

Sept. 6, 1966

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3,271,608

X-RAY VIDICON TARGET ASSEMBLY

Filed April 30, 1962

2 Sheets-Sheet 1

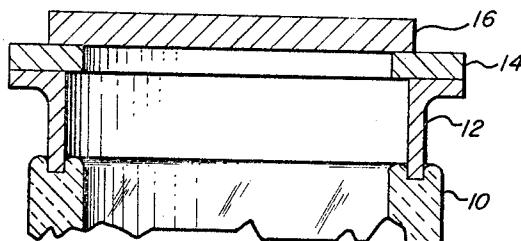


FIG. 1

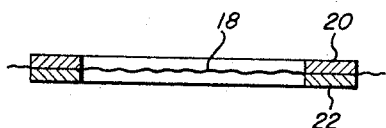


FIG. 2a

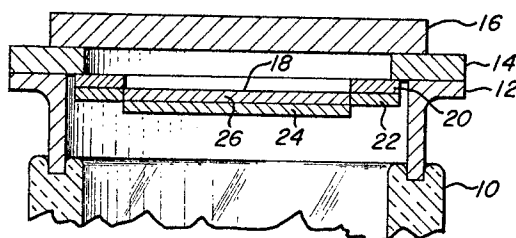


FIG. 2b

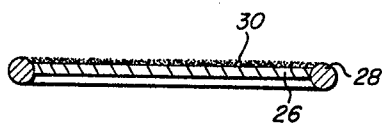


FIG. 3a

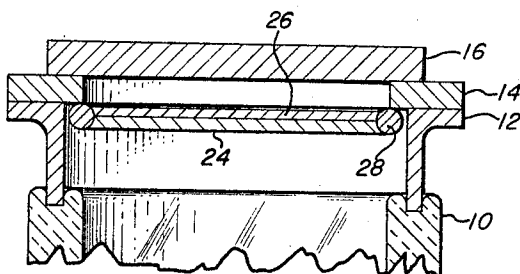


FIG. 3b

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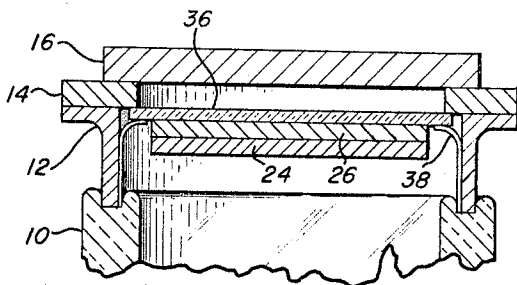


FIG. 4

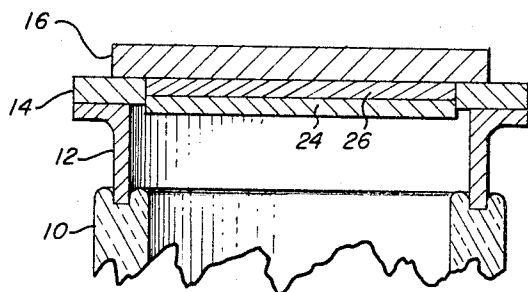


FIG. 5

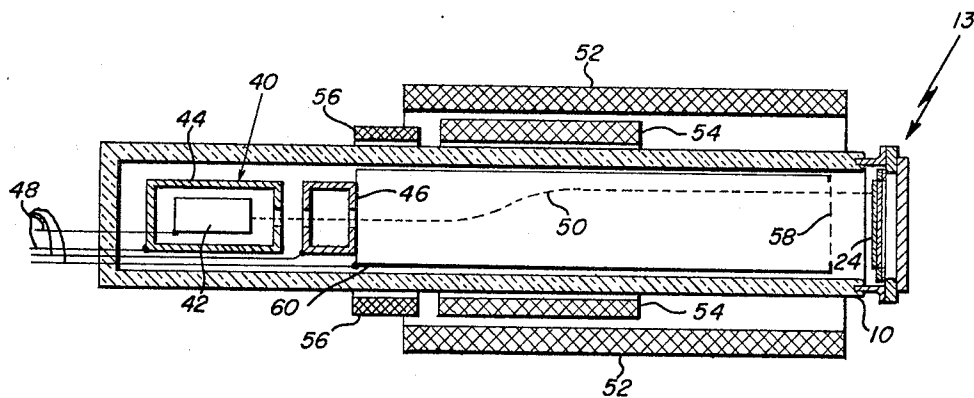


FIG 6

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3,271,608

X-RAY VIDICON TARGET ASSEMBLY

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Filed Apr. 30, 1962, Ser. No. 191,099

7 Claims. (Cl. 313-65)

This invention relates to an X-ray vidicon and, more particularly, to a novel X-ray vidicon window assembly.

The application of television techniques to X-ray pick-up devices has necessitated utilizing a window having minimum X-ray absorption in place of the conventional glass window as the vacuum-tight terminating element. Beryllium metal, noted by its low X-ray absorption, is an ideal window for use in X-ray sensitive pick-up tubes, particularly in applications involving low X-ray energy level incident radiation. The low X-ray absorption of beryllium metal, compared to glass, enhances the sensitivity of the camera tube, particularly at low energy levels, simply by permitting more radiation to become incident on the photoconductive surface.

However, beryllium surfaces cannot be conveniently prepared with the high degree of uniformity and polishing required for high resolution pick-up tubes. Both the microcrystalline structure and the protective oxide layer are detrimental influences on the selenium photoconductor substrate used with the beryllium window. That is, if the selenium photoconductor is vaporized directly onto the beryllium metal, there occurs a detrimental recrystallization of the selenium from the amorphous to a lower resistivity crystalline form due, at least in part, to the beryllium.

Accordingly, it is a primary object of our invention to provide structures in which the beryllium window may be sealed to a glass bulb forming the vacuum-tight envelope for the camera tube.

Another object of our invention is to provide a means for preventing a reaction or change in crystal structure by interposing a barrier layer between the beryllium and selenium.

Still another object of our invention is to provide a smooth polished uniform substrate for the selenium without a substantial increase in X-ray absorption.

Yet another object of our invention is to provide a thin smooth uniform metallic substrate for the selenium that is an exact replica of the original beryllium surface which may be more readily polished than the refractory beryllium.

A further object of our invention is to provide a thin, metallic, thermally conductive substrate which will also meet the requirements of low X-ray absorption and a smooth uniform surface.

A still further object of our invention is to provide a smooth, uniform, thermally conductive substrate for the selenium without a substantial increase in X-ray absorption.

The features of our invention, which we believe to be novel, are set forth with particularity in the appended claims. Our invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may be best understood by reference to the following description, taken in conjunction with the accompanying drawings in which:

FIG. 1 is a partial sectional view of the basic beryllium faceplate structure for an X-ray vidicon;

FIG. 2a is an enlarged sectional view of one embodiment of an X-ray vidicon subassembly having particular applicability to the basic structure;

FIG. 2b is an enlarged partial sectional view of an X-ray vidicon using the subassembly of FIG. 2a;

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FIG. 3a is a sectional view of another embodiment of a subassembly having particular applicability to the basic structure;

FIG. 3b is an enlarged partial sectional view of an X-ray vidicon using the subassembly of FIG. 3a;

FIG. 4 represents an enlarged partial sectional view of a further embodiment of our novel X-ray vidicon beryllium faceplate structure;

FIG. 5 represents an enlarged partial sectional view of still another embodiment of our novel X-ray vidicon beryllium faceplate structure wherein the subassembly is in direct contact with the beryllium window, and

FIG. 6 represents a sectional view of a schematic representation of our novel beryllium window structure as used in a typical X-ray vidicon.

It should be noted that in all the following figures, similar elements are similarly numbered.

Referring now to FIG. 1, there is shown the basic structure which utilizes a beryllium window in an X-ray vidicon. In the basic structure, an envelope 10 is shown having affixed at one end thereof a cylindrical L-shaped flanged ring 12 made of Kovar or other similar material having a coefficient of thermal expansion approximately similar to the expansion coefficient of glass or other material used for the envelope wall. Ring 12 is sealed into wall 10 by any of the many standard glass-to-metal sealing techniques. The main portion of ring 12 has a configuration which substantially conforms to the end of envelope 10. Adjacent the flanged portion of ring 12 is a Kovar ring 14 having an outside diameter approximately equal to the outside diameter of the ring 12 and having an inside diameter somewhat smaller than the inside diameter of the main portion of ring 12. Upon the Kovar ring 14 and on the side thereof opposite ring 12 is the beryllium window 16. In this and all subsequent embodiments, both the Kovar-to-Kovar seal and the beryllium-to-Kovar seal may be accomplished by any one of the standard techniques, many of which are well known in the art and, hence, any exegesis is unnecessary.

It is the purpose of this structure to provide the means by which the beryllium window assembly is sealed to a glass bulb, thus forming a vacuum-tight envelope for the camera tube. In FIG. 1, the beryllium window 16, in the form of a disc, is brazed in vacuum to a Kovar ring 14 using B.T. or similar braze material. Kovar ring 12, which has been previously sealed to envelope 10, may then be soldered to the Kovar-beryllium window assembly (14 and 16) at the outside periphery of ring 14 and ring 12, using a low melting point solder such as indium-tin alloy.

While the Kovar ring 14 has been described as sealed to ring 12 by means of an indium-tin alloy, it will be obvious to those skilled in the art that these two elements may also be sealed by heliarc weld. This latter weld has the advantage of high mechanical strength as well as the ability to withstand temperatures in excess of the melting point of the previously discussed braze materials. However, this is a most difficult operation to perform.

There is another embodiment which results in a structure similar to FIG. 1, except that the beryllium faceplate 16 is sealed directly to the ring 12 without the internal support ring of Kovar 14. In this instance, the heliarc weld may be made directly between the beryllium faceplate 16 and Kovar ring 12.

Referring now to FIGS. 2a and 2b, there is described another structure having particular applicability to an X-ray vidicon. In FIG. 2b, envelope 10, ring 12, kovar support ring 14 and beryllium faceplate 16 are identical in all respects, both physical and functional, with the structure described in FIG. 1. However, in this instance, the X-ray sensitive material has been placed in the tube

in a particular manner. Referring to FIG. 2b, there is shown a thin membrane structure 18 that is prepared by first sputtering a conductive material, such as palladium, platinum, nickel, etc., onto a highly polished glass disc, not shown. The coated disc then has a layer of copper deposited thereon to a thickness of about 4-10 microns. This layer may be deposited by any one of many techniques, one of which is electroplating. The resulting copper foil 18 is then removed from the glass, mounted between two supporting rings, 20 and 22, and sealed into position by spot welding around the periphery of rings 20 and 22. The support rings may be of a thickness ranging from 0.002" to 0.005". After trimming the edges of excess foil extending beyond the support rings, the copper foil ring assembly is fired in a reducing atmosphere at about 800° C. to cause the copper to recrystallize, and thus form an extremely taut membrane with extremely uniform surface characteristics.

The whole assembly, consisting of rings 20 and 22 and the taut membrane 18, is then sealed to the underside of supporting ring 14, across the inside diameter thereof. The layer 18 then serves as the substrate for the subsequent layer of photoconductor 24, such as selenium, antimony trisulfide, arsenic sulfides, and arsenic selenides, applied thereto (FIG. 2b). If required, a thin layer 26 of freshly vaporized tin, gold, or aluminum may be interposed between the copper layer 18 and the selenium layer 24 to prevent any possibility of reaction between the copper and selenium. If the additional layer of tin or gold or aluminum is necessary, it is possible to avoid the chemical reaction contamination by depositing interposed layer 26 to a thickness of the order of 700 angstroms.

The only other consideration in both this embodiment and in the following embodiments, reside in the spacing between layer 18 and the underside of beryllium window 16. It should be here noted that this distance should be maintained at a minimum, preferably with the copper foil being contiguous with the underside of the beryllium window 16. To do this, it may be necessary, upon some instances, to undercut that portion of kovar ring 14 in which the supporting rings 20 and 22 rest.

One of the most important considerations for an X-ray vidicon is that there be a smooth polished substrate for the selenium photoconductor without introducing any substantial increase in X-ray absorption. Another method of solving this problem is shown in FIGS. 3a and 3b. To accomplish this, a metallic ring 28 is provided of the order of 0.02" thick. Onto ring 28 there is placed a nitrocellulose membrane 30. Layer 26, which may be nickel, aluminum, gold, or other easily evaporated, low vapor pressure material is then deposited onto the membrane 30. Thus, ring 28 acts as a support for the assembly of newly vaporized material 26 and membrane 30. The assembly is then baked at an appropriate temperature to remove the membrane and, in the case of nitrocellulose, a temperature of 400° C. is found to be adequate. Thereafter photoconductor layer 24 may be evaporated or deposited on layer 26, the result being a very smooth, taut member consisting of nickel, aluminum, gold, or other easily evaporated, low vapor pressure material, supported by a metal ring with the photoconductor 24 being placed on the surface of the taut member. The whole assembly is then welded or clamped into position against kovar ring 14, as shown in FIG. 3b.

It has been found that an extremely thin layer of glass or mica may be used as a substrate without an appreciable increase in X-ray absorption. In the embodiment of FIG. 4, there is shown a glass or mica disc 36, approximately 5 mils thick, interposed between beryllium faceplate 16 and photoconductor 24. On the side of the glass disc facing the photoconductor layer 24, there is vaporized a thin conductive material 26 which may consist of aluminum, tin, or gold (or other vaporizable metallic ma-

terial) to act as a conductive coating for selenium layer 24.

Another version of this embodiment which will now become obvious involves preparing the glass disc in a manner similar to the production of an Image Orthicon glass target. That is, a large bubble of glass is blown wherein the thickness of the glass is of the order of 0.0001". Thereafter, a ring, preferably nickel-iron, is provided on which the thin glass is stretched and affixed. Thereafter, the intermediate metallic layer 26 is provided on the glass surface and the photoconductor layer 24 deposited on the metallic layer 26. Considerable improvement in surface conditions may be realized if the blown glass substrate 36 that is used is completely devoid of marks that usually are found in glass of such small thickness. By carefully selecting portions of the glass bubble prior to its use, a surface virtually free of any detrimental marks or blemishes can be attained.

It will also be obvious to those skilled in the art that a sheet of mica of the order of 0.001" may be substituted for the glass disc 36. Mica is superior to glass in that a thinner supporting structure may be more readily attained without the need for any supporting rings. However, it is obvious that, insofar as surface uniformity characteristics are concerned, it is considerably more difficult to obtain a sheet of mica that is completely free of any detrimental blemishes.

Since glass or mica may be used in this embodiment, it will be necessary to use a spring-like arrangement 38 or some other means for clamping and holding the assembly in place.

Referring now to FIG. 5, there is shown a structure eminently suited for use in a beryllium faceplate X-ray vidicon. However, it has been found that when the photoconductor layer 24 is vaporized directly onto the beryllium, a large percentage of selenium recrystallizes from the desirable amorphous state to a much less desirable low resistivity crystalline form. It, therefore, becomes necessary to provide means for preventing the reaction between the beryllium and photoconductor. This may be done by interposing a layer of vaporized tin 26 between the beryllium faceplate 16 and the photoconductor layer 24.

This layer of tin satisfies all the requirements for the barrier layer in that it provides low X-ray absorption, it may be easily vaporized without the formation of lumps, it is non-reactive with beryllium and, lastly, it has been found to be non-reactive with the photoconductor. While gold and aluminum also work well, we have found that tin is preferable.

For a showing of our invention incorporated in a typical X-ray vidicon-type tube, reference is made to FIG. 6 which shows, for example, the embodiment of FIG. 2b incorporated in a completed device. In this figure, the basic structure 13 is shown wherein ring 12 is embedded in wall 10, as previously described. The wall 10 and the structure 13 together comprise a vacuum-type envelope having an electron gun 40 mounted in one end thereof. The components that make up gun 40 include the usual cathode 42, control electrode 44, and one or more accelerating electrodes 46, all of which are connected to lead-in means 48 in a well-known manner. An electron beam 50 emanating from gun 40 is directed onto the target of photoconductive material 24 at the other end of envelope 10, and means is provided for focusing beam 50 and scanning it over the photoconductor 24. Such means may include a focussing coil 52, a deflection yoke 54, and an alignment coil 56, all of which are arranged approximately as shown. Another electrode such as grid 58 having a suitable potential applied thereon is positioned adjacent a photoconductive material 24 and, in operation, functions cooperatively with focussing coil 52 to insure that electron beam 50, in its final approach to the surface 24, is normal thereto. A final accelerating electrode 60 is also provided and may take the form of a metallic

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cylinder or a conductive coating painted on the interior wall 10. The lead-in means, not shown in detail, are provided for the purpose of connecting electrode 60 as well as the gun electrodes 42, 44, and 46 to the appropriate source of electrical potential located externally of the tube.

While there has been described what is presently considered a preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the inventive concept contained therein, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. An X-ray sensitive electron discharge device comprising an evacuated dielectric envelope, a source of electrons in one end of the envelope, and a faceplate assembly sealing the opposite end of the envelope, said faceplate assembly comprising a beryllium disc on the outer surface thereof, said disc being transparent to X-radiation and opaque to visible light, a layer of X-ray sensitive photoconductive material on the inner surface thereof, said material being noncompatible with beryllium and being exposed to electrons from said source, and means between said beryllium disc and photoconductive material for preventing reaction between the photoconductive material and the beryllium disc.

2. An X-ray sensitive electron discharge device comprising an evacuated dielectric envelope, a source of electrons in one end of the envelope, and a faceplate assembly sealing the opposite end of the envelope, said faceplate assembly comprising a beryllium disc on the outer surface thereof, said disc being transparent to X-radiation and opaque to visible light, a layer of X-ray sensitive photoconductive material on the inner surface thereof, said material being noncompatible with beryllium and being exposed to electrons from said source, said photoconductive material being spaced from said beryllium disc to prevent reaction therebetween.

3. An X-ray sensitive electron discharge device comprising an evacuated dielectric envelope, a source of electrons in one end of the envelope, and a faceplate assembly sealing the opposite end of the envelope, said faceplate assembly comprising an annular metal structure sealed at one end to the end of the envelope, a beryllium

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disc sealed to and closing the opposite end of the structure, and a layer of photoconductive material on the inner surface of the faceplate assembly and exposed to electrons from said source, said photoconductive material being noncompatible with beryllium and being supported at a point inwardly removed from said beryllium disc, and means between the beryllium disc and photoconductive material for preventing reaction therebetween.

4. A device substantially as set forth in claim 3 wherein said annular structure comprises a first ring sealed to the end of the envelope, and a second ring sealed to one side of the beryllium disc, the rings being sealed together in a manner having an annular portion of the second ring extending inwardly of the structure, the photoconductive material being supported by an annulus secured to said exposed portion of the second ring.

5. A device substantially as set forth in claim 3 wherein an annulus is mounted on said annular structure and supports a thin transversely extending metal membrane upon which the photoconductive material is deposited, the membrane lying between the photoconductive material and beryllium disc.

6. A device substantially as set forth in claim 3 wherein an annulus is mounted on said annular structure and supports the layer of photoconductive material, a thin layer of X-ray transparent material being disposed between the photoconductive material and the beryllium disc to prevent reaction therebetween.

7. A device substantially as set forth in claim 3 wherein a thin layer of glass is supported upon the annular structure, and the photoconductive material is disposed upon the surface of the layer of glass opposite the beryllium disc.

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