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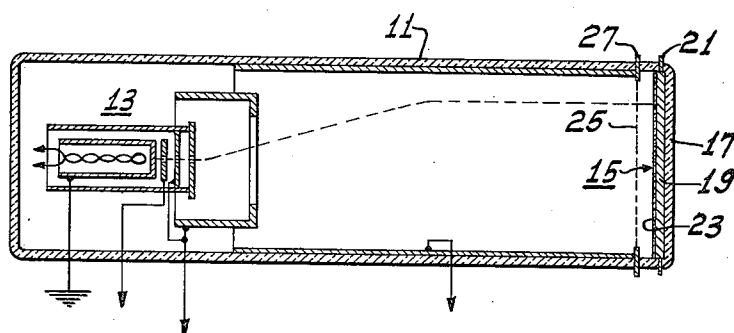
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2,654,852

PHOTOCONDUCTIVE TARGET FOR CATHODE-RAY DEVICES

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Fig-1



MIXTURE OF RED ANTIMONY
TRISULFIDE AND ANTIMONY
OXIDE.

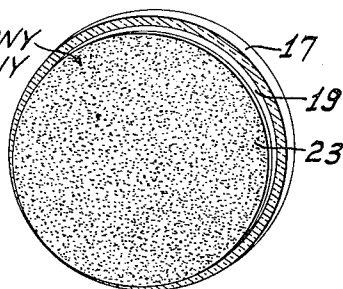


Fig-2

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PHOTOCONDUCTIVE TARGET FOR
CATHODE-RAY DEVICESRobert R. Goodrich, Cranbury, N. J., assignor to
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3 Claims. (Cl. 313—65)

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This invention relates to targets for electron discharge devices, and, more particularly, to improvements in photo-conductive targets for cathode ray camera tubes of the type utilizing antimony tri-sulfide as a photo-conductor.

Television camera tubes employing photo-conductive targets and known as "Vidicons" are described in an article beginning on page 70 of the May 1950 issue of Electronics Magazine, in co-pending U. S. patent application, Ser. No. 198,130 of S. V. Forgue, filed November 29, 1950, and in a U. S. patent application of S. V. Forgue and R. R. Goodrich, filed concurrently with this one.

A Vidicon camera tube consists of an electron gun and a target assembly contained in a glass envelope approximately six inches long and one inch in diameter. The electron gun is of the conventional type used in the image orthicon and other television pickup tubes. The target assembly comprises a film of light-transparent, electrically-conductive material on a glass supporting surface, with a layer of photo-conductive material deposited upon the electrically-conductive film. The target and the gun are so arranged within the envelope that the electron beam from the gun scans the photo-conductive surface of the target.

The photo-conductive material used for Vidicon targets is an electrical insulator in the dark, but becomes electrically-conductive under the influence of light. The conductivity is proportional to the amount of light affecting the material, and is limited to the immediate area under the influence of the light.

Vidicons may be operated at either high or low velocity. That is, they may be operated with the target at a sufficiently high voltage positive with respect to the cathode so that the electron beam strikes the target with enough force to drive secondary electrons from the photo-conductive material, thereby rendering it more positive. Or, they may have cathode and target at approximately the same potential so that the scanning electron beam deposits electrons on the target with a negligible amount of secondary emission, thereby making the target more negative.

In one type of high velocity operation, the electron beam scans the photo-conductive surface facing the electron gun at a velocity above "first crossover" (i. e. at a sufficiently high velocity so that the number of secondary electrons leaving the surface will be greater than the number of primary electrons which arrive at the surface to cause the secondary emission therefrom). The "first crossover" potential differs with different

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target materials and surface conditions. Two hundred volts between target and cathode has given satisfactory results with red antimony trisulfide targets.

The target potential is applied to the electrically-conductive film in contact with the opposite side of the photo-conductive layer from the one scanned by the electron beam. A collector potential, about ten volts positive with respect to the target potential, is applied to a metal screen or ring, which is termed the "collector electrode" and is located immediately in front of the scanned surface of the photo-conductive layer. When the high velocity beam scans this surface, it releases secondary electrons which are attracted to the collector electrode making the scanned surface more positive until it reaches the potential of the collector electrode and equilibrium is established between them. When the scanning electron beam has brought the scanned surface to collector potential, it makes that surface ten volts positive with respect to the conductive film on the other side of the photo-conductive layer.

When a light image is focused upon the target, the photo-conductive material becomes conductive in the areas where the light affects it. The effect of this conductivity is to cause a leakage of electrons from the conductive film, through the photo-conductor, to the scanned surface. The amount of leakage depends upon the intensity of the light incident upon each area; and, its effect is to make the area of the scanned surface affected by the light a volt or so more positive. When the scanning electron beam rescans an area from which the electron charge has leaked, it restores the ten-volt difference between the surfaces of the photo-conductor. This leakage and restoration causes an electron current flow in a circuit between the light-transparent, electrically-conductive film in contact with the photo-conductive target and the source of potential to which it is connected. Variations in the electron current through this circuit, as more or fewer electrons are needed to restore the difference in potential, become the signal output of the tube.

In low velocity operation, the electrically-conductive film is connected to a source of potential approximately ten volts positive with respect to the cathode which is at ground potential. The electron beam scans the photo-conductive surface; and, by depositing electrons thereon at a velocity less than first crossover (i. e. where the ratio of secondary electrons leaving the surface when primaries strike it is less than unity), brings the bombarded surface to cathode potential and

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produces approximately a ten volt difference of potential across the target.

When light is focused upon an area of the target, it renders the photo-conductive material conductive in that particular area, and causes the corresponding portion of the scanned surface of the photo-conductor to give up electrons and come a volt or so closer in potential to the conductive film. The next time the electron beam scans this area it restores to cathode potential the area from which electrons have leaked under the light-induced conductivity. This return to cathode potential restores the ten volt difference across the target and causes an electron current to the conductive film from the source of potential to which it is electrically connected. This electron current through an output resistor provides the signal output from the tube.

Some of the qualities of photo-conductive materials which affect their usefulness as Vidicon targets are: sensitivity, resistivity in the dark, lag, useful life, and current-to-light response.

Sensitivity has reference to the ability of the material to become conductive under the influence of light. It is measured in micro-amperes of video current output per lumen of light on the target.

Resistivity in the dark has reference to that quality of photo-conductive material which enables it to store an electrical charge in a given spot without leakage from front to back surface as long as there is no light on the target. Dependent upon the resistivity of the target material is its dark current which is the current flowing through the material between energized electrodes when there is no light on the target.

By "lag" is meant rapidity of response of the target to changes in light, i. e. the ability of the target to erase a signal in a given period of time without showing a shadow or trail of light. The problems arising from a lag become acute when light-colored moving object is televised against a dark background.

"Useful life" has reference to the hours of operation that can be expected from a target, and its ability to stand up under the handling etc. involved in manufacturing processes.

Current-to-light response indicates the range of changes in light intensity which can be covered within given limits of current output.

The concurrently filed application of Forgue and Goodrich, identified above, describes a method for evaporating red antimony tri-sulfide photo-conductive targets onto a light-transparent, electrically-conductive surface in a Vidicon type of television pickup tube. Targets prepared in accordance with this method are characterized by exceptionally good sensitivity, but for some purposes they would be more satisfactory if they had a lower level of background signal, thereby producing a more uniform black. The background signal is proportional to the "dark current" of the photo-conductor.

Accordingly, it is an object of the present invention to provide an improved photo-sensitive target for electron discharge devices.

Another object is to provide an improved photo-conductive target for cathode ray tubes, and one characterized by its substantial freedom from dark current.

The above and other related objects are accomplished in accordance with the invention by a new photo-conductive target material comprising a mixture of red antimony tri-sulfide with

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approximately one to five per cent of antimony oxide.

The invention is explained in more detail by reference to the accompanying single sheet of drawings wherein:

Fig. 1 is a view in section of a cathode ray camera tube using the photo-conductive target of the invention;

Fig. 2 is a plan view of a photo-conductive target in accordance with the invention.

The camera tube shown in Fig. 1 comprises a glass envelope 11 containing an electron gun assembly 13 and a target assembly 15. The glass face plate 17 of the envelope 11 is coated on its inner surface with a light-transparent electrically-conductive film 19. This film may be constituted of a compound of tin, such as tin oxide or tin chloride. A metal ring 21 passes through the glass wall of the envelope 11 to make electrical contact with the conductive film 19.

A photo-conductive layer 23 is coated upon the electrically-conductive film 19. This photo-conductive layer, in accordance with the invention, consists of a mixture of red antimony trisulfide and antimony oxide.

Immediately in front of the photo-conductive coating 19, in the direction of the approaching electron beam, is a collector electrode 25 which consists of a wire mesh screen connected to a metal ring 27 which also passes through the glass wall of the envelope 11 in the same manner as the ring 21 which is connected to the electrically-conductive film 19. The operation of the tube is explained previously in this specification.

Fig. 2 shows a plan view of the target assembly 15 of Fig. 1, from the direction of the approaching electron beam. In this view, the photo-conductive layer 23 of red antimony tri-sulfide mixed with antimony oxide is shown coated upon the electrically-conductive light-transparent film 19 which in turn is supported by the glass face plate 17.

Various combinations of antimony oxide and red antimony tri-sulfide can be used to produce a photo-conductive target, but the inventor has found by experiment that when the antimony oxide exceeds more than approximately 5% by volume of the red antimony tri-sulfide, the sensitivity of the target falls off to a considerable extent.

In preparing targets in accordance with the invention, the antimony oxide and antimony trisulfide should be thoroughly mixed when they form the photo-conductive layer of the target assembly. This can be accomplished by mixing the ingredients and precipitating, spraying, settling etc. the mixture onto a supporting surface, or evaporating the material in a crucible after the manner of the concurrently filed application of R. R. Goodrich and S. V. Forgue identified above.

Alternatively, the two materials can be fused together as a mixture of antimony oxide and antimony trisulfide, or when the antimony sulfide is originally combined from its constituent elements. They would then be applied by one of the methods suggested above. Or, the ingredients could be simultaneously evaporated onto a supporting surface.

The percentage of antimony oxide to be mixed with the antimony tri-sulfide does not appear to be very critical within the approximate limits of from 1 to 5% by volume. But, when the volume of antimony oxide exceeds by more than 5% the volume of antimony tri-sulfide, the sensitivity of

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the resulting photo-conductor, as mentioned previously, falls off.

The antimony tri-sulfide used in this mixture may be either the black or the red variety. But red antimony tri-sulfide is preferred because of its higher sensitivity and other desirable qualities.

Photo-conductive targets prepared in the manner described above have demonstrated good sensitivity with high resistivity in the dark and consequently a low level of background signal, giving a uniform black level in a television system.

What is claimed is:

1. A light sensitive target for an electron discharge device comprising a support member and a coating formed of a mixture of antimony tri-sulfide and antimony oxide on said support member, said antimony oxide being in an amount of 1% to 5% of the mixture.

2. A photo-conductive target for an electron discharge device comprising a transparent support member and a coating formed of a mixture of red antimony tri-sulfide and antimony oxide on said support member, said antimony oxide being in an amount of 1% to 5% of the mixture.

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3. A cathode ray camera tube comprising an evacuated envelope containing an electron gun and a light-sensitive target assembly, said target assembly comprising a light-transparent supporting member, a light-transparent electrically-conductive film on said supporting member, and a coating comprising a mixture of red antimony tri-sulfide and antimony oxide on said conductive film said antimony oxide being in an amount of 1% to 5% of the mixture.

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