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METHOD AND APPARATUS FOR COATING FLUORESCENT LAMPS

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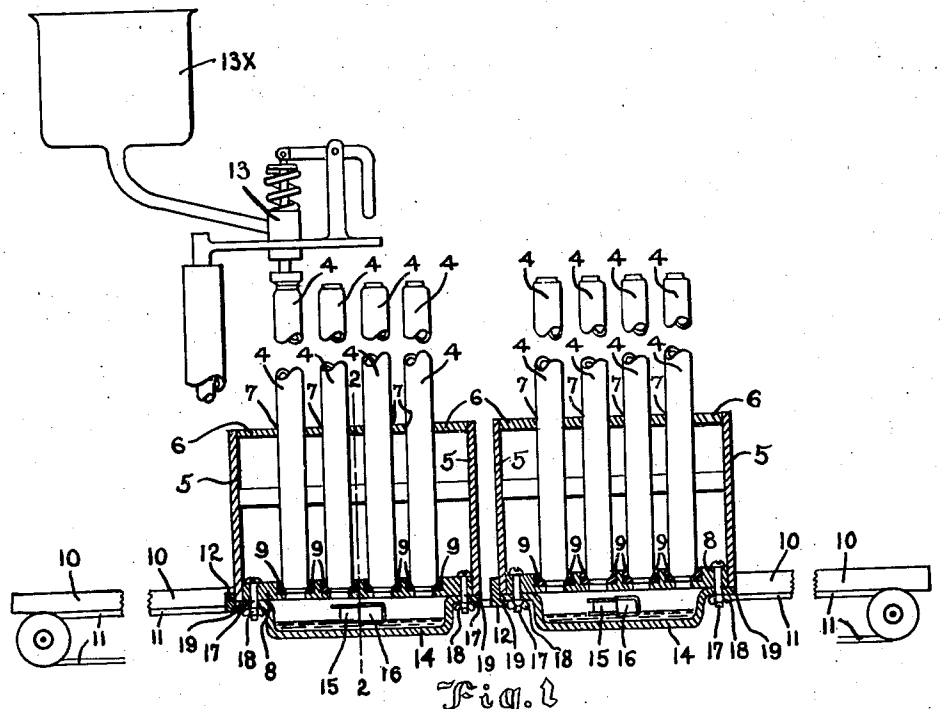


Fig. 1

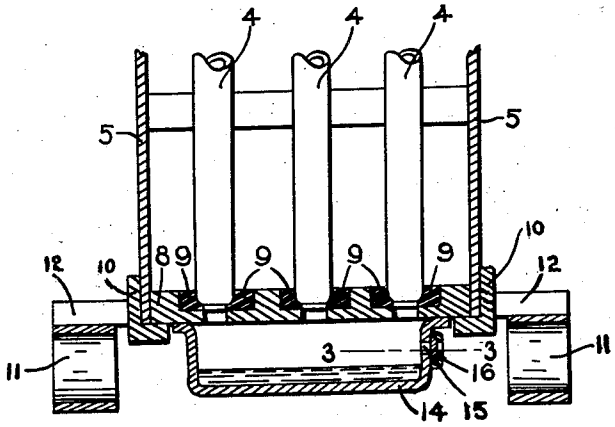


Fig. 2

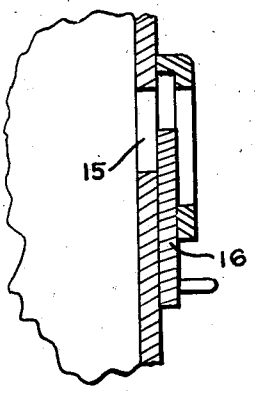


Fig. 3

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METHOD AND APPARATUS FOR COATING FLUORESCENT LAMPS

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3 Claims. (Cl. 117—33.5)

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This invention relates to a method and apparatus for coating the inner surface of fluorescent lamps with fluorescent material and particularly to such a method wherein the coating material used has fast drying characteristics.

It is highly desirable that the coating material upon fluorescent lamps be applied evenly and to a predetermined thickness. Heretofore it has been considered of advantage to forego some of the advantages of a rapid drying coating in the interest of better quality obtainable, prior to the present invention, by using a slower drying solvent. The slow drying solvent however, delayed the drying time and the process showed poor production economy.

The practice of the present invention permits the use of rapid drying solvents, and produces a high quality coating in a greatly reduced period of time.

The principles of the invention may be applied to many types of lamps but are particularly adapted to the coating of elongated open-ended lamp tubes. The coating material is prepared with a highly volatile solvent such as acetone and is applied to the inner walls of the tubes by flowing it thereon at their upper ends while they are vertically disposed. The liquid coating flows downward wetting and coating the walls and the surplus liquid flows out at the bottom where it is collected to be used again.

The top of the tubes are left open while the bottom openings are restricted in their access to the atmosphere by controllable means. By such an arrangement certain natural properties of the vapors generated by the drying process are utilized to control and stabilize the drying conditions within the tubes in a manner to produce a perfect and highly efficient coating, as will appear more fully hereinafter.

An object of the invention is to provide means for rapidly coating fluorescent lamp envelopes with a highly efficient light emitting coating.

A further object of the invention is to provide means for utilizing the advantages of rapid drying solvents while controlling the evaporation conditions at the coated surface in a manner to produce a uniform layer of fluorescent material of predetermined thickness and density.

A further object of the invention is to provide a method of coating the inner surface of a lamp tube in which the natural vaporization characteristics of the solvents used in the coating material are employed to condition the coating during the drying period.

Other objects and features will more fully appear from the following description taken in connection with the accompanying drawing, and will be particularly pointed out in the claims.

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To present a better understanding of the invention a specific embodiment thereof is herein described and illustrated in the drawing in which:

Figure 1 is a diagrammatic view of an apparatus suitable for practicing the invention;

Figure 2 is an enlarged detail view to more clearly show the structure of the tube holding racks; and

Figure 3 is a cross section on line 3—3, Figure 2.

The desirability of using highly volatile solvents in the liquid material employed in coating fluorescent lamps is well recognized. The art of successfully using such a material on a practical production scale however, had not been successfully developed prior to the present invention. Without proper handling and control, the resulting coating is inclined to be uneven and generally inefficient in light output.

The coating material is prepared by mixing together the desired fluorescent powder, a suitable temporary binder such as nitrocellulose, and a volatile solvent the major portion of which is acetone or other similarly volatile liquid.

The principles of the invention may be applied to the coating of many types of lamp envelopes. However, the invention is herein applied to the elongated type of lamp tubes which are open at both ends when the coating is applied. The apparatus illustrated in the drawing enables the coating operation to be executed rapidly and accurately on a commercial scale. The lamp tubes 4 are held in a vertical position in racks 5 which are arranged to hold a plurality of tubes. A positioning plate 6 is perforated with a number of holes 7 and is disposed above a base plate 8 having apertures 9 therein situated in vertical alignment with the apertures 7. The tubes are loaded into the racks by passing them through the apertures 7 and projecting their end portions into the apertures 9.

Desirably the racks are so constructed that they may be moved along a conveyor framework 10. To feed the racks along the conveyor, a conveyor drive 11 is provided having lugs 12 thereon which are positioned to engage the racks 5 and move them along the ways 10. A suitable power means and control not shown is provided which enables the operator to position the tubes successively beneath one or more applicator nozzles 13 communicating with a supply of liquid 13X.

The nozzles 13 are or may be of well-known construction having a hand or automatic means for flowing a quantity of the coating material onto the upper portion of the inner wall of the tubes from where it flows downward by gravity along the tube walls wetting and laying a coating thereon. The surplus material flows out at the bottom end of the tubes.

To prepare the coating material a suitable fluorescent powder is mixed with a temporary binder and the desired quantity of solvent is added to give the material the correct consistency. The type of solvent used is important. It has been found that acetone alone is a satisfactory material to use but other highly volatile liquids may be used or other solvents in combination with acetone may also be used.

The proportion of fluorescent powder temporary binder and solvent are adjusted to produce the required thickness of coating, when dried and baked.

As is well known, acetone vaporizes very rapidly at room temperature and its vapor is heavier than air. These properties are utilized to accomplish the desired end result. The whole operation of coating and drying is carried out at ordinary room temperature. If no control is exercised over the drying of the coating the rapid evaporation rate causes a sharp lowering of temperature at the coated surface and a relatively violent down flow of the vapor results from its rapid generation. If the bottom of the tubes are open freely to the atmosphere the vapors rapidly pass downward and cause sudden drying of the lower portions of the coating prior to the drying of the upper portion, which, being liquid or semi-liquid tends to flow downward over the dried portions causing undesirable uneven dense areas. The drying period under such circumstances is very short but the whole operation produces a generally unsatisfactory result. If, however, the bottom opening of the tube is closed or partially closed to the flow of vapors a very different result is effected. By closing or partially closing the bottom end of the tubes and leaving the top ends open during the drying period a definite and highly beneficial control is exercised over the drying operation. Under such conditions the solvent vapors as they are generated remain within the tube and in contact with the coating during the drying operation. The natural tendency for the vapors is to flow downward since they are heavier than air. A small regulated portion only of the vapor is permitted to escape from the bottom of the tubes consequently a column of vapor automatically accumulates in the tube. Throughout the drying period therefore an atmosphere of vapor remains in the tube in contact with the coating. If an attempt is made to restrict the flow of vapor by any means other than at the bottom of the tubes a convection takes place at the tube bottom which causes premature drying at that point which results in an uneven coating. This effect is particularly noticeable in tubes of large diameter.

The process is carried out at normal room temperature and the natural tendency is for the solvent vapors to reach saturation pressure within the confines of the tube. Means are provided however to control the degree of vapor pressure to that value which produces the most favorable drying conditions. This is done by regulating an adjustable opening at the bottom of the tubes which permits a measured amount of acetone

vapor and air to escape. The escape of vapor and air at the bottom of the tube sets up a slow movement of air downward into the top. This air becomes saturated shortly after entering the top of the tube, after which it can no longer have a drying effect. In the zone in which saturation is taking place the coating becomes dried. As this portion of the tube no longer contributes vapor to the stream of air, the portion immediately below it becomes the drying zone. The drying zone thus moves smoothly down the tube and the whole tube is dried progressively.

By varying the size of the adjustable opening during the drying period, automatically or manually, the density of coating along the length of the tube can be controlled, and it may be varied according to some predetermined pattern.

The control of the vapor at the base of the tubes may be effected in any suitable manner. In the construction illustrated a pan-like container 14 is secured to the bottom face of the base plate 8 of the racks 5. The containers 14 serve to enclose all of the openings 9 in the plate 8 and also to catch the surplus liquid coating material which drains from the tubes. Adjustable openings 15 are provided in the containers 14 by means of which the downward flow of vapor from the tubes may be regulated. The vapor flow from all of the tubes in the rack is thus controlled by a single opening. However, any suitable arrangement for accomplishing the same result may be employed. As shown herein the size of the opening 15 may be adjusted by means of a sliding door 16, or other suitable means.

The receptacles 14 are detachably secured to the racks in any desired manner such as by means of bolts 17 in the plate 8 having thumb nuts 18 thereon engaging the flange 19 upon the upper rim of the receptacle. To produce a satisfactory vapor tight seal between the tubes and the apertures 9 suitable gaskets may be provided which are secured to the periphery of the apertures and have openings to tightly receive the tubes.

In brief the coating procedure may be reviewed as follows. The liquid coating material is first prepared by mixing the desired type of fluorescent powder, a suitable temporary binder such as nitrocellulose, and acetone, or similar highly volatile solvent. The proportions employed are calculated to provide the correct viscosity and flow characteristics required to produce a dried and baked coating of the desired density and light emission.

The coating liquid is placed in the supply container 13X and racks 5 containing tubes to be coated are placed on the conveyor. The conveyor is then manipulated to bring one or more tubes into position under the nozzle or nozzles 13. The ends of the nozzles are inserted in the upper ends of the tubes and a quantity of coating liquid is flowed onto the inner walls of the tubes by operating the valve upon the nozzle 13. The liquid flows downward wetting and depositing a coating on the tube walls. The surplus liquid drains into the receptacles 14. Immediately the coating starts to dry giving off heavy acetone fumes, some of which is permitted to escape through the opening 15. The opening is so regulated that the movement of air in the tube is restricted to the proper rate to provide the correct drying time for the coating. The tubes in the racks are successively coated and as they are moved along the conveyor become dried. The whole procedure

takes place at normal room temperature and without forced air jets or vacuum devices. The vapor content of the exhaust air is therefore high allowing economical recovery of the solvent vapor by commonly known means.

The drainage liquid in the containers 14 is removed by detaching the containers and returning the liquid to the main supply or by a drainage tube.

In a short period of time the coating is dry and the tubes are removed and placed in a baking oven to remove the temporary binder after which they are ready to be received by the operator who performs the necessary operations to complete the lamps.

By coating the lamps in accordance with the principles of the invention the total time consumed in coating and drying is greatly reduced from that required when slow drying solvents are used and moreover, due to the accurate control which is exercised over the drying conditions a more uniform and efficient coating is produced.

What we claim is:

1. A method of coating the inner surface of vertically disposed tubular fluorescent lamp envelopes comprising the steps of preparing a liquid coating material containing fluorescent powder in which at least the major portion of its solvent is highly volatile and in which the solvent produces a vapor heavier than air, flowing the liquid onto the surface to be coated, draining and collecting the surplus coating liquid which passes completely through the tubes, restricting the downward flow of solvent vapor and air within the tubes by partially closing the bottom ends thereof whereby the coating is dried in an atmosphere of solvent vapor and air regulated to a predetermined rate of flow.

2. An apparatus for coating with fluorescent material the inner walls of open ended tubular lamp envelopes comprising a supply of liquid coating material having a solvent which produces a vapor heavier than air, an applicator nozzle connected with said supply for flowing the material upon the surface to be coated vapor tight means for collecting the surplus material which flows through the tubes and means in the wall of said collecting means acting to control the downward flow of vapor and air during the drying period to maintain the proper rate of drying within the tubes to produce an even coating of the required density.

3. An apparatus for coating with fluorescent material the inner walls of open ended tubular lamp envelopes comprising a supply of liquid coating material having a highly volatile solvent and in which the solvent produces a vapor heavier than air, an applicator nozzle connected to said supply operable to flow the material upon the surface to be coated, conveyor means for holding the tubes in upright position and positioning them beneath said nozzle, means for collecting the drainage from said tubes, and means for adjustably restricting the escape of solvent vapor and air from the bottom ends of the tubes during the drying period to restrict the rate of flow of air through the tubes to such a value that a smooth even coating of the required density is produced.

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