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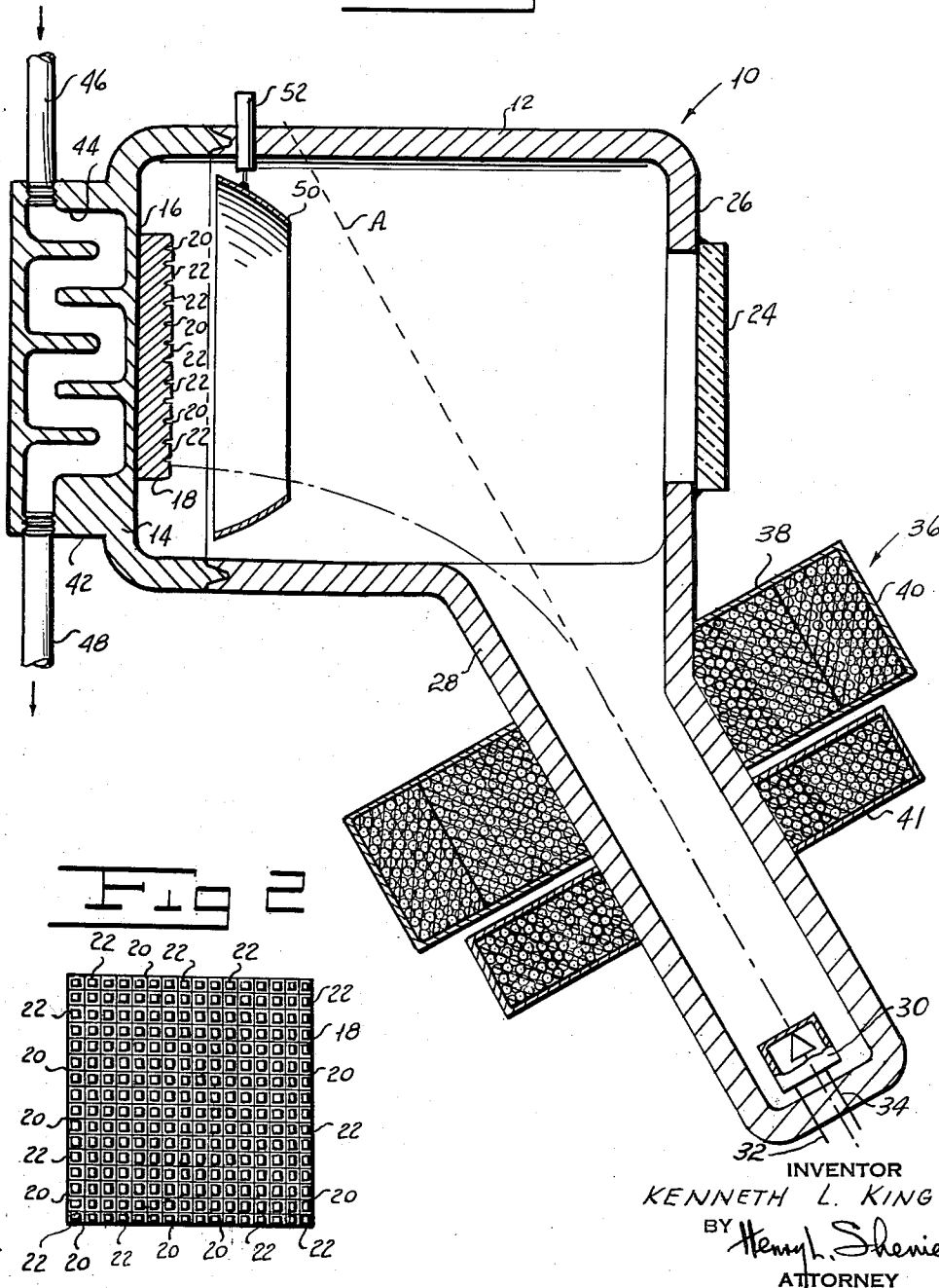
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INFRARED PHOTO-IMAGING DEVICE

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INFRARED PHOTO-IMAGING DEVICE

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My invention relates to a photo-imaging device and more particularly to a photo-imaging device which is adapted to operate in the infrared region of the spectrum.

It is often desirable to convert a radiation image into an electrical signal representing the radiation distribution of the image. The resultant signal may, for example, be applied to a cathode-ray tube to produce a visual image of the radiation image.

In the prior art devices such as the iconoscope and image orthicon are known in which a visible image is projected onto a photosensitive mosaic which is scanned by an electron beam to produce an electrical signal representing the light distribution of the image. With the present day importance of infrared detection, it is desirable that a device be provided for producing an electrical signal representing the energy distribution in an infrared image so that a visible image of the infrared radiation image may be produced. It is now known that a photovoltaic cell sensitive to infrared radiation can be produced on the surface of a crystal. The properties of this cell are deleteriously affected by a rise in temperature resulting from heat energy from any source other than the image-producing source.

I have invented a photo-imaging device which is especially adapted for use in the infrared portion of the spectrum. The photovoltaic element of my photo-imaging device is shielded from heat energy other than that emanating from the image-producing areas. I provide my photo-imaging device with means for maintaining the photovoltaic element at a substantially constant temperature.

One object of my invention is to provide a photo-imaging device which is especially adapted for use in the infrared portion of the spectrum.

Another object of my invention is to provide a photo-imaging device for producing an electrical signal representative of the energy distribution in an infrared image.

A further object of my invention is to provide a photo-imaging device in which the photo-sensitive element is shielded from radiant heat energy from sources other than a target area.

A still further object of my invention is to provide a photo-imaging device having means for cooling the photosensitive element.

Other and further objects of my invention will appear from the following description.

In general my invention contemplates the provision of an evacuated envelope having a surface for supporting a photosensitive mosaic and provided with means for admitting energy from a target area. I position the mosaic in the path of the energy. I form my envelope with a neck having an axis extending in a direction to pass clear of the surface of the mosaic. I deflect the electron beam of an electron gun disposed in the neck to scan the surface of the mosaic. Owing to the disposition of the neck with respect to the mosaic surface radiant heat energy emanating from the gun passes clear of the mosaic surface. Electrons from the beam which are reflected from the mosaic surface are collected by a collector to produce an electrical current which is representative of the energy distribution in the image projected on the mosaic surface. I provide my device with cooling means for maintaining the mounting surface of the photosensitive element at a substantially constant temperature.

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In the accompanying drawings which form part of the instant specification and which are to be read in conjunction therewith, and in which like reference numerals are used to indicate like parts in the various views:

FIGURE 1 is a diagrammatic sectional view of my infrared photo-imaging device.

FIGURE 2 is a plan view of a portion of the surface of the photosensitive mosaic of my infrared photo-imaging device drawn on an enlarged scale.

Referring now to the drawings my infrared photo-imaging device indicated generally by the reference character 10 includes an evacuated envelope 12, one end 14 of which provides a surface 16 on which I mount a crystal 18 by any convenient means known to the art such as a suitable adhesive. The crystal 18 may be of any suitable photovoltaic type of sensing material such, for example, as an indium antimonide crystal. I score the surface of the crystal 18 along a plurality of lines to form grooves 20 which divide the crystal into a plurality of discrete photovoltaic cells 22. For example, a one-inch square crystal may be ruled by means of a ruling engine or may be photoetched into, for example, 1,000 x 1,000 elements 22 on a single base. In this manner I form a mosaic of photosensitive elements or cells 22 on the surface of crystal 18. As is known in the art, the potential at the surface of each of the elements 22 with respect to the base of the crystal is a function of the radiant energy falling on the element. It will be seen that if a radiant image such, for example, as an infrared image, is projected on the surface of crystal 18 the potential distribution over the surface of elements 22 will represent the energy distribution in the image.

I mount a window 24 in the end 26 of envelope 12 remote from end 14 to admit radiant energy from a target area into the envelope to fall on the surfaces of elements 22 to produce a potential distribution on the surfaces of the elements which represents the energy distribution of the target image. Window 24 may be formed of any suitable material which transmits infrared radiation, such, for example, as synthetic sapphire.

I form the envelope 12 with an offset neck 28 having an axis indicated by the broken line A. I mount an electron gun 30 of any appropriate type known to the art within neck 28. Respective conductors 32 and 34 connect gun 30 to a suitable source of external potential. Any means known to the art such as a deflection yoke indicated generally by the reference character 36 made up of a vertical deflecting coil 38 and a horizontal deflecting coil 40 may be used to bend the electron beam from gun 30 and to move it across the surfaces of the elements 22 to scan the mosaic 18. Means such as a coil 41 may be employed to focus the electron beam. As will be apparent from FIGURE 1 of the drawings, the axis A of neck 28 extends in a direction to clear the surface of the mosaic element 18. Owing to this disposition of the neck 28, no thermal radiant energy from the gun 30 is permitted to reach the elements 22. Thus I have avoided the deleterious effects of thermal radiant energy from the gun reaching the elements 22.

I provide the end 14 with a cooling block 42 which may, if desired, be integrally formed with end 14. A serpentine passage 44 in block 42 permits the passage of cooling fluid through the block. A pipe 46 admits a suitable cooling fluid such, for example, as liquid nitrogen to the passage 44. A pipe 48 connected to the outlet of passage 44 permits cooling fluid introduced into the passage to flow back to the source (not shown) of fluid. The cooling fluid passing through the block 42 maintains the temperature of the crystal 18 substantially constant to ensure that its photovoltaic properties remain substantially constant to operate effectively in the infrared band of the spectrum.

As has been explained hereinabove, a radiant image projected onto the surfaces of elements 22 produces a potential distribution on these surfaces, which distribution represents the energy distribution of the image-producing area. As the electron beam from gun 30 strikes the surface of an element 22, respective percentages of the electrons are absorbed and reflected depending upon the potential of the surface of the element with respect to the base of crystal 18. Since the surface potential of an element 22 is a function of the radiation falling on the element, the number of electrons reflected will be some function of the energy falling on the element. I mount a collector 50 within envelope 12 by any convenient means known to the art. A terminal 52 extending through the wall of envelope 12 provides a connection for collector 50 to a suitable source of potential. Electrons reflected from the surface of an element 22 are collected by collector 50 to produce a current in the external circuit which is proportional to the light energy impinging on the element. As the beam from gun 30 scans the surfaces of elements 22, a current flows in the external circuit which is representative of the potential distribution on the surfaces of elements 22 and thus representative of the energy distribution in the target area. It will be obvious that the surface of crystal 18 must be scored to produce the mosaic elements 22 if the result described above is to be achieved.

In operation of my photo-imaging device I project a radiation image such, for example, as an infrared image onto the elements 22 by any convenient means known to the art. As a result, the potential distribution on the surfaces of elements 22 is representative of the energy distribution of the target area. As the beam 30 scans the elements 22 percentages of electrons from the beam are reflected and collected by collector 50 to produce an external circuit current representing the energy distribution of the target area. Owing to the disposition of neck 28 with respect to the element 18 radiant thermal energy from gun 30 is prevented from falling on the elements 22 to give a false indication in the external circuit. At the same time the cooling liquid passing through block 42 maintains the temperature of crystal 18 substantially constant to maintain substantially constant the photo-voltaic properties of the elements 22.

While I have described my photo-imaging device as being especially adapted for use in the infrared band of the spectrum, it is to be understood that it functions as well in other bands of the spectrum such, for example, as the visible band.

It will be seen that I have accomplished the objects of my invention. I have provided a photo-imaging device for producing an electrical signal representing the energy distribution in a target area. My device is particularly adapted for use in the infrared band of the spectrum. I shield the mosaic of my device from radiant thermal energy from the electron gun producing the scan-

ning beam. Cooling means maintains the temperature of my mosaic crystal substantially constant.

It will be understood that certain features and sub-combinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of my claims. It is further obvious that various changes may be made in details within the scope of my claims without departing from the spirit of my invention. It is, therefore, to be understood that my invention is not to be limited to the specific details shown and described.

Having thus described my invention, what I claim is:

1. A photo-imaging device including in combination an envelope having a body providing a mounting surface and a neck having a wall and having a longitudinal axis, a photo voltaic mosaic element, means carried by said envelope for admitting radiation into said envelope, means mounting said mosaic element on said mounting surface in a position to receive radiation admitted into said envelope, said neck being so disposed with respect to said body that its axis extends in a direction to clear the surface of said element, an electron gun for producing a beam of electrons, means mounting said gun in said neck in a position at which any straight line from said gun to said element intersects said neck wall to cause said neck to intercept thermal radiation emanating from said gun in the direction of said element, means for causing said beam to scan the surface of said photo voltaic mosaic, means for collecting electrons reflected from said element surface and means for cooling said surface by conduction.

2. A photo-imaging device as in claim 1 in which said element is a mosaic formed with a plurality of photo-voltaic cells.

3. A photo-imaging device as in claim 1 in which said element is an indium antimonide crystal scored to form a plurality of mosaic cells.

4. A photo-imaging device as in claim 1 in which said cooling means includes a cooling block and means for passing a coolant through said block.

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