July 8, 1947. C. S. SZEGHO 2,423,626

METHOD OF MANUFACTURING SCREENS IN CATHODE RAY TUBES

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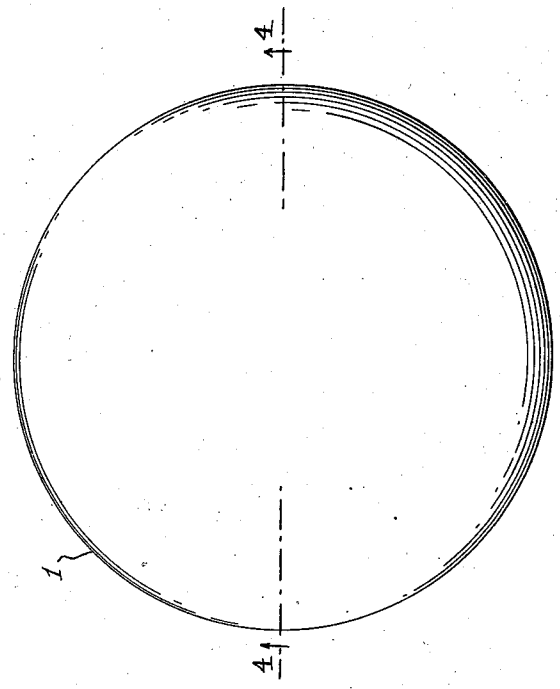


Fig. 3.

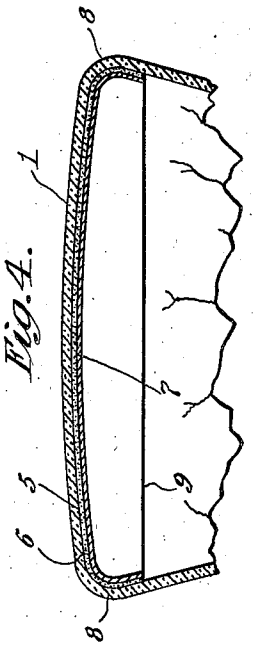


Fig. 4.

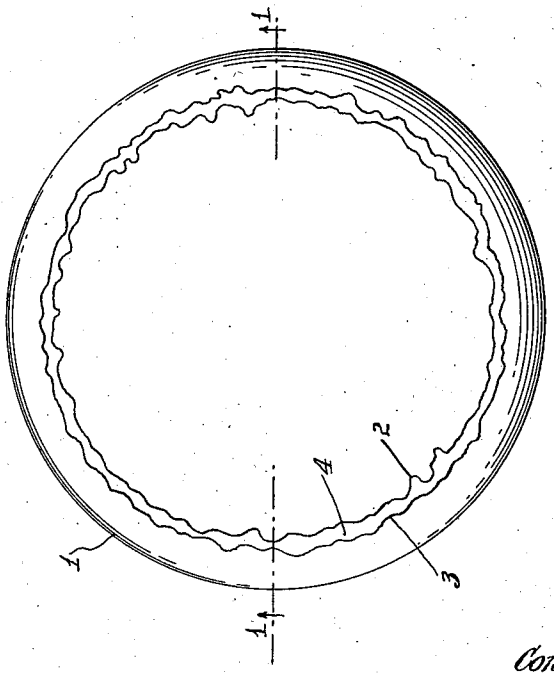


Fig. 1.

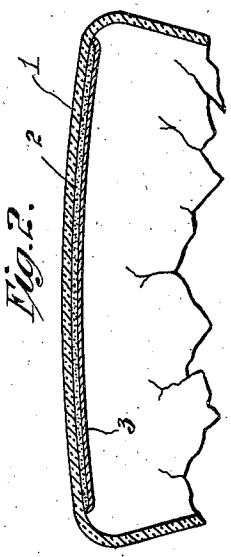


Fig. 2.

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METHOD OF MANUFACTURING SCREENS IN CATHODE-RAY TUBES

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Application May 20, 1944, Serial No. 536,628

1 Claim. (Cl. 117—33.5)

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This invention relates to an improved method of manufacturing fluorescent screens which are particularly useful in cathode ray tubes.

Neither the surface nor the inside of screens are sufficiently uniform for best results. This defect is particularly noticeable in multi-layer screens since the characteristics of one layer are not only dependent upon the layer itself, but also upon the characteristic of a supporting base layer or a supported top layer, which are apt to multiply the defects of an individual layer to an intolerable extent.

For example, multi-layer screens often have ragged edges, presumably caused by insufficient and uncontrolled adherence of the base screen layer. This deficiency also affects the settling of a second layer to be supported by the base layer. This unfavorable effect is not limited to the edge portions but extends to the center portions of the screen as well. The sagging effect tends to be gradual and causes an uneven distribution of the powder, even on portions which are not close to the already damaged edge section of the screen.

Ragged edges are believed to be caused by uneven or uncontrolled settling of the fluorescent powder on the curved portions of the envelope of the tube. This effect is less noticeable in relatively small screens which have only slightly curved surfaces, insuring even settling of the powder. However, adverse effects may be obtained in tubes carrying relatively large screens which are sharply curved, particularly at the rim. The edge portions of such large screens are usually found to be undefined in size and of uneven quality. The effective or useful diameter of the screen may thus be reduced by as much as three inches. In a twelve-inch tube this would cause a loss of almost 50 per cent of useful screen surface.

This invention avoids these drawbacks and permits an almost complete exploitation of the screen surface. The quality of the entire screen is enhanced and its manufacture is facilitated.

The object of the invention is to prepare the glass surface of the tube envelope in such a way that the fluorescent powder will settle evenly, even on steeply curved surfaces.

In order to achieve this object, an extremely thin binder layer is produced on the glass surface to be screened. Such a binder layer may be applied in accordance with my copending application Serial No. 481,072, filed March 30, 1943.

The glass surface reserved for the screen usually consists of a circular relatively flat center portion surrounded by an annular relatively curved rand portion. According to the invention, the thin binder layer should be applied to cover both these portions evenly.

The binder layer may be applied by pouring binder solution into the tube and removing it after wetting the surface to be screened. The

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excess solution is usually poured out. The inventor prefers, however, to suck it out which is simpler and increases the definition of the rand portions of the screen. This process also lends itself easily to automatic operation. Portions of the tube not affected by the screen remain clean.

Upon the film thus produced, fluorescent powder is applied which is firmly held by the layer and forms a first screen. With this screen as a base, a second screen is formed by means of a settling process.

The settling process is known in the art as well as the settling solutions and the fluorescent powders used therein.

This invention has for its object to apply the settling process to large screens and, in particular, to curved screen surfaces, without wasting any portion of the available glass surface.

The second fluorescent screen may have the same or different characteristics as the first screen. In the first case a composite single layer screen is obtained which consists of a partial screen represented by the base layer and a complementary screen of the same characteristics represented by the settled top layer.

In the second case a multple layer screen is produced which consists of a first or base screen and a second or top screen of different characteristics.

The two fluorescent powders used, whether of the same or of different characteristics, may also have different grain sizes and be of different thickness. Preferably, the second powder should have a finer grain than the first powder while the first powder layer may be made heavier than the second powder layer.

The settling process may consist of filling into the tube a settling solution such as a solution of water glass.

According to this invention, the settling solution forms a liquid column covering both relatively flat and relatively curved portions of the glass surface to be screened. Care should be taken to cover at least part—and preferably not more—of that portion of the glass surface carrying the extremely thin binder layer to which the first powder has been applied. Preferably the extension of the first screen should, as far as practically possible, coincide with the extension of the surface covered by the liquid column of the settling solution.

The settling solution may contain the second powder before it is poured in. Under circumstances which depend among others on the concentration of the settling solution, the second powder may be applied to the settling solution after the solution has been poured into the tube.

After sufficient powder has settled through the settling solution, this solution, instead of being poured out, is sucked out, whereby the unscreened

portions of the tube remain clean. Additional cleaning is avoided and the settling process may easily be mechanized without the use of turn tables and other complicated equipment. Since the settling solution may attack the glass where it is unprotected by the base screen, any damage to the glass surface of the tube is eliminated; the danger of impurities and of evacuation difficulties is reduced.

The settling conditions and the screen characteristics may be influenced by proper selection of the settling solution, its concentration and specific density, and by the grain size of the powder as is well-known in the art, without exceeding the scope of this invention and without limiting the invention to any particular settling solution or procedure.

A specific method consists of applying a thin film of an acid, e. g. phosphoric acid binder solution as described in my said copending application. Such a solution is probably adsorbed by the glass section to be screened, without attacking the glass. Thus after evaporation of the solvent an extremely thin, firmly adhering base film is formed which extends uniformly over both flat and adjacent curved portions of the glass surface. The fluorescent powder is dusted on the film. After drying and, if necessary, baking, a strong and consistent base screen is formed.

Then a settling solution of water glass is introduced into the tube on top of said base screen. The second fluorescent powder may already be part of the settling solution before filling it in or it may be filled in separately after the solution has been poured in.

Other objects of the invention will become apparent to those skilled in the art as I proceed with the specification and the description of the drawings in which:

Fig. 1 is a front view of a double screen made in the conventional manner;

Fig. 2 is a cross section of Fig. 1, taken through 1—1 of Fig. 1;

Fig. 3 is a top view of a double screen made in accordance with the method of the invention; and

Fig. 4 is a cross section of Fig. 3, taken through 4—4 of Fig. 3.

In tubes of large diameter which usually have a curved bottom, the conventional settling methods do not yield a satisfactory screen because the powder runs down along the curved part of tube 1 and as shown in Fig. 1 forms a heavy ragged ring 4 on the outer edge of the screen layers 2, 3. The diameter of this heavy ring may be one inch or several inches smaller than the actual diameter of tube 1. In a twelve-inch tube the settled screen often has a diameter of only nine inches.

I succeed in settling a screen to the full diameter of a large curved bulb 1, as shown in Figs. 3 and 4.

This is done in the following manner: first, a substantially monomolecular layer of phosphoric acid is produced on the properly prepared glass surface in a manner such as described in my copending application. To this end a weak phosphoric acid solution is applied which, after evaporation of the solvent, shows regular interference rings. Then, in the manner described in my copending application, fluorescent powder is dusted upon this monomolecular layer 5. The first screen thus produced is then dried and baked. The quantity and characteristic of the powder may be such as to form a first screen 6

or such as to form part of a single screen the balance of which is settled in the manner to be described.

As a next step, a 6 per cent water glass solution in water or alcohol is filled into the bulb to cover both flat and curved portions of the tube up to the point to which it is desired to extend the screen, as indicated by line 9 in Fig. 4.

Then, a second fluorescent powder, or some more of the first powder is stirred into a small quantity of a 6 per cent solution of water glass which is poured into the settling solution through a spray uniformly directed towards the edges of the surface. The powder is then allowed to settle.

The water glass solution is then slowly sucked out and, when there is no solution left, warm air is introduced to dry the screen 7 which is afterwards baked in an oven.

The surprising result is that not only is the first layer of powder 6 completely uniform up to its edges but also the second powder does not run down and a uniform second screen 7 of very good grain and coverage results. The two layers coincide precisely. In the case of a twelve-inch tube, the two screens may extend well over one inch around the curved portion 8 of the glass vessel towards the neck of the tube (not shown). The edges of the screens not only coincide but are sharp and uniform.

The settling of the powder should preferably occur gradually, not suddenly, in order to achieve the utmost homogeneity in the screen structure.

Appropriate baking, heating, drying or cooling operations may be inserted, if required, after or before any step of the method disclosed without exceeding the scope of this invention. Baking after the dusting of fluorescent powder is particularly recommended. The temperature for baking depends to some extent upon the characteristics of the powder used and may be subjected to all types of variations without exceeding the scope of this invention.

What is claimed is:

In a method of manufacturing screens in cathode ray tubes, having a screen section which is relatively flat, the periphery of which flat portion is more sharply and annularly curved, the steps which include applying a weak solution of phosphoric acid binder on both the relatively flat and sharply curved portions of the screen section to form a tacky film of uniform thickness, said section including a circular relatively flat portion and an adjacent annular relatively curved portion, removing excess of said solution, dusting a first fluorescent powder, filling into the tube a settling solution to form a liquid column covering said section, said settling solution comprising a second fluorescent powder, allowing said second powder to settle on said section, and sucking out excess settling solution.

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