

[54] **LARGE, TWO DIMENSION, SCREEN FOR CONVERTING AN OPTICAL IMAGE PROJECTED ON ONE SIDE TO AN IDENTICAL INFRARED IMAGE DISPLAY ON THE OTHER SIDE**

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[58] Field of Search: 250/84, 83.3 H, 83.3 HP, 250/211 R, 213 R

[56] **References Cited**

UNITED STATES PATENTS

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[57] **ABSTRACT**

A screen panel having conductive lattices, such as a copper plate, juxtaposed on each side of a dielectric substrate. The back side of the substrate and the conductive lattice thereon is covered with some photoconductive material, such as cadmium sulphide. The front side of the substrate and the conductive lattice thereon is covered with an infrared emitting substance of electrically resistive material having a high thermal emissivity, such as resistive black or a carbon slurry paint. A power supply is connected across the lattices on each side of the substrate and a conductor is inserted through the substrate for conductively connecting the photoconductive material and the electrically resistive material. An electrical circuit is formed that includes the voltage source, the back lattice, the photoconductive material, the conductor through the substrate, the electrically resistive material, and the front lattice, all connected in series. Light intensity, according to an image pattern projected on the back of the panel, lowers the electrical resistance of the photoconductor material. Lowering of the resistance in the photoconductive material causes increased current flow in the electrical circuit, and thus through the electrically resistive material on the front of the panel. Increased current flow in the electrically resistive material causes a temperature increase therein, and thus a pattern of infrared energy is emitted from the resistive material on the front of the panel in proportion to the visible light displayed on the back of the panel.

12 Claims, 3 Drawing Figures

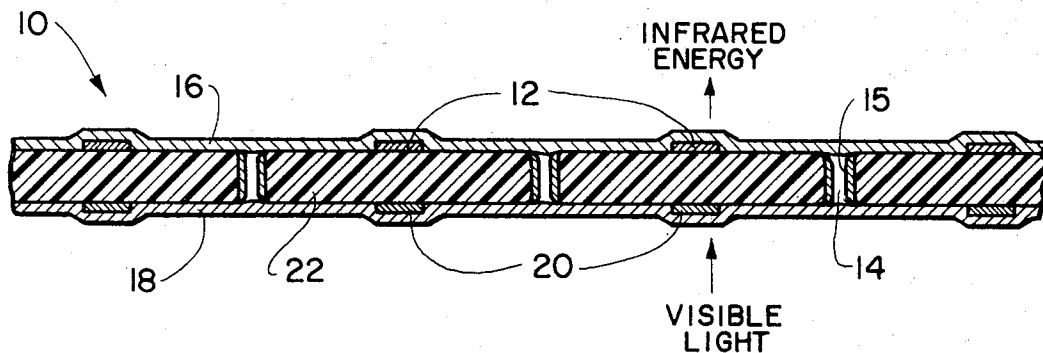


FIG. 1

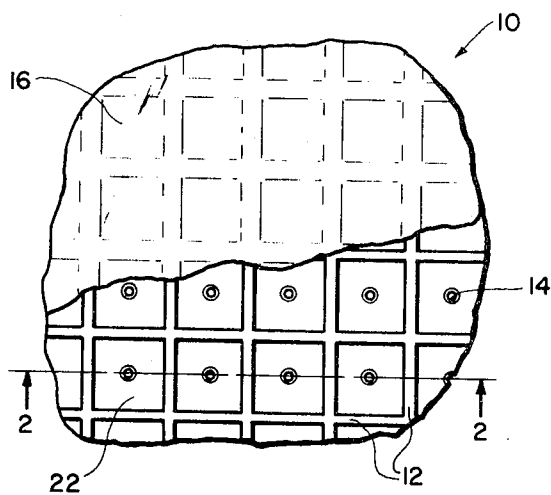


FIG. 2

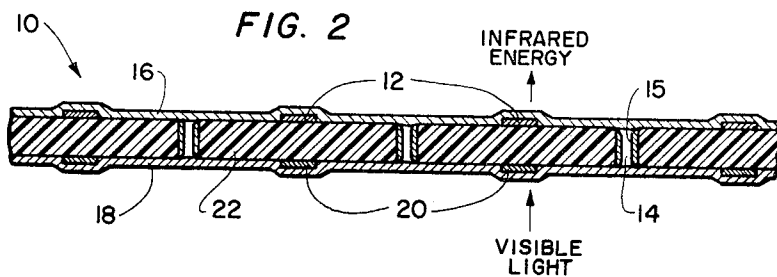
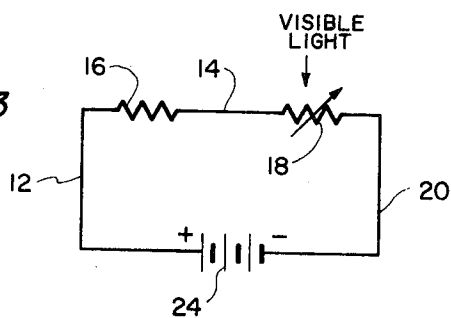


FIG. 3



LARGE, TWO DIMENSION, SCREEN FOR CONVERTING AN OPTICAL IMAGE PROJECTED ON ONE SIDE TO AN IDENTICAL INFRARED IMAGE DISPLAY ON THE OTHER SIDE

BACKGROUND OF THE INVENTION

This invention is in the field of converting a visible image into an infrared image over a large area.

There is a need for life size, or near life size, panels for displaying infrared images, also known as thermal images, for evaluating infrared systems at normal focusing distances. Panels as large as 10 feet $\times$ 25 feet and larger are needed.

To provide large area panels for converting visible light to infrared radiation, amplification of the light signal is required since the required concentration of visible light would be 1,000 foot-candles or more; if no amplification was available. Furthermore, it is extremely difficult to provide an input illumination level above 10 foot-candles, over surfaces of these dimensions. In this invention, the relatively small light signal modulates power, which is externally supplied to the panel to provide the necessary amplification.

SUMMARY OF THE INVENTION

The invention is a large screen panel that has a mosaic of conductive lattices juxtaposed on opposite sides of a dielectric substrate. A layer of photoconductive material coats the lattice and substrate on the back side of the panel. A coat of electrically resistive material, or resistive black, which emits infrared energy in proportion to its temperature, is coated over the lattice and substrate on the front of the panel. Conductive connections are formed through the substrate at equal distances from the conductive lattices. These conductive connections electrically connect the photoconductive material and the resistive black. A power supply is connected across the lattices on the front of the panel to the lattice on the back of the panel. Light impinging on the back of the panel lowers the resistance of the photoconductive material, thus causing increased current through the circuit formed by the photoconductive material, the conductive connection through the substrate, and the resistive black. Increased current flow through the resistive black raises its temperature, causing more infrared energy to be emitted therefrom. Therefore, infrared energy is emitted from the front surface in proportion to the intensity of the visible image impinging on the back of the panel.

It is an object of this invention to provide a mosaic array of elements incorporating a photoconductor and an emitting surface, such that when the photoconductor is modulated by a light image, the image is emitted from the emitting surface in the infrared spectrum.

BRIEF ILLUSTRATION OF THE DRAWINGS

FIG. 1 illustrates a plan view of the front side of the panel of this invention;

FIG. 2 shows a sectional view of the panel taken through 2—2 of FIG. 1; and

FIG. 3 shows a schematic diagram of the electrical circuit formed by materials and electrodes on the panel.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIGS. 1 and 2, a portion of a large

screen panel 10 of the present invention is shown. The panel 10 may, for instance, be as large as 10 feet $\times$ 25 feet or perhaps larger. Panels of this size require active amplification of the very weak visible light that is imaged on the back side of panel 10. The amplification is possible by the specific arrangement of materials and voltage connections as discussed hereinbelow. Panel 10 is formed by conductive lattices 12 and 20 laid on opposite sides of a dielectric substrate 22. Lattice 12 is on the front side of panel 10 and is designated as the front conductive lattice. Lattice 20 is on the back side of panel 10 and is designated as the back conductive lattice. Lattices 12 and 20, are juxtaposed directly opposite each other on substrate 22, forming a matrix of individual cells of square conducting grids on each side of panel 10. These grids may be made of copper. In the center of each square, a hole 14 is drilled and some conductor is placed therein. The conductor may be a conducting pin inserted in the hole, or the hold could be made conductive by electroless plating. Hole 14 could also be formed by mechanically drilled or chemically etched and a rivet or eyelet passed therethrough with a conductive paste, such as liquid aluminum, placed inside the rivet or eyelet and then squigged off the front and back of the panel. A layer of photoconductive material 18 is deposited on the backside of the panel, covering both lattice 20 and substrate 22. The photoconductive material may be cadmium sulphide, but is not limited to cadmium sulphide. The photoconductive material could alternately be cadmium sulfoselenide or lead selenide. The photoconductive material can be vacuum deposited by the thin film techniques or electrostatically sprayed by the thick film techniques. The layer of photoconductive material 18 is then sintered for a period of time.

A layer of resistive black 16 is deposited over lattice 12 and substrate 22 on the front of panel 10. Resistive black 16 could be some material that is relatively inexpensive and has a high emissivity, such as carbon slurry type paint.

Refer now to FIG. 3 which illustrates a schematic diagram of the electrical circuit formed by the inventive panel 10. A voltage source 24 is connected across front and back conductive lattices 12 and 20 with the polarity as shown. Completing the electrical circuit as shown with reference to FIGS. 2 and 3 is the photoconductive material 18, the conductor hole 14, and resistive paint 16. The resistance of material 18 varies inversely with the amount of light from the visible image impinging on each square of lattice 20. Even though there is only one voltage source 24 used to apply a potential differences on lattice 12 and 20, the schematic as shown in FIG. 3 is an electrical circuit representing only one of the squares included within the lattices. There are, in effect, many electrical circuits with each electrical circuit representing one square cell, with the current flow through that individual circuit varied in proportion to the resistance of 18.

In the operation of panel 10, a visible light image impinging on photoconductive material 18 varies the resistance of the photoconductor material 18, thus modulating the current flowing through the infrared emitting resistive black 16 of the electrical circuit. For example, when light intensity increases over an individual cell of material 18, resistance of 18 decreases and current increases through the resistive black 16 in the corresponding juxtaposed square on the front of panel 10. A

current increase through this individual cell of resistive black 16 causes an increase of infrared energy emitted therefrom. Clearly the increase in visible light in a specific pattern on the back of panel 10 also causes increase of infrared radiation from resistive black 16 in the same specific pattern, thus effecting the technique of transferring and amplifying a direct visible-to-infrared image in life size, or near life size.

In one use of such a large panel as that disclosed herein, slides or view graphs of tactical targets, such as the replica of an enemy tank in terrain, may be projected on the back of the panel with the resultant thermal or infrared radiation image being emitted from the front. The emitted infrared radiation may then be observed by infrared imaging systems. Many slides may be used with a projector for projecting separate images on the back of the panel. Other uses for panel 10 may be in the medical field where a camera takes thermal graph pictures to establish cold zones of the body to detect, for example, breast cancer, tumors, varicose veins, etc. The pictures that display light transparencies where the cold zones are located may then be projected on the back of panel 10 to emit thermal or infrared images out the front of panel 10. Many other uses of transparent films that record a pattern of density or of temperature conditions, etc., may be used with panel 10 for displaying an infrared image therefrom.

I claim:

1. A panel for converting a visible light image to an infrared energy image, the panel comprising:
 - a matrix of individual cells mounted on a common substrate;
 - a front conductive lattice;
 - a back conductive lattice, said front and back conductive lattices inter-connected on said substrate to form said matrix of individual cells;
 - a plurality of individual conductors positioned through said substrate wherein each of said conductors is associated with an individual cell;
 - a power supply, said power supply connected between said front said back conductive lattices for applying an electrical charge equally across said individual cells;
 - a layer of photoconductive material deposited over said back conductive lattice and the side of said substrate adjacent thereto; and
 - an infrared emitting substance deposited over said front conductive lattice and the side of said substrate adjacent thereto whereby an increase in light flux on the photoconductive material at each of said cells will decrease the resistance between said electrically changed lattices associated with each of said cells thereby increasing current flow through each of said infrared emitting surfaces as-

sociated with each cell for causing increased infrared radiation from said emitting surface in a pattern identical to an image effected by modulation of said light flux on the photoconductive material.

2. A panel as set forth in claim 1 wherein said substrate is dielectric material.

3. A panel as set forth in claim 2 wherein said dielectric material is epoxy.

4. A panel as set forth in claim 1 wherein said front and back conductive lattices are square copper grids juxtaposed directly opposite each other on said substrate.

5. A panel as set forth in claim 1 wherein said photoconductive material is cadmium sulphide.

6. A panel as set forth in claim 1 wherein said photoconductive material is cadmium sulfoselenide.

7. A panel as set forth in claim 1 wherein said photoconductive material is lead selenide.

8. A panel as set forth in claim 1 wherein said infrared emitting substance is resistive black.

9. A panel as set forth in claim 8 wherein said resistive black is a carbon slurry paint.

10. A panel as set forth in claim 1 wherein said plurality of individual conductors positioned through said substrate is a plurality of holes with an eyelet of liquid aluminum placed therein.

11. A panel as set forth in claim 10 wherein said plurality of individual conductors are positioned through said substrate to emerge therefrom in said photoconductive material and said infrared emitting substance at an equidistance from said front and back conductive lattices.

12. A technique for transferring and amplifying a visible image to an infrared image, the technique comprising:

modulating visible light on a photoconductive material covered conductive lattice that is mounted on one side of a dielectric substrate;

converting said visible light into electrical energy within said photoconductive material;

transferring said converted electrical energy through a plurality of elongated electrical conductors positioned through said dielectric substrate to an infrared emitting substance conductive lattice; and

connecting a voltage source across said photoconductive material covered conductive lattice and said infrared emitting substance covered conductive lattice whereby said modulating visible light modulates power from said voltage source within said infrared emitting substance for emitting infrared radiation in proportion to the intensity of said modulating visible light.

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