

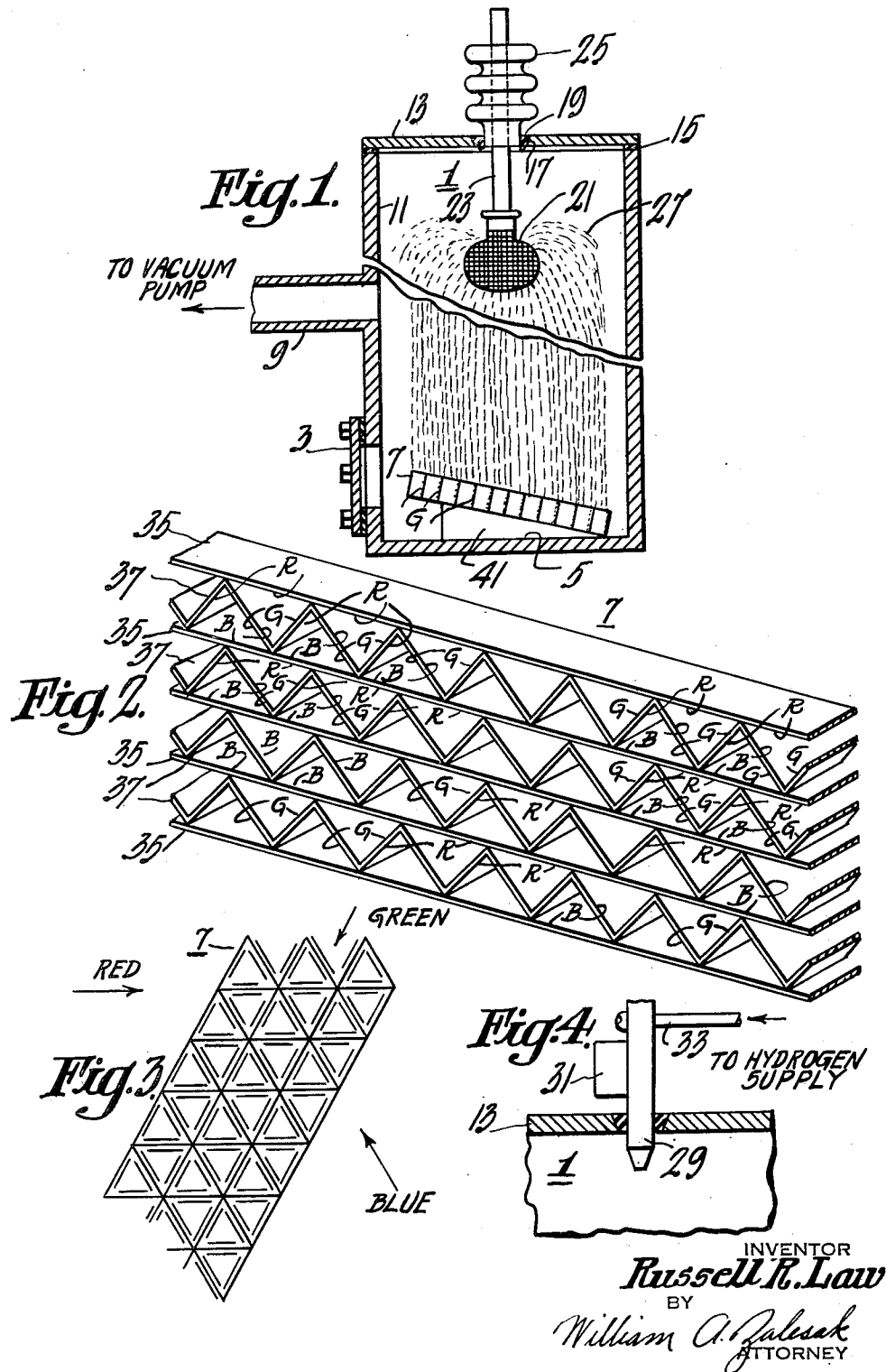
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R. R. LAW

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METHOD OF POWDER-COATING TELEVISION SCREENS

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METHOD OF POWDER-COATING
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4 Claims. (Cl. 117-16)

1

2

This invention relates to improvements in the art of applying electron-sensitive materials, in powder form, to the target areas or screen elements of color-kinescopes and other electron tubes.

In coating the target area of a cathode-ray tube with a fluorescent material the usual practice is to create a cloud of fluorescent material adjacent to the open end of the bulb and permit it to settle in the form of a powder upon the surface to be coated. The powder may be settled either from a dry cloud or a liquid suspension. (As to this, see Johnson 1,495,487, Fairbrother 2,152,991 and Gardner 2,221,474). Alternatively, the fluorescent material or materials may be sprayed on (as in French patent 866,965) or they may be applied by a printing process such, for example, as the "silk-screen" process (see co-pending Appln. Serial No. 158,901 of H. B. Law; now U. S. P. 2,625,734).

Irrespective of the advantages claimed for each of the above mentioned methods, it may be said, generally, that they do not lend themselves readily to the manufacture of the relatively complex types of screens used in some electronic color-television systems. Thus, while printing methods can be used in laying down even the most complicated color-phosphor patterns upon a plane and, indeed, upon a curved surface, they cannot be used in applying the same materials to three-dimensional screens, such, for example as the "honeycomb" screen described by Schroeder in co-pending application Serial No. 140,786 filed January 27, 1950, now U. S. P. 2,579,705 or the "miniature-pyramid" screens of Geer 2,480,848 and Goldsmith 2,481,839.

Conventional spraying methods require careful masking of the non-sensitized areas, and this is not commercially practical in all types of screens. Furthermore, it is difficult to provide a phosphor coating of uniform thickness when a conventional spray-gun method is used. Settling from a liquid suspension is commonly used in the manufacture of conventional (i. e. "black and white") kinescopes and oscilloscopes. However, because liquids "run" this method cannot be used in making tri-color targets or screens.

In attempting to apply the conventional "powder-cloud" method to the manufacture of angular-face screens it was observed that the phosphor particles did not fall in straight lines but exhibited "falling leaf" motions, fluttering downwardly with a forward and backward oscillating motion. As a result, the particles frequently settled upon areas other than the ones

upon which they were intended to settle. It might appear that this difficulty could be overcome by making the phosphor particles so small that the amplitude of the fluttering motion becomes negligible. In practice, however, it was found that when the particles were made very small they were subject to Brownian movements which, in some cases, were so violent as to prevent the particles from settling.

Accordingly, the principal object of the present invention is to obviate the foregoing and other less apparent objections to present day methods of depositing powdered electron-sensitive materials.

Another important object of the invention is to provide an improved powder-depositing method and apparatus which shall lend themselves readily to the manufacture of cellular and other angular-faced electron-sensitive screens.

The foregoing and related objects are achieved in accordance with the method of the present invention by establishing a highly attenuated gaseous ambient or partial vacuum about the foundation surface to which the electron-sensitive material is to be applied, and then creating a cloud of the powdered material in said ambient above the level of said surface and permitting the powdered material to settle upon said surface through the attenuated ambient. The attenuated ambient may comprise air or a lightweight gas, such as hydrogen. When the pressure of the ambient is of the order of 0.1 of a millimeter of mercury the "falling leaf" and Brownian movements characteristic of powder in falling in air at atmospheric pressure, are absent and, as a consequence, the powder is deposited with a nice degree of accuracy upon the areas which were intended to be sensitized.

The invention is described in greater detail in connection with the accompanying drawing, wherein:

Fig. 1 is a vertical sectional view of an evacuable chamber containing a mechanism, with an external control, for creating a powder cloud which settles upon a "target surface"; here shown as supported at an angle with respect to the horizontal on the base of the chamber;

Fig. 2 is an enlarged view in perspective of a cellular type kinescope-screen having angularly disposed faces capable of being coated or sensitized in the chamber of Fig. 1; and

Fig. 3 is an end view of the screen of Fig. 2, the drawing being marked with arrows to indicate the orientation required to activate its different angular faces, and

Fig. 4 is a fragmentary view of the top or lid of the chamber of Fig. 1 showing an alternative type of cloud-making device.

In the drawing, 1 designates, generally, an evacuable chamber, say 10 feet high, having a vacuum tight door 3, adjacent to its base 5, through which the object 7 to be sensitized may be admitted, and withdrawn from, the chamber. A port 9 in the side wall 11 of the chamber 1 will be understood to be connected to a pump (not shown) capable of establishing a vacuum of the order of 0.1 millimeter of mercury within the chamber. The top of the chamber preferably comprises a removable lid 13 which is rendered vacuum tight by a suitable gasket 15. The lid is provided adjacent to its center with an aperture 17 and a removable stopper or plug 19 for the aperture. The plug 19 serves as a support for a powder dispenser which, in Fig. 1, takes the form of a porous bag 21 supported upon a rod 23 which extends through the plug 19 and through a flexible air-tight seal, exemplified by the metal bellows 25. The flexible seal 25 about the rod 23 permits the bag 21 to be shaken to release the powder in the form of a cloud 27, without breaking the vacuum in the chamber 1. The shaking force may be applied to the bag 21 through the rod 23, either manually or mechanically. Alternatively, as shown in Fig. 4 the powder dispenser may comprise a spray-gun 29 which, in the instant case is fed from a reservoir 31 containing a liquid (e. g. acetone) suspension of the powdered phosphor, or other electron-sensitive material, and is actuated by a stream of air or of hydrogen gas supplied to the gun through a hose 33.

It is advantageous to employ hydrogen for the spray gun, rather than air, because hydrogen pumps-out more readily than air and a somewhat higher pressure (e. g. 0.3 millimeter of mercury) of hydrogen can be tolerated in the chamber than any other gas. The low viscosity of hydrogen may account for the fact that it pumps-out so easily and for that fact the powder particles fall more readily than in air.

The absence of any "falling-leaf" and Brownian movements in the powder particles while falling in an attenuated gaseous ambient, permits the method and apparatus of the present invention to be used in applying phosphor materials even to the most complex forms of tri-color phosphor target electrodes. The particular three-dimensional, cellular type of tri-color target electrode 7 shown in Figs. 1, 2 and 3 is similar to the one described and claimed by D. A. Jenny in co-pending application Serial No. 209,800 filed concurrently herewith. It comprises a multi-layer sheet-metal "sandwich" constituted of alternate flat and corrugated metal strips, 35 and 37, respectively. The problem here is to coat the inner plane surfaces of the cells with phosphors of different color-response characteristics, for example, in the pattern indicated by the letters R (red) B (blue) G (green) indicated in Figs. 2 and 3. The problem is complicated by the small size and very large number of cells in the screen. (A 12" x 12" Jenny screen ordinarily contains about 275,000 cells.)

In order that the phosphor powder particles shall adhere to the steeply inclined surfaces R, B and G of the individual cells, said surfaces should first be coated with a sticky substance (such, for example as a butyl carbitol acetate) that possesses the property of remaining on the metal, in vacuo, yet bakes off easily during sub-

sequent processing of the tube in which this screen is incorporated. The screen 7, thus coated, is next entered into the vacuum chamber 1, through the door 3 and supported, as on a wedge-shape block 41 on the bottom of the chamber, with the orientation and at the angle of tilt required to expose but a single set (say the "green" set G) of its surfaces to the phosphor particles which descend, in straight lines, from the cloud 27 created by the powder dispenser 21 (Fig. 1) or 29 (Fig. 4). It is best to make the angle of tilt equal to the angle at which the electron-beam in the finished tube (not shown) approaches that particular set of cell surfaces. Thus, in the case of an angle-of-approach of two degrees for the electron-beam, the screen should be so tilted that the set of surfaces (G) to be coated are inclined at angle of two degrees with respect to the horizontal, as shown (exaggerated) in Fig. 1.

Prior to releasing the powdered phosphor (or other electron-sensitive material) from the powder dispenser 21 or 29 the chamber 1 should be evacuated. In theory, the degree of vacuum required is such that the mean free path of the powder particles shall be large compared to the particle size. In such an attenuated atmosphere the particles fall freely in straight lines, solely under the influence of gravity. In practice it has been observed that a vacuum of the order of 0.1 millimeter of mercury is adequate.

It will be apparent that when, as in the instant case, phosphors of different color-response characteristics are to be deposited upon the different angularly disposed faces of the screen, the powder must be changed and the screen re-oriented prior to coating the other sets (i. e. "blue" B and "red" R) of screen faces. The practice of the invention is not limited to the use of any one group of powdered materials. The particular kind of electron-sensitive material employed depends upon the type (i. e. transmitting or receiving) target or screen to be sensitized. When the target is to comprise a tri-color kinescope screen the powdered phosphor materials employed may conveniently be the ones specified in Leverenz U. S. Patent 2,310,863; i. e. for "green": zinc silicate with manganese activator; for "red": cadmium borate with manganese activator and, for "blue": calcium manganese silicate with titanium activator.

From the foregoing detailed description, it is believed apparent that the present invention provides a powder-depositing method which obviates the "falling-leaf" and Brownian motions inherent in comparable prior art methods, and thus lends itself readily to the manufacture of three-dimensional electron-sensitive targets.

What is claimed is:

1. Method of depositing powdered phosphor materials of different color-response characteristics upon respectively different angularly-disposed faces of a prefabricated color-television screen of the cellular variety, said method comprising mounting said cellular screen in a position whereat only corresponding ones of its angularly disposed cell faces are accessible along parallel vertical lines, establishing a partial vacuum about said screen, creating a cloud of powdered phosphor material of a desired color response-characteristic in said partial vacuum above said screen, permitting said powdered material to settle through said partial vacuum along said parallel vertical lines upon said corresponding ones of said angularly disposed cell faces, re-

5

mounting said cellular screen in a position whereat other angularly disposed ones of its cell faces are accessible along parallel vertical lines, creating a cloud of powdered phosphor material of a different color-response characteristic above said screen and permitting said different powdered phosphor material to settle along said parallel vertical lines upon said other angularly disposed cell faces.

2. The invention as set forth in claim 1 and wherein said partial vacuum comprises free hydrogen at a pressure of the order of 0.3 of a millimeter of mercury.

3. The invention as set forth in claim 1 and wherein the powdered material in said cloud is substantially dry.

4. The invention as set forth in claim 2 and wherein said cloud includes a fluid carrier for said powdered material.

6

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