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PARAMETRIC TARGET FOR INFRARED TELEVISION PICKUP TUBES

Filed April 18, 1960

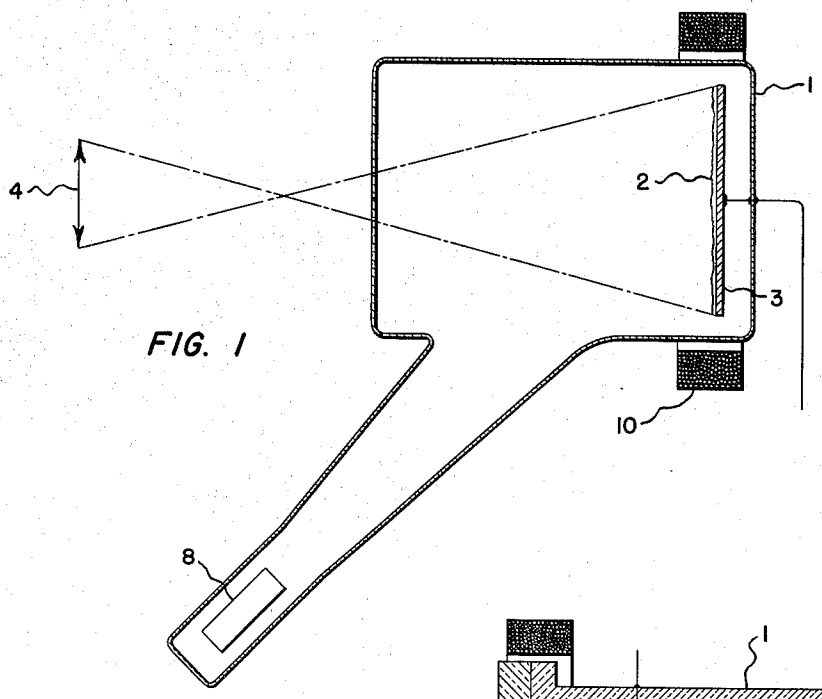


FIG. 1

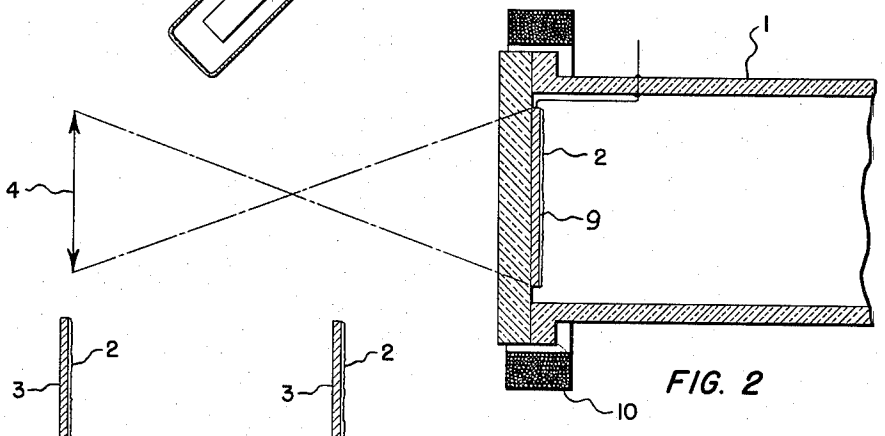


FIG. 2

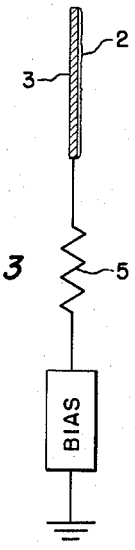


FIG. 3

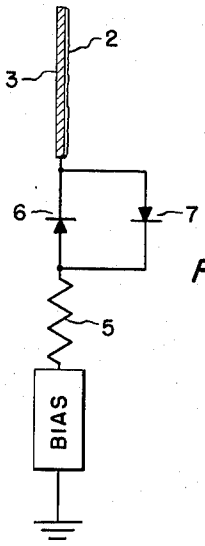


FIG. 4

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PARAMETRIC TARGET FOR INFRARED TELEVISION PICKUP TUBES

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The present invention relates to television pickup tubes, and more particularly to infrared television pickup tubes, and provides a target which has a high sensitivity in the infrared spectral region.

Usually, the principle of operation of television pickup tubes which are sensitive in the infrared region is based on the photoconductive sensitivity of the target material. In order to increase this sensitivity the target must, during operation, be cooled to a very low temperature, which creates great inconvenience.

It is the object of the present invention to provide a television pickup tube with a target having, because of its different principles of operation, a higher sensitivity and more convenient mode of operation in the infrared region than the infrared pickup tubes constructed heretofore.

Generally, the target, for instance, of a Vidicon-type pickup tube consists of a translucent, electrically conductive layer on the side of the picture to be televised. On this layer semiconducting granules or layers are deposited on the side of the electron gun of the pickup tube. The translucent layer is connected through a resistor to a bias voltage. If an electron beam sweeps over the semiconducting layer on the side of the target which faces the gun, and a picture is focused on the junction of the two mentioned layers, video signals are created across the mentioned resistor, which signals are further amplified.

In an alternative arrangement, the semiconducting layer faces both the picture to be televised and the electron gun, and is deposited on a base metallic layer which is connected through a resistor to a bias voltage. The electron beam sweeps over the semiconductor layer on whose surface the picture to be televised is directly focused. In both cases mentioned the photoconductive properties of the semiconductor material may be utilized. In certain other cases the photovoltaic effect created at the junction between the translucent material and the semiconductor may be the effect on which the video signal generation is based.

According to the present invention, the video signal generation is to be accomplished by using such semiconducting materials in the target electrode whose properties actuate different principles in target operation upon infrared illumination than those on which the operation of the other, so far used pickup tubes are based.

In the present application a new target is described where the semiconducting materials chosen enable the utilization of heretofore not used phenomena in the target operation, whereby the infrared sensitivity of the target is considerably increased. Accordingly, the operation of the pickup tube target which is the subject to the present invention, is based on different principles.

In accordance with the present invention, the infrared-sensitive target electrode consists of a layer of translucent, electrically conductive material situated on the picture side of the tube, on which conductive layer another, semiconducting layer is deposited on the side looking towards the gun. This latter material will, upon infrared irradiation, exhibit heretofore not utilized properties.

The part of the target consisting of the translucent layer is connected direct, or through a rectifier diode, and through a resistor to the proper bias. Alternatively, the translucent part of the target can be connected to the

resistor which creates the video signal, through two diodes, one of which works in forward, the other in reverse bias direction.

In an alternative target solution the above mentioned semiconductor material faces directly both the infrared picture to be televised and the cathode ray tube gun. The other side of this material forms a junction with a conductive metallic sheet which is connected to the aforementioned bias in a manner as described earlier.

The semiconducting material which constitutes the one of the two target layers and faces, in the obvious solution, the electron gun, is a ferro electric substance, or the like, for instance, barium titanate.

Materials as this have three important characteristics, which are to be the basis of the operation of the target which is the subject of the present invention. One of these characteristics is that the permittivity, or dielectric constant of the material varies with the temperature, which variation is particularly sharp before and after the Curie temperature of the material.

The second characteristic property of the material to be utilized is that its dielectric constant changes in an electric field into which the material is placed. The effects of these two characteristic properties may be caused to add up, thereby achieving an enhanced effect.

The third characteristic property is that the infrared absorption of the mentioned material is considerably larger at higher temperatures than at normal (room) temperature. Consequently, if the target temperature is artificially kept on a higher level, its infrared absorption is thereby increased.

The operation of this infrared-sensitive target can be interpreted as follows:

The elementary part of the whole target may be considered as a small capacitor. One of the latter's elementary electrodes faces the electron gun, the other electrode, which is an elementary part of the translucent layer, or the metallic sheet respectively, is connected through a rectifier, or through oppositely biased rectifiers, to the resistor creating the video signal, which in turn is connected to one terminal of the bias source, the other terminal of which is grounded.

Such an elementary capacitor, which is an elementary part of the target, is charged, by the bias source, to a certain potential difference between its electrodes. If an infrared picture is projected onto the target, the heat absorbed by the target will cause a lowering of the dielectric constant. Now each individual infrared picture element which impinges on the target will reduce the dielectric constant of the semiconducting material by a different amount in each elementary capacitor, and as a consequence of the dielectric constant being reduced to a different value in each individual elementary capacitor, the potential differences across the elementary capacitors will accordingly rise to different values.

When the electron beam scans the target material facing the gun and hits an electrode of one of the elementary capacitors, this will further increase the potential difference between the electrodes of this elementary capacitor, which in turn, according to the second principle used, will create a further lowering of the individual dielectric constant of the individual elementary capacitor hit by the beam, thereby causing a further (change) increase of the potential difference between the two electrodes of this elementary capacitor. This sudden change of potential difference between the two electrodes of the elementary capacitor at the time of its being hit by the scanning beam will create a current pulse across the resistor creating the video signal.

If therefore the scanning beam sequentially hits one elementary capacitor after the other, this will accordingly create different current pulses across the resistor, and thus

video signals will have been formed in accordance with the infrared picture.

The infrared absorption of the target material on which the scanning beam impinges is larger at higher temperatures. The target temperature is thus to be raised to the value where the optimum infrared absorption occurs.

According to the described operation, the originally generated signal will, because of the phenomena involved, be twice amplified, each individual amplification being achieved by a separate principle of operation.

The objects of the present invention and the means of achieving them will become more apparent when the following claims are considered, in connection with the accompanying drawings.

FIGURE 1 schematically represents the infrared pickup tube and its target, where the material which changes its dielectric constant upon illumination with infrared rays and upon the impinging of the scanning electron beam directly faces the infrared picture to be televised, as well as the electron gun.

FIGURE 2 schematically represents the alternative arrangement of the target in the pickup tube, where the material which changes its dielectric constant upon illumination with infrared rays and upon the impinging of the scanning beam faces the electron gun of the pickup tube, and the translucent conductive layer faces the infrared picture to be televised.

FIGURE 3 schematically represents the way in which the translucent conductive layer, or the metallic sheet electrode respectively, is connected directly to the resistor across which the video signal is created, which resistor is in turn connected through the bias to the ground.

FIGURE 4 schematically represents the way in which the translucent conductive layer, or the metallic sheet electrode respectively, is connected through rectifier diodes to the resistor across which the video signal is created, which resistor is in turn connected through the bias to the ground.

Referring to FIGURE 1, the cathode ray tube **1** comprises the new target consisting of the semiconducting layer **2** which has properties similar to those of some ferro electric substances, and is deposited on an electrically conducting layer, or respectively, metallic sheet **3**. The infrared object **4** is focused on layer **2**. The electrode **3** is connected, as shown in FIGURES 3 and 4, directly, or through a forward biased diode **6**, or through forward and backward biased diodes **7** to the resistor **5**, which is connected to the grounded bias supply.

The infrared picture **4** (from FIGURE 1) is focused on layer **2**, whereupon the target elements of layer **2** will absorb different amounts of infrared radiation, and consequently the different semiconductor-layer elements will acquire different dielectric constants. The different elementary capacitors whose one electrode will be an elementary part of electrode **3**, thus are charged to different potentials by the bias. When the scanning electron beam, which originates from gun **8**, hits, during the scanning, one of the elementary surface parts of **2**, which elementary surface may be considered as being the other electrode of an elementary capacitor, the potential difference between the electrodes of this elementary capacitor will change again, and with it also the dielectric constant of this elementary capacitor. The resultant sudden change of potential difference will create a current pulse through resistor **5** of FIGURE 3. As the beam scans the target, therefore, the video signals are created across resistor **5**.

A further embodiment of the present invention, as shown in FIGURE 2, comprises an arrangement where the whole target is situated on the front surface of the cathode ray tube **1**, the translucent and electrically conducting material **9** being a base on which the material **2** is deposited, which latter's dielectric constants change upon irradiation by the infrared picture **4** which is focused on the target, and upon the action of the electric field created by the scanning electron beam. The connection of electrode **9** in FIGURE 2 to the ground is the same as the connection of electrode **3** of FIGURE 1.

The procedure of obtaining video signals which correspond to the infrared picture focused on the target is the same for FIG. 2, as described in connection with the embodiment of the invention comprised in FIGURE 1.

The electrically conductive layers **3** in FIGURE 1, and **9** in FIGURE 2, may be substituted in FIGURE 1 by some semiconductor material, and in FIGURE 2 respectively, by some translucent and conductive semiconductive material.

The eventually necessary heating of the target in order to increase its infrared absorption, can be achieved either with the heating coils **10**, or by some other convenient means.

In reviewing my invention, the picture element can be considered to comprise an equivalent circuit having a capacitor, resistor and a voltage source in parallel. Through infrared illumination of the target, the dielectric constant of the capacitor is changed.

The semiconductor-layer elements comprise materials having a dielectric constant that change with the target temperature, wherein the dielectric constant increases with an increase in temperature to the Curie point and thereafter decreases with further increases in temperature. The materials dielectric constant will also decrease upon an electrical stress. Thus, in my invention, I am utilizing these two effects in such a way that these two changes are amplifying each other.

When an infrared picture of varying over-all intensity is focused on the target it will create different temperatures on different elements of the semiconductor material. Assuming a bias temperature above the Curie point, the greater the infrared illumination, the greater decrease in dielectric constant of the capacitor of the equivalent circuit. The electrons in the sweeping electron beam upon contacting the target further decrease the dielectric constant of the equivalent circuit capacitor. Thus, these two effects combine into a composite decrease of the dielectric constant.

The bias temperature must be above the Curie temperature, otherwise the aforesaid changes in dielectric constant will compromise each other into inconclusive results.

Having now described the invention, what is claimed is:

1. A target electrode for an infrared television pickup tube comprising a sheet of material which is electrically conductive, means providing another sheet of semiconductor material adjacent on one side to said electrically conductive material, said semiconductor material changing its dielectric constant upon incident infrared radiation and upon an impressed electric field created by the impinging electrons of the scanning cathode ray beam on said target, and said radiation and said electric field amplifying each other in changing said dielectric constant above the Curie temperature on the negative slope side of the dielectric constant vs. temperature curve of said semiconductor material.

2. A target electrode for an infrared television pickup tube comprising a sheet of material which is translucent to infrared rays and electrically conductive, means providing another sheet of semiconductor material adjacent to said electrically conductive material, said semiconductor material changing its dielectric constant upon incident infrared radiation and upon an impressed electric field created by the impinging electrons of the scanning cathode ray beam on said target, and said radiation and said electric field amplifying each other in both decreasing said dielectric constant above the Curie temperature on the negative slope side of the dielectric constant vs. temperature curve of said semiconductor material.

3. A target electrode for an infrared television pickup tube comprising a sheet of material which is electrically conductive, means providing another sheet of semiconductor material adjacent on one side to said electrically conductive material, means for raising the temperature of

said semiconductor material above its Curie temperature, said semiconductor material changing its dielectric constant upon incident infrared radiation and upon an impressed electric field created by the impinging electrons of the scanning cathode ray beam on said target, and said incident infrared radiation and said impressed electrical field combining to amplify each other in reducing said dielectric constant when said semiconductor material is at a temperature above the Curie temperature.

4. A target electrode for an infrared television pickup tube comprising a sheet of material which is translucent to infrared rays and electrically conductive, means providing another sheet of semiconductor material adjacent to said electrically conductive material, means for raising the temperature of said semiconductor material above its Curie temperature, said semiconductor material changing its dielectric constant upon incident infrared radiation and upon an impressed electric field created by the impinging electrons of the scanning cathode ray beam on said target, and said incident infrared radiation and said impressed electrical field combining to amplify each other when said semiconductor material is at a temperature above the Curie temperature.

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