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IMAGE AMPLIFYING DEVICE

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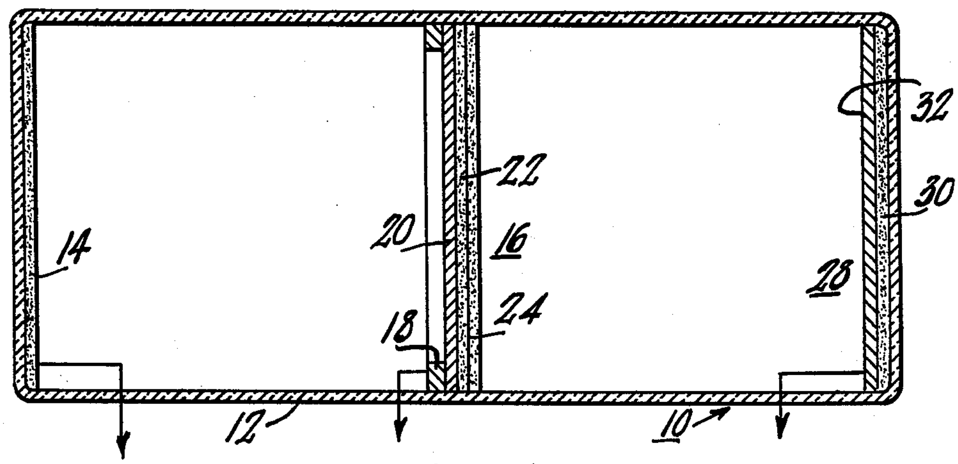

Fig.1.

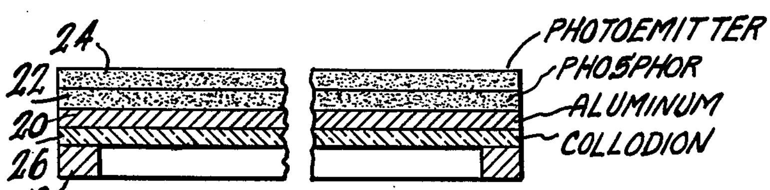

Fig.2.

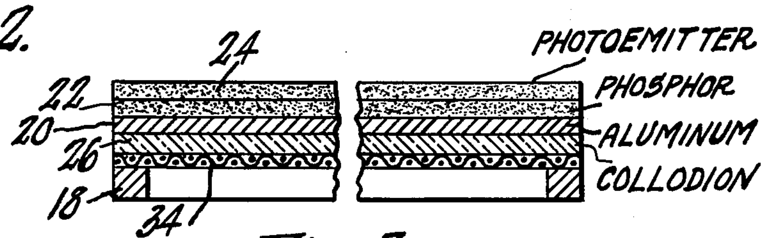

Fig.3.

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IMAGE AMPLIFYING DEVICE

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This invention relates to image intensifying tubes. In particular, this invention relates to image intensifying tubes, including one or more image amplifying multi-layer elements each of which includes a phosphor and a photosensitive member.

There are certain tube types known in the prior art used to intensify an image. These tube types include image tubes wherein the intensified image is reproduced as a light image, and image intensifying pickup tubes wherein the intensified image is reproduced as video signals.

In general, the image intensification is accomplished by directing the image from a scene onto a photoemissive cathode. Electrons from the photoemissive cathode are accelerated and strike a phosphor screen. The light from the phosphor is optically coupled to a second photoemissive cathode which produces an intensified electron image, as compared to the electron image from the first photoemissive layer. The intensified electron image may then be intensified again, visibly reproduced, or converted into a video signal.

One factor which has limited the resolution that is obtainable from a phosphor photoemissive element of the type briefly described above, is that the more efficient phosphor materials adversely affect, or are adversely affected by, the more efficient photoemissive material. Due to this harmful effect of the materials upon each other, the amplifying multilayer elements or sandwiches which have used the more efficient materials have included a thin translucent separating membrane between the phosphor and the photoemissive cathode. The separating membrane has been used (1) to physically separate the phosphor material from the photoemissive material, and (2) to support the amplifying sandwich. As is well known, the minimum possible thickness of a separating layer to provide these functions should be used so that spreading of the light image from the phosphor, as it passes through the separating layer and before it strikes the photoemissive surface, is minimized. Thus, light diffusion in the separating layer or support membrane is completely eliminated only when the separating layer is eliminated. However, because of the chemical interreaction of the phosphor and photoemissive material, this has not been possible, prior to this invention, when using the high efficiency, known phosphor materials and photoemissive materials.

Furthermore, when using an efficient amplifying sandwich of the known phosphor and photoemissive materials, there have been no known combinations of materials which would provide a self-supporting sandwich which did not require a support membrane of some type.

It is therefore an object of this invention to provide a new and improved image intensifying device.

It is a further object of this invention to provide a novel image intensifying sandwich which is characterized by its sharpness of image definition.

These and other objects are accomplished in accordance with this invention by providing an image intensifying sandwich of a phosphor and photoemissive material whrein the phosphor is made of an evaporated layer of activated alkali halide phosphor and the photoemitter is deposited directly onto the phosphor. The evaporated layer of alkali halide phosphor is deposited onto a thin light-opaque, electron-transparent aluminum film, which

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prevents light feedback and causes forward light reflection.

The invention will be more clearly understood by reference to the accompanying single sheet of drawings wherein:

FIG. 1 is a sectional view of an image intensifying device made in accordance with this invention;

FIG. 2 is an enlarged fragmentary sectional view of the image amplifying sandwich shown in FIG. 1; and,

FIG. 3 is an enlarged sectional view of another embodiment of an image amplifying sandwich made in accordance with this invention.

Referring specifically now to FIG. 1, an image intensifying device 10 is shown, which is an image intensifying image tube. The device 10 comprises an evacuated envelope 12 that is elongated and has a first semi-transparent photoemissive cathode, or photocathode 14, in one end thereof. The photocathode 14 is deposited on an end wall, or transparent face plate, of the envelope 12 and may be made of any conventional photoemissive materials. Examples of known photoemissive materials are the multi-alkali photocathode described in the U.S. patent to A. H. Sommer, 2,770,561, and the well known S–11 photosurface of manganese, oxygen, antimony and cesium described in U.S. patent to Polkosky, 2,676,282. If particular wavelengths of radiation are to be detected, for example ultra violet rays or infra-red rays, etc., the photoemissive cathode is selected for its high photoemissive response to these particular wavelengths.

Spaced from the photocathode 14 is an image amplifying sandwich 16 as is shown more clearly in FIG. 2. The image amplifying sandwich 16 comprises an annular support ring 18 which is shown as being supported from the inner walls of the envelope 12. Any other conventional support means for the ring, such as lead in pins connected to the ring 18, may also be utilized. The annular support ring 18 may be made of a material such as nickel or a nickel chromium alloy and may be approximately 10 mils thick.

Positioned upon the annular support ring 18, and spanning the aperture therein, is a light reflective electron transparent layer 20. The layer 20 may be made of a material such as aluminum and may be approximately 1,000 Angstrom units thick. The aluminum layer 20 is deposited onto the support ring 18 by first fixing a thin film of collodion 26 (FIG. 2) to the support ring 18. The collodion film 26, which is present only during the manufacture of the sandwich, may be fixed to the support ring 18 by floating a collodion film on water (not shown) and then lifting the ring 18 so as to lift the collodion film from the water. The collodion film 26 may comprise, for example, cellulose nitrate in a suitable solvent such as ethyl acetate. When the collodion body has been deposited on the support ring 18, the aluminum layer 20 may be deposited by evaporating substantially pure aluminum metal onto the collodion film 26 which now spans the aperture in the support ring 18.

After the aluminum has been deposited, an evaporated layer of phosphor 22 is deposited onto the aluminum layer 20. The evaporated layer of phosphor 22 may be any of the cathodoluminescent phosphors of the activated alkali halide class. Phosphors of this type are described in the co-pending U.S. application of D. Kleitman, Serial No. 32,397, now abandoned, filed May 27, 1960. One particular example is thallium activated rubidium iodide.

The evaporated alkali halide phosphors have been found to be very efficient. Also, these phosphors are capable of being directly exposed to chemical reaction with the known, highly efficient photoemissive surfaces without harmfully affecting the photoemissive properties of the photoemissive surface or the light producing properties of the phosphor.

Deposited on the evaporated layer **22** (in a manner described more fully hereinafter) is a photoemissive surface **24** which may be the conventional S–11 photosurface previously referred to.

In the prior art, the highly efficient cathodoluminescent phosphors normally contain sulfide. The sulfide adversely reacted with the cesium which is conventionally found in the normally efficient photoemitters. Because of this reaction, probably chemical, the prior art amplifying sandwich either did not use the materials that were known to be highly efficient materials, or the materials were deposited on opposite sides of a separating membrane. The presence of the membrane, in the prior art, inherently causes a certain amount of light spreading as the light from the phosphor passes through the membrane to the photoemitter. This disadvantage is eliminated by this invention.

On the other end of the envelope **10** there is provided an electron responsive screen **28**. The electron responsive screen **28** that is shown comprises a phosphor material **30** which is covered by a thin aluminum layer **32**. The phosphor material **30** may be any conventional phosphor e.g. zinc sulfide, or may be an evaporated alkali halide phosphor with a conventional aluminized surface **32** thereon.

It should be understood that the electron responsive screen **28** could also be a second amplifying sandwich, such as sandwich **16**, if more than one stage of amplification is desired. Furthermore, the electron responsive screen **28** could also be the storage target in an image intensified image orthicon type tube wherein the storage target is scanned by an electron beam and video signals are produced.

During the manufacture of the amplifying sandwich **16**, the collodion film **26**, the aluminized coating **20** and the phosphor **22** are preferably deposited at a time prior to the insertion of the sandwich within the tube. At this time, the support ring **18** may be spot welded to support means (not shown), within the tube. Then, the tube is evacuated and baked. The baking step volatilized the collodion film **26** so that it is removed by the evacuating pumps and the aluminum layer **20** becomes fixed to the support ring **18** as shown in FIG. 1. When this has been done, the photoemissive surface **24** is deposited from conventional evaporating boats, within the tube, not shown.

The embodiment of this invention shown in FIG. 3 is similar to that of FIG. 1 and FIG. 2 except that a mesh screen electrode **34** is fixed to the support ring **18**, for example by spot welding, and the collodion film **26** is deposited on the mesh screen **34**. The mesh screen **34** may be of the electro-formed type and may include approximately 750 apertures per inch. The mesh screen **34** may be made of copper and may be spot welded to the support ring **18**. The embodiment shown in FIG. 3 provides a more rugged structure of an image amplifying sandwich and is particularly useful where the tube is to be subjected to physical vibration during use.

The tube shown in FIG. 1 may use any conventional electrostatic or magnetic focusing and accelerating means, none of which is shown for simplicity of illustration.

What is claimed is:

1. An image intensifying tube comprising an evacuated envelope, a first photoemissive cathode for producing a photoelectron beam in one end of said envelope, a cathodoluminescent phosphor positioned so as to be energized by said photoelectron beam, said phosphor comprising a layer of activated alkali halide a second photoemissive cathode, said second photoemissive cathode being positioned on one surface of said phosphor and adapted to be excited by light from said phosphor whereby a second photoelectron beam is produced, and means for receiving said second electron beam.

2. An image intensifying tube as in claim 1 wherein a light reflective electron transparent layer is provided on said phosphor and on the side of said phosphor toward said first photoemissive cathode.

3. A self-supporting amplifying sandwich for use in an image intensifying tube comprising an annular support ring, a layer of light reflective electron transparent aluminum on said support ring, an evaporated layer of activated alkali halide phosphor on said layer of aluminum, and a cesiated photoemissive cathode on said phosphor.

4. A self-supporting amplifying sandwich as in claim 3 further including an apertured mesh screen.

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