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ELECTROSTATIC COATING APPARATUS

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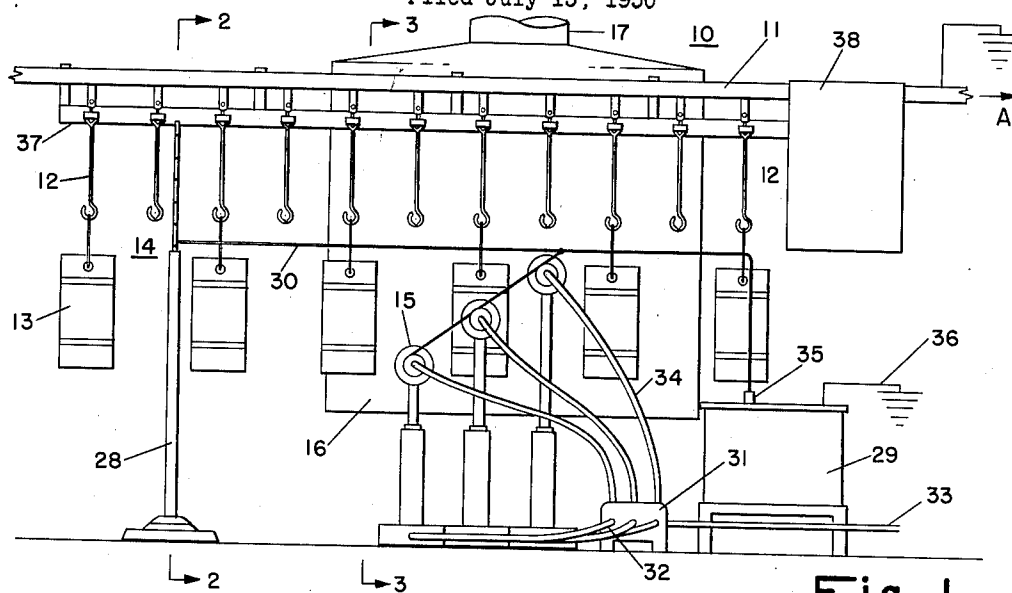


Fig 1

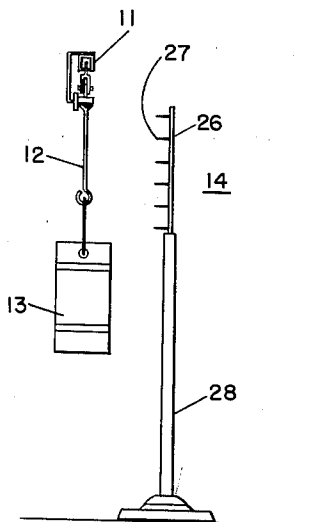


Fig 2

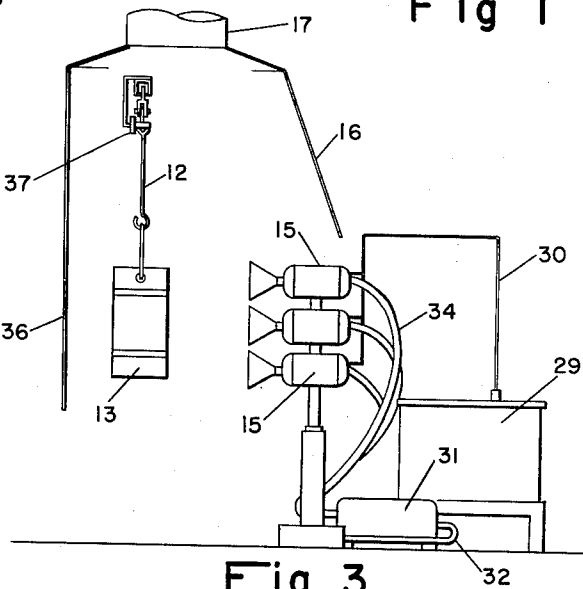


Fig 3

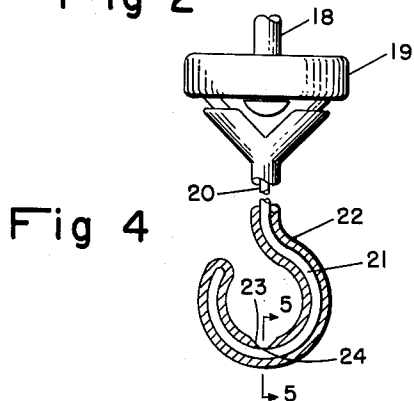


Fig 4

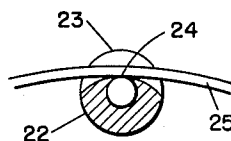


Fig 5

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2,729,191

ELECTROSTATIC COATING APPARATUS

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4 Claims. (Cl. 118—51)

This application relates to method and apparatus used in electrostatic coating operations to inhibit the deposition of the coating material upon certain selected surfaces. Specifically, it relates to method and means whereby such parts as support hooks and shields may be kept reasonably free of material even though they are necessarily introduced into the coating zone with the object to be coated.

In electrostatic coating operations the objects to be coated are supported from a conveyor and are carried thereby into a coating zone where a cloud of charged particled coating material is maintained to be attracted to the object by virtue of an electrostatic field. Since it is necessary that the supports for the objects also serve the additional purpose of maintaining the object at a potential different from that of the cloud, they are usually made of some relatively inexpensive conducting material such as steel. Because they are conducting and grounded such supports are themselves at a potential different from that of the surrounding cloud and therefore have for the adjacent cloud of charged coating material particles an attraction which is comparable to that possessed by the object to be coated. Under the influence of this attraction some of the coating material is deposited upon such supports and continues to accumulate to a heavier and heavier layer as each individual support carries a new and uncoated object through the coating zone.

This accumulative attraction of material by the supports is naturally undesirable since the aim of the process is to apply the material to the objects and any attraction to other surfaces results in inefficiency. Further, it is essential that the supports remain in a condition which permits their being readily electrically contacted by subsequent objects placed upon them. An accumulation of coating material on such supports as above described could well result in complete lack of electrical contact or at least could result in it becoming necessary to give definite attention to insuring that there is contact every time a new object is placed upon the hook. Such special attention is undesirable in any operation being used for large scale production.

It is an object of the present invention to provide a method and apparatus to be used in electrostatic coating operations which while maintaining the attraction of the object for the coating material particles, will reduce, eliminate or even reverse the forces acting between the particles and the object support whereby the object support will remain essentially free of collected material while the object is being satisfactorily coated.

It is a further object of this invention to provide an apparatus for electrostatic coating objects in which coating material precipitation is preferentially controlled to those surfaces which are to be coated and in which coating material is repelled from other surfaces.

Another object of the present invention is to provide a method and apparatus for electrostatically coating articles in which greater efficiency in utilization of the coating material is obtained.

A further object of this invention is to provide an

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apparatus for electrostatically coating objects in which the coating material is inhibited from collecting upon the object supports by a static charge placed upon the support surface and in which apparatus is provided for neutralizing such charge after the coating operation is completed.

For a better understanding of the invention, together with other and further objects thereof, reference may be had to the following specification in connection with the accompanying drawings, and the scope of the invention will be pointed out in the appended claims.

In the drawings:

Fig. 1 is a diagrammatic side elevation of a typical commercial installation embodying the improved apparatus and method;

Fig. 2 is a sectional view on the line 2—2 of Fig. 1;

Fig. 3 is a sectional view on the line 3—3 of Fig. 1;

Fig. 4 is an enlarged view partially in section of the improved object support;

Fig. 5 is a sectional view taken on line 5—5 of Fig. 4;

Referring to Fig. 1 wherein a typical commercial installation of one type of electrostatic coating apparatus embodying the features of the present invention is illustrated, the reference numeral 10 indicates generally the coating zone or station of the operation. A conveyor 11 of the overhead type is equipped with object supports 12 whose structure will be described later in detail in connection with Fig. 4.

Objects 13 are suspended from the supports 12 and are arranged to be carried thereby in the direction of the arrow A in succession past electrode 14 and then past atomizers 15. These atomizers are of the electrostatic type and are located generally below and centrally of the exhaust hood 16. When these atomizers are maintained at a difference of potential with respect to the objects on the conveyor the liquid coating material issuing from the atomizers in the form of a cloud of charged coating material particles is attracted to the objects to be precipitated thereon as a coating. A more complete description of this type of coating operation using this type of atomizer can be found in my co-pending application Serial No. 57,259, filed October 29, 1948, now abandoned.

The excess solvent fumes from the operation are removed from the area by a fan (not shown) in duct 17. The coated article is then carried by the conveyor through the discharging enclosure 38 and then to any suitable drying arrangement.

In the arrangement shown in Fig. 1 the conveyor may be any of the conventionally used types although a normal overhead enclosed chain type is illustrated. Attached to the pendants of this conveyor are object supports 12 shown in detail in Fig. 4. These supports are of the improved type required by this invention. An attachment pin 18 passing through the central race of a bearinged wheel whose outer race is designated by 19, is used to affix the entire support to the conveyor pendant. Affixed to the outer race of bearing 19 and arranged to rotate with it about pin 18 is a Y structure of metal whose end is designated as 20 and which is part of the central conducting core of the hook-shaped support 21. The entire central core of the support (Y section included) is covered with a coating of material which is a good electrical insulator. For best results this material should be of such a character that its bulk resistivity, surface resistivity and dielectric constant are all high. A wedge section 23 is cut through this insulation to expose the central conducting core 20 at the bottom of the wedge as at 24. The actual taper of the wedge and its width should be such that when an object or object part, such as handle 25 of Fig. 5, is placed on the support it settles naturally into the groove to practically fill the groove and to contact the central core at point 24. Although the support

is shown as being completely sheathed in insulating material it is to be understood that partial coverage if desirable would be within the scope of the present invention.

The electrode 14 stationed in advance of the spray zone 10 is of the discharge type and comprises a conducting rod 26 to which are attached a group of sharpened conducting extensions 27. This entire assembly is supported on an insulating base 28 and is connected to a source of high voltage 29 by a suitable conductor 30. Under the action of the high voltage such an electrode will produce in the air adjacent the points, an abundance of ions. These ions will automatically be driven to locations or surfaces of different potential which may be in the vicinity. If these locations or surfaces are electrically connected to the other terminal of the high voltage source, the electrical charges of the collected ions will bleed from the surface or location and the surface will remain at the different potential. If, however, the collecting surface is insulating in all respects, the captive charge can not leave the surface and the surface will continue to acquire charges thus increasing its potential until further collection of charge is not possible. Any additional charged particles will then be repelled from such a surface by the trapped surface charge.

In the spray zone 10 of Fig. 1 are located three electrostatic atomizers 15 of the type described in the copending application of J. W. Juvinall and M. R. Miller, Serial #160,556, filed May 6, 1950. The heads of these atomizers are rotated by a common unit 31 by way of flexible drives 32. Pumps in the same unit also deliver coating material from a supply (not shown) to the atomizing heads by way of pipe 33 and hoses 34. The atomizers 15 are connected to the high voltage terminal 35 of a high voltage source whose other terminal is grounded as at 36. Coating material which is pumped to the forward edge of the atomizer and distributed to its discharge edge by the rotation of the head, finds itself, by virtue of the atomizer being connected to the high voltage source 29, in a region of high potential gradient. Under the influence of this gradient the material leaves the edge as small charged particles to be dispersed into the region adjacent the edge and under the action of the electrostatic field is precipitated upon the object. So long as the objects are maintained at ground potential as by being connected to ground through the support core 20 these particles will be attracted to them, precipitated upon them and their charge will be lost in the current carried to ground from the objects.

The coating area is essentially enclosed by a fume-collecting hood 16 which is arranged about the operation so as to carry away solvent vapors and to supply general ventilation to the coating zone. The rear drop 36 of this hood extends below the bottom of the objects on the conveyor and thus serves to catch any stray material from the atomizing heads when objects are not attached to the supports.

A bar 37 is attached to the conveyor and extends alongside it at a level corresponding to that of the wheel 19 of the support. The supports, by frictional contact of wheel 19 with the bar, are thus caused to rotate as the conveyor moves along.

Immediately following the coating zone along the conveyor there is located a discharging enclosure 38 which has openings in its ends for entrance and exit of the conveyor and the object supports. An opening slot along the bottom permits the support to extend below the enclosure 38 so that an object can be on the support and be carried by the conveyor past enclosure 38. In this enclosure a suitable ultra violet quartz light maintains the atmosphere in a conducting condition. Because of this conductivity of the surrounding atmosphere the supports are essentially immersed in a conducting fluid and all surfaces of their insulating coatings are thereby connected to ground. A trapped charge under these condi-

tions will be neutralized or flow off to ground through the grounded conveyor.

In operation the arrangement shown in Fig. 1 of the various elements described above and representing one modification of the present invention, functions in the following manner.

The conveyor 11 has attached to it the supports 12 shown in detail in Fig. 4. The objects to be coated 13 are placed on hook portions of these supports at 23 so that they contact the central core of the support. The objects are thus grounded electrically by way of the core and the conveyor. The core of the support is covered with the layer of good electrical insulation as shown in Fig. 4 as 22. As each support with its attached object moves along the conveyor the rotator 19 contacts bar 37 and the object and the support are slowly rotated.

The electrode system 14 by way of conductor 30 is connected to the high voltage supply 29 and is thus maintained at a potential of approximately 100,000 volts with respect to ground. A high potential gradient thus exists adjacent the points 27 and this produces ions in abundance in the region between the electrode 14 and the supports 12. These ions, in being driven toward the central core by the existing electrostatic field, will be intercepted by the insulating layer 22. A charging zone is thus created along the conveyor in which a surface charge of the same polarity as the electrode 14 will be built up upon the insulating surface of the support. Since such surface charge can not escape because of the high bulk and surface resistance of the insulating coating, there will quickly be built up on the support surface a potential equal to that of the approaching ions. No additional ions will then be deposited on the support.

On the other hand, since each object is grounded, a ready path will be provided by which charges given to each object can leak off to ground. Each object's potential is thus held at ground and it therefore is constantly receptive to new charged particles or ions.

Each grounded object, attached to its corresponding support on the insulating surface of which there is an accumulated surface charge, is now carried into the coating zone opposite the atomizing heads 15. These heads are rotated and have fluid coating material fed to them by unit 31.

Under the conditions shown in which the atomizing heads are connected to the high potential source, the objects grounded, and the surface of the support carries a charge, there exists an electrical field distribution between these objects which is ideal for the coating operation. Adjacent the atomizer's forward edge there exists a region of high potential gradient which causes coating material supplied to this edge to be transformed into a cloud of charged particles. Between the head and the grounded article a field exists which urges the charged particles toward the object surface. Between the charged surface of the object support and the grounded object a field exists which also urges the charged particles toward the object surface. Between object support and the atomizer the field is practically zero and therefore no particles will be urged toward the surface of the support. Those particles urged toward the object will be deposited there and have their charge neutralized by the current flow to ground which retains the object at ground potential and thus constantly receptive to additional material. On the other hand the support will remain repellant to charged particles because the insulation character of the support coating is such that the surface charge cannot leak off to ground. The objects thus become coated as they pass through the coating zone while the supports remain essentially free of coating material.

After the coating zone the conveyor carries the supports and the objects suspended therefrom toward the enclosure 38. As the supports pass through this enclosure the conducting atmosphere existing therein supplies a conducting path by which the charges trapped on the in-

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insulating surface of the support can leak off to ground to be neutralized. The support thus leaves the coating operation in a neutral or uncharged condition. Objects can then be freely removed from their supports by operating personnel without fear of shock or electrical discharge.

With the modification of the invention shown in Fig. 1 it is therefore possible to support and carry objects to be coated through the coating zone to receive their coating while the supporting members remain essentially free of coating material. Even when the supports are run through the field without any object attached, the material will still be repelled. The need for periodic cleaning of the supports is thus materially reduced.

Since the point of contact of the object and the support core is very effectively shielded by the contacting part of the object when the object is in place on the support, the contact point remains clean and free of material. Even though no object is present on the support the portions of the V groove about the point of contact will inhibit the collection of material on the contact point because of the electrical charge which they carry. It is therefore evident that through the use of the present invention a proper electrical contact can repeatedly and easily be established between the object and the conveyor by the simple act of placing the object on its support.

While the invention has herein been described in connection with a conveyor of the overhead type, it is to be understood that it is equally applicable for use in connection with conveyors of other types. Similarly, the nature of the charging electrode in advance of the coating zone is not restricted to the type shown. Any electrode arrangement capable of precharging the surface of the support to the required polarity and potential will adequately serve the purpose. The electrode 14 need not be energized by the same voltage source as is used to charge the coating material in the coating zone or, if the same voltage source is used, it is not essential that its full potential be applied to the electrode 14. Further, it is not intended that the invention should be limited to coating processes using electrostatic atomization as shown but that it will be equally applicable with any coating operation wherein charged particles are precipitated upon the surface by the action of a potential difference. However, the invention has special merit when used with electrostatic atomization methods as compared with those obtained when it is used with other electrostatic coating processes using air or mechanical atomizers. With electrostatic atomization the field conditions are such that particles of coating material are never actually urged toward the supports but are constantly repelled by them. With other methods the forces of air or mechanical atomization actually can direct particles toward the support despite the repelling action of the electric surface charges. In these cases only the relative size of these forces determines whether or not the support will become coated. The surface charge must first overcome such forces if it ultimately is to repel the material from the support. No such initial competition between forces exists in the case of electrostatic atomization.

Whereas the support of the invention is shown as being composed of a central conducting, supporting core coated with a suitable layer of insulating material it is to be understood that the conducting core could be reduced to a fine wire if the insulation layer is completed to the conveyor and is adequate to support the object.

Further, it is not essential to completely cover the support. The insulating layer need only be applied to that portion of the support which is apt to accumulate coating material when it is in the coating zone. Also it is not necessary that the insulated surface of the sup-

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port be the actual insulating layer itself. A conducting coating can be used on the exterior of the insulating layer to accomplish the purposes of the invention so long as this conducting coating is adequately insulated from the central core or grounding element of the support. Where an insulated conducting surface cover is used an adequate surface charge can be placed on this surface by bringing it into direct contact with a conductor of proper potential and polarity. Subsequent to the coating operation, the charge can likewise be removed from such insulated conducting cover by bringing it into direct contact with a conductor of proper potential and polarity. Any combination of conductor and insulator which adequately serves the needs of the invention can be used without departing from the scope of the invention.

The essential characteristic of the invention lies not in the nature of the conveyor or coating operation used but rather in providing for the object a support of such character that its surface can be precharged by one electrostatic field to such an extent that in a following field it will repel particles charged for attraction to the object.

What I claim is:

1. In an electrostatic coating apparatus, a support for an article to be coated, conveyor means for moving said support and an article supported thereby along a predetermined path through a coating zone, means for creating in the coating zone a spray of coating-material particles bearing electrical charges of the same polarity, said support having an article engaging portion and being electroconductive to maintain a supported article at a particle-attracting potential, said support being provided with a permanent sheath of insulating material encasing all portions of the support exposed to the coating zone except that support-portion engaged by the article, and means including a discharge electrode disposed at one side of said path and at a point therealong anterior to the coating zone for impressing on each of said sheaths prior to its entry into the coating zone an electrical surface charge of the same polarity as that borne by the coating-material particles, said sheath being sufficiently non-conductive to maintain such impressed surface charge for the duration of its passage to and through the coating zone, whereby the charged particles of coating material will be electrostatically repelled from the sheath.

2. Electrostatic coating apparatus as set forth in claim 1 with the addition that said discharge electrode is of comb-like form and has a plurality of spaced teeth from the tips of which the electrical discharge occurs.

3. Electrostatic coating apparatus as set forth in claim 1 with the addition of discharging means located along said path posterior to the coating zone for removing the surface charge from said sheath.

4. Electrostatic coating apparatus as set forth in claim 1 with the addition that said means for creating the cloud of electrically charged coating-material particles comprises an atomizer charged similarly to said discharge electrode to maintain between the atomizer and the article traversing the coating zone an electrostatic field affecting the atomization of coating material from the atomizer.

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