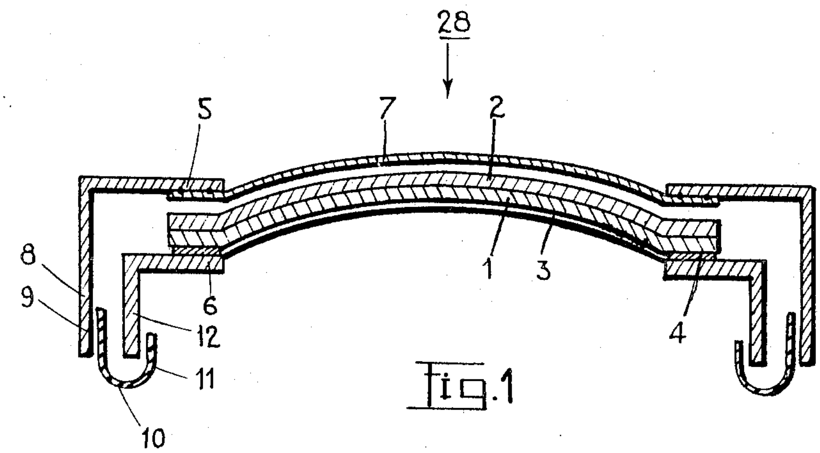

Fig. 1

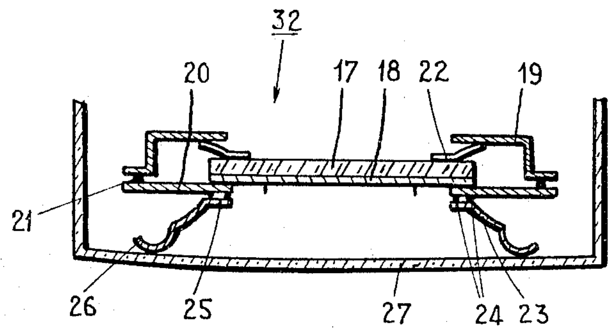

Fig. 2

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IMAGE-CONVERTER TUBE WITH OUTPUT FLUORESCENT SCREEN ASSEMBLY RESILIENTLY MOUNTED

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Fig. 3

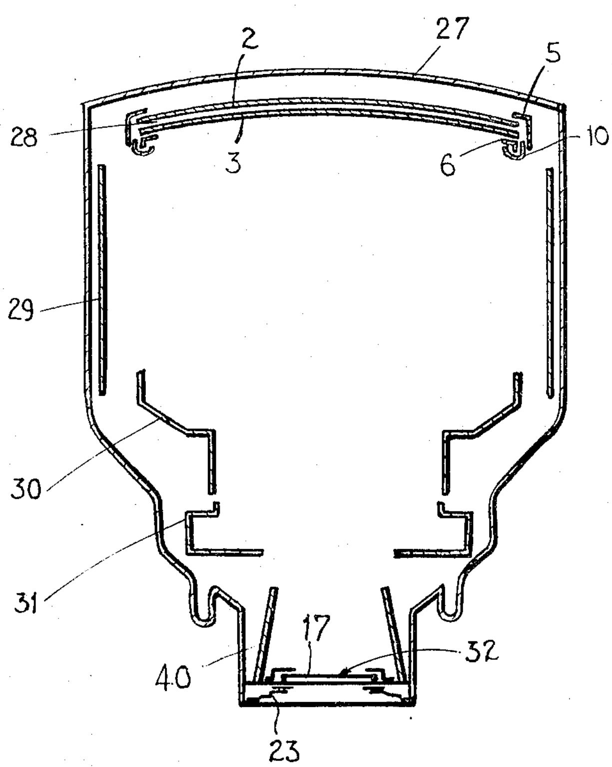

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IMAGE-CONVERTER TUBE WITH OUTPUT FLUORESCENT SCREEN ASSEMBLY RESILIENTLY MOUNTED

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7 Claims. (Cl. 313—94)

This invention relates to electron tubes of the general class including an output image-forming screen, usually fluorescent or luminescent in character, provided in the sealed envelope of the tube, and upon which an image pattern is formed by impact of photo electrons on the screen in the operation of the tube. The image-forming screen may be adapted for direct visual observation or it may serve to transmit the image pattern formed on it to further apparatus. Tubes of this general class are herein termed image converter tubes.

One type of image converter tube to which the invention is more especially, though not exclusively directed is that of brightness amplifier or image-intensifier tubes as used especially in X-ray work to increase the brightness of a primary image produced by X-rays.

It is a general object of this invention to improve the construction of image converter tubes in respect to immunity of the output image from defects due to dust and the like contaminating particles present within the sealed envelope of the tube.

In the manufacture of large electron tubes there are many sources of contamination which no amount of care during fabrication is able to avoid. Minute particles and dust motes of all description floating about in the atmosphere of the shop, frequently small shreds of textile fabric from the operators' clothing, become charged with electricity, find their way into the tube before evacuation and cling to the tube walls by electrostatic attraction, and finally become permanently sealed in the tube. Fragments of metal and metal oxides from electrode-soldering operations performed in the tube are another source of contamination. Frequently, a photoemissive layer is formed within the tube after sealing, through evaporation-deposition of alkali metals vaporized in situ from electrically heated evaporator receptacles enclosed in the envelope. Such process leads to the presence of contaminant particles within the sealed tube, such as particles stripped off or/and evaporated from the walls of the evaporator receptacles and chemical compounds produced by side reactions.

In brightness amplifier tubes of the kind used e.g. for intensifying an X-ray image, another and particularly troublesome source of contamination has been provided by the presence of the fluorescent layer coating the outer surface of the primary or input screen of the tube. The fluorescent coatings used in such tubes contain relatively fragile constituents, and particles are apt to be stripped from them throughout the service life of the tube.

In view of the gain in brightness inherently provided by an image converter tube, and the optical magnification of its output image when viewed through an optical instrument or other means of observation, the presence of any such foreign particles that may have settled on or beyond the surface of the output image screen of the tube is seen as a conspicuous flaw and detracts seriously from the utility of the apparatus.

For these reasons, certain delicate image converter tubes, such as image orthicons used in television camera apparatus, have heretofore been required to be manipulated carefully and operated only in a horizontal position or at a small angle to the horizontal plane, in order to avoid setting up a "cloud" of floating particles inside the tube which might then settle on and beyond the output screen and spoil the image. This is a serious limitation, and one that is entirely unacceptable in many applications, such in particular as the X-ray image intensifier tubes earlier mentioned, since medical X-ray work, for example must have to be carried out in any orientation of the tube, including the vertical.

It is an object of this invention to overcome the above difficulties and limitations by positively preventing any foreign particles inevitably present in an image converter tube from being deposited on or beyond the output surface of the output image forming screen of the tube. Another object, relating more especially to image converter tubes provided with a fluorescent primary image-forming screen, is to prevent in a positive manner any particles that may be stripped off the fluorescent surface from entering the general tube cavity whence they may settle on or beyond the output screen.

According to an important feature of the invention, there is provided in an image converter tube having a sealed envelope, a photocathode in the envelope near an input end thereof, an output image-forming screen assembly in the envelope near to an output end thereof, and electron-optical means in the envelope for directing photo electrons from the photocathode on to an input surface of said output screen to form an image pattern thereon, the improvement comprising an annular dust-shield member positioned generally in a space between said output image-forming screen assembly and the output end of the envelope, and having one marginal portion sealingly engaging the periphery of said screen assembly and another marginal portion sealingly engaging the inner surface of said envelope so as substantially to seal off the said space from the general cavity of the envelope.

According to another feature of the invention, more especially applicable to X-ray image-intensifier tubes and the like, there is provided in such a tube having a sealed envelope, a primary or input screen assembly in the envelope near an input end thereof said primary screen assembly including a supporting plate transparent to light radiations, a fluorescent surface on its input side and a photoemissive surface on its output side, a secondary or output image-forming screen in the envelope near the output end thereof and electron-optical means for directing photoelectrons from the photoemissive surface of the primary screen on to an inner surface of the secondary screen to form an image pattern thereon, the improvement comprising means for sealing the primary screen assembly comprising a pair of annular flanged supporting members having first flanges thereof sealed to peripheral portions of opposite sides, respectively, of said primary screen assembly, and having second flanges projecting therefrom, and an annular sealing strip of generally U-shaped cross section having its leg respectively sealingly secured to said second flanges whereby to seal off said fluorescent surface of the primary screen assembly from the general cavity of the envelope.

An exemplary embodiment of the invention will now be described for purposes of illustration but not of limitation with reference to the accompanying drawings, wherein:

FIG. 1 is a cross sectional view, with certain dimensions exaggerated for clarity, showing a primary or input screen assembly for an improved brightness intensifier tube;

FIG. 2 is a cross sectional view with certain dimensions exaggerated, of the output end of the same tube showing the secondary or output screen assembly provided with the dust shield member of the invention; and

FIG. 3 is a small-scale simplified view in section of the image intensifier tube provided with both improvements shown in FIGS. 1 and 2, only the main components of the tube being shown.

The embodiment of the invention disclosed by way of example is an image-intensifier tube for X-rays. Referring first to FIG. 3, the tube comprises a sealed evacuated glass envelope **27**. Suitably supported in the envelope near its input, herein upper, end is a primary screen assembly generally designated **28**. This screen assembly, as will be described in detail later with reference to FIG. 1, has a fluorescent coating **2** on its input or upper side, and a photoemissive layer **3** on its output or lower side. Mounted within the reduced output end, or lower end, of the envelope **27** is a secondary or output screen assembly **32**, which also will be described in detail later (FIG. 2). The screen has a fluorescent coating **17** on its input or upper side.

A system of annular electron-optical electrodes are positioned coaxially between the primary screen **28** and secondary screen **32**. These electrodes, shown in outline at **29**, **30**, **31**, and **40**, are connected in operation to certain definite potentials for focussing a beam of photoelectrons emitted from the photo-emissive under surface **3** of primary screen **28** on to the fluorescent upper surface **17** of secondary screen **32**. A more detailed description of the X-ray image intensifier tube here referred to may be found in the following copending patent applications: Prop. 2946, Prop. 2954.

The general operation of the tube is as follows: X-rays striking the fluorescent upper surface **2** of primary or input screen **28** excite fluorescence in it and the resulting photons strike the photo-emissive under surface **3**, or photocathode, of said primary screen assembly **28**. Photoelectrons are thereby emitted in a pattern corresponding to the original X-ray image. These photoelectrons are accelerated and at the same time focussed by the action of the electrode system **29**, **30**, **31**, **40**, on to secondary screen **32**. The photoelectrons excite the fluorescent upper surface **17** of secondary screen **32** and form an image corresponding accurately to the original X-ray image but of reduced size and greatly increased brightness. When such image formed on screen **32** is viewed through a magnifying optical instrument to restore it to its initial dimensions, the gain in brightness or luminance is of the order of several thousand times. Instead of direct viewing, the image may be exploited in other ways, e.g. photographically, cinematographically or televisually.

It will be readily conceived that any small foreign particle penetrating into the space between the secondary screen **32** and the end wall of the tube, will result in a serious flaw in the output image especially after magnification.

Such particles when settling on either the output side of the secondary screen assembly **32** or the inner surface of the end wall of glass envelope **27** constituting a viewing window, will project highly contrasting optical shadows which very seriously affect the quality of the observed image even when the particle originating the shadow is quite small. It will be readily understood that the settling of particles on the input side of the output screen assembly **32** is much less troublesome because the incident beam of photoelectrons strikes each point of the fluorescent layer **17** at a wide range of angles of incidence, so that there will generally be an appreciable number of electrons to excite the fluorescent emission of the layer in the area under such a particle.

The sources of contaminating particles in the tube are many and unavoidable as earlier indicated. They include dust particles drifting in the shop atmosphere and which become electrostatically charged so that they cannot be removed on evacuation of the tube. They also include fragments of metallic and oxide and other compounds generated during evaporation deposition of the photocathode surface **3** of screen **28**, after the tube has been sealed, from evaporator receptacles (not shown) which may be positioned within the specially formed central electrode **31** as disclosed in a co-pending application. Perhaps the chief source of contamination within the tube is the fluorescent upper surface **2** of the primary screen **28**. The fluorescent coatings used in certain applications contain rather fragile constituents and tiny fragments tend to be stripped from it. These fragments, in addition to impairing the output image as described above, may also impair the photoemissive properties of the photocathode layer **3** on the under surface of the primary screen **28**.

Reference will now be made to FIG. 1 which shows in detail the construction of the primary screen assembly **28** according to the invention. This assembly includes a thin domed glass plate **1** having the afore-mentioned photoemissive (photocathode) layer **3** provided on its under surface, preferably by the evaporation-deposition process within the sealed tube, earlier referred to. The upper surface of glass plate **1** carries the fluorescent coating **2**, of a suitable composition to be excited by X-rays. The under surface of plate **1** is secured through an interposed annular electrode **4** serving to apply an operating potential to photocathode **3**, to the upper surface of the inwardly projecting flange of an inner annular supporting member **6**, of angle section, made of suitable metal. The assembly further includes a thin sheet element **7** of aluminum transparent to the incident X-rays, domed to the same curvature as the glass plate **1** and spaced a short distance above the upper surface of fluorescent coating **2**. The purpose of this aluminum shield is mainly to reflect back on to the primary screen a major amount of the photons emitted by the fluorescent layer **2** in an upward direction, and thereby increase the efficiency of the screen assembly. The periphery of aluminum sheet **7** is secured to the under surface of the inwardly projecting flange of an outer annular supporting member **5**, which in turn is suitably supported from the inner wall surface of the envelope of the tube, as by way of a Kovar seal or otherwise.

The annular supporting members **5** and **6** have downwardly projecting flanges **8** and **12** respectively, with the flange **12** of the inner member being fitted into the flange **8** of the outer member. In this connection it will be understood that in FIG. 1 the width of the gaps between various components has been exaggerated for clarity. Actually the inner flanged member **6** is fitted into the outer member **5** with relatively small clearance. In practice however it is found that such clearance which may be of the order of 0.2 mm. on the radius, is sufficient to allow small fragments from the less stable constituents of the X-ray sensitive fluorescent layer **2**, to slip past the gap between the flanges **8**, **12** of the supporting members.

In accordance with the invention, passage of such fragments through the gap between flanges **8** and **12** into the general cavity of the tube is prevented by the provision of a sealing strip member **10**, of annular form and U-shaped cross section as shown, preferably made of thin aluminum foil of e.g. 0.05 mm. thickness. The sealing strip **10** has its outer leg bonded to the inner surface of the outer flange **8**, and its inner leg bonded to the inner surface of the inner flange **12**, as shown. Thus the seal **10** acts to trap particles dislodged from the fluorescent coating **2** and prevent their fouling the secondary screen **32** and/or the photocathode surface **3**.

Referring now to FIG. 2, the secondary screen assembly **32** comprises a flat glass plate **18** having a fluorescent layer **17** deposited on its upper surface. The under surface of glass plate **18** is supported at its periphery on the inner marginal part of a flat, metallic annular supporting member **20**. Member **20** may be peripherally supported from the inner surface of tube envelope **27** through any suitable means, e.g., a Kovar seal. A metallic retainer member **19** of the flanged cross sectional shape shown has a lower flange secured to the outer periphery of supporting member **20** as by spots of solder **21**, and its inwardly projecting upper flange overlies the outer edge part of the fluorescent layer **17**. An annular spring member **22** or spring washer is clamped between the upper surface of layer **17** and the under surfaces of said upper flange of retainer **19**, so as to maintain the secondary screen in resiliently assembled relation with its supporting means.

Soldered as at **24** to the under surface of flat annular supporting member **20** around its inner periphery, is the inturned upper flange **25** of a generally frustoconical, annular, metallic dust shield member **23**. The larger base of this frustoconical member has an out-turned, rounded flange **26** which engages the upper surface of the end wall of the tube envelope **27**. The dust shield member **23** positively protects the space between the secondary screen assembly and the tube end wall against the ingress of foreign particles. In the manufacture of the tube, it is convenient that relatively large tolerance should be available as to the precise point at which supporting member **20** is supported from the glass tube casing, and hence the free space between the secondary screen plate **1** and the tube end wall may vary from one tube to another. The resiliency of the dust shield member **23** due especially to the rounded lower-flange **25** makes it possible to take up such dimensional variations. The flared fructoconical shape of dust-shield member **23** prevents unwanted reflection of light from the fluorescent coating **17** at the inner surfaces of said member.

X-ray image intensifier tubes constructed as here disclosed and embodying simultaneously both main features of the invention, namely the sealing strip **10** preventing egress of fluorescent particles from out of the primary screen assembly, and dust shield **23** preventing ingress of particles from whatever source into the space under the secondary screen assembly **32**, have given excellent performance in regard to the clearness and general quality of the output images produced by them. The extremely troublesome effects of floating dust particles sealed in the tube on the quality and resolution of all parts of the output image, a constant source of trouble to users of tubes of this general class in the past, are completely eliminated, no matter how the tube is manipulated or oriented in use. It will be realized however that the two improvements just mentioned may well be used separately. In particular, in image-converter tubes having no fluorescent layer provided on their primary screen assembly, it is self-evident that the sealing strip **10** would be superfluous. Various other departures from the exemplary embodiment illustrated and described may be conceived within the scope of the invention.

I claim:

1. In an image converter tube having a sealed envelope, a photocathode in the envelope near an input end thereof, an image-forming output screen assembly in the envelope near and spaced from an output end thereof, and electron-optical means in the envelope for directing photo-electrons from the photoacthode on to an inner surface of said output screen to form an image pattern thereon, the improvement comprising means supporting said output screen assembly at a prescribed spacing from said output end of the tube including spring means resiliently pressing the output screen assembly against its supporting means an annular dust-shield member positioned in the space between the output screen assembly and the output end of the envelope and having one marginal portion sealingly engaging the periphery of the screen assembly and another marginal portion sealingly engaging the inner surface of said envelope so as to seal off said space from the general cavity of the tube envelope against ingress of foreign particles thereinto.

2. In an image converter tube having a sealed envelope, a photocathode in the envelope near an input end thereof, an image-forming output screen assembly in the envelope near and spaced from an output end thereof, and electron-optical means in the envelope for directing photoelectrons from the photocathode on to an inner surface of said output screen to form an image pattern thereon, the improvement comprising a resilient, annular, frustoconical dust-shield member positioned in the space between the output screen assembly and the output end of the envelope and having its smaller base portion sealingly engaging the periphery of the screen assembly and its larger base portion sealingly engaging the inner surface of the end wall of said envelope so as to seal off said space from the general cavity of the tube envelope against ingress of foreign particles thereinto, said resilient member being capable of compensating for variations in the distance from the output screen assembly to the end wall of the tube envelope.

3. In an image converter tube having a sealed envelope, an input image-forming screen assembly in the envelope near an input end thereof including a fluorescent layer on an input side and a photoemissive layer on an output side of said input screen assembly, an output image-forming screen assembly in the envelope near the output end thereof and electron-optical means for directing photoelectrons from said photoemissive layer of the input screen assembly to an image-forming input surface of the output screen assembly, the improvement comprising means for sealing the input screen assembly comprising a pair of flanged annular supporting members having first flanges sealed to peripheral portions of opposite sides, respectively, of the input screen assembly and having second flanges projecting therefrom, and an annular sealing strip of generally U-shaped cross section having its legs respectively sealingly engaging the second flanges of the respective members whereby to seal off said fluorescent layer from the general cavity of the tube envelope against the egress of fluorescent particles into the cavity.

4. A tube according to claim **3** wherein the sealing strip comprises aluminum foil.

5. A tube according to claim **3** including the further improvement comprising an annular dust-shield member positioned in a space provided between the output screen assembly and the output end of the envelope and having one marginal portion sealingly engaging the periphery of the screen assembly and another marginal portion sealingly engaging the inner surface of said envelope so as to seal off said space from the general cavity of the tube envelope against ingress of foreign particles thereinto.

6. In an image converter tube having a sealed envelope, an input image-forming screen assembly in the envelope near an input end thereof, said assembly comprising, serially-disposed in the direction of propagation of input radiations, a sheet element transparent to such radiations, a fluorescent layer and a photoemissive layer, an output image-forming screen assembly in the envelope near the output end thereof and electron-optical means for directing photoelectrons from said photoemissive layer of the input screen assembly to an image-forming input surface of the output screen assembly, the improvement comprising means for sealing the input screen assembly comprising a pair of flanged annular supporting members having first flanges sealed to peripheral portions of said sheet element and said photo-emissive layer respectively and having second flanges projecting therefrom, and an annular sealing strip of generally U-shaped cross section having its legs respectively sealingly engaging the second flanges of the respective members whereby to seal off said fluorescent layer from the general cavity of the tube envelope against the egress of fluorescent particles into the cavity.

7. A primary image-forming screen assembly for an image-intensifier tube comprising in combination a supporting plate transparent to light, a fluorescent coating on an input side surface of the plate, a photoemissive coating on an output side surface of the plate, a shielding sheet element transparent to input radiations supported adjacent the input side of said fluorescent coating, a first flanged, annular supporting member having a first flange sealingly secured to the periphery of said shielding element and a second flange projecting therefrom towards the output side of said screen assembly, a second flanged, annular supporting member having a first flange sealingly secured to the periphery of said photoemissive coating and a second flange projecting therefrom towards the output side of said screen assembly and fitted a loose fit into the second flange of the first annular supporting member, and an annular sealing strip of U-shaped cross section having an outer leg sealingly engaging a surface of the second flange of said first annular supporting member and an inner leg sealingly engaging a surface of the second flange of said

second supporting member whereby to seal off the interior of said screen assembly against the egress of particles stripped off said fluorescent coating.

References Cited by the Examiner

UNITED STATES PATENTS

2,418,780	4/1947	Leverenz	313—92 X
2,640,162	5/1953	Espenschied et al.	313—65 X
3,026,437	3/1962	Niklas	313—65
3,043,974	7/1962	McGee	313—65

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