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PICTURE TRANSMITTER

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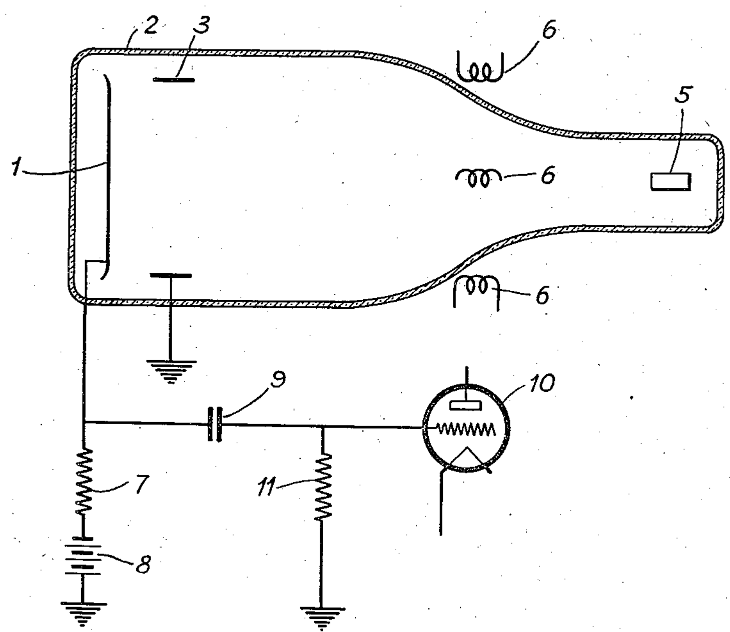

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PICTURE TRANSMITTER

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2 Claims. (Cl. 178—7.2)

The present invention relates to cathode ray tube television transmitting apparatus, and in particular to tubes in which there is used a photosensitive screen of the kind exhibiting the photoelectric conduction effect. This effect is exhibited by water-free crystalline materials, either in the form of single crystals or of compressed polycrystalline powders, having a high refractive index, greater than 2, and include

(a) Sulphides of many heavy metals such as copper, lead, thallium, mercury, cadmium, silver, zinc and antimony;

(b) Oxides of the above metals;

(c) Halogen compounds of the first five metals abovementioned, and

(d) Some crystalline modifications of certain pure elements such as selenium, sulphur, phosphorus and iodine.

It has already been proposed to make use of the photoelectric conductive effect in cathode ray transmitting apparatus but I have found in the use of such apparatus that certain serious defects occur. These defects include lack of sensitivity, undue lag in electrical response to varying illumination and what is known as the "tilting" effect. The tilting effect is manifested in the picture signals, obtained when scanning the screen in the well known way under the control of oscillations of saw-tooth wave form, by these signals having superimposed upon them a saw-tooth wave so that the picture signals generated when scanning a line of constant brightness are such as should correspond to a line having a progressively changing brightness along its length.

It is the chief object of the present invention to provide improved methods of operating cathode ray tubes of the kind employing photoconductive material with a view to eliminating or at least partially eliminating the above-mentioned defects. It has been found that the above-mentioned defects are in part due to the use of an unsuitable potential difference between the screen and the collecting electrode, partly due to insufficient current in the scanning beam and partly due to the use of an unsuitable striking velocity for the scanning electrons.

According to one feature of the invention a cathode ray transmitting tube is employed in a television transmitting system, such tube comprising a conductive screen coated with a material exhibiting a photo-conductive effect, adapted to receive an image of the object to be transmitted, a cathode ray gun for developing a cathode ray beam, means for causing the beam to scan the screen and an electrode for collecting secondary electrons liberated from the screen and wherein a potential difference is applied between the screen and the collecting electrode not exceeding 100 volts. Various materials may be employed for coating the screen and of such materials which will be hereinafter more particularly referred to, zinc selenide is preferred and when employing such material the potential difference between the screen and the collecting electrode should not exceed 50 volts but should preferably be in the region of 5–10 volts. By adjusting the potential difference as stated above it is found that lag is substantially reduced consistent with satisfactory sensitivity but such a decrease in the potential difference between the screen and the collecting electrode causes the tilting effect to increase and hence it is desirable to make a compromise between the factors which govern the lag and tilting effects and the sensitivity. In some cases, however, lag can be entirely eliminated by maintaining the screen and the collecting electrode at the same potential such as for example, at earth potential.

According to another feature of the invention the magnitude of the beam current is adjusted so that it lies between 1 and 10 microamperes, the value chosen within this range being as high as is consistent with tolerable background. The adjustment of the beam current in this manner is a contributory factor towards reduction of lag, as will be more apparent hereinafter.

A further feature of the invention consists in adjusting the striking velocity of the scanning electrons to a value of about 1–4 kilovolts and when zinc selenide is employed as the photoconductive material the striking velocity is preferably in the region of 1 kilovolt.

According to a further feature of the invention the thickness of the coating of the photo-conductive material is small compared with the diameter of the scanning spot.

In order that the said invention may be clearly understood and readily carried into effect the same will now be more fully described with reference to the accompanying drawing which illustrates diagrammatically a cathode ray transmitting tube suitable for use with the invention.

In the drawing, the reference numeral 1 indicates a screen which may be made in the manner hereinafter referred to, the screen being disposed within an evacuated envelope 2 of suitable form, and adjacent to the screen is disposed a collecting electrode 3, which serves to collect secondary electrons liberated from the screen when the latter is scanned by a cathode ray beam generated in known manner from a cathode ray gun 5, indicated, diagrammatically, the beam being focussed by one or more focussing electrodes not shown in known manner. The cathode ray beam is caused to scan the image projected on the screen 1 by suitable means indicated at 6 and comprising coils which generate suitable magnetic fields, or comprising plates between which electrostatic fields are formed for the same purpose. The arrangement so far described is similar to the construction of a transmitting tube known as an iconoscope with the exception that the mosaic screen of the latter tube is replaced by the screen exhibiting the photo-conductive effect. The screen 1 is connected through a resistance 7 and a source of potential 8 to earth and through a condenser 9 to the control grid of an amplifying valve 10, which is provided in the usual way with a leak 11 to earth. Since the source of potential 8 is connected between the screen 1 and earth, and the collecting electrode 3 is connected to earth, the potential source 8 will maintain a uniform difference of potential throughout substantially the entire screen area between the screen 1 and the collecting electrode 3.

Amongst the substances which have been found satisfactory for the photo-conductive material are zinc selenide, the sulphides of zinc, cadmium, antimony and the compound sulphide of zinc and cadmium. Of these the first named is at present preferred.

In preparing the screen 1, the photo-conductive material, after suitable grinding is deposited upon a metal backing. Usually the metal backing is formed by coating an insulating sheet such as mica with a metallic layer such as platinum deposited by a cathode sputtering process, liquid silver (a suspension of colloidal gold and colloidal palladium in a vapourisable medium such as lavender oil) or nickel coated in turn with a thin layer of gold.

The sensitive material may be deposited by spraying, sublimation, settling from suspension or by chemical action between suitable substances spread upon the backing surface. The method chosen will depend upon the nature of the material used. It is important that the coating should be uniform and this has been found difficult of achievement (at least in the case of zinc sulphide and selenide) with the spraying method, and hence the preferred method in the case of these two substances is to deposit the material by settling from a suspension in a liquid.

A number of different arrangements are possible. Thus the optical image may be cast upon the side of the screen bearing the sensitive material or the backing may be transparent and the optical image may be cast on the sensitive material through the backing. In the latter case the optical axis of the image projector and the mean direction of the scanning beam may be both normal to the screen.

When the screen is prepared by settling from suspension it is preferred to allow the material to settle on to a metal disc instead of on to a metallized piece of mica, although the metal disc construction cannot be employed when the signal plate is required to be translucent.

As above stated the lag in the screens employing materials of the kind mentioned, it is found is in part due to the use of unsuitable potential differences between the screen 1 and the collecting electrode 3, insufficient current in the scanning beam and the use of unsuitable striking velocities in the scanning electrons. The striking velocity of the beam is dependent upon the potential difference between the screen 1 and the cathode ray gun 5. It is found that over the lower range of positive values of the potential difference between the screen 1 and the collecting electrode 3, that is to say, those values in which the collecting electrode is positive with respect to the screen, the sensitivity increases with an increase in such potential difference. Above a certain value, which in the case of zinc selenide is about 50 volts the increase in sensitivity is not pronounced.

The lag, however, increases for a given beam current as the potential difference between the screen 1 and the collecting electrode 3 is increased. It is, therefore, desirable that such potential difference should have as low a value as possible consistent with satisfactory sensitivity. However, the "tilting" effect is greater with low values of the potential difference between the screen 1 and the collecting electrode 3 than with higher values thereof. For these reasons it is necessary in cases where it is desirable to avoid "tilting" effect whilst at the same time maintaining the lag as low as possible and obtaining satisfactory sensitivity to make a compromise between the values of the potential difference between screen 1 and the collecting electrode 3, which afford optimum individual results.

This compromise becomes unsatisfactory in the case of zinc selenide when the potential difference between the screen 1 and the collecting electrode 3 exceeds 50 volts, optimum results being obtained with a potential difference of 5–10 volts.

With zinc sulphide the compromise becomes unsatisfactory when the potential difference exceeds 100 volts, the optimum value being about 10 volts. For other substances it is possible to arrive at the optimum value by experiment, bearing in mind the above-mentioned factors.

In the drawing it will be seen that the collecting electrode 3 is at a positive potential with respect to the screen 1 to which is applied a negative potential from battery 8 and at a predetermined value a positive pulse is generated when the screen is scanned, but by arranging the electrode 3 to be at a negative potential with respect to the screen 1 a response in the opposite direction can be generated.

If desired, lag can be made substantially zero by maintaining the electrode 3 and the screen 1 at substantially the same potential. For example, by omitting the source of potential 8, the screen 1 can be maintained at earth potential corresponding to the potential of the electrode 3. It will, of course, be appreciated from the above that when lag is reduced to substantially zero, the "tilting" effect correspondingly increases, and sensitivity decreases but such effects in certain cases may not be disadvantageous.

If desired the tilting effect can be reduced to substantially zero by maintaining a large potential difference between the screen 1 and the collecting electrode 3. Such a method of operation results in the introduction of a degree of lag which would be intolerable for the transmission of the images of moving objects, but which may satisfactorily be employed for the transmission of "still" images.

In determining the scanning beam current the following factors must be taken into consideration. It is found that the lag decreases with increase in beam current, at least over a wide range of beam current, and the background disturbance, that is to say, unwanted signals appearing in the picture signal output, increases with increase in beam current. The optimum beam current has been found to lie between 1 and 10 microamperes.

With a constant scanning beam current, the lag has been found to decrease with increase in the striking velocity of the scanning beam, such striking velocity as aforesaid being determined by the potential difference between the electron gun 5 and the screen 1. The thickness of the layer of the zinc selenide applied to the screen 1 also to some extent determines the required striking velocity and with a layer having a thickness of the order of one to three times 10^{-4} cms. the striking velocity is found to be about 1–2 kilovolts. Preferably, it should be arranged that the diameter of the scanning spot be larger than the thickness of the coating, and in a case in which scanning is accomplished in 400 lines the diameter of the scanning spot may be of the order of two to three times 10^{-2} cms. and in such case it will be observed that the coating thickness abovementioned is small compared with this spot diameter.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. In a television system wherein is included a cathode ray tube having a conductive signal plate having on its surface a non-photo-emissive layer of photo-conductive material comprising zinc selenide, said tube having included therein a source for producing a concentrated electron scanning beam and an electron collecting electrode located intermediate the signal plate and the electron source and an output impedance conductively connected to the signal plate, the method of television which comprises projecting an optical image upon the photo-conductive layer of the signal plate to vary its photo-conductivity in proportion to the intensity of the optical image and thereby producing an electrical counterpart of the optical image, establishing a substantially uniform normal potential difference between substantially the entire area of the signal plate and the collecting electrode, said potential difference being less than 50 volts whereby an optimum ratio of sensitivity of the photo-conductive layer to the lag effect is obtained, then traversing the area of the signal plate by the concentrated electron scanning beam to scan the electrical counterpart of the optical image as developed on the signal plate and thereby releasing from the signal plate to the collecting electrode secondary electrons in substantial proportion to the light of the optical image at the area scanned and then deriving from the output impedance a signal voltage representing the scanned optical image.

2. In a television system wherein is included a cathode ray tube having a conductive signal plate having on its surface a non-photo-emissive layer of photo-conductive material of a predetermined thickness comprising zinc selenide, said tube having included therein a source for producing a concentrated electron scanning beam and an electron collecting electrode located intermediate the signal plate and the electron source and an output impedance conductively connected to the signal plate, the method of television which comprises projecting an optical image upon the photo-conductive layer of the signal plate to vary its photo-conductivity in proportion to the intensity of the optical image and thereby producing an electrical counterpart of the optical image, establishing a substantially uniform normal potential difference between substantially the entire area of the signal plate and the collecting electrode, said potential difference being less than 50 volts whereby an optimum ratio of sensitivity of the photo-conductive layer to the lag effect is obtained, focusing the concentrated electron scanning beam at its point of impact on the photo-conductive signal plate so that its diameter is greater than the thickness of the said photo-conductive layer, then traversing the area of the signal plate by the concentrated electron scanning beam to scan the electrical counterpart of the optical image as developed on the signal plate and thereby releasing from the signal plate to the collecting electrode secondary electrons in substantial proportion to the light of the optical image at the area scanned and then deriving from the output impedance a signal voltage representing the scanned optical image.

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