June 23, 1942. E. T. CASELLINI 2,287,024

APPARATUS FOR COATING FLUORESCENT LAMP TUBING

Filed Oct. 5, 1940 3 Sheets-Sheet 1

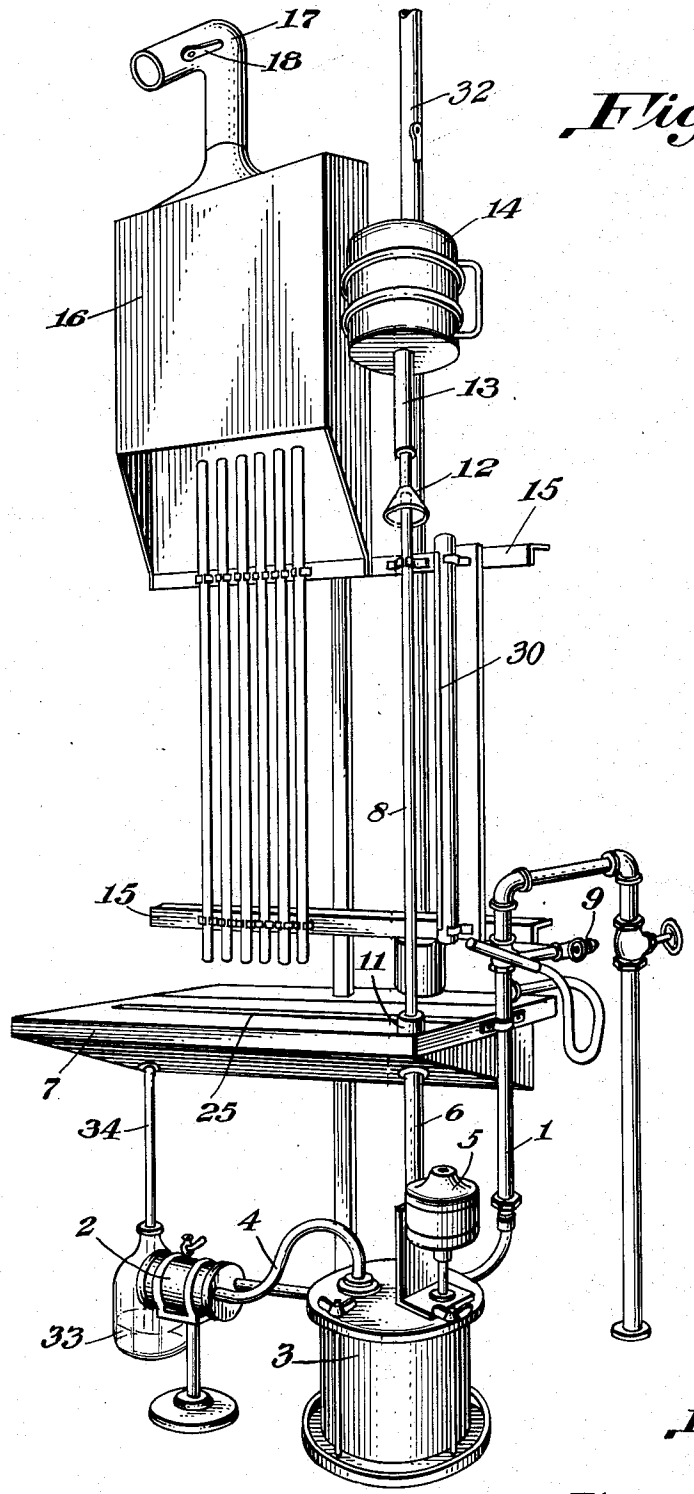


Fig. 1.

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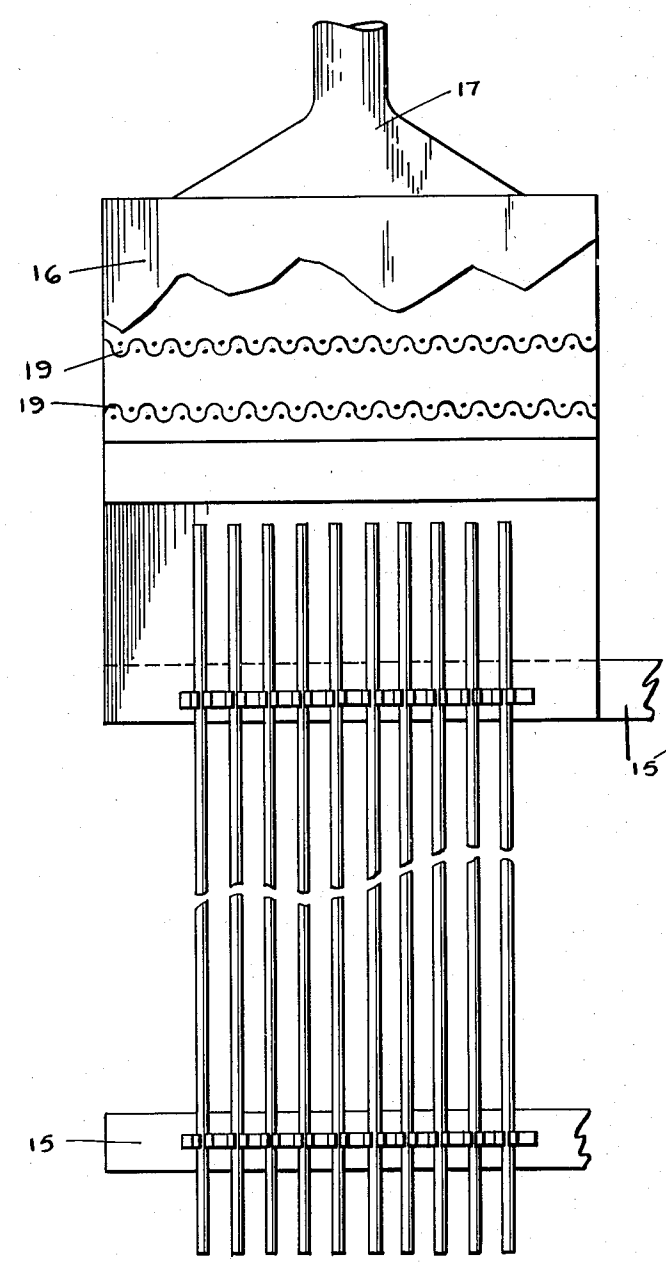


Fig. 2

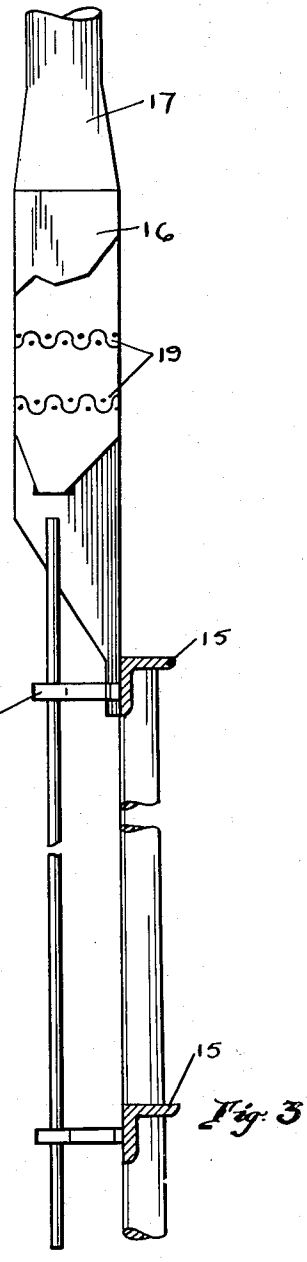


Fig. 3

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Filed Oct. 5, 1940 3 Sheets-Sheet 3

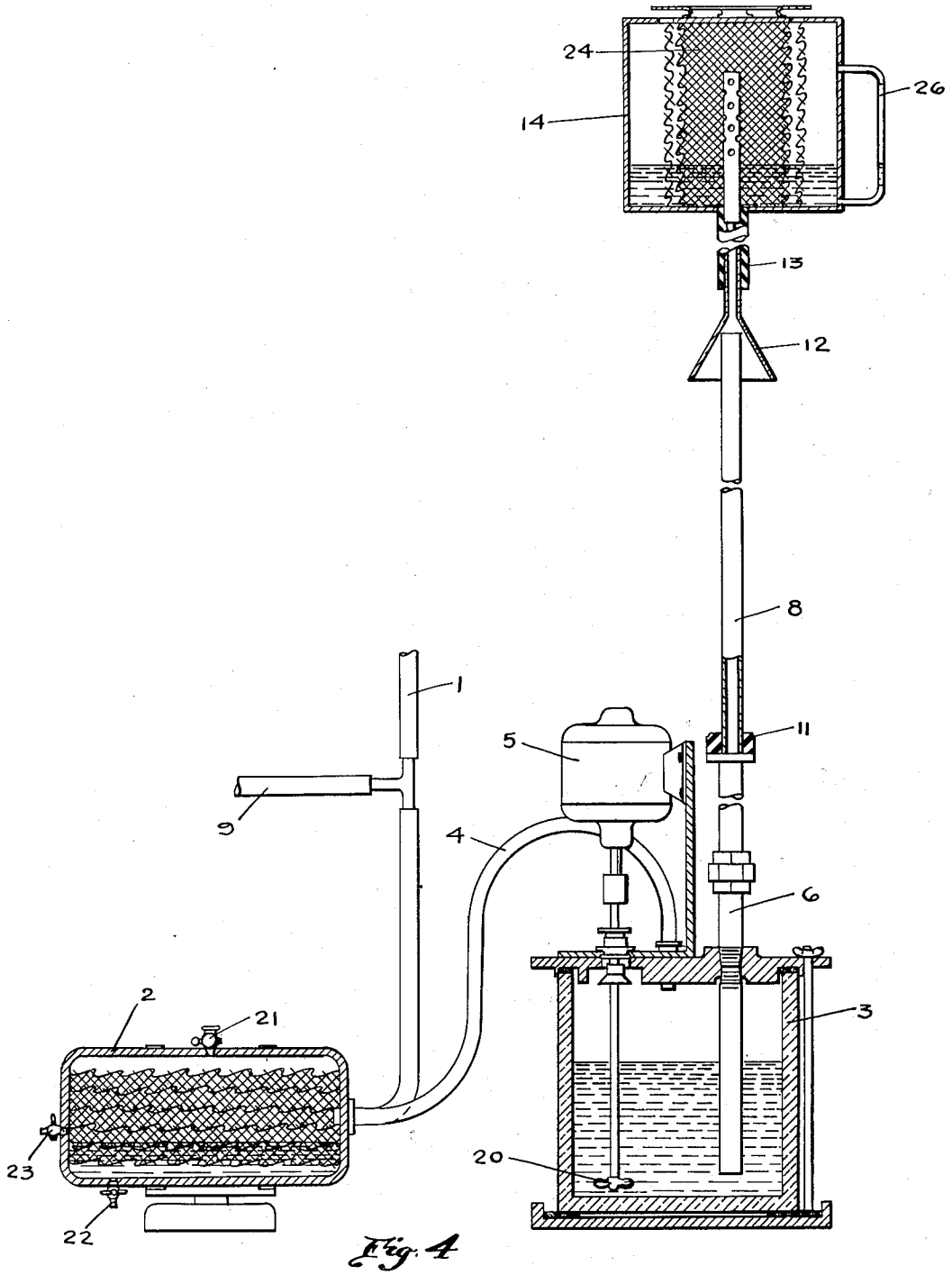


Fig. 4

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UNITED STATES PATENT OFFICE

2,287,024

APPARATUS FOR COATING FLUORESCENT LAMP TUBING

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Application October 5, 1940, Serial No. 359,917

5 Claims. (Cl. 91—18)

This invention relates to methods and means for coating the interior surface of glass bulbs or tubes and more particularly to the application of a luminescent coating on the interior walls of electric gaseous discharge lamps or tubes.

An object of this invention is to provide a method of applying a uniform coating of fluorescent material to the inner walls of a glass envelope.

Another object is to provide a method of applying a coating of fluorescent material to the inner walls of a fluorescent lamp or tube in such a manner that the coating will have a uniform thickness at all points along the length of the bulb or tube.

A further object is to provide a method of applying a coating of fluorescent material to the inner walls of a fluorescent lamp or tube in such a manner that it will be free from mottling, "comb-marks" and "tapering."

Another object is to provide a method of applying a coating of fluorescent material that will produce a desirable coating in one coating application.

Further objects, advantages and features of this invention will be apparent from the following description taken in conjunction with the accompanying drawings in which:

Figure 1 is a front perspective view of the tube coating and drying apparatus.

Figure 2 is a front elevational view partly in section of the tube drying apparatus.

Figure 3 is a side elevational view partly in section of the tube drying apparatus.

Figure 4 is a front elevational view partly in section of the tube coating apparatus.

Similar reference characters refer to similar parts throughout the several views of the drawings.

One of the most difficult problems in the process of applying a coating of luminescent material to the inner walls of a glass envelope has been the obtaining of a smooth, even coating free from streaks and of a uniform thickness at all points along the length of the glass envelope. By employing the method of my invention, the drying of the coating suspension on the walls of the glass envelope is controlled in a manner as to provide a smooth, even coating, free from streaks, mottling and uneven thickness along the length of the envelope.

It has been found that a solvent such as acetone is desirable as the vehicle in which to suspend the luminescent material in the coating of fluorescent lamps or tubing. Other organic vehicles well-known as nitrocellulose solvents may be used to disperse the powders. Those having a high solvent action, such as acetone, on nitrocellulose are desired for they give a lacquer of almost constant viscosity or consistency over a wide range of nitrocellulose concentration. This means that as the lacquer dries, there will result only a slight difference in viscosity. Poorer solvents such as alcohol or amyl acetate may be used but then a more viscous flow of the material results as it dries. Viscous flow is not preferred because rapid drying will produce a finished coating showing runs and/or streaks. A suspension having a low viscosity or consistency permits it to drain almost immediately from the tube and thus allow rapid drying in a short period of about a minute.

The air used to force the coating mixture up into the tubing is passed through an acetone saturation chamber before it enters the crock in which the coating mixture is kept. By thus causing the air to become substantially saturated with acetone before it comes in contact with the coating mixture, the acetone in the mixture will not, as would otherwise happen, vaporize under the influence of the air and thus change the powder concentration in the coating mixture. It is desirable that the powder to vehicle ratio in the coating mixture be kept within predetermined concentration limits, such as a specific gravity range between 2.17 and 2.34 for the fluorescent calcium tungstate phosphor of about .5 to 6 microns average with 28 microns maximum grain size in an acetone vehicle.

I suspend about 14,000 grams of powder, which may be, for example, a calcium tungstate phosphor in a medium of 5500 cc. of acetone, 56 grams of one-half second viscosity nitrocellulose containing about 30 per cent wetting alcohol, and 195 cc. of dimethyl phthalate, the latter being added as a plasticizer to keep the dried nitrocellulose film from peeling off the walls of the glass envelope when coated.

Final adjustment for the operating specific gravity of the total suspension is accomplished by additions of acetone to obtain a specific gravity in the range between 2.17 and 2.34, for the phosphor mentioned.

The amount of nitrocellulose may be varied to obtain the desired coating appearance. For example, if the amount of nitrocellulose be decreased by one-half, the above mixture would produce a coating having a rough or sandy appearance which may be useful such as in covering glass defects. Larger amounts, as about 50 per

cent more, will give a coating having a satin-like appearance whereas much larger amounts will produce comb marks.

The above composition is largely determined by the particle size and the surface character of the phosphor. For example, a smaller particle size of the calcium tungstate will require a smaller quantity of nitrocellulose and possibly a change in acetone content to produce a similar coating. Ratio of the liquids to the powder may be varied to give the desired coating thickness. The proportions given are preferred.

The amount of dimethyl phthalate is not critical. Twice the amount given changes the coating characteristics only slightly but results in condensation and difficulty in subsequent baking out of the organics in the coating. One-half the amount may be used satisfactorily. The primary function of the dimethyl phthalate is to keep the lacquered coating on the tube from drying completely which may result in peeling due to inflexible shrinkage of the film.

Other phosphors may be used. A different formulation is necessary for the various phosphors or their blends. The criterion of their formulation is analogous to that of the calcium tungstate.

Since there is air present in the bulb or tube about to be coated, I have provided a saturation chamber connected to the top of the tubing to be coated. Thus the air in the tubing will be forced up into this chamber by the column of coating mixture. When this column reaches the top of the tubing, the air pressure which forced it up into the tubing is released to the atmosphere and the column of coating mixture drops rapidly back into the crock due to its low viscosity.

When the suspension in the tubing drops, air substantially saturated with acetone, will be drawn into the tubing from the saturation chamber. If this air, rushing into the tubing as the column of coating mixture drops, were not substantially saturated with acetone, the top part of the tubing would dry very quickly due to the inrush of air on the quick-drying acetone and since the flow of the coating mixture would still be in turbulence, that is, an uneven, streamy flow, then its drying would result in forming a streaky or unevenly coated tubing near the top. The tubing is kept under this treatment until the flow along the whole tubing length has become sufficiently uniform so that the subsequent drying will not produce drain marks or waves or streaks appearing in the dried coating.

In Figure 1, the air line 1 is connected to the saturation bell-chamber 2 which is in turn connected to the crock or container 3 through the line 4. This crock contains the luminescent coating mixture which is to be applied to the glass tubing. The motor 5 mounted on top of the crock 3 has a shaft extending down through a substantially air-tight connection into the coating mixture. A small propeller is attached to the end of the shaft and is used to keep the coating mixture sufficiently agitated to prevent the luminescent powders from settling out of their suspension in the acetone. Line 6 extends from the lower section of the crock 3 up through the trough 7 to the rubber stopper connection 11 in which the tube 8 to be coated is mounted. The exhaust line 9 and the hand pressure control 10 are connected to the air line 1.

When the tubing 8 is to be coated, it is placed in the rubber stopper connection 11, thus placing it in a position to be in contact with the coating mixture in the crock 3. The air which flows through line 1 enters the saturation bell chamber 2 where it becomes substantially saturated with acetone. This air then passes through line 4 into the crock 3. The control of this air which forces the coating mixture up line 6 and up into the tubing 8 is maintained through the hand pressure control 10. Thus the operator can control the air, substantially saturated with acetone, which enters the crock 3 to force the coating mixture up into the tube 8 to the desired height.

Since there is a certain amount of air in the tubing before the coating mixture is introduced therein, the coating mixture, as it moves up the length of the tubing will force the air up through the funnel 12 and line 13 and into the saturation chamber 14. The nature of this chamber is such that it causes this air to become substantially saturated with acetone. Thus, after the coating mixture has reached the top of the tubing 8, the air pressure into the crock 3 is released and the column of coating mixture in the tubing drops back into the crock. When the mixture drops, air will be drawn down into the tubing from the saturation chamber 14. Since this air is substantially saturated with acetone, little or no drying of the coating deposit, left on the walls of the tubing by the flushing, will take place. This condition is desirable, for drying is thereby prevented until the turbulent flow of the coating has ceased and a smooth, uniform flow takes place. The length of time required for drying is determined by visual inspection aided by the fluorescent lamp 30 mounted on the rack directly behind the tubing or by trial and is of the order of about ten seconds. By keeping the air entering the tubing substantially saturated with acetone until most of the drainage has taken place, the tubing has become sufficiently drained to dry.

The tubing is then placed on the drying rack 15 as shown in Figures 2 and 3. On the rim of the trough 7 is the vent 25 leading to the exhaust chamber 31 which is connected to the exhaust duct 32 for the purpose of drawing off any fumes from the coating mixture as it drains from the tube. Draining from the tube may be salvaged in the container 33 connected through line 34 to the trough 7. This rack 15 consists of a frame on top of which the static pressure chamber 16 is mounted. Air is introduced into this chamber through the air duct 17 and may be controlled by the damper 18. In order to prevent turbulence and venturi effects and to obtain a static pressure in the chamber 16, one or more finely meshed screens 19 may be used, thus giving a steady, evenly diffused flow of air of uniformly parallel velocity and direction downward into the tubes and resulting in a uniform drying of the tube. If too much air is allowed to pass through the tubing being dried, the coating near the bottom of the tubing will be too thick and if too little air is used, the coating near the bottom will be too thin and may even flow out considerably. However, if it is found that even when the coating is drying at about the same rate at all points along the entire length of the tubing it is still too thick, then the coating mixture is thinned out with acetone. If it is too thin, less acetone should have been used in the coating mixture and it must then be concentrated by drying or addition of powder or strong powder suspension.

Figure 4 shows the saturation bell chamber 2, the crock or container 3, and the saturation chamber 14 in section. These two saturation

chambers may take various forms and may be of different types, for example a bellows type instead of a bell chamber may be used. The bell chamber **2** encases a series of concentrically wound wicks partially immersed in acetone. When the air passes through the chamber **2** from the air line **1** to the line **4** leading into the crock **3** it becomes substantially saturated with acetone. There are three petcocks on this chamber, petcock **21** being for filling purposes, petcock **22** being for draining purposes and petcock **23** being used to gauge the height of the acetone in the chamber. A glass visual gauge may be used instead of these petcocks.

The propeller **20** in the crock is very small in order to avoid the generation of heat in the coating mixture as a result of its motion. This propeller is used to keep the luminescent particles in suspension. It should turn in a direction such that the liquid is driven to the bottom of the crock, to mix again with the powder which has settled out.

The chamber **14** contains a quantity of acetone and a wick **24**. The gauge **26** acts as a means of determining the height of the acetone in the chamber. Although I have used this type of chamber, any chamber which will substantially saturate the air and be adaptable to my method may be used.

Although air has been used in forcing the coating mixture up into the tube to be coated, other suitable gases may readily be used. Although the exhaust duct **32** connected to the vent **25** in the trough **7** is used to draw off fumes from the coating, it has been found that since these fumes and gases are heavier than air, this exhaust arrangement may be used to obtain the proper drying of the coating on the tube.

What I claim is:

1. Apparatus for coating the inner surface of glass tubing with a luminescent coating mixture said apparatus comprising: a source of air at high pressure; a saturation chamber connected to said source of air; a container for the luminescent coating mixture, said container being connected to said saturation chamber; a second saturation chamber in register with the top of the tube being coated; and a drying rack having a static pressure chamber mounted thereon and from which a steady, evenly-diffused flow of air is caused to be directed down into the tube to dry the coating of luminescent material therein.

2. Apparatus for coating the inner surface of glass tubing with a luminescent coating mixture, said apparatus comprising: a closed container for the luminescent coating mixture, said container having an inlet for air and an outlet for said mixture; a holder to keep the tube being coated in contact at its bottom with said outlet; and a saturation chamber in position to fit over the top of said tubing being coated.

3. Apparatus for coating the inner surface of glass tubing with a luminescent coating mixture, said apparatus comprising: a saturation chamber; a closed container for the luminescent coating mixture, said container having an inlet for air and an outlet for said mixture, said inlet for air being connected to said saturation chamber; a support to hold the tubing to be coated in register with said outlet; and a second saturation chamber in position to fit over the top of the tubing to be coated.

4. Apparatus for coating the inner surface of glass tubing with a luminescent mixture, said apparatus comprising: a saturation chamber; a closed container for the luminescent coating mixture, said container having an inlet for air and an outlet for said mixture, said inlet for air being connected to said saturation chamber; a support to hold the tubing to be coated in register with said inlet; a second saturation chamber in position to fit over the top of the tube to be coated; and a drying rack comprising a static pressure chamber mounted thereon and from which a steady, evenly-diffused flow of air is caused to be directed down into the tube to dry the coating of luminescent material therein.

5. Apparatus for coating the inner surface of glass tubing with a luminescent coating mixture, said apparatus comprising: a closed container for the luminescent coating mixture, said container having an inlet for air and an outlet for said mixture; a saturation chamber connected to said inlet for air; and a support for tubing to be coated, in register with said outlet.

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