United States Patent

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[54] **IMMERSION APPARATUS**
7 Claims, 6 Drawing Figs.

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[51] Int. Cl. B05c 11/10
[50] Field of Search 118/50, 50.1, 4, 7, 429, 423, 425, 421; 134/57, 141; 137/253, 571, 453, 386; 117/113, 114, 116, 117

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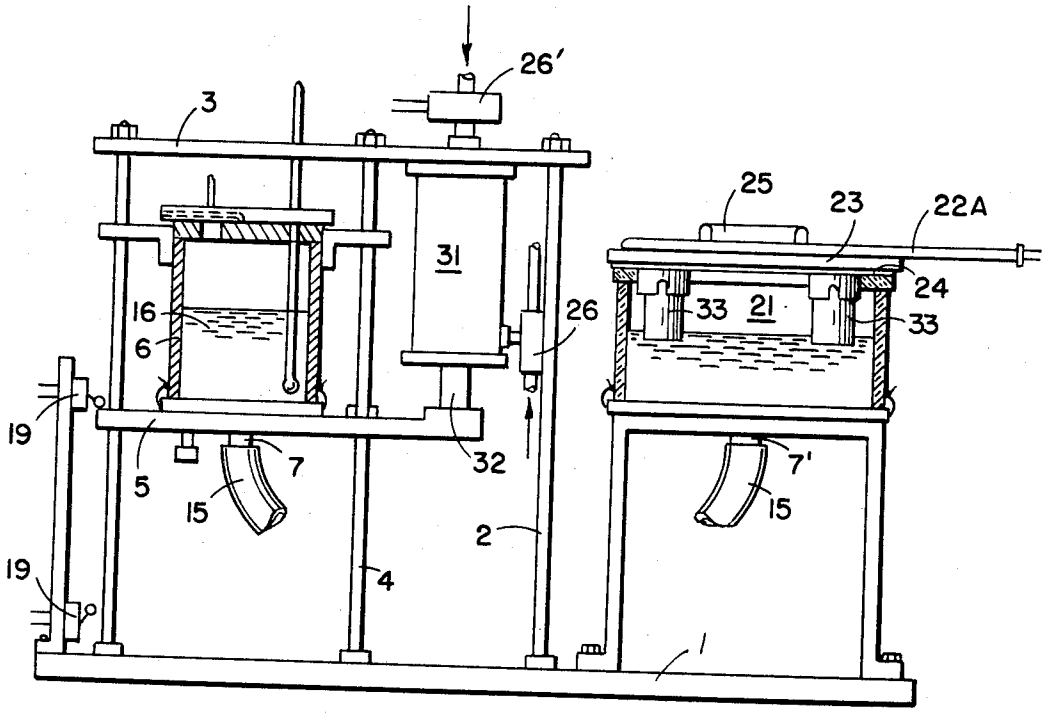
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ABSTRACT: Immersion-coating apparatus having the work holder depending from the immersion vat cover. The holder is a part of the substrate heating and cooling means. A vertically traveling supply tank feeds and drains the immersion vat by variation in the hydrostatic head.



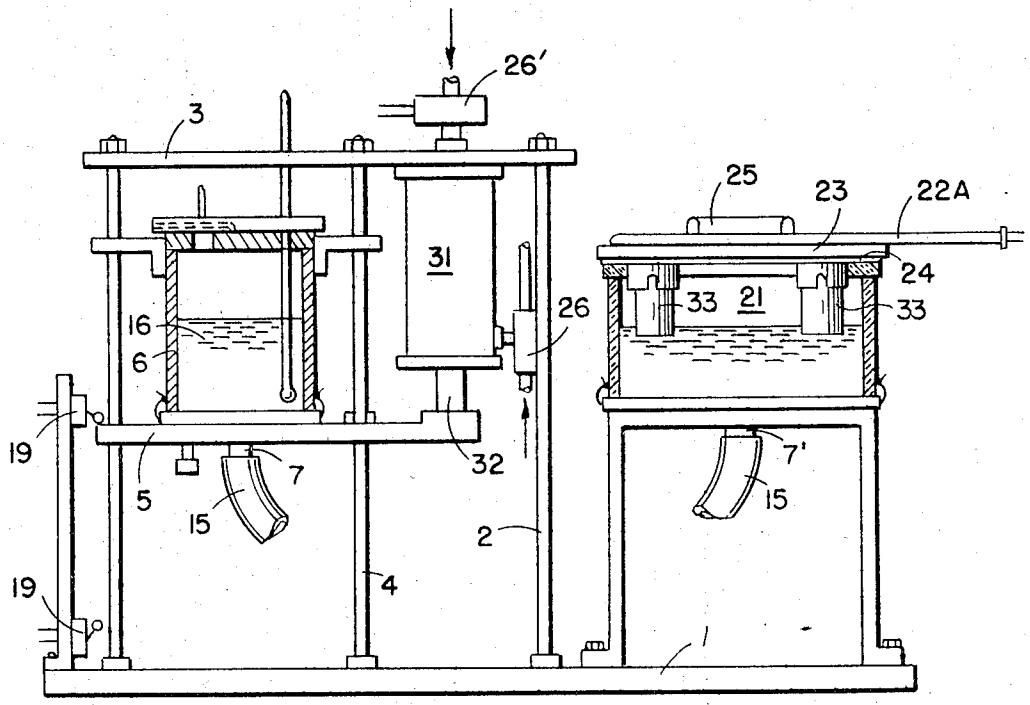


FIG. 1

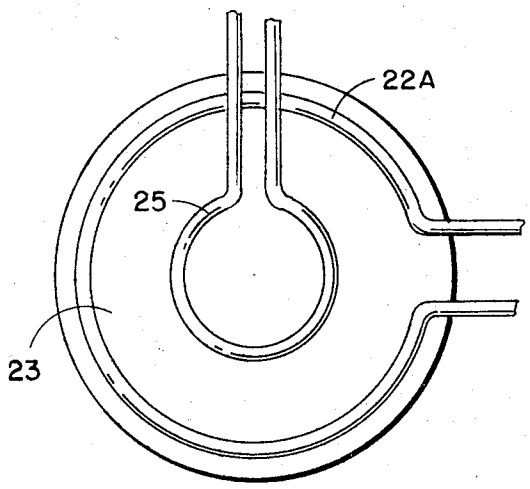


FIG. 2

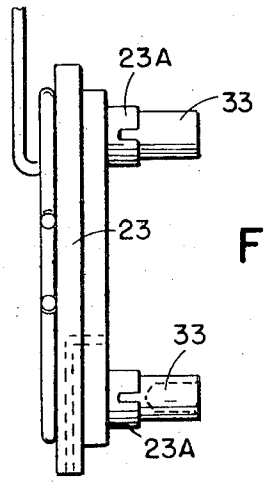


FIG. 3

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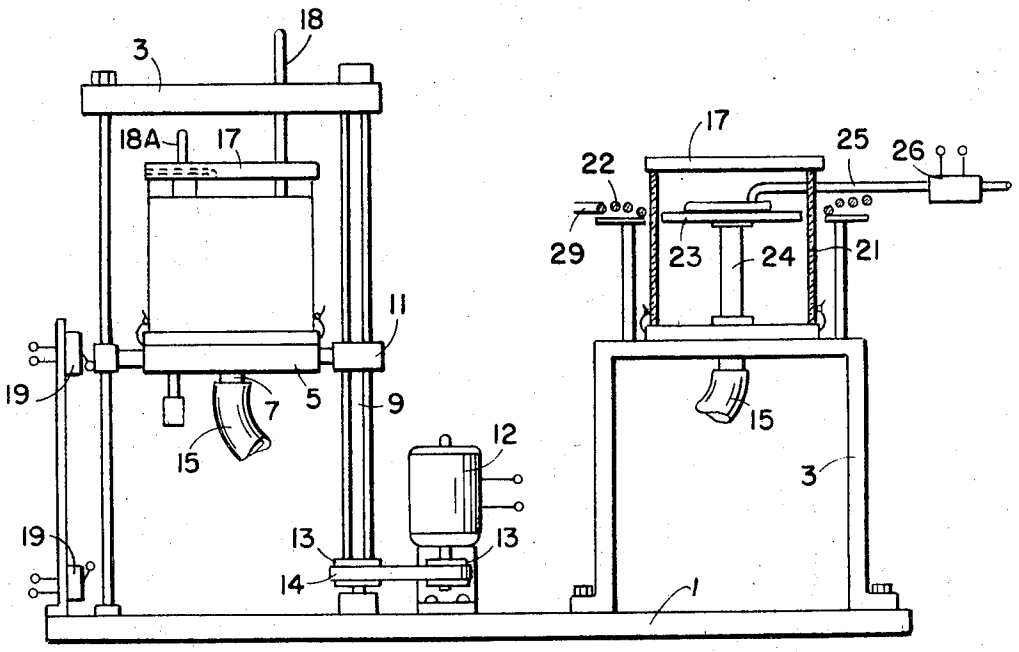


FIG.4

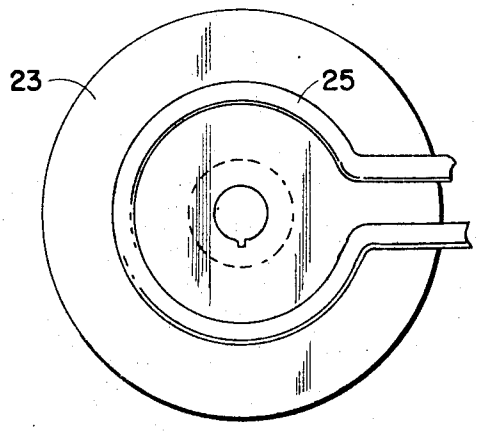


FIG.5

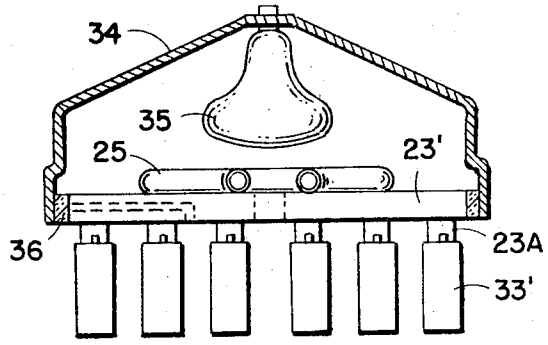


FIG.6

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IMMERSION APPARATUS

Although immersion or dip-coating is one of the most economical mass production methods of applying coatings to metal objects, the coatings obtained are usually of somewhat inferior quality and result in many rejects.

Among the objects of the invention is to provide an improved apparatus for the production of dip-coated metal objects.

The apparatus of the invention is especially adapted to coat metal objects with liquid compositions of low to medium viscosity, i.e., with emulsions, dispersions, suspensions, colloidal solutions, etc., which may be varnishes, lacquers, paints, vitreous or organic enamels, plastic dispersions, etc., so that the coating material is distributed uniformly to the required thickness on the surface of the objects, and to complete the coating by drying, sintering, polymerizing or otherwise setting or curing the coating layer.

When an object is immersed into a viscous liquid which "wets" the object, it is well known that a certain amount of the viscous liquid remains as a coating on the surface of the object. The amount of coating and the uniformity of distribution depends on the density, surface, tension, and viscosity of the coating liquid, and on the speed of withdrawal of the object from the liquid. A uniform withdrawal rate is desired to avoid the production of horizontal streaks and the withdrawal rate should also be relatively slow to avoid vertical streaks.

The present invention is based on the concept of a device for holding the objects to be coated in a stationary position while providing a fully closed system for filling a coating vat or container with coating liquid to a predetermined level and then withdrawing the coating liquid at a uniform rate by gravitational force. In said closed system, excessive evaporation of the vehicle of the coating material is prevented and the coating material, as well as the object to be coated, is protected from contamination of the environment. Dust particles in the air, for example, are capable of contaminating the coating material and the layer of coating retained on the object.

To prevent any contamination of the coating material in use and of the surface of the objects after coating, means are provided to cure or set the coating layer on said objects without removing them from their position in the coating vat. Most setting, drying, or curing steps involve a heating treatment (or some treatment which generates heat exothermically). In a previous patent, U.S. Pat. No. 1,967,031, the article which has to be heat-treated is placed in a magnetic field of a H.F. coil and the induced Eddy current generates the heat in the article's metallic part. This method has serious limitations. The holding fixture has to be made completely of nonmetallic and nonmagnetic material which is not sensitive to elevated temperature and considerable temperature changes, and must be mechanically stable under such conditions. Further, the distance between the H.F. induction coil and the metal article has to be the same in every direction for equal heating rate. To eliminate these limitations, the apparatus of the present invention provides indirect heating methods, which means that the objects are placed on a heat-conductive holding fixture and are heated to the necessary temperature indirectly, through heat transmission in the fixture, i.e., after the holding fixture is heated through H.F. induction, or alternately through heat conduction, or radiation, or convection. It is also desirable to provide means to cool the objects after the coating is cured because in many instances the rate of cooling determines the characteristics of the coating.

Further objects and features of the invention will be apparent from the reading of the subjoined specification and claims and from a consideration of the accompanying drawings illustrating principles of the invention.

In the drawings:

FIG. 1 is a side view of the coating apparatus of the invention.

FIG. 2 is a top view of the object holding means and of the coating vat of FIG. 1.

FIG. 3 is a side top view of an object holding device.

FIG. 4 is a side view partly in cross section of another form of the coating apparatus.

FIG. 5 is a view, similar to FIG. 2, of the holding device of FIG. 4.

FIG. 6 is a side view of the holding device of FIG. 5, with a heating attachment.

According to FIG. 1, the dipping vat 21 is suitably supported above the level of base plate 1 and the supply tank 6 is supported on bearing plate 5 which in turn is guided for vertical movement on guide rods 4. The interior of vat 21 is connected to the interior of tank 6 through flexible conduit 15 and suitable connectors 7 and 7', so that the level of coating liquid 16 tank 6 corresponds to the level in vat 21. Bearing plate 5 and tank 6 is moved up or down by the pressure cylinder 31, suitable electromechanical valves 26 and 26' being provided to control the flow of fluid or air in and out of the cylinder to move piston rod 32 and bearing plate 5, up or down. FIG. 1 shows tank 6 in an intermediate position. Accurate and steady lowering of the tank 6 can be obtained by fluid or air pressure so that the level of liquid in vat 6 is lowered at a uniform and desirable rate. Raising the level of tank 6 to fill vat 21 to the desired level can be conducted at a faster rate. Suitable electrical switches 19 can be provided to stop the movement of plate 6 at its upper and lower limits.

The cover 23 of vat 21 also serves as the holder for the objects to be coated. As shown in FIGS. 2 and 3, the cover or holder 23 comprises a metal plate, fitted in its lower side with one or more fixtures 23A for snugly holding the objects to be coated 33 and on the upper side of said plate, a first means, such as heating coil 22A is provided, for heating the plate, and a second suitable means, such as refrigerated coil 25, is provided for cooling the plate 23. The articles to be coated are indirectly heated by transmission of heat from heating coil 22A or 25 through the metal cover and fixtures 23A. The vat 21 can be made of glass, ceramic or other heat-resistant materials so that heat from the cover 23 is not damaging to the walls of said vat 21, or said vat can be made of plastic whereupon an insulating gasket 33 is interposed between vat 21 and cover 23.

The modified form of the devices shown in FIGS. 4, 5 and 6 are similar to the devices of FIGS. 1, 2 and 3 respectively and like numbers are used to designate like parts in the respective FIGS.

In FIG. 4, the vertical movement and position of tank 6 is controlled by a reversible motor 12, operating through pulleys 13, belt 14 and screw rod 9, the bearing plate 5 being secured to nut 11 which rides on the threads of screw 9.

The metal plate 23 of vat 21 is provided with a refrigerating coil 25, but is heated inductively by means of H.F. coil 22. It will be noted that coil 22 is positioned to heat the plate 23, rather than to directly heat the objects being coated.

The objects 33' of FIG. 6 are snugly held by fixtures 123A which are designed to fit snugly within a tubular portion of objects 33' to provide good thermal conductivity to said objects.

It will be understood that the various kinds of fixtures 23A and 123A can be designed to support and conduct heat to whatever type of object 33, it is desired to coat.

Another method of heating the holder 23' is shown in FIG. 6. Thus, the holder 23' may be provided with a reflecting covering means 34, within which is positioned an infrared lamp 35. Preferably, the cover means 34 is provided with an insulating gasket 36.

In operation it will be seen that from the time the bodies 33 or 33' are racked on cover 23 or holder 23' and the holder is supported within vat 21, said articles are protected from outside contamination until the coating process is completed. At the start of a cycle, the supply tank 6 is at its lowermost position so that it contains substantially all of the coating composition 16. After the holder 23 or 23' has been inserted in the vat 21 and the vat covered, supply tank 6 is raised until the level of coating material reaches the predetermined point in applicator vat 21. The supply tank 6 is then lowered at a uniform rate so as to gradually and uniformly lower the level of liquid

16 in vat 21. Once the coating composition 16 is removed from vat 21, the metal bodies 33 or 33' are indirectly heated through the holder 23 or 23' to cure the coating and then the bodies are cooled to ambient temperature at a predetermined rate, before being removed from the vat 21.

It will be seen therefore that the invention succeeds in:

1. Providing a processing apparatus for dip-coating where the coating takes place in a stationary and closed area, by immersing the fixed objects to a predetermined level into the coating material and wherein the level of the coating is then gradually lowered at a controlled rate,
2. providing for heat treatment of the uniformly distributed coating on the predetermined portion of the surface of an object without moving said object from fixed position,
3. providing for cooling of the coated and heat treated objects without removing them from their fixed position,
4. protecting the coating material from contamination by moving it in a closed system,
5. controlling and preventing the loss of coating material through evaporation,
6. providing a system that can be operated by a suitable programming circuit, so that
7. all operations take place automatically.

I claim:

1. An apparatus for uniformly coating metal objects with coating materials applied in the form of a liquid composition, comprising:

a stationary vat;

means for covering said vat and metal means depending from said cover and heat insulated therefrom for holding one or more objects to be coated within said vat;

a vertically movable supply tank for the coating material and means for covering said supply tank;

conduit means connecting the interior of said supply tank to the interior of said vat to form a closed system whereby moving the supply tank upwardly automatically charges the vat with said coating material and moving the supply tank downward discharges the vat through gravitational force;

means for moving said supply tank downward at a controlled uniform speed so that the liquid coating composition can be withdrawn at a uniform rate from the vat;

switch means disposed at the extremes of supply tank travel whereby to limit said upward and downward movement;

means to indirectly heat the coated object to cure the coating composition, remaining thereon after said excess composition has been discharged from vat;

means to cool the coated objects; and

means for heating and cooling including said metal means.

2. The apparatus as claimed in claim 1 comprising electrical means to lower the supply tank from its upper most position at a relatively slow uniform rate whereby to withdraw the coating material from the surface of the object and leave a uniform layer on the object.

3. The apparatus as defined in claim 1 comprising pneumatic means for lowering the supply chamber from its uppermost position at a relatively slow, uniform rate.

4. The apparatus as defined in claim 1 comprising hydraulic means for lowering the supply chamber from its uppermost position at a relatively slow, uniform rate.

5. The apparatus as defined in claim 1, wherein the heating means including said metal means comprises an electrical heating element to raise the temperature in said object through conduction.

6. The apparatus as defined in claim 1, wherein said heating means includes a H.F. induction coil whereby to heat said metal means through Eddy current.

7. The apparatus as defined in claim 1, wherein said heating means includes infrared heating means whereby to heat said metal means.