

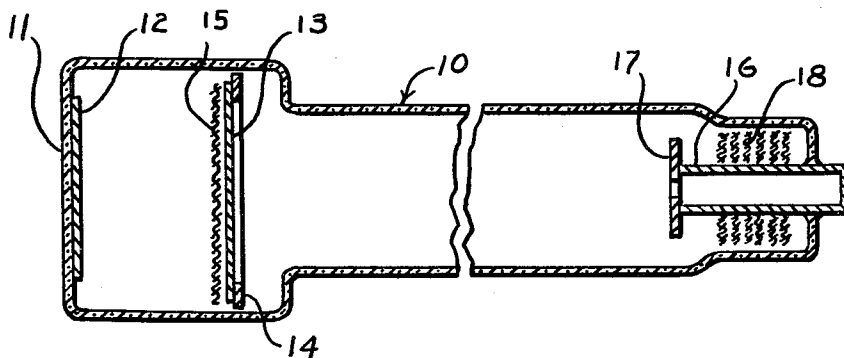
Dec. 18, 1962

G. B. HARES ETAL

3,069,578

IMAGE ORTHICON TARGET

Filed March 31, 1960



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3,069,578

IMAGE ORTHICON TARGET

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Filed Mar. 31, 1960, Ser. No. 19,034

4 Claims. (Cl. 313-68)

This invention relates to improved targets for use in image orthicon tubes.

Such tubes are utilized in video cameras to convert an optical image into an electronic image for broadcasting purposes. Their general structure is well known to those skilled in the art pertaining to television and requires little amplification here. For a better understanding of the invention, however, reference is made to the accompanying drawing which is a schematic sectional view of an image orthicon tube showing its general structure.

In the drawing a glass tube or envelope generally designated 10 has a plain front end or face plate 11 having on its inner surface a photo-cathode 12 (shown in exaggerated thickness) consisting of a thin, continuous, semi-transparent layer usually comprising cesium, silver oxide and silver. Spaced from the photo-cathode is a glass target 13 (shown in exaggerated thickness), an improved composition for which forms the subject of this invention.

In a typical image orthicon tube, the target 13 is a circular membrane of glass, which may be about 40 mm. in diameter and 3-5 microns thick, sealed to a supporting ring 14 of metal having a thermal expansion coefficient compatible with that of the glass. Such glass, heretofore used for the target, was normally composed of a soda-lime-silicate glass of the type used in making incandescent lamp bulbs, such as is described in Patent No. 1,369,988 and particularly in Example 4 of that patent. However, in tubes utilizing a multi-alkali metal cathode, a potassia-titania-silicate glass as described in Patent No. 2,879,420 was thought to be necessary.

In front of the target 13 and spaced about 50-100 microns therefrom is a very fine metal gauze 15 (shown in exaggerated thickness) having about 20 meshes per mm. with about 50-65% open area. In the opposite end of the tube 10, an electron gun 16 is provided with a grid 17 surrounding the aperture of the gun and a multi-stage electron multiplier 18.

In the operation of the image orthicon tube an optical image formed by a lens system (not shown) arranged in front of the face plate 11 is projected on the front surface of the photo-cathode 12. Photo-electrons thereby emitted from the rear surface of the photo-cathode strike the front face of the target 13 and cause the emission therefrom of secondary electrons in larger numbers than the photo-electrons. The emitted secondary electrons which are carried off by the metal gauze 15 leave electron deficiencies or positive charges on the front face of the target. Since the photo-electrons were compelled to pass through the metal gauze 15 on their way to the target 13, a pattern of individual positive charges thus remain on the front face of the target and delineate the image thereon.

Such charges are conducted perpendicularly but not laterally through the target glass to its rear face where they are neutralized by a scanning beam of low-velocity

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of electrons provided by the electron gun. The electron beam thus modulated is returned to the grid 17 causing the emission of secondary electrons therefrom which are collected by the multiplier 18 and subsequently amplified for broadcasting.

Further details of the structure in the operation of the image orthicon tube are described beginning at page 95 of R.C.A. Review, volume 10 (June 1949), in an article entitled "Development and Performance of Television Camera Tubes," by James, Johnson, and Moore.

The proper functioning of the glass target depends upon the rapid transfer of the positive charges of the image perpendicularly through the thin glass membrane without substantial equalization or loss by lateral conductance, as such lateral conductance causes poor resolution of the transmitted image. To prevent such lateral loss the glass should have a high volume resistivity. Too high a resistivity, however, can cause the incomplete discharge of the image by the scanning beam, a phenomenon known as "sticking," resulting in a transmitted signal which produces an after image on a television screen. To facilitate the rapid removal of the image charge, the glass target is made as thin as possible and with as low a resistivity as is consistent with the prevention of lateral conductance. Suitable targets have a volume resistivity of about 11.4-13.0 for log R at room temperature and a thickness of about 3-5 microns.

Another problem associated with the target in such image orthicon tubes is known as "raster burn." During the course of the operable life of such a tube, the area of the target which is scanned by the low-velocity electron beam provided by the electron gun is enlarged by a lengthening of the horizontal and vertical tranverse of such beam, through inadvertence or design, with the attendant result that the transmitted picture appears on a television screen with a brighter area surrounding the central portion of the picture. This phenomenon is known as raster burn.

Another important consideration with regard to targets for such tubes is their influence on the usable life of the tube. The life of tubes heretofore produced has quite generally been determined by the target. Thus tubes which are entirely satisfactory when first utilized, may rapidly deteriorate causing them to be unusable after as little as only a few hours, because of the appearance of one or more of the above listed defects, such as sticking or raster burn. Even tubes which have been commercially acceptable have generally been found to have useful lives of only about 300 to 500 operating hours, at which point the amount of sticking encountered precludes their further use.

The principal object of the present invention is to provide a glass composition suitable for a target in an image orthicon tube which is more resistant to common defects, such as sticking and raster burn, to provide an increase in the useful life of the tube.

Another object is to provide a target which can be utilized in an image orthicon tube regardless of the type of photo-cathode utilized in combination therewith.

According to the invention such object is achieved by utilizing a target consisting of a glass having a volume resistivity of between about 6.3×10^{10} and 1000×10^{10} ohms-cm. said glass containing a total of at least 2% by weight of at least one readily reducible metal oxide selected

from the group consisting of lead oxide, zinc oxide, bismuth oxide, iron oxide, cadmium oxide, and copper oxide.

We believe that the improvements achieved in tubes containing targets having the above-described structure result from the fact that such targets maintain their stability over a much greater period of time during which they are exposed to electron beams. It appears that a contributing factor to this lack of stability in prior art targets is an increase in resistivity of the target glass during the operation of the tube. We believe that such increase in resistivity of the target during operation of the tube results from a reduction of the alkali ions in the target by the scanning electron beam thereby decreasing the number of alkali ions which could migrate and, hence, raising the resistivity of the target. The inclusion of at least 2% of the described readily reducible oxide in the target of this invention dramatically obviates the change in resistance of the target during the operation of the tube as we believe that such oxides are reduced by the electron beam in preference to the reduction of the alkali metal ions or that alkali metal ions which are reduced by the beam are regenerated by reduction of the readily reducible oxides. Thus any glass which is otherwise suitable as a target can be improved dramatically for such use by the inclusion therein of at least 2% by weight of such readily reducible metal oxides.

The term readily reducible metal oxides, as used in the present specification and claims annexed hereto, means oxides of metals having oxidation potentials, referred to the hydrogen-hydrogen ion couple as zero, when measured at 25° C. of less than +0.8 volt for the reaction $M \rightarrow M^{n+} + ne$. While many elements satisfy this basic requirement, many, such as the halogens and mercury, cannot readily be incorporated in sufficient quantity in the glass as they are volatile at ordinary glass-melting temperatures. Others, such as the noble metals and tin, are not satisfactory because neither the metals nor their oxides are appreciably soluble in glasses. Still others are impractical because of their cost and their tendency to precipitate from the glass during the reworking necessary to produce the thin-walled membranes and to seal them to metal rings.

Examples of glass compositions which can be used for targets to obtain the advantages of this invention can be prepared by melting the batches set forth in parts by weight in Table I.

Table I

	1	2	3	4	5	6	7	8
Sand	276	274	826	750	745	745	750	276
Na ₂ CO ₃	100	100	212	278	237	237	246	106
NaNO ₃	22	22	179	66	66	66	72	23
K ₂ CO ₃					35	35		14
CaCO ₃	39	46						
MgO	2	2						
Al(OH) ₃	18	18			37	37	60	
Al ₂ O ₃			26	24				
H ₃ BO ₃	7	7						
Sb ₂ O ₃	2							2
As ₂ O ₃		4	4	4	4	4	3	
Fe ₂ O ₃	12							
CuO		8						
Bi ₂ O ₃			260	60				
ZnO				180	240	180		
PbO						60		
92% Lead Silicate							338	44

	9	10	11	12	13	14	15	16
Sand	751	751	475	226	251	234	254	296
Na ₂ CO ₃	235	246	163	155	112	124	89	89
NaNO ₃	72	72	20	28	28	22	22	22
K ₂ CO ₃	10							
Al(OH) ₃	60	60						
Feldspar			38					
As ₂ O ₃	3	3	2					
Sb ₂ O ₃				2	2	2	2	2
MnO ₂	1	1	1					
PbO			192					
92% Lead Silicate	338	338		164	164	88	88	44

The glasses corresponding to the above batches, calculated in weight percent on the oxide basis, as well as the more important physical and electrical properties, are set forth in Table II.

Table II

	1	2	3	4	5	6	7	8
SiO ₂	70.0	69.9	63.5	62.5	62.5	62.5	60.0	70.0
Na ₂ O	16.8	16.8	14.5	15.5	13.5	13.5	13.0	17.0
K ₂ O					2.0	2.0		2.0
Al ₂ O ₃	3.0	3.1	2.0	2.0	2.0	2.0	3.0	
CaO	5.7	6.7						
MgO	0.5	0.5						
B ₂ O ₃	1.0	1.0						
Fe ₂ O ₃	3.0							
CuO		2.0						
Bi ₂ O ₃			20.0	5.0				
ZnO				15.0	20.0	15.0		
PbO						5.0	24.0	10.0
Exp. Coeff. (per ° C. × 10 ⁻⁷)	92	92	95	92	91	93	90	100
Log R (25° C.)	11.8	12.2	12.2	11.6	12.4	12.0	12.7	12.0
Log R (100° C.)	9.1	9.5	9.4	8.9	9.5	9.2	9.8	9.0

	9	10	11	12	13	14	15	16
SiO ₂	60.0	60.00	62.0	50.0	55.0	60.0	65.0	75.0
Na ₂ O	12.5	13.0	12.9	20.0	15.0	20.0	15.0	15.0
K ₂ O	0.5		0.4					
Al ₂ O ₃	3.0	3.0	0.9					
PbO	24.0	24.0	23.8	30.0	30.0	20.0	20.0	10.0
Exp. Coeff. (per ° C. × 10 ⁻⁷)	90	90	89	130	109	117	96	80
Log R (25° C.)	12.9	12.8	13.0	11.4	12.8	11.4	12.2	11.7
Log R (100° C.)	10.0	9.8	10.2	8.7	9.8	8.7	9.5	9.1

The Sb₂O₃ and As₂O₃ function as fining agents and have no substantial effect on the fundamental properties of the glass. As the fining agents are quite volatile at the temperatures utilized for melting such batches and are present in the batches in relatively small amounts, they have not been included in Table II. Additionally, minor amounts of a decolorizer, such as MnO₂, may also be added to the glasses.

The batches melt readily either in a closed pot or in a tank, and are melted under oxidizing conditions at a temperature of about 1300–1450° C. Preferably the glass should be stirred during melting and fining in order to minimize cords.

The improvement in the life of image orthicon tubes by the use of our improved targets is illustrated by the fact that tubes containing targets of the glass set forth in Example No. 10 consistently achieve useful operating lives of from 1000 to 1800 hours whereas similar tubes utilizing conventional soda-lime-silica targets have operable lives of only about 300–500 hours.

While any glass having the above defined resistivity and containing therein the defined operable amount of readily reducible metal oxides of the class specified are suitable for the purposes of our invention, glasses containing about 12% to about 20% by weight of Na₂O, are particularly suitable examples of glasses having the desired resistivity because of the ease of melting and working such glasses. Furthermore, other glass modifying ingredients, such as aluminum oxide and boric oxide, and other divalent metal oxides (e.g. MgO, CaO, SiO, and BaO) may be included therein to modify the glass working properties or characteristics of the resultant materials such as thermal expansion coefficient and durability.

Furthermore, it has been found that glasses containing lead oxide are especially suitable because of the large amount of lead oxide which can be included in a glass without adversely affecting durability, stability against devitrification and the like. Particularly suitable are lead oxide glasses comprising by weight 50–75% SiO₂, 12–20% Na₂O, 10–35% PbO, 0–5% K₂O, the total R₂O (Na₂O+K₂O) not exceeding 20%, said oxides comprising at least 85% of the glass composition.

What is claimed is:

1. In an image orthicon tube comprising a glass envelope containing in longitudinal arrangement a photo-

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cathode, a grid of fine metal gauze, a thin glass target and an electron gun, the improvement which comprises a target of a glass having a resistivity of between 6.3×10^{10} and 1000×10^{10} ohm-cm. at 25° C. and containing a total of at least 2% of at least one readily reducible metal oxide selected from the group consisting of lead oxide, bismuth oxide, zinc oxide, copper oxide, cadmium oxide and iron oxide.

2. In an image orthicon tube comprising a glass envelope containing in longitudinal arrangement a photocathode, a grid of fine metal gauze, a thin glass target and an electron gun, the improvement which comprises a target of a glass having a resistivity of between 6.3×10^{10} and 1000×10^{10} ohm-cm. at 25° C. and comprising by weight of 50–75% SiO_2 , about 12–20% Na_2O , at least a total of 2% of at least one readily reducible metal oxide selected from the group consisting of lead oxide, bismuth oxide, zinc oxide, copper oxide, cadmium oxide and iron oxide, said essential constituents comprising at least 80% by weight of the glass.

3. In an image orthicon tube comprising a glass envelope

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containing in longitudinal arrangement a photocathode, a grid of fine metal gauze, a thin glass target and an electron gun, the improvement which comprises a target of a glass comprising by weight 50–75% SiO_2 , 12–20% Na_2O , 10–35% PbO , 0–5% K_2O , the total R_2O not exceeding 20%, said oxides comprising at least 85% of the glass composition.

4. In an image orthicon tube comprising a glass envelope containing in longitudinal arrangement a photocathode, a grid of fine metal gauze, a thin glass target and an electron gun, the improvement which comprises utilizing a target of the glass consisting essentially by weight of about 60% SiO_2 , about 13% Na_2O , about 24% lead oxide, and about 3% of aluminum oxide.

References Cited in the file of this patent

UNITED STATES PATENTS

2,587,830	Freeman	Mar. 4, 1952
2,879,420	Hares	Mar. 24, 1959
2,964,414	Dalton et al.	Dec. 13, 1960