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Banks et al.

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[54] **PICK-UP TUBES**

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[30] **Foreign Application Priority Data**

July 30, 1970 United Kingdom..... 36870/70

[52] **U.S. Cl.** **313/384;** 313/390; 313/2

[51] **Int. Cl.**[2] **H01J 31/38;** H01J 31/08

[58] **Field of Search**..... 313/65 R, 65 T, 65 A, 66, 313/94, 116

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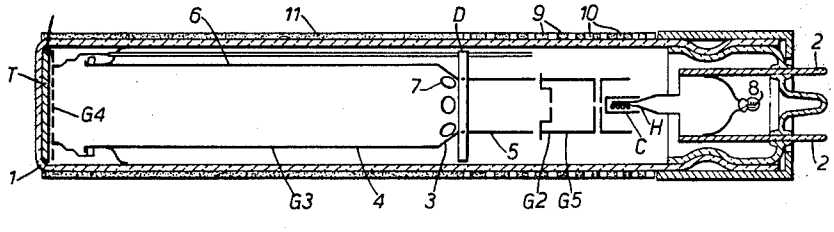
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[57] **ABSTRACT**

The invention provides a photo-conductive target pick-up tube in which light is introduced into the tubular anode electrode on the gun cathode side of the target. The light is introduced evenly around the circumference of the anode, the inner surface of which is roughened to achieve diffused illumination of the rear of the target. In operation of the tube an artificial dark current is obtained which tends to reduce build up and decay lag at low light operating conditions

24 Claims, 5 Drawing Figures



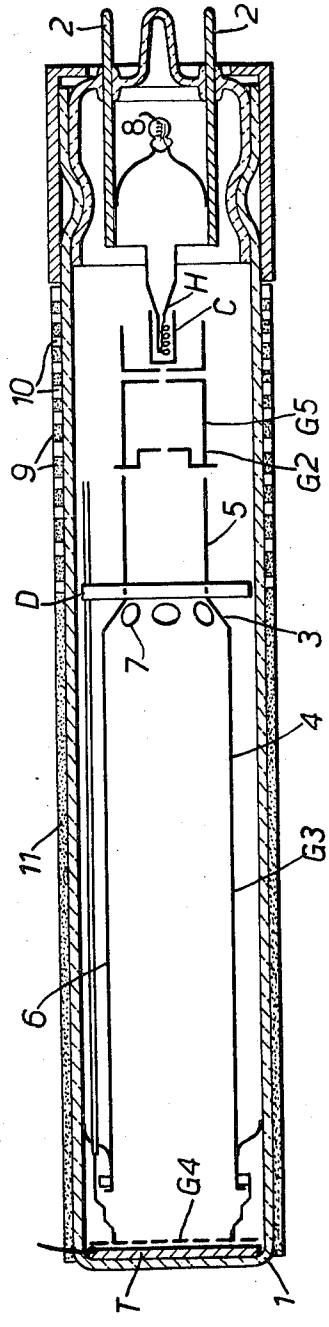


FIG. 1.

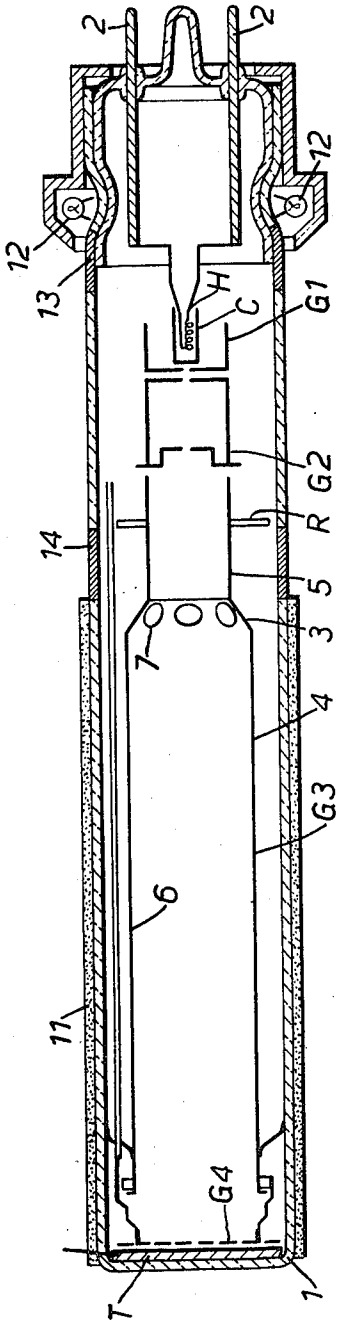


FIG. 2.

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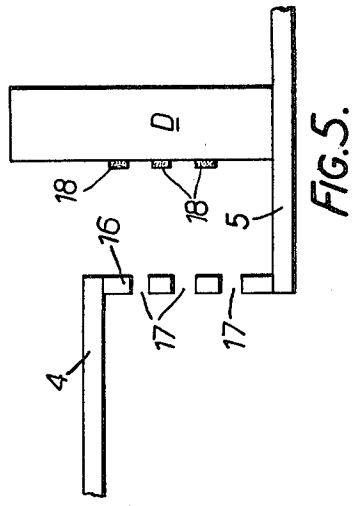


FIG. 5.

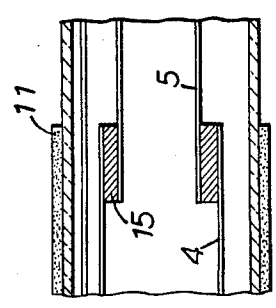


FIG. 3.

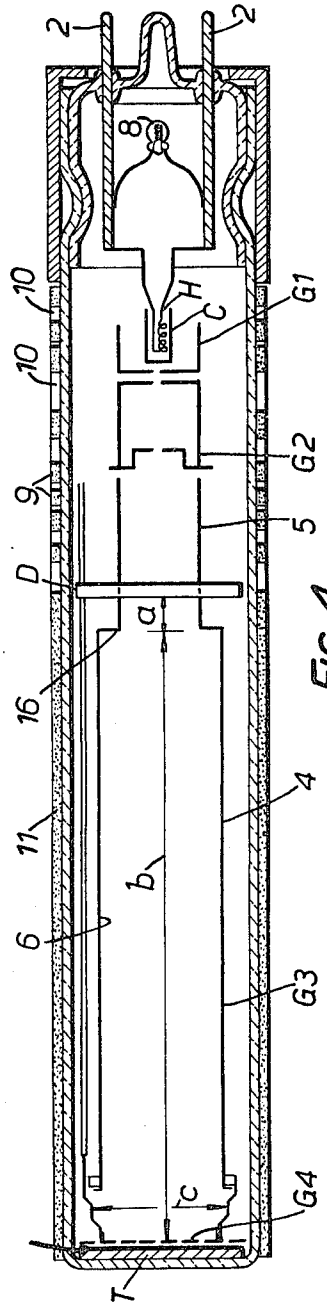


FIG. 4.

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PICK-UP TUBES

This invention relates to pick-up tubes and more particularly to pick-up tubes of the photoconductive target type.

Photoconductive target pick-up tubes are now known in which the target is comprised of lead monoxide.

Compared with the conventional vidicon pick-up tube utilising a target composed of antimony trisulphide, the lead monoxide target pick-up tube exhibits increased resolution, a faster response and a lower dark current. In general these features are advantageous. However at low operating light levels the low dark current of the lead monoxide target camera tube tends to accentuate two undersirable effects. The first of these is build-up lag, that is to say a delay in the build-up of signal current following a change in tone from black to white, and decay lag, that is to say a delay in the decay of signal current following a change in tone from white to black.

The present invention seeks to provide improved photoconductive target pick-up tubes of the kind in which the target exhibits a natural relatively low dark current, and in particular improved lead monoxide pick-up tubes, in which the tendency to suffer from build-up lag and decay lag is reduced.

According to this invention a photoconductive target pick-up tube including the normally provided tubular anode electrode on the gun cathode side of the target comprises means for introducing light into said tubular anode electrode in a substantially even manner around the circumference thereof, the inner surface of said tubular electrode being roughened or otherwise provided to have light scattering properties in order to achieve diffused illumination of the rear of said target whereby in operation an artificial dark current is obtained which tends to reduce build-up and decay lag at low light level operating conditions.

Chemical etching and shot blasting are two techniques which may be employed to provide the inner surface of the anode electrode with the required light scattering properties.

Where, as is usually the case, the tubular anode electrode has a reducing tapered portion along its length distant from its end adjacent the target electrode and between two portions of different cross sectional dimensions, the means for introducing light into the tubular anode may comprise a ring of holes provided in said reducing tapered portion.

Preferably a ring of light diffusing material is provided surrounding the portion of the tubular anode electrode of smaller cross-sectional dimensions and shielding the holes provided in said tapered portion.

Alternatively the normally provided tapered portion may be replaced by a light diffusing ring occupying a space between the portion of the tubular anode electrode of larger cross-sectional dimension and the portion of smaller cross-sectional dimension. In either case the ring should of course be formed of some such material as ground fused silica in order to withstand the high temperatures to which the metal parts of the anode electrode are raised during outgassing in manufacture. Whilst theoretically a construction to be preferred from the point of view of uniformity of illumination, the use of a fused silica ring between the two portions of the tubular electrode has the disadvantage that both it and the two sections of the tubular anode electrode between which it lies must be made to very precise dimensions in order that the three parts may be satisfactorily united.

Where a ring of holes is provided in the normally provided reducing tapered portion of the tube and a diffuser ring is provided to shield the holes, it has been found that the artificial dark currrent obtained is higher by up to 15% in the centre of the target than at its edges. If a more uniform distribution of dark current is required a technique similar to the shadow mask technique may be employed. The reducing tapered portion of the tubular electrode may be perforated by a plurality of small holes and the diffuser ring is rendered less light transmissive in places "seen" by the centre of the target. The diffuser ring may be rendered less light transmissive in said places by thin metal coatings. A suitable metal is aluminium and the metal may be deposited by an evaporation technique. Preferably however the reducing tapered portion is replaced by a perforated flat metal disc arranged perpendicularly to the axis of the tube and extending between the portion of the tubular electrode of larger crosssectional dimensions and the portion of the tubular electrode of smaller cross-sectional dimensions. In a preferred construction utilising the flat disc above mentioned the perforated flat metal disc is spaced from the diffuser ring such that the ratio of this spacing to the diameter of the holes in the metal disc is twice the ratio of the spacing between the target and the metal disc to the target diameter, the metallisation of the diffuser ring being such that the centre of the target "sees" only metallised areas whilst the extremities of the target sees only clear areas. The metallisation referred to above is achieved in manufacture by evaporating the metal, before assembly from a point corresponding to the centre of the target.

The source of light may be external of the tube envelope, in which case preferably means are provided for mounting a plurality of small light bulbs around the neck of the tube, adjacent the gun section, the envelope of the tube including a frosted portion adjacent the mounting position of the plurality of bulbs and a frosted portion adjacent said ring of holes provided in said reducing tapered portion so that the tube envelope may act as a light guide transmitting light from said bulbs to said holes.

Where the source of light is external as above described, preferably a disc of metal is provided around said portion of the tubular anode electrode of smaller cross sectional dimension on the cathode gun side of said first mentioned frosted portion of the tube envelope to reflect light therefrom towards said ring of holes. The reflecting surface of said metal disc facing said holes is preferably matt, in which case it may be possible to omit the light diffusing material shielding said holes in some cases.

Preferably however the source of light is internal of the tube envelope, and preferably is a light bulb mounted adjacent the heater for the cathode gun, light from the bulb being conducted to the means for admitting light into said tubular anode electrode by at least one reflection from the wall of the tube envelope.

The bulb within the tube envelope may be arranged to be supplied with current via its own connection passing through the envelope of the tube. Whilst this has the advantage that the intensity of illumination may readily be adjusted following final manufacture by adjusting the amount of current permitted to flow to the

bulb, it suffers from the practical disadvantage that it is inconvenient to provide an additional external connection to the tube. It is, for example, usual to construct the tube for use with a standard base connector and all of the pin positions of the standard connector are already occupied.

Preferably therefore the bulb is connected in parallel with the cathode gun heater and is supplied via the same external connections. Where, as is usual, it is desirable to make adjustment to the intensity of the illumination provided following manufacture, this is preferably achieved by covering the portions of the tube envelope from which light is reflected during its passage from the bulb to the means for introducing light into the tubular anode electrode with materials of different light reflecting properties. Use may be made for example of zones of white and black paint over the portions of the tube envelope from which light is reflected, the ratio of black to white being adjusted until a suitable dark current is achieved.

The use of coloured paints or dichroic materials is conceivable where some control of the colour of the light reaching the target is required.

Preferably, in all cases, the outer surface of the tube envelope between the region of reduction in the cross-sectional dimensions of the tubular anode electrode and the tube target is painted black in order to reduce the possibility of stray light reaching the front face of the target.

The invention is illustrated in and further described with reference to the accompanying schematic drawings in which:

FIG. 1 shows a lead monoxide pick-up tube in accordance with the present invention and utilising an internal light source,

FIG. 2 shows a tube similar to that of FIG. 1 but utilising external light sources,

FIG. 3 shows a modification applicable to the tube of FIG. 1 or FIG. 2 and,

FIGS. 4 and 5 show a modification of the tube of FIG. 1 intended to provide a more uniform distribution of artificial dark current.

Referring to FIG. 1 the pick-up tube consists of a glass envelope 1 having at one end a gun cathode C indirectly heated by a heater H the supply connections 2 for which pass through the glass base of the envelope. G1, G2 and G4, G5 are the normally provided electrodes known under those designations whilst G3 is the normally provided tubular anode electrode and T is the normally provided lead monoxide target electrode consistng of a layer of lead monoxide deposited on a film of conductive tin oxide on the face plate of the tube. As will be seen the tubular anode electrode G3 has a reducing tapered portion 3 which joins a portion 4 of larger cross-sectional dimension and a portion 5 of smaller cross-sectional dimension. As so far described, the lead monoxide target pick-up is as known per se.

In accordance with the present invention the interior surface 6 of tubular anode electrode G3 is roughened by chemical etching and a ring of holes 7, eleven in number, are provided in the reducing tapered portion 3 of the tubular anode electrode G3 so as to permit light to enter the inside thereof, which light, scattered by the roughened interior surface 6, provides diffused illumination of the interior surface of the target T. This diffused illumination produces an artificial dark current which tends to reduce build-up and decay lag experienced at low light levels in the known tube. A ring D of ground fused silica is provided around the portion 5 of the tubular electrode G3, shielding the holes 7.

The source of the light entering the tubular anode electrode G3 is a bulb 8 of output 1.4 lumens connected in parallel with the heater H. Since it is desirable to adjust the effective intensity of the illumination of the interior surface of the target T following manufacture (this is not an adjustment usually required during service) bands of black and white paint 9 and 10 respectively are provided on the glass envelope of the tube between the gun cathode section and the fused silica ring D. Light from the bulb 8 reaches the fused silica ring D by at least one reflection by the wall of the glass envelope and thus by varying the widths of the black and white bands 9 and 10 the amount of light reaching the fused silica ring D may be varied. In order to reduce the possibility of stray light reaching the front of the target T, the section of the tube envelope between the region of reduction in the crosssectional dimensions of the tubular anode electrode G3 and the target T is given a coating 11 of black paint.

Referring the FIG. 2, the tube shown therein is essentially similar to that shown in FIG. 1 except for the arrangement of the light source. In this case the light source is a ring of low power light bulbs 12 arranged around the gun cathode section of the tube. A frosted portion 13 is provided in the glass wall of the tube envelope adjacent the ring of bulbs 12 whilst a frosted portion 14 is included in the glass wall of the tube envelope adjacent the ring of holes 7 so that the tube envelope acts as a light guide conducting light from the bulbs to the region of the ring of holes 7. A disc R of aluminium is provided around the portion 5 of the tubular anode electrode on the gun cathode side of the frosted portion 14 of the tube envelope. The surface of the disc R facing the holes 7 is matt in order to reflect ligh theretowards in non-specular fashion. In this example diffuser ring D of FIG. 1 is dispensed with. In this case the intensity of illumination may be controlled by directly varying the current passed through the bulbs.

Referring to FIG. 3, this illustrates so far as is necessary a modification to the tube of FIG. 1 in which the diffuser ring D and the tapered portion 3 of the tubular anode electrode G3 are dispensed with and a ring of ground silica 15 is positioned between the portions 4 and 5 of different cross-sectional dimensions of the tubular anode electrode. Conductive straps (not shown) are provided between the two portions to maintain good electrical connection.

Referring to FIG. 4, this shows one modification of the tube of FIG. 1 intended to provide a more uniform distribution of artificial dark current by reducing the intensity of the illumination at the centre of the target. The reducing tapered portion 3 of FIG. 1 is removed and replaced by a perforated metal disc 16 arranged perpendicularly to the tube axis and extending between the portions 4 and 5 of the tubular anode electrode. The diffuser ring D is rendered less light transmissive in places seen by the centre of the target T by metallisation. To achieve this metallisation, before assembly aluminium is evaporated from a position corresponding to the centre of the target through the holes in the disc 16. The spacing *a* of the flat metal disc 16 from the diffuser ring D is such that the ratio of "a" to the diameter *d* of the holes in the disc 16 is twice the ratio of the spacing *b* between the target T and the disc 16 to the target diameter *c*. In other words

$$\frac{a}{d} = 2\left(\frac{b}{c}\right).$$

FIG. 5 is an enlarged representation of the metal plate 16 and diffuser ring D of FIG. 4 above the centre line of that drawing. The holes in the metal plate 16 are reference 17 and the metallised portions of the diffuser disc are referenced 18. FIG. 4 is not drawn to scale and is not intended to illustrate the relationship given above for any particular case.

I claim:

1. In a television camera tube of the type comprising an evacuated envelope having a transparent face plate, a photoconductive target at said face plate having a surface receiving an image of a scene and constituted of material exhibiting a relatively low dark current, said target having a transparent signal plate between it and the face plate, means for scanning the opposite surface of said target with an electron beam thereby generating an electrical current corresponding to light variations in said said scene, said means including an electron gun for generating an electron beam remote from said target and means for deflecting the electron beam before it reaches said target and a tubular anode electrode having one end adjacent said opposite surface of the target and extending therefrom to adjacent said electron gun, said electrode having opening means therein spaced from said one end thereof, and means for illuminating said opposite surface of said target through said opening means and that portion of the tubular anode electrode lying between said opening means and said one end of the electrode to produce an artificial dark current for reducing build up and decay lag at low light level operating conditions, the improvement wherein:

said means for illuminating comprises a light scattering surface on the inner surface of said portion of the tubular electrode lying between said target and said opening means, light source means disposed in spaced relation to said opening means and exteriorly of said electrode for illuminating said opposite surface of the target through said portion of the electrode as aforesaid, diffuser means located adjacent said opening means and extending circumferentially around said electrode for shielding said opening means from said light source means and for diffusing light emanating from said light source means prior to reaching said light scattering surface, and said opening means constituting means for admitting diffuse light from said diffuser means into the interior of said anode electrode substantially uniformly circumferentially therearound and inwardly of said light scattering surface whereby substantially uniformly to illuminate said opposite surface of the target.

2. A tube as claimed in claim 1 wherein the light scattering surface of said tubular electrode is chemically etched to provide light scattering properties.

3. A tube as claimed in claim 1 and wherein said tubular electrode is shot blasted to provide said light scattering properties.

4. A tube as claimed in claim 1 and wherein the tubular anode electrode has a reduced tapered portion along its length distant from its end adjacent the target electrode and between two portions of different cross-sectional dimensions, said means for admitting diffuse light into the tubular anode comprising a ring of holes provided in said reducing tapered portion.

5. A tube as claimed in claim 4 and wherein said diffuser means comprises a ring of light diffusing material surrounding the portion of the tubular anode electrode of smaller cross-sectional dimensions and shielding the holes provided in said tapered portion.

6. A tube as claimed in claim 1 and wherein said tubular anode electrode comprises a first portion adjacent said target and a second portion remote from said target, said second portion being of smaller cross-sectional dimension than said first portion, said diffuser means comprising a light diffusing ring occupying a space between said portions of the tubular anode electrode.

7. A tube as claimed in claim 5 whereis said light diffusing ring is of ground fused silica.

8. A tube as claimed in claim 6 wherein said light diffusing ring is of ground fused silica.

9. A tube as claimed in claim 5 and wherein the reduced tapered portion of the tubular electrode is perforated by a plurality of small holes and the diffuser ring is rendered less light transmissive in places seen by the centre of the target.

10. A tube as claimed in claim 9 and wherein said diffuser ring is rendered less light transmissive in said places by thin metal coatings.

11. A tube as claimed in claim 10 wherein said metal coatings are of aluminium.

12. A tube as claimed in claim 1 and wherein said tubular anode electrode includes a perforated flat metal disc arranged perpendicularly to the axis of the tube and defining said opening means, said electrode having a portion of large cross-sectional dimension and a portion of small cross-sectional dimension and said disc extending between such portions, said diffuser means being in the form of a ring of light diffusing material surrounding the portion of the tubular anode electrode of smaller cross-sectional dimension shielding the holes in said perforated flat metal disc, which ring is rendered less light transmissive in places seen by the centre of the target.

13. A tube as claimed in claim 12 and wherein said perforated flat metal disc is spaced from the diffuser ring such that the ratio of this spacing to the diameter of the holes in the metal disc is twice the ratio of the spacing between the target and the metal disc to the target diameter, the metallisation of the diffuser ring being such that the centre of the target sees only metallised areas whilst the extremities of the target sees only clear areas.

14. A tube as claimed in claim 1 in which said light source means is external of the tube envelope.

15. A tube as claimed in claim 14 and wherein said light source means comprises a plurality of small light bulbs around the neck of the tube, adjacent the gun section, the envelope of the tube including a frosted portion adjacent the mounting position of the plurality of bulbs and a frosted portion adjacent said ring of holes provided in said reduced tapered portion so that the tube envelope may act as a light guide transmitting light from said bulbs to said holes.

16. A tube as claimed in claim 14 wherein said tubular electrode has two portions of different cross-sectional dimensions and wherein a disc of metal is provided around said portion of the tubular anode electrode of smaller cross-sectional dimension on the cathode gun side of said first mentioned frosted portion of

the tube envelope to reflect light therefrom towards said ring of holes.

17. A tube as claimed in claim **16** and wherein the reflecting surface of said metal disc facing said holes is matt.

18. A tube as claimed in claim **1** and wherein said light source means is internal of the tube envelope.

19. A tube as claimed in claim **18** and wherein said light source means is a light bulb, light from the bulb being conducted to the means for admitting light into said tubular anode electrode by at least one reflection from the wall of the tube envelope.

20. A tube as claimed in claim **19** and wherein the bulb within the tube envelope is arranged to be supplied with current via its own connection passing through the envelope of the tube.

21. A tube as claimed in claim **19** and wherein the bulb is connected in parallel with the cathode gun heater and is supplied via the same external connections.

22. A tube as claimed in claim **21** and wherein the portions of the tube envelope from which light is reflected during its passage from the bulb to the means for introducing light into the tubular anode electrode are covered with materials of different light reflecting properties whereby adjustment to the interior of the illumination provided may be made following manufacture.

23. A tube as claimed in claim **22** and wherein said materials of different light reflecting properties are provided as zones of white and black paint over the portions of the tube envelope from which light is reflected, the ratio of black to white being adjusted until a suitable dark current is achieved.

24. A tube as claimed in claim **1** wherein the tubular anode electrode has two portions of different cross-sectional dimensions and wherein the outer surface of the tube envelope between the region of reduction in the cross-sectional dimensions of the tubular anode electrode and the tube target is painted black in order to reduce the possibility of stray light reaching to said opposite surface of the target.

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