that two baths are required. The provision of facilities for two baths adds to the size and space requirements of a machine, thereby increasing its initial cost as well as the cost of operation thereof. The use of two baths, moreover, requires transit of a coated base prior to the application of a binder thereto, with resultant hazards of coating loss.

One attempt to economize in space has involved reducing the capacities of tanks containing the two baths, to relatively small volumes. Such reduction in volume, however, has required increased frequency of replacement of the coating suspension, due to the rapid depletion of the coating material therefrom. This disadvantage is considerably aggravated when bases of relatively large cross-section, such as ribbon filaments, are coated. It should also be noted in this connection that manufacturing efficiency is adversely effected by an appreciable reduction of coating material in the suspension.

A further disadvantage of existing cataphoretic coating machines flows from the need to constantly stir the suspension as by means of paddles to prevent a settling of coating particles therefrom. Such stirring produces turbulence in the suspension adjacent the base to be coated, resulting in appreciable relative movement between the suspension and the base. Such relative movement is in addition to that produced in passing the base through the suspension. These relative movements are objectionable not only in that they tend to impede the travel of coating particles to the base, but also in that they are accompanied by frictional forces, that may remove coating particles already deposited on the base.

It will be apparent from the foregoing that removal

2

of the disadvantages referred to will contribute appreciably to the efficiency of a cataphoretic coating machine. The efficiency would be further enhanced by incorporating in the machine the following desirable features.

5 Cataphoretic coating suspensions may contain highly inflammable and readily vaporizable solvents. Unless systems containing suspensions of this type are substantially closed, there is not only danger of fire but also likelihood of rapid loss of the solvent by evaporation.

10 In order to provide a coating of desired purity, it is necessary that cataphoretic coating machines be cleaned periodically. It is therefore desirable that all parts of the machine coming in contact with the suspension be readily accessible for cleaning.

15 Where cataphoretic coating machines are used to coat spooled filament or ribbon stock, it is necessary to thread the wire through means determining the path of travel of the wire through the machine. It is desirable that the structure of the machines be of such character as to facilitate a threading of the wire through the means aforementioned, to economize in operator time.

As will be appreciated from the foregoing, a prime object of the invention is to provide a simplified cataphoretic coating machine of improved efficiency. Further purposes to this end are to provide a cataphoretic coating machine characterized by

(1) A single bath for applying simultaneously to a base in one pass both a desired coating material as well as a binder for such material;

(2) Reduction to a minimum of relative movement in the coating field between the suspension and the base to be coated and at the same time maintaining a constant composition of the suspension;

(3) A substantially closed system for holding, agitating, and circulating the suspension,

(4) Easy dismounting for cleaning; and

(5) Facility in placing a filamentary base to be coated in operative position in the machine.

One embodiment of the invention in which the aforementioned purposes are realized comprises a cataphoretic coating machine having two containers adapted to confine a desired coating suspension. This suspension may be of a type especially suited for a one-bath application by cataphoresis, as described in applicant's co-pending application, Serial No. 370,657, filed July 27, 1953, and assigned to the same assignee as the present application.

One of the two containers referred to may comprise a tube of approximately 500 cubic centimeters capacity adapted to receive the base to be coated, such as a filamentary wire or ribbon. An anode is disposed in the one container aforementioned. The other of the two containers is preferably of larger capacity than the first named container and serves as a reservoir of the coating suspension.

Means for agitating, circulating, and transferring a portion of the suspension in the second named container to the first named container are provided. The circulation referred to causes an upward rise of the suspension in the first named container, and the rate of such upward rise may be controlled in accordance with the invention, to any desired value. For convenience of description, the first named container may be referred to as a coating container and the second named container as a reservoir container.

The base to be coated may be suitably entrained so as to move upwardly in a predetermined path in the coating container adjacent the anode referred to. The rate of such upward movement is preferably fixed to equal the rate of rise of the suspension in this container.

To permit a continuous circulation of the suspension in the coating container, it is necessary to provide means

for returning the suspension to the reservoir container. This may be accomplished by gravity through an overflow tube in the coating container connecting directly with the reservoir container.

The resultant circulation of the suspension in the two containers provides an effective stirring of the suspension for keeping the coating particles therein desirably dispersed, and for avoiding relative movement between the suspension and the base being coated, for a good coating application.

The coating container may comprise an assembly including a tubular glass member having an open end and defining the coating container proper. The glass member is removably suspended from a recessed support member including a flat portion serving as a closure for the open end referred to. Also suspended from the support member and in fixed relation therewith, is a tubular anode structure defining the aforementioned predetermined path for upward travel in the glass member of a base to be coated. The tubular glass member is adapted to be removed easily from the support, to permit a cleaning of the anode structure and glass member. To facilitate a mounting of base in desired position with respect to the anode structure, the support referred to as well as the anode structure, are provided with slots extending through adjacent side portions thereof to permit a side extension of a filament or ribbon into the aforementioned path defined by the anode structure.

Another feature of the invention involves the provision of a sloping bottom on the coating container to contribute further to prevention of sedimentation of the coating material.

Other purposes and advantages of the invention will become evident from the following detailed consideration of an illustrative embodiment thereof taken in connection with the appended drawing wherein,

Figure 1 shows an elevation partly in section of a cathaphoretic coating machine incorporating the invention;

Figure 2 shows an enlarged view partly in section of the coating container assembly of the machine shown in Figure 1;

Figure 3 is a top view of the coating container assembly shown in Figure 2;

Figure 4 is a cross-sectional view taken along the line 4-4 of Figure 2; and

Figure 5 is a fragmentary sectional elevation of the lower portion of a glass member having a conical or sloping lower end wall that may be used advantageously in the tubular glass member of the coating container assembly shown in Figure 2, for reducing to a minimum any possible sedimentation on the end wall referred to.

Referring now to the drawing in more detail, a cathaphoretic coating machine embodying the invention may include, as shown in Figure 1, a reservoir container assembly 10 supported on a table 11; a coating container assembly 12 supported above the reservoir container assembly on a bracket 13 fixed to an upright 14 mounted on a table 15; a baking oven 16 supported above container assembly 12 on a bracket 17 fixed to upright 14 for drying a coated base; a spool system including a supply spool 18 mounted for rotation on a panel 19 for supplying a filamentary or ribbon base to be coated, and a take-up spool 20 also mounted for rotation on panel 19 and connected to a power source comprising a motor 20a for drawing the base from supply spool 18 and through the coating container assembly 12 and the oven 16; and idling rollers 21, 22 mounted for rotation on panel 19, and adapted to align the filamentary base with operative portions of the coating container assembly 12 and oven 16.

For connecting the reservoir container assembly 10 to the coating container assembly 12, two conduits are provided. One conduit or tube includes portions 23, 24 connected together by a coupling 25, which may be of

rubber or other resilient material inert with respect to the suspension. The other conduit includes a nipple 26 and tube 27 joined by a coupling 28 which also may be made of the same material as coupling 25.

The reservoir container assembly

The reservoir container assembly 10 includes a container 29, which may be made of a corrosion resistant metal or glass, having an open end. The open end referred to is effectively closed by a cover 30 having a vent 31.

Within the container 29 is disposed a centrifugal pump 32 connected by a shaft 33 to a motor 34. Mounted on shaft 33 and below pump 32, is a supplementary agitator in the form of a paddle 33a. The pump has several inlet portions 35, 36 communicating with the interior of container 29, and an outlet portion 37. The outlet portion 37 is connected to the end of tube 27 remote from coupling 28. For this purpose, the tube 27 extends into container 29. An adjustable valve 38 across the tube 27 provides means for regulating the rate of flow through tube 27. The container 29 is adapted to contain a coating suspension which may comprise materials described in the aforementioned copending application for applying to a filamentary or ribbon base, carbonates of electron emitting materials. These materials, for example, may comprise acetone, a polymeric ester of methacrylic acid, an ionizable salt, carbonates of barium, strontium and calcium, and dibutyl phthalate, in the relative amounts called for in the copending application referred to.

The tube portion 24 also extends into container 29, to an extent to dispose the end thereof remote from coupling 25, slightly below the surface of the suspension 39 during a coating application, for a purpose to be described.

The coating container assembly

The coating container assembly 12 as shown in Figures 1 and 2, includes a container 40, which may be of glass, within which is disposed tube 23 extending through and upwardly from bottom end 41 of the container. The tube 23 has an upper open end adjacent the upper end of container 40, serving as a gravity overflow and adapted to determine the upper level of the suspension pumped to the upper container 40.

It will be noted, therefore, that the suspension 39 is circulated by means of pump 32, tubes 27, 23 and 24, through both the lower and upper containers referred to. The disposition of pump 32 and agitator 33a adjacent the bottom of the lower container 29, and the open free end of tube 25 at a higher position but under the surface of the suspension, provide an effective stirring to maintain at all times a constant composition of the suspension. As a further contribution to prevention of sedimentation, the bottom portion of the upper container 40 may be conical in shape to provide steeply sloped walls 42, and a relatively small area end wall portion 43, as shown in Figure 5.

The coating container assembly 12 also includes a plate 44 made of insulating material such as formica and having a slot 45 therein, shown best in Figure 3, and an aperture 46, the purposes of which will become apparent in the following. An annular ring 47 also preferably made of insulating material, is affixed to plate or cap 44 by suitable means such as screws 48, 49. The flange 50 extending from plate 44 together with the ring 47, provide an inner annular wall for snugly engaging the upper portion of container 40.

Supported on plate 44 is an electrode assembly including an electrically conducting metal plate 51 fixed to plate 44 by suitable means such as rivets 52, 53. The plate 51 extends across the inner surface of the plate 44 and is provided with a slot, not shown, in registry with slot 45. Suitably affixed to plate 51 and depending therefrom is a metal collar 54. Affixed to collar 54 is an electrode structure comprising metal collars 55, 56, 57 to which are

5

affixed a plurality of metal rods 58 disposed in an array defining a tubular passageway in registry with the bottom portion of slot 45. As shown in Figure 4, the collars 55, 56, 57 are provided with slots 56a vertically registering with slot 45 in the plate 44 and with the slot not shown in metal plate 51. Collar 54 is provided with a similarly registering slot, not shown. This slot arrangement facilitates threading a filament or ribbon base to be coated through the electrode assembly, by permitting a side extension thereof through cap 44, plate 51 and the collars 54, 55, 56, 57 of the electrode assembly, after removal of the container 40.

As shown in Figure 2, a portion of metal plate 51, extends through the flange 50 of the plate 44, and is connected to a suitable source of positive potential. A metal contact member 59 may be mounted on plate 44, to extend into the path of travel of filamentary base 60 and contact the same. The contact member referred to is connected to a source of negative potential. For very fine wire bases to be coated the source of negative potential may be applied through a mercury contact incorporated as a part of the unwinding shaft on which spool 18 rotates. The support of container 40 is provided by a clamp 61 having two arms pivoted at 62 and adapted to be separated readily by releasing a screw 63 for removing container 40 from engagement with the clamp, as shown in Figure 1. The clamp is positioned on the upper surface of table 15. If desired, one of the arms of the clamp may be affixed to the upper surface referred to.

Since the rate of rise of the suspension in the container 40 is an important factor in the operation of the machine, this container may be provided with suitable graduation marks 64 shown in Figure 2.

According to one example for practicing the invention, the container 40 may have a capacity of 500 cubic centimeters and a depth of 10 inches. The time required for the filament to rise through this depth when travelling at 5 meters per minute, will be about 3 seconds. If the suspension also travels upwardly at 5 meters per minute, it will take about 3 seconds for the suspension in the coating container to be completely renewed. This will cause a volume of about 10,000 cubic centimeters or about 2.5 gallons of suspension per minute to flow through the coating container.

The spool and idler systems

An idling roller 65, shown in Figures 1 and 2, is supported for free rotation on a bracket 66 fixed to the lowest collar 57 of the ruggedly supported electrode assembly. The idling roller has a diameter for disposing one side thereof in tangent relation to a predetermined path through the electrode assembly referred to, and the opposite side in tangent relation to a predetermined path through a tubular shield 67, made of glass for example, and extending through aperture 46 in plate 44 and supported on a bracket 68 fixed to collar 57 of the electrode assembly.

The oven 16 disposed above upper container assembly 12 is provided with a passageway 69 in vertical registry with the slot 45 and the tubular passageway defined by collars 55, 56, 57 and rods 58 of the electrode assembly. Idling roller 22 is mounted above the oven 16 to provide a side thereof in tangent relation to the passageway 69 in the oven. A side of each of rollers 65 and 22 are therefore tangent to a rectilinear path therebetween and through the aforementioned electrode assembly, plate 44 and oven 16.

A path parallel to and spaced from the aforementioned rectilinear path is provided between rollers or pulleys 21 and 65. This path extends through shielding tube 67 and aperture 46 in the plate 44. A ribbon or filament base 60 supported on spool 18, and threaded through shield tube 67, into engagement with idler pulley 65, through the passageway defined by collars 55, 56, 57 and rods 58 of the electrode assembly, into engagement with

6

idler pulley 22, and into fixed engagement with take-up spool 20, will therefore be moved upwardly through the electrode assembly in response to the pull exerted by the take-up spool 20. The rate of such upward movement can be determined readily by the power transfer means, not shown, connecting spool 20 to a motor 20a.

It will be noted that disposition of the idling pulley 65 in position to dispose a side thereof in tangent relation to the path of travel of the base to be coated through the aforementioned electrode assembly, requires appreciable spacing between the lower end of the electrode assembly and the bottom 41 of the container 40. This spacing is advantageous in that it disposes the lower end of the electrode assembly away from the bottom region of the container where the suspension is in a condition of some turbulence caused by the inflow of suspension through nipple 26 in the container bottom.

To contribute to continuity of operation of the machine of the invention, means are provided for removing spool 20 after it has been fully loaded with coated filament and substituting an empty spool therefor. This substitution is conveniently effected by providing clamping members 70, 71 supported on panel 19, as shown in Figure 1. Prior to the removal of a loaded spool 20, the clamps referred to are brought together to clamp the filament 60 therebetween. A portion of the filament extending from the clamping members 70, 71 to the spool 20 may then be cut and suitably fastened to an empty spool substituted for the full spool.

To facilitate replacement of spool 18 when empty by a spool loaded with uncoated filament, clamping members 72, 73 mounted on panel 19 may be provided. When replacement of spool 18 is desired, the clamping members 72, 73 are brought together to clamp a portion of filament 60 adjacent spool 18, and the filament is severed at a portion thereof extending from the clamping members referred to to the spool 18. A full spool is then substituted for an empty spool 18, and the cut of the filament is suitably affixed to the filament on the full spool.

It will be apparent therefore, that the two groups of clamping members mentioned permit replacement of spools 20 and 18 without disturbing the threaded relation of the filament with respect to the container 40 and oven 16. This facilitates a continuous operation of the machine involving exhaustion of a plurality of full spools 18, and the loading of a plurality of spools 20 with coated filament.

Operation of the machine

A description of the operation of the cataphoretic coating machine described in the foregoing, will involve a consideration of the transverse area of the filament to be coated. As used herein, the term "filament" is intended to include not only round wire but also flat or channeled ribbon stock. Filaments of relatively small cross-section have a diameter of 1 mil and filaments of relatively large cross-sections, such as ribbons, have a width of about 40 mils.

The speed of upward travel of the filament 60 in coating container 40, the type of suspension used, and the D. C. voltages employed in the operation of the machine of the invention should preferably be in accord with the values set forth in the aforementioned co-pending application.

Initial use of the machine involves threading an uncoated filament into operative position in the coating container 40 and oven 16. In accomplishing this threading operation, the clamp 61 is loosened to permit the container 40 to drop out of engagement with plate 44. This renders the shield tube 67, the idling pulley 65 and anode assembly, accessible to a manual threading operation. The threading operation involves threading the uncoated filament through shield tube 67, partly around idling pulley 65, and laterally into the electrode assembly

through slots 56a, 45 provided therein and in plate 44. The filament is then extended laterally into the passageway 69 in oven 16, partly around idling roller 22 and into engagement with take-up spool 20.

After this threading operation is completed, the motor 20a is energized by closing a switch causing take-up spool 20 to rotate to take-up filament. This causes the filament to travel upwardly in the electrode assembly. This upward rise may be at a rate, for example, of five meters per minute. A satisfactory range of rates of the upward rise referred to is indicated below. The valve 38 is then opened and motor 34 is connected to a suitable power source for pumping suspension from the reservoir container 29 into the coating container 40. The valve is then set to provide a rate of transfer of suspension to produce a rate of rise thereof in the container 40 of preferably five meters per minute.

With respect to the rate of rise of the suspension in container 40 controlled by valve 38, the ideal rate of raise is the rate at which the filament base travels through the coating container. Under these conditions, there is no relative movement between the filament and suspension. Consequently, no frictional forces between the filament and suspension are involved and coating efficiency is improved.

It will be noted from the foregoing that the initial adjustment of the machine, after filament stock has been threaded into operative position in the machine, involves a control of the speed of take-up spool 20. This speed may be such as to provide a rate of upward travel of the filament in container 40 of from approximately 1 to 10 meters per minute, depending upon the unit surface of the filament, the slower speed being associated with the larger areas. Commercial gear assemblies are available for providing the desired rate of rotation of spool 20, and require no description herein.

After this initial adjustment has been made, the valve 38 may be opened to an extent to provide the desired rate of rise of suspension in container 40, which rate approaches the filament rate as indicated by the graduation marks 64 on the container.

When it is desired to remove container 40 for inspecting the filament therein, or otherwise, the container can be conveniently inspected by stopping operation of pump 32 and opening valve 38. The suspension in container 40 will then flow back into the reservoir container 29 through tube 27 and openings 35, 36 in the pump shell.

During a coating operation, the oven 16 is heated to a temperature high enough to drive off volatile components of the suspension. The contact member 59 and plate 51 of the electrode assembly are suitably connected to D. C. sources of different polarity of electrical potential, as described in the aforementioned co-pending application, causing current flow through the suspension between the electrode assembly and a rising section of the filament being coated. The positively charged coating particles in the suspension, are thus caused to migrate to the negative filament for coating the same.

At the same time, a portion of the methacrylate resin is removed from solution for effectively bonding the deposited particles to the metallic base and to themselves. The portion of the filament so coated is then carried through oven 16 wherein the coated filament is dried. The dried coated filament is then taken up by spool 20 for further processing or for storage.

It will be apparent from the foregoing, that the cataphoretic coating machine of the invention is characterized by many advantages absent in machines heretofore available. One important advantage resides in the fact that both containers employed are substantially closed, thereby avoiding fire hazards from readily inflammable materials, such as acetone, used in the suspension. This closure of the containers, furthermore reduces loss of suspension material by evaporation and therefore contributes to efficiency in use.

Another advantage results from the fact that the base to be coated is subjected to only one bath. This reduces the number of components of the machine that require cleaning.

A further advantage flowing from the two-container, one-bath feature of the machine of the invention, is the constant agitation to which the suspension is subjected in both containers. This serves to prevent a settling of particles out of the suspension. Moreover, the agitation is accomplished without creating turbulence in the coating region of the suspension. This contributes to further efficiency of the machine.

Other important advantages resulting from the one-bath construction of the invention involve the elimination of substantial relative movement between the filament to be coated and the suspension through which it is passed, and assurance of a constant composition of concentration of coating suspension in the coating container. This adds appreciably to the efficiency of the machine by eliminating frictional forces adversely affecting coating application, and avoiding depletion of coating material.

A still further appreciable advantage is realized by the novel mounting of the coating container 40 to permit convenient removal thereof for cleaning purposes and for threading or mounting a filament in desired position in the machine. In this connection, it will be noted that the slotted construction of the electrode assembly and its support, contributes further to facility in mounting the filament as aforementioned.

It is preferable to dispose the coating container 40 above the reservoir container 29, for facility in emptying the coating container. Such emptying is accomplished by merely stopping motor and leaving valve 38 open. This wall causes the suspension in the upper container to fall by gravity into the lower container.

However, it is to be understood that the invention is not limited to such disposition of the containers. It is feasible to dispose the two containers on the same level or even to position the coating container below the reservoir container.

While it is preferable to cause the suspension in the coating container to rise at the same rate as the upward travel of the filament, it is feasible to have the filament travel at a different rate than that of the upward rise of suspension. When the rates are the same, a minimum of friction between the filament and suspension is produced. However, varying these rates while producing some upward movement of both the suspension and filament, entails results superior to those heretofore obtainable since it serves to reduce at least some of the friction between the filament and suspension.

What is claimed is:

1. A cataphoretic coating machine comprising a coating container having a bottom wall, a coating electrode in said container, means for directing a filamentary base to be coated in a path adjacent said electrode in said coating container, a reservoir container, means for stirring a suspension in said reservoir container only, a conduit communicating with said containers, and non-turbulent means adjacent to said stirring means for feeding the stirred suspension through said conduit from said reservoir container to said coating container to immerse a region including said electrode and said path in said stirred suspension, said means for stirring and said non-turbulent means being adjacent to said bottom wall, said means for stirring being between said bottom wall and said non-turbulent means, whereby the suspension adjacent said electrode is substantially uniform in concentration during a coating operation and said path is free from turbulence for providing an improved coating.

2. A cataphoretic coating machine comprising a first container adapted to contain a suspension including coating particles, a second container, means for supporting said second container above said first container, a pump in said first container and extending into said suspension, a conduit connecting said pump to the lower end portion

of said second container, a turbulence producing member connected to said pump and adjacent thereto, power means connected to said pump for actuating said pump and said member, whereby transfer of said suspension having a uniform concentration of said particles to said second container takes place, means across said conduit for adjusting the rate of said transfer, whereby said suspension rises in said second container at a predetermined rate, an electrode in said second container, a shielding tube parallel to said electrode and in said container, means for feeding a filamentary base first downwardly through said tube and then upwardly adjacent said electrode at substantially said last mentioned rate, and means having an opening adjacent the upper end portion of said second container and extending into said first container for receiving flow of said suspension above said opening, said tube extending above said opening, whereby said base is substantially free from coating applications in said tube and receives a uniform coating when adjacent to said electrode.

3. A cataphoretic coating machine comprising two vertically spaced containers, the lower container being adapted to confine a coating suspension, a conduit extending from the bottom region of said lower container to the bottom region of the upper container, a pump in said lower container having an output portion connected to one end of said conduit, a stirring member connected to said pump and adjacent thereto, power means connected to said pump, whereby stirred suspension is pumped from said lower container to said upper container and rises in said upper container, means across said conduit for controlling the rate of rise of the suspension in said upper container to a predetermined value, a second conduit extending from said lower container to an upper portion of said upper container for returning by gravity to said lower container said rising suspension overflowing into said upper portion, whereby said suspension is circulated for effectively preventing appreciable sedimentation thereof, a shield tube in said upper container extending from a bottom portion of said upper container to a region above said upper portion, whereby said suspension is free from movement in said shield tube after the suspension has reached said upper portion, and means for moving downwardly through said tube and upwardly in said upper container a filamentary base to be coated at a rate substantially equal to said predetermined value, whereby relative movement between said base and said suspension in said upper container is reduced for improved coating of said base.

4. In a cataphoretic coating machine for coating a metal base energized by a source of negative electrical polarity and including means for passing the base through a suspension containing coating particles and in proximity to an electrode energized by a source of positive electrical polarity: the improvement comprising an agitating system for keeping the composition of said suspension constant, said system including two vertically spaced containers, the lower of said containers being adapted to initially confine said suspension, and means for circulating said suspension through said containers including a pump in the lower container, a paddle connected to said pump and adjacent thereto in said lower container, and overflow collection means extending from the upper container to the lower container, said pump being disposed relatively close to the bottom of said lower container, said paddle being positioned below said pump.

5. A cataphoretic coating machine comprising an elongated vertically disposed container adapted to receive a suspension containing coating forming particles, said container having an inlet in the bottom thereof, and an outlet at an upper portion thereof, means for feeding said suspension through said inlet and into said container, whereby said suspension rises in said container and overflows into said outlet, an elongated electrode supported vertically in said container between said inlet and outlet,

an elongated shield tube in said container and parallel to said electrode and having open ends, means for passing a filamentary base to be coated downwardly through said tube and upwardly in said container at a predetermined rate and adjacent to said electrode, said electrode being connected to a source of positive electrical polarity, said base being connected to a source of negative electrical polarity, whereby said base receives coating particles from said suspension, and means adjacent said inlet for controlling the rate of feed of said suspension to said container to provide a rate of rise of the suspension substantially equal to said predetermined rate of upward passage of said base, the upper end of said tube being above said outlet, whereby said suspension in said tube is substantially free from movement and total relative movement between said base and said suspension in said tube and adjacent to said electrode is substantially reduced for providing an improved coating.

6. A cataphoretic coating machine comprising a supporting means, a tubular electrode supported vertically on said supporting means, said electrode having a vertically extending slot in a side thereof, said supporting means having a slot in rectilinear registry with said first named slot, and an elongated container removably mounted on said supporting means and enclosing said electrode, whereby said container is removable from said supporting means for exposing said electrode for facilitating a lateral threading of a filamentary base to be coated through said slots and into operative position in said electrode.

7. A single pass cataphoretic coating machine comprising a reservoir adapted to contain a suspension including particles of coating material, a binder, and a volatile solvent; a container above said reservoir; means for transferring successive portions of said suspension to said container at a predetermined rate, said means including a conduit extending through the bottom of said container; whereby the transferred suspension rises in said container at a predetermined rate, an elongated electrode vertically disposed within said container, an elongated shield tube vertically disposed in said container and spaced from said electrode, entraining means in said container affixed to said electrode and adapted to engage a filamentary base to be coated for guiding said base from said tube to said electrode, a take-up spool above and in vertical registry with said entraining means, said take-up spool and entraining means defining a path for said filamentary base adjacent said electrode, and means for rotating said take-up spool at a predetermined velocity for causing said base to move downwardly in said tube and upwardly in said container adjacent to said electrode at substantially the same rate as the upward rise of said suspension therein, an overflow means in said container, said tube having two open ends, one of said ends being above said overflow means and the other of said ends being below said overflow means, whereby said tube restrains overflow of suspension in said tube, and said suspension in said tube is substantially free from movement when said suspension has reached the level of said overflow means, whereby relative movement between said base and rising suspension is reduced for providing an improved coating containing said particles and binder.

8. A cataphoretic coating machine comprising a reservoir adapted to contain a relatively large amount of a coating suspension, a container disposed adjacent to said reservoir and adapted to contain a relatively small amount of coating suspension, means extending through the bottom of said container from said reservoir for transferring said suspension to said container, means in said reservoir and between the bottom of said reservoir and said transferring means, for agitating said suspension therein, whereby the composition of the suspension transferred to said container is constant, said container having side walls normal to said container bottom and sloping walls joining said container bottom, and said side walls,

whereby said bottom has a reduced area for reduced sedimentation of said suspension.

9. A cataphoretic coating machine comprising two vertically spaced and vertically mounted containers, the lower of said containers comprising a storage tank for a suspension containing coating forming ingredients, the upper of said containers comprising a coating applicator tank, means in said storage tank for agitating suspension therein for preventing sedimentation of particles out of said suspension, a conduit between said storage tank and the lower portion of said coating applicator tank, means for feeding suspension from said storage tank to said applicator tank through said conduit, whereby the suspension fed to said lower portion only is in a state of turbulence, a coating electrode in said applicator tank, and entrainment means in said applicator tank for disposing a filamentary base adjacent said electrode for coating said base, said entrainment means being adapted to engage the lowermost portion of said base in said applicator tank, said means for feeding causing said suspension to rise above said lower portion, said electrode and said entrainment means being positioned above said lower portion and in said rising suspension, whereby said base is remote from said lower portion and a coating operation is free from adverse effects from said turbulence.

10. In a cataphoretic coating machine, an agitating system including two spaced containers adapted to contain a coating suspension, means for circulating said suspension through said containers, said means including a pump in one of said containers having inlet openings adjacent and facing the bottom of said one of said containers, and a paddle fixed to said pump for rotation therewith and disposed between said pump and said bottom, whereby said suspension is agitated by said circulation thereof and by said paddle for preserving the composition of said suspension substantially constant.

11. An electrophoretic coating machine for coating a metal filament base with emitting material, comprising an elongated vertically mounted container, an elongated electrode in and parallel to said container, an elongated rectilinear shielding tube of insulating material in said container and in spaced parallel relation to said electrode, means for passing said base successively in one direction through said tube and in the opposite direction in a path outside of said tube and adjacent to said electrode, means for moving a coating suspension in said container in said opposite direction only, and an overflow tube in said container having an open end for receiving a portion of said suspension when the suspension reaches a predetermined level, said shielding tube extending above said level, whereby said suspension is substantially free from movement in said shielding tube after said suspension reaches said predetermined level and follows the movement of said base adjacent to said electrode for contributing to uniformity in thickness of the coating applied to said base.

12. A cataphoretic coating machine for applying a uniformly thick coating of electron emitting material to an elongated metal base, comprising means for moving in one direction in an elongated vertical path and to a predetermined level a suspension containing said material, an elongated electrode vertically disposed in said path, an elongated tube having a rectilinear course only, parallel to and spaced from said electrode in said path, and means

for longitudinally moving said elongated base to be coated first through said tube and in a direction opposite to said one direction, and then in said one direction and adjacent to said electrode, said tube extending above said predetermined level and having a lower open end for receiving a portion of said suspension, said tube having an upper open end, whereby said suspension is free to rise in said tube and is substantially free from movement after reaching said predetermined level in said tube, for reducing friction between said suspension in said tube and said base for contributing to uniformity of the coating applied.

13. A cataphoretic coating machine comprising a fixed supporting means, an elongated electrode and an elongated shielding tube depending from said supporting means in spaced parallel relation, a pulley mounted adjacent to the lower end of said electrode and intermediate axial projections of said electrode and tube and having a diameter substantially equal to the distance separating the axes of said electrode and tube for guiding a filamentary base to be coated from said tube to said electrode, and a container for a coating suspension removably depending from said support means and receiving said electrode, tube and pulley, whereby said container is adapted to be removed from said supporting means for providing manual access to said electrode, tube and pulley for mounting said filamentary base in operative position with respect to said electrode, tube and pulley.

14. A cataphoretic coating machine comprising an elongated coating container, a rectilinear anode in and parallel to the longitudinal axis of said container, a rectilinear shielding tube spaced from and parallel to said anode in said container and having two open ends, entraining means adapted to engage a filamentary base work piece and pass said work piece in a first path through said tube in one direction only, and in a second path outside of said tube and adjacent to said anode in a direction opposite to said first direction, said means including a pulley having a diameter substantially equal to the spacing between said first and second paths, said pulley being mounted for rotation in a region within said container remote from said anode and tube and in a position to dispose said paths in tangent relation to the periphery of the pulley, means supporting said container in a vertical position, overflow means having an opening in the upper portion of said container, said tube extending above said opening, and means for feeding a coating suspension from the lower portion of said container to the upper portion thereof only, whereby said suspension is free from movement in said tube after the upper level of the suspension in said container reaches said opening, for reducing friction between said work piece and said suspension in said tube, and said work piece in said tube is shielded from said anode for providing an improved coating when said work piece is passed in said second path.

References Cited in the file of this patent

UNITED STATES PATENTS

1,101,078	Kiefer	June 23, 1914
1,590,603	Taylor	June 29, 1926
2,127,413	Leguillon	Aug. 16, 1938
2,576,362	Rimbach	Nov. 27, 1951