Nov. 29, 1949 R. A. LIEBEL 2,489,456

METHOD OF APPLYING UNIFORM COATING BY IMMERSION

Filed Aug. 21, 1945

Fig. 1

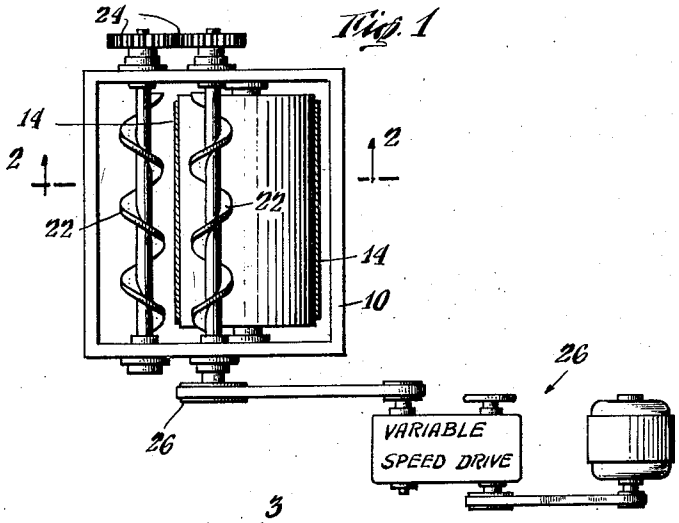


Fig. 2

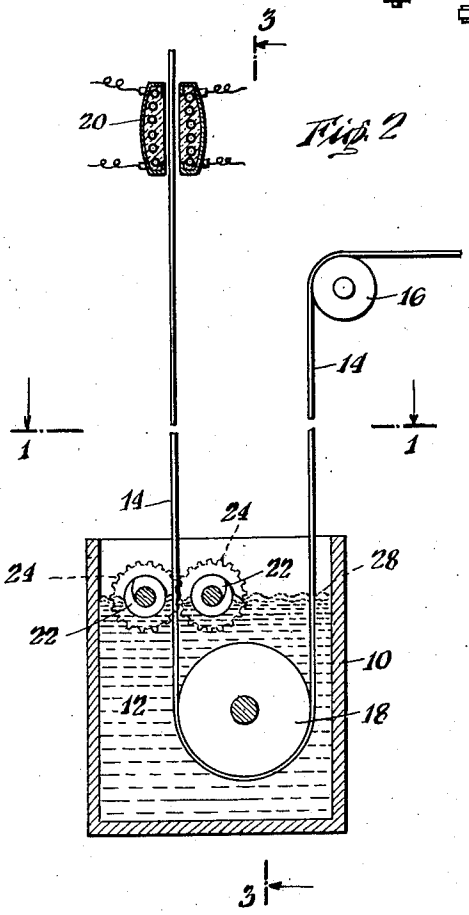
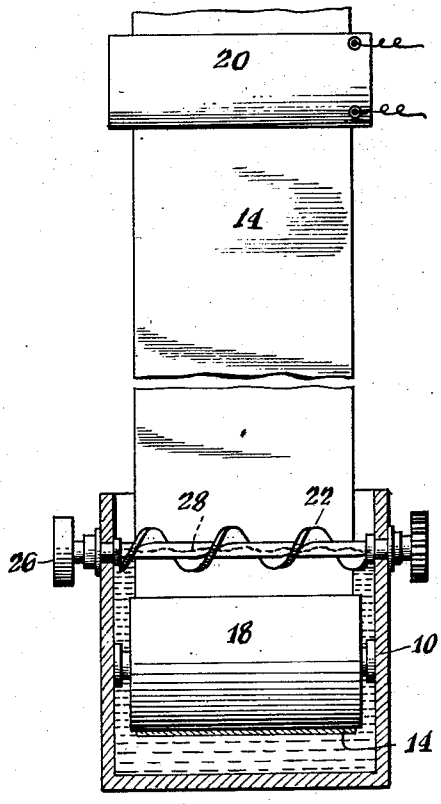


Fig. 3



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Patented Nov. 29, 1949 2,489,456

UNITED STATES PATENT OFFICE

2,489,456

METHOD OF APPLYING UNIFORM COATING BY IMMERSION

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Application August 21, 1945, Serial No. 611,885

2 Claims. (Cl. 117—115)

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This invention relates to a method and apparatus for applying a coating composition.

In a common method of coating metal sheets, plates, and wire, for instance, the material to be coated is immersed in an enamel or other liquid coating composition and then withdrawn through the upper exposed surface of the composition. The film of flowable liquid so applied is then hardened, as by evaporation of diluting solvent initially present in the composition, by polymerization or oxidation of the film forming material, or in some cases by cooling a composition originally softened by heat.

When the coating composition is non-metallic and consequently of relatively low density, as compared to galvanizing or most metal coatings, special problems arise. One of these is the formation of nodes or overly thick bands alternating with thin zones of the coating composition, appearing as striations upon the surface of the object being coated. When, for example, a metal sheet emerges from an enameling bath of the oleoresin type, the enamel alternately clings to and releases itself from the sheet. The level of the liquid at the position of emergence is raised momentarily, then gives way, only to rise again in a moment, and then sink. This repeated alternation of lifting and sinking of the surface gives thickened bands or nodes of the coating composition at levels on the object to which the surface momentarily adhered.

This problem of the unevenness of coatings so applied has been recognized for a long time. Various means have been proposed to correct the difficulty. Coated wires are sometimes sent through dies which remove excessive coating from the thick zones and thus give the desired uniformity of thickness. Sheets are sometimes passed through rollers or between doctor blades for removing excess of unevenly applied material.

There has been difficulty also in obtaining a coating that is sufficiently thick everywhere and not objectionably thick anywhere.

The present invention provides a simple and inexpensive means of insuring a satisfactory, uniform coating. The invention provides also an economical method of applying a coating that is of the desired thickness in all areas without objectionable thickness in any zone. The invention thus avoids unevenness and unnecessary consumption of coating material.

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Briefly stated, the invention comprises maintaining the surface of the coating bath at a constantly fluctuating level and constantly changing slope where the object being coated emerges from the bath. In one embodiment, the invention comprises causing the bath of fluctuating level also to be in continuous motion laterally with respect to the surface of the object being coated. In the preferred embodiment, the invention comprises the use of coating compositions of abnormally low viscosity as compared to those which have been used heretofore in coating objects by immersion and withdrawal from baths of like coating material.

Included within the invention is the herein described apparatus for causing the continually fluctuating level of upper surface of the coating bath.

Using the method and apparatus described, I obtain a substantially uniform thickness of coating upon an object. When it is desired to smooth additionally the surface of the applied film of coating composition, heat may be applied as by electrical strip heaters to the coated object immediately after withdrawal from the coating bath, so that the elevation of temperature causes reduction of viscosity of the coating composition and promotes flow in the exposed surface of the composition. This feature is also included as part of the present invention.

The invention will be illustrated in greater detail by description in connection with the attached drawing to which reference is made.

Fig. 1 is a plan view partly in section of my improved apparatus.

Fig. 2 is an end view in section of the apparatus, the view being on line 2—2 of Fig. 1.

Fig. 3 is a sectional view on line 3—3 of Fig. 2.

The views are partly diagrammatic. Parts not shown or described in detail are conventional when considered individually.

There are shown container 10 for the coating bath 12. The object to be coated such as the strip of flexible steel 14 is passed over guide roller 16 into the bath and over the second guide roller 18. It is then withdrawn and passed between heaters 20.

The means for moving the strip are conventional and not shown.

Disposed on opposite sides of the sheet 14 are means for setting up waves of desired frequency

in the surface portions of the coating composition 12. In the illustrative form shown, these wave-making agitators are parallel screws 22. One of them is driven by a usual type of motor and belt drive indicated at 26 and the other through gears 24. The wavy surface of the coating bath is indicated generally at 28 in Fig. 3.

The flexible metal sheet 14 is passed through the coating composition, and withdrawn continuously through the upper surface of the composition. When the coating composition is one which is hardenable by heat, the coated object may be passed through a usual type of heated chamber (not shown) of proper temperature and size to cause evaporation of some volatile solvent, polymerization, or whatever change is required to cause setting of the film of coating composition to hard, durable condition.

As the object is withdrawn from the coating bath, the level of the bath which washes the surface of the object as withdrawn is caused to fluctuate constantly as by the setting up of waves or ripples at the surface by means of the agitators 22. Care is required in the design of the agitators and their method of operation to avoid introducing air bubbles. The agitators should be of kind to give an adequate wave effect without churning in air.

I have used to advantage fluctuations of the surface level of frequency 20 or more a minute for speeds of movement of the sheet 14 up to 300 linear feet a minute. Satisfactory results with most objects being coated are obtained when the rate of fluctuation of the surface level is made at 10 or more per minute and preferably at least 20 to 140 for speeds of movement of the sheet 14 up to 500 linear feet a minute, fluctuations being figured as complete cycles from the crest of one wave to the crest of the succeeding wave.

At the frequency of 10 fluctuations for 500 feet of movement of the sheet, this is a ratio of 1 fluctuation from crest to crest of the wave for each 50 feet of emergence of the sheet. When it is considered that the depth of the ripples or waves is ordinarily about ¾ inch from top to bottom of the wave or within the range of ¼ to 1½ inch, it will be noted that the recoating effect, due to the washing of the enamel composition up and down on the surface of the sheet being coated, is a relatively minor influence. It is considered that a major part of the effect is due to the irregularity of surface of the top of the enameling composition. There is a constantly changing slope of surface of the enamel bath, that is, there is a continual change in the angle which the surface of the bath at any point makes with the horizontal. As a result of this, there is at no time an appreciable extent of level surface of the composition in contact with the object being coated.

The fluctuation of the level of the coating composition prevents the level from becoming associated for any appreciable time with any particular spot on the article being withdrawn.

As a result there is no clinging of the surface of the coating composition to the object being withdrawn. There is no pulling up of the surface followed by collapse. There are no nodes of the coating composition on the object coated.

Also the lateral movement of the coating composition of continually fluctuating level contributes to smoothness of application of the coating composition upon the surface of the object being coated.

The invention makes possible, in a simple and economical operation, the application of a thicker coating of the given composition than heretofore obtained by the immersion and withdrawal method.

When a thin but uniform coating is desired, then heat may be applied as by passing the coated object, at a level just above that of emergence from the bath, as between electrical heaters shown in the drawing at 20. These heaters cause a rise in temperature and a decrease in viscosity of the adhering coating solution. They promote run back of coating material. Also the heaters exert a maximum effect upon the surface of the coating film and thus make this the least viscous part of the film, so as to cause smoothing of the film surface.

As the coating composition to be used with my method and apparatus, there may be employed any one of a large number of finishing compositions now in regular use. Thus, there may be used conventional coating compositions of the following types: pigmented baking enamels of the common oleoresin type; alkyd, phenol-formaldehyde, and urea-formaldehyde resin varnishes and enamels; and finishing compositions containing vinyl or styrene polymers of resinous consistency. These compositions as used may be diluted, with any conventional solvent or thinner for the selected composition, to the range of viscosities described. Among the solvents that may be used are toluene, naphtha, turpentine, and butyl acetate. The solvents selected should be those that are compatible with the finishing compositions selected.

The problem of alternate pulling and release of the surface as the object emerges is serious with the relatively light weight coating compositions of the kind described. This problem is not serious with metal coatings where the specific gravity of the composition is so large as to minimize riding up of the surface. However, metal coatings may be used in the apparatus and method as, for instance, in applying molten zinc, tin, or low melting alloys as a coating upon wire or sheets.

The invention makes possible the use of coating compositions of abnormally low viscosity.

Other objects that may be coated with the method and apparatus described, particularly with the light weight, non-metallic types of coatings, include wire, textile fabrics, woven wire gauze, paper, sheets and webs of plastic material, and like material. In addition to such strip material, thereby may be dip-coated, by the present method and apparatus, rigid articles such as castings, machine or radiator covers, lamp shades, novelties and toys. The strip steel, wire, and castings are examples of objects having a non-absorbent, smooth surface.

It will be understood from the description that has been given that there is relative movement between the liquid coating composition and the object being coated, this movement being in more than one direction at the position of emergence of the object from the upper surface of the coating composition. In the wave motion referred to there is always some lateral movement. Also there is relative movement in a vertical direction between the object to be coated and the surface of the liquid through which the object is being withdrawn.

It will be understood also that it is intended to cover all changes and modifications of the examples of the invention herein chosen for the

purpose of illustration which do not constitute departures from the spirit and scope of the invention.

What I claim is:

1. The method of applying a coating of a liquid heat hardenable organic finishing composition of low viscosity to an object having a non-absorbent smooth surface which comprises immersing the object in the said composition, withdrawing the object at a steady rate through the upper surface of the composition, and subjecting said composition to mechanical agitation applied at and immediately below the surface thereof, to cause alternations of rise and fall of the level of the said surface at predetermined regular frequency of at least 10 complete cycles a minute and to cause also movement of the coating liquid at the said surface in direction generally lateral to the surface of the object being withdrawn through the surface.

2. The method described in claim 1, the frequency of said fluctuation being at least one for each 50 feet of linear movement of the object being coated.

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