

## Description

### BACKGROUND OF THE INVENTION

#### Field of the Invention

The present invention generally relates to methods of manufacturing a cathode ray tube and, more particularly, is directed to an apparatus for injecting and recovering slurries in the process for making a phosphor screen.

#### Description of the Prior Art

When a phosphor screen of a color cathode ray tube is produced, so-called slurries, such as phosphor slurries of respective colors, carbon slurries, PVP photosensitive liquid, PVA photosensitive liquid or the like are injected into a panel in response to the respective processes, are uniformly coated on the whole surface of the panel, and then extra slurries within the panel are recovered.

In the prior art, as shown in FIG. 1, a panel 1 is located so as to face the inner surface thereof upwardly and a desired slurry 3 is injected through an injection nozzle 2 into the inner surface of the panel 1 (see FIG. 1A). Then, the panel 1 is rotated on its own axis (in the direction shown by an arrow a in FIG. 1B) so as to spread and coat the slurry 3 on the entire surface of the panel (see FIG. 1B). Thereafter, the panel 1 is revolved (in the direction shown by an arrow b in FIG. 1C) such that the corner portion of the panel 1 is faced downwardly to thereby exhaust extra slurry 3 from the panel 1 (see FIG. 1C). The panel 1 is then rotated on its own axis (in the direction shown by an arrow a) so as to urge the slurry of a desired film thickness to be coated thereon (see FIG. 1D). Thus, the coating process of slurry is finished.

According to a conventional method as disclosed by GB-A-2225157 the slurry is injected into the panel. Then, the panel is rotated on its own axis so as to spread and coat the slurry on the entire surface of the panel. Thereafter, the panel is revolved to thereby exhaust extra slurry from the panel. Furthermore, an apparatus for carrying out the above steps of the film forming method is disclosed.

#### OBJECTS AND SUMMARY OF THE INVENTION

It is an object of the present invention to provide an apparatus for forming a coating film on an inner surface of a panel of a cathode ray tube.

In accordance with the present invention, an apparatus is provided for forming a coating film on an inner surface of a panel of a cathode ray tube comprising a panel clamping apparatus for holding a panel of a cathode ray tube, a vertical revoluted robot, an injection nozzle for injecting a slurry into the inner

surface of the panel, a recovering hood for recovering therein an extra slurry, and a cleaning device for cleaning the inside of the recovering hood, wherein the panel clamping apparatus can automatically rotate the panel on its own axis and revolve the panel independently, and the vertical revoluted robot is of an exchangeable type which selectively utilizes at least the slurry injection nozzle, the slurry recovering hood and the hood cleaning means in response to a position signal supplied thereto from the panel clamping apparatus.

The above and other objects, features, and advantages of the present invention will become apparent from the following detailed description of an illustrative embodiment thereof to be read in conjunction with the accompanying drawings, in which like reference numerals are used to identify the same or similar parts in the several views.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A through 1D are respectively process diagrams showing an example of how to inject and recover the slurry according to the prior art;

FIG. 2 is a diagram showing an arrangement of a treatment apparatus to which the present invention is applied;

FIG. 3 is a plan view of the main portion thereof;

FIGS. 4A through 4E are respectively diagrams used to explain processes of a method of injecting and recovering slurry according to the present invention; and

FIG. 5 is a timing chart of the processes in which the slurry is injected and recovered by using the treatment apparatus.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In order to facilitate the understanding of this embodiment, an example of the process of making a color phosphor screen of a color cathode ray tube will be described. A PVP (polyvinyl pyrrolidone) photosensitive liquid is injected into the inner surface of a panel of a cathode ray tube to form a PVP photosensitive layer having a uniform film thickness. After being dried, the thus formed photosensitive layer is exposed by using a color selecting electrode as an optical mask and developed by a rinsing-process by water or the like to thereby form resist layers of strip patterns on the photosensitive layer at positions corresponding to respective colors. Then, a carbon slurry is injected into the whole inner surface of the panel including the resist layers to form a uniform carbon layer. After a dry-process, a reversing agent, e.g., hydrogen peroxide, is injected into the inner surface of the panel to dissolve the resist layers, and the resultant product is reverse-developed by the rinsing-process

by water (i.e., the resist layer and the carbon layer formed on the resist layer are both lifted off) to thereby form carbon stripes of a predetermined pattern, i.e., black stripes. Then, a PVA (polyvinyl alcohol) photosensitive liquid is injected into the panel to form a PVA photosensitive layer of a uniform film thickness. After the dry-process, the resultant layer is exposed in accordance with two colors of, for example, red and blue by using the color selecting electrode as the optical mask, and developed by the rinsing-process by water, thereby resist layers being formed on the resultant layer at its portions corresponding to two colors of red and blue. Then, a green phosphor slurry is injected into and coated on the panel, dried and then exposed in its outer surface from the front surface of the panel. In the next process, the reversing agent, e.g., hydrogen peroxide, is injected into the resultant product to dissolve the resist layer, and reverse-developed (i.e., the resist layer and the phosphor slurry on the resist layer are both lifted off) by the rinsing-process by water, thereby a green phosphor stripe being formed on the resultant product at its position between predetermined carbon stripes. In a like manner (external exposure, reverse-development and so on are performed), red and blue phosphor stripes are formed on the resultant product at its positions between other predetermined carbon stripes. In the next process, hot water is injected into the panel to raise a temperature of the panel, an intermediate layer is formed and an all metal backing layer is further formed, thereby a target color phosphor screen being formed.

In the following embodiment, the present invention is applied to the process for injecting phosphor slurries of respective colors into the panel and the process for recovering the slurries from the panel in the above process for producing a phosphor screen.

An embodiment of the present invention will hereinafter be described in association with the apparatus therefor.

FIG. 2 shows an apparatus 11 for injecting slurries and also recovering the slurries according to the present invention. FIG. 3 is a plan view illustrating a layout of a robot, an injection nozzle, a recovery hood cleaning sponge brush or the like of the above apparatus.

Referring to FIGS. 2 and 3, a treatment apparatus 11 is composed of a panel clamping device 13 for clamping the panel 1, a vertical revolute 6-axis robot 15, a slurry injection nozzle 17, a slurry recovery hood 19, a cleaning means for cleaning the inside of the recovery hood, such as a sponge brush 20 and a cleaning tank 16 in which the sponge brush 20 is washed and so on.

The panel clamping device 13 includes a clamping head 24 which substantially holds the panel 1 on the top of an arm 23 rotating intermittently, for example, about a main shaft 22 within the horizontal plane.

The clamping head 24 can make the panel 1 rotatable in the rotation direction (shown by an arrow a in FIG. 2) and in the revolution direction (shown by an arrow b in FIG. 2) by means of a rotation shaft 25 and a revolution shaft 26 and also clamps the panel 1 with its outside four sides.

The robot 15 is what might be called an exchangeable-type robot and is controlled by a computer so as to selectively exchange the injection nozzle 17, the recovery hood 19 and the cleaning sponge brush 20 so that the robot may be operated in accordance with the works of the respective processes.

The injection nozzle 17, the recovery hood 19 and the cleaning sponge brush 20 are respectively placed at predetermined positions on a temporary table as shown in FIG. 3. In FIG. 3, a chain line 30 shows an area in which the panel clamping device 13 is operable.

According to the method, the slurry will be injected and recovered by the above apparatus 11 as follows. FIG. 5 shows a timing chart of motions of respective parts.

As shown in FIG. 4A, the panel 1 is held by the clamping head 24 of the panel clamping device 13 so that the inner surface of the panel 1 is directed upward at a predetermined angle. Then, the injection nozzle 17 is clamped by the robot 15 and moved to the injection position at timing point  $t_1$  of FIG. 5. Thereafter, the injection of the phosphor slurry 12 into the panel 1 is started (at timing point  $t_2$  of FIG. 5). During the period when phosphor slurry 12 is being injected into the panel 1, the phosphor slurry 12 may be injected into the panel 1 while the injection nozzle 17 is being regularly translated (moved) in a scanning fashion. From timing point  $t_3$  after the injection of the phosphor slurry 12 into the panel 1 is started, the panel 1 is started to rotate on its own axis (at low speed). At timing point  $t_4$ , the injection of the slurry 12 into the panel 1 is finished and after the injection of the slurry 12 is ended, the injection nozzle 17 is returned to the predetermined position (on the temporary table) at which the clamping of the injection nozzle 17 by the robot 15 is loosened.

The panel 1 is continued to rotate about the rotation shaft 25 at low speed so as to uniformly coat the phosphor slurry 12 on the entire surface of the panel 1 as shown in FIG. 4B, and then the panel 1 stops being rotated on its own axis at timing point  $t_5$ .

Then, as shown in FIG. 4C, the recovery hood 19 is clamped by the robot 15 and moved to a desired position  $P_1$ , near the panel 1 (at timing point  $t_7$  of FIG. 5). Thereafter, the panel 1 is revolved about the revolution shaft 26 and the recovery hood 19 is moved in synchronism with the revolution of the panel 1 in an opposing relation to the inner surface of the panel 1, that is, the recovery hood 19 is moved along a locus shown by the positions  $P_1$  to  $P_6$  in synchronism with the revolution of the panel 1, thereby the extra phos-

phor slurry 12 within the panel 1 being fully recovered back into the recovery hood 19 (the recovery of slurry is started at timing point  $t_8$  and the recovery of slurry is finished at timing point  $t_9$ ). When the position of the recovery hood 19 is controlled, a rotational position information from a revolution AC servo mechanism (not shown) of the clamping head 24 is supplied to the robot 15 side, whereby the position of the recovery hood 19 is reproduced by the robot 15. At that time, the recovery hood 19 is moved so as to receive the panel 1 therein and substantially parallelly opposed to the panel 1 at the final revolution position  $P_5$  under the condition such that the panel 1 is inserted into the recovery hood 19 by a predetermined amount  $d$  (e.g., approximately  $d = 100$  mm).

Then, as shown in FIG. 4D, at the final revolution position  $P_5$  of the panel 1, the panel 1 is rotated about the rotation shaft 25 (at high speed) so that the phosphor slurry 12 of proper film thickness is coated on the panel 1 (the panel 1 starts rotating on its own axis at timing point  $t_{10}$  and stops rotating on its own axis at timing point  $t_{11}$ ). When the phosphor slurry is uniformly coated on the panel 1, a turbulence tends to take place within the recovery hood 19 so that slurries are spattered within the recovery hood 19, thus resultant slurry spray can be scattered to the panel 1 side. In order to prevent the occurrence of turbulence, the recovery hood 19 has through its rear surface formed an air escape hole 18 of a shutter configuration, whereby air is escaped from the inside of the recovery hood 19 through this air escape hole 18. Also, air flow 28 is produced by the absorption of air from the rear side of the recovery hood 19 to prevent the occurrence of turbulence, thereby preventing the spray of slurry from being scattered to the panel 1 side.

The slurry 12 recovered into the recovery hood 19 is returned to a recovery tank, not shown, and supplied to an ordinary slurry tank, and also supplied from this slurry tank to the injection nozzle 17, thereby being recycled.

After the film thickness of the slurry becomes proper, as shown in FIG. 4E, the recovery hood 19 is placed at the predetermined position (on the temporary table) (at timing point  $t_{12}$  of FIG. 5) and the cleaning means for cleaning the inside of the recovery hood 19, i.e., the sponge brush 20 is clamped by the robot 15 (at timing point  $t_{13}$  of FIG. 5) so as to urge the sponge brush 20 to contact with the inner circumferential side surface of the recovery hood 19. Also, the sponge brush 20 is moved along the inner circumferential side surface of the recovery hood 19 by the robot 15 to thereby clean the whole surface of the inner circumferential side of the recovery hood 19. After the inner circumferential whole surface of the recovery hood 19 is cleaned, the sponge brush 20 is cleaned in the cleaning tank 16 and then the sponge brush 20 is returned to the predetermined position (on the temporary table) (at timing point  $t_{14}$  of FIG. 5). The inner

circumferential side surface of the recovery hood 19 may be cleaned each time the slurry 12 is recovered (every time) or at the intervals in which the slurry 12 is recovered a plurality of times.

According to the above embodiment, when the panel 1 is revolved to recover the phosphor slurry 12 after the phosphor slurry 12 is injected into and uniformly spread into the panel 1, the recovery hood 19 is moved in an opposing relation to the panel 1 in synchronism with the revolution of the panel 1 (i.e., in such a manner as to insert the panel 1 into the recovery hood 19), whereby the phosphor slurry 12 can be recovered without being scattered to the surroundings, thus to reduce the contamination on the surroundings.

Furthermore, since the inner surface of the recovery hood 19 is cleaned by the sponge brush 20 each time the phosphor slurry 12 is recovered, the inner circumferential side surface of the recovery hood 19 can be prevented from being smudged by the slurry. Thus, when the film thickness of the slurry is made uniform, defects due to the splash of slurry can be alleviated.

Furthermore, since the recovery hood 19 can be positioned with large freedom by the robot 15 in accordance with the size of the panel 1, the phosphor slurry can be prevented from being scattered regardless of the kind of cathode ray tubes being coated when the phosphor slurry is recovered. In addition, when the phosphor slurry 12 is recovered and recycled, phosphor slurries otherwise scattered can be effectively utilized and saved, unlike the prior art.

When the phosphor slurry 12 is injected into the panel 1, the injection position of the slurry 12 by the injection nozzle 17 can be freely selected by the robot 15 in accordance with the kind of cathode ray tube being coated. In addition, since the injection nozzle 17 is regularly translated in a scanning fashion in injecting the slurry into the panel 1, the panel 1 having a small aspect ratio can be coated with a small amount of slurry, thus not only preventing the slurry from being scattered but also saving the slurry.

While the apparatus as described above is applied to the injection and recovery processes of phosphor slurry, it is not limited thereto but may be applied to the injection and recovery processes of carbon slurry, slurries of PVP photosensitive liquid, PVA photosensitive liquid or the like.

When the extra slurry of the slurry injected into the panel in the process of making the phosphor screen is recovered, the slurry can be prevented from being scattered to the outside. Therefore, the surroundings can be prevented from being smudged or contaminated by the slurry, and reliability in the manufacturing process can be improved.



## Claims

1. An apparatus for forming a coating film on an inner surface of a panel of a cathode ray tube comprising:

- a panel clamping device (13) for holding a panel (1) of a cathode ray tube, said device being able to automatically rotate said panel on its own axis and revolve said panel independently;
- an injection nozzle (17) for injecting a slurry into the inner surface of said panel;
- a recovering hood (19) for recovering therein an extra slurry;

characterized in that

the apparatus further comprises:

- cleaning means (20) for cleaning the inside of said recovering hood;
- a vertical revolute robot (15) being of an exchangeable type which selectively utilizes at least said slurry injection nozzle (17), said slurry recovering hood (19) and said hood cleaning means (20) in response to a position signal supplied thereto from said panel clamping device.

## Patentansprüche

1. Vorrichtung zum Herstellen eines Überzugfilms auf der Innenfläche einer Frontwanne einer Kathodenstrahlröhre, mit:

- einer Wannenklammvorrichtung (13) zum Halten einer Wanne (1) einer Kathodenstrahlröhre, wobei die Vorrichtung die Wanne automatisch um deren eigene Achse drehen und unabhängig davon die Wanne umkehren kann;
- einer Einspritzdüse (17) zum Einspritzen einer Aufschlämmung auf die Innenfläche der Wanne;
- einer Rückgewinnungshaube (19) zum Rückgewinnen überschüssiger Aufschlämmung;
- dadurch gekennzeichnet, daß die Vorrichtung ferner folgendes umfaßt:
- eine Reinigungseinrichtung (20) zum Reinigen des Inneren der Rückgewinnungshaube;
- einen Vertikalumkehrroboter (15) vom Wechseltyp, der wahlweise mindestens die Aufschlämmung-Einspritzdüse (17), die Aufschlämmung-Rückgewinnungshaube (19) und die Haubenreinigungseinrichtung (20) auf ein Positionssignal hin verwendet, das ihm von der Wannenklammvorrichtung zugeführt wird.

## Revendications

1. Un dispositif, pour former un film d'enduction sur une surface intérieure d'un panneau d'un tube à rayon cathodique, comprenant :

- un dispositif (13) d'agrippement de panneau, pour maintenir un panneau (1) d'un tube à rayon cathodique, ledit dispositif étant apte à tourner automatiquement ledit panneau sur son axe propre et pivoter ledit panneau indépendamment ;
- une buse (17) d'injection, pour injecter une pâte épaisse dans la surface intérieure dudit panneau ;
- une calotte (19) de récupération, pour récupérer en elle une pâte épaisse en excédent ;

caractérisé en ce que

le dispositif comprend de plus :

- des moyens (20) de nettoyage, pour nettoyer l'intérieur de ladite calotte de récupération ;
- un robot (15) de révolution vertical, étant d'un type échangeable, qui utilise sélectivement au moins : ladite buse (17) d'injection de pâte épaisse, ladite calotte (19) de récupération de pâte épaisse et lesdits moyens (20) de nettoyage de calotte, en réponse à un signal de position fourni à celui-ci à partir dudit dispositif d'agrippement de panneau.