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X-RAY IMAGE INTENSIFIER SCREEN

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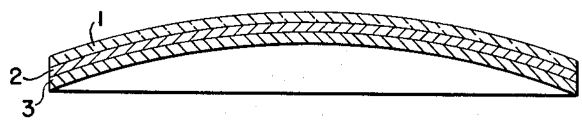

Fig. 1.

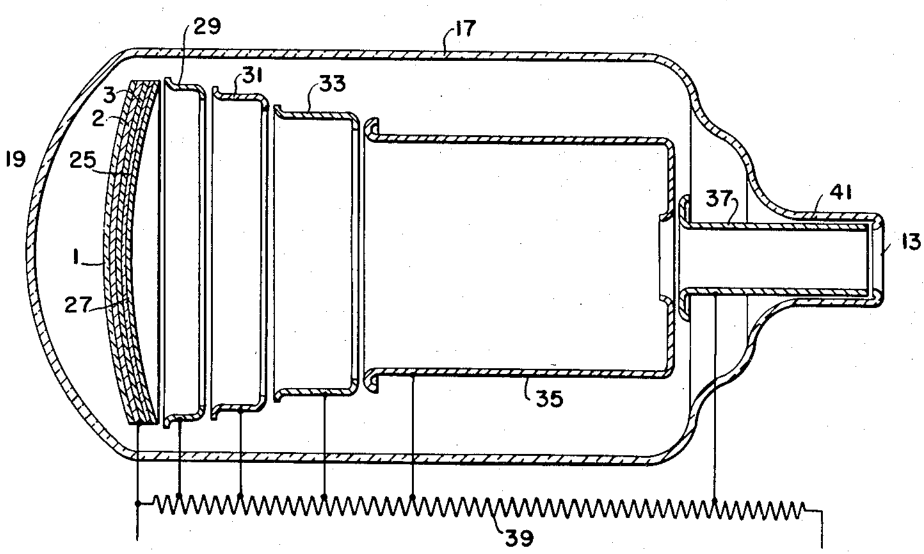

Fig. 2.

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X-RAY IMAGE INTENSIFIER SCREEN

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My invention relates to fluorescent screens, and in particular relates to an arrangement for eliminating the slow decay component of light which is characteristic of certain such screens as zinc sulphide-silver.

Zinc sulphide-silver has many highly desirable qualities for fluorescent screens such as those used in X-ray fluoroscopy and in particular has proved highly satisfactory in many respects for the fluorescent material used in the X-ray Image Intensifier described in Mason and Coltman U. S. Patent 2,523,132. However it has been found to have one somewhat undesirable characteristic in the form of a slow building up of energy storage during X-radiation, which stored energy is later given out as an afterglow continuing for hours after the X-radiation has ceased. In the course of several hours use for X-ray examination this accumulated after glow becomes strong enough to partially obscure picture detail.

In accordance with my invention I avoid the above-mentioned persistent afterglow by providing a layer of a red-emitting phosphor in close proximity to the zinc sulphide-silver. This phosphor is stimulated to emit red light partly by the incident X-rays or other primary radiation and partly by the bluish radiation generated by that primary radiation in the zinc sulphide-silver. Such red light has the effect of releasing the above-mentioned slowly stored energy from the zinc sulphide-silver. One suitable red-emitting phosphor is zinc sulphide-manganese, ZnS(Mn), but other substances which emit red or even infra-red radiation may also be used.

One object of my invention is to provide means for eliminating the afterglow just described in zinc sulphide-silver and other fluorescent materials showing it.

Another object of my invention is to provide a novel type of fluorescent screen.

Still another object is to provide a short-persistence fluorescent screen of high efficiency in transforming X-rays into light.

Another object is to provide a composite fluorescent screen having the short-time luminous characteristics of zinc sulphide-silver screen without the long-time afterglow found in the latter.

A further object is to provide an improved form of image intensifier free from substantial cumulative long term background glow.

Other objects of my invention will become evident on reading the following description taken in connection with the drawings in which:

Fig. 1 shows a fluorescent screen embodying the principles of my invention; and

Fig. 2 shows an image intensifier tube employing such a screen.

Referring to the drawings in detail the fluorescent screen of Fig. 1 comprises a glass backing-layer 1, which may for example have the shape of a watch-glass, of lime-glass having a layer 2 of a phosphor such as zinc sulphide-manganese [ZnS(MN)] which emits red or infra-red light (i. e. light not lower than 6000 angstroms in wave length) when irradiated with the bluish light which zinc sulphide (silver) emits under incidence of X-rays or electrons. Superposed on the layer 2 is a layer 3 of zinc sulphide-silver or other phosphor having an undesired emissive component, the emission of which is expedited by light of the character given out by the layer 2. To give a specific example the glass backing-plate 1 may be about 15 cm. in diameter by 0.1 cm. thick; the layer 2 may be of ZnS(Mn) about 0.02 cm. thick; and the layer 3 may be 0.01 cm. thick.

When X-rays are projected through the backing-layer 1 some are absorbed in layer 2 but a greater portion passes through and may be absorbed by the layer 3. The portion absorbed in layer 2 generates red light a large portion of which is absorbed in layer 3, and there prevents the long-time storage of the energy which the X-rays would otherwise build up in layer 3 producing a long-term afterglow.

The screen of Fig. 1 may be employed in the X-ray image intensifier of Fig. 2 which comprises a vacuum-tight envelope 17 which has a transparent end portion 19 near which the fluorescent screen of Fig. 1 is mounted.

On the input fluorescent surface, a transparent conductive layer 25 is deposited. A suitable transparent conductor is manufactured by the Pittsburgh Plate Glass Company and is identified by the trade-name Nesa.

A photosensitive surface 27 is formed on the transparent conductive layer 25. This photosensitive surface should have the property of emitting electrons substantially only when light of the frequencies equal to or greater than that of the light emitted by the input fluorescent screen impinge thereon. In the preferred practice of the invention, the photosensitive screen is composed of cesium-antimony. In the following specification I shall refer to his photo-electric surface as of the caesium antimony type.

The transparent barrier 25 between the input fluorescent screen 3 and the photoelectric surface 27 is used to assure a conductive return for the charges which leave the photoelectric surface during operation. This conductive barrier is necessitated by the fact that in general the photosensitive surface 27 is not sufficiently conductive to serve as a return. In certain situations, the photosensitive material may be sufficiently conductive. In such situations, the transparent layer 25 may be non-conductive or omitted; for example, it may be glass of the type with which the fluorescent material of the input screen 3 is mixed.

A plurality of conductive cylinders 29, 31, 33, 35 and 37 of progressively increasing length and progressively decreasing diameter extend from the input plate longitudinally along the envelope 17. The first of these cylinders 29 is insulated from the input plate and each of the other cylinders is insulated from succeeding and preceding cylinders. Potentials of different magnitudes are impressed on the cylinders 29 to 37 from a suitable voltage divider 39. The cylinders function as an electron optical lens system for the electron image emitted by the photosensitive surface 27.

The cylinder 37 having the smallest diameter extends into a constricted neck 41 of the envelope 17. At the terminal of this neck, very near to the opening of the cylinder 37 of smallest diameter, the composite output fluorescent plate 13 is mounted. This composite plate is composed of an electron-responsive phosphor screen on which a layer of aluminum is deposited. The phosphor may be of any suitable type but in accordance with the preferred practice of our invention is composed of zinc cadmium sulphide and is identified by RCA Victor, its manufacturer, as 33Z604B. The aluminum layer is of sufficient thickness to obstruct back emission of light from the output phosphor to the photosensitive surface **27** and sufficiently thin to permit penetration of the electrons.

While I have described the zinc sulphide-silver and zinc sulphide-manganese as if in separate layers they may be mixed to form a single layer.

I claim as my invention:

1. A fluorescent screen comprising a layer of zinc sulphide-silver and zinc sulphide-manganese, a coating on said layer comprising cesiated antimony and an electrically conductive material transparent to the fluorescent light from said zinc sulphide-silver, and supporting means for said layer.

2. A fluorescent screen comprising a layer of zinc sulphide-silver and a material which emits radiation predominantly above 6000 angstroms in wave-length when irradiated by the fluorescent light of said zinc sulphide-silver, a coating comprising an electrically-conductive first material which is transparent to the fluorescent light of said zinc sulphide-silver and a photoelectric second material which emits electrons when struck by said fluorescent light and being superposed on said layer, and supporting means which is transparent to X-rays on the opposite side of said coating from said layer.

3. A fluorescent screen comprising a layer of zinc sulphide-silver and a material which emits radiation predominantly above 6000 angstroms in wave-length when irradiated by the fluorescent light of said zinc sulphide-silver, a coating comprising cesiated antimony and an electrically-conductive material which is transparent to the fluorescent light of said zinc sulphide-silver superposed on said layer, and supporting means for said layer.

4. A fluorescent screen comprising a layer of zinc sulphide-silver and a first material which emits radiation predominantly above 6000 angstroms in wave-length when irradiated by radiation which is below 6000 angstroms in wave-length, a coating on said layer comprising an electrically conductive second material which is transparent to the fluorescent light of said zinc sulphide-silver and a photoelectric third material which emits electrons when struck by said light, and supporting means which is transparent to X-rays on the opposite side of said coating from said layer.

5. A fluorescent screen comprising a layer of zinc sulphide-silver and a material which emits radiation predominantly above 6000 angstroms in wave-length when irradiated by radiation which is below 6000 angstroms in wave-length, a coating on said layer comprising cesiated antimony and an electrically conductive material which is transparent to the fluorescent light of said zinc sulphide-silver, and supporting means for said layer.

6. A fluorescent screen comprising a layer comprising zinc sulphide-silver and zinc sulphide-manganese, a coating on said layer comprising an electrically conductive material which is transparent to the fluorescent light of said zinc sulphide-silver and a photoelectric material which emits electrons when struck by said light, and supporting means for said layer.

7. A fluorescent screen comprising a layer comprising zinc sulphide-silver and zinc sulphide-manganese, a coating on said layer comprising cesiated antimony and an electrically conductive material which is transparent to the fluorescent light of said zinc sulphide-silver, and supporting means on the opposite side of said coating from said layer.

8. An X-ray image intensifier comprising a fluorescent screen comprising a layer of zinc sulphide-silver and a first material which emits radiation of wave-length predominantly greater than 6000 angstroms when irradiated by the fluorescent light from said zinc sulphide-silver, a coating on said layer which comprises an electrically conductive second material which is transparent to the fluorescent light of said zinc sulphide-silver and a photoelectric third material which emits electrons when struck by said light, supporting means for said layer, and an output screen upon which said electrons are incident.

9. An X-ray image intensifier comprising a fluorescent screen comprising a layer of zinc sulphide-silver and a first material which emits radiation of wave-length predominantly greater than 6000 angstroms when irradiated by the fluorescent light from said zinc sulphide-silver, a coating on said layer which comprises cesiated antimony and an electrically conductive second material which is transparent to the fluorescent light of said zinc sulphide-silver, supporting means for said layer, and an output screen upon which said electrons are incident.

10. An X-ray image intensifier comprising a layer of zinc sulphide-silver and zinc sulphide-manganese, a coating on said layer comprising an electrically conductive material which is transparent to the fluorescent light of said zinc sulphide-silver and a photoelectric material which emits electrons when struck by said light, supporting means for said layer, and an output screen to receive said electrons.

11. An X-ray image intensifier comprising a layer of zinc sulphide-silver and zinc sulphide-manganese, a coating on said layer comprising cesiated antimony which emits electrons when struck by the output light from said layer when said layer is energized by X-rays, and an electrically conductive material which is transparent to the fluorescent light of said zinc sulphide-silver, supporting means for said layer, and an output screen to receive said electrons.

12. A fluorescent screen comprising a layer of zinc sulphide-silver and zinc sulphide-manganese, a coating on said layer comprising an electrically conductive first material transparent to the fluorescent light from said zinc sulphide-silver and a photoelectric second material which emits electrons when struck by said light, and supporting means transparent to X-rays and positioned on the opposite side of said coating from said layer.

13. A fluoroscopic device adapted for operation with a source of a radiant energy image and an output screen, said device comprising a first layer of zinc sulphide-silver, a second layer on said first layer and comprising zinc sulphide-manganese, each of said first and second layers being operative to emit light when energized by radiant energy from said source, a third layer on the second layer and comprising a photoelectric material which emits electrons when struck by said light, support means including a fourth layer positioned on the third layer and comprising a material transparent to said radiant energy, said device being adapted for operation with said source such that all of said layers may be positioned between the source and the output screen, with the fourth layer positioned closest to the source and the first layer positioned closest to the screen.

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