

May 3, 1960

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2,935,711

THERMALLY SENSITIVE TARGET

Filed March 11, 1952

FIG. 1

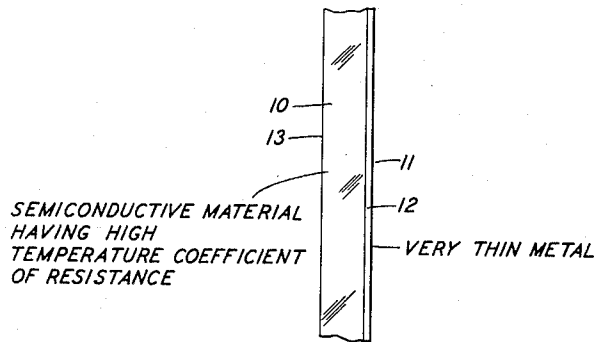
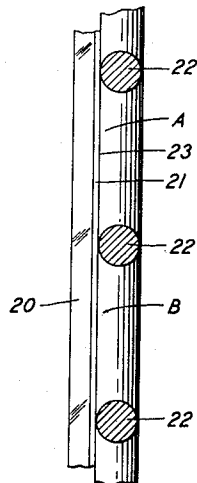


FIG. 2



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THERMALLY SENSITIVE TARGET

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Application March 11, 1952, Serial No. 275,997

7 Claims. (Cl. 338—18)

This invention relates to conductive elements which are sensitive to radiant energy and particularly to thin flake thermally sensitive conductive elements.

In the application of Joseph A. Becker, Serial No. 127,707, filed November 16, 1949, a radiant energy translating device is disclosed comprising a thermally sensitive conductive flake upon which radiation from a panorama is focussed and means for converting that panorama into a potential picture which may be converted into an electron image and portrayed on a fluorescent screen.

Objects of this invention are to improve the thermal resolution in thermally sensitive conductive flakes, to reduce the thermal time constant of thermally sensitive conductive flakes, to reduce lateral heat flow in thermally sensitive conductive flakes, to improve targets of the type employed in translating devices similar to those disclosed in the above Becker application, and to enable thinner flakes to be produced and employed in bolometers and the like.

A feature of this invention resides in attaining an effective thermal separation of a thermally sensitive conductive flake into a plurality of substantially independent thermal elements by mounting bodies of relatively large thermal capacity in intimate contact with the flake and spaced several flake thicknesses apart. These bodies act as thermal sinks which produce large thermal gradients in the portions of the flake immediately adjacent them.

Another feature of this invention resides in providing a flake target of the type employed in the above-noted Becker application with a thermal sink which assures high thermal resolution. In one embodiment, this sink, which may be of grid form, is mounted on a blackened very thin metal electrode which in turn is in intimate contact with the flake. The strands of the grid are of high heat conductivity material and are connected to more massive radiating elements and therefore have a thermal capacity which is high relative to the flake so that any heat tending to flow laterally in the flake or electrode is subjected to a thermal gradient produced by the strands of the heat sink to inhibit such flow.

The above and other features of this invention may be more readily appreciated from the following detailed description when read in conjunction with the accompanying drawing in which:

Fig. 1 is a section of a portion of a thermally sensitive semiconductive flake of the type disclosed in the Becker application; and

Fig. 2 is a section of a portion of a flake and heat sink constructed in accordance with this invention.

In the following disclosure of a specific embodiment of this invention a construction will be presented which is particularly suited to targets for radiant energy translating devices of the type disclosed in the application above identified. However, it is to be understood that the invention is not limited in its construction or application to such devices.

A target of the type disclosed in the aforementioned appli-

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cation is shown in Fig. 1. It comprises a thin flake 10 of thermally sensitive semiconductive material having a high temperature coefficient of resistance, for example one or more of the oxides of nickel, manganese, iron, copper, zinc, beryllium, and cobalt. This flake, which is of uniform composition and thickness and less than 10 microns thick, may be produced by a number of processes such as those disclosed in Patent 2,414,793, issued January 28, 1947, to J. A. Becker and H. Christensen; and the applications of H. Christensen, Serial No. 127,715, filed November 16, 1949 (now United States Patent No. 2,746,129, issued May 22, 1956), Serial No. 133,608, filed December 17, 1949 (now United States Patent No. 2,636,012, issued April 23, 1953), and Serial No. 134,790, filed December 23, 1949 (now United States Patent 2,674,583, issued April 6, 1954). One surface of this flake is coated with a thin layer of conductive material 12, which may be a layer of platinum about 0.1 micron thick, to form an electrode. The target flake may be supported in a metallic ring (not shown) which contacts the electrode surface 11 to provide an electrical connection thereto. A typical target area is of from 1 to 9 square centimeters.

In operation, a heat pattern emanating from a panorama is directed on a surface 11 of flake 10 to cause the portions of the target corresponding to portions of the panorama to assume temperatures in accordance with the infra-red radiating from those panorama portions. The effectiveness of heat absorption by the target may be improved by the application of some blackening agent to the surface 11, such as an organic lacquer or a layer of platinum black. Since the material of the target has a high temperature coefficient of resistance the resistances of the various portions of the target are modified according to the infra-red or heat radiation they receive. A further conversion of this array of varying resistance over the target surface to a potential picture is effected by biasing the electrode slightly positive relative to a cathode from which is emanating an electron stream which scans the semiconductive flake surface 13. A potential drop occasioned by the flow of scanning current through the flake occurs in each portion of the flake as it is scanned, and is dependent upon the resistance of the portions of the flake. Thus, a potential picture corresponding to the radiation from the panorama is produced on the scanned surface of the flake.

Both the thermal resolution and the permissible scanning rate of targets of the above type are improved substantially by the target construction shown in Fig. 2.

Target response can be improved by decreasing the electrical and thermal relaxation time constants of the flake and by increasing the thermal resolution. The first-mentioned factors can be reduced by reducing the flake thickness. A construction which permits a reduction in flake thickness and increases the thermal resolution of the flake is shown in Fig. 2. It comprises a flake 20 of semiconductive material having a high temperature coefficient of resistance, an electrode 21 on its rear surface, and a grid composed of strands 22 of high thermal conductivity in intimate contact with this electrode and connected to a large heat sink such as a supporting ring arranged to radiate the heat it receives. This grid serves as a support for the flake and as a thermal sink which thermally separates the flake into an array of thermally independent elements two of which are represented at A and B. The grid may be applied to a flake which has been produced by one of the methods mentioned above or produced by first covering the mesh with a metal foil which is given a suitable oxidation to form a semiconductive material of the desired electrical properties and then coated with an electrode layer evaporated through

the grid openings so that it bridges the oxide layer and the mesh.

A typical target construction may comprise an NiO flake of 10^{13} ohm-centimeters resistivity one micron thick and an area of the order of 2 by 2 centimeters. This flake is provided with an electrode such as a .05 micron layer of platinum bright on its rear surface. The grid secured to the electrode 21 has a spacing about as small as the line pair resolution of the potential picture being scanned and the mesh element width is less than the line pair resolution. In a typical construction a 100-line per centimeter nickel electromesh having openings about 80 microns across separated by mesh elements about 20 microns wide is satisfactory.

The principal purpose of a stranded thermal sink is to prevent lateral heat flow in the target flake and thereby to improve thermal resolution. Thus, where an element A receives a greater intensity of infra-red radiation on its rear surface 23 than its neighboring element B and therefore is at a higher temperature than that element, the heat of element A which would ordinarily tend to flow to element B because of the thermal gradient existing between them is prevented from so doing by the high thermal gradient produced by strand 22 on the flake and electrode in the region intermediate the elements. Element B is thereby maintained at a temperature corresponding to the radiation received from its portion of the panorama and therefore its resistance accurately represents that quality of radiation.

Proper operation of the target construction requires that certain limits be placed thereon. As in any thermal sink the grid strands must have a high thermal capacity relative to that of the flake. This is achieved by employing a relatively large mass of material which conducts heat readily for the grid. The target material should have a resistivity of at least 10^8 ohm-centimeters and a high temperature coefficient of resistance so that only slight changes in the temperature of a target element will result in a substantial changes in its resistance. This resistance limitation is fixed by the lower limit of the electrical discharge time constant of the target, the product of the flake resistance and capacitance which is in turn fixed by the thermal time constant of the flake element. The electrical time constant should be such that the cooler portions of the target should lose approximately one-half the surface charge during a scanning interval. The electrical capacitance of the flake element is inversely proportional to its thickness while the heat capacity and resistance are directly proportional to its mass or thickness. The flake has a thermal time constant which is the product of its thermal capacity and thermal resistance, the reciprocal of its thermal conductance; this should be as low as practicable and is obtained by making the flake as thin as possible. The resulting electrical time constant is then considered in determining the scan rate employed.

The location of the strands of the thermal sink relative to the flake is also important. They obviously should be in good heat transfer relationship to the flake and thus should be in intimate contact with it, either on its electrode surface or embedded in it near the electrode surface. While the strands of the sink should be posi-

tioned close enough together to divide the flake surface into substantially independent thermal elements of suitable area for scanning they should not be positioned so close together that they provide a thermal screen for incoming radiation or cool the flake too rapidly. Therefore, the strands should be spaced at least several thicknesses apart.

It is to be understood that the above-described arrangements are illustrative of the application of the principles of the invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A thermally sensitive target having a high order of thermal resolution comprising a thin body of semiconductive material having a high temperature coefficient of resistance and a resistivity of at least 10^8 ohm-centimeters, one face of said body being arranged to receive infra-red radiation, and a plurality of strands having a relatively high thermal conductivity in intimate contact with said one face of said body, said strands being spaced several body thicknesses apart.
2. A thermally sensitive target having a high order of thermal resolution comprising a thin body of semiconductive material having a high temperature coefficient of resistance, a thin metal electrode layer on one major surface of said body, and a plurality of strands having a relatively high thermal conductivity in intimate contact with said electrode layer.
3. A thermally sensitive target having a high order of thermal resolution comprising a thin body of semiconductive material having a high temperature coefficient of resistance, and a plurality of heat sinks in intimate contact with a surface of said body at spaced intervals on said surface.
4. A thermally sensitive target having a high order of thermal resolution comprising a thin body of semiconductive material having a high temperature coefficient of resistance divided into a plurality of essentially thermally discrete elements.
5. A thermally sensitive target having a high order of thermal resolution comprising a thin body of semiconductive material having a high temperature coefficient of resistance and uniform electrical characteristics, and a grid composed of strands having a relatively high thermal conductivity in intimate contact with one face of said body.
6. A thermally sensitive target having a high order of thermal resolution comprising a body of semiconductive material having a high temperature coefficient of resistance and uniform electrical characteristics, said body having a thickness between the major faces of less than 10 microns, and a grid having a plurality of strands of relatively high thermal conductivity in intimate contact with one face of said body.
7. A thermally sensitive target having a high order of thermal resolution comprising nickel oxide semiconductive body of less than 10 microns thickness, an electrode layer on one major surface of said body, and a metallic grid in intimate contact with said electrode layer, said grid having openings several body thicknesses across.

No references cited.