Aug. 4, 1964 W. C. MARTYNY 3,143,435

ROUND PANEL LAMP PHOSPHOR COATING

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Fig. 1.

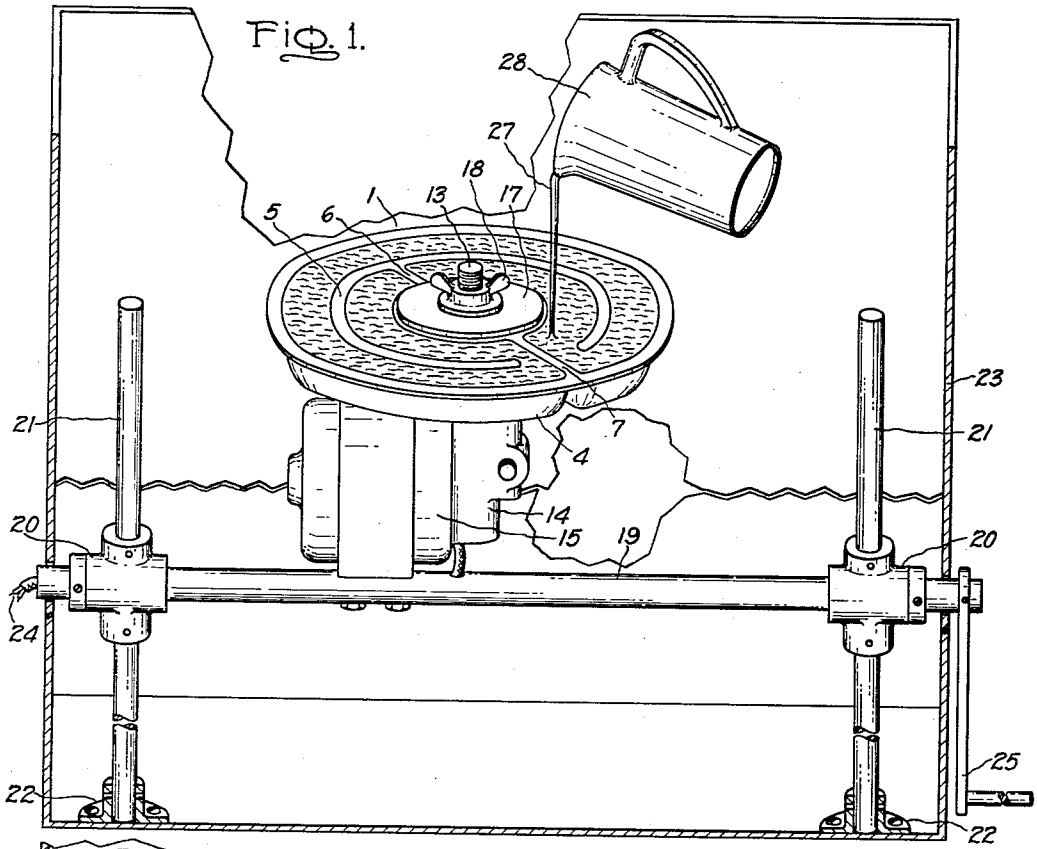

Fig. 2.

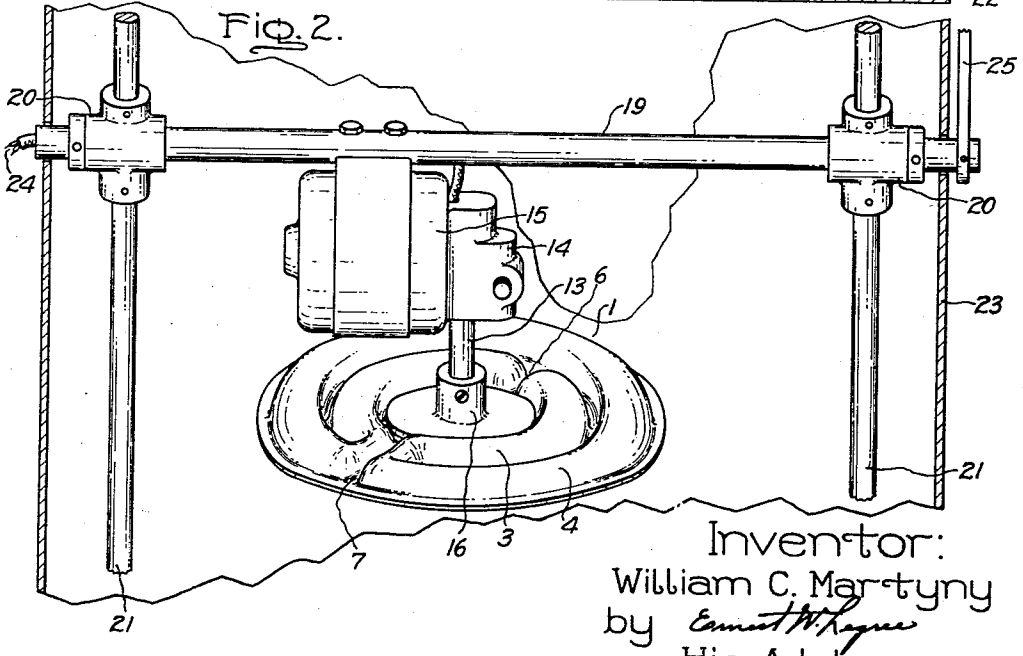

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Fig. 3.

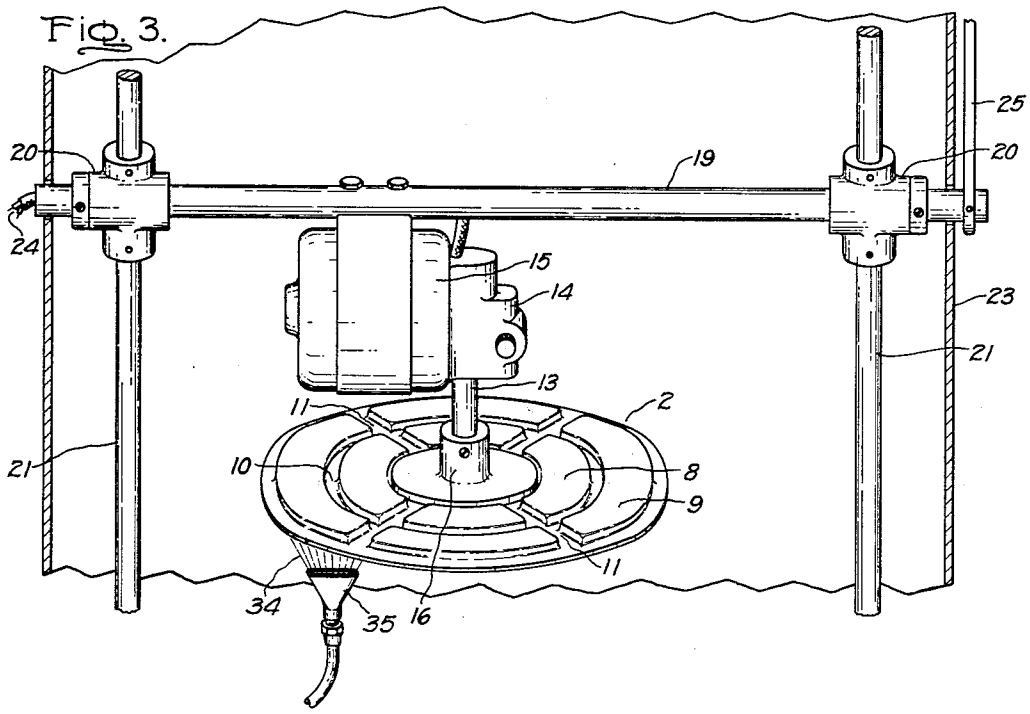


Fig. 4.

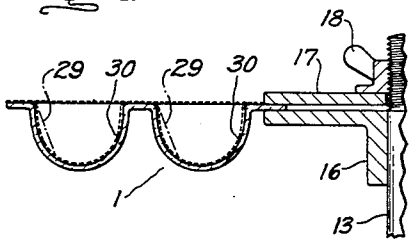
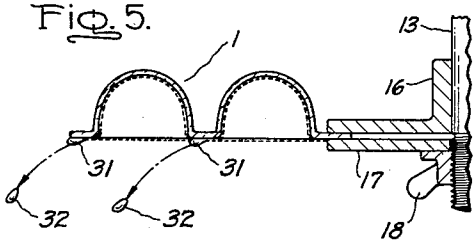


Fig. 5.



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ROUND PANEL LAMP PHOSPHOR COATING

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Filed Jan. 5, 1962, Ser. No. 164,523
4 Claims. (Cl. 117—33.5)

This invention relates to a process for applying the phosphor coating in a round fluorescent panel lamp.

Fluorescent panel lamps achieve compactness by providing a discharge path as a labyrinthine channel between two vitreous components sealed together along their margins. In a round panel lamp, the components are circular or disc-like complementary molded glass plates; in apertured round panel lamps, both plates have a circular hole in the center and are sealed together at their inner and outer peripheries. Generally, it is intended that only the faceplate be exposed to view, the channelway is therefore molded in the backplate and consists of concentric grooves separated by a circular partition, radial partitions being also provided where the discharge passes from one groove to another. The face plate is in general planar but for greater strength and better appearance is provided with a pattern of shallow embossments in the from of circular segments overlying the groves in the backplate.

The panel lamp, like any fluorescent lamp, is coated internally with a phosphor. Visual appearance therefore depends in large part on the quality and uniformity of the phosphor coating. When conventional flow coating is attempted, objectionable flow patterns and streaks, due to the circular and radial ridges in the plates, occur as the excess coating drains off. With spray coating, the phosphor does not adhere properly unless a heavy wet coating is applied which again entails flow patterns and streaks.

The object of the invention is to provide a process for applying a phosphor coating to the circular plates of a round fluorescent panel lamp which will achieve a smooth even coating free of streaks and unsightly flow patterns.

Another object is to provide a coating process which is rapid, convenient, and easy to practice.

In accordance with my invention, the plates of a round panel lamp are phosphor coated prior to sealing together by flow coating with centrifugal throw-off of the excess.

In a process embodying the invention and suitable for small scale production the plate is mounted horizontally, concave side up, on a vertical spindle and coating suspension is poured on the plate so as to cover the entire surface. Excess coating is then thrown off radially by spinning the plate and in this way no visible drain marks occur. Residual excess coating is disposed of by overturning the plate so that the depressions face down and spinning at a lower speed; the coating is dried by blowing hot air upon the plate as it spins. Plates coated in this manner have remarkably good coating appearance due to the rapid removal of the excess coating by radial flow. The coating is substantially free of objectionable flow patterns or streaks and adheres well.

For large scale production, it is preferable to support the plate horizontally with the concave side down. A jet or spray of phosphor is directed from below up against the underside of the spinning plate, the jet is cut off, and the spinning continued until the excess is thrown off.

For other features and for further objects and advantages of the invention, attention is now directed to the following description of a preferred coating process in accordance with the invention, to be described in conjunction with the accompanying drawings. The features of the invention believed to be novel will be more particularly pointed out in the appended claims.

In the drawings:

FIG. 1 illustrates pictorially the backplate of a round panel lamp mounted concave side up and being filled with phosphor.

FIG. 2 illustrates the backplate turned concave side down and spinning while drying.

FIG. 3 illustrates the faceplate being sprayed with phosphor while spinning concave side down.

FIGS. 4 and 5 are fragmentary sectional views through the backplate showing the phosphor suspension remaining at various stages of the process.

Referring to the drawings, there is shown at **1** in FIGS. 1 and 2 the backplate of a round fluorescent panel lamp. By way of illustrative example, the plate may be approximately 12" in diameter. The complementary faceplate is shown at **2** in FIG. 3. Both plates are disc-like sheets of glass with a circular opening in the center. To make a lamp, they are joined together, while maintaining the orientations in which they are illustrated in FIGS. 1 and 3, by sealing along their inner and outer peripheries. The backplate is molded to define, in cooperation with the faceplate, a labyrinthine discharge channelway by means of two concentric grooved channels **3**, **4** with a circular ridge or partition **5** in between. In the assembled lamp, the electrodes are mounted on opposite sides of a partition **6** which extends across the inside channel only. On the diametrically opposite side of the lamp, an internal partition **7** extends across both channels and causes the arc or discharge to curve around the ends of circular intermediate partition **5** between inner and outer channels. The course of the discharge may be generally described as a half circle counterclockwise through the inner channel from radial partition **6** to radial partition **7**, a full circle clockwise through the outer channel back to the other side of partition **7**, and then a half circle counterclockwise through the inner channel back to the opposite side of partition **6**. The face plate **2** is provided with a pattern of shallow embossments in order to improve the appearance and increase the strength of the plate. The embossments extend circularly in the form of inner and outer rings **8**, **9** separated by a circular land **10** and divided into quadrants by radial lands **11** which extend from inner to outer peripheries. In the assembled lamp, circular land **10** in the faceplate overlies circular partition **5** in the backplate, and likewise a pair of radial lands **11** overlie radial partitions **6** and **7**. Both plates are coated internally with a phosphor which converts the ultraviolet radiation produced by the low pressure mercury vapor discharge within the lamp into visible light.

In order to phosphor coat the backplate, it is supported horizontally, concave side up, on a spindle or arbor **13** adapted to rotate on a vertical axis. Spindle **13** projects from a reduction gear box **14** integral with an electric motor **15**. The backplate is supported on the spindle by clamping its inner rim between a hub **16** fast to the spindle and a plate **17** which is clamped down by a wing nut **18** screwed on the threaded upper end of the spindle. Conveniently, the motor may be attached to a hollow horizontal shaft **19** which is supported in bushings **20** clamped to a pair of vertical rods or standards **21** mounted on flange plates **22**. All the apparatus is located within a water tight enclosure, suitably a stainless steel box **23**, in order to catch any splash or overflow liquid. The ends of the hollow shaft **19** project out of the box through suitable apertures. Electrical conductors **24** for energizing the motor are brought out at one end of shaft **19**. At the other end of the shaft, a crank handle **25** is provided by means of which the shaft may conveniently be rotated to turn the motor over in order to hold the backplate or faceplate upside down.

In practicing the process, prosphor suspension **27** is poured into the backplate while it is stationary and right side up, that is concave side up, conveniently from a

beaker **28** as illustrated in FIG. 1. Suspension is poured in until the plate is filled and the excess overflows into the box **23**. For the purpose of the present invention, the kind of phosphor used or the type of binder in which it is suspended is not important. The phosphors most commonly used are calcium halophosphates activated with manganese or antimony. For the suspension, I prefer to use a water-soluble binder consisting of an ammoniacal aqueous solution of the copolymer of methyl vinyl ether and maleic anhydride (PVM/MA) and of polyacrylic acid (PAA), as disclosed and claimed in my Patent 3,006,-781, Phosphor Coating Method, issued October 31, 1961. However other binder solutions or suspensions may be used, such as for instance the nitro binders which until recently have been widely used in fluorescent lamp manufacture and which consist of a solution of nitrocellulose in butyl acetate.

The motor is then switched on and as the plate begins to spin, the excess coating is thrown off radially into the stainless steel box **23**. In the throw-off, the phosphor solution washes over the internal partitions and the outer rim of the lamp, leaving practically no drain marks. There may occasionally be a rather inconspicuous pattern of drain marks but the direction is radial, that is like the spokes of a wheel so that even where noticeable, they are not objectionable in appearance. The speed of rotation is gradually increased until only a very slight pool of phosphor remains in each groove in the form of a shallow ring, indicated at **29** in FIG. 4, supported at an angle against the outside wall in the grooves as a result of the combined effect of centrifugal force and gravity. The quantity of suspension remaining pooled in the lamp at this point is not critical but it should be less than 20% of the original volume. In general, satisfactory results are obtained when 5 to 10% of the suspension remains pooled in the grooves; for a 12" diameter round lamp, this occurs with a speed of rotation of approximately 250 revolutions per minute. It will be appreciated that by increasing the speed of rotation sufficiently, all the excess coating could be thrown off; however this is undesirable because the coating would then be too thin at **30** on the inside walls of the grooves.

The speed of rotation is now reduced to a relatively low value, for instance 50 revolutions per minute and, using the crank **25**, the motor and spindle are pivoted over to turn the plate upside down as illustrated in FIG. 2. The residual excess coating which had pooled along the outer walls of the grooves now flows out and may cling and thicken along the faces of the circular partition and outer rim as indicated at **31** in FIG. 5. Drops **32** of coating may also break off from these thickenings. However the flight of the drops is out and down as indicated by the curving dotted line arrows so that such drops fly clear of the lamp and do not leave any drain or flow marks. The reduced speed rotation of the lamp at this stage need only be sufficient to assure that the minor poolings of phosphor which remained after the higher speed right side up spinning, flow out in a radial direction. Since the flow is radially out and down at this stage, a much lower speed of rotation suffices. A hot air drier may now be turned on to direct a flow of hot air against the plate; rotation at the reduced speed is preferably continued until the phosphor coating is completely dry and set.

To coat the faceplate, the same procedure may be followed as is used for the backplate. The plate is mounted on the spindle concave side up so that the embossments now appear as shallow depressions and the lands appear as ridges. Phosphor suspension is poured on the plate to overflowing, the motor is switched on, and excess phosphor is thrown off radially. The speed of rotation is increased until just a slight pooling of phosphor remains in the hollows along the outside edges of the embossments, that is along the inside of any circular ridges. The speed of rotation is then reduced and the motor turned over to support the plate upside down as

illustrated in FIG. 3. The minor poolings of phosphor run out along the faces of the outer rim and of the ridges corresponding to lands **10**, **11**, with drops of the excess flying off as previously described, until the phosphor coating is dried and set by hot air flow.

For large scale production, it is desirable to avoid overturning the plates. This may be done by mounting the plate concave side down on a vertical spindle, as shown in FIG. 3 for the faceplate. A stream of phosphor suspension, suitably a fan-shaped jet **34** issuing from a nozzle **35**, is directed upwardly against the underside of the plate while it is spinning. Alternatively, a heavy spray may be used, that is, one producing a wet coating which will flow. Whether jet or spray, the volume of liquid reaching the plate must be in excess so that flow of the liquid along the glass surface, as a result of centrifugal force, occurs. This is necessary in order to achieve good adherence of the phosphor. The jet or spray is then cut off, and spinning of the plate continued long enough to throw off the excess suspension. Preferably spinning is continued while a flow of hot air is directed against the plate and until the phosphor coating is dry and set. The spinning of the plate is desirably at a speed adequate to cause the excess suspension to flow off without forming thin areas. In general, a suitable speed for this particular lamp will be intermediate the high and low figure previously given.

Prior to assembling the two plates together to form a lamp, the phosphor is wiped off the inner and outer rims since the glass must be fused together at these places to form a hermetic enclosure. Along the internal junctures between the partitions **5**, **6** and **7** in the backplate and the flat areas or lands **10**, **11** between embossments in the faceplate, sealing of the glass is not necessary. The surfaces are merely pressed together into close conformance and this is sufficient to prevent the electric discharge from leaking through and to constrain it to follow the labyrinthine channel through from end to end. It is also desirable to have the faceplate of the lamp appear substantially uniformly white throughout, that is inclusive of the area of the lands. Therefore the practice which I prefer to follow is to wipe off the excess phosphor from the faces of the partitions in the backplate but to leave it on the ridges corresponding to the lands in the faceplate. This avoids an excessive thickness of phosphor between the glass surfaces at the junctures, and at the same time provides a faceplate with a uniformly white appearance throughout.

Plates of round panel lamps coated in accordance with my invention have remarkably good coating appearance which appears to be due to the rapid removal of the excess coating through an even radially directed flow. Attempts have been made to spray the phosphor coating onto the plates without flow, and I find that the coating adheres much more tenaciously when applied by the process of excess coating and spinning off as described herein. I believe that the better adherence results achieved by my method are due to settling and packing of the phosphor particles onto the glass surface from out of the suspension. This can only occur if the coating suspension is present in excess, a condition which cannot be achieved with conventional spray coating.

The specific examples of a process in accordance with my invention which have been described in detail are intended by way of example only and not in order to limit the invention thereto. Modifications and variations in detail will readily occur to those skilled in the art and it is intended by the appended claims to cover any such as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A process for phosphor coating a vitreous plate of a round fluorescent panel lamp having circularly extending concave depressions therein separated by circular and radial ridges which comprises supporting the plate

concave side up, flowing a phosphor suspension over the plate, spinning the plate to throw off the major part of the excess phosphor suspension by radial flow, overturning the plate, and spinning it at reduced speed concave side down to allow the residual excess phosphor to flow out of the depressions, and continuing the spinning at reduced speed while drying the coating.

2. A process for phosphor coating a vitreous plate of a round fluorescent panel lamp having circularly extending depressions therein with circular and radial ridges therebetween which comprises supporting the plate horizontally concave side up, filling the plate with a phosphor suspension to overflowing, spinning the plate to throw off the major part of the excess phosphor suspension by radial flow, reducing the speed of rotation to a substantially lower value, overturning the plate to concave side down, spinning at said lower speed to allow the residual excess suspension to flow out along said ridges with part of the remaining excess being cast off as drops flying radially out and down, and continuing the spinning at said reduced speed while directing a flow of warm air against the plate in order to dry and set the coating.

3. A process for phosphor coating the surface of a vitreous plate of a round fluorescent panel lamp having depressions therein which comprises supporting the plate horizontally concave side down, directing a stream of phosphor suspension upwardly against the surface of the

plate to provide a quantity exceeding the amount which will adhere thereto, spinning the plate on a vertical axis to throw off the excess phosphor suspension by centrifugal force causing flow of suspension along said surface and drying the coating.

4. A process for phosphor coating a vitreous plate of a round fluorescent panel lamp having circularly extending depressions therein with circular and radial ridges therebetween which comprises supporting the plate horizontally concave side down, directing a stream of phosphor suspension upwardly against the lower surface of the plate while spinning the plate to throw off the excess by radial flow, cutting off the stream of phosphor and continuing the spinning to throw off any excess remaining, and directing a flow of warm air against the plate in order to dry and set the coating.

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