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VIDICON TARGET HAVING AREAS OF DIFFERENT CONDUCTANCE

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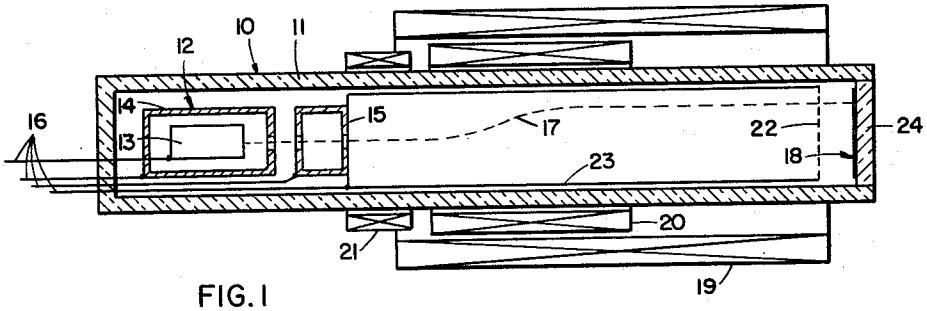


FIG. 1

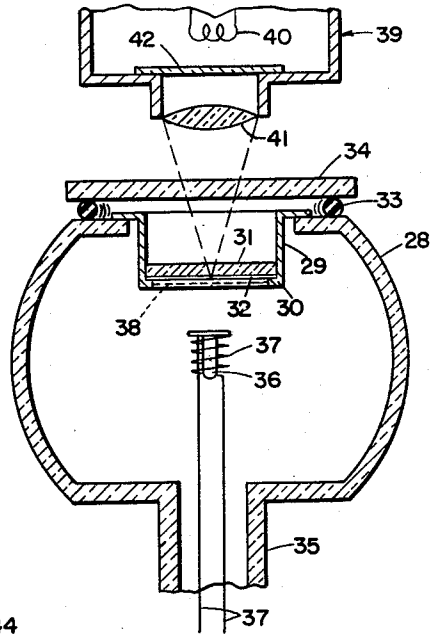


FIG. 2

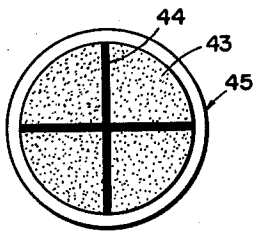


FIG. 4

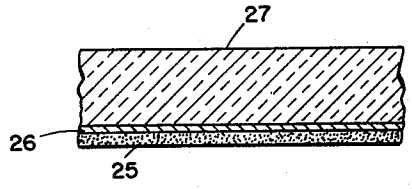


FIG. 3

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VIDICON TARGET HAVING AREAS OF DIFFERENT CONDUCTANCE

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This invention relates to electron discharge devices and has particular reference to photoconductive target electrodes for electron tubes such as vidicons or the like.

Electron discharge devices of the presently described character embody an electron gun and a target electrode located in spaced relation within an evacuated envelope, the electron gun being adapted to direct a beam of electrons against one side of the target electrode. The target electrode comprises a support upon which is deposited a thin layer of photoconductive material. In the operation of the device, the electron beam impinges upon the photoconductor to establish a charge thereon, and when the target electrode is exposed to a light image, electron flow occurs through the charged photoconductive layer in accordance with the intensity of the image. This action produces a charge pattern which can be removed from the photoconductor as an electrical signal corresponding to the image picked up by the target.

The photoconductive layer is, in conventional tubes, deposited upon the transparent support by evaporation, preferably in the presence of an inert gas such as argon. This process is usually carried out in normal room illumination, or in darkness. In cases where it is desired that a target be provided with a superimposed pattern, such as a "cross-wire," reticle, or graticule, the pattern is generally etched into the transparent support before the photoconductor is evaporated.

In accordance with this invention, a reticle or other pattern is provided within the body of the photoconductor by exposing the photoconductor to relatively brilliant illumination through a transparency, whereupon the portion of the target upon which the pattern is imaged will be provided with higher optical transmission and, more important, higher electrical conductance than the other portions of the target. The different characteristics of the target are permanent in nature and can readily be introduced by the use of means such as a projector for directing a beam of light onto the photoconductor through a transparency bearing the selected pattern.

Although the photoconductor is preferably provided with such different conductance characteristics by exposure during the process of evaporating the photoconductor onto its support, this may be accomplished subsequent to the evaporation process if desired, if being important, however, to do so in any case before the target is subjected to electron bombardment such as occurs during the "aging" operation of the tube.

By this process, the photoconductor is provided with permanently different conductance characteristics by virtue of the fact that the areas thereof upon which the image of the pattern falls is exposed to a greater or lesser extent, depending upon whether the transparency is negative or positive, than other areas. In the operation of an electron tube utilizing such a target, the differences in conductance of the two differently exposed areas are readily apparent in the final display, which again may be negative or positive, that is, black or white, depending upon the transparency.

Accordingly, it is a primary object of this invention to provide an electron discharge device with a novel means and method of providing areas of different electrical conductance characteristics in a photoconductor for electron tube targets.

A further object is the provision of novel means and method of providing a target for electron discharge devices with a reticle or similar pattern having improved definition.

Another object is to provide a target with a reticle or other selected pattern which is in the plane of the photoconductor, thereby eliminating parallax.

A further object is to provide a target with a pattern which appears to be superimposed upon, but which does not appear as a completely opaque image obliterating the scene reproduced in the final display.

A still further object is to provide a target with a pattern having varying shades of "gray," that is, areas of several different levels of electrical conductance.

Other objects and advantages of this invention will become apparent from the following description taken in connection with the accompanying drawings, wherein

FIG. 1 is a longitudinal sectional view of an electron discharge device utilizing a target in accordance with this invention;

FIG. 2 is a diagrammatic illustration of the preferred method of exposing a photoconductor;

FIG. 3 is an enlarged horizontal sectional view of a target of the character described; and

FIG. 4 is an enlarged elevational view diagrammatically illustrating a target embodying a pattern within the photoconductor in accordance with this invention.

The invention will be best understood by referring more particularly to FIG. 1 wherein is shown an electron discharge tube **10** of the vidicon type comprising a vacuum tight envelope **11** having an electron gun **12** mounted in one end thereof. The electrodes of the electron gun **12** include the usual cathode **13**, control electrode **14**, and one or more accelerating electrodes **15** which are connected to lead-in means **16** in a well-known manner. An electron beam **17** from the gun **12** is directed upon a target **18** in the other end of the envelope **11**, and means is provided for focusing the electron beam **17**, and scanning it over target **18** to form a raster. Such means may include a focus coil **19**, a deflection yoke **20**, and an alignment coil **21** as shown. An electrode such as grid **22** is positioned adjacent the target **18** and, in operation, functions cooperatively with focus coil **19** to insure that the electron beam **17** in its final approach to the surface of target **18** is normal thereto. A final accelerating electrode **23** may take the form of a metal cylinder or a conductive coating on the interior wall of envelope **11**. The lead-in means **16**, not shown in detail, are provided for the purpose of connecting the electrode **23** and the various parts of the electron gun **12** to sources of electrical potential externally of the tube.

Target **18** may be supported interiorly of the envelope **11** upon a separate supporting structure, but is preferably located, as shown in the drawings, directly upon the inner surface of a transparent window or disc **24**, known as a faceplate, which closes the end of the envelope and forms a part thereof. The target comprises a layer of photoconductive material **25** (FIG. 3) which overlies a thin transparent layer **26** of electrically conductive material such as tin oxide. Layer **26** is deposited upon a transparent rigid support **27**, which may be the faceplate of the tube or may be a separate transparent support within the envelope adjacent the faceplate. The conductive layer or signal plate **26** may be deposited by any suitable means such as the process known as iridizing, and in the final tube assembly is connected to a source of unidirectional operating potential by means not shown. While conductivity can, in some cases, be produced in the glass support itself, it is preferable to employ layer **26**, whereupon layer **26** becomes part of the transparent support for the photoconductor.

The photoconductor **25** superimposed upon the signal

plate 26 is antimony trisulfide, zinc oxide, cadmium sulfide, or other material which produces photocurrent when it is charged by an electron beam and simultaneously exposed to visible light. This photocurrent is conveyed to the signal plate 26 and may be transmitted from the tube as an electrical signal corresponding to the visible image falling upon the photoconductor.

The photoconductor 25 is evaporated onto the signal plate 26 by use of a device such as shown in FIG. 2. A bell jar 28 is provided with an opening at its upper end in which is suspended a supporting cup 29. The inner end of cup 29 has an opening encircled by an inwardly turned flange 30 upon which is positioned a faceplate or other transparent target support 31, which has already been provided on its lower surface with a layer 32 of transparent electrically conductive material such as tin oxide. About the opening in the bell jar is located a rubber O-ring 33 which supports a transparent disc 34, as shown, closing the upper end of the bell jar.

The lower end of the bell jar 28 is provided with a tubulation 35 which is connected by suitable piping to a vacuum pump (not shown). Operation of the pump will create a vacuum within the bell jar, after which a suitable inert gas, preferably argon, is introduced into the bell jar to a pressure of about from .3 to .5 mm. of mercury.

Located within the ball jar 28 is a boat 36 of selected photoconductive material which is encircled by a heating coil 37. Conductors 37 are connected to the coil, and support the coil and boat beneath cup 29.

In the operation of this device, the bell jar 28 is evacuated after which the argon or other selected gas is introduced. When this has been done, the boat 36 is heated by coil 37 to a temperature high enough to volatilize antimony trisulfide or other photoconductive material in the boat. Such volatilization or evaporation results in depositing a layer 38 of the vaporized photoconductive material on the layer 32 of conductive material, and may be continued for a controlled time period in accordance with the thickness desired of layer 38. This is conventional procedure for forming photoconductors for the targets of vidicon tubes or the like.

However, in accordance with the preferred method of this invention, simultaneously with the photoconductor evaporation process, the target is exposed to relatively brilliant illumination. This may be done by means of a projector 39 in which is a suitable light source 40, such as a tungsten light source which emits about 500 ft.-c. of illumination. A lens system 41 is provided for focussing the light beam from source 40 onto the photoconductive layer 38 as it is being formed.

This exposure to light causes a permanent change in the photoconductor which occurs when the light is focused onto the substrate during the evaporation process. The exposed target has higher optical transmission and, more important, higher electrical conductance than target areas which are not so exposed. For example, an antimony trisulfide photoconductor evaporated in argon gas at a pressure of about 0.4 mm. of mercury and having areas simultaneously exposed to incident illumination of about 500 foot candles will have, when conventional target potential is applied, about four times the effective conductance in the exposed areas than in the unexposed areas.

In accordance with this invention, the desired pattern such as a reticle, graticule or "cross-hair" is formed within the body of the photoconductor by interposing within the light beam a film or other transparency 42 bearing the selected pattern. This pattern will be imaged on the photoconductive layer 38 and the area or areas of the layer which are exposed to the light will be altered to a greater extent than the unexposed areas. This inherently produces in the areas corresponding variations in dark current levels. This produces a pattern in the photoconductor 43, as indicated at 44 in FIG. 4, which is difficult to observe visually in the resultant target 45. However, the differences in conductivity and in photocurrent response of the exposed and unexposed areas 43–44 are very clearly distinguishable in the resultant television or other display image produced by the system in which the tube is utilized. The terms "conductivity" as used in the foregoing sentence and "conductance" as used throughout this description relate to the characteristic of photoconducting materials to transmit current in the dark when subjected to electrical fields. Such "conductance" in the dark is known as "dark current" (see Van Nostrand's Scientific Encyclopedia, Third edition, page 477). The production of "dark current" or "current that flows in the dark" is described in "The Vidicon Photoconductive Camera Tube" by Weimer, Forgue and Goodrich in the May, 1950 issue of Electronics.

Since the degree of conductance of the photoconductor appears, in accordance with this invention, to be a function of light level and exposure time, when a selected pattern is optically focussed onto the photoconductor during evaporation, a corresponding conductance pattern is produced which will appear to be superimposed in the final display. The image of the pattern is sharply defined and more distinct than the image of a pattern etched onto the uncovered surface of a faceplate as taught by the prior art.

Although the foregoing describes a method whereby the photoconductor is provided with the pattern while it is being evaporated onto the faceplate, it is possible to expose the photoconductor to the light image after the evaporation process is completed. In such a case it is desirable to evaporate the photoconductor in relatively dim light or darkness, after which it can be exposed at any time before it is subjected to electron bombardment, such as occurs during ageing of the electron tube in which it is assembled. When the photoconductor is exposed subsequent to evaporation, the changes in electrical conductance and optical transmission are permanently embodied within the photoconductor as described above, although possibly to a slightly lesser degree.

The pattern illustrated in FIG. 4 is a cross-hair or reticle 44 having uniform opacity. However, it is to be understood that patterns being different varying degrees of gray or opacity may be provided merely by exposing the photoconductor to light through a transparency which is provided with a pattern image having the desired variations in optical transmission. In any case, the pattern in the photoconductor is clearly distinguishable in the final display of relatively dark scenes, or scenes of relatively low brightness, as well as in highly illuminated scenes. Furthermore, the pattern in the final display appears visually as superimposed upon the scene, with the scene being clearly visible through the pattern. This latter feature is achieved due to the fact that exposure of the photoconductor does not, by increasing its electrical conductivity, destroy its photocurrent response but only effects the described change in the photoconductor which permits the pattern to be clearly visible as well as the scene.

From the foregoing, it will be apparent that there has been provided a novel photoconductive target for electron discharge devices, together with novel means and method of producing the same, which target is provided with a selected conductance pattern for visual observation in a final display.

While the preferred structures and methods only are set forth herein, it is to be understood that various modifications and changes therein may be made by those skilled in the art without departing from the spirit of the invention as expressed in the appended claims.

I claim:

1. The method of making a photoconductive target for electron tubes comprising evaporating onto an electrically conductive transparent support a layer of photoconductive material and simultaneously therewith exposing different areas of the photoconductive material to relatively bright illumination through a transparency bearing a relatively

opaque pattern to produce in said areas different electrical conductance characteristics corresponding to said pattern.

2. The method of making a photoconductive target for electron tubes which is adapted to be bombarded by electrons in operation of the tube comprising evaporating onto an electrically conductive transparent support a layer of photoconductive material and exposing different areas of the photoconductive material before electron bombardment to relatively bright illumination through a transparency bearing a relatively opaque pattern to produce in said areas different electrical conductance characteristics corresponding to said pattern.

3. The method of making a photoconductive target for electron tubes comprising evaporating onto an electrically conductive transparent support a layer of photoconductive material and simultaneously therewith exposing different areas of the photoconductive material to relatively bright illumination of varying intensities to produce in said areas different electrical conductance characteristics corresponding to said varying intensities of the illumination.

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