March 18, 1958 R. H. GARRIGUS 2,827,390

PRODUCTION OF KINESCOPE TARGETS

Filed Feb. 14, 1955

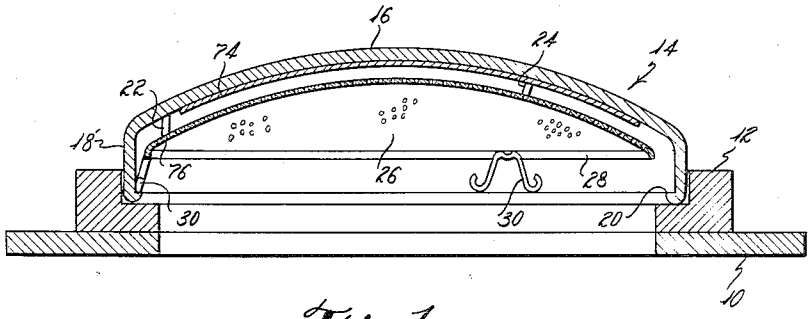


Fig. 1.

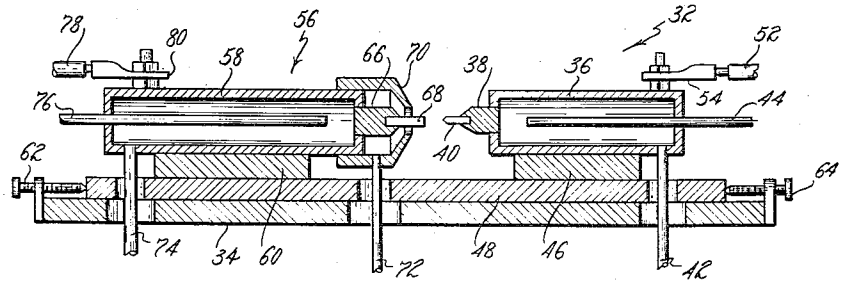


Fig. 2.

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United States Patent Office 2,827,390 Patented Mar. 18, 1958

2,827,390

PRODUCTION OF KINESCOPE TARGETS

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Application February 14, 1955, Serial No. 488,029

7 Claims. (Cl. 117—8.5)

This invention relates to a method of making color cathode ray tubes and more particularly relates to a method of applying fluorescent coatings to a picture tube target.

In cathode ray tubes of the subject type the electron sensitive target comprises a multiplicity of groups of sub-elemental picture areas, wherein the sub-elemental areas of which the groups are comprised are each coated with a different phosphor material. Each phosphor material, when struck by electrons, emits light of a color component (usually red, green or blue) individual to a given sub-elemental area and the phosphor areas may take the form of parallel, horizontal or vertical lines or may comprise a dot-like pattern. The masking electrode, or master pattern which is disposed adjacent to the sensitized face of the target, contains apertures of the same shape and pattern as the phosphor areas. The number of apertures in the mask is less than the number of phosphor areas on the target and if a three color target is employed the mask contains one-third as many apertures as there are phosphor areas on the target.

If the color tube is of the three gun variety, the electron guns are individual to the separate color components of the phosphor covered areas of the target. The beams approach the mask at different angles and cross and diverge at the mask to impinge upon separate sub-elemental areas in each phosphor group.

In the prior production of color tubes of the foregoing type it has been customary to produce the mask by a photographic process and to then utilize this mask in the photographic production of a stencil of either the metal or cloth type, which could be employed in applying the phosphor compounds to the target. The stencil is located in place on the target and the target is then coated with the phosphors through the apertures in the stencil, the stencil being shifted so as to apply the necessary number of groups of individual sub-elemental phosphor dots to provide the separate color components of the target.

According to the present invention the target or face of the color tube is initially given a coat of soluble polymeric material which is light sensitive, and which has incorporated therein one of the desired phosphors. This film is then exposed through a mask or negative, which is a duplicate of the mask subsequently to be utilized in the color tube, to harden the exposed areas of the film and the unexposed material is then washed out to leave the desired pattern of phosphor material. This procedure is then repeated to apply other patterns of phosphor materials and after the last such pattern has been applied the organic polymeric material is removed from the target by baking, leaving the phosphor pattern on the target.

Since the satisfactory operation of the color tube depends to a large extent upon the proper alignment of the sub-elemental areas of phosphors with respect to the apertures in the mask, it is necessary to utilize a source of light for exposing the film which is substantially a point source. In addition, the dictates of economical mass production require that the exposure take place in a minimum time and that the point source of light be of low initial cost and long life. The mercury, zirconium and carbon arcs heretofore utilized have not been entirely satisfactory in these respects and generally speaking have not provided what might be termed a satisfactory point source of radiation. Mercury and zirconium arc lamps are enclosed in evacuated bulbs and both are expensive. After a relatively short life, in some cases as little as twenty hours, the light from these lamps becomes so diffuse and the intensity falls to such an extent that they are unsatisfactory and must be discarded. The cost of such lamps is often as high as $1.50 per hour. The carbon arc is a relatively unstable light source for this purpose because the arc moves, giving a fuzzy image and varies in intensity so that it has been found necessary to utilize a light integrating device where it is employed. None of these sources are particularly well adapted to production line picture tube production.

Efforts have been made to overcome the difficulties which result when the mercury or zirconium lamps become too diffuse or when the carbon arc wanders, but the expedients used to compensate for these defects have introduced other deficiencies. For example, diaphragms or optical systems, or both, have been used to restrict or concentrate the light from such sources, but these diaphragms or optical systems cause large light losses so that while the effect of a point source is obtained the intensity is low and long exposure times are required.

According to the present invention an inert gas refractory metal arc is utilized in which the refractory metal is substantially non-consuming and the intensity of radiation high at the desired wavelengths. Both the initial and operating cost of such a unit are low.

The phosphor containing films presently used are comprised primarily of bichromate sensitized polyvinyl alcohols which have a maximum sensitivity at approximately 3600 Angstroms. Since the energy output of an inert gas tungsten arc is high at this wavelength an extremely short exposure time results.

It is accordingly a primary object of the present invention to provide a method of forming phosphor screens upon targets which is adapted to assembly line production of low cost high quality units.

It is another object of the invention to provide a method of manufacturing phosphor coated targets utilizing a target filming operation in conjunction with an economical point source of ultra-violet radiation.

It is another object of the present invention to provide a method of manufacturing color picture tube targets in which a light sensitized film is exposed to the ultraviolet radiation of an inert gas tungsten arc.

It is another object of the present invention to provide a method of manufacturing color picture tube targets in which a light sensitive film containing a phosphor is exposed to the radiation of a tungsten arc enshrouded in argon, helium, kryton or a mixture thereof.

It is another object of the present invention to provide a light source comprising an arc of small size and high intensity in the neighborhood of 3600 A.

It is another object of the present invention to provide a method of manufacturing color picture tube targets in which a film of bichromate sensitized polyvinyl alcohol containing a phosphor is exposed to the radiation of an inert gas tungsten arc.

It is another object of the present invention to provide a method of manufacturing color picture tube targets in which a film of bichromate sensitized polyvinyl alcohol containing a phosphor is exposed to the radiation of an inert gas tungsten arc.

It is another object of the present invention to provide a method of manufacturing color picture tube targets in which successive films of phosphor containing light sensitive material are adhered over substantially the entire target face, exposed to an inert gas tungsten arc and then washed to remove unexposed portions.

It is another object of the present invention to provide a method of manufacturing high quality color picture tubes wherein the use of a high intensity light source and short exposure time limits the light dispersion to produce a considerable improvement in sharpness of definition of the pattern.

Further objects and advantages of the invention will become apparent upon reference to the following specification and claims and appended drawing wherein:

Figure 1 is a vertical cross section showing the mounting of a kinescope face plate over a light source according to the present invention; and

Figure 2 shows a vertical cross section of the light source over which the kinescope face plate of Figure 1 is mounted.

Referring more particularly to the drawing there is shown a work table **10** on which is mounted a centering ring **12** which supports a color picture tube target **14**. The target **14** is comprised of a spherical portion **16** and skirt **18** having a peripheral inwardly turned bead **20**. The inner surface of the spherical portion **16** has three lugs **22**, **24** and a third lug, not shown, which support an arcuate mask **26**. The mask **26** is provided with a peripheral groove **28** which receives a plurality of spring clips **30** which engage the bead **20** and maintain the mask in position against the lugs **22**, **24**.

Beneath the table **10** and spaced therefrom by a distance approximately equal to the spacing between the target **14** and the center of deflection of the electron beams in the assembled color picture tube, is a light assembly **32** which is adjustably supported on a table **34**. The light assembly **32** consists of a positive electrode coolant jacket **36** which carries a copper block **38** into which a refractory metal electrode **40** is pressed. Coolant is supplied to the jacket **36** by means of a delivery tube **42** and is removed therefrom through an exhaust tube **44**. The jacket **36** and its associated electrode **40** are mounted on a support **46** which is carried by a slide **48** slidably mounted on table **34**. Current is supplied to the electrode **40** by means of a cable **52** and connector **54** on the jacket **36**. While I normally prefer to use tungsten electrodes, other refractory metals, such as molybdenum, tantalum, zirconium and platinum are also satisfactory.

An inert gas electrode assembly, shown generally at **56**, is mounted adjacent the electrode **40**, and comprises a coolant jacket **58** supported on and secured to a slidable member **60**. The member **60** is in turn slidably supported on slide **48** which may be moved across the table **34** by any suitable means, such as adjustment screws **62** and **64**. The jacket **58** carries a copper, or other high electrical and heat conductivity, block **66**, into which a refractory electrode **68** is pressed. A cap **70** is mounted over the end of jacket **58** and is provided with an inert gas inlet **72**. A coolant inlet **74** enters the rear end of jacket **58** and a coolant outlet **76** passes through the rear wall. Current is supplied to electrode **68** by means of a cable **78** and connection **80** on the jacket **58**.

It will thus be seen that the entire light unit **32** is movable as a unit in a plane perpendicular to the axis of the color tube target **14**, and the electrode assembly **56** is adjustable with respect to the slide **48**. Any suitable fluid coolant may be utilized and should be provided at such a flow rate as to prevent either of the electrodes **40** or **68** from becoming incandescent and thereby destroying the point source nature of the light supply. The negative electrode **68** is preferably larger than the positive electrode, and the latter is preferably pointed to make the unit easier to start and steadier in operation.

Prior to utilizing the apparatus shown in the drawing the color picture tube target **14** has its interior surface coated with a thin film **74** of a light sensitive transparent water soluble material. One very satisfactory film consists of polyvinyl alcohol prepared by polymerization of vinyl acetate followed by hydrolysis of the polyvinyl acetate to polyvinyl alcohol. A medium viscosity solution which is 86–89% hydrolyzed is preferable and "Elvanol" polyvinyl alcohol 52–22, marketed by E. I. Du Pont de Nemours and Company is quite satisfactory. If less water sensitivity or solubility is desired, a product of higher percentage hydrolysis and lower viscosity may be utilized. Best adhesion to a non-absorbent surface such as glass is obtained with the products of lower degree of hydrolysis. Plasticizers in general weaken the adhesion of the polyvinly alcohol film to glass.

Suitable solutions are most easily prepared by sifting the dry polymer into rapidly agitated water and warming the resulting dispersion with slow agitation at 90° C. (195° F. or higher) for 30 to 60 minutes to obtain a clear solution. Addition of the polymer to hot water instead of dispersing in cold water often results in the formation of lumps which dissolve slowly. Water is an adequate solvent but the solution will tolerate up to 25% of a water miscible alcohol. Such solutions containing an 80:20 water: alcohol ratio will give clearer, more stable solutions with the higher viscosity materials and will dry more rapidly.

Solutions containing as much as 20% solids can be prepared by the above technique. Such solutions are stable to storage over long periods, but should be kept in non-corrosive containers such as glass or stainless steel, since the water and electrolyte in the solution are slightly corrosive. Although the viscosity and stability of these solutions is good, there may be a slight drop in pH during long storage.

For coating tubes a solution containing about 3% polymer and 0.65% of a bichromate such as ammonium bichromate is satisfactory. The keeping quality of the bichromate containing solution has not been thoroughly investigated but it should be kept in brown bottles and not used when it is more than ten days old. The target face may be coated with such a solution, drained and dried to form a polyvinyl alcohol film about 1 mil thick. Pigments or phosphors may be added to these solutions prior to coating. Such slurries work equally as well as the clear solutions. To obtain maximum sensitivity, the film should be very dry before the exposure step.

Subsequent to forming the phosphor containing film the mask **26** is placed in the color tube target **14** with the lugs **22** mating with dimples **76** in the edge of the mask. The mask is then secured into position by means of the springs **30** which engage the groove **28** and lip **20**. The target **14** is then placed in the centering ring **12** on the table **10** and the film **74** is ready for exposure.

As heretofore stated, the center of the arc between the electrodes **40** and **68** is located a distance from the target **14** equal approximately to the distance between the target and the electron guns subsequently to be mounted in the completed picture tube. The support **56** is now adjusted by means of the adjusting screws **62** and **64** and the unillustrated screws in a plane normal thereto in order to place the center of the arc at the precise position to be occupied by one of the electron beams in the completed picture tube.

Exposure to light renders the film insoluble and when the film is exposed through the mask **26**, the exposed portions become insoluble while the unexposed portions do not. After exposure the target **14** is removed from the table **10** and the mask **26** taken out. The unhardened polyvinyl alcohol, i. e., the unexposed portions of the film **74**, is removed by flushing the surface with a jet of water or by gently brushing underwater. This treatment re-

moves all of the unexposed polyvinyl alcohol film **74** while leaving the exposed areas substantially unaffected.

If subsequent treatments are to be applied, as the application of further phosphors to the target, it may be desirable to harden the exposed polyvinyl alcohol. This may be accomplished by heating the film to 150° C. for approximately fifteen minutes, or by treatment with a formaldehyde derivative such as dimethylolurea. For the latter treatment, it is preferable that approximately a 2% solution of dimethylolurea containing approximately 1% of ammonium chloride as a catalyst be used to soak the pattern and that it be subsequently heated at 100° C. for a few minutes. A further method of hardening is to treat the developed pattern with a bichromate solution followed by reexposure to light or heat.

Subsequent phosphor applications are made in the same manner as the first, the order of phosphor application being determined by the type of phosphors used and the type of screen to be prepared. In subsequent applications the mask **26** is again snapped into the same position as in the preceding exposure and the target centered on the table **10** in the same rotational position as in the preceding exposure. The light assembly **32** is then shifted to place the center of the arc in the position to be occupied by the second electron beam and the second film exposed. This film is then washed and the entire procedure repeated with the arc in the position of the third electron beam. While individual adjustments have been disclosed for moving the arc it will be apparent that preset positions may be utilized with a suitable camming or indexing arrangement.

The arc obtained with the light used in this process is relatively small, a size less than ⅛ inch by ⅛ inch, being common, and is extremely stable, thereby providing an excellent point source of light. The light emission in the range 3000 A. to 4000 A. is high and since this is the most sensitive range of the polyvinyl alcohol, extremely short exposure times are possible. The tungsten wire electrodes are inexpensive and substantially non-consuming, resulting in a low cost of operation. There is no necessity for an evacuated bulb surrounding the light source and consequently the efficiency of light transmission is high.

With other light sources to the extent that they are satisfactory, relatively long exposure times are required. For example, a zirconium lamp requires an exposure time of about 6 to 15 minutes, a mercury arc lamp about 10 to 25 minutes, and a carbon arc about 3 to 5 minutes. With the light source of the present invention, the proper exposure is obtained in about 30 to 60 seconds.

It will be apparent from the foregoing that the method of this invention makes it possible to produce high quality color picture tube targets in an assembly line manner at a relatively low cost. While the light assembly has been illustrated as being below the picture tube target it will be apparent that this relationship could be reversed or a horizontal arrangement may be used. The illustrated arrangement is preferable, however, in order to prevent falling particles and dirt from collecting in the target and mask. The method of this invention is not restricted to applying phosphors to picture tube targets but is also suitable for applying electron-sensitive materials to any desired solid surface. It will be apparent that while the illustrated embodiment of the invention provides for a physical shifting of the light source the same result may be achieved through the use of suitable reflectors.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. A method of applying electron-sensitive materials to a transparent solid surface in predetermined patterns comprising the steps of: incorporating an electron-sensitive material in a light sensitive soluble polymeric fluid, applying a coat of said fluid to the surface to be treated, mounting a foraminous mask adjacent said coating, positioning an inert gas shrouded refractory metal arc on the side of said mask remote from said film at an adjustable selected point where the arc therefrom will pass light through the apertures in said mask and expose a desired portion of said film, and energizing said arc to expose said coating.

2. A method of applying plural electron-sensitive materials to a transparent solid surface in predetermined distinct patterns comprising the steps of incorporating a first electron-sensitive material in a light sensitive water soluble polymeric fluid, applying a coat of said fluid to the surface to be treated, mounting a foraminous mask adjacent said coating, positioning an inert gas shrouded refractory metal arc on the side of said mask remote from said coating at an adjustable selected point where the arc therefrom will pass light through the apertures in the mask and expose a desired portion of said coating, energizing said arc to expose said coating and harden said coating, removing the unexposed portions of said coating, incorporating a second electron-sensitive material in a light sensitive water soluble polymeric fluid, applying a coat of said fluid to the surface to be treated, mounting said foraminous mask adjacent said coating in the same position relative to said surface as in said previous mask mounting, positioning said inert gas shrouded refractory metal arc on the side of said mask remote from said coating at a selected adjustable point having a different position relative to said surface than in said first exposure, energizing said arc to expose said surface and harden said coating, and removing the unexposed portions of said coating.

3. A method of applying phosphors to a transparent glass kinescope target in predetermined patterns comprising the steps of: incorporating a phosphor in a bichromate sensitized polyvinyl alcohol, applying a coat of said phosphor containing alcohol to the surface of said target, mounting a foraminous mask adjacent said coating, positioning an inert gas shrouded refractory metal arc on the side of said mask remote from said coating at an adjustable selected point where the arc therefrom will pass light through the apertures in the mask and expose a desired portion of said coating, and energizing said arc to expose said portions of said coating.

4. A method of applying plural phosphor materials to a transparent glass kinescope target in predetermined distinct patterns comprising the steps of: incorporating a first phosphor in a bichromate sensitized polyvinyl alcohol, applying a coat of said phosphor containing alcohol to the surface of said target, mounting a foraminous mask adjacent said coating, positioning an inert gas shrouded tungsten arc on the side of said mask remote from said coating at an adjustable selected point where the arc therefrom will pass through the apertures in the mask and expose a desired portion of said coating, energizing said arc to expose portions of said coating and to harden said coating, removing the unexposed portions of said coating, incorporating a second phosphor in a bichromate sensitized polyvinyl alcohol, applying a coat of said phosphor containing alcohol to the surface of said target, mounting said foraminous mask adjacent said coating in the same position relative to said surface as in said previous mask mounting, positioning said inert gas shrouded tungsten arc on the side of said mask remote from said coating at a selected adjustable point having a different position relative to said surface than in said first exposure, and energizing said arc to expose said surface

and harden said coating, and removing the unexposed portions of said coating.

5. A method of applying phosphors to a transparent glass kinescope target in predetermined patterns comprising the steps of: incorporating a phosphor in a light sensitive water soluble polymeric fluid, applying a coat of said phosphor containing fluid to the surface of said target, mounting a formaminous mask adjacent said coating, mounting said target in fixed relation to a pair of tungsten electrodes at least one of which comprises a rod electrode, igniting an arc between said electrodes, shrouding said arc in an inert gas, and cooling said electrodes to substantially prevent either electrode from incandescing.

6. A method of applying plural phosphor materials to a transparent glass kinescope target in predetermined distinct patterns comprising the steps of: incorporating a first phosphor in a bichromate sensitized polyvinyl alcohol, applying a coat of said phosphor containing alcohol to the surface of said target, mounting a foraminous mask adjacent said coating, mounting said target in fixed relation to a pair of tungsten electrodes at least one of which comprises a rod electrode, igniting an arc between said eletrodes, shrouding said arc in an inert gas, cooling said electrodes to substantially prevent either electrode from incandescing, removing the unexposed portions of said coating, incorporating a second phosphor in a bichromate sensitized polyvinyl alcohol, applying a coat of said phosphor containing alcohol to the surface of said target, mounting said foraminous mask adjacent said coating in the same position relative to said target as in said previous mask mounting, mounting said target in a fixed relation to said electrodes, said last named fixed relation being relatively laterally shifted from said first named fixed relation, igniting an arc between said electrodes, shrouding said arc in an inert gas, cooling said electrodes so as to prevent either electrode form incandescing, and removing the unexposed portions of said coating.

7. A method as set out in claim 6 in which said target is mounted above said electrodes.

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