

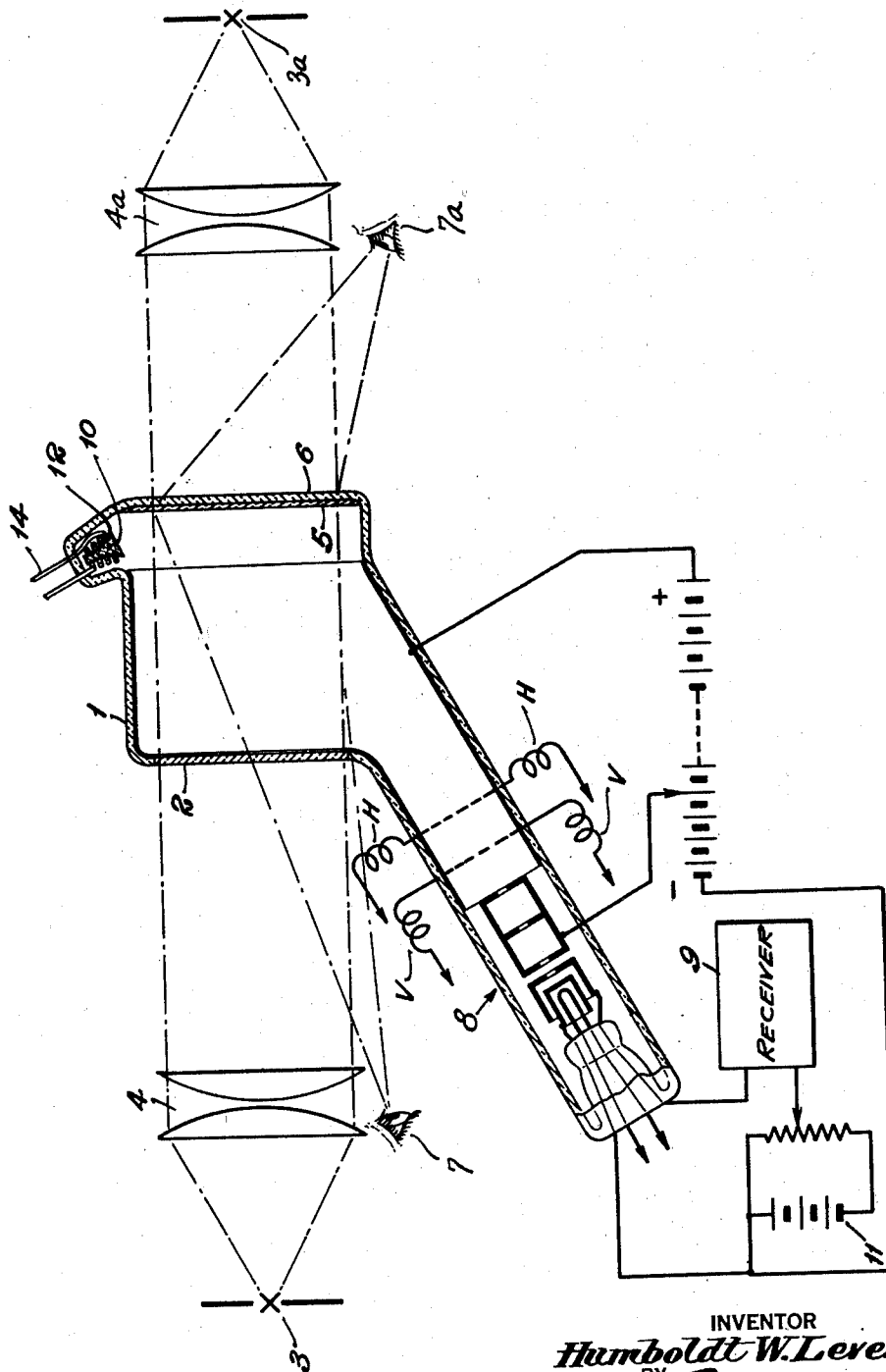
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CATHODE RAY TARGET AND METHOD OF MANUFACTURE

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CATHODE-RAY TARGET AND METHOD
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My invention relates to cathode ray tubes and particularly to tubes and targets comprising materials which change color under electron bombardment, such as targets incorporating alkali halide crystals and to the method of manufacturing such targets.

It is known that alkali halides, notably potassium chloride, have the property of coloring, that is, developing color centers, under electron bombardment. For example, when such an alkali halide target is scanned by an electron beam, electrons are injected into the crystal or crystals in the scanned area thereby developing a group of color centers of a density depending upon the instantaneous intensity of the electron beam. This coloration has been used to produce images for television and oscillograph purposes. The recent development of aircraft position and indicating equipment utilizing cathode ray tubes wherein the electron beam of the cathode ray tube is sequentially pulsed to form on the target a trace representing the trajectory of the aircraft necessitates the development of high contrast between the areas of a target indicating aircraft position and distance with respect to the surrounding areas of the target. One method whereby improvements in contrast is obtained is disclosed in my copending application Serial No. 451,870, filed concurrently herewith.

The ordinary alkali halide screens or targets have an inherent disadvantage in that repeated bombardment or very strong bombardment by cathode rays produces a coloration which is difficult to eradicate by conventional means such as by heat, illumination within the coloration absorption band or by the application of electric fields through the target.

It is an object of my invention to develop color centers and control their dissipation more effectively in an alkali halide crystal screen. It is another object to accelerate the rate of return of colored alkali halide crystals to their uncolored state. It is a further object to provide a cathode ray tube having an alkali halide target wherein the dissipation of color centers developed by scanning the target with a cathode ray beam is more effectively controlled and it is a still further object to provide a more stable and more easily controlled cathode ray target of the alkali halide type. These and other objects, features and advantages of my invention will become apparent when considered in view of the following description and the accompanying drawing wherein the single figure shows a cathode ray tube having a target structure made in accordance with my invention.

I have shown in the figure one type of a cathode ray tube utilizing a target made in accordance with my invention wherein the effect of the electron beam trace on the target may be viewed

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either by reflected or transmitted light, and it should be understood that this showing of a tube is merely exemplary, and various other modifications and arrangements may be utilized to an equal advantage as hereinafter explained. Referring to the figure, the tube comprises a highly evacuated envelope or bulb 1 of cylindrical shape with a neck or arm section enclosing a conventional electron gun. The cylindrical portion of the bulb 1 is provided at one end with a window 2 if the tube is to be utilized for viewing by transmitted light so that light from a substantially constant light source 3 may be formed into parallel light rays by a lens system 4, projected through the cylindrical portion of the bulb and upon the target 5 which may be on or deposited upon a second window 6 as hereinafter disclosed. The effects of the trace on the target may be viewed preferably from a position as at 7, although a position 7a may be used. Alternatively, the trace may be viewed at 7a utilizing a constant intensity light source 3a developing light projected on the target 5 through the lens system 4a, although for this position of the light source the target is preferably viewed on the side thereof scanned by the electron beam such as from the position 7. Furthermore, conventional Schmidt optical systems, referred to in the Journal of the Optical Society of America, Volume 34, No. 2, page 89, February, 1944, may be used to project the light upon a viewing screen for observation purposes. Alkali halide targets have a relatively narrow spectral absorption characteristic so that only a portion of a light from a relatively wide spectral range light source is absorbed by the color centers developed in the halide target by the scanning operation. Therefore, it is essential that the light source have a spectral emission band falling at least partially, or preferably entirely, within the spectral absorption band of the halide target so that the differences between the light transmission or reflection of excited areas and that of non-excited areas of the target may be distinct.

The electron gun assembly 8 may be of any one of the conventional types either of the magnetic focus or of the electrostatic focus type as shown. The electron beam developed by the electron gun 8 is modulated in intensity, such as by grid control from a receiver 9 and scanned over the target 5 by horizontal and vertical deflection coils H and V supplied with operating currents of the desired wave form depending upon the type of trace, whether of circular, radial or rectangular form.

In accordance with my invention I accelerate and thereby control to better advantage the rate of return of colored halide crystals to the uncolored state by introducing a deficiency structure in the halide crystals. More particularly I synthesize the halide crystals in such a manner

and I utilize such a composition that a considerable number of the crystal lattice units are missing from the normally complete crystal structure. All of the alkali halides used heretofore consisted of monovalent ions and anions and in accordance with my invention I partially substitute polyvalent ions for a number of the monovalent ions of the alkali halide. For example, by co-crystallizing a small amount of a halide of a quadrivalent metallic element with the monovalent alkali halide the halogen ion positions are apparently filled throughout the resulting crystal lattice, but for every quadrivalent cation there will be three vacant alkali ion positions. Similarly it is within the scope of my invention to introduce oxygen or other suitable polyvalent anions for some of the halogen ions in the alkali halide crystals so that vacant lattice positions may be introduced in the anion part of the lattice structure. For example, by co-crystallizing a small amount of potassium oxide with an alkali halide, such as potassium chloride, the potassium ion positions are presumably filled throughout the resulting crystal lattice but for every oxygen ion there will be one unfilled chlorine ion position. Consequently, the crystal lattice is provided with vacant chlorine ion positions which are conducive to more rapid dissipation of the color centers following their formation by the cathode ray beam. The dissipation of the color centers is thereby controlled and may be further accelerated by the application of heat, illumination within the coloration or the absorption band of the halide screen, or by the application of electric fields across the crystal boundaries.

As a specific example of preparing my improved alkali halide screen, I will refer particularly to potassium chloride as the halide and to thorium as the metal of the polyvalent metal compound co-crystallizing therewith for introducing the crystal lattice deficiency structure. Thus, as a specific example, I weigh 0.462 gram of pure potassium chloride and 0.045 gram of pure octo-hydrated thorium chloride



into a platinum container. I thoroughly mix the two salts in the container and carefully heat the salts to avoid decrepitation. This heating is preferably by radiation from a hot body to a red heat (500° C.-1000° C.) for a sufficient time until the two salts have melted or at least are well sintered together. I utilize the resultant mixture as a source of treated halide to produce the alkali halide screen.

Referring again to the figure the co-crystallized salts 10 are supported in the small platinum container 12, which is placed within the envelope 1 and supported with its open end facing the foundation, such as the end wall 6, on which the halide screen is to be produced. The platinum container is preferably surrounded by an insulated resistance heater coil 14 through which current may be made to flow to heat the platinum container 12 thereby vaporizing the prepared halide 10 which is condensed upon the end-wall 6 to form the target 5. Obviously, other heating means than the resistance heater 14 may be utilized such as induction heating or radiant energy incident upon the container 12. The condensation of the halide 10 on the end-wall 6 produces a target 5 composed of alkali metal halide crystals having deficient crystal lattices. Although the target 5 is preferably formed by evaporation and condensation in vacuo, following the evacuation

of the envelope 1 during the tube manufacturing process, other methods may be used. Following preparation of the target it may be subjected to an atmosphere containing either water vapor, ammonia or both followed by sealing and evacuating the envelope 1 prior to the operation of the tube to decrease the transparency of the target to white light and render it more milky in appearance. Such treatment appears to increase the contrast during use. Obviously in view of this teaching the halide target 5 may be prepared in an evacuated envelope other than the tube envelope 1 whereupon it may be transferred to the envelope 1 either through an atmosphere totally devoid of all moisture, or the target may be exposed to water vapor, ammonia or both just prior to sealing it within the envelope 1 followed by evacuating the envelope whereupon the tube is ready for use. Furthermore, the co-crystallized salts may be comminuted and deposited by settling from a suitable gas or liquid suspension, such as air or amyl-acetate.

While I have described my invention with particular reference to a thorium halide, it will be appreciated that other metallic ions may be utilized to induce the deficiency structure provided, however, polyvalent metals are used. Thus, titanium, zirconium and hafnium may be substituted either in whole or in part for the thorium. Similarly tin or lead may be substituted in whole or in part for the thorium. Other polyvalent metals, such as barium, cadmium, uranium and manganese, may be utilized for providing the deficient crystal lattice in the alkali halide target material. As indicated above, a polyvalent non-metallic element such as oxygen may be used to replace some of the halide anions in the alkali halide crystals to produce the vacant lattice positions in the anion part of the lattice structure. Similarly, selenium and/or sulphur may be utilized either in whole or in part in place of the oxygen for producing these vacant lattice positions. It will be understood that several polyvalent substituents may be present simultaneously, such as both thorium and oxygen, in thorium oxide. In all cases, the substituent ion should have a higher valency than that of the ion it replaces. For example, if the color center material be magnesium oxide, then the substituents should have valencies greater than two.

Both the kind and the amount of the substituted ion or ions may be varied widely with respect to the total amount of the coloration material base, such as alkali halide, although I prefer to utilize not more than 30% of a polyvalent substituent element based on the mole-weight of the base material element for which it is substituted. More particularly a smaller amount than 30% is preferable and I have found approximately one-sixth of this amount or 5% of the polyvalent metal introduced into an alkali halide, such as potassium chloride, reduces the time normally required for strongly colored traces to return to the un-colored state by a factor of approximately 50 at room temperature. The concentration of vacant lattice positions and hence the rate of dissipation of the color centers, may be varied by varying the concentrations and valencies of the substituted polyvalent ions.

While I have described my invention with particular reference to the preparation and use of a target wherein color centers are developed by corpuscular energy, such as a cathode ray beam, it will be appreciated that these color centers may be developed by undulatory energy such as radia-

tion with suitable wavelengths of X-ray or by ultraviolet light without departing from the scope of my invention as set forth in the appended claims.

I claim:

1. A cathode ray screen comprising a transparent foundation, a translucent layer on said foundation consisting of a halide of an alkali metal and a halogen compound of a member from the group consisting of titanium, zirconium, hafnium, and thorium and mixtures thereof, said member being from 5% to 30% by weight of the alkali metal and said halide and halogen compound being co-crystallized.

2. A cathode ray screen comprising a transparent foundation and a translucent layer on said foundation consisting of a halide of an alkali metal and a halide of thorium, the thorium being 5% to 30% by weight of the potassium and said halides being co-crystallized.

3. A cathode ray screen comprising a transparent foundation, a translucent layer on said foundation consisting of co-crystallized potassium chloride and thorium chloride, the thorium being 5% to 30% by weight of the potassium and said potassium chloride and thorium chloride being co-crystallized.

4. A cathode ray tube comprising an evacuated envelope containing a cathode ray beam gun and a screen adapted under illumination to exhibit a dark trace upon impingement of the beam of said gun thereon, said screen consisting of a halide of an alkali metal and a halogen compound of a member from the group consisting of titanium, zirconium, hafnium and thorium and mixtures thereof, and said member being from 5% to 30% by weight of the alkali metal and said halide and halogen compound being co-crystallized.

5. A cathode ray tube comprising an evacuated envelope containing a cathode ray beam gun and a screen adapted under illumination to exhibit a dark trace upon impingement of the beam of said gun thereon, said screen consisting of an alkali metal co-crystallized with thorium chloride, the thorium being from 5% to 30% by weight of the potassium.

6. A cathode ray tube comprising an evacuated envelope containing a cathode ray beam gun and a screen adapted under illumination to ex-

hibit a dark trace upon impingement of the beam of said gun thereon, said screen consisting of potassium chloride co-crystallized with thorium chloride, the thorium being from 5% to 30% by weight of the potassium.

7. A cathode ray screen comprising a transparent foundation and a translucent layer on said foundation consisting mainly of a halide of an alkali metal and a minor proportion of a halide of thorium.

8. A cathode ray screen comprising a transparent foundation and a translucent layer on said foundation consisting mainly of a halide of an alkali metal and a minor proportion of a halide of zirconium.

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